Economics and Livestock Farming Mechanization

Review

Labor, Location, and Size as Technical Efficiency Factors of Dairy Systems

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ABSTRACT

Background: Technical efficiency (TE) refers to the ability of obtaining the highest possible amount of products, depending on production and technology factors. **Aim:** The aim of this paper was to review the effect of factors like labor, geographical location, and farm size on the TE of dairy systems.

Development: Document review was conducted to study factors such as labor, geographical location, and farm dimensions, and the influence of these factors on technical efficiency (TE) in dairy systems. An evolution in the increase of total cows and the number of TE in dairy systems has been reported, regarding the existing relation with location, labor, and herd size. Studies of farm size and total cows showed a positive relation with ET, which suggested that large dairy farms have higher TE than smaller farms; however, the size-efficiency ratio does not look very strong.

Conclusions: The relation of technical efficiency with labor, technical training, and rural extension in differential mode, were observed. However, no significantly sustained relation was observed between farm dimensions and technical efficiency in several countries and by different kinds of farmers, showing a negative relation with efficiency and farm size in some. This might also reflect the additional complexity of allocating more resources and accomplishing technical efficiency at different scales.

Key words: location, economy, efficiency, livestock raising, human resources (Source: *AIMS*)

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INTRODUCTION

According to Jiang and Sharp (2014); Torres-Inga *et al.* (2016); Torres-Inga *et al*. (2019), and Guevara *et al.* (2019), in recent years, several review articles have been published in relation to economic analysis of dairy systems to improve technical efficiency (TE), through different means, and technical training. Hence, in New Zealand, a solid and successful chain of elements of dairy systems has been developed thanks to favorable grazing conditions and proper training in technology, which have played a key role leading to highly efficient dairy systems. This has been also possible due to proper Research-Development, and extension, based on livestock farmers, the industry, and consumers, (Jiang and Sharp, 2014; Ma, Renwick, and Bicknell, 2018; Ma, Renwick, and Greis, 2019).

Technical efficiency is determined by using different ways. As a concept, it refers to the ability of making the most possible yields, according to production factors and the level of technology. It relies on the qualities of the human capital that manages farms, as well as personal training (Torres-Inga *et al*., 2019). The reviewed literature includes different analysis techniques in relation to technical efficiency (TE), as the Stochastic Boundary (Cobb-Douglas Function), Data Envelope Analysis (DEA), and Neural Networks (NN), though the article did not tackle methods (Jiang and Sharp, 2014; Ma, Renwick and Bicknell, 2018; Guevara *et al*., 2019; Torres-Inga *et al*., 2019).

Upon evaluation of livestock systems, various authors (Angón *et al*., 2013; Patel *et al*., 2016; Torres-Inga *et al.* 2016; Ma, Renwick, and Greis, 2019, and Guevara *et al*. 2019) reported that the level of productive efficiency is influenced by farm size, the inclusion of family labor (women), training of the personnel, and so on. According to the above-mentioned aspects, the aim of this paper was to review several determining factors, such as labor, geographical location, and farm size, regarding the technical efficiency of dairy systems.

DEVELOPMENT

Factors of technical efficiency linked to labor, and human talent on dairy farms

Human talent and labor go hand in hand on dairy farms. Even employees without a degree develop proper technical activities on empirical bases, a routine learned through practice; trained workers also play this role to achieve more efficiency (Comerón, 2012;Torres-Inga *et a*l.,2016; Latruffe, Fogarasi, and Desjeux, 2012; Ma, Renwick, and Bicknell, 2018; Torres-Inga *et al*.,2019).

Additionally, several authors (Chang and Mishra, 2011; Jiang and Sharp, 2014; Patel *et al*., 2016; Guevara *et al*., 2017; Ma, Renwick, and Bicknell, 2018; Torres-Inga *et al*., 2019) have noted that more demanding good dairy practices are implemented to conduct adequate husbandry, and increase relations with developers and investors, seeking greater participation of women,

particularly (Patel *et al*., 2016; Guevara *et al*.,2017; Caceres, Aguirre, and Riveros, 2018; Ma, Renwick, and Bicknell, 2018).

