Comparison of economic efficiency and its components for the resources used in wheat production between conservation agriculture and traditional agriculture systems in Nineveh province for the 2018-2019 agricultural season using DEAP technology (Data Envelopment Analysis Program)

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Abstract

The method of soil conservation agriculture (farming without tillage) is one of the modern methods that was introduced to Iraq and was used in growing wheat and barley crops in Nineveh province and some provinces of central Iraq. The research aims to estimate the economic efficiency values and its components for the conservation agriculture system compared to the traditional agriculture system to determine the extent of optimization in Using resources for both systems and diagnosing the amount of waste in the production elements used, based on field data from a sample of wheat farmers amounting to (72) farmers, including (36) farmers who used the conservation agriculture system and (36) farmers who used the traditional agriculture system in Nineveh province for the 2018-2019 agricultural season., use the data envelopment analysis method (DEAP). The results showed that the conservation agriculture system outperformed the traditional agriculture system in indicators of technical, allocative and economic efficiency on the input side with changes in capacity returns, where they reached (0.87, 0.83, 0.73) respectively for the conservation agriculture system and reached (0.80, 0.78, 0.63) respectively for the agriculture system. Traditional, and excelled in the average technical efficiency index on the output side with changes in capacity returns, as it reached (0.83) for the conservation agriculture system and (0.78) for the traditional agriculture system. Therefore, the researcher recommends expanding the use of the conservation agriculture method as it is the method that contributed to raising productivity and reducing Quantities and costs of production elements used to achieve the best possible revenue.

Keywords: conservation agriculture, economic efficiency, data encapsulation method.

introduction

Grain crops are among the most important strategic crops in the world because a large percentage of the world's population depends on them for food. The wheat crop comes at the forefront of these crops, where it is grown on vast areas in all cities of the world as well because of the high nutritional value it contains. In Iraq, this crop is considered the first in terms of The cultivated area and quantity of production, as well as the state's interest in producing it to achieve self-sufficiency in this strategic crop. Accordingly, the conservation agriculture method came as one of the modern scientific techniques and methods in growing this crop, the application of which achieves several aims, the most important of which is reducing the costs of using production elements and reaching the best net revenue. Possible within the limits of available resources, the research aims to estimate and compare the technical, allocative and economic efficiency of the resources used in producing the wheat crop using the conservation agriculture method and traditional agriculture, in addition to comparing the average efficiency values between the two methods to find out which of them is better in using production elements and reducing the amounts of waste in using these elements.

research importance:

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The importance of the research comes from the importance of the wheat crop where it is the first strategic crop in Iraq and from the importance of using modern technologies in developing the crop's production and resistance to climatic conditions, in addition to the fact that the resources used in its production are limited in nature, so it is necessary to study the quantities and costs of these resources and identify the optimal combinations that achieve efficiency. Economic and avoiding waste and adding to the deficit of these resources, thus achieving the best possible production with the lowest possible costs, and which farming method is the best in achieving this.

Research problem:

The problem of the research lies in revealing the extent of the excelled of modern technologies (such as conservation agriculture or no-tillage farming) compared to traditional agriculture of the same crop and agricultural area, with the aim of pushing farmers' convictions to adopt modern technologies and try to spread them to achieve the aims of economic merit.

Research aims :

The research aims to compare conservation and traditional agriculture systems by estimating the technical, allocative and economic efficiency of the resources used in wheat production, leading to a recommendation to follow one of the two systems, which is better from the technical and economic aspects.

research method.

The quantitative analysis was based on the non-parametric analysis method using the DEAP (Data envelopment analysis program) program, through which we can measure the technical, allocative and economic efficiency of each farm separately, as well as calculate efficiency averages to compare the two systems, and its mechanisms are based on linear programming.

Data sources

We relied on cross-sectional data for a random sample of wheat farmers in Nineveh province for the 2018-2019 agricultural season, relying on a special questionnaire prepared for this purpose that includes questions through which we can know the size of the resources used, their costs, and the volume of their production and revenue, directed to the sample's (72) farmers. Farms distributed in the areas of (Nimrod, Al-Hamdaniya, Bashiqa, Hamidat, Tel Kaif, Tal Abta, Mosul Center).

theoretical side:

Efficiency is defined as the optimal allocation and efficient use of resources with the aim of obtaining the greatest possible amount of production (1).

