Technical Efficiency Analysis of Broiler Farms in Iraq

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Abstract

Broiler chicken production, which has an important place in human nutrition in the world, has become a growing sector due to its production in a short time and its cheapness compared to its counterparts. However, the sensitivity of the production cycle consisting of short growing periods and the ruptures in the chain of activity deeply undermine the production effectiveness and lead to insufficient supply by pushing companies into an economic stalemate. This study aims to determine the technical efficiency of the broiler production farms in Iraq, to determine the causes of inefficiency that negatively affect the farms during production activities, and to develop solutions to the problems. To satisfy these objectives, the data from 181 randomly selected broiler farms were analyzed with the Data Envelopment Analysis method. As a result of the analysis, the technical efficiency scores of the farms were found to be 0.89 under constant return to scale (CRS) and 0.95 under variable return to scale (VRS). Of the 181 farms analyzed, 142 under CRS and 72 under VRS were found to be inefficient. It was determined that the main reason for the efficiency of the enterprises that are not working effectively was the use of excess input, as well as solutions and suggestions to all the problems identified. For inefficient farms, new levels of input have been estimated to make the farm efficient. In addition; In order to increase the effectiveness values of farms, farmers need to reduce the amount of input available, organize educational courses for farm workers, and improve the performance of employees.

Keywords: Broiler farms. Efficiency. Return to scale. Iraq.

1. Introduction

While agriculture is vital for the continuation of human life, it is an important sector for the economic and developments of the countries. In addition to providing employment for many people, the realization of production for direct nutrition increases the importance of this sector even more. Supporting, promoting, and sustaining such a highly valued sector is also a requirement for the better transfer of this production sector to the next generations (Gollin et al., 2021). Animal production is one of the most important parts of agriculture. In animal production; red and white meat production meets most of the protein needs of people in their daily lives. In recent years, the tendency to consume white meat in humans has been increasing due to the supply of red meat and related problems. This trend is especially towards poultry chicken breeding. Poultry farming has become an indispensable part of the white meat production sector in terms of both unit price and production. In addition, poultry chicken breeding has a significant contribution to the economy of countries, especially employment.

Chicken which has a high protein value was found in forest areas in Southeast Asia in 3200 BC, domesticated and spread to African and European countries, especially Asian countries (Ullah et al., 2019). Today, it has an important place in human nutrition almost all over the world. Chicken production constitutes the supply group of many enterprises in order to meet the white meat demand in all countries. According to FAO statistics, more than 50 billion chickens are produced annually worldwide and the United States is the leading producer. The USA is followed by Asian countries. On the other hand, although Iraq produces, it is the fourth importer (Ullah et al., 2019). Broiler production for Iraq, which has a high chicken import, has an important place for the people living in Iraq in terms of country's economy, employment and nutrition. Although there are many broiler production farms in the country, the dispersal of farms to different parts of the country and the small scale of farms cause broiler production to be insufficient. In addition, a large number of people who can work here are negatively affected in terms of employment. However, broiler production is an agricultural activity that is less affected by climate events compared to vegetable production and can be produced easily in all countries (Cicekgil and Yazici, 2016).

Considering both consumption and production conditions, Iraq has the conditions to easily produce broiler chickens. In the white meat sector, which is increasing the value day by day for human life, farms producing broilers in Iraq will benefit the country's economy in many ways and reduce Iraq's dependence on white meat. In addition to the benefits it will provide to the country, the short production period, the high level of feed efficiency of the chickens produced on the farm, and the less labor required for the farm's operation compared to other agricultural activities are an important advantage and production priority for the farms (Ikikat Tumer et al., 2018). Considering all these conditions, it is obvious that the broiler production in Iraq should be evaluated and the activities in this field should be improved. Analyzing the productivity of the farms, identifying the problems affecting the production and putting forth the studies that will make the farms more effective will also increase the broiler production in the region.

The aim of this study is to reveal the technical efficiency of broiler breeders who continue their production activities in the north of Iraq, offering input-output-oriented solutions that will make inefficient farms effective, and revealing activities that can provide economic benefits to farms.

