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Economic Feasibility of Recycling Animal Waste using Sewage Water in a proposed Model for a large Biogas Unit in Fayoum Governorate

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ABSTRACT: Biogas technology is considered to be one of the most clean and renewable energy sources that depend entirely on sewage water as an input for gas production. In Egypt, there is a continuous increase and accumulation of animal waste, which necessitates rapid utilization (about 32 million tons of animal waste in 2021). So this study suggested establish a model of a large unit for a village in Fayoum, aiming at estimating the return and cost of waste as an alternative model for small biogas units for farmers or the distributed by the state. Also, the study aimed to determine the financial indicators of the proposed large biogas unit in the light of treating inflation in the economizer, then applying the sensitivity analysis test, which deals with emergency and potential changes in costs and revenues,(Despite operating by about 50%,75% of the energy in the first and second years, also raising most of the operating costs by 10% from the sixth year when calculating the internal rate of return before conducting a sensitivity analysis).

The results reflected the possibility of the successful application of such a proposed model, where the net present value was achieved by about 5.46 million EGP, the return on costs was about 1.36, the internal rate of return was about 31%, and the payback period for the invested capital was within 5 years, despite raising most of the operating costs from the fifth year of study. When applying the sensitivity analysis by increasing operating costs by 10% with stable revenues, the net present value was achieved by about 4.22 million pounds, the return on costs was about 1.26, the internal rate of return was about 25%, and the payback period for the invested capital was within 6 years and five and a half months. With an increase in operating costs by 10% with a reduction in revenues by 10%, the net present value was achieved by about 2.21 million pounds, the return on costs by about 1.13, the internal rate of return by about 14%, the payback period for the invested capital within 12 years and 4 months. The study recommended paying attention to holding seminars and courses to raise environmental awareness of the damages of the accumulation of animal waste. Also the necessity of using recycling wastes and converting it into energy by biogas technology, as well as spreading culture and social awareness in the countryside and new areas of the importance of this technology. Such target indicates the need to support and finance it to expand its spread, and implement large biogas units through the units in local villages and centers. This will lead to contribute wastes to provide energy for multiple purposes, and so not wasting large amounts of drinking water, ensuring access to cheap organic fertilizers to save foreign exchange. Meanwhile, in addition to providing job opportunities, and finally ensuring the safe disposal of animal waste, which contributes to the sustainability of environmental resources, increasing the acre productivity, and preserving natural wealth.

KEYWORDS: EconomicFeasibility,Recycling Animal Waste , Sewage Water , Biogas , Fayoum Governorate.

I. INTRODUCTION

Environmental issues are the most important major challenges facing the world today, and the most important environmental problems are biological pollution and waste in all its forms that harm the ecosystem and cause a decrease in productivity. The World Bank estimates that Egypt

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bears about 2.42 billion pounds in 2021 as a result of air pollution. Fresh water and the integration of the ecosystem are severely affected by the waste dumped in it, dead animals, sanitation and agriculture, in addition to climatic changes, increasing population, and the lack of water quality. Biogas technology is one of the clean and renewable energy sources that depend entirely on waste as inputs for gas production. Egypt is suffering from continuous increase and accumulation of waste without any benefit. (about 32 million tons of animal waste in 2021). Therefore, the state cares about the small projects of biogas as a renewable source of energy. It can also be used in the production of electrical energy by biogas-powered generators. It also produces organic fertilizer as a good by-product which is rich in organic matter content, fertilizer elements, plant hormones, vitamins and growth regulators. It is also free of harmful microbes, disease pests, larvae and weed seeds. Hence, the importance of studying the safe disposal of animal waste in Fayoum Governorate is highlighted.

As a result of start filling the Renaissance Dam in Ethiopia, a shortage of Nile water supply is expected by about 20 billion m^3. So, the use of drinking water must be rationalized in small biogas units, along with the reuse of sewage water, and the protection of Lake Qarun from pollution, since there were no fish in 2019 and 2020, respectively.

Study problem

The study problem includes a group of related problems, including the disposal of animal waste in unsafe ways, and there are about 98 villages that drain sewage either into irrigation water, which harms crops, or to Qarun Lake, which harms the environment and fish. Beside the mentioned above, despite the water poverty in most household biogas units farmers use part of drinking water to produce the biogas. In addition, some villages suffer from the lack of fuel in the winter season. The use of biogas energy in Egypt is usually carried out on a small scale as a renewable energy that contributes to achieving sustainable development. The optimum exploitation of plant and animal waste, despite its largeness, has not been made. As well as the high interest of the government loan for biogas units this distributed to farmers within the decent life program. Also, the presence of problems in the operational phase because of the lack of training programs for farmers. Finally, the lack of feasibility studies for large units grouped into one village or group of villages reduces the attraction of private sector investments and NGOs.

Study Objectives

The general objective of the study is to estimate the return and cost of energy production from waste for a proposed model in one large biogas unit for village residents as an alternative to small biogas units through the studying the financial, economic and environmental feasibility for the possibility of expanding its production. The sub-objectives include first, studying each of the most important methods of safe disposal of animal waste in Fayoum and its obstacles, secondly, the importance of expanding biogas production and its economic and environmental impact in achieving sustainable development and finally, studying problems of the operation of small household biogas units (capacity 4 m^3),Then, identifying the most important available solutions of the intertwined environmental problems and finally studying the distribution of the cost structure and economic feasibility for the establishment of a proposed biogas unit to serve an entire village.

