ASSESSMENT OF SUSTAINABLE EFFICIENCY ON POTATO FARMS AT BAGHDAD GOVERNORATE

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ABSTRACT

This study aimed to evaluate the sustainable efficiency and calculate the sustainable value, opportunity cost and revenue to cost of potato production farms in Baghdad Governorate. Data were collected from a random sample of 102 spring potato producers in Baghdad governorate for the year 2022, the value-added function was estimated using three levels: economic (seeds and space), and social (education level), while environmental represented by (residual and volatile of nitrogen). Effective resources were calculated to extract the sustainability value- SV appeared on an average of 18023.15 thousand Iraqi dinars. Positive relationship with residual nitrogen and productivity, and Inverse relationship to the amount of volatile nitrogen. Whereas the average sustainable efficiency was 0.59% and has a positive relationship with productivity. The highest level of sustainable efficiency was achieved with the highest productivity of 7.4 tons/ donum, as well as residual nitrogen, where at its maximum quantity, the sustainable efficiency reached a maximum of 1.54%, although it was an inverse relationship to volatile nitrogen. The research found that, on average, the opportunity cost was 3.7 and the cost-benefit ratio was 1.09. The study concluded that as farming areas expand, the sustainable efficiency of farmers increases. It also recommended the optimal use of resources and expansion of areas to take advantage of mass production benefits. Additionally, the research emphasized the importance of using resources sustainably to avoid negative environmental impacts. This includes committing to specific dates and quantities when adding fertilizers and pesticides, as their impact on the environment is direct. Furthermore, the research highlighted the importance of participating in training courses to improve scientific knowledge and production performance.

Keywords: Value of sustainability, sustainability of capital, potato farms, volatile nitrogen.

***Post of M.Sc. thesis of 1st author.**

تقييم الكفاءة المستدامة في مزارع البطاطا في محافظة بغداد

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المستخلص

هدف البحث الى تقييم الكفاءة المستدامة وحساب القيمة المستدامة وتكلفة الفرصة البديلة والعائد على الكلفة لمزارع انتاج محصول البطاطا في محافظة بغداد، جمعت البيانات من عينة عشوائية بلغت 102 منتجا للبطاطا الربيعية في محافظة بغداد لسنة 2022، تم تقدير دالة القيمة المضافة باستخدام ثلاث أبعاد: اقتصادية تمثلت بالبذور والمساحة والاجتماعية (المستوى التعليمي) بينما البيئية تمثلت (النيتروجين المتبقي والمتطاير)، وبعد ذلك تم حساب الموارد الفعالة لاستخراج قيمة الاستدامة SV وظهرت بالمتوسط 18023.15 ألف دينار، وتناسبت طردياً مع النيتروجين المتبقي والإنتاجية، وتناسبت عكسياً مع كمية النيتروجين المتطاير. بينما بلغ متوسط الكفاءة المستدامة 0.59% وتناسب طردياً مع الإنتاجية، حيث ان اعلى مستوى للكفاءة المستدامة تحقق معه اعلى انتاجية بلغت 7.4 طن/ دونم، كذلك النيتروجين المتبقي حيث عند اقصى كمية له بلغت الكفاءة المستدامة أقصاها 1.54% بينما تناسبت عكسياً مع النيتروجين المتطاير. بلغت تكلفة الفرصة البديلة 3.7 بالمتوسط، وبلغ معيار نسبة العائد على التكلفة نحو 1.09 بالمتوسط. استنتج البحث انه بتوسع المساحات تزداد الكفاءة المستدامة للمزارعين، وأوصى البحث بضرورة استخدام الموارد بالشكل الأمثل والتوسع بالمساحات للاستفادة من مزايا الإنتاج الواسع واستخدام الموارد بشكل مستدام الذي يأخذ بنظر الاعتبار عدم التأثير على البيئة والالتزام بمواعيد وكميات إضافة الأسمدة والمبيدات لان تأثيرها مباشر على البيئة والاشتراك بالدورات التدريبية التي ترفع من المستوى العلمي والاداء الانتاجي.

الكلمات المفتاحية: قيمة الاستدامة، استدامة رأس المال، الفرصة البديلة ، النيتروجين المتطاير.