The following section of the paper briefly describes the literature on the technical or economic efficiency of broiler farms. The material and methods are presented in the third section. The results are presented and discussed in the fourth and the main conclusions, recommendations and limitations of the study are presented in the final section of the paper.

2. Literature Review

Many researches have been carried out on broiler production farms in the world and Iraq, either technically or economically. Sarıözkan and Sakarya (2006), in their study, conducted an efficiency analysis on the performance of egg poultry farms in Afyon province to increase productivity. The data were obtained by layered sampling method from 40 egg poultry farms and the Cobb-Douglas production function was used to analyze data. According to their results, there was a decreasing return to scale situation in all farms and it would not be right for farms to expand their farm scale with their current situation. In a study conducted on the same sector in Iran, which is also close to this region, the efficiency scores of broiler chicken producers were determined as CRS 0.92 and VRS 0.93, respectively (Heidari et al., 2011). Ezeh et al. (2012) investigated the cause of inefficiency in poultry production in Abia state of Nigeria. They determined 60 poultry broiler breeders by multi-stage sampling technique and evaluated them with estimated stochastic frontier production function. They found that the critical problem in poultry production in Nigeria is due to low production and resource allocation problems. As a suggestion, they stated that the awareness of the breeders should be raised through the extension agencies in order to increase the efficiency in the enterprises. Mahjoor (2013) determined the technical and allocation efficiency of the broiler production in Iran, and the economic efficiency of the farms using the Data Envelopment

Analysis (DEA) method. The 100 broiler production farms were randomly selected from a total of 438 farms and data were obtained by face-to-face interviews in 2010. In the study, the CRS was found to be 82%, 70% and 57% for technical, allocation and economic efficiency, respectively. When the inefficiency factors were evaluated, education and age of farmer and membership to the cooperative were statistically significantly associated with technical, allocation and economic inefficiency. In another study, Ali et al. (2014) calculated the productivity of broiler farmers in Punjab, Pakistan. Data were randomly collected from 60 broiler breeders in 2014. The stochastic frontier Cobb-Douglas production function was used in the study. The average return to scale of the farms was found to be 0.88. Considering the factors affecting productivity, it was determined that the number of chicks, feed and labor force positively affected broiler production. In addition, it has been determined that the training to be carried out in the region will directly contribute to the effectiveness of the producers. Farhan et al. (2015) conducted a survey on 60 farms producing broiler in Anbar province in 2012. They used the Aledjala model based on Cobb-Douglas production function analysis and calculated technical competence and capacity efficiency. As a result of the study, they found that the capital increase is flexible. In addition, the researchers determined that the return to scale of technical efficiency is 0.88 and the return of variables is 0.98. With these results, the researchers revealed that the producers in the region should reduce the use of resources. In another study on broiler production farms in Nigeria, the technical efficiency score of the farms was found to be 0.97. Efficiency performances were determined as 79.6% (Sadiq et al., 2016). In the study of İkikat Tümer et al. (2018) identified factors related to production satisfaction of broiler producers. The data of the study were obtained by survey method from 87 broiler farms in Tarsus district of Mersin province. The analysis of the research was carried out with probit regression. As a result of the analysis, the positive effect of the producer's age, experience and income on the satisfaction factor was determined. The number of family members in the farms, the type of broilers and chick deaths in the farms have a negative effect on the satisfaction factor. Ullah et al., (2019) analyze the profitability of broiler production farms in Pakistan Data for this study were collected from 120 broiler farms using random sampling technique in order to obtain the maximum possible output in the farms. In the analysis of the data, the maximum output for the farms was estimated using the stochastic frontier approach. As a results, the technical efficiency was found to be 0.85. As the effect of technical inefficiency, parameters such as age, experience, credit, occupation and labor force were found to be statistically negative and significant. According to the researchers, credit facilities will increase the productivity of these farms. In another study, Inci et al. (2019), conducted a research to determine the problems of broiler farms with the data obtained from 9 broiler farms in Bingol province in Turkey. According to results, the majority of the problems of the breeders were caused by feed and diseases. In order to increase production, they revealed the need to train producers for disease problems and to support them in feed supply. In another study, Sengul and Boyraz (2019) determine the structural and technical characteristics of broiler producers in Malatya by using a survey data from 77 contracted broiler production farms. It has been determined that the main problems of broiler farms in the region are diseases, feed supply, credit and education. Recently, an efficiency study was conducted on broiler production farms in Egypt with the same method and technical efficiency scores were determined as 0.91 and 0.98 for CRS and VRS, respectively (Hassan, 2021). In this context, in other studies, researchers have reached similar conclusions about overused inputs and have made suggestions to companies for the optimal use of inputs (Sarıözkan and Sakarya, 2006; Heidari et al., 2011; Todsadee et al., 2012; Olorunwa 2018). The results of the study were found to guide policy makers to increase productivity.

