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Technical Efficiency of Dairy Farms in Central Kosovo

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ABSTRACT

Kosovo has the key resources needed for a developed agriculture. However, Kosovo's agriculture consists of very small farms which are featured with the fragmentation of their land, old buildings and equipment, though functional. Ministry of Agriculture (MAFRD) started to support farmers with direct payments in 2009, but only for a few agricultural cultures. Support for dairy cows started in 2012, and support for milk quality started in 2014. In this context, the purpose of this paper is to accurately portray the characteristics, and technical efficiency of dairy farms in Central Kosovo, respectively in the region of Pristina - beneficiaries of direct payments for milk quality. Consequently, through data envelopment analysis, under variable return to scale using output orientation, the efficiency rate of dairy farmers is calculated. Therefore, findings show that not all the farms are fully efficient, or fully utilizing their assets and their inputs. Additionally, the study revealed that the size of the farm, and the feeding system affect the TE. Therefore, large-size farms and farms who used seasonal grazing had overall higher TE. However, the level of education does not have a significant effect on the farm's efficiency.

Keywords: Dairy Sector, Kosovo, Technical Efficiency, Data Envelopment Analysis
JEL Classifications: D24, Q12, Q1

1. INTRODUCTION

Milk is one of the most produced and valuable agricultural commodities worldwide (FAO, 2016). Global demand and production of dairy are projected to increase in the future. According to Deloitte (2017), global demand for dairy is expected to increase by 2.5% per annum to 2020, and FAO (2016) estimates that world milk production is projected to increase by 177 million tonnes by 2025, at an average growth rate of 1.8% per annum in the next 10 years. Currently, Europe[1] is the largest cow milk producer in the world with 215.7 mil tons produced annually, and it covers 32.7% of world market share, however, as a single country, the USA is the largest producer of fresh cow's milk in the world (FAOSTAT, 2016).

In Kosovo, milk production is very important and also very sensitive as well, due to the structures of farms. They are small in size and herds as well, and also don't have the proper conditions for the production of high-quality milk (MBPZHR, 2013). The average size farm is less than 5ha (MAFRD, 2017). According to the Ministry of Agriculture of Kosovo, the average number of dairy cows in Kosovo's farms is 1-5 heads of dairy cows (94.2%), and 5.8% (4,238 farms) are commercial which consists with more than 5 heads of dairy cows (MAFRD, 2015). Though for the structure of breeds, the majority of dairy farms in Kosovo (60%) consist of mixed breeds, while Noble Races takes place with 35%, and Busha[2] with 5%. In terms of productivity, Kosovo's dairy farms tend to score low compared to regional and other European countries. The highest average milk production in Kosovo belongs to Noble Races with 3050 L per lactation (305 days) (MAFRD, 2015).

Milk is a strategic product, and countries pay a lot of attention to its production. Support of milk production through investment grants, subsidies and milk quotas are present throughout the world, but are more emphasized in the developed countries. In case of

1 All European countries, not just European Union.

2 Busha is native breed which belongs to small or short horn group.

Kosovo, MAFRD started to support farmers with direct payments in 2009, but for only a few agricultural cultures. Support for dairy cows started in 2012, with 50 €/head (MBPZHR, 2014). Budget for direct payments and grants has increased year by year, from where it started. Therefore, direct payments for dairy cows and buffalos – for those farmers who have 5 or more heads of dairy cows or buffalos, or jointly, has increased by 40% to 70 €/head (MAFRD, 2017).

Additionally, from 2014, farmers are being supported for milk production as well, based on milk's quality (AZHB, 2015). In this segment, dairy farmers to benefit from this scheme, first have to register their farms, and then within three months have to deliver at least 1500 L of milk in one of the licensed dairies. Support for milk production is done based on its quality/class, where extra class and first-class get an overall higher price, while on the other hand, those farmers who deliver low-quality milk, respectively second and third class are "punished" by milk processing companies by getting a lower price since the factories are obligated to correct each type of milk (Hasani and Veldhorst, 2017). Table 1 presents each category of milk and the monetary support from MAFRD.

However, the competitiveness analysis of Kosovo's agriculture shows that currently only a fraction of its small farms can compete in the regional, EU and international markets. "The main causes of this low competitive ability are small size in the most agricultural businesses, fragmentation of their land, old buildings and equipment, lack of financial means for investment and low level of knowledge related to contemporary manufacturing technology" (MBPZHR, 2017). Moreover, the awareness of dairy farmers on food safety and animal diseases is low, as well (Zeqiri et al., 2015).