The importance of the study

This study is an important practical and economic study due to the continuous increase in the volume of animal waste with the lack of traditional energy sources such as gas, oil and coal, which highlighted the importance of searching for alternative sources to produce clean and renewable energy, as well as the role of biogas energy in achieving sustainable development without harming the environment. It also stimulates investments in this field. The results of this study could be a guide for the flow of more technologies and projects appropriate to the conditions of the Egyptian society and environment.

Research method and data sources

The study relied on descriptive and quantitative analysis methods, primary data from a questionnaire form designed for the study, then secondary data obtained from government agencies, previous studies, some websites, and related reports.

First: Previous studies

1.The study of Abdel Qader, Mohamed Suleiman Mahmoud (2017) "Environmental and Economic Evaluation of Bioenergy Projects in the Egyptian Rural" concluded that the biogas project ensures the safe disposal of animal waste in addition to the production of cheap gas that can be used to generate electricity in rural homes, which benefits the The national economy when optimizing the use of animal waste in Egypt, which amounts to about

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93 million kg of organic waste resulting from 8 million livestock that can be converted into biogas with about 4 million m^3 per day, and this quantity can produce 43 million gas cylinders annually, which is equivalent to 12.5% of the total Egypt consumption of gas annually. Therefore, the study recommended the need to pay attention to the production of biogas as a renewable fuel that contributes to supporting energy supplies.

2.Eman Ahmed El-Sayed et al. (2018) aimed in their study "The Economic and Environmental Impact of Using Biogas Technology in Newly Reclaimed Egyptian Areas" to provide a sustainable and low energy sourceCost-effective and industrially and environmentally safe for remote and rural areas, as well as benefiting from agricultural waste by recycling and converting it into one of the important agricultural inputs. An economic feasibility study was conducted alone with a small biogas capacity of 6 m^3 in newly reclaimed areas in the governorates of South Sinai, Fayoum and Assiut on a sample of 100 individuals. The project's internal rate of return was 15% and the capital recovery period was about 7 years. The study concluded that the project is serviceable to meet household needs or heating livestock wards (a profit from saving household spending), and it also achieves a national economic return by providing government spending from foreign exchange in the field of importing both fertilizers and supporting butane cylinders.

3.Ghanemand Azza.Z.Mahmoud(2020) indicated in their study" Estimating the Social Return of the Renewable Energy Project (Biogas) for the Development of Rural Families in Assiut Governorate" that the returns achieved and provided by the project to improve the standard of living of rural families include the social return, which was estimated with relative strength75%, and the vast majority was in its contribution to reducing energy hassles, and the least in saving the burden of expenses. and the economic return, which was estimated with a relative strength 72.2%, and the vast majority was in its provision of the energy required for daily life, and the lowest percentage in its contribution to increasing the average income. And the lowest percentage in its contribution to raising health awareness. Finally, the educational return, which was estimated with a relative strength of 84%, the great majority was in teaching how to use biogas, and the lowest percentage was the contribution to paying children's education expenses(improving the educational level).

4.Etimad showed in her study "Economic Assessment of Animal Waste Recycling,CaseStudy in Fayoum Governorate" 2019 that technological development, climatic changes, population growth and escalation of environmental pollution rates have caused an imbalance in the natural balance, as well as the deterioration of public health, scarcity and sometimes poor quality of drinking water. And highlighted the urgent need to provide new sources of renewable energy from waste harmful to the environment and the use of biogas technology as the most important safe means. Despite the establishment of home units, they do not achieve an economic return, as the invested pound achieves 1.01 pounds, and the recovery period for the invested capital is about 5.33 years, and the units also depend on pure drinking water. The study recommended the establishment of large capacity units in each village or several villages together that use sewage water.

Second: Theoretical framework

1. The concept of economic feasibility

Moza Al-Harami (2009) defined it as a scientific tool to rationalize new investment decisions or to evaluate decisions that have been taken previously, or a comparison between available alternatives on technical and financial grounds (project location, operating capacities, technology used and labor costs, costs and operating income). The Institute of Banking Studies (2013) defined it as the process of collecting data and information on a proposed project, then analyzing it technically, financially and economically, and then conducting a sensitivity analysis test to know the extent to which economic indicators change with fluctuations in revenues and costs, and the decision to start the project or modify some of its clauses.

2. The importance of agricultural waste

Its importance, whether plant or animal, is justified in how to dispose of it and optimal use of it technically, economically and environmentally, and the importance of dealing with it as a basic economic resource must be reconsidered from its optimal use, economic and development returns, and its waste and neglect entail economic and social burdens and damage environmental. It is considered sustainable agricultural development that directs and stimulates various efforts to make maximum use of all available and possible production elements to increase the value of income from the agricultural sector, which increases national income without harming the environment.

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3. Disposal of animal waste

They are disposed of in a traditional manner in the governorate, where they are placed on the ground as fertilizer or dried to be used as fuel or sold, and this causes health and environmental risks, or safe disposal within the household biogas units(Kg of waste/day). The resulting gas is used to clean the rumen, head and legs of animals, and the digested manure was sold and then stopped in 2006 to abolish the city council.

