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Does European Union's Agricultural Support Contribute to Energy Efficiency of Dairy Farms?

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ABSTRACT

The purpose of this research was to investigate whether the European Union's high amounts of construction and technology grants provided to dairy farms under The Instrument for Pre-accession Assistance for Rural Development (IPARD) program make a real contribution in terms of energy use and efficiency. The primary data of the study were obtained from Dairy Farms Supported (SDF) and Non-Supported (NSDF) by the IPARD program by using a questionnaire filled during the face-to-face interviews. The full count method was used to determine the 50 SDF while the Neyman allocation sampling method was used to determine the 100 NSDF. Energy indicators were used to evaluate the efficiency of input energy transformation into output and data envelopment analysis was used to calculate technical efficiency and pure technical efficiency. Unlike other studies in the literature, we analyzed energy efficiency of dairy farms in terms of the contribution of the EU supports. The results showed that SDF were more energy-efficient dairy farms with much better energy indicators and efficiency scores than NSDF. Productivity, benefit/cost ratios, and energy scores clearly show that EU grants given to dairy farms contribute to the efficient use of resources, including energy, increasing the competitiveness of dairy farms, and contributing to the rural area through energy efficiency and economic performance.

Keywords: Full count method, IPARD program, Neyman allocation sampling method, Technical efficiency.

INTRODUCTION

Energy efficiency is commonly seen as a key policy option for climate change mitigation (Bilandzia *et al.,* 2018; Edelenbosch *et al.,* 2020; Palm and Thollander, 2020; Rabhandari and Zhang, 2017; Röck *et al*., 2020; Sattler *et al*., 2020; Scaramuzzino *et al*., 2019; Swain and Karimu, 2020). The European Union's (EU) 2030 Climate and Energy Policy Framework describes energy efficiency as fundamental in the transition toward a more competitive, secure, and sustainable energy system (Anonymous, 2014). The EU set a 20% energy efficiency target by 2020 under the Energy Efficiency Directive (2012/27/EU) and the Amending Directive on Energy Efficiency (2018/2002) set energy efficiency target for 2030 at least 32.5%.

The EU provides grants to institutions, non-governmental organizations, companies and individuals for proects that will contribute to the realization of energy efficiency and similar policies. The EU member countries benefit from the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural

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Development (EAFRD) funds for the agricultural sector (Anonymous, 2020b), while the enlargement countries (Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, Serbia and Turkey) benefit from The Instrument for Pre-accession Assistance for Rural Development (IPARD) funds (Anonymous, 2020a).

Turkey as a candidate country benefits from the IPARD program to prepare its agriculture sector and rural areas for EU membership. The main obective of the IPARD program for dairy farms is to make them competitive against other dairy farms in the EU's common market by supporting economic, social, and territorial development, with a view to a smart, sustainable and inclusive growth, through the development of physical capital and by promoting the efficient use of resources and expansion of utilization of renewable energy (Anonymous, 2015). For energy use and efficiency, we can examine the supports of the IPARD program under two headings as direct and indirect supports. Direct supports are investments in biogas and solar energy facilities for farm activities while indirect supports are investments in construction and technologies that promote the efficient use of resources and increase production efficiency. Within the scope of the IPARD program, beneficiaries can make dairy farm investments with an investment budget of 1 million euro and they can receive grant support up to 65% (Kaya and Örs, 2019).

There are many studies related to energy indicators and energy efficiency. Although different methods were used in the energy studies for dairy farms, the calculations in these studies were based on input-output energy (Bos *et al*., 2014; Refsgaard *et al*., 1998; Shine *et al*., 2018; Upton *et al*., 2013), and analyzed the energy consumption and productivity in organic and conventional dairy systems (Elahi *et al*., 2019; Frorip *et al*., 2012; Hosseinzadeh-Bandbafha *et al*., 2018; Llanos *et al*., 2018; Meul *et al*., 2007).