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INTRODUCTION

Sustainability has become the emerging goal of countries, companies and individuals Sustainability is not a short-term problem; it is a long-term issue, posing problems of intergenerational equality. It also needs efficiency and effective use of energy, natural, physical and information resources. Economic sustainability is generally seen as economic feasibility, whether agriculture has to endure in the long term in a changing economy. Changes in the economic context may be significant, in output prices, inputs, returns, quantities of production, support and organization (31). It can be understood that the farmer is linked to continuity during his career (across generations) which means the ability of the farm to move forward. Economic feasibility is mainly measured by profitability, liquidity, stability and productivity. Profitability here is calculated by comparing revenue and cost, either in the form of differences or ratios or quoted by income variables. Liquidity measures the availability of cash to meet immediate and short-term obligations, and stability is usually measured by the share and evolution of equity capital. Productivity is a measure of the ability of factors to generate output and is generally measured as a partial or total productivity indicator, as well as by other measures such as total resource productivity and technical efficiency. These indicators of profitability and productivity are quantitative. However, economic sustainability is rarely used as benchmarks are rarely used, as they usually extend beyond these indicators (6). For this, a wide range of indicators for farming systems associated with sustainability has been proposed. Because the transformation or application of sustainability requires looking at ecological and economic indicators. In other words, we need a deeper look at economic, social and environmental indicators. In general, the main indicators of sustainable agriculture are economic, environmental and social (7). Assessing sustainability through sustainable value and sustainable efficiency is a method developed to cover all these indicators by (10) and (29) and then applied by Ang et al. in Europe. Later, the basic concept of SV used the difference between actual resource utilization productivity and standard resource productivity values. It is used to measure sustainability at the farm level Sustainability has historically relied on continuous productivity over a long time. Over the past decades, sustainability has become a variable that needs to be analyzed and measured because sustainable agriculture is critical in developing countries, especially since economic and natural resources are limited and the lack of technology requires increased agricultural production to meet the growing demands of the population. Thus, sustainability is important in agricultural production (26), especially food crops. It can be said that sustainability is a useful tool for evaluation, complex and ambiguous at times, or an elusive concept that may be difficult to communicate to the public and policymakers (8). Therefore, sustainability is a multifunctional concept and therefore it is not easy to assess, but assessing the sustainability of agricultural systems is a challenge because it often mixes multiple dimensions, measures and criteria, and it is addressed by the study of sustainability efficiency by a large number of researchers, including (10) Applying a methodology to measure the cost of capital sustainability and creating sustainable value for companies, he presented in this research a theoretical explanation of how to calculate the SV and SE where the value of sustainability amounted to -72373 The research found that the reallocation of capital, can help producers make the use of capital more sustainable. (29) assessed the sustainable value of farms using parametric efficiency criteria, it combines the sustainable value method SV and parametric efficiency standards using four resources. It was noted that there is a difference between the amount of actual and effective resources that the sustainable efficiency amounted to 0.80 and that the value of sustainability improved slightly during the study period where it amounted to -140,000. As well as, (23) compared the concepts of measuring sustainability, namely (sustainability value, data envelope, and indicators). The research used production, labour, capital, energy, three main nutrients and area, while the outputs were represented by the net added value of the farm and the added value ranged between (400-1200) €/ha UAA Sustainable Value -4,200, 0.86, 0.61, 4.62, 29. The research concluded that sustainability is mainly a method based on the national or global level. While (17) studied the sustainable value of vulnerable soils in China, this study used data envelope analysis (DEA) and set criteria to compare the sustainability of different agricultural systems and crop techniques, SV was calculated which measures the opportunity cost of each form of invested capital and the sustainable efficiency was 0.67 The study concluded that one of the main challenges in measuring sustainability is to determine how to compare market (such as profit) and non-market (such as environmental degradation) effects. In addition, (3) theoretically studied the relationship between efficiency and sustainability, the main objective of the paper was to identify and analyze key criteria that allow clarifying the relationship between the concepts of sustainability and efficiency. In light of this, there are some difficulties when trying to apply Clear theories about sustainability in practical activities to maintain or increase economic efficiency at the micro and macroeconomic levels, including factor 4 theory, factor 10 theory, and environmental efficiency. While (30) aimed to analyze the sustainability of rice cultivation using the sustainable value method, which depends on economic efficiency in the use of agricultural resources, the economic efficiency reached an average of 0.29 and the results also indicated that the value of sustainability is distributed in rice farms between $7089 in the rainy season and $7.924 in the dry season and there is a significant difference between the actual sustainability values. As well as, (19) measured sustainability in agriculture, social indicators related to sustainability typically cover two main themes: sustainability related to the agricultural community and sustainability related to society as a whole. However, measuring these social indicators is difficult because they are often qualitative and therefore can be considered personally. While (9) studied the determinants of sustainable efficiency of rice cultivation in Thailand, based on data that the sustainability efficiency of the sample was 0.84, which is higher in large holdings than small and medium holdings, indicating that farmers are less efficient than the opportunity cost of all forms of capital used in rice cultivation, and it was also found that 66% of the sample is sustainable. And (14) measured sustainability efficiency using the data envelope analysis method in two stages from a sample consisting of 20 countries, The results indicated inequality between the countries examined, where the values of sustainability efficiency ranged between 0.460 in Germany and 0.991 in Portugal, and it turned out that high levels of production efficiency in a particular country do not reflect high environmental efficiency performance. Also, (25) Analysis of environmental efficiency based on the sustainable development goals of the wheat crop in Iran. The research used a combination of environmental life cycle assessment and data envelope analysis to calculate environmental efficiency, the results showed that 27 farms (16% of the sample) achieved environmental efficiency and the rest are environmentally inefficient due to wasteful use of resources and the research emphasizes improving environmental performance through the optimal use of resources in wheat production. As well as (12) evaluate the environmental efficiency in farm management and linking it to the sustainability of the wheat crop in Turkey The researcher used data envelope analysis (DEA) to find out the potential areas for improving efficiency and it became clear from the results that only about 50% of wheat farms were working under efficiency conditions and the research stressed the issue of increasing efficiency by reducing inputs that affect production and thus affect environmental efficiency as well as (5,13,20) studies. The problem with the research is that the improper use of production inputs, especially water and land, as well as the effects of climate change represented by desertification, water scarcity and high temperatures, have made there a risk that these resources will not remain at current levels and will become insufficient for sustainability requirements. In addition to the fact that our farmers are not sustainable in their practices and did not follow sustainability practices, along with the lack of use of technology and the high costs of production inputs made the failure to use resources in optimal quantities and this threatens the value of sustainability and efficiency in these farms. Because sustainability is the state in which productive resources are managed without waste or deficit to preserve them for subsequent generations, this research aimed to assess the sustainability of potato cultivation by measuring the value and efficiency of sustainability to know the effective use of economic resources and to know the impact of economic, social and administrative characteristics on the efficiency of sustainability to enhance sustainability, on top of estimating the opportunity cost of capital to know if the capital used is sustainable or not, to help producers make the use of capital more sustainable.

MATERIALS AND METHODS

The research relied on the preliminary data obtained from its field sources as a random sample of 102 in Baghdad Governorate Farm which represents about 7% of the total farms for spring potato producers for the year 2022, through a questionnaire form, and a sample of the soil of each farmer was analyzed and the amount of residual nitrogen and the amount of volatile nitrogen was calculated, and then by estimating the added value function and some indicators, calculating effective resources, estimating sustainable value, and through them sustainable efficiency, and then calculating some criteria as opportunity cost alternative, spread value and return on cost criterion.