Third: The study sample

A random sample of 30 individuals was collected by personal interview in 2022 from two centers, namely Senouras and Tamiya in Fayoum Governorate from farmers who have animal possession and applied home biogas technology. The village pours the sewage into open channels around the houses to collect in the public drain and then to Qarun Lake.

Fourth

Evolution of the quantity and value of animal production waste in Fayoum Governorate

Table (1,2) shows that the number of cows is decreasing in the governorate after 2013, and that the general temporal trend of their number is decreasing annually by about 7.9 thousand heads, representing about 6.3% of the average number of about 126 thousand heads for the study period. The quantity of cow waste in the governorate decreased by about 2259.9 thousand tons annually, representing about 5.7% of the average amount of about 39,734 thousand tons for the study period. It was found that the value of waste in the governorate increased by about 2.3% of its average value of about 131,902 thousand pounds for the period of the study.

Table (1): Numbers of cows, buffaloes and poultry in thousands, and the quantities and value of animal waste in the governorate during the study period.

Years	Cows			Buffalo			Poultry		
	Number one thousand	Quantity thousand tons	Values thousand Pound	Number one thousand	Quantity thousand tons	Values thousand Pound	Number one thousand	Quantity thousand tons	Values thousand Pound
2011	158	47394.5	118486	112.9	39516.6	116350	838.3	670.6	224834
2012	158	47397.3	142192	113.2	38623	115869	896.5	717.2	212534
2013	158	50551	101102	112.6	48540	114150	780.0	663.0	251955
2014	147.2	47112	141336	104.9	36710.8	120540	780.8	663.7	235472
2015	140.3	44895.4	134686	98.4	34448.4	112639	641.4	545.2	218061
2016	106.5	34085.4	102256	56.3	19691.4	68,920.	448.1	403.3	169372
2017	122.2	391122.9	78226	76.6	26798.8	62735	542.6	488.4	205116
2018	106.5	34080	170400	64.6	22610	113050	448	425.6	212800
2019	106.6	34112	170560	59.2	20720	103600	996	946.2	473100
2020	101.7	32544	162720	49.9	17,465	87325	662	628.9	314450
2021	80.6	25792	128960	44.0	15400	77000	770	731.5	365750
Average	126	39734	131902	81	29139	99289	709	626	262131

Source: Compiled and calculated from the data of the Ministry of Agriculture in 2021.

The number of buffaloes is also decreasing in the governorate, and the general temporal trend is decreasing, reaching about 7.82 thousand heads annually, representing about 9.6% of the average number of about 81 thousand heads for the study period. Also, the amount of buffalo waste decreases by about 0.4% of the average waste of about 626 thousand tons for the average period of the study, and that the value of buffalo waste decreases by 3.7% from the average Its value is about 99289 thousand pounds for the study period. The coefficient of determination shows that time is responsible for 88%, 80%, and 33% of the changes in the number, quantity and value of its waste in the governorate (Table 3).

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Table (2) The minimum and maximum limits in thousand units, tons and pounds and the percentage increase during the period (2011-2021)

Statement pointer	Number cows	Quantity a.waste	Values a.waste	Number Buffalo	Quantity a.waste	Values a.waste	Number Poultry	Quantity p.waste	Values p.waste
the year	2021	2021	2013	2021	2021	2017	2016	2016	2016
Minimum value	80.6	25792	101102	44	15400	62735	448	403	196372
the year	11-13	2013	2017	2012	2013	2014	2019	2021	2019
Maximum value	158	50551	195564	113	48540	120540	996	731	473100
the difference	77.4	24759	94462	69	33140	57805	548	328	276728
%(*)	49	49	48.3	61.1	68.3	47.9	55	44.9	58.5

(*) difference/maximum
source: was calculated from Table (1) of the study in 2022.

Table(3)Values results of the equations of the general time trend of numbers and animal waste in Fayoum Governorate during the period (2011-2021)

Statement	A	B	T	R^2	F
Cows (1,000 heads)	173.2	- 7.9	9.28	0.91	86.08**
Waste quantity m^3	53293.6	-2259.9	- 7.27**	0.86	52.86**
Waste value	113110	3132.04	1.11	0.12	1.22
Buffalo (1,000 heads)	12.07	-7.82	8.17 **	0.88	67.67 **
Waste quantity m^3	468310	-2950.24	-6.05**	0.8	36.6**
Waste value	1215.14	-3704.18	-2.12	0.33	4.51
Poultry (1,000 heads)	785.78	-12.69	0.73	0.06	0.53
Waste quantity m^3	611.17	2.44	0.16	0.003	0.024
Waste value	49185.15	7251.96	2.15	0.34	4.64 **

$y^{\wedge}e = a + bxe$, where $y^{\wedge}$ refers to the estimated value of the dependent variable, x e refers to the time component as an independent variable where e(1, 2, 3, 4.....11).
*** Significant at 5% level, ** Significant at 1% level.**
Source: Calculated from Table No. (1) of the study.

also, tables (1,2) show that the general time trend for the number of poultry in the governorate is decreasing, reaching about 12.69 thousand annually, representing about 1.8% of the average number of about 709,000 chickens for the study period. The amount of waste increased by 0.24% from the average amount of about 633.6 thousand tons for the average study period. The value of the waste increased by 2.8% from its average value of 262,131 thousand pounds. The coefficient of determination shows that time is responsible for 6%, 0.3%, 34% of the changes in the number of poultry, and the quantity and value of poultry waste in the governorate (Table 3).

