Impact Of Adopating Biogas Technology On Technical Efficiency In Egypt Farms

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ABSTRACT

Biogas energy is a flexible renewable energy source that can be used as a replacement for fossil fuels. The objective of this paper is to compare the technical efficiency (TE) between biogas and conventional farms in Egypt. Data was collected via face to face interviews with the farmers during the summer season 2015. A sample of 300 farms divided equally between biogas farms and conventional farms. Results show that biogas farms are more technically efficient and more profitable than conventional farms. Different factors are found to affect TE levels such as (Credit, farmer experience and environmental preferences). Farmers with more experience and with environmental preservation preferences are more technically efficient compared with conventional farms. The levels of farm debt have a negative significant effect on efficiency of the two types of farms with greater impact on conventional farms.

Keywords: technical efficiency, stochastic frontier analysis, Egypt, biogas farms

INTRODUCTION

Energy is a basic need of human society in which keeps human civilization progressing. In poor countries, people are in need for energy as an important input to production and without adequate access to modern energy, poor countries can be trapped in a vicious circle of poverty, social instability and underdevelopment. The demand for energy is growing globally where 88% of this demand is satisfied by fossil fuels. It is expected that this demand will be doubled during this century (IPCC 2000). As the concentration of greenhouse gases (GHG) is increasing rapidly, fossil fuel-driven GHG is considered the most important contributor (IEA 2006). To reduce climate change effects, GHG must be reduced to levels lower than half of 1990. In this regard, biogas from agricultural residues can play an important role in the future. Biogas is an alternative renewable energy that can replace fossil fuels in power and heat production. It can be used also as gaseous vehicle fuel. Bio-methane can also substitute natural gas as a production input (El-Haggar 2015).

The government of Egypt has recently been developing policies to reduce the dependence on fossil fuels and promote the use of renewable energies such as biogas technologies to meet the 20 percent of power generation from renewable energy technologies goal by 2020 (NREA 2014). Egypt's current RE output of represents one percent its total energy supply (EOG 2015). The Egyptian government has supported more than 1000 farms with biogas digesters with different capacities in various governorates in line with Bioenergy for Sustainable Rural Development project as a cooperation project between the Egyptian Environmental Affairs Agency (EEAA), Ministry of State for Environmental Affairs, Global Environment Facility (GEF) and the United Nations Development Program (UNDP). The objective of the project is to overcome the technical, institutional, financial and market barriers to increase the awareness of using bioenergy in rural Egypt and reducing the negative local environmental impacts associated with the use of fossil fuels UNDP (2015).

The objective of this paper is to compare the technical efficiency (TE) between biogas and conventional farms in Egypt through using the Stochastic Production Frontier (SPF) methodology and conduct financial analysis using cost-benefit technique. The contribution of this work is twofold: first it focuses on the Egyptian agricultural farming, in contrast to the predominant literature, where developing countries have not received much attention, second, while most of the literature has focused on financial evaluation of biogas farms, the study conducts a comparative study of TE scores between biogas and conventional farms in Egypt. Assessing technical efficiency scores helps in identifying whether economic agents use their resources optimally to achieve the production objectives.

LITERATURE REVIEW

The biogas technology is growing in many developing countries. Arafa and El-Shimi (1995) investigated biogas technology adoption in rural communities of Egypt by identifying the factors that affect the biogas technology adoption using pre-feasibility study for the household of biogas digester, Indian type, to evaluate the economic return of this biogas digester. They have concluded that biogas digester is a viable economic option in rural Egypt. They recommended building more biogas digester in rural areas expecting reliable economic and environmental services. Zahran and El-Dorghamy (2010) studied biogas potentials in Egypt using economic returns method. They also concluded that among the various bioenergy technologies, biogas production uniquely provides a set of solutions and benefits and is applicable to a wide variety of sectors. They recommended that establishing infrastructure for this industry is good investment opportunity to promote local manufacturing of renewable energy technologies to meet renewable energy demands and to promote rural development and job creation. Islam (2010) addressed biogas renewable energy as a solution of energy crisis and economic development in Bangladesh. The author concluded that using renewable energy have several economic and environmental benefits such as reducing dependency on fossil fuels and increasing employment opportunities for rural people. Islam recommended wither developing countries aim to diversify renewable energy then they can meet their energy needs in the near future.