RESULTS AND DISCUSSION

Measuring the efficiency of sustainability

First: Sustainable value

To measure sustainable efficiency, some of its components must be estimated through multiple stages, as the production function is estimated using the parametric analysis, and the function is as follows (10):

$$ln(y_{it}) = f(x_{it}, \beta) + v_{it} - u_{it}$$

y_{it}: production quantity.

x_{it}: Resources involved in the production process.

β: Parameters.

v_i - u_i: Random error.

The effective amount can be as follows:

$$x_i^{efficient} = g(y_i, x_1, \dots, x_n, u_i)$$

We model environmental assets as traditional inputs rather than being undesirable, as this fits perfectly with a sustainable value approach. The second reason (also somewhat practical) is the fact that the use of environmentally harmful inputs is easy to measure (e.g., increased nitrogen use), so we define random production limits as (29):

$$ln(VA_i) = f(x_i, z_i, \beta) + v_i - u_i$$

Where: VA is value-added, X is traditional inputs, and Z is environmental and social inputs.

Therefore, the effective expression of x_i and z_i can be expressed by:

$$x_i^{efficient} = g(VA_i, x_1, \dots, x_n, z_1, \dots\dots z_n, u_i)$$

$$z_i^{efficient} = g(VA_i, x_1, \dots, x_n, z_1, \dots\dots z_n, u_i)$$

It may be difficult to distinguish between traditional economic inputs (x) and environmental and social (29), so we assume that they all contribute to the production of added value in the sustainability system, so the term r resources that includes economic, environmental, forms of social capital (and aspects derived from capital) was introduced in the following form:

$$r_i^{efficient} = g(VA_i, r_1, \dots, r_n, u_i)$$

The sustainable value of a farm with different resources is calculated as follows:

It stands for a resource (economic, environmental and social) of farm r_i, VA_i for the added value of farm i, using efficiency analysis and as follows:

Therefore, we need to estimate the VAT equation which is calculated from the following law (1):

$$\left(\frac{VA}{r}\right)_{benchmark} = \frac{VA_i}{r_i^{efficient}} = \frac{VA_i}{g(VA_i, r_1, \dots, r_n, u_i)}$$

$$\text{sustainable value}_i = \frac{1}{n}\sum_{s=1}^{n} r_i \times \left[\left(\frac{VA}{r}\right)_i - \left(\frac{VA}{r}\right)_{benchmark}\right]$$

$$VA = TR - TD$$

Where**:**

TR: revenue that can be obtained from the product of the quantity and price of production.

TD: Direct costs of the project.

The added value was considered a dependent factor and some economic, social and environmental resources were introduced as independent factors according to the following function:

$$Ln\,VA_i = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + V_i - U_i$$

Whereas:

VA: The approved variable represents the added value (one thousand dinars).
β_0: fixed term.
β_s: parameters.
X_M: Independent variables include: X_1 area (donum), X_2: seeds (kg), X_3: education level, X_4: amount of residual nitrogen (kg $^{h-1}$), X_5: amount of volatile nitrogen (kg $^{h-1}$).
V_i - U_i: random error.
Using the Eviews12 program, the value-added function was estimated and Table(1). shows its results.

Table 1. Value-added function.

Dependent Variable: LAV
Method: Least Squares
Date: 05/31/24 Time: 20:18
Sample: 1 102
Included observations: 94

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.03422	1.419153	7.070570	0.0000
LX1	0.707417	0.161458	4.381421	0.0000
LX2	0.398741	0.143926	2.770461	0.0068
LX3	-0.114172	0.121951	-0.936213	0.3517
LN1	0.412964	0.242313	1.704256	0.0919
LN2	-0.018372	0.009709	-1.892352	0.0617

R-squared	0.814933	Mean dependent var	16.16302
Adjusted R-squared	0.804418	S.D. dependent var	1.375037
S.E. of regression	0.608106	Akaike info criterion	1.904766
Sum squared resid	32.54177	Schwarz criterion	2.067104
Log likelihood	-83.52401	Hannan-Quinn criter.	1.970339
F-statistic	77.50064	Durbin-Watson stat	1.881425
Prob(F-statistic)	0.000000		

Source: By authors using Eviews 12.

Although the purpose of estimating the value-added function is to obtain the parameters of calculating effective resources (r_1, r_2, r_3, r_4, r_5), we will go through its impact briefly, the inputs (seeds and area) had a positive and significant effect, and this means that when the inputs increase, the output and value-added will increase, as by increasing seeds and area by 1%, the added value will increase by (0.7, 0.39%) respectively, while the inputs (educational level) had a negative impact and this may contradict the economic logic that assumes the positive relationship between educational level and value. But it may correspond to reality as learners may have little experience or consider agriculture a less important project due to their scientific qualifications, and it turns out that increasing the educational level by 1% will reduce the value added by 0.11% and we see that it is possible when increasing the educational level may turn the farmer to the government job more than to work in agriculture. While the environmental inputs (residual and volatile nitrogen) came by the technical logic that assumes that when increasing the remaining nitrogen, the added value will increase taking advantage of the amount of nitrogen added and remaining in the soil from the previous season, and therefore when the remaining nitrogen is increased by 1%, the added value will increase by 0.41%, as well as when the volatile nitrogen is increased by 1%, the added value will decrease by 0.01%, because the increase in volatile nitrogen means on the other hand a decrease in the amount absorbed from the plant, as well as environmental effects. The two variables were significant at the level of 10%, either statistically, these inputs (environmental, economic and social) explained 81% of the variables in the value added and the remaining 19% is due to other variables not included in the model, which are many, especially since the dependent factor a large part of it depends on the price of output and the cost of the variable resource, and these variables are characterized by fluctuations and depend on market conditions and many other factors, and the model through the value of F is significant at the level of 1% and this confirms the realism The function on the one hand and the importance of the variables involved in the function on the other hand. After obtaining the parameters from the value-added function in Table 1. we calculate effective resources by the following laws:

$$r_{i1}^{\text{efficient}} = \exp\left[\frac{-(b_1+b_2) \pm \sqrt{(b_1+b_2)^2 - 4\left\{-\ln \widetilde{\mathrm{VA}}_i + b_0 - (b_2+b_5)\ln(k_i) + b_4(\ln k_i)^2\right\}\left\{b_3+b_4+b_5\right\}}}{2(b_3+b_4+b_5)}\right]$$

$$r_{i2}^{\text{efficient}} = \exp\left[\frac{-(b_1+b_2) \pm \sqrt{(b_1+b_2)^2 - 4\left\{-\ln \widetilde{\mathrm{VA}}_i + b_0 + (b_1+b_5)\ln(k_i) + b_3(\ln k_i)^2\right\}\left\{b_3+b_4+b_5\right\}}}{2(b_3+b_4+b_5)}\right]$$

Table 2. Effective economic, social and environmental resources

$r^{efficient}$	MIX	MIN	MEN
r_1	**5.34**	**0.85**	**3.16**
r_2	**5.12**	**0.63**	**2.96**
r_3	**5.27**	**0.78**	**3.08**
r_4	**5.73**	**1.00**	**3.36**
r_5	**11.0**	**1.00**	**8.80**

Source: Authors calculation.

It is clear from Table (2). that the highest value of r_1 for the seed variable was 5.34% and the lowest value was 0.85%, while the average was 3.16%, while for r_2 for the area variable, the average was 2.96%, ranging between a minimum of 0.63% and a maximum of 5.12%, while r_3 for the educational level variable had a maximum value of 5.27% and the lowest value was 0.78% with an average of 3.08%, while r_4 And r_5 for environmental variables, which were represented by residual and volatile nitrogen, reached a minimum of 1.00%, while the maximum limits were 5.73%, 11.0%, respectively, while the average for them was 3.36%, 8.80%, respectively, and through this the efficiency of use of the variables is calculated, as shown in Table 3, where the efficiency of using the area resource appeared 1% and it is considered a very low efficiency, and this efficiency is according to the effective resource and differs from the types of efficiency that were previously estimated and estimated later, which refers to not to use the area optimally, which means the possibility of maximizing the output with an area less than the cultivated, either the efficiency of using seeds was 47%, and the seed resource is a very important resource that contributes significantly to maximizing the output and then the added value, while the educational level reached its efficiency of 23%, either the efficiency of the remaining and volatile nitrogen 4% and 19%.

Table 3. Actual, effective and efficient use of resources

Resources	Actual usage	Effective use	Efficiency of use
Area	**13.3**	**3.1**	**0.01**
Seeds	**6.30**	**2.96**	**0.47**
Level of education	**2.22**	**3**	**0.23**
Residual nitrogen	**74.67**	**3.3**	**0.04**
Volatile nitrogen	**45.12**	**8.8**	**0.19**

Source: By authors based on effective resources calculation.

From it, the sustainable value is extracted:
The sustainability value was calculated using the following criterion:

$$\text{sustainable value}_i = \frac{1}{2}\left\langle r_{i1} \times \left[\left(\frac{\widetilde{\mathrm{VA}}_i}{r_{i1}}\right) - \left(\frac{\widetilde{\mathrm{VA}}_i}{\left[\widetilde{\mathrm{VA}}_i \times \exp(-b_0) \times k_i^{b_2}\right]^{\frac{1}{(b_1+b_2)}}}\right)\right] + r_{i2} \times \left[\left(\frac{\widetilde{\mathrm{VA}}_i}{r_{i2}}\right) - \left(\frac{\widetilde{\mathrm{VA}}_i}{\left[\widetilde{\mathrm{VA}}_i \times \exp(-b_0) \times k_i^{-b_1}\right]^{\frac{1}{(b_1+b_2)}}}\right)\right]\right\rangle$$

Sustainable value is one of the processes used by project managers to determine the extent to which sustainable development can be achieved. Sustainable value attempts to link performance to the use of different resources. This approach assesses contributions to farm sustainability by comparing farm resource productivity to resource productivity (4), and this is for all resources that are used to calculate the value of sustainable efficiency. Sustainable value also means the need to conserve resources to achieve a higher return and to know which farms create greater value using economic and environmental resources. Future decisions, decision-makers and policymakers depend on sustainable value, as it requires the policymaker to choose between several options (22), it is important in terms of sustainable development to choose the option that increases the sustainable value of the farm, sector or region, and as shown in Table 4, sustainability values have fluctuated in the study sample from one farm to another according to productivity, economic, social and environmental conditions, as we note that the average sustainable value reached 18023.15 thousand dinars, and this indicates the good level of the sample and that it achieved sustainability in terms of value and that it achieved a higher revenue, fluctuating between a minimum of -1126.58 thousand dinars at farm No. 49 and a maximum of 90496 thousand dinars at farm 80, and it must be noted that there are 5 farms that have achieved negative sustainability values and this indicates that they are unsustainable in terms of value, and this means that their use of resources has been inefficient.