Show (5) that Economic Efficiency consists of Technical Efficiency and Allocative Efficiency. The following is a definition of each of its components:

a. Technical Efficiency (TE) Technical Efficiency

Technical efficiency is defined as the facility's ability to reach the greatest output or achieve the best service given the set of available resources (6).

Explain (5) the concept of technical efficiency using Figure (1), which shows the establishment or economic unit's use of two inputs x1, The facility uses quantities of inputs defined as point p to produce a unit of output. The amount of technical inefficiency for that unit is represented by the distance QP, and point Q on the isoquant represents the technical efficiency of the economic unit produced at point P, which lies on the line OP. We obtain technical efficiency by The following equation:

$$TE = \frac{OQ}{OP} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Since:

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TE: technical competence.

OQ: Quantity of inputs achieved technical efficiency.

OP: producing unit.

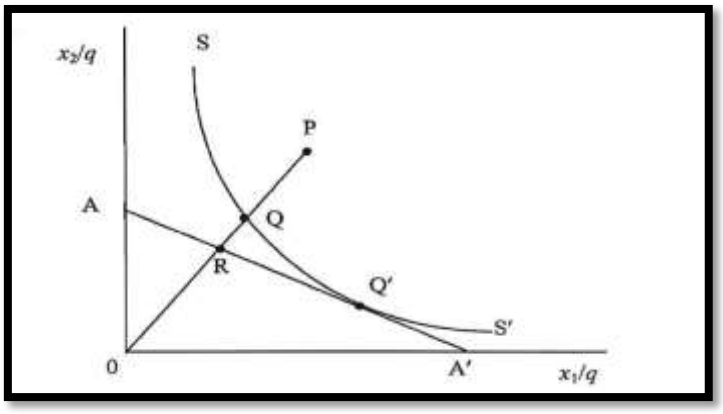

Figure (1) Technical efficiency and allocative efficiency

Source: (7).

B. Allocative Efficiency (AE)

Allocative efficiency means that it is one of the sources of economic efficiency in addition to technical efficiency, and it reflects the facility's ability to obtain the optimal allocation of economic resources, taking into account the prices of resources among the available economic options (2), and from Figure (1), the scientist (Farrell) also explained the interpretation of efficiency. Allocative efficiency: In the presence of the isocost line, represented by (AA`), and at point Q, complete technical efficiency is achieved, but complete allocative efficiency is not achieved. The ratio RQ represents the amount of reduction in production costs to reach point Q', which achieves allocative efficiency and thus economic efficiency, and allocative efficiency can be measured. For the facility at point P through the following equation:

$$\mathbf{AE}=\frac{OR}{OQ} \quad \text{.....(2)}$$

Since:

AE: allocative efficiency

OR: Input achieving allocative efficiency

OQ: Input achieved technical efficiency

By multiplying Equation 1 by Equation 2, we obtain the economic efficiency equation as follows:

TE × AE = (OQ\OP) × (OR\OQ) = (OR\OP)= EE..... (3)

Previous studies:

(9) published a study on estimating the technical efficiency of wheat farms in Sindh, Pakistan. A random sample of 384 farmers was collected to achieve the research objectives, using a production function with random terms and a data envelopment analysis method. The results showed that the average technical efficiency of wheat farms reached (36%), meaning that there is A waste of resources amounted to (64%), and production can be increased by this percentage without any increase in the costs of production factors.