Reviewing the literature, it's been found that several authors presented/explained the situation of dairy farming in Kosovo, and the challenges it is facing. (Behluli et al., 2017; Miftari et al., 2011; Musliu et al., 2017), are just a few to mention. (Shkodra, 2020), measured the profitability of dairy farms in Central Kosovo –beneficiaries of direct payments for milk quality, and found that mid-size farms (10-25 heads) and large farms (25< heads) tend to have higher profitability than small farms (1-10 heads). (Bajrami et al., 2017), found that in national level dairy farms in Kosovo scored 0.72 (on a scale 0-1.00) of Technical Efficiency. While in another study conducted by (Musliu et al., 2019), dairy farms in Kosovo had better results of TE, 0.95. However, there was no study specifically for dairy farms - beneficiaries of direct payments for milk quality.

Consequently, the purpose of this paper is to accurately portray the characteristics, and technical efficiency of dairy farms in Central Kosovo, respectively in the region of Pristina - beneficiaries of direct payments for milk quality from the MAFRD, and implemented by AAD.

Table 1: Support of MAFRD to milk producers based on milk categories

Category of milk	Support from MAFRD
Extra class	0.06€/l
First class	0.04€/l
Second class	0.02€/l

Source: (AZHB, 2017)

2. MATERIALS AND METHODS

Using Data Envelopment Analysis (DEA), the efficiency rate of dairy farmers is calculated. In DEA the organization of firms in the study is called a Decision-Making Unit (DMU). DMU is regarded as an entity for converting inputs, and whose performance is to be evaluated (Cooper et al., 2002). The idea of DEA was first originated by Farrell in 1957 (Farrell, 1957). However, Charnes et at. (1978) offered it in a mathematical program which is still used nowadays. They were the first to develop a Constant Return to Scale model (Charnes et al., 1978). However, for this study Variable Return to Scale (VRS) model is employed. This model is first originated by Banker et at (1984), who added an extra variable "u" to the model developed by Charnes et al. (1978), and this variable allows the change of scale (Joro and Korhonen, 2015).

The framework for the DEA approach has been introduced by Farrell (1957) at first and popularized by Charnes et al., (1978). DEA is a non-parametric mathematical programming approach to frontier estimation.

The first and widely applied model was the input orientated CRS models, which solves the following linear programming problem for each firm to obtain the efficiency score:

$$\begin{aligned} &\max_{u,v} (u'y_i/v'x_i),\\ &\text{constrains: } u'y_j/v'x_j \leq 1,\ j=1,2,\ldots,N, \qquad (1)\\ &u,v \geq 0 \end{aligned}$$

Where regarding Coelli et al. (2005), assuming K inputs and M outputs for each N firms. For the i-th firms, the column vectors are represented by x_i and y_i respectively. X indicates the K*M input matrix and Y shows the M*N output matrix for all N firms. To measure efficiency, we want to obtain the measure of the ratio of all outputs over all inputs, like $u'y_i/v'x_i$ where u represents the M*1 vector of output weights and v represents the K*1 vector of input weights. The obtained efficiency score will be less than or equal to one. There is one problem with this formulation because it has an infinite number of solutions. Charnes et al. (1978) solve it by adding one constrain $v'x_i=1$ and reformulate the objective function a bit, this form we known as the multiplier form of the DEA. Using the duality linear programming method from the multiplier formula the envelopment form can get, which is the following:

$$\begin{aligned} &\min_{\theta\lambda} \theta,\\ &\text{constrains: } -y_j + Y\lambda \geq 0, \qquad (2)\\ &\theta x_i - X\lambda \geq 0,\\ &\lambda \geq 0, \end{aligned}$$

where λ represents the vector of peer weights. θ is a scalar and the value of it will be the efficiency score for the i-th firm, the value of 1 indicate the frontier and hence a technically efficient firm (but in practice, it does not exist). This linear programming problem must be solved N times, once for each firm in the sample. Hence, each firm has its own θ efficiency score (Coelli et al., 2005). The points of the fully efficient firms determine the fully efficient frontier line.

Regarding the Eq. (2), takes the i-th firm and then seeks to radially contract the input vector, x_i, as much as possible, while still remaining within the feasible input set. The inner boundary of this set is a piece-wise linear isoquant (refer Eq. (1)), determined by the observed data points which are the firms in the sample. The radial contraction of the input vector, x_i, produces a projected point, $(Y\lambda, X\lambda)$, on the surface of this method. This projected point is a linear combination of these observed data points. The constraints in Eq. (2) ensure that this projected point cannot lie outside the feasible set (Coelli et al., 2005).