Butleret et al. (2011) analyzed biogas adoption in the UK dairy farms by examining the economic and environmental impact of integrating anaerobic digesters into five UK farming systems through anaerobic digestion analytical model using Cost Benefit analysis. The results showed that on-farm anaerobic digestion (AD) posses the capacity to reduce (CO_2) carbon emissions that a dairy farm produces. Cowley and Cortney (2015) conducted a study on production and cost functions for methane digesters to determine the NPV-maximizing levels of relevant inputs through using a nationwide survey and Cobb-Douglas production function and cost function. The results showed that digester population exhibited increasing returns to scale for methane production. As the animal population feeding the digester increases, fixed and variable costs decrease at decreasing rates.

Based on the literature review presented the biogas production is growing in the developing countries due to inexpensive inputs and producing outputs such as biofuel and bio-fertilizer. Most of research has mainly focused on Cost Benefit analysis and less attention has been given to study the technical efficiency as a prerequisite for economic efficiency of biogas in Africa in general and in the Egyptian industry in particular. This paper will contribute to cover this research gap.

METHODOLOGY

The assessment of farm Technical Efficiency (TE) and the factors illustrate TE provides valuable information to enhance farm management and economic performance. Avoiding sources of inefficiency and waste of resources is necessary for economic sustainability. Generally, a farmer who operates with a high TE level obtains better economic results than others. In this regards, studies productive efficiency have important effects on economic performance, technological innovation and the overall input use in the agricultural sector.

There are two leading approaches extensively used to estimate TE: parametric Stochastic Frontier Analysis (SFA) or Deterministic Frontier Analyses and non-parametric approaches Data Envelopment Analysis (DEA). Non-parametric techniques are more flexible than parametric approaches because they can be applied without knowing the proper specification of the functional of the production function. However, they do not allow to distinct inefficiency effects from random noise. SFA was first introduced simultaneously by Aigner et al. (1977) and Meeusen and Van den Broeck (1997). They differentiated between exogenous shocks outside the firm's control and inefficiency. In contrast to DEA and Deterministic Frontier Analyses, SFA accounts for random noise and can be used to conduct conventional tests of hypotheses. The general model is specified as:

$$y_i = f(X_i;\beta)exp(e_i);\ e_i = v_i - u_i, i = 1,2,\dots,N \qquad (1)$$

where, y_i represents the level of output and i-th observation (farm); X_i is the vector of input quantities used by the i-th farm in the production process; β is the vector of parameters to be estimated; and f (X_i; β) is a suitable functional form for the frontier. The cobb-Douglas functional form was adopted in the analysis. From a statistical point of view, the error term e_i in model (1) can be decomposed into two components, u_i and v_i; it is assumed that u_i and v_i are independently distributed from each other.

The first part, v_i is a standard random variable capturing the random noise that arises from four sources (1) the unintended omission of relevant variables from vector X_i (Oude Lansink et al. 2002); and (2) measurement errors and approximation errors associated with the choice of the functional form; and (c) unexpected changes in production (weather influences, for example); and (4) other factors that are not under the control of the farm. The second part (v_i) is usually assumed to be symmetric, independent and identically distributed as N (0, σ^2). The random error v_i can be positive or negative and so the stochastic output can vary the deterministic part of the model (1). The second part, u_i, is a one-sided, non-negative random variable representing the stochastic shortfall of the i-th farm output from its production frontier as a result of the existence of technical inefficiency. The definition of TE is based upon the distance of the farm from the production frontier. Depending on the selection of the reference to measure efficiency, two different efficiency measures can be distinguished (Kumbhakar and Lovell, 2000). In contrast to v_i, several specifications of density distribution have been proposed for u_i. The most common specifications are the half-normal, gamma, exponential, and truncated normal distributions. The truncated normal and gamma models allow for a wider range of distributional shapes.