(3) presented a study entitled The technical, distributional and economic efficiency of wheat farms irrigated with spraying in Al-Dur district of Salah al-Din Governorate for the 2012-2013 production season, using the data envelopment analysis (DEA) method, and according to a questionnaire form for (130) farmers of the

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wheat crop irrigated with spraying. The results of the analysis showed that the technical efficiency of the sprinklers with a capacity of 60 dunums and in light of the change in capacity returns was on average (0.97%). As for the sprinklers with a capacity of 80 dunums, the technical efficiency in light of the change in capacity returns was on average (0.98%). As for the technical efficiency of the sprinklers with a capacity of 120 dunums it was on average. In light of the change in capacity returns, it reached (100%). The results showed that the allocative efficiency of the sprinklers with a capacity of (120,80,60) dunums in light of the change in capacity returns amounted to (0.80%, 0.86%, 0.90%). As for the economic efficiency, it reached for the sprinklers with a capacity of (60, 80, 120) in light of the change in capacity returns amounting to (0.84%, 0.89%, 0.99%), respectively.

(4) conducted research on the efficiency of using available resources to produce the wheat crop in Gharbia province in Egypt. The research aimed to estimate the technical, allocative and economic efficiency using the data envelopment analysis (DEA) method. The research sample amounted to 75 observations, divided into three categories according to the area of the holding, and the results showed The analysis for the first category showed that the average technical, allocative, and economic efficiency reached (0.98, 0.78, 0.77), respectively, while for the second category, it reached (0.98, 0.74, 0.73), respectively, while for the third category, it reached (0.99, 0.72, 0.71), respectively

Analysis and discussion

1.Estimation results for farms adopting a conservation agriculture system

The technical, allocation and economic efficiency of the resources used in producing the wheat crop in farms adopting the conservation agriculture system in the research sample for the 2018-2019 agricultural season was estimated from the input side with changes in capacity returns in light of the amount of resources used in estimating the technical efficiency, including (cultivated area, amount of seeds, and human labor). and the costs of these elements (land rent, the cost of seeds, the cost of human labor, the cost of mechanical labor, the cost of chemical fertilizers, and the cost of pesticides), and the results showed that the value of the average technical efficiency reached (0.87), meaning that there is a waste in the quantities of production elements. The same amount of production can be achieved with fewer resources of this amount, or a higher output of (0.13) can be achieved with the same available resources. It is also clear that the number of farms that have achieved complete technical efficiency is (14) farms, the percentage of which is about (39%), meaning that this The farms produce on the production possibilities curve, while the rest of the farms (22) accounted for (61%) producing below the production possibilities curve. As for the allocative efficiency, the average value reached (0.83), meaning that there is a waste in the costs of the production elements used by an amount of (0.17) and it is possible to achieve The same production at lower costs by (0.17). Among the results there are also (6) farms that achieved complete allocative efficiency, which constituted a percentage of (17%). The reason for the low levels of allocative efficiency is due to the increase in production factors used in the process of producing the crop.

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Table (1) Technical, allocative and economic efficiency of resources used in producing wheat with a conservation agriculture system

Economic efficiency	No.	Economic efficiency	No.	Allocative efficiency	No.	Allocative efficiency	No.	Technical efficiency	No.	Technical efficiency	No.
0.65	**19**	0.32	**1**	0.65	**19**	0.80	**1**	0.99	**19**	0.40	**1**
0.71	**20**	0.37	**2**	0.74	**20**	0.68	**2**	0.95	**20**	0.54	**2**
1.00	**21**	0.43	**3**	1.00	**21**	0.86	**3**	1.00	**21**	0.50	**3**
0.84	**22**	0.79	**4**	0.90	**22**	0.79	**4**	0.93	**22**	1.00	**4**
0.80	**23**	0.69	**5**	0.80	**23**	0.87	**5**	1.00	**23**	0.79	**5**
1.00	**24**	1.00	**6**	1.00	**24**	1.00	**6**	1.00	**24**	1.00	**6**
0.59	**25**	1.00	**7**	0.91	**25**	1.00	**7**	0.64	**25**	1.00	**7**
0.78	**26**	0.81	**8**	0.78	**26**	0.87	**8**	1.00	**26**	0.93	**8**
0.87	**27**	0.85	**9**	0.88	**27**	0.85	**9**	0.93	**27**	1.00	**9**
0.89	**28**	0.53	**10**	0.89	**28**	0.84	**10**	1.00	**28**	0.62	**10**
1.00	**29**	0.67	**11**	1.00	**29**	0.73	**11**	1.00	**29**	0.91	**11**
0.47	**30**	0.79	**12**	0.91	**30**	0.79	**12**	0.52	**30**	1.00	**12**
0.81	**31**	0.81	**13**	0.85	**31**	0.81	**13**	0.95	**31**	1.00	**13**
0.54	**32**	0.68	**14**	0.70	**32**	0.68	**14**	0.76	**32**	1.00	**14**
0.62	**33**	0.73	**15**	0.72	**33**	0.73	**15**	0.85	**33**	1.00	**15**
0.72	**34**	1.00	**16**	0.75	**34**	1.00	**16**	0.95	**34**	1.00	**16**
0.63	**35**	0.69	**17**	0.89	**35**	0.73	**17**	0.71	**35**	0.94	**17**
0.66	**36**	0.62	**18**	0.84	**36**	0.75	**18**	0.78	**36**	0.82	**18**
0.73	**average**			**0.83**	**average**			**0.87**	**average**		