Fifth

The cost structure of establishing a 4 m3 medium-sized home biogas unit: The unit is a construction building built underground or above it, consisting of 3 main parts and some secondary parts. The main includes a feeding basin for mixing organic materials with water and separating impurities, and a fermenter for fermenting organic materials after mixing them with water in isolation from air to produce biogas and organic fertilizer, and it consists of a part used for fermentation, and a part for storing biogas. And finally, the displacement basin to equalize the pressure inside the fermented and receive the resulting fertilizer from the fermented. Table (4) shows the total fixed costs for the establishment of a medium-sized home biogas unit (4 m3) that includes all the costs of the mentioned items in addition to the cost of the executing company's expenses and fees and maintenance fees for the year. The farmer pays 40% of the value of the cost, the rest is a loan over 3-5 years with an interest rate of 8%.

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Table (4) Fixed costs for establishing a home biogas unit, capacity of 4 m^3 (according to a decent life project)

م	Item	Quantity	Value(L.E)
1	Drilling: drilling area 4*4.5 and depth 1.8m	5 Worker	1000
2	Auxiliary2 workers during implementation for a period of 4 days	8 Worker	1600
3	Feeding Auxiliary Labor	4 Worker	800
4	first class red brick	2000 brick	3000
5	Ordinary cement (price per ton)	1 ton	2500
6	building sand	$5m^3$	1000
7	age slip	$3m^3$	900
The total costs of constructing the unit building from building materials , raw materials & labor wages		10800	
8	Tank + 6 mm iron for plate and lid	15 k.g	1500
9	PVC pipeor6 inch UPVC	2m	400
10	Manual iron tipper for greased and insulated tank	1	1000
11	entry basinforGreased and insulated lid	1	600
12	trough coverPainted and insulatedfor compost storage	1	1000
13	Acrylic plate with complete unit data	1	200
14	Flat cooker with all inclusions	1	1500
15	Iron pipe 20 cm 0.5 inch galvanized + 2 valves	1	300
16	Polypropylene pipes and accessories (in meters)	30 m	900
The total costs of the tank, stove, supplies and materials for operating the unit		7400	
The total expenses of the executing company for inspection, implementation, follow-up and a one-year guarantee		5000	
		23200(L.E)	

Source: compiled and calculated in 2022.

Sixth

Description of the study sample: From the study of the sample, it was found that about 36.7% of the sample members neither read nor write, 33.3% read and write, and 30% have a qualification. And that only about 60% of the units are working efficiently, while 40% are stopped as a result of poor operation, and 83.3% of the operating units use drinking water for feeding. The average water consumption for the sample was about 26 liters / day, and the water company estimated in July 2022 that the price of 1 m3 for the first, second and third segments was about 66, 165, 227 piaster and any increase and so on, and the unit consumes about 9360 liters / year on average.

Seventh

The most important operating problems of the sample and their solutions: They are summarized in the absence of a maintenance center, the presence of stove malfunctions with an increase in use by 100%, the lack of gas produced in the winter with the difficulty of finding an alternative by 88.9%, the unpleasant smell of gas by 83.3%, the high accounting prices for water bills Drinking by 11.1%. Regarding the solutions, about 83.3% suggested establishing a maintenance center in each center, and 61.1% hoped to reduce the accounting for water bills for unit owners, (and find a way to store gas in summer and consume it in winter, and some requested follow-up work from the Ministry of Environment for units) by 50%, with the provision of alternatives, especially in Winter season with a rate of 22.2%, according to my tables (5,6).

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Table (5) Problems of operating small biogas units

the problem	Repetition	%
• No maintenance center	18	100
• Burner malfunctions with increased use	18	100
• Shortage of gas produced in winter	16	88.9
• Bad smell of gas	15	83.3
• The high cost of water accounting	7	38.9
• Transferring water from the canal is stressful	2	11.1

Source: 2022 field study sample.

Table (6) Problem solving proposals for the sample farmers.

Solutions	Repetition	%
• Establishment of maintenance centers	15	83.3
• Reducing the price of water accounting	11	61.1
• Follow-up work from the Ministry of Environment	9	50
• Finding a way to store gas	9	50
• Providing alternatives in winter	4	22.2

.Source: 2022 field study sample

Eighth

The effects of waste on Lake Qarun: The ecological balance must be restored to Lake Qarun as the largest and oldest fresh lake in the world, where wild and marine animals and rare birds are located. However, with the continuous drainage of agricultural lands for decades, the salinity increased in a way that necessitated the establishment of a factory to extract salts, and the bottom sediments from the agricultural drainage increased. The industrial drainage of the lake was carried out from the industrial cities, in addition to the sewage pollutants for about 163 villages located on the Al-Battas and Al-Wadi banks, and about 12 other sub-drains supplying them with about 69% of the wastewater in Fayoum. With the Tikrit works and the entry of sewage into a decent life project for about 65 villages in the centers of Itsa and Youssef Al-Siddiq, the percentage of contamination decreased. Table (7) shows the total fish production per ton from the lake during the period (2011-2020), despite the presence of more than 25 species of fish, the most important of which is the world-renowned moose, which is world-renowned for its quality and distinctive taste. The largest production amounted to 4518 tons in 2014 with a rate of 20.91% equivalent to the production of A thousand feddans of fish farms with modest production, and production dwindled until it reached zero in the last two years (Etimad Shaaban Othman 2016).