The constant returns to scale assumption is acceptable if the firms in the sample are operating at an optimal scale, but in practice, the firms with imperfect competition do not behave like that. Banker et al., (1984) suggested a model which can deal with variable returns to scale (VRS) situation. This model is quite similar to the CRS model except by adding a convexity constraint ($N1'\lambda = 1$) to the model, which accounts for the variable returns to scale. The model regarding Banker et al. (1984) and Coelli and Perelman (1996) presents an output-oriented model when the firms have fixed quantity of resources (capital, labour, livestock, land) and want to produce output (milk, calf) as much as possible. This model is very similar to the input orientated model. So the formula of an output orientated VRS model is the following:

$$\begin{aligned} &\max_{\phi\lambda} \phi,\\ &\text{constrains: } -\phi\, y_j + Y\lambda \geq 0,\\ &x_i - X\lambda \geq 0, \qquad (3)\\ &N1'\lambda = 1\\ &\lambda \geq 0, \end{aligned}$$

where the N1 is an N*1 vector of ones moreover $1 \leq \phi < \infty$ and $\phi - 1$ is the proportional increase in output that could be achieved by the i-th firm, with input quantities held constant. $1/\phi$ determine the technical efficiency score, which lies between zero and one.

In our study, sampled dairy farms in Central Kosovo are DMU's. In the DEA, five inputs and one output are employed. Total assets, heads of dairy cows, number of employees (including family members), feed cost, and other costs except for feed cost, are the inputs used in the analysis. Milk production is the only output in the model. The reason for using one output method is that milk is the main product derived from cows, and sampled farms were milk-oriented, and not meat-oriented. Furthermore, the majority of farms used to sell the calves as soon as possible and used to save only one or two for family consumption, and of course, they used to grow those calves that they thought that would be good heifers, and dairy cows as a result. Moreover, the sale of milk is the main source of income for the sampled farmers, and they were interested in increasing milk production, and its quality.

Different farms used different feeding diets, and had a different level of milk production, with the same breed (at least their genetic potential for milk production). Thus, an increase or decrease in the usage of inputs can potentially increase or decrease the level of outputs. Therefore, we assume that an increase in the inputs (feed), can potentially increase milk production, but not necessary. That's why VRS method is employed in our study. Furthermore, tested DMU's are grouped into three groups based on the number of dairy cows they possess. Thus, small, medium and large farms are our testing groups. Based on the results from DEA, the most efficient group will be determined. Moreover, further analysis will be conducted to see if other factors like education and farm size have any impact on farms performance.

3. DATA

Registered dairy farms in Central Kosovo or the region of Pristina are the finite target population for this study. Region of Pristina is one of the seven regions of Kosovo. It is the largest, and most populated region in Kosovo, and consists of eight municipalities: Pristina, Fushë Kosovë, Drenas, Artanë, Lipijan, Kastriot, Besianë, and Gracanicë. The sample frame was the list of the farmers who applied for the direct payments per milk quality at the MAFRD, respectively AAD. Overall the number of farmers who apply for direct payments for milk quality is relatively low, because to get direct payments for milk quality, farms first should be registered, and sell at least 1500 L of milk in any of the milk processing companies or collecting point within 3 months.

Furthermore, direct payments for milk quality are done based on the hygiene of milk, and therefore not all the farms can achieve these requirements. To further explain this phenomenon, in 2016, in the region of Pristina where our sample is taken, 1516 farms applied for direct payments for heads of cows, and only 204 farms for milk quality. Furthermore, the application and the payments for milk quality are done every 3 months, or in a quarter of the year. Hence, in 2016, the fourth quarter had the highest number of beneficiaries for milk quality – 67 farms, while in the 1st quarter the number of beneficiaries was 32 (AZHB, 2017).

Consequently, the sample of 20 dairy farms out of 45 applicant farms is set. The sample consists of seven small size farm, ten medium-size, and one large farm in this region. Moreover, it is important to mention that there were also farmers who refused to get interviewed, but overall the refusal rate was not high.

4. RESULTS AND DISCUSSION

The efficiency of sampled DMUs is measured through the DEA by using VRS method. There were present different forms of input usage and different level of output (milk production) as a result. In case of dairy farming, an increase in inputs does not necessarily mean an increase in the outputs, and this is the why VRS method is employed in the study.