Battese and Coelli (1995) suggested that the use of a single-stage approach yields more consistent and robust results than using the two-stage estimation procedure, which is inconsistent in its assumption regarding independence of the inefficiency effects. These authors proposed the following TE effects model:

$$u_i = \delta_o + \sum_{m=1}^{M} \delta_m Z_{mi} + \varepsilon_i \qquad (2)$$

Where (Z_{mi}) are farm-specific variables associated with technical inefficiencies; δ_0 and δ_m are parameters to be estimated; and ε_i is a random variable with zero mean and finite variance (σ_ε^2) defined by the truncation of the normal distribution such that:

$$\varepsilon_i \geq -[\delta_o + \sum_{m=1}^{M} \delta_m Z_{mi}] \qquad (3)$$

The mean of (u_i), is farm-specific variables while the variance components are assumed to be equal ($\sigma_u^2 = \sigma_v^2$). The above model formulation (3) identifies and explains sources of inefficiency that differ among farmers. However, this formulation does not allow for input variables that can also explain the predicted TE level. The correct and efficient application of a given technology or the use of a certain input may require a certain education or experience level. We estimate the parameters of the model defined by (1) and (3) by Maximum Likelihood estimator (MLE). The log likelihood function to be maximized for a sample of i producers is specified as:

$$\ln L = \text{constant} - \frac{1}{2}\ln(\sigma_u^2 + \sigma_v^2) - \sum_i \ln \Phi\left(\frac{u_i}{\sigma_u}\right) + \sum_i \ln \Phi\left(\frac{u_i^*}{\sigma^*}\right) - \frac{1}{2}\sum_i \ln \frac{(\varepsilon_i + u_i)^2}{\sigma_u^2 + \sigma_v^2} \qquad (4)$$

RESULTS

A. Technical efficiency analysis

Data are collected from a sample via a face-to-face interviews with farmers in Fayoum governorate (Tamia Center) from August to October 2015, specialized in maize production to make a comparison between the production characteristics of biogas technology adopting farms (biogas farms) and non-adopting farms (conventional farms). Tamia center has been chosen because it contains the largest number of biogas adopting farms. The data collected farm and farmer's characteristics which will be used for the assessment of technical efficiency for the conventional and biogas farms. A sample of 300 farms divided equally between biogas farms and conventional farms. The analysis was carried out using STATA 11.0 software. The Cobb-Douglas production function and the inefficiency models were estimated in one step.

Descriptive statistics for the production structure of conventional and biogas farms are presented in table 1. The total cost per feddan labour, machines, fertilizers and pesticides are equal L.E 4,575 for biogas farms and L.E 3,964 for conventional farms. Therefore, the profit per feddan is L.E 4,185 for biogas farms which is higher than for conventional farms (L.E 3,436). Total of other inputs such as fuels, seeds and maintenance are equal L.E 5,500 for conventional farms and L.E 7,700 for biogas farms.

Table 1. Summary statistics of biogas and conventional farms in Fayoum.

Farm characteristics	Unit	Biogas Farms	Conventional Farms
Area	Fed.	1.12	1.31
Yield	Ton/fed.	4.38	3.7
Price	L.E/ton	2,000	2,000
Total Revenue	L.E/fed.	8,760	7,400
Labour	Hours	1,314	1,248
Machines	Numbers	3.24	3.54
Cost of Fertilizers & pesticides	L.E	1,557	1,211
Other costs	L.E	1,700	1,500
Total cost	L.E	4,575	3,964
Profit	L.E	4,185	3,436

The variables included in the production function are: (Yi) the dependent variable representing total production of maize measured in tons, and the factors of production are (X1) cultivated area measured in feddan, (X2) labour measured in the number of hours per year, (X3) the expenditure on chemical fertilizer and pesticides measured in Egyptian pounds. (X4) total amount of machines used in the farm. According to the results in table (2), the Cobb-Douglas production function estimates increasing in cultivated area, labour and machines in both biogas and conventional farms will leads to the increase in maize output with labour being the largest contributor. While chemical fertilizer and crop protection inputs and machines are found to be relevant in conventional farms only, this is expected since biogas farms have increased their consumption bio fertilizers obtained from the biogas processing unit.

Table 2. MLE of production function of biogas and conventional farms of maize in Egypt in Fayoum.