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

As for economic efficiency, the average value reached (0.73), meaning that there is a waste of production factors amounting to (0.27) and it is possible to achieve the same output with fewer resources of this amount. Economic efficiency values ranged between a minimum of (0.32) and a maximum of (1.00) and that there is (6) Farms that have achieved complete economic efficiency, meaning that these farms result from the point of contact between the equal output curve and the cost line, and the rest of the farms can emulate them and achieve the same level of economic efficiency by using combinations of production factors at the same costs.

2. Estimation results for farms using the traditional farming system:

The technical, allocation and economic efficiency of the resources used to produce the wheat crop in farms using the traditional agricultural system in the research sample for the 2018-2019 agricultural season was estimated from the input side with the change in capacity returns in light of the amount of resources used in estimating the technical efficiency, which includes (cultivated area, amount of seeds, human labor and labour). Machinery, the amount of chemical fertilizers, and the amount of pesticides) and the costs of these elements (land rent, the cost of seeds, the cost of human labor, the cost of mechanical labor, the cost of chemical fertilizers, and the cost of pesticides). The results showed that the value of the average technical efficiency reached (0.80), meaning that there is a waste in the quantities of production elements used. By (0.20) the same amount of production can be achieved with fewer resources by this amount or a higher

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output of (0.20) can be achieved with the same available resources. Remixing the quantities of production elements correctly will provide quantities of these elements by (0.20) without changing the level of production. It is also clear that the number of farms The ones that achieved complete technical efficiency are (9) farms, the percentage of which was about (25%), meaning that these farms produced on the production possibilities curve. As for the rest of the farms, which numbered (27), the percentage of which was (75%), producing at the bottom of the production possibilities curve. As for the allocative efficiency, it reached The average value is (0.78), meaning that there is a waste in the costs of the production elements used by an amount of (0.22), and it is possible to achieve the same production at lower costs by an amount of (0.22). Among the results there are also (6) farms that achieved complete allocative efficiency, which constituted a percentage of (17%), which is the reason for the low levels of Allocative efficiency is due to the high production factors used in the crop production process.

Table (2) Technical, allocative and economic efficiency of the resources used in producing the wheat crop using the traditional agricultural system