Table 2 shows CRS, VRS and Se DEA models for output orientation. This is done only to provide an insight into the overall

Table 2: Estimated TE of sampled dairy farms

	Output orientation			
Item	**Min**	**Max**	**Mean**	**SD**
CRS	0.56	1.00	0.91	0.124
VRS	0.58	1.00	0.96	0.105
SE	0.65	1.00	0.95	0.084

Source (Own model by using sampled DMU's data). SE: Scale efficient

TE of sampled dairy farms, and to see how our results compare to other studies in this field. Efficiency scores in the study are presented on a scale of 0-1.000, where those farms with 1.000 score are fully efficient with the current level of inputs and technologies used, relative to other farms used in the study. The CRS model show the mean technical efficiency of 91.2% with a standard deviation of 12.4%. On the other hand, under the VRS model with the output orientation, the MTE is 96% with a standard deviation of 10.5%. To simplify, results show that an average farm with the same level of inputs and available technology has the possibility to improve its technical efficiency by 8.8% under the CRS model, and 4% under VRS respectively, based on the frontiers or the best performing farms in the study.

Under the CRS model, the results of this study agree with the study of (Musliu et al., 2019) whose dairy farms used in their study resulted in mean TE of 0.95. Additionally, results show that 40% of sampled farms scored 1.000 both on CRS and VRS as well, thus are scale efficient. Another 40% of farms were recorded under increasing returns to scale, also known as weakly efficient. Those farms have possibilities to improve their efficiency by increasing the usage of inputs to achieve optimal milk production. On the other hand, 20% are signed with decreasing returns to scale, and for that level of milk production, they are using more inputs than necessary. Therefore, they have to slightly decrease the usage of inputs, or with the current level of inputs and technology used could have higher milk production based on the frontiers from the analysis.

4.1. Relationship of Educational Level, Farm Size and Feeding System with Farm Efficiency

Through DEA VRS model using output orientation, it is aimed to see if the educational level of the owner or manager of the farm, farm size, and feeding system (grazing vs confined) determine of affect farm efficiency.

Results from Table 3 show that in our studied farms, the level of education does not have a significant impact on the overall farm efficiency.

In this case, under the VRS model, farmers who have finished only the primary school have the highest technical efficiency (1.000), compared to the other two groups. Besides, those farmers whose level of education was high school scored lower than those with primary school, but better than farmers with higher degrees (BSc and MSc). Therefore, high school farmers scored 0.957 of TE and those with BSc and MSc 0.933 out of 1.000. In this respect, in our study primary school farmers, even though with the lowest level of education turned out to be the most efficient under the VRSTE.

During personal discussions with farmers, they mentioned that it's their long experience and passion for dairy farming that makes them stand out. Furthermore, farming for them is not just a profession or a business, it is a way of life. However, it is not known exactly if the expertise alone is the main indicator for high TE or the quality of education in Kosovo is not in the satisfactory level, so it does not affect the profitability and overall efficiency of those dairy farms. Consequently, this could lead as a direction for further research and a sample that would include the whole Kosovo.

Following, the mean of VRS for each farm size is calculated. After the level of education, it is intended to see if farm size has a positive correlation with technical efficiency (Table 4). Results show that under the DEA VRS model, farm size has a positive correlation with TE. Small farms with 0.893 score, have overall weaker efficiency compared to the other two groups. Following, the mid-size farms have a higher TE than small farms with 0.996 scores under the VRS. And lastly, the large farms with a score of 1.000, recorded the highest technical efficiency of all groups, and thus are fully efficient relative to other farms in the study.

Larger farms tend to have overall more assets, including land and machinery which is used to produce the animal feed. Furthermore, with mixers that prepare the concentrates, the feed at the end tend to be of higher quality and a more suitable form for animals. Accordingly, higher milk production was recorded. Consequently, with present herd/breed and current level of inputs and technology of production, they cannot achieve better results/efficiency.

On the other hand, small farms recorded lower percentage of feed cost to total costs relative to other two types of farms, however the feed cost per litre of milk in the small farms is relatively higher than on the other two groups of farms. Hence, high feed cost is a major indicator of low efficiency. Therefore, while the cow's breed, feeding and milking system are the same, there are possibilities for improvements in being more efficient, and more competitive, and as a result to survive or prosper in this highly competitive market.

In the case of the mid-size farms, they are in a much better position than small farms. Their TE score is 99.6%, and just 0.04% needs to be enhanced to reach full efficiency based on best-performing farms in the study. In this respect, mid-size dairy farms in our sample have a relatively low cost of feed per litre of milk, and the overall cost of production. Furthermore, they are well equipped and capable of producing the necessary feed for their animals. However, higher-quality seeds and fertilizer would increase both quality and quantity of animal feed, and thus if not increasing - then maintaining the same level of milk production with fewer inputs.