Table 4. Sustainable Value (SV) Thousand Dinars for Sample Farmers

Firm	SV	Firm	SV	Firm	SV	Firm	SV	Firm	SV
1	509.00	21	1965.00	41	-406.23	61	16345.85	81	46869.00
2	5274.00	22	2429.00	42	-103.48	62	18792.57	82	51876.00
3	7614.00	23	9040.00	43	10355.35	63	38993.98	83	34936.00
4	8409.00	24	1389.00	44	5480.06	64	26330.00	84	78461.00
5	3476.00	25	7796.00	45	45812.94	65	2362.00	85	76614.00
6	8870.00	26	2231.00	46	28307.34	66	1851.00	86	10846.00
7	3918.00	27	1156.00	47	14747.02	67	5838.00	87	84132.00
8	6532.00	28	6296.00	48	14765.69	68	5500.00	88	3393.00
9	8505.00	29	2203.00	49	-1126.58	69	4972.00	89	13968.00
10	4361.00	30	1531.00	50	6195.57	70	3265.00	90	66386.00
11	1031.00	31	1252.00	51	27375.90	71	5267.00	91	87704.00
12	6457.00	32	-625.00	52	27779.52	72	1468.00	92	89017.00
13	5794.00	33	2563.00	53	3993.73	73	3283.00	93	62887.00
14	1283.00	34	1239.00	54	29926.51	74	5033.00	94	14160.00
15	1119.00	35	6748.00	55	13597.85	75	3328.00	95	25389.00
16	3911.00	36	1666.00	56	4960.80	76	4511.00	96	2924.15
17	4101.00	37	32798.50	57	9196.48	77	4044.00	97	15145.00
18	9773.00	38	10832.78	58	45631.53	78	4496.00	98	6692.00
19	7560.00	39	23725.58	59	16320.50	79	7634.00	99	46576.00
20	3340.00	40	15691.78	60	32853.47	80	90496.00	100	21233.00
18023.15		MEN		90496.00			MAX	101	90245.00
				-1126.58			MIN	102	85669.00

Source: By authors based on the results of value calculations.

Sustainable value and productivity relationship: To understand the relationship between sustainable value and productivity, the sustainable value was divided into multiple categories, starting from the lowest value -1100 _ 4100 and ending with the highest value of 30101 and it was shown in Figure 1. that there is a strong and direct relationship between sustainable value and productivity, as we note at the level of productivity 6.2 tons/ donum, the sustainable value was -1100 _4100 and with the increase in productivity levels to 6.3 tons/ donum. The level of sustainable value gradually increased with the increase in productivity, as it is observed that the highest level of productivity of 6.9 tons / donum has become a sustainable value at a maximum of 30101 or more and high productivity means higher added value and therefore higher sustainable value.

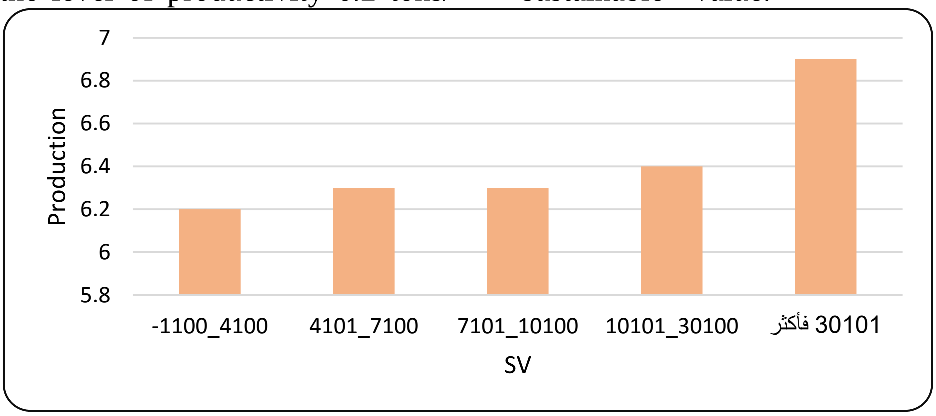

Figure 1. The relationship between sustainable value and productivity

Source: Researchers' work based on Table 4

Relationship of sustainable average value with residual and volatile nitrogen : The sustainable value is affected by the level of residual nitrogen in the soil because whenever there is a percentage of nitrogen remaining in the soil, this means that the plant will benefit from it and increase its absorption and thus increase production and then increase the added value, which when increased improves the sustainable value and from Table 5. and Figure 2. to illustrate this effect The relationship between residual nitrogen and sustainable value has been clarified and observed at low levels of residual nitrogen 41-60 kg^{h-1} The sustainable value reached 1628.94 thousand dinars and with the increase in nitrogen levels, the sustainable value improved, and at the maximum nitrogen level of 91 kg $^{h-1}$ or more, it amounted to 70173.00 thousand dinars, as well as the sustainable value was also linked with volatile nitrogen to know its impact on the sustainable value and it was found that there is an inverse relationship between sustainable value and volatile nitrogen, as with the increase in volatile nitrogen, this means a decrease in the amount absorbed from the plant as well as its environmental repercussions, which reflects negatively on the plant and therefore on the quantity of production and on the sustainable value, where we note from Table (6) Figure 3. at the minimum levels of volatile nitrogen 20 - 40 kg^{h-1}, the sustainable value reached a maximum of 11111.38 thousand dinars, and with the increase in volatile nitrogen, the sustainable value decreased, as at the maximum level of volatile nitrogen 81 kg $^{h-1}$ and more, the sustainable value was low, reaching about 3137.49 thousand dinars.

Table 5. The relationship between sustainable value averages and residual and volatile nitrogen.

Average sustainable value (thousand dinars)	Volatile nitrogen levels (kg $^{h-1}$)	Average sustainable value (thousand dinars)	Residual nitrogen levels (kg $^{h-1}$)
11111.38	**20-40**	**1628.94**	**41-60**
5653.01	**41-60**	**5993.65**	**61-80**
3412.16	**61-80**	**21422.08**	**81-90**
3137.49	**More than 80**	**70173.00**	**More than 90**

Source: The work of the researchers based on Table 4 and the results of soil analysis.