This study aimed to investigate whether the high amounts of construction and technology grants provided to dairy farms under IPARD make a real contribution in terms of energy use and efficiency. While these kinds of analysis are performed at the macroeconomic level in general, in this study, analyses were performed at the microeconomic level and dynamics of farm-level were taken into account. This will contribute to measuring the impact of energy efficiency policies at the microeconomic level and developing new policies.

MATERIALS AND METHODS

Materials

We selected Konya Province as a research area because it had the highest number of cattle (740,148 head) and the highest amount of milk production (1,018,917 t yr^{-1}) in Turkey, according to the Turkish Statistical Institute's data. Konya was also one of the first three provinces that received the highest grant from the IPARD program. The analysis was carried out through the dairy farm data, which were obtained through the interviews in Konya from 50 supported dairy farms by the IPARD program (SDF) and 100 non-supported dairy farms (NSDF). Survey data span the period between May-November, 2017. For energy coefficients and formulas, previous research findings and published data were used. In this study, "$1= 3.58 Turkish Lira", which was the average exchange rate of the May and November 2017 (The Central Bank of the Republic of Turkey).

Methods

We used energy studies on dairy farming to determine inputs and outputs and to calculate energy indicators and energy efficiency. Unlike other studies, we used regression analysis to determine the inputs by considering the percentage of the impact of inputs on the milk yield. In other studies, while the energy efficiency was analyzed, data was not grouped (Elahi *et al*., 2019; Hosseinzadeh-Bandbafha *et al*., 2018; Upton *et al*., 2013) or was grouped according to the housing system (Uzal, 2013), plate heat exchanger procedure (Shine *et al*., 2018), or the number of animals (Aldeseit, 2013; Oğuz and Yener, 2019; Unakıtan and Kumbar, 2019). However, in this study, we grouped data according to whether they received IPARD support or not, and by the number of milking cows. The Data Envelopment Analysis (DEA) was used to calculate energy efficiency. The literature containing the application of the DEA method in the evaluation of agriculture economic efficiency was also examined (Blancard and Martin, 2014; Hosseinzadeh-Bandbafha *et al*., 2018; Ke-fei, 2015; Nassiri and Singh, 2009; Oğuz and Yener, 2019; Soni *et al*., 2018; Toma *et al*., 2017; Vlontzos *et al*., 2014).

Considering the aim of this study, we compared energy efficiency in dairy farms supported and non-supported by the IPARD program in Konya Province of Turkey. The statistical information was obtained from face-to-face surveys with dairy farmers. The five key sub-obectives identified the following main obectives of this study: (i) To investigate current energy use profiles at dairy farms, (ii) To calculate energy inputs and outputs, (iii) To calculate energy indicators, (iv) To perform an economic analysis of milk production, and (v) To assess technical, pure and specific efficiency of energy use by using DEA method.

Sampling Method

During the sampling period, there were only 50 SDF operating in Konya. Because the population was small and it was easy to reach the desired information, the full count method was used to determine the SDF. According to the IPARD program, milking cow number criteria for dairy farms is a minimum of 10 and a maximum of 120. Following this criterion, the mainframe of NSDF was determined as 4.209 establishments in 16 districts of Konya, which had milking cows between 10 to 120 head. The Neyman allocation from the stratified sampling method was used in the calculation of sample size (Yamane, 1967).

$$n = \frac{[\sum(N_h S_h)]^2}{N^2 D^2 + \sum[N_h (S_h)^2]} \quad (1)$$

Where, n= Sample volume, N= Total unit Number belonging to the sampling frame, S= Standard deviation of sample mean, S2= Variance, D= d/t, d= Derivation from the average, t= Standard normal distribution value. The sample size was calculated as 100 for a confidence interval of 95% and an error margin of 5%. As a result, 150 dairy farms were determined as total sample size.