Table(7) the total fish production from Lake Qarun during the period (2011- 2020) in tons

Year	Production	%
2011	4364	**20.2**
2012	4410	**20.41**
2013	4420	**20.46**
2014	4518	**20.91**
2015	1124	**5.2**
2016	878	**4.06**
2017	1061	**4.91**
2018	832	**3.85**
2019	0	**0**
2020	0	**0**
Total	21607	**100**

Source: Compiled and calculated from the Ministry of Agriculture, Fisheries Statistics Annual Book for the year 2020.

Ninth

The proposal of the biogas unit: The proposal allows the village to solve the problems of the largest part of the pollution while tightening control over the discharge of factories. The proposed village is the village of Rahim, the center of Sennuris in the governorate, and it was chosen because it is located on the Cairo-Fayoum road for

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ease of follow-up of the project. Its population reached about 5000 people and it has about 750 houses, and the per capita consumption per day is estimated at about 150 liters of water, and the number of livestock is about 300 heads. Table (8) shows the development of the number of cattle, sheep and goats per thousand for the period 2015-2021 in the Bani Etman facility in the Rahim area within its administrative division, as there is no data recorded in the Directorate of Veterinary Medicine for Rahim and the lowest in number in 2018 and 2019.

Table (8) Evolution of the number of livestock, sheep and goats per thousand establishments in Bani Atman during the period (2015-2021)

Year	Cows	%	Buffalo	%	sheep/goats	%
2015	5.3	31.2	2.7	27.66	2.8	31.46
2016	3	17.64	2.26	23.15	2.6	29.21
2017	1.6	9.41	1	10.25	0.5	5.62
2018	1.5	8.82	0.9	9.22	0.6	6.74
2019	1.5	8.82	0.9	9.22	0.6	6.74
2020	2.2	12.94	1	10.25	0.9	10.11
2021	1.9	11.17	1	10.25	0.9	10.11
Total	17	100	9.76	100	8.9	100

Source: collected and calculated from the data of the Directorate of Veterinary Medicine in Fayoum in 2022.

The idea of establishing the project

It depends on the construction of a yard in which the sewage collects from the houses (with a diameter of 6 meters and a depth of 8-10 meters) with the presence of 2 pumps to raise the drainage of 25-30 liters / sec, receiving the sewage waste to the fermented through the feeding basin to be fermented Anaerobic and digestion of animal waste and sanitation. The proposal allows ending water pollution in canals, drains, and Lake Qarun, and provides job opportunities and drinking water consumed in household biogas units, where sewage is collected in the orchard and the wastewater is rushes to the fermented feed inlet with animal waste to take place anaerobic fermentation and we get the biogas and the digested manure comes out.

Tenth: Fixed costs, variable and investment costs, and the total costs of the proposed project:

1. Fixed costs

Table (9) shows that the value of the proposed assets for the project amounts to about 2.34 million pounds. The values of constructing the fermented and the well-yard represent the two highest values, with percentages of 31.4% and 27.1%. They are followed by the values of electricity and main construction works, with rates of 18% and 10.6%. In other words, these four assets represent about 87.1% of the value of the project's assets. The annual depreciation of all assets has been calculated according to their proposed life expectancy, and then there are the scrap values and the non-depreciated value, which will be used when calculating the economic feasibility of the project as shown in Table (10).

2. Variable costs

The variable costs of the project are of great importance because they reflect the operational costs in which the project is managed and also their rise according to the years or periods according to inflation, reflecting the depreciation of the assets purchased in the zero year of the project (the period of construction and implementation). Table (12) shows that the values of waste and operating wages represent the two highest values, with percentages of 66.3% and 27.5%. Table (13) shows the distribution of the project's workforce according to the different items.

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Table (9) The value of the proposed assets for the project

assets	Value(L.E)	%
the price of the land	200000	8.5
Costs for building supplies	636100	27.1
main building	248628	10.6
Annex Building	102000	4.4
Electricity works	422665	18
Create a leavened	735150	31.4
Total asset value	2344543	100

Source: Suggestion by researchers with specialized engineers for the study proposal for Rahim Village, SenourasCenter, Fayoum Governorate 2022.

Table (10) Annual depreciation in pounds for project inputs from fixed assets other than land

Statement assets	the age default	Values the asset	scrap ratio from the asset	Values Scrap	Value the rest	Premium Annual depreciation	Unconsumed value for the asset
Create a garden	15	636100	10	63610	572490	38166(*)	190830
the main building	25	248628	25	62157	186471	7459	111881
Annex Building	25	102000	25	25500	76500	3060	45900
Electricity works	15	422665	15	63400	359265	23951	119755
Create a leavener	15	735150	15	110273	624877	41658	208297
Total	-	2344543	-	324939	1819604	114294	676664(**)

(*)Consumed value= 38166*(10 project Period)
(**)A total of more than 10 years of unamortized value has been calculated for all assets in the project .
Source: It was collected and calculated from data related to the study proposal for the village of Rahim, Senoras Center, Fayoum Governorate 2022 .