Variable		Biogas farms		Conventional farms	
	Parameter	Estimate	Standard- error	Estimate	Standard-error
Cultivated area	(X1)	0.163	0.033***	0.133	0.022***
Labour	(X2)	0.241	0.049***	0.267	0.046***
Chemical fertilizer	(X3)	0.020	0.073	0.237	0.064***
Machines	(X4)	0.172	0.039***	0.112	0.051***

***** indicate statistical significance at the 1%.**

The variables of the inefficiency equation are (Z1) farmers' experience measured as the number of years dedicated to agriculture is (Z2) a dummy variable that reflect farmers' preferences for environmental when making their production decisions. (Z3) a dummy variable equal to 1 if the farmers have financial debt and zero otherwise (Credit). According to table (3), farmers with more experience will be more technically efficient, it is TE increases with skills and practice of farmer. The results also show that TE can be affected by farmers' preferences. In biogas farms, Farmers with environmental preferences are more technically efficient compared with conventional farms. The dummy variable that reflects farmers' environmental preferences takes the value of 1 if the farmer rated the relevance of environmental preferences with the highest punctuation. The level of farm debt does have a significant impact on increasing the inefficiency of the two types of farms with greater impact on conventional farms.

As is usual, the variance parameters of the likelihood function are estimated in terms of $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2/\sigma^2$ (Battese and Corra, 1977); where the γ is close to one, deviations from the frontier are mainly due to the technical inefficiency effects. Conversely, when γ is close to zero, the deviations are mainly due to noise and the average response production function is an adequate representation of the data.

Table 3. MLE of the inefficiency effects model for conventional & biogas farms of maize in Egypt in Fayoum.

Variable		Biogas farms		Conventional farms	
	Parameter	Estimate	Standard-error	Estimate	Standard-error
Experience	(Z1)	-0.004	0.001***	-0.003	0.001***
Env. Preferences	(Z2)	-0.125	0.027***	-0.27	0.019***
Credit (Z3)	(Z3)	0.182	0.037***	0.032	0.039***
$\sigma^2 = \sigma_u^2 + \sigma_v^2$	-	0.104	-	0.2	-
$\gamma = \sigma_u^2/\sigma^2$	-	0.02	-	0.05	-
Log likelihood function	-	130	-	252	-

***** indicate statistical significance at the 1%.**

According to table (4), TE scores for conventional and biogas farms are calculated as output-oriented measure following Battese and Coelli (2015). The average technical efficiency score is 49% for conventional farms and 62% for biogas farms. Moreover, these technical efficiencies range from a minimum of 36% for conventional farmers to and 43% for biogas to a maximum of 100%. The results indicate that if biogas farms effectively used available resources and enhanced current technology, it would be able to increase their output by 38% on average. Improving TE levels can reduce production costs and improve the economic viability of farms.

Table 4. Frequency distribution of technical efficiency for conventional & biogas farms of maize in Egypt in Fayoum.

TE-Range (%)	Biogas farms	(%)	Conventional farms	(%)
0-20	0	0	0	0
20-40	0	0	75	50
40-60	0	0	63	42
60-80	118	78	0	0
80-100	32	22	12	8
Sample	150	100	150	100
Mean efficiency	0.62	-	0.49	-
Minimum	0.43	-	0.36	-
Maximum	0.99	-	0.99	-

B. Cost-benefit analysis

In this section, we will present the results of the cost-benefit analysis for the biogas unit in rural Egypt through to evaluate the economic viability of this technology. Most biogas units in the rural areas are constructed in livestock farms consisting of 4 to 7 cattle on average which produce around 12 kg dung per day per head. They consist of a biogas digester, gasholder, moisture unit and a retrofit.

Despite of the high cost of installation, the operational cost of biogas digester is L.E 100-150 per year. Farmers, on average, spend L.E 550 per year on Liquid Petroleum Gas (LPG) for cooking. Biogas digesters produce a secondary output that is organic fertilizer produced from the biogas digesters. Biogas digester yields from 6 to 22 tons of organic fertilizer per year based on its capacity. The organic fertilizer is sold in local markets at a cost of L.E 400 per ton. Therefore, farmers earn from L.E 2900 to L.E 8600 per year. By using biogas for cooking and for landing, rural people are able to save L.E 500 every year, enjoying a net benefit without selling the biogas manner about 500 L.E per year or a net benefit with sold the biogas manner from 1,300 to 5,950 based on biogas digester capacity. The costs and savings associated with different biogas digester capacity are summarized in table 5 below.

Table 5. Cost benefit analysis of biogas digester of maize in Egypt in Fayoum.