Calculation of Energy Inputs and Outputs

Literature of energy studies on dairy farming to determine inputs and outputs were reviewed. The most comprehensive study of inputs and outputs for dairy farms is in the study of Oğuz and Yener (2019). We performed regression analysis to determine to what extent these inputs affect the milk yield by using our data. As a result of the regression analysis, 9 inputs were determined to have a significant relationship with milk yield (R= 0.978; R^2= 0.956; F= 334,879; P= .000). The effect of nine inputs on milk yield was determined as 96%. Therefore, in calculations, input and output variables given in Figure 1 were used. The energy input was classified into direct and indirect, and renewable and non-renewable energy. While direct energy inputs are the primary energy sources used by the farm, indirect energy inputs are other sources used in livestock and can be converted into energy value. In addition, non-renewable energy is consisted of diesel, lubricant, electricity, feeds, and machinery and renewable energy is consisted of labor (Elahi *et al*., 2019; Hosseinzadeh-Bandbafha *et al*., 2018; Oğuz and Yener, 2019; Uzal, 2013).

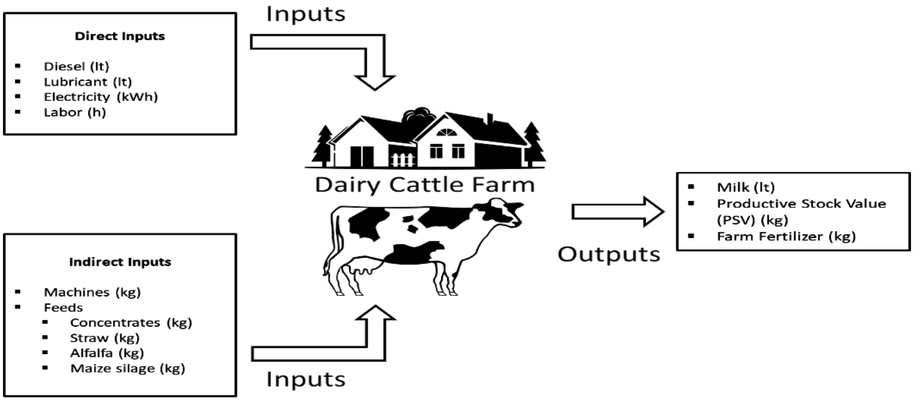

Figure 1. Inputs and outputs scheme of dairy cattle farms (Source: Research results).

Energy Value of Inputs and Outputs

The energy value of inputs and outputs was calculated by using the amount of input or output (Qi) and Energy Equivalent for that input or output (EEi). The formula used in energy calculations was given below (Elahi *et al*., 2019; Hosseinzadeh-Bandbafha *et al*., 2018; Oğuz and Yener, 2019; Uzal, 2013).

$$E_i = Q_i \times \mathrm{EE_i} \tag{2}$$

Only the energy value of machines was calculated by a different formula. The Energy value of machines (Em) was calculated by using the material mass used for manufacturing (G) as kg LAU^{-1}, the Energy Equivalent for machines (EEm) as M kg^{-1}, the time a machine is used (t) as h, and the economic life of the machine (T) as h.

$$E_m = \frac{(G \times EE_m \times t)}{T} \tag{3}$$

Energy Indicators

Energy indicators can evaluate the efficiency of input energy transformation into output (Alluvione *et al*., 2011). Energy Ratio (ER), Energy Productivity (EP), Specific Energy (SE) and net Energy Gain (NEG) were calculated by using the following formulas as energy indicators (Alluvione *et al*., 2011; Elahi *et al*., 2019; Ghorbani *et al*., 2011; Heidari *et al*., 2011; Hosseinzadeh-Bandbafha *et al*., 2018; ankowski *et al*., 2016; Kizilaslan, 2009; Mousavi-Avval *et al*., 2011; Oğuz and Yener, 2019; Ramedani *et al*., 2011; Soni *et al*., 2018; Unakıtan and Kumbar, 2019; Uzal, 2013).

$$ER = \frac{Energy\ output\ (MJ\ LAU^{-1})}{Energy\ input\ (MJ\ LAU^{-1})} \tag{4}$$

$$EP = \frac{Milk\ yield\ (kg\ LAU^{-1})}{Energy\ input\ (MJ\ LAU^{-1})} \tag{5}$$

$$SE = \frac{Energy\ input\ (MJ\ LAU^{-1})}{Milk\ yield\ (kg\ LAU^{-1})} \tag{6}$$

$$NEG = Energy\ output\ (MJ\ LAU^{-1}) - Energy\ input\ (MJ\ LAU^{-1}) \tag{7}$$

Data Envelopment Analysis (DEA)