Another comparison between sampled farms is done based on their feeding system. The majority of farms in the study (75%) used

Table 3: The means of VRSTE for the level of education

Level of education	Mean VRSTE
Primary school	1.000
High school	0.957
BSc and MSc	0.933

Source (Own model by using sampled DMU's data)

Table 4: Means of VRSTE for each farm size

Farm size (No. of heads)	Mean VRSTE
Small (1–10)	0.893
Medium (11–25)	0.996
Large (25<)	1.000

Source (Own model by using sampled DMU's data)

Table 5: Mean of VRSTE for the sampled farms based on the feeding system

Feeding system	Mean VRSTE
Closed	0.916
Seasonal grazing	0.975

Source (Own calculation by using sampled DMU's data)

seasonal grazing, while the other 25% kept their cattle closed, and tied within a farm throughout the year. Consequently, a question raised is: does the feeding system has an influence in TE, and if yes, which feeding system is more efficient?

Data from Table 5 show that farms who use seasonal grazing have higher VRS technical efficiency score (97.5%), than farms who keep their cattle permanently contained (91.6%). Therefore, an average farm in a closed feeding system could increase its milk production for 8.4% with the current level of inputs. On the other hand, pasture farms can increase their milk production by 2.5%. Other studies like (Cabrera et al., 2010), found the pasture has a negative relationship with TE, however, in our study, farms who used seasonal grazing not just have a higher TE, but healthier and happier animals, together with higher quality milk with lower costs are other supplementary benefits from grazing as well. More specifically, farms who use grazing do not record any problem with cow's legs, which is common in the closed system farms.

However, it is important to mention that feeding system was determined from the farm's location, respectively if it has the possibility for grazing or not. In this context, those farms who were deeper in the villages used to graze their cattle, and those who were nearer cities, grazing was limited or impossible at all. Nevertheless, farms who used closed feeding system owned and rented the necessary land to produce the animal feed, and bought only those products that cannot be produced within a farm, like minerals and vitamins, and also some pre-prepared concentrates (if used).

5. CONCLUSION

The efficiency of sampled DMU - of dairy farms in central Kosovo – beneficiaries of direct payments for milk quality is measured with DEA by using VRS method. There were present different forms of input usage, and different levels of milk production, as a result. Furthermore, in the case of dairy farming an increase in inputs does not necessarily mean an increase in outputs, and this is why VRS is employed.

Findings show that not all the farms are fully technical efficient, or fully utilizing their assets, and their inputs. Mid-size farms scored the highest level of efficiency under SE. However, under the VRS technical efficiency, it was large farms that recorded the highest score. Furthermore, it is shown that a higher level of education does not affect farm's efficiency, but feeding system does. Therefore, farms who used seasonal pasture scored better in technical efficiency than those with closed feeding system.

Accordingly, to increase the overall efficiency those farms have to put their focus mainly on:

- Proper feed management - Here it is recommended to use and produce more plants that are rich in protein like alfalfa and soybean. Grass silage was missing as well. Thus, these ingredients should have the proper usage and share in the complete diet used in animal feed
- Second, making necessary investments in essential technologies for dairy production. Investing in mixers that prepare the feed/concentrates for animals, reduces the time, the labour force, losses, and increases the feed quality as well. Furthermore, in those farms where the collection of milk is not done every day, building a separate room for milk storage, and buying a milk cooling tank is essential. Therefore, they will prevent milk fermentation, and increase the level of hygiene. This would result in a higher level of support from direct payments as well
- Increase labour productivity - Even though the majority of employees are family members and do not get a regular salary, it is recommended to reduce the number of employees – or to increase the number of cattle with the same level of the labour force in order to increase their productivity. Furthermore, additional engagement in other fields would increase the incomes in the family.

And last but not least, farmers must become data-oriented. Except for the largest farm, none of the sampled farmers used to record the expenses and revenues that occur during farm operations. Furthermore, none (except the large farm) used to calculate the cost of production, and don't even know how to calculate it. And in the era when firms are utilizing digitization and artificial intelligence this is disagreeable. Farmers are price-taker, so they should know the situation and try to improve and upgrade the processes, increase overall efficiency, and thus increase the profits as a result. There are always opportunities for improvements, but without the proper data and analysis, it is hard to identify the problem. Simply, if you do not measure – you cannot improve.

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