Capacity (cubic meters/day)	2	3	5	6
Digester Unit Cost after Government Subsidy (L.E)	1,500	1,700	2,000	2,500
Operational cost (L.E/Year)	100	100	150	150
Total Costs (L.E/Year)	1,600	1,800	2,150	2,650
Savings on LPG (L.E/Year)	500	500	600	600
Sold of Manure (L.E/Year)	2,400	2,800	5,600	8000
Total benefit (L.E/Year)	2,900	3,300	6,200	8,600
Net benefit (L.E/Year)	1,300	1,500	4,050	5,950

According to the table above, production of biogas units are (2, 3, 5 or 6) cubic meters per day depend on digester unit capacities. The cost of constructing (L.E 5,500 for 2 cubic meters, L.E 6,500 for 3 cubic meters, L.E 8000 for 5 cubic meters and L.E 10,500 for 6 cubic meters). However, in order to promote the dissemination of biogas technology, the Egyptian government provides a subsidy for farmers ranging from L.E. 4000 to L.E. 8000 depending on the capacity of biogas unit. Biogas digesters, once constructed have a long life ranging between 25-30 years and require no repairing. Biogas digester is economically viable option for rural households, this result is also supported by previous literature results such as Arafa and El-Shimi (1995), Islam (2010) and Butleret et al (2011).

CONCLUSIONS

The objective of this study is to compare the efficiency scores of biogas and conventional maize farms in Egypt and to attempt to identify the factors that affect technical efficiency levels. Productivity differences between the two agricultural practices are also measured by means of calculating the output elasticity of different inputs. To do so, we use the Stochastic Production Frontier (SPF) methodology. A preliminary descriptive analysis permits detecting several structural, physical and economic differences between biogas and conventional farms. We find that biogas farms on average are more profitable, on a per feddan basis, than conventional farms.

Results derived from the SFA permit comparing output elasticity for different inputs between the two groups. The study shows that biogas farms, exhibit higher partial output elasticities for cultivated area and labour except chemical fertilizer and pesticides and machines compared to conventional farms.

Biogas plants are gaining rapid popularity in Egypt. By only using one inexpensive input, (animal waste), biogas technology can produce two extremely valuable outputs i.e. clean fuel (biogas) for cooking and heating and highly potent organic fertilizer. Cost-benefit analyses were carried out in order to evaluate the economic feasibility of biogas digester. The cost-benefit analyses were carried out without including the numerous positive social impacts that biogas technology has on the lives of the rural people. The results showed that biogas digester is economically viable option for rural people.

Egyptian policy-makers should adopt new policies that have two main dimensions; first one is discourage the heavy subsidy directed to non-renewable energy and start directing it to investments in renewable energy with special attention to biogas production, and second one is encourage the benefits of biogas technology. Recently, more than 1000 biogas digesters were constructed with different capacities, gas utilization operating in various governorates in the framework of Bioenergy for Sustainable Rural Development project. The project is a cooperation activity between the Egyptian Environmental Affairs Agency (EEAA), Ministry of Environmental Affairs, Global Environment Facility (GEF) and the United Nations Development Program (UNDP).

The adoption of biogas technology is still new in Egypt. In order to overcome the barriers of adoption of this technology, some policy recommendations are suggested based on the results of the analysis to promote biogas applications. Exemptions and facilitation of licensing procedures to encourage access to land for biogas projects. Exemptions of taxes and custom duties for equipment related to biogas projects to reduce the capital costs. Government should rely on local manufacturing of biogas digester. Promotion of funding schemes should be expanded. Biogas applications must be included in the activities funded by donors' of renewable energy programs.

REFERENCES

Aigner, D., Lovell, C., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production functions models. Journal of Econometrics, 6 (1), 21-37.

Arafa, S., & El-Shimi, S. (1995), Biogas Technology for Rural Egypt. Conference on Settling Technology for Industrial and Social Development, 24-26 January Alexandria, Egypt.

Battese, G., &Coelli, T (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. Journal of Econometrics, 148 (1) , 36-45.

Battese, G.E., &Corra, G.S., (1977). Estimation of a Production Frontier Model: With Application to the Pastoral Zone of Eastern Australia. Australian Journal of Agricultural Economics 21, 169-179.