DEA is a method for measuring the efficiency of Decision-Making Units (DMU) using linear programming techniques to envelop the observed input-output vectors as tightly as possible (Lee and i, 2010). This model has been used in the study to assess the energy amount by ranking dairy cow enterprises on the basis of their performance and to determine the resource usage efficiency. The CCR (Charnes-Cooper-Rhodes) model measures the efficiency of each DMU obtained as a maximum of the ratio between weighted outputs and weighted inputs. In other words, the fewer the inputs invested in producing the given output, the more efficient the production. The CCR model presupposes that there is no significant relationship between the scale of operation and efficiency by assuming a Constant Return to Scale (CRS). The CRS assumption is only suitable when all DMUs are operating optimally (Tan, 2014). Later, Banker *et al.* (1984) (BCC) introduced the Variable Returns to Scale (VRS) efficiency measurement model allowing the breakdown of Efficiency into Technical (TE) and Scale Efficiency (SE) in DEA. The VRS assumption allows measurement of Pure Technical Efficiency (PTE) [i.e., the measurement of Technical Efficiency (TE) devoid of the Scale Efficiency (SE) effect] (Tan, 2014).

Technical efficiency can be calculated by the ratio of the sum of weighted outputs to the sum of weighted inputs (Cooper *et al*., 2006).

$$TE = \frac{\sum_{r=1}^{n} u_r y_r}{\sum_{s=1}^{m} v_s x_s} \qquad (8)$$

Where, yr= Amount of output r, u_r= Weight assigned to output r, x_s= Amount of input s, v_s= Weight assigned to input s.

Each DMU sets its weights in solving an optimization problem to maximize its efficiency subject to the condition that all efficiencies of other DMUs remain less than or equal to 1 and the values of the weights are greater than or equal to 0 (Gelan and Muriithi, 2012). The Constant Return to Scale (CRS) linear programming problem can easily be modified to account for Variable Returns to Scale (VRS) by adding the convexity constraint. The relationship between CRS and VRS is given as:

$$TE_{CRS} = TE_{VRS} \times SE \qquad (9)$$

In this study, DEA was used to compare energy efficiency. We used Max DEA Basic 8.3 software for calculations of DEA. Input and output data were prepared as a table and solved in Max DEA software by using both the CCR and BCC models by input-oriented forms.

RESULTS AND DISCUSSION

General Information

General information about the dairy cattle farms surveyed in the field study is presented in Table 1.

Table 1. General information about dairy farms.

	NSDF	SDF
Number of surveyed dairy farms	100	50
Labor force used in the farm (Manpower unit×Day)	556.24	1,397.05
Area of processed land (Decares)	251.42	533.11
Milking cows (Heads)	30.65	108.76
Large animal unit (LAU)	49.8	159.71
Active capital ($ LAU^{-1})	12,014.28	14,182.40
Foreign capital ($ LAU^{-1})	1,711.18	1,072.48
Equity capital ($ LAU^{-1})	10,303.11	13,109.92
Dairy farm investment ($ LAU^{-1})	8,404.61	11,361.04
Lactation period (d yr^{-1})	300.00	300.00
Milking frequency (times d^{-1})	2.00	2.00
Milk yield (kg d^{-1})	20.85	26.38
Milk yield (kg yr^{-1} Cow^{-1})	6,255.00	7,914.00
Barn type	Semi-open	Semi-open
Feeding method	Total mixed ration	Total mixed ration

Comparison of Input-Output Energy Consumption of Dairy Farms

All input and output variables were converted to energy unit for comparison. Energy Equivalent coefficients (EE) of inputs and output are shown in Table 2. It was used by averaging the different EE values found for the same inputs-outputs variable in the literature. Energy values of all feeds were calculated on dry matter.