Economic efficiency	**No.**	**Economic efficiency**	**No.**	**Allocative efficiency**	**No.**	**Allocative efficiency**	**No.**	**Technical efficiency**	**No.**	**Technical efficiency**	**No.**
0.48	**19**	0.81	**1**	0.73	**19**	0.88	**1**	0.66	**19**	0.91	**1**
0.62	**20**	0.24	**2**	0.81	**20**	0.55	**2**	0.76	**20**	0.43	**2**
1.00	**21**	0.63	**3**	1.00	**21**	0.92	**3**	1.00	**21**	0.68	**3**
1.00	**22**	0.49	**4**	1.00	**22**	0.49	**4**	1.00	**22**	1.00	**4**
0.63	**23**	1.00	**5**	0.89	**23**	1.00	**5**	0.71	**23**	1.00	**5**
0.43	**24**	0.68	**6**	0.71	**24**	0.94	**6**	0.60	**24**	0.72	**6**
0.50	**25**	0.51	**7**	0.72	**25**	0.65	**7**	0.69	**25**	0.78	**7**
0.60	**26**	0.46	**8**	0.92	**26**	0.57	**8**	0.65	**26**	0.81	**8**
0.65	**27**	0.73	**9**	0.87	**27**	0.74	**9**	0.74	**27**	0.98	**9**
0.73	**28**	0.63	**10**	0.89	**28**	0.83	**10**	0.82	**28**	0.76	**10**
0.52	**29**	1.00	**11**	0.78	**29**	1.00	**11**	0.67	**29**	1.00	**11**
0.43	**30**	0.62	**12**	0.56	**30**	0.95	**12**	0.78	**30**	0.65	**12**
0.54	**31**	0.69	**13**	0.54	**31**	0.79	**13**	1.00	**31**	0.86	**13**
0.36	**32**	0.39	**14**	0.64	**32**	0.68	**14**	0.55	**32**	0.58	**14**
0.69	**33**	0.55	**15**	0.69	**33**	0.74	**15**	1.00	**33**	0.74	**15**
0.45	**34**	0.47	**16**	0.58	**34**	0.61	**16**	0.77	**34**	0.76	**16**
1.00	**35**	0.86	**17**	1.00	**35**	0.86	**17**	1.00	**35**	1.00	**17**
0.47	**36**	1.00	**18**	0.63	**36**	1.00	**18**	0.74	**36**	1.00	**18**
0.63	**Average**			**0.78**	**Average**			**0.80**	**Average**		

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

As for economic efficiency, the average value reached (0.63), meaning that there is a waste of production factors amounting to (0.37) and it is possible to achieve the same output with fewer resources of this amount. Economic efficiency values ranged between a minimum of (0.24) and a maximum of (1.00) and that there is (6) Farms that have achieved complete economic efficiency, meaning that these farms result from the point of contact between the equal output curve and the cost line, and the rest of the farms can emulate

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them and achieve the same level of economic efficiency by using the same combinations of production elements and at the same costs.

3. Comparing the economic efficiency and its components between the conservation agriculture system and the traditional agriculture system:

By comparing the values of economic efficiency and its components between the two agricultural systems, it becomes clear to us that the conservation agriculture system is superior to the traditional agriculture system, as in the table below, where the difference reached (0.07, 0.05, 0.10) for technical, allocative, and economic efficiency, respectively. This is due to the advantages of this system by using smaller quantities of The production elements used in producing the crop over the traditional agricultural system, which was reflected in the value of technical efficiency. It is clear from the table that the difference in the economic efficiency index and its interpretation is that there is an increase in production at the farm level as well as a reduction in production costs, especially the cost of plowing, preparing the land, the cost of seeds and fertilizers used, and achieving rationalization. In using resources to reach a higher level of production with the same available resources.

Table (3): Averages of economic efficiency, its components, and the difference in efficiency percentages between the conservation agriculture system and the traditional agriculture system

Difference in efficiency % percentages	**Traditional farming % system**	**Conservation farming % system**	Average efficiency
0.07	**0.80**	**0.87**	Technical efficiency
0.05	**0.78**	**0.83**	Allocative efficiency
0.10	**0.63**	**0.73**	Economic efficiency

Source: Prepared by the researcher based on data from Tables (1) and (2

4. Comparing the technical efficiency of the traditional agriculture system and the conservation agriculture system from the output side with changing returns to capacity

The technical efficiency was estimated from the output side of the conservation agriculture and traditional agriculture systems, and the results were recorded in the table below:

Technical efficiency of traditional farming system				**Technical efficiency of conservation agriculture system**			
Technical efficiency%	**No.**	**Technical efficiency%**	**No.**	**Technical efficiency%**	**No.**	**Technical efficiency%**	**No.**
0.57	**19**	0.92	**1**	0.93	**19**	0.40	**1**
0.68	**20**	0.28	**2**	0.81	**20**	0.32	**2**
1.00	**21**	0.72	**3**	1.00	**21**	0.48	**3**
1.00	**22**	1.00	**4**	0.93	**22**	1.00	**4**
0.66	**23**	1.00	**5**	1.00	**23**	0.77	**5**
0.59	**24**	0.76	**6**	1.00	**24**	1.00	**6**
0.68	**25**	0.71	**7**	0.63	**25**	1.00	**7**
0.67	**26**	0.80	**8**	1.00	**26**	0.92	**8**
0.74	**27**	0.97	**9**	0.99	**27**	1.00	**9**

