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Pathways towards to improve the feasibility of dairy pastoral system in La Pampa (Argentina)

Elena Angón,1 José Perea,1 Paula Toro-Mújica,2 José Rivas,3 Carmen de-Pablos,4 Antón García1
1Departamento de Producción Animal, University of Cordoba, Spain
2Facultad de Agronomía e Ingeniería Forestal, Pontifical Catholic University of Chile, Santiago, Chile
3Departamento de Producción Animal, Central University of Venezuela, Maracay, Venezuela
4Department of Business Economics, Rey Juan Carlos University, Madrid, Spain

Abstract

Over the last decade, pastoral systems have been intensified in response to an increasing demand for meat and milk, by generating environmental and social problems due to its high dependence on external inputs. The objective of this research was to analyze the economic feasibility of dairy pastoral system in La Pampa (Argentina). The main successful factors were identified through technical efficiency analysis, and subsequently improvement actions were suggested. The technique data envelopment analysis creates efficiency indexes by comparing the performance of each farm with the best practice, which defines the production frontier. The farms were classified attending to two criteria: first, the level of efficiency, second, the regular use of supplementation feed. The results showed that about 40% of the farms were efficient and the efficiency rate of the farms without supplementary feed was 80%. A 70% of the farms uses their own grassland resources adjusting milk yield to the capacity of the pasture. The technical efficiency for this group is 14% higher than the rest. Inefficient farms can adopt different strategies to enhance by practicing benchmarking. One of the examples studied shows two ways to do it: on the one hand the extensification by producing at a minimum cost; on the other hand, the technification, linked to the increase of stocking rate and the use of strategic supplementation. Finally, small changes in the management of the farms positively impact on performance, use of resources, and the sustainability of the system.

Introduction

In the last years an increase in the dairy specialisation has taken place as a consequence of the intensification of processes and an increase of the dimension of farms in response to a rising demand for meat and milk (FAO, 2012). This way, in developing countries the conventional milk yield usually responds to high input dairy systems and to the improvement of the industry competitiveness that is associated to the implementation of technology, the increase of the scale of farms, the reduction of costs and the increase of the individual productivity (Rivas et al., 2015; Toro-Mújica et al., 2015). The first question that arises is referred to the capacity of highly specialised systems and the huge dependence on external inputs whenever a firm tries to reach a competitive position in the market and maintain the technical and economical feasibility from a sustainable perspective.

From the environmental perspective, Nahed-Toral et al. (2013) indicate that large scale and high input systems are environmentally unsustainable. Blanco-Penedo et al. (2013) and Peryaud et al. (2014) analyse the negative effects of intensive systems in the environment and their relationship with the change of the climate, the loss of biodiversity, soil degradation, the increase in water consumption and its social impacts. Besides, the society demands each time more corporate social values in the production and consumption aspects by searching sustainable systems fair, from the social perspective and respectful with the environment. According to FAO statistics, the demand for food in 2050 will increase of 70% (FAO, 2012). Under this statement, the idea that the planet has the capacity to satisfy the demand for food and at a reasonable environmental cost is being considered.

Nowadays there are different strategies in the dairy production; in concordance with Van’t Hooft et al. (2012) the most frequently used farming systems in the world are smallholders of dual-purpose and dairy pastoral systems. Both respond to extensive livestock farming and carry out family business models, a low dependence of external inputs and they keep with the social objective of supplying their own territories. According to Torres et al. (2014) the dual-purpose is defined as a system livestock that combines production of milk and meat, and is located in tropical areas in south Mexico, Colombia, Venezuela, Ecuador, Bolivia and the west of Brazil. Dual-purpose smallholders assigns a 75% of the production to the internal market where the diversification of the production creates a social, economic and production stability that positively impacts in the sustainability of the system as indicated by Urdaneta et al. (2010).