In order to put the animals of different species and structures in the farms on the same base and to examine them proportionally, the existing animals were converted to the Large Animal Unit (LAU) by using the coefficients (bull 1.40, cow 1.00, heifer 0.70, calf 0.50) (Erkuş *et al.*, 1995) and all of the inputs and outputs were quantified on LAU base.

Table 2. Energy equivalent coefficients of inputs and outputs.

Source	Unit	EE coefficients	References
A. Inputs			
1. Direct Inputs			
Diesel	M l^{-1}	43.10	(Hosseinzadeh-Bandbafha *et al*., 2018; Meul *et al*., 2007; Refsgaard *et al*., 1998; Wócicki, 2000)
Lubricant	M l^{-1}	37.70	(Hosseinzadeh-Bandbafha *et al*., 2018; Refsgaard *et al*., 1998)
Electricity	M kWh^{-1}	10.73	(Hosseinzadeh-Bandbafha *et al*., 2018; Refsgaard *et al*., 1998)
Labor	M $hour^{-1}$	1.96	(Elahi *et al*., 2019; Hosseinzadeh-Bandbafha *et al*., 2018; Nassiri and Singh, 2009; Ramedani *et al*., 2011)
2. Indirect Inputs			
Machines	M kg^{-1}	79.83	(Elahi *et al*., 2019; Ramedani *et al*., 2011; Wócicki, 2000)
Concentrates[a]	M kg^{-1} DM	6.30	(Elahi *et al*., 2019; Meul *et al*., 2007)
Straw[a]	M kg^{-1} DM	2.20	(Meul *et al*., 2007)
Alfalfa[a]	M kg^{-1} DM	1.50	(Oğuz and Yener, 2019)
Maize silage[a]	M kg^{-1} DM	14.00	(Maikhuri, 1996)
B. Outputs			
1. Milk	M kg^{-1}	7.14	(Oğuz and Yener, 2019)
2. Productive Stock Value	M kg^{-1}	9.22	(Hosseinzadeh-Bandbafha *et al*., 2018)
3. Farm Fertilizer[a]	M kg^{-1}	2.10	(Maikhuri, 1996)

[a] Dry matter ratios were taken as 88% for concentrates, 85% for straw, 85% for alfalfa, 30% for maize silage and 70% for farm fertilizer (Oğuz and Yener, 2019).

The calculations of energy inputs and outputs are presented in Table 3 according to dairy farm groups. In the NSDF, the average of the total energy inputs was 46,000.47 M LAU^{-1} consisting of 4,496.96 M LAU^{-1} direct inputs and 41,503.51 M LAU^{-1} indirect inputs. In the SDF, the average of the total energy inputs was 39,964.29 M LAU^{-1} consisting of 6,161.05 M LAU^{-1} direct inputs and 33,803.23 M LAU^{-1} indirect inputs. In NSDF, the first three energy inputs with the highest ratio were concentrates (47.28%), straw (27.07%) and maize silage (11.80%), and in SDF, the first three energy inputs were the same as NSDF's with different ratios: concentrates (41.31%), straw (23.25%), and maize silage (14.49%). Results were compared with three other dairy studies in the literature. In the study of Uzal (2013), 93.52% of energy input was feed; in the study of Hosseinzadeh-Bandbafha *et al*. (2018), 91.48% of energy input was feed; in the study of Oğuz and Yener (2019), feed ratio was 89.10% in energy inputs. The average of total energy outputs was 42,297.15 M LAU^{-1} in the NSDF, while it was 55,164.99 M LAU^{-1} in the SDF. When the percentage distribution of the energy outputs was examined, the NSDF's energy outputs consisted of 80.00% milk production, 1.65% PSV and 18.35% farm fertilizer. On the other hand, in SDF, it consisted of 84.01% milk production, 1.39% PSV and 14.60% farm fertilizer. While 9.78% of input energy in NSDF was direct energy and 90.22% was indirect energy, these ratios were 15.42 and 84.58% in SDF, respectively. Regarding renewable energy, 1.14% of input energy in NSDF was renewable energy and 98.86% was non-renewable energy, while it was 1.03 and 98.97% in SDF, respectively

(Table 4). In the study of Oğuz and Yener (2019), 8.05% of input energy was direct, and 91.95% was indirect energy, while 1.41% of input energy was renewable and 98.59% was non-renewable.