Butleret, A., Hobbs, P., & Winter, M. (2011). Expanding biogas on UK dairy farms: a question of scale. No 108937, 85th Annual Conference, April 18-20, 2011, Warwick University, Coventry, UK, Agricultural Economics Society. Available at: http://EconPapers.repec.org /RePEc:ags:aesc 11:108937.

Coelli, T.J., PrasadaRao, D.S., Battese, G.E., (1998). An introduction to efficiency and productivity analysis. Kluwer Academic Publishers, Boston.

Cortney, C., &Brorsen, B. (2015). Anaerobic digester production and cost functions, No 205667, 2015 AAEA & WAEA Joint Annual Meeting, July 26-28, San Francisco, California, Agricultural and Applied Economics Association. Available at: http://EconPapers.repec.org/ RePEc:ags:aaea15:205667.

El-Haggar, S. (2015). Conference on Renewable energy: challenges and opportunities for Egypt's energy problems, 10 March 2015, AUC, Cairo, Egypt.

Egypt oil and gas (EOG), (2015). Diversifying Egypt's energy mix: the road to RE. Available at:http://www.egyptoil-gas.com/publications/diversifying-egypts-energy-mix-the-road-to-renewable-energy. (Accessed on March 29, 2016).

Hadrich, J. (2014). Factors affecting anaerobic digester adoption in the West, No 170535, 2014 Annual Meeting, July 27-29, 2014, Minneapolis, Minnesota, Agricultural and Applied Economics Association. Available at:http://EconPapers.repec.org/RePEc:ags:aaea14:170535.

The Intergovernmental Panel on Climate Change (IPCC), (2000). IPCC special report: emissions scenarios, Intergovernmental Panel on Climate Change. Available at: http://www.ipcc.ch/ipccreports/sres/emission/index.php?idp=0.

International Energy Agency (IEA), (2006). World energy outlook: international energy agency report. Available at: http://www.worldenergyoutlook.org.

Islam, M. (2010), Renewable Energy resources and Technologies Practice in Bangladesh. Renewable and Sustainable Energy Reviews. 12 (2), 299-343. 2008.

Kumbhakar, S., & Lovell, C. (2000). Stochastic Frontier Analysis. Cambridge UK: Cambridge University Press, American Journal of Agricultural Economics, 84 (2), 532-532.

Meeusen, W., & Van Den Broek, J. (1977). Efficiency estimation from Cobb-Douglas production functions with composed error. International Economic Review, 18 (2), 435-444.

New & Renewable Energy Authority (NREA) (2014). New and Renewable Energy Authority plans. Available at: http://www.nrea.net.

Lansink, A., Pietola, K., & Backman, S. (2002). Efficiency and productivity of conventional and organic farms in Finland 1994-1997. European Review of Agricultural Economics, 29 (1), 51-65.

Oude Lansink, A., Pietola, K.S., & Backman, S., (2002). Efficiency and productivity of conventional and organic farms in Finland 1994-1997. European Review of Agricultural Economics 29, 51-65.

United Nations Development Programme (UNDP). (2015). Bioenergy for Sustainable Rural Development in Egypt. Available at: http://www.eg.undp.org.

Zahran, A., & El-Dorghamy, A. (2010). Biogas potential in Egypt, Tri-Ocean Carbon and Renewables. 7-11. Available at: http://trioceanenergy.com.

أثر تبني تكنولوجيا الغاز الحيوى علي الكفاءة الفنية في المزارع المصرية

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الملخص العربي

إن الطلب علي الطاقة ينمو عالميا؛ حوالي ٨٨% من هذا الطلب يتم تلبيته عن طريق الوقود الحفري ويتوقع العلماء بزيادة الطلب علي الطاقة خلال هذا القرن. يتزامن مع ذلك، الوقود الحفري لـــه أثـــار بيئيـــة واقتصادية مدمرة مع الزيادة المستمرة لتركيز الغازات المسببة للاحتباس الحراري. الوقود الحفـــري يعتبـــر المحرك الرئيسي للغازات المسببة للاحتباس الحراري. في هذا السياق، الغاز الحيوي هـــو أحـــدي مـــصادر الطاقة المتجددة المرنة التي باستطاعتها استخدامها كبديل للوقود الحفري. ففي الريف المصري، الأفراد فـــى حاجة إلي الطاقة كمدخل مهم للإنتاج. لذلك قامت الحكومة فى مصر بتبني سياسات لكي تقلل الاعتماد علـــي الوقود الحفري ويحفز استخدام الطاقات المتجددة كتكنولوجيا الغاز الحيوي للوصول إلي ٢٠% مـــن الطاقـــة المولدة من تكنولوجيات الطاقة المتجددة بحلول ٢٠٢٠ من خلال تبني أكثر من ١٠٠٠ مزرعـــة لتكنولوجيـــا الغاز الحيوي في مختلف المحافظات والمرتبط بمشروع التنمية المستدامة للطاقة الحيوية فى الريف.