The dairy pastoral system is defined as an extensive production of herbivorous livestock using pasture. It is mainly located in New Zealand, Australia, and South America (Brazil, Chile, Uruguay and Argentina). In the last years, due to the high increase in the international prices of grains and oilseed and the resulting increase in crop profitability, a considerable pressure on beef and dairy farming has been exerted in Argentina, and it has been displaced to marginal areas of the western Pampas (Angón et al., 2013; Giorgis et al., 2011). In the Pampa, the traditional mixed farming system prevails. It involves the cultivation of several crops and the raising of both beef and dairy cattle (Carreño et al., 2012). Cattle farms have reacted in different ways to decline livestock-raising margins, adopting a whole range of competitive strategies. An effective strategy aimed at ensuring the feasibility and sustainability of farms requires a deep knowledge of the farming system, its own specific objectives, potentials, limitations and right of being (Rivas et al., 2015; Viglizzo et al., 2011).

In addition, the economic feasibility and competitiveness of pasture dairy systems are put into question in comparison to other alternative production systems. The literature review shows different advantages of pasture systems facing the specialised ones, such as: a slender dependence on external inputs; low production costs by maximising milk yield from inexpensive pasture and minimising the use of costly feeds supplements on the other
hand (Fariña et al., 2013; Roche, 2011); the production of green and clean products containing higher levels of conjugated linoleic acid (CLA) that produces health benefits (Aviléz, 2012); and the improvement of the animal welfare as opposed to the containment of intensive systems (Faruggia et al., 2014). Nevertheless, there is a lack of quantitative studies that support the strengths of pasture systems and the development of innovative strategies to face a global economy showing strong turbulences in the prices of inputs and outputs.

A key indicator of resource optimisation within farming systems is the assessment of technical efficiency (TE), which measures the amount of physical output attainable from a given set of inputs (Barnes et al., 2011). This implies an optimal management and utilisation of production stock, feed, labour, etc. TE can be measured by a number of econometric methods, including the construction of stochastic (Areial et al., 2012) or deterministic (Toro-Mújica et al., 2011; Angón et al., 2013; Toro-Mújica et al., 2015) frontier models; and non-parametric methods, such as Data Envelopment Analysis (DEA), have also been widely used to estimate the efficiency score of dairy farms (Chang and Mishra, 2011).

There are numerous studies related to the evaluation of the efficiency of intensive dairy cattle (Areial et al., 2012; Chang and Mishra, 2011; Hansson, 2007). In the same way, Urdaneta et al. (2010) and Gamarra (2004) studied the technical efficiency of dual-purpose farms in Venezuela and the Colombian Caribbean coast respectively. Although there is scarce and insufficient research referred to the efficiency of pastoral systems, more focus should be put on them since it is needed to know these systems to improve their economic competitiveness and the maintaining of their sustainability (Angón et al., 2013).

This research aims to advance in the knowledge of family pastoral system characterised by a low dependence of external inputs, environmentally friendly, socially equitable and balanced with the internal resources. Therefore, the main objective consists of enhancing the feasibility of the pastoral system in La Pampa (Argentina) by analyzing their technical efficiency through a diagnosis that will make possible to identify the critical success factors and suggest measures to improve.

**Materials and methods**

The dairy pastoral system in La Pampa

Dairy production in the province of La Pampa is developed in pastoral systems with the addition of supplements in agreement with Giorgis et al. (2011) and Angón et al. (2013). Most of the diet (72.5%) corresponds to roughage and 27.5% is based on supplements. Supplements are concentrate feed or fodder (silage, hay and grain). Concentrate feed (with 85-90% dry matter) are occasionally used to balance diets, cover seasonal deficiencies in the production of the grassland and for providing food in stages with higher nutritional requirements. Permanent grasslands based on alfalfa (Medicago sativa), pure or associated with grasses or other leguminous, occupy 48% of the surface. The grasses often used are cebadilla (Bromus unioloides), festuca (Festuca arundinacea) and rye grass (Lolium perenne), while the other more frequent leguminose is white clover (Trifolium repens). In 17% of the surface seasonal winter pastures are cultivated: oats (Avena sativa), rye (Secale cereale) and triticale (Triticeae). The rest of the surface is kept for seasonal summer pastures, primarily sorghum (Sorghum sp.) and maize (Zea mays), which can be grazed or harvested for herd feeding in periods of higher requirements.