Table 3. Energy inputs and outputs in NSDF and SDF.

	NSDF		SDF	
Inputs/Outputs	Energy values (M LAU^{-1})	%	Energy values (M LAU^{-1})	%
A. Inputs				
1. Direct inputs				
Diesel	1,694.87	3.68	1,761.75	4.41
Lubricant	10.08	0.02	10.48	0.03
Electricity	2,266.57	4.93	3,977.33	9.95
Labor	525.44	1.14	411.49	1.03
Total direct inputs	4,496.96	9.78	6,161.05	15.42
2. Indirect inputs				
Machines	283.75	0.62	199.90	0.50
Concentrates	21,749.19	47.28	16,509.99	41.31
Straw	12,451.97	27.07	9,293.61	23.25
Alfalfa	1,588.88	3.45	2,010.32	5.03
Maize silage	5,429.72	11.80	5,789.42	14.49
Total indirect inputs	41,503.51	90.22	33,803.23	84.58
Total inputs	46,000.47	100.00	39,964.29	100.00
B. Outputs				
1. Milk	33,839.60	80.00	46,345.26	84.01
2. Productive stock value	696.19	1.65	765.46	1.39
3. Farm fertilizer	7,761.36	18.35	8,054.27	14.60
Total outputs	42,297.15	100.00	55,164.99	100.00

Energy indicators in NSDF and SDF were calculated and are shown in Table 5. The Energy Ratio (ER) was calculated as 0.92 in NSDF and 1.38 in SDF. Energy Productivity (EP) was calculated as 0.10 kg M^{-1} in NSDF and 0.16 kg M^{-1} in SDF. Specific Energy (SE) was calculated as 9.71 M kg^{-1} in NSDF and 6.16 M kg^{-1} in SDF. When the energy values required for 1 kg milk production were converted to kWh and the cost was calculated, NSDF spends \$ 0.05 for 1 kg of milk and SDF spends \$ 0.03. The Net Energy Gain (NEG) value was calculated as -3,703.32 M LAU^{-1} in NSDF while it was 15,200.70 M LAU^{-1} in SDF. While the input energy was higher than the output energy in the NSDF, the opposite was the case in the SDF.

Table 4. Different types of energy inputs in NSDF and SDF.

	NSDF		SDF	
Energy type	Energy (M LAU^{-1})	%	Energy (M LAU^{-1})	%
Direct energy	4,496.96	9.78	6,161.05	15.42
Indirect energy	41,503.51	90.22	33,803.23	84.58
Renewable energy	525.44	1.14	411.49	1.03
Non-renewable energy	45,475.03	98.86	39,552.80	98.97
Total energy input	46,000.47	100.00	39,964.29	100.00

Table 5. Energy indicators in NSDF and SDF.

Indicators	NSDF	SDF
ER	0.92	1.38
EP (kg M^{-1})	0.10	0.16
SE (M kg^{-1})	9.71	6.16
NEG (M LAU^{-1})	- 3,703.32	15,200.70

Economic Analysis of Milk Production

Within the scope of economic analysis, production costs, gross production value, gross profit, unit milk cost, milk sales price, productivity, net return and benefit/cost ratio values were calculated and are presented in Table 6 (Açıl and Demirci, 1984; Çetin, 2013; Geetha and Lavanya, 2013; Ghorbani *et al*., 2011; Hanrahan *et al.,* 2018; Kıral *et al.,* 1999; Kumawat *et al.,* 2014; Örs and Oğuz, 2019; Ramsbottom *et al.,* 2015; Shoemaker *et al.* 2008; Tapki, 2019; Tranel and Gary, 2002). The average gross profit was higher in SDF and this was an indicator that they were more competitive and more successful in terms of business organization.