When the literature on productivity in broiler farming is examined, there are many studies in the world and in Iraq, and the results of the study include many positive results in order to increase the productivity of the farms. However, although the studies are mostly carried out in different countries, the factors affecting the efficiency of the farms have been studied. Studies focused on ensuring the input-output balance of farms are not sufficient. In the literature, it has been determined that the studies examining the efficiency values of the enterprises and reducing the costs of the producers in Iraq, where there are many active enterprises and suitable for broiler breeding, are insufficient. As such, this study will make an important contribution to the literature.

3. Material and Methods

The main material of the research consists of the data obtained from the broiler farms in Erbil, located in the north of Iraq. The region was chosen because it has an important place in broiler production. In addition, research findings previously made on this subject were used in the analysis of the study and in comparison, of the results.

The research was carried out in 2016 in Erbil, where intensive broiler production takes place. In order to collect the study data, the previously prepared survey questions were directed to the randomly selected 180 broiler farms. The data covers the input-output amounts used in the 4 production periods of the farms within a year. It has been determined that the 180 farms data received can represent the whole of this region. In the research, the survey data were obtained by face-to-face interviews with the farm owners and these values were analyzed with the Data Envelopment Analysis (DEA) method. In the analysis, a total of 9 input units were used, including the amount of labor force, the total number of chicks taken into the enterprise for each year, the average mortality rate, the feed used during the production periods, the cost of hatching, electricity and heating expenses, the costs related to the labor force, the vaccination and pesticide costs and other expenses. In addition, the total chicken meat production obtained from the farm in 4 production periods was taken as output for the analysis.

In the broiler farms examined in the research, technical efficiency analysis was made over the input and output figures, and the efficiency of the farms was revealed in terms of return to scale. Data Envelopment Analysis (DEA) used in the study has been used as an important study method in Iraq and other countries, especially in broiler production, in recent years (Sarıozkan and Sakarya, 2006; Farhan et al., 2015; Hassan 2021; Bahadji and Cheikh, 2021). In Data Envelopment Analysis (DEA), data were tested under conditions of constant returns to scale (CRS) and variable returns to scale (VRS). In the analysis, efficiency values were calculated for both models by using the input amounts. In addition, the constant return to scale situation is divided by the variable return to scale result and the scale efficiency of the enterprise is calculated as a scale (CRS/VRS). In the test made over the inputs, the aim is to obtain the same or target output by minimizing the inputs. The model in which the inputs will be minimized is as follows (Akdogan, 2019):

$Min_{\theta,\lambda}\theta$ subject to $Y\lambda - y_i \geq 0$ And $\theta x_i - x\lambda \geq 0$ $\lambda \geq 0$

where θ is a scale and λ is at the position of vector Nx1 of the formula. These values are calculated for each farm. This process gives the efficiency values of farms for constant returns to scale (Fraser and Cordina, 1999):

$n_{\theta,\lambda}\theta$ subject to $Y\lambda - y_i \geq 0$

and $\theta x_i - x\lambda \geq 0$ $N'\lambda \geq 0$ $\lambda \geq 0$

where, N is a Nx1 vector of variable return to scale. In function efficiency analysis, it gives the efficiency values for the variable return to the scale (Banker et al., 1984).