**Study area and data collection**

The study was carried out in the milk-producing area of La Pampa province, comprising eight of the province’s 22 administrative departments, with a total of 172 dairy farms and 26,408 milking cows. It is located between depression of 63° and 65° W and 35° and 39° S, with a surface of 32,467 km². Soils are mostly composed of thick variable texture between loam and clay. The rest of the surface is kept for seasonal summer pastures, primarily sorghum (Sorghum sp.) and maize (Zea mays), which can be grazed or harvested for herd feeding in periods of higher requirements.

**Variables used**

DEA model was constructed by 47 farms of the sample considering one output and four inputs. Table 1 shows the output and inputs, their units, means, standard deviations and coefficient of variation. The output used was annual milk yield (L) (milk density: 1.03 kg/L) as the main product coming from dairy systems (Tauer, 2001; Stokes et al., 2007; D’Haese et al., 2009; Angón et al., 2013). According to Bravo-Ureta et al. (2007) this procedure favours subsequent meta-analysis between countries and regions.

The inputs have been classified in internal to the system or controlled by the farmer: surface, the number of animals, use of the labor, etc.; and the external or not controlled by the system, mainly, the climate and the prices for inputs and outputs. In the DEA methodology the use of few variables that can show a high impact on efficiency and can also be modified preferable in the short term by the producer are promoted (Jaforullah and Whiteman, 1999). According to the described criteria and to the literature review, the chosen variables were: herd size (number of cows), pasture area (ha), labor (WU) and supplementary feed per cow (g/d).

**Data envelopment analysis and second analysis stage**

Data envelopment analysis, whose first empirical application is attributed to Charnes et al. (1978), has become a popular tool for measuring the technical efficiency of production units. This non-parametric approach measures TE estimators as optimal solutions to mathematical programming problems. DEA defines a non-parametric frontier and measures the efficiency of each decision making unit (DMU) relative to that frontier, attributing all observed deviations from that frontier to inefficiencies (Theodoridis et al., 2012). DMU is a commonly used term in DEA analysis and it corresponds to a dairy farm. DEA model needs an orientation, either input or output oriented. The dairy sector in Argentina is not constrained by regulatory supply restrictions such as the milk-quota policy operative in EU countries (Breustedt et al., 2011). For that reason, analysis of TE needs to be focused on the internal outputs of the system, as indicated by Peña (2012).

Construction of the mathematical model first requires definition of the DMU under investigation, which use j inputs (P) to produce m products (P), such that the i-th DMU is represented by the vectors Pi and Pi. The measure of the efficiency of each DMU (i) is obtained as the maximum of a ratio of weighted outputs to weighted inputs, by solving the dual problem, as follows:
Max $\theta_i$ in $(\theta, \lambda)$
$-\Theta_i + A \lambda \geq 0, m$
$F_i - B \lambda \geq 0, j$
$I \lambda = 1$
$\lambda \geq 0$

where $A$ and $B$ are matrices containing all available observations for inputs and outputs, respectively; $\Theta$ is a scalar measuring the efficiency of the $i$-th DMU, whose values lie between 0 and 1; $\lambda$ is a vector of constants for weighting each DMU; $I$ is a vector of ones and the restriction $I \lambda = 1$ allows for variable returns to scale.