Table 6. Economic analysis of milk production

	Unit	Values	
		NSDF	SDF
Total variable costs	$ LAU^{-1}	1,882.29	2,044.30
Total fixed costs	$ LAU^{-1}	720.77	844.79
Total production costs	$ LAU^{-1}	2,603.06	2,889.10
Gross production value[a]	$ LAU^{-1}	3,104.98	3,909.29
Gross profit[b]	$ LAU^{-1}	1,222.69	1,864.99
Unit milk cost	$ kg^{-1}	0.37	0.33
Milk sales price	$ kg^{-1}	0.38	0.40
Net return[c]	$ LAU^{-1}	501.92	1,020.19
Productivity[d]	kg $$^{-1}$	2.40	2.74
Benefit/Cost ratio[e]	-	1.19	1.35

[a] Gross production value= [Milk production amount (kg)×Milk price ($ kg^{-1})]+Productive stock value ($)+Animal manure income ($); [b] Gross profit= Gross production value ($)-Total variables costs ($); [c] Net return= Gross production value ($)–Total production costs ($); [d] Productivity= Milk yield (kg)/Total production costs ($); [e] Benefit/Cost ratio= Gross production value ($)/Total production costs ($).

In this respect, productivity and benefit/cost ratios were 2.40 kg $$^{-1}$ and 1.19 in NSDF, while they were 2.74 kg $$^{-1}$ and 1.35 in SDF. It was clear that the yield and gross production value obtained against the unit cost were higher in SDF and this was an indication that SDF were more competitive enterprises.

Energy Efficiency Analysis in Milk Production

For a more comprehensive assessment of energy efficiency, we grouped dairy farms by the number of milking cows. The results of the DEA are showed in Table 7. When TE is equal to 1, we call the DMU as efficient, and when TE is smaller than 1, we call it as inefficient (Ke-fei, 2015). When we examine Table 7 according to farm size groups, technical efficiency appears to be similar across both SDF and NSDF. The dairy farms that had 51 head or more milking cows were the group with the highest TE score.

The average TE and PTE scores in NSDF were 0.93 and 0.94, respectively, while they were 0.94 and 0.96 in SDF. Although the average energy efficiency of SDF is higher than that of NSDF, the difference is very low. TE and PTE scores according to farm size groups are shown in Figure 2 as a radar chart.

In Figure 2, the group with the outer ring is the group with 51 or more head of milking cows. Since the outer ring is the closest to 1.00, which is the energy-efficient value, it represents the group with the highest energy efficiency. In this group, the PTE values of NSDF and SDF are the same as 0.96, while the TE value of NSDF (0.96) is slightly higher than the TE value of SDF (0.94). The group with 51 or more heads of milking cows is the group with the highest energy efficiency, and it can be said that the energy efficiency of NSDF in this group is slightly higher than the SDF.

Table 7. Results of data envelopment analysis.

	Farm size groups (No of milking cows)	No of farms	TE	PTE	SE	Efficient	Inefficient	The ratio of efficient farms (%)
NSDF	10-25	63	0.92	0.94	0.98	35	28	55.56
	26-50	20	0.90	0.93	0.98	9	11	45.00
	51+	17	0.96	0.96	0.99	9	8	52.94
	Avg	100	0.93	0.94	0.98	53	47	53.00
SDF	10-25	2	0.93	0.95	0.98	0	2	-
	26-50	2	0.81	0.81	1.00	1	1	50.00
	51+	46	0.94	0.96	0.98	24	22	52.17
	Avg	50	0.94	0.96	0.98	25	25	50.00