Technical efficiency (TE) scores were calculated for each farm as the efficiency of the numbers formed as a result of the analysis. When TE = 1, the farm is operating effectively, and when TE < 1, the farm is considered to be ineffective. It has been determined that the ineffective operation of the farm is due to excessive use of input amounts and disproportionate use of inputs. In addition, farms that do not work effectively on the same data were determined and optimum new input values were calculated for these farms that would make the farm effective.

4. Results and Discussion

In terms of education, it was determined that 27.2% of the producers participating in the survey were at primary school level, 54.0% of producers were at high school level and 17.8% of broiler producers were at university level. The average age of producers producing broiler chickens was found to be 41.8 years. In addition, while all of the individuals participating in the research are male, the average experience of these producers in broiler production is 11 years. The statistical figures of the farms participating in the research are given in Table 1. When the farms are evaluated in terms of inputs, an average of 3.32 labor force is employed in the farms. At the same time, approximately 56.000 chicks are taken on average for four production periods in a year within the farms.

Table 1: Descriptive statistics of inputs and outputs

Type	Variables	Unit	Mean	S.d.	Min	Max
Input 1	Labor	Person	3,32	1,53	2,00	9,00
Input 2	Chick	Number	56917,00	27545,56	19850,00	190000,00
Input 3	Mortality rate	Percent	15,18	6,16	2,79	41,07
Input 4	Feed	Tons	253,11	107,53	81,00	715,00
Input 5	Hatchery	$	231,91	28,30	159,00	326,00
Input 6	Electricity and Heating	$	17944,00	6771,41	3440,00	40000,00
Input 7	Labor cost	$	15326,50	7656,09	6400,00	47000,00
Input 8	Medicine-vaccine	$	9246,71	4375,62	3200,00	26000,00
Input 9	Other costs	$	8387,18	6923,45	1520,00	80000,00
Output	Production	Tons	126,61	56,91	56,50	350,00

The mortality rate of these chicks is around 15%. On the other hand, the amount of feed consumed on the basis of farms is 253 tons, and farms have an average expenditure of 231 dollars for incubations. Two of the highest costs of the farms include the electricity costs that provide the heating and lighting of the farms and the costs due to the labor force. Against all inputs, the average broiler produced by the farms throughout the year is 126 tons.

When the data of 180 farms included in the analysis were tested in terms of technical efficiency, they were evaluated under two different scales. These; constant return to scale (CRS) efficiency of farms was determined as 0.89 and variable return to scale (VRS) as 0.95.

While the most inefficient farm among the farms worked with 65% efficiency under CRS conditions, this rate was 69% under VRS conditions. The return to scale of all farms was calculated as 0.93 (Table 2).

Table 2: Technical efficiency scores of farms

	Technical efficiency		
	CRS Constant returns to scale	**VRS Variable returns to scale**	**Scale**
Mean	0,895	0,959	0,934
Std. deviation	0,090	0,068	0,079
Min	0,645	0,693	0,685
Max	1,000	1,000	1,000

The farms were examined in terms of constant return to the scale and they were divided into two groups as productive farms and inefficiently operating farms (Table 3). In comparison, 142 of the 180 broilers production farms that participated in the scale from Erbil province under the status of constant return worked 15% more inefficiently than the other 38 efficient farms. It is seen that the producers working effectively on the basis of farms use more inputs in terms of labor force, number of chicks taken into operation, total heating and electricity costs, labor-based costs and vaccine-medicine costs. On the other hand, in the total meat obtained from broiler production, there is a very large production difference of 49% in the farms that work effectively. The reason for ineffectiveness was that the inefficient farms could not minimize their input levels according to the current output, even though they used less input amount than the farms that were efficient on the basis of inputs.