يركز البحث علي مشاكل الطاقة التى تواجهه المناطق الريفية فى مصر ومن ضمنها ارتفاع أســـعار الطاقة، ، نضوب الطاقات الغير متجددة والآثار الضارة بالبيئة نتيجة الاعتماد على الوقود الأحفوري. ولـــذلك الغرض الرئيسي من هذا البحث هو المساهمة في التغلب على هذه المشاكل عن طريق إيجاد بدائل للطاقة فى الريف والتي بدورها سترفع كفاءة الوضع الأقتصادى بالنسبة للمزارع فى هذه المناطق والدولة ككل أيـــضا. يساهم البحث فى إن يثري الندرة فى المراجع المتعلقة بتبني تكنولوجيا الغاز الحيوي فى مصر من خلال عقد دراسة لمقارنة الكفاءة الفنية بين المزارع التي تتبني والتي لا تتبني تكنولوجيا الغاز الحيوي فى مـــصر عـــن طريق تقدير معدل الكفاءة الذي يساعد فى تعريف إذا ما كان المزارعين فى المزارع التقليدية ومزارع الغـــاز الحيوي يستخدموا مواردهم بالشكل الأمثل لتحقيق أهدافهم المتعلقة بالإنتاج من عدمه. الإختلاف الإنتاجي قـــد تم تقيمه إيضا لممارسات الزراعية لنوعين المزارع من خـــلال قيـــاس مرونـــة المخرجـــات مـــن مختلـــف المدخلات. بالإضافة إلي، تحليل العوامل المختلفة التي يمكن تؤثر فالكفاءة الفنية. ولتحقيق هذا الهـــدف، تـــم استخدام نموذج ال Stochastic Production Frontier.

تم تجميع البيانات عن طريق استمارات استبيان خلال موسم الصيف (٢٠١٥) لعمـــل مقارنـــة بـــين خصائص الإنتاج للمزارع التقليدية ومزارع الغاز الحيوي، العينة تحتوي علي ٣٠٠ مزرعـــة حيـــث تقـــسم بالتساوي بين مزارع الغاز الحيوية والمزارع التقليدية. أظهرت النتائج بأن مزارع الغاز الحيوي أكثر كفـــاءة فنية وربحية من المزارع التقليدية. تم إيجاد عوامل مختلفة لها أثر على مستوي الكفاءة الفنية مثل (الائتمـــان، خبرة المزارع والتفضيل البيئي). المزارعون ذوي الخبرة يتميزون بكفاءة فنية عالية مما يعنـــى أن الكفـــاءة الفنية تتزايد تدريجيا مع الممارسة والمهارات العالية. يفضل المزارعون العاملين بمـــزارع الغـــاز الحيـــوي الحفاظ على البيئة اكثر وانه يؤثر بشكل ايجابي على الكفاءة ، مستوى دين المزرعة مؤشر يؤثر بشكل سلبي على مستوى الكفاءة بين المزارع التقليدية ومزارع الغاز الحيوي مع وجود أثر أكبر علي المزارع التقليديـــة. وفي ضوء هذه النتائج، يجب علي الحكومة المصرية تتبني سياسات جديدة ويكون لها اتجاهين؛ الاتجاه الأول هو عدم تشجيع الاعتماد علي الوقود الحفري عن طريق التوعية لمخاطره البيئية والاقتصادية مـــع تخفيـــف الدعم علي الطاقة وتوجبه إلي الاستثمار فى مجال الطاقات المتجددة والاتجاه الثاني هو تعزيز منافع الاعتماد علي تكنولوجيات الطاقة المتجددة عن طريق تبني مشروعات للطاقة المتجددة مثل مشروع الطاقـــة الحيويـــة للتنمية الريفية المستدامة فى الريف المصري.