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0.82	**28**	0.71	**10**	1.00	**28**	0.57	**10**
0.63	**29**	1.00	**11**	1.00	**29**	0.86	**11**
0.71	**30**	0.54	**12**	0.49	**30**	1.00	**12**
1.00	**31**	0.82	**13**	0.97	**31**	1.00	**13**
0.44	**32**	0.50	**14**	0.56	**32**	1.00	**14**
1.00	**33**	0.65	**15**	0.69	**33**	1.00	**15**
0.75	**34**	0.73	**16**	0.71	**34**	1.00	**16**
1.00	**35**	1.00	**17**	0.69	**35**	0.89	**17**
0.72	**36**	1.00	**18**	0.78	**36**	0.68	**18**
0.77	**Average**			**0.83**	**Average**		

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

It is clear from the table that the average values of the technical efficiency of the conservation agriculture system and the traditional agriculture system in terms of outputs reached (0.83, 0.77) respectively, meaning that the same output can be achieved with fewer resources by (0.17, 0.23) for the two systems respectively. This means that the amount of waste in the resources used in The wheat crop production in the conservation agriculture system is less than the waste in the traditional agriculture system by an amount of (0.6). This is due to what is characterized by the conservation agriculture system by using smaller quantities of production factors such as human labor and mechanical working hours.

Conclusions and recommendations:

From the values of the average technical, allocative and economic efficiency of the conservation agriculture and traditional agriculture systems, we conclude that there is waste in the quantities of production elements as well as in the costs of production elements in both systems. When comparing them, we conclude that the amount of waste in production elements for users of the traditional agriculture system is greater than the amount of waste for users of the conservation system. Conservation agriculture is due to the advantage of this system in saving the quantities of production elements and reducing agricultural operations and thus reducing the costs of production elements. Therefore, we recommend expanding the use of conservation agriculture technology as it is one of the modern technical methods in cultivating these crops and the advantages that distinguish this system economically include reducing costs, raising productivity and achieving higher Net income with the lowest possible costs.

References:

1. Abu Ali, Muhammad Sultan (1979). Manpower and productivity planning. Basra University Press.
2. Shabib, Bassem (2005). Measuring total productivity (technical change, utilization of production capacity, technical efficiency, economic efficiency). Bahrain Center for Studies and Research. Manama. the two seas.
3. Zanzel, Hassan Thamer and Latif, Bassem Fadel and Hassan, Yasmine Hatem. (2017). Technical, distributional and economic efficiency of wheat farms irrigated with sprinklers in Al-Dur district for the 2012-2013 production season. Tikrit Journal of Agricultural Sciences. A special issue of the proceedings of the Sixth Scientific Conference for Agricultural Sciences, March 2017.
4. Farraj, Wajih Abdel Aziz and Abdel Aziz, Hossam Hosni. (2021). Efficient use of available resources to produce wheat in Gharbia Governorate. Journal of Agricultural and Environmental Sciences. Damanhour University. Volume 20. Issue 2.

ISSN 2072-3857

5. Farrell,m.j. (1957). The measurement of productive efficiency.Journal of the royal statistical society. series A.
6. Coelli, T. Estache, A. Perelman, S. and Trujillo, L. (2003). A primer on efficiency measurement for utilities and transport regulators. World Bank Publications.Washington. Usa.
7. Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., and Battese, G. E. (2005). An introduction to efficiency and productivity analysis. springer science and business media.
8. Coelli, T. J. (1996). A guide to frontier version 4:1 A computer program for stochastic frontier production and cost function estimation. CEPA. University of new England.
9. Hashmi, M. S., Kamran, M. A., Bakhsh, K., and Bashir, M, A.(2015). Technical Efficiency And Its Determinants In Wheat Production: Evidence From The Southern Punjad, Pakistan. Journal of Environmental and Agricultural Sciences, 3.

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