Table 3: Effective and ineffective farms (CRS) under constant return to scale

	Input Variables		**TE < 1 (n = 142)**		**TE = 1 (n = 38)**		
		Unit	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**%**
CRS	Technical efficiency		0,87	0,08	1,00	0,00	14,9
Input 1	Labor	Person	3,13	1,33	4,00	1,96	27,6
Input 2	Chick	Number	53244,01	22617,09	70642,37	37997,36	32,7
Input 3	Mortality rate	Percent	15,97	6,32	12,21	4,44	23,6
Input 4	Feed	Tons	233,45	86,41	326,61	141,52	39,9
Input 5	Hatchery	$	233,78	26,42	224,89	33,49	3,8
Input 6	Electr. and Heating	$	17432,00	6564,00	19857,26	7179,66	13,9

Input 7	Labor cost	$	14794,23	6580,44	17315,53	10527,33	17,0
Input 8	Medicine-vaccine	$	8809,35	3869,67	10881,05	5599,03	23,5
Input 9	Other costs	$	8512,77	7482,62	7917,89	4189,60	7,0
Output	Production	Tons	114,74	44,75	170,96	73,22	49,0

When the farms subject to the analysis are examined in terms of variable returns to scale (Table 4), it has been observed that 72 of the 180 farms are inefficient and the other 108 farms are operating efficiently. Efficiently operating farms were equal to 1 in terms of technical efficiency, while the efficiency score of inefficiently operating farms was found to be 0.90. When the inputs used by the farms for production are evaluated, it differs from the amount of inputs used under the CRS. Effective farms have managed to produce output that will provide the effectiveness score, especially when using inputs at a lower rate in input amounts. On the other hand, inefficient farms produced 9% more output than efficient farms, but remained inefficient due to the high utilization rate of labor-based inputs, electricity-heating, chick numbers and other costs. Farms that work inefficiently have used the most input use in the workforce with 31.8% compared to farms that work efficiently. This order is followed by 22.3% of expenses related to other conditions of the farm, 18.3% of other expenses related to labor force and 17.0% of excess input usage in the number of chicks taken into operation.

Table 4: Effective and ineffective farms (VRS) under variable returns to scale

	Input Variables	Unit	TE < 1 (n = 72)		TE = 1 (n = 108)		
			Mean	Std. dev.	Mean	Std. dev.	Percent %
CRS	Technical efficiency		0,90	0,07	1,00	0,00	11,5
Input 1	Labor	Person	4,10	1,19	2,80	1,51	31,8
Input 2	Chick	Number	63402,78	26167,95	52593,15	27592,55	17,0
Input 3	Mortality rate	Percent	16,80	6,85	14,10	5,40	16,1
Input 4	Feed	Tons	268,89	103,03	242,60	109,17	9,8
Input 5	Hatchery	$	237,24	29,16	228,35	27,13	3,7
Input 6	Electricity and Heating	$	19657,44	7586,02	16801,70	5898,54	14,5
Input 7	Labor cost	$	17221,25	7445,42	14063,33	7533,10	18,3
Input 8	Medicine-vaccine	$	10223,33	4792,68	8595,63	3941,71	15,9
Input 9	Other costs	$	9679,85	9854,13	7525,41	3646,60	22,3
Output	Production	Tons	133,87	53,19	121,77	58,76	9,0

In Table 5, based on the input and output values of 142 inefficient farms under constant return to scale (CRS), new input amounts that will make these farms effective have been calculated. These farms, which work with 87% performance as an efficiency level, will activate the operating status of the farm, assuming that they make a vertical change in the amount of inputs they use. These farms should reduce their current other expenses item by 30%, electricity and heating expenses by 26%.

In addition, it is necessary to reduce the mortality rate in the farm by approximately 26%. In addition to all these, in order for farms to become effective, they need to reduce labor costs by 21%, incubation costs by 17.9% and labor force by 16.3%. The required input decreases in the amount of vaccine-medicine and feed used are lower.