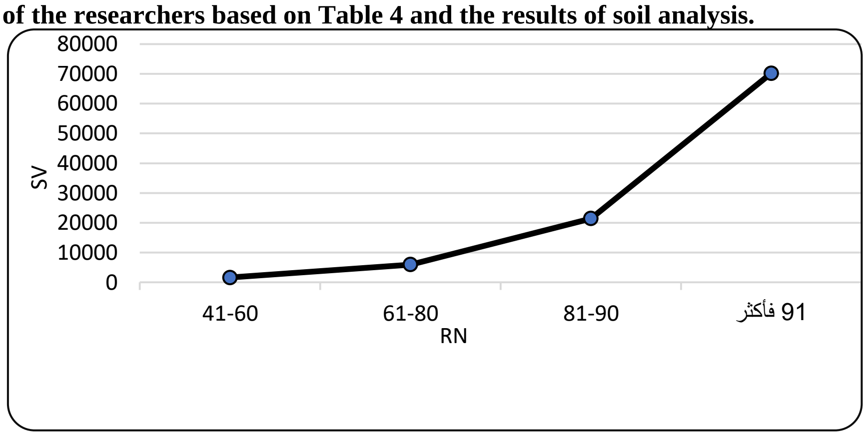

Figure 2. The relationship of sustainability value with residual nitrogen

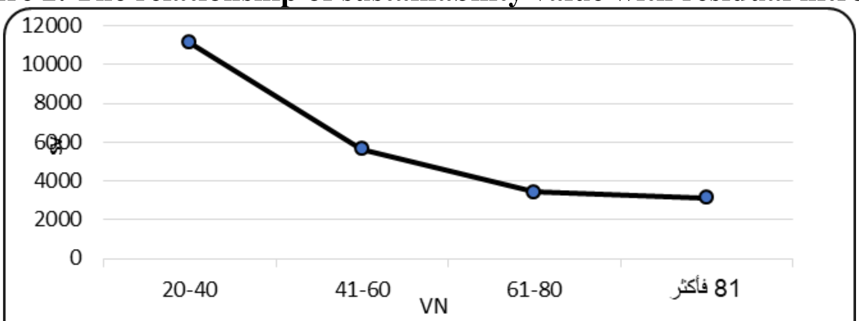

Figure 3: The relationship of sustainability value with volatile nitrogen

Source: By authors based on Table 5.

The relationship between sustainable value and the size of the farm: Sustainable value is clearly affected by the size of the farm because the size of the farm affects in one way or another the level of efficiency of resource use because it is assumed that with the increase in the size of the farm efficiency will improve and the use of resources will be better taking advantage of the advantages of large production and economies of scale and economies of capacity as with the expansion of tenure can benefit from the volume of family work and fixed assets and thus operate mechanical or manual work on a larger area and thus improve the level of production based on the above and all this it is reflected in the sustainable value and to clarify these effects, the relationship between sustainable value and the size of the holdings was clarified, as it is noted from Table 8. that the few tenure groups 1-10 donums were of low sustainable value, and with the increase in tenure and the sustainable value improved, the sustainable value became 44582.18 thousand dinars when the size of the farm exceeded 11 donums and the sustainable value became the maximum possible 63992.40 thousand dinars at the size of 21- 30 donums, and this means that farms with large sizes It is the most sustainable, but to a certain extent, where we notice when the category of 31 donums or more, it decreased to 34225.91 thousand dinars, and this means that the optimal volume of production is 30 donums, and then the sustainable value begins to decline due to poor administrative viability, poor division of labour and lack of sufficient funding, which makes the needs of these sizes of resources greater than the viability of the product, which leads to a decrease in added value.

Table 6. The relationship between sustainable average value and cultivated area

Area Categories	No. of farmers	Sustainable Average Value
1_10 Donum	77	9428.54
11_20 Donum	10	44582.18
21_30 Donum	6	63992.40
31 and more	9	34225.91

Source: Researchers' work based on Table 4 and questionnaire.

Second: Sustainable efficiency : After estimating the added value and calculating the sustainable value, the sustainable efficiency is calculated as follows:

Sustainable efficiency was obtained by linking the added value with the sustainability value that was previously extracted (10):

$$\textbf{sustainable efficiency} = \frac{\textbf{value added}_i}{\textbf{value added}_i - \textbf{Sustainable value}_i}$$

Among the main objectives that must be taken into account when producing crops is the use of safe and environmentally friendly production methods and the provision of high-quality production that meets the requirements of consumers, sustainability is seen as an essential element towards a profitable long-term future for agriculture and rural areas (20). Therefore, many researchers have been interested in the subject of studying sustainable efficiency as it works to clarify the extent to which farmers are sustainable and achieve sustainable value through the optimal use of resources, taking into account the lack of impact of this use on the environment, sustainable efficiency expresses the efficiency of farmers' use of the environmental, economic and social resources they need for their production (16), is an indicator of the behaviour of farmers in the use of their inputs, this indicator is suitable for both economic and environmental resources in fact, as can be seen from Table 7, the values of sustainable efficiency ranged between a minimum of -3.84% and a maximum of 4.45%. as we note, negative values of sustainable efficiency and positive values appeared between them values less than one where the reason for the existence of values less than one is due to negative sustainability values, which are one of the most important components of sustainable efficiency, where sustainable efficiency values depend on sustainable value, that is, when the sustainable value is negative, efficiency appears less than one, and this is consistent with the findings of the researcher Hou, Passel, Triyono, where 4 farms achieved values less than one (farm 32, 41, 42, 49) The average efficiency for them was 0.72%, while the negative values of sustainable efficiency were 26 farms, the average it has -1.35 %, and this means that farmers are inefficient and unsustainable, and there is a waste in the use of resources and not using them optimally, with an impact on the environment due to their use, for example, more quantities of fertilizers, which of course negatively affect the environment, while farms that achieved positive values for sustainable efficiency were 72 out of 102 farms, where the average sustainable efficiency was 1.28%, and this means that farmers are efficient and use resources optimally with coverage of the costs of Production and production higher and therefore higher added value and higher sustainable value taking into account the impact of resource use on the environment and it can be said that most farmers were sustainable and their sustainable efficiency was good.

Table 7. Sustainable efficiency (SE) of sample farmers.