Table (11) The variable costs of the full operation from the third year of the project

Items	Value(L.E)	%
Estimated land rent	4000	0,2
The value of the waste during the year	1460000	63.7
The annual cost of transporting the water consumed from the sewage system (600 m3 per day, equivalent to 219,000 m^3)	40560	1.8
Project management fees	588000	25.7
The value of the electricity consumption	72000	3.1
Annual depreciation	114294	5
The annual maintenance value from the second year (5% of the value of the assets excluding the land)*	13025	0.6
Total	2291879	100

(*) The value of maintenance in pounds = 0.5 of the value of assets excluding land (117227), divided by 9 years from the second year (13025).
Source: It was collected and calculated from data for the study proposal for the village of Rahim, Senoras Center, Fayoum Governorate 2022.

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Table (12) fees of the administrative body delegated to the project from the local unit of the village.

Statement	Monthly wage in thousand pounds per person	Total annual wage in thousand pounds
Project manager (*)	6	72
technical engineers	8	96
Executive Engineers	8	96
accountant	4	48
service workers	5	60
operational workers(**)	18	216
Total	-	588

(*) from inside the local unit, (**) they are only in the table from outside the local unit
Source: It was collected and calculated from data for the study proposal for the village of Rahim, Senoras Center, Fayoum Governorate 2022.

3. Investment costs: usually include 4 items

Fixed costs, working capital, establishment, advertising, and other costs: Since the project is national, there are no last two items. The project's investment costs are estimated at about 2.735 million pounds (assets amounting to 2.34 million pounds, and the value of working capital, two months of annual operating costs, amounting to about 0.382 million pounds).

4. Total costs and annual total revenues

Table (14) shows that the project needs about 4.64 million pounds, including assets and annual operating costs. The total annual costs are estimated at about 2.29 million pounds, and the project achieves annual total revenues of about 4.02 million pounds (gas and organic fertilizers).

Eleventh

Indicators of the feasibility study and financial indicators of the project

1. Undiscounted measures:

a. Return on Invested Pound = (Total Revenues / Total Costs) = 38.6/24.4 = 1.58

That is, every pound spent in the project achieves an annual return = 0.58 pounds throughout its useful life.

B. Return on investment = net annual income/investment costs
=(1.69/2.73)*100=61.9%

This means that the money invested in the project achieved a rate of return of 61.9%.

C. Average annual income of the project:
=(Total annual net income)/project life=16.87/10=1.69 million pounds.(The project each year average income of 1.69 million pounds).

Table (13): Items of costs and revenues for the year of full operation of a large biogas unit in Rahim Village in 2022.

Items	Value(L.E)
the price of the land	200000
Costs for building supplies	636100
Annex Building	248628
Electricity works	102000
Create a leavened	422665
Create a leavened	735150
Total	735150
Estimated Rent land (5 carats)	4000
Waste value starting from the third year(*)	1460000
The value of transporting the water consumed from the sewage system (600 m3 per day equivalent to 219,000 m^3)	40560
Project management fees	588000
The value of the electricity consumption	72000
Annual depreciation	114294
The annual maintenance value from the second year (5% of the value of the assets	13025

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excluding the land)	
Total operating costs for the third year (the first is subtracted from maintenance)	2291879
The amount of gas produced in the year m^3	317880
Gas revenue(**)	3051648
Urea fertilizer quantity (50 kg bag)	1645
Values	575750
Phosphate fertilizer quantity (50 kg bag)	3290
Values	394800
Digested fertilizer revenue(***)	970550
Total revenue for one year	4022198

(*) These costs are for the full operation, approximately 11.43 m^3 of animal waste per day at a price of 350 pounds / m^3.
(**) The price of m^3 of biogas = 9.6 pounds, where the first subsidized segment of gas (up to 20 m3) price of m^3= 3.5 l.E.
(***) 388 m^3 compost at a price of 2500 pounds / m^3 (= 1645 urea bags / 350 pounds, 3290 phosphate bags / 120 pounds)
Source: collected and calculated from data for the study proposal for the village of Rahim, Senoras Center, Fayoum Governorate 2022

Table (14) analysis of the economic return for a biogas production unit based on animal waste.

Years	Years Total Costs	Total Revenues	Net Revenues
0	1528574 (**)	2011099	482525
1	1851939(***)	3016649	1164710
2	2291879	4022198	1730319
3	2291879	4022198	1730319
4	2291879	4022198	1730319
5	2291879	4022198	1730319
6	2291879	4022198	1730319
7	2291879	4022198	1730319
8	2291879	4022198	1730319
9	2291879	4022198	1730319
10	2291879	5414791 (****)	3122912
Total	24442088	38597925	14155837

(*) Investment costs = fixed costs + operating costs for two months (publicization and establishment expenses and others not calculated for a national project). (**) 50% of waste and water costs only. (***) 75% of waste and water costs have been calculated. Just. And starting from the third year, the costs will be in full. (****) The values of land and scrap of assets and non-depreciated values of assets have been added to the income of the last year.
Source: compiled and calculated from the cost table (13)