The utilization of technical efficiency (TE) results showed that dairy systems developers might detect problems that hinder full farm efficiency. The study of these managing practices showed that efficiency and yields could be improved in more than 40% (Jiang and Sharp, 2014; Guevara *et al*.,2016; Ma, Renwick, and Bicknell, 2018; Ma, Renwick, and Greis, 2019; Torres-Inga *et al*., 2019).

As to gender, Patel, Patel, Patel, Patel, and Gelani (2016) noted that the role of women within a livestock production system varies from region to region, and it is linked to social, cultural, technical, and economic factors.

Technical efficiency factors linked to the farm location

Higher production can be achieved through better technology, methods for analysis of advanced systems, and higher input levels, along with enhanced technical efficiency (Ma, Renwick, and Bicknell, 2018, and Ma, Renwick, and Greis, 2019). Likewise, they indicate differences of technical efficiency values, with significant variations by country (Jiang and Sharp 2015; Dong *et al*., 2016; Mareth *et al*., 2017; Latruffe, Fogarasi, and Desjeux, 2012; Cloutier, and Rowley, 1993).

Keizer and Emvalomatis (2014); Uddin, Brümmer, and Peters (2014), and Jiang and Sharp (2014) found a significant relation between farm size and technical efficiency in Sweden, the Netherlands, Australia, and New Zealand, respectively. On the other hand, low productive efficiency is one of the main challenges of livestock raising in developing countries (Guevara *et al*.,2016; Bell and Wilson, 2018). In China, Cheng, Shi, Ning, and Xianzhou (2020), stressed that crop livestock integration is important for grazing systems, leading to higher technical efficiency. In Germany, Stampa, Schipmann-Schwarze, and Hamm (2020) pointed out that most dairy systems have proper technical efficiency (Jiang and Sharp, 2014; Ma, Renwick, and Greis., 2019; Torres-Inga *et al*., 2019).

The relation between farm location and technical efficiency was not significant (Van der Voort *et al*. 2014; Jiang and Sharp, 2014, and Torres-Inga *et al*; 2019), but in some systems, the technical level of livestock farmers determined high efficiency (Jiang and Sharp, 2014; Ma, Renwick, and Bicknell, 2018). The negative impact of inefficient farms has been reduced by local or national subsidizing policies; for instance, in the US, and technical grazing dairy systems in South America (Comerón, 2012; Torres-Inga *et al*., 2016; Torres-Inga *et al*., 2019), or as a result of low-cost philosophies, in Australia and New Zealand, with proper technical management of farmers, and successful extension services (Comerón, 2012; Jiang and Sharp, 2014; Ma, Renwick, and Bicknell,2018).

Factors of technical efficiency linked to the size of dairy farms

Regarding the link existing between herd size and a probable increase of technical efficiency, it is important to highlight that for the last 20 years, processes related to dairy systems have shown increases in the number of cows, and the availability of lands due to mortgages and purchasing. This has led to more technological benefits in critical areas of the systems (Jiang and Sharp, 2014; Guevara *et al*., 2017; Ma, Renwick, and Bicknell, 2018; Ma, Renwick, and Greis, 2019; Torres-Inga *et al.*, 2019). A large variety of papers have addressed simple relations that link farm size and technical efficiency (Van der Voort, Van Meensel, Lauwers, Vercruysse, Van Huylenbroeck, and Charlier (2014), together with land use (Jiang and Sharp, 2015).

A literature review on the acceptance of products from small and mid-sized dairy systems based on grazing (Feldmann and Hamm (2014) indicated higher efficiency. The negative relation between technical efficiency and farm size, shows the complexity of managing a broader set of resources and achieving technical efficiency, as pointed out by Guevara *et al.* (2016), and Jiang and Sharp (2014).