Firm	SE	Firm	SE	Firm	SE	Firm	SE	Firm	SE
1	-2.42	21	-1.25	41	0.73	61	1.28	81	1.19
2	-1.54	22	-1.30	42	0.99	62	1.29	82	1.25
3	-1.15	23	-1.00	43	1.25	63	1.26	83	1.22
4	-1.05	24	-1.30	44	1.20	64	1.30	84	1.24
5	-2.31	25	-1.00	45	1.30	65	1.29	85	1.25
6	-0.85	26	-3.84	46	1.27	66	1.23	86	1.27
7	-1.17	27	1.26	47	1.00	67	1.29	87	1.22
8	-0.94	28	1.22	48	1.06	68	1.27	88	1.24
9	-0.85	29	1.30	49	0.93	69	1.28	89	1.28
10	-1.18	30	1.12	50	1.12	70	1.25	90	1.22
11	-1.25	31	1.30	51	1.27	71	1.28	91	1.26
12	-0.93	32	0.21	52	1.31	72	1.19	92	1.19
13	-1.01	33	1.16	53	1.01	73	1.24	93	1.14
14	-1.29	34	1.29	54	1.28	74	1.23	94	1.22
15	-1.31	35	1.23	55	1.21	75	1.20	95	1.29
16	-0.79	36	1.28	56	1.23	76	1.24	96	1.53
17	-1.19	37	1.27	57	1.15	77	4.45	97	1.28
18	-0.85	38	1.28	58	1.30	78	1.22	98	1.11
19	-1.09	39	1.29	59	1.22	79	1.24	99	1.29
20	-2.26	40	1.28	60	1.30	80	1.28	100	1.17
0.59	MEN			4.45		MAX		101	1.22
				-3.84		MIN		102	1.21

Source: By authors based on sustainable competency calculations.

The relationship of sustainable efficiency with productivity and residual and volatile nitrogen: To clarify the relationship between sustainable efficiency and productivity, the values of sustainable efficiency were divided into multiple levels, starting from the lowest level -1.20% and ending with the highest level of 1.54%, and it was shown from Table 10. that there is a strong and positive relationship between sustainable efficiency and productivity, as we note when productivity was 5.2 tons/ donum, sustainable efficiency reached about -1.20%, and with the increase in productivity, we note a rise in sustainable efficiency to 5.7 tons of donum, due to the increase in productivity leads to an increase in value added and therefore sustainable value and sustainable efficiency, then sustainable efficiency gradually increased with the increase in productivity, as it is noted at the maximum level of productivity of 7.4 tons / donum, sustainable efficiency has become at its highest average of 1.54%, and nitrogen, which is one of the most important components of fertilizers that are used to meet the need of agricultural crops, is one of the most important influences on the environment in all its forms, whether remaining in the soil or volatile in the atmosphere (28). We notice from Table (8) . that there is a positive relationship between sustainable efficiency with residual nitrogen in the soil, where at the lowest level of residual nitrogen 51.54 kg $^{h-1}$, the sustainable efficiency reached its lowest value of -1.20 %, while at the highest value of residual nitrogen of 98.86 kg $^{h-1}$, the sustainable efficiency reached its maximum value of 1.54%, as the more nitrogen remaining in the soil from the previous season, the greater the benefit of the current crop and thus increases. Productivity increases the added value and thus sustainable value and sustainable efficiency, either the relationship between sustainable efficiency and volatile nitrogen to the air was inverse, as the higher the level of volatile nitrogen, the lower the productivity and thus the added value and sustainable value, which is one of the most important components of sustainable efficiency, where at the highest level of volatile nitrogen of 48.38 kg $^{h-1,}$ sustainable efficiency reached its lowest level of -1.20 sustainable efficiency was peaked at 1.54% at the lowest volatile nitrogen level of 41.03 kg $^{h-1}$.

Table 8. The relationship of average sustainable efficiency with productivity and residual and volatile nitrogen.

SE	Productivity ton/ donum	Residual nitrogen kg $^{h-1}$	Volatile nitrogen kg $^{h-1}$
-1.20	5.2	51.54	48.38
1.16	5.7	66.72	46.40
1.27	7.3	80.33	46.21
1.54	7.4	98.86	41.03

Source: By authors based on Table 7, questionnaire form and soil analysis.

The relationship of sustainable efficiency with space: Sustainable efficiency is affected by the size of the holding, as we note in Table (9) when increasing the volume of tenure, sustainable efficiency increased with it, whereas when the small group, which ranges between 1-10 donums, the average sustainable efficiency was about 0.38%, which is less than one, and this means that there is no optimal use of resources and lack of interest in the environmental aspect, and thus a decrease in productivity, added value, sustainable value and sustainable efficiency, and then the value of sustainable efficiency improved with the expansion of the size of the holding, where it reached The category of 31 donums and more reached a maximum sustainable efficiency of 1.26%.

Table 9. The relationship between sustainable efficiency and cultivated area.

Area Categories	No. of farmers	SE
1_10 Donum	77	0.38
11_20 Donum	10	1.24
21_30 Donum	6	1.22
31 and more	9	1.26

Source: By authors based on Table 7 and the questionnaire.