Overall technical efficiency or technical efficiency at constant return to scale (TEcrs) for each DMU, can be broken down into pure technical efficiency (technical efficiency at variable return to scale, TEvrs) and scale efficiency (SE). TEcrs does not include the portion of any inefficiency that is the result of not operating at the optimal scale. The SE of each DMU is given by the ratio TEcrs/TEvrs (Mousavi-Aval et al., 2012), where EE=1 indicates constant returns to scale and EE<1 indicates scale inefficiency. SE is due to either increasing or decreasing returns to scale, which can be determined by inspecting the sum of intensity variables. According to Theodoridis et al. (2012) if the sum of is greater than 1, DMUs exhibit decreasing returns to scale (DRS), while if the sum of the weights is less than 1, DMUs exhibit increasing returns to scale (IRS).

Once the model has been determined and the level of efficiency of the Pampa dairy pastoral farms has been calculated, the variables responsible for the success of the farms situated in the efficient frontier and their strategic position have been identified (Gaspar et al., 2009). The variables that generate significant differences were identified through variance analyses based on the level of efficiency ($P<0.05$).

According to Angón et al. (2013) pastoral dairy system in La Pampa carry out two feeding strategies; the first one without addition of concentrated feed adjusting milk yield to capacity of pasture, and a second one with seasonal concentrate supplementation according to the nutritional requirements of animals. Bartaburu (2001) considers supplementation levels above 150 grams of concentrate per liter of milk produced. The supplementary mean feed mean of the farms studied is $114\pm20.51$ g/L of milk produced. 44% of farms do not supply concentrated feed; ten farms perform occasional supply and the rest of them carry out seasonal concentrate supplementation.

Therefore farms are classified into two groups according to realized or not a regular supplementation ($P<0.05$): Group I. Without supplementary feed ($<150$ g/L) comprises 35% of the farms and Group II. With supplementary feed (>$150$ g/L) in a range between 150-500 grams per liter of milk produced comprises the rest of the farms. The variables that generate significant differences were identified through variance analyses based on level of concentrate ($P<0.05$).

Finally, by making use of benchmarking techniques and by comparing the two pairs of references on the frontier, as detailed Stokes et al. (2007), the best managerial practices were identified and measures for the promotion, maintaining and improvement of the efficiency of the farms in the Pampa pasture system have been offered.

All the statistical analyses were carried out with SPSS v.14 (SPSS, 2005) and the program used to calculate the model was DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program, whose detailed operation is described in Coelli (1996).

### Table 1. Variables used in the model data envelopment analysis.

| Variable                  | Mean±SD (VC, %) |
|---------------------------|-----------------|
| Output                    |                 |
| Milk yield per farm, L/y  | 388.074±54.890 (96.9) |
| Inputs                    |                 |
| Supplementary feed per cow, g/d | 1148.3±239.1 (142.7) |
| Herd size, LU             | 112.9±10.04 (60.9) |
| Total labour, AWU         | 3.75±0.32 (50.5) |
| Pasture area, ha          | 88.7±10.01 (77.4) |

SD, standard deviation; VC, variation coefficient; LU, livestock unit; AWU, annual work unit.

### Table 2. Descriptive statistics of the dairy pastoral farms studied.

| Variable                  | Mean±SD (VC, %) |
|---------------------------|-----------------|
| Herd size, LU             | 115±10 (61)     |
| Milking cows, LU          | 79.2±7.9 (69)   |
| Total farm surface, ha    | 222±21 (65)     |
| Cultivated area, ha       | 13±16 (349)     |
| Total labour, AWU         | 3.72±0.32 (50.5) |
| Stocking rate, LU/ha      | 0.66±0.05 (56)  |
| Grazing area, ha/cow      | 0.85±0.08 (67)  |
| Milk productivity, L/year | 388.074±54.890 (97) |
| Concentrate feed per cow, kg/day | 1.66±0.34 (140) |
| Milking cow, %            | 68.7±1.4 (14)   |
| Meat productivity, kg/year| 16.411±2569 (107) |
| Family labour, AWU        | 2.15±0.18 (58)  |
| Seasonal pasture surface, ha | 173±21.5 (85)  |

SD, standard deviation; VC, variation coefficient; LU, livestock unit; AWU, annual work unit.