Table (15) annual income statement in million pounds

statement/year	1	2	3	4	5	6	7	8	9	10
Total revenue	2.1	3.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	5.41
materials	0.73	1.1	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46
Labor	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
water transfer value	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Electricity value	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Depreciation value	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
maintenance value	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total costs(*)	1.52	1.91	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28
Gross profit	0.49	1.11	1.74	1.74	1.74	1.74	1.74	1.74	1.74	3.13

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land rent	**0.004**	**0.004**	**0.004**	**0.004**	**0.004**	**0.004**	**0.004**	**0.004**	**0.004**	**0.004**
Net profit	**0.486**	**1.106**	**1.736**	**1.736**	**1.736**	**1.736**	**1.736**	**1.736**	**1.736**	**3.126**

Source: compiled and calculated from my table (13,14).

2. Discounted measures: cash flow statement

A.Discount rate:

Reflects the opportunity cost of investing capital in the community:

= a / (a + t) n where t = interest rate, n = number of years of project life.

a. Payback period = investment costs / average net cash flow = 2.73/0.546 = 5 years

B. The net present value at a discount rate (12%) = 5.46 million pounds

It shows the difference between the current values of cash inflows and outflows. It is accurate and objective, and depends on discounting cash flows to arrive at current values, and it is considered one of the international standards for evaluating projects for international financial institutions.

C. Ratio (inflows / outflows) at a discount rate (12%)=20.6/15.1= 1.36

The project is considered economically acceptable if the output is greater than the correct one, and economically rejected if the output is less than the correct one. It is clear from Table No. (16) that the return on costs amounted to 1.36

D. Internal rate of return = 31%

Theoretically = the smallest discount price + the difference between the two prices *(present value at the smallest / sum of the two present values at the two priceswithout reference), and it is considered one of the important criteria for differentiating between the proposed projects and investment alternatives, asIt is relied on by international financial institutions when providing investment loans, and it is known as the discount rate that It has the same cash inflows and outflows, or the discount rate, which gives a present value = zero.

Table (16) the internal rate of return for a biogas production unit.

Years	**0**	**1**	**2**	**3**	**4**	**5**	**6-9**	**10**
Item %Operation	**50**	**75**	**100**	**100**	**100**	**100**	**100**	**100**
cash flows in	**-**	**-**	**100**	**100**	**100**	**100**	**100**	**100**
Revenues	**0**	**2011099**	**-**	**-**	**-**	**-**	**-**	**-**
Working capital recovery	**0**	**0**	**3016649**	**4022198**	**4022198**	**4022198**	**16088792**	**4022198**
Scrap and unused value	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**190990**
the price of the land	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1001603**
Total cash inflows	**0**	**2011099**	**0**	**0**	**0**	**0**	**0**	**200000**
cash outflow	**-**	**-**	**3016649**	**4022198**	**4022198**	**4022198**	**16088792**	**5414791**
investment costs	**2726543**	**0**	**-**	**-**	**-**	**-**	**-**	**-**
Operating costs	**0**	**1528574**	**0**	**0**	**0**	**0**	**0**	**0**
Total cash outflows	**2726543**	**1528574**	**1851939**	**2291879**	**2291879**	**2291879**	**9167516**	**2291879**
net annual cash flow	**-2726543**	**482525**	**1851939**	**2291879**	**2291879**	**2291879**	**(*)10084268**	**2521067**
Discount rate factor at 12%	**1**	**0.893**	**0.797**	**0.712**	**0.635**	**0.567**	**0.431**	**0.322**
Adjusted net cash flow	**-2726543**	**430895**	**928274**	**1231987**	**1098753**	**981091**	**2587950**	**931779**
internal rate of return	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**31%**

(*) Outflows have been increased by 10% from the sixth year as a safety measure for the study from annual inflation.

Source: compiled and calculated from my table (13,14).

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Twelfth: Sensitivity Analysis:

1. Increasing costs by 10% with stable revenues (Table 17)

A. Payback period = investment costs / average net cash flow = 2.73/0.422 = 6 years and 5 and a half months

B.The net present value at a discount rate (12%)=4.22 million pounds

C. Ratio (inflows / outflows) at a discount rate (12%)= 20.6/16.3 = 1.26

D. IRR = 25%

Table(17) The internal rate of return for a biogas production unit with an increase in variable costs by 10%.

Years Item %Operation	0	1	2	3	4	5	6-9	10
	50	75	100	100	100	100	100	100
cash flows in	-	-	-	-	-	-	-	-
Revenues	0	2011099	3016649	4022198	4022198	4022198	16088792	4022198
Working capital recovery	0	0	0	0	0	0	0	190990
Scrap and unused value	0	0	0	0	0	0	0	1001603
the price of the land	0	0	0	0	0	0	0	200000
Total cash inflows	0	2011099	3016649	4022198	4022198	4022198	16088792	5414791
cash outflow	-	-	-	-	-	-	-	-
investment costs	2726543	0	0	0	0	0	0	0
Operating costs	0	1528574	1851939	2291879	2291879	229187	10084268	2521067
Total cash outflows	2726543	1681431	2037133	2521067	2521067	2521067	11092695	2773174
net annual cash flow	-2726543	329668	979516	1501131	1501131	1501131	4996096	2641617
Discount rate factor at 12%	1	0.89	0.8	0.71	0.635	0.567	0.431	0.322
Adjusted net cash flow	-2726543	293405	783613	1065803	953218	851141	2153317	850601
internal rate of return	-	-	-	-	-	-	-	25%

Source: compiled and calculated from my table (13,14).