Sustainable efficiency, technical efficiency and sustainable value :Sustainable efficiency is defined as the ability of the enterprise to maximize the output or service in light of the range of available resources and is one of the important indicators by which it is possible to identify the efficiency of management in directing various economic resources (11). It is a relationship between inputs and outputs amounting to an average of 63% between a minimum of 21% and a maximum of 99% and the importance of the size of farms has been linked to technical efficiency, and it turns out that technical efficiency increased with the expansion of the volume of tenure and this is due to the optimal exploitation of spaces and resources, which gives higher production and thus higher profit, either sustainable efficiency, which means the efficiency of farmers' use of environmental, economic and social resources and the establishment of a balance between resources (21), It is concerned with the environmental aspect of the rest of the types of efficiency and the impact of resources on the environment amounted to an average of 59% between a minimum of -3.84 % and a maximum of 4.45% and agreed with the technical efficiency in terms of expansion of areas leads to an increase in technical efficiency as well as sustainable efficiency, despite the difference in how both technical and sustainable efficiency is calculated, as we note from Table (9) that it increased with the expansion of the sizes of holdings, where at the largest category of areas 31 donum or more, a maximum of 1.26% and returns this is to optimize the exploitation of resources and benefit from large production, which leads to an increase in added value and thus sustainable value, which is the most important component of sustainable efficiency, while sustainable value, which expresses the efficiency of resource use for a particular economic unit, which amounted to an average of 18023.15 thousand dinars between a minimum of -1126.58 thousand dinars and a maximum of 90496 thousand dinars agreed with technical and sustainable efficiency in terms of expanding the area leads to an increase in sustainable value in categories less than 31 donums or more where it increased with the expansion of the area, but to a certain extent, where the areas of 31 donums or more, the sustainable value decreased to 34225.91 thousand dinars, as shown in Table (10) . In general, sustainable efficiency, technology and sustainable value depend entirely on the management of resources and their optimal use, whether economic, environmental or social resources.

Table 10. Sustainable efficiency, technical efficiency and sustainable value

Area Categories	TE	SE	SV
1_10 Donum	0.54	0.38	9428.54
11_20 Donum	0.85	1.24	44582.18
21_30 Donum	0.94	1.22	63992.40
31 and more	0.98	1.26	34225.91

Source: By authors based on previous tables.

Third: Opportunity cost of capital and spread value Standard rate of return on cost: Opportunity cost criterion: Opportunity costs refer to the value that could have been created through the use of alternative capital in financial markets, opportunity cost of capital CC can be determined by equation (10):

$$CC = \frac{VC^M}{CE^M}$$

Where:
VC^M: Value created in the market that can be expressed in terms of (return on capital, market profit, cash flow).
CE^M: Capital.
Whenever the value of this criterion is greater than one, the project is economically, socially and environmentally feasible, meaning that it achieves lower costs and higher profit, as in Table 13. and according to the size of the areas, as we note that with the increase in sizes, the value of the criterion increases, as it reached at the category of small areas 2.05%, while at large areas, the standard reached its maximum value of 5.05%, and this means that the project is good and there is no need to transfer capital to the financial markets. As for the spread value criterion: The cost of capital can be subtracted from the company's return on capital The result is called the spread of value by subtracting the cost of capital from the return from the farm capital The result is called the spread of value (Value Spread) The spread of value shows the amount of value created per unit of capital used (18):

$$VS = \frac{VC^C}{CE^C} - \frac{VC^M}{CE^M}$$

Whereas:
VC^C: The value created by the farm.
EC^C: The amount of capital used by the farm.
VC^M: Value created in the market that can be expressed in terms of (return on capital, market profit and cash flow).
CE^M: Capital.
As well in this criterion, whenever it is greater than one, the project is good, it agrees with the opportunity cost criterion in terms of the high value of the standard when large areas, where the standard in small areas reached 1.22% and its highest value at large areas was 26.2%, and this means that the project is good and that the added value established by the farm was relatively good, as shown in Table (10). The ratio of return to cost: It is considered one of the most important criteria to know the extent of optimal use of resources and sustainable use, and the more the value of the criterion appears greater than one, the more productive the farms and therefore more profitable and thus greater added value and greater sustainability and is calculated through the following (27):

$$Return\ to\ cost = \frac{y_i}{y_i - SV_i}$$

Where: Y_i = added value, SV_i: sustainable value.
This criterion takes into account the size of the farm as we can see from Table (11) . the values of the criterion increased with the expansion of areas as is the case with the previous standards, where its value when small farms 0.45% and we note that it is less than one because the added value of these farms was negative and some of them achieved a loss, which made the added value negative, so the value of the criterion became less than one, and this reflects the lack of optimal use of resources in these categories and the small size of the area clearly affected the blending resources in an optimal manner, which was reflected in the criterion of return on cost, and with the expansion of areas and the distribution of cost over a larger area, the average cost began to decrease and thus led to an improvement in the added value, which led to an increase in the return on cost greater than one, and this indicates that these medium farms achieved higher production, higher productivity and higher profits, until the standard reached its maximum at large areas, where it reached 1.54%, which is a good percentage, and this means that the farms have achieved high productivity and added value. Higher and took advantage of the advantages of large production, optimal and sustainable exploitation of resources, investment of assets, benefit from family work and distribution of the cost to the size of a larger project.

Table 11. cost-benefit ratio.

Categories	RC	CC	VS
Small farms	0.45	2.05	1.22
Medium Farms	1.28	4.26	5.31
Large farms	1.54	5.05	26.2

Source: By authors based on previous tables.

Sustainable efficiency depends on factors including added value and sustainability value, which is dependent on the resources involved in the production process. The research concluded that sustainable efficiency is less than one when farms achieve negative sustainable value, as well as sustainable efficiency increases when cultivated areas expand, and that the remaining nitrogen is directly proportional to sustainable efficiency and sustainable value, as sustainable efficiency and sustainable value reached its maximum at the highest levels of residual nitrogen, as well as the case of productivity was directly proportional while nitrogen the remaining is inversely proportional to sustainable efficiency, through certain criteria it turns out that the project is good and there is no need to transfer capital to the financial markets that the farms have achieved high productivity and higher added value and have been taking advantage of the advantages of large production and exploitation of resources optimally and sustainably and investment assets and benefit from family work and distribute the cost to the size of a larger project the research recommended the need to use resources optimally and expand areas to take advantage of the advantages of large production and the optimal and sustainable exploitation of resources that takes taking into account not to affect the environment and increase experience in adding quantities of fertilizers and pesticides because their impact is direct on the environment through participation in training courses.

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