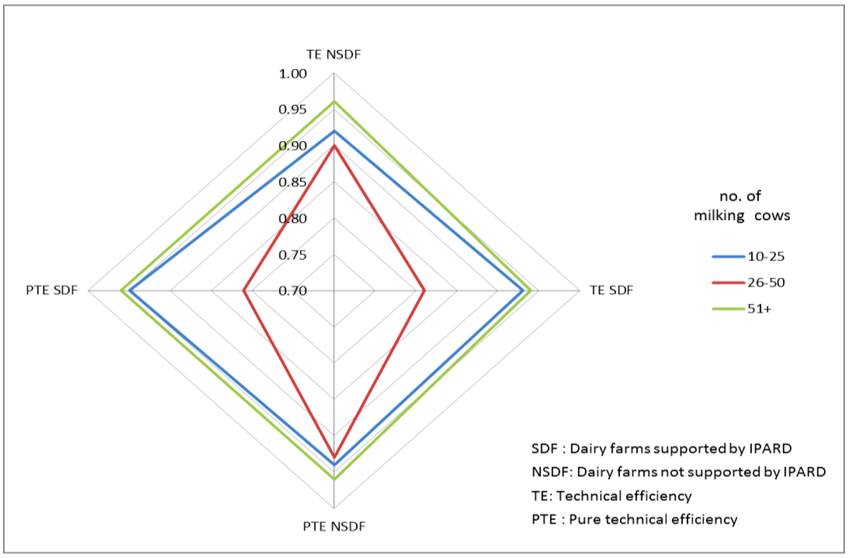

Figure 2. Comparison of TE and PTE values of dairy farms.

CONCLUSIONS

In some studies (Oğuz and Yener, 2019; Unakıtan and Kumbar, 2019), it was observed that energy efficiency increased as the number of milking cows increased, while in other studies (Aldeseit, 2013), the opposite was observed i.e. energy efficiency decreased as the number of animals increased. Unlike literature, in our study, no correct or inverse proportional relationship was observed between the number of cows and energy efficiency. It has been determined that the energy efficiency scores of the dairy farms with 51 or more heads of cows and those with 10-25 heads of cows are higher than 26-50 group.

The study confirms that SDF were more energy-efficient dairy farms with much better energy indicators and efficiency scores than NSDF. Productivity, benefit/cost ratios, and energy scores clearly show that EU grants given to dairy farms contribute to the efficient use of resources, including energy, and make them businesses that are more competitive. Future studies might concern with not only dairy farm sizes but also need to analyze comprehensively whether or not dairy farm has the financial power to reach the expected sizes.

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آیا حمایت های کشاورزی اتحادیه اروپا به کارآیی انرژی در دامداری‌ها کمک میکند ؟

آ. اورس، و س. اوگوز

چکیده

هدف این پژوهش بررسی این پرسش بود که آیا مبالغ زیاد کمک های مالی بلاعوض اتحادیه اروپا برای ساخت و ساز و فناوری ارائه شده به دامداری‌ها تحت برنامه "ابزار پیش از الحاق برای توسعه روستایی (IPARD) " کمکی واقعی از نظر استفاده و کارایی انرژی می کند یا خیر. داده‌های اولیه این مطالعه از گاوداری‌های حمایت شده (SDF) و غیرحمایت‌شده (NSDF) در برنامه IPARD و با استفاده از پرسشنامه تکمیل‌شده در طی مصاحبه حضوری و رو در رو به‌دست آمد. از روش شمارش کامل برای تعیین SDF ۵۰ و از روش نمونه گیری تخصیصی(allocation (sampling method Neyman برای تعیین NSDF ۱۰۰ استفاده شد. برای ارزیابی کارایی تبدیل انرژی ورودی به خروجی از شاخص‌های انرژی و برای محاسبه کارایی فنی و کارآیی فنی خالص از تحلیل پوششی داده‌ها (data envelopment analysis) استفاده شد. بر خلاف سایر مطالعات، در این پژوهش، ما کارآیی انرژی در دامداری‌ها را از نظر سهم حمایت‌های اتحادیه اروپا تجزیه و تحلیل کردیم. نتایج نشان داد که دامداری‌های SDF ازنظر انرژی کارآمدتر و ازنظر شاخص‌های انرژی و کارآیی انرژی بسیار بهتر از NSDF بود. بهره وری، نسبت سود/هزینه و عدد امتیاز انرژی به وضوح نشان می دهد که کمک های بلاعوض اتحادیه اروپا به دامداری ها منجر می شود به استفاده کارآمد از منابع، از جمله انرژی، افزایش رقابت پذیری دامداری‌ها، و کمک به مناطق روستایی از طریق کارآیی انرژی و عملکرد اقتصادی.