Several articles on dairy farm size and technical efficiency have been published. The main conclusions are associated to dairy farm efficiency determinants, such as soil, potential, animals, technical training, input level, and rural extension (Jiang and Sharp, 2014; Torres-Inga *et al.*, 2016; Guevara *et al*., 2019). Another indisputable finding is the relationship of policy implementation, the level of technical education, intervention of rural extension, and TE values, which were sometimes over 70% (Guevara *et al*., 2017; Ma, Renwick, and Bicknell, 2018; Torres-Inga *et al.*, 2019).

Most studies report that farm labeling based on their size and number of cows, had a positive relation between farm size and TE, which implied that large dairy farms are more technically efficient than the small ones (Guevara *et al*., 2017; Torres-Inga *et al*., 2019). Although size-efficiency relation is not strong, and it seems that the most critical aspect was the efficient way in which inputs were utilized in all the scales.

In New Zealand, dairy systems are characterized by having constant scale yields, and the farms have a better financial situation (Bell and Wilson, 2018), improved agricultural services, like extension, nutrition, and veterinary medicine. In addition to it, they have better TE dynamics, and a more favorable life cycle (Bartl, 2012; Baldini, Gardoni, and Guarino, 2017). Avadí, Corson, and Van der Werf (2018), and FAO (2019) consider farms the most appropriate level for decision-making and strategic management in livestock raising. Generally, large farms would invest more in human capital, animal health, agricultural services, as well as measurement, quality, and organization of data (FAO, 2019; Ma, Renwick, and Greis, 2019).

Recent studies (Chobtang *et al*., 2017; Salou, Le Mouël, and van der Werf *et al*. (2017; Borchardt *et al*., 2018; Hadrich *et al*., 2018; Schorr and Lips, 2018) used fixed and random effect models,

based on data collected by the Swiss Network of Agricultural Accounting Data, and reported an association between efficiency and intensification with farm size.

An analysis of dairy farms in New Zealand (Chobtang *et al*. 2017), showed that different from less intensive systems, more intensive systems produce more milk, but also generate greater negative environmental impacts, and have efficient financial effects, which was observed by Sumner von Keyserlingk and Weary *et al*. (2018), who reported that farmers, in general, seek veterinary counseling to make decisions and make necessary expenses, which, in turn, affect technical efficiency.

Torres-Inga *et al*. (2019) estimated efficiency of milk production in 1 168 cases, in Ecuadoran Sierra Sur Andina, through the application of a model of neural networks. The cases were collected from the Official Statistics Institute. The efficiency-related variables were total milk/day production, as dependent variable, and total cattle, laborers, and surface, as independent variables, reporting almost 61% of farms that reach technical efficiency values between 0.65 and 1.0. Jiang and Sharp (2014) found a high technical efficiency score in farms from New Zealand, with differences compared to other countries. This study also found that technical efficiency of dairies in South Island (81.96%) was greater than in the North Island (69.52%), where the size of the farm and herd had led to higher technical efficiency.

Caceres, Aguirre, and Riveros (2018) measured the technical efficiency of a group of dairy farmers in Los Rios, Chile, and found that factors like supplementary crops, productive specialization, and size and organization of farmers, were important in terms of technical efficiency.

CONCLUSIONS

The relation of technical efficiency with labor, technical training, and rural extension in differential mode, were observed. However, no significantly sustained relation was found between farm size and technical efficiency in several countries, and by different kinds of farmers, which showed a negative relation to efficiency and farm size in some. This might also reflect the additional complexity of allocating more resources and accomplishing technical efficiency at different scales.

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AUTHOR CONTRIBUTION

Conception and design of research: RGV, GGV, CTI, CVH, RGJ. Data analysis and interpretation: RGV, GGV, AAJ, CTI, CVH. Redaction of the manuscript: GGV, RGV, CTI, AAJ, RGJ, CVH.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.