Table (18) The internal rate of return for a biogas production unit with an increase in costs by 10%, a decrease in revenues by 10%

Years Item %Operation	0	1	2	3	4	5	6-9	10
	50	75	100	100	100	100	100	100
cash flows in	-	-	-	-	-	-	-	-
Revenues	0	1809989	2714984	3619978	3619978	3619978	14479913	3619978
Working capital recovery	0	0	0	0	0	0	0	190990
Scrap and unused value	0	0	0	0	0	0	0	1001603
the price of the land	0	0	0	0	0	0	0	200000
Total cash inflows	0	1809989	2714984	3619978	3619978	3619978	14479913	5012571
cash outflow	-	-	-	-	-	-	-	-
investment costs	2726543	0	0	0	0	0	0	0
Operating costs	0	1528574	1851939	2291879	2291879	2521067	10084268	2521067
Total cash outflows	2726543	1681431	2037133	2521067	2521067	2521067	11092695	2773174
net annual cash flow	-2726543	128558	677851	1098911	1098911	1098911	3387218	2239397

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Discount rate factor at 12%	**1**	**0.89**	**0.8**	**0.71**	**0.635**	**0.567**	**0.431**	**0.322**
Adjusted net cash flow	**-2726543**	**114417**	**542281**	**780227**	**697808**	**623083**	**1459891**	**721086**
internal rate of return	-	-	-	-	-	-	-	**14%**

Source: compiled and calculated from my table (13,14).

2. Increasing variable costs by 10%, decreasing revenues by 10%, Table (18)
A. Payback period = investment costs/average net cash flow
= 2.73/0.221 = 12 years, 4 months
B. Net Present Value at Discount Rate (12%)
= Present value of cash inflows - Present value of cash outflows = 2.21 million pounds
C. Ratio (inflows/outflows) at a discount rate (12%)= 18.6/16.3 = 1.14
D. Internal rate of return = 14%

From the above it is clear that despite the increase in the increase of some items of operating costs by 10% from the sixth year in the basic data to address the impact of inflation on the Egyptian economy, then applying the sensitivity analysis method in the first two scenarios, increasing some items of operating costs by 10% from the first year with revenues remaining the same The second is an increase in some items of operating costs by 10% from the first year, while reducing revenues by 10% from the first year. The project's internal rate of return did not fall below 14%. However, such national projects are negatively affected to a large degree when revenues are reduced, and this does not prevent the continuation of such purposeful projects, where the social return must prevail over the economic return.

II. CONCLUSION

Biogas technology, which produces gas from wastewater, is one of the cleanest and most sustainable energy sources. Animal waste is growing in Egypt (32 million tons in 2021) and has to be used quickly. This research proposed a big unit model for a community in Fayoum to estimate waste return and cost as an alternative to small biogas units for farmers or state distribution. The study also determined the financial indicators of the proposed large biogas unit in light of treating inflation in the economizer and then applying the sensitivity analysis test, which deals with emergency and potential changes in costs and revenues.

The net present value was 5.46 million EGP, the return on costs was 1.36, the internal rate of return was 31%, and the payback period for invested capital was 5 years, despite raising most operating costs from the fifth year of study. When operating costs were increased by 10% with stable revenues, the net present value was 4.22 million pounds, the return on costs was 1.26, the internal rate of return was 25%, and the payback period for invested capital was 6 years and 5 months. With a 10% rise in operating expenses and a 10% decrease in revenues, the net present value was 2.21 million pounds, the return on costs was 1.13, the internal rate of return was 14%, and the payback period was 12 years and 4 months. The study advised hosting seminars and workshops to enhance environmental awareness of animal waste impact. Also, recycling garbage and employing biogas technology to turn it into electricity, as well as educating rural and new regions about the value of this technology. It needs cooperation and funding to spread and implement massive biogas units in local communities andcenters. This will reduce water waste, supply inexpensive organic fertilizers, and save foreign exchange by using trash to generate electricity. Additionally, giving jobs and safely disposing of animal waste helps protect environmental resources, increase acre production, and preserve natural riches.

Recommendations

1. Interest in holding seminars and courses to raise environmental awareness of the damages resulting from the accumulation of animal waste and the need to exploit and benefit from it.
2. Exploiting animal waste and converting it into energy using biogas technology, making it a resource of high economic value.
3. Spreading culture and social awareness in the countryside and new areas of the importance of biogas technology.
4. The necessity of supporting and financing renewable energy projects, including biogas units, to expand their spread.
5. Implementation of large biogas units through local units in villages and centers to contribute to the provision of energy for domestic purposes, and to ensure access to useful organic fertilizers for agriculture to provide foreign exchange, in addition

to providing job opportunities, and finally ensuring the safe disposal of animal waste (sustainability of environmental resources, and increased productivity of acres, and preservation of natural resources).

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