Table 5: Current input usage averages and suggested input usage averages (CRS) of 142 inefficient farms under constant returns to scale

Variables	Unit	Average of current input usage	Average of recommended input usage	Change + - (%)
Technical efficiency		0,87	1,00	14,9
Labor	Person	3,13	2,62	-16,3
Chick	Number	53244,01	45198,36	-15,1
Mortality rate	Percent	15,97	11,78	-26,3
Feed	Tons	233,45	210,10	-10,0
Hatchery	$	233,78	192,00	-17,9
Electricity and Heating	$	17432,00	12778,81	-26,7
Labor cost	$	14794,23	11568,45	-21,8
Medicine-vaccine	$	8809,35	7815,08	-11,3
Other costs	$	8512,77	5921,11	-30,4
Production	Tons	114,74	115,00	0,1

In the same way, new input amounts that can make these farms effective for the farm producing 72 broilers found inefficient under variable return (VRS) were calculated and compared with the existing input quantities (Table 6). Due to the minimum input-oriented working model of the farms, the outputs were kept close to the same and the inputs were reduced.

Table 6: Current input usage averages and suggested input usage averages (VRS) of 72 inefficient farms under variable returns to scale

	Variables	Unit	Average of current input usage	Average of recommended input usage	Change + - (%)
VRS	Technical efficiency		0,90	1,00	11,1
Input 1	Labor	Person	4,10	3,09	-24,6
Input 2	Chick	Number	63402,78	53019,31	-16,4
Input 3	Mortality rate	Percent	16,80	11,73	-30,2
Input 4	Feed	Tons	268,89	241,27	-10,3
Input 5	Hatchery	$	237,24	197,52	-16,7
Input 6	Electricity and Heating	$	19657,44	14709,31	-25,2
Input 7	Labor cost	$	17221,25	12863,45	-25,3
Input 8	Medicine-vaccine	$	10223,33	8535,06	-16,5
Input 9	Other costs	$	9679,85	6546,98	-32,4
Output	Production	Tons	133,87	133,94	0,1

When Table 6 is examined, these farms that do not work effectively are working with 90% performance. In order to have an effective working situation by increasing this performance, farms need to reduce inputs by up to 32% in external input costs, approximately 30% in chick mortality during the breeding, up to 25% in labor force, labor-based expenses and electricity-heating expenses. On the other hand, around 16% savings should be made in the costs of medicine-vaccine and incubation. A decrease of 10% in the amount of feed, which is the main element in the nutrition of broiler chickens, will be sufficient to make these inefficiently operating farms work effectively.

5. Conclusion and Recommendations

Within the scope of the analysis, 180 farms in the region were selected randomly, the effective scores of the farms were calculated under CRS and VRS by using the Data Envelopment Method. Constant return to scale (CRS) of farms was found to be 0.89 and variable return to scale (VRS) was found to be 0.95. In the analysis, 21% of all farms are working efficiently under constant return to scale while 60% of farms under variable return to scale are working effectively. Efficiency is quite low for broiler production farms in Erbil region. The reason why the efficiency scores are low at this level is due to the inefficient use of the inputs at an optimal level, 142 under CRS and 72 under VRS. There are inconsistencies when the amount of inputs used by the farms and the outputs obtained are evaluated. While a farm operating in the same region reaches a certain output by using less input amounts, another farm operates inefficiently even though it uses more inputs. Especially the large variability in the amount of inputs that are not directly dependent on the amount of production is the leading cause of this. The first is the high amounts of electricity and heating-based costs. Farms that are not efficient in this area have approximately 26% more input usage for CRS and VRS, respectively. On the other hand, there is a lot of input usage (approximately 30%) compared to efficiently working farms in the input levels reported by inefficient farms under the name of other expenses. Likewise, inefficient farms, chick deaths are important reasons for the inefficient operation of these farms (30% surplus). However, the difference between efficient and inefficient farms on the basis of the amounts of feed used is around 10% and more understandable than other input differences. In the examinations, the farms producing broiler chickens are required to re-optimize the input amounts and use them. Moreover, it is obvious that inefficient farms can increase their effectiveness levels by referencing efficient working farms. In order for farms to use more optimal input, agricultural organizations, the private sector, and related units in the region should provide seminars, conferences, and training courses to the relevant farms and train the farm personnel. Thus, farms will save money by avoiding the inputs they use as inactive, and these savings will be transferred to the use of new technology autonomy in farms by increasing the size of the farm, supplying the deficiencies, or in the farms. The activities to be carried out will contribute to the regional economy, especially to the farm and its employees, both economically and on the basis of production.

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