### Table 3. Descriptive statistics of technical efficiency scores.

|                     | TEcrs | TEvrs | SE  |
|---------------------|-------|-------|-----|
| Mean, %             | 71.7  | 77.0  | 93.4 |
| Standard error      | 3.4   | 3.6   | 1.16 |
| Minimum             | 14.2  | 14.3  | 70.4 |
| Maximum             | 100   | 100   | 100  |
| Efficient farms, %  | 25.5  | 40.4  | 29.8 |
| Number of DRS farms, n | -    | -     | 11 (23.4%) |
| Number of IRS farms, n | -    | -     | 22 (46.8%) |

TEcrs, technical efficiency at constant return to scale; TEvrs, technical efficiency at variable return to scale; SE, scale efficiency; DRS, decreasing return scale; IRS, increasing return scale.
Results

Description of the grazing dairy system

Table 2 presents a synthesis of the characteristics of the dairy pastoral farms evaluated. The mean herd size was 113 milking cows in 222 ha total farm surface and a stocking rate of 0.66 LU/ha. Livestock farmers owned 71% of the land, 43% of which was given over to permanent grazing, mostly alfalfa. The feeding regime was primarily pasture-based, although inter-farm variability was considerable (VC=143%); 25% of farms used no supplementary feeds at all. Mean feed use was 1.15 kg/day/cow (110 g/L). Mean milk yield was 3128 kg per cow and lactation. Labour productivity was 33.6 LU/WU and most farms (66%) were family-run.

Technical and scale efficiency

Results obtained using output-oriented DEA are presented in Table 3. The average measure of overall technical efficiency was 71.7%, assuming constant returns to scale, and 77% assuming variable returns to scale. Examination of the maximum and minimum values suggests a considerable degree of variation in the efficiency of dairy pastoral systems. The value of 77% recorded for TEsrs indicates that production could be increased by 23%, given current input levels and production technologies, provided that farms adopt best-observed practices. Twelve of the 47 farms in the sample were found to be efficient at constant return scale, compared with 19 at variable return scale systems. Seven farms thus displayed scale inefficiencies; therefore, though producing properly in technical terms, they need to fine-tune production in order to become more efficient. SE (TEcrs/TEvrs ratio) measures potential productivity gains for a farm operating at optimal scale. Mean SE was 93.4%; most scale-inefficient farms (46.8%) were operating under increasing returns scale (IRS), while 23.4% displayed decreasing returns scale (DRS). In order to increase SE, attention should be paid to factors such as herd size and pasture area.

Comparative analysis of efficient vs inefficient farms

Firstly, a variance analysis was applied between efficient and inefficient farms to determine variables that showed significant differences (Table 4). Efficient farms were a 53% smaller (P<0.001), and herd size was a 27% smaller (P<0.01); stocking rate was thus 27% smaller (P<0.01); stocking rate was thus 53% smaller (P<0.001), and herd size was a differences (Table 4). Efficient farms were a 53% smaller (P<0.001), and herd size was a 27% smaller (P<0.01); stocking rate was thus 27% smaller (P<0.01); stocking rate was thus 53% smaller (P<0.001), and herd size was a differences (Table 4). Efficient farms were a 53% smaller (P<0.001), and herd size was a

Table 4. Comparison of technically efficient vs inefficient farms.

| Variable                        | Efficient farms Mean±SD (VC, %) | Inefficient farms Mean±SD (VC, %) |
|---------------------------------|--------------------------------|----------------------------------|
| Dimension                       |                                |                                  |
| Farm surface area, ha           | 132.1±104.2 (78.9)b            | 282.4±136.6a                     |
| Herd size, LU                   | 92.1±70.2 (76.1)b              | 127.1±65.5a                      |
| Intensification and feeding supplementary |                  |                                  |
| Stocking rate, LU/ha            | 0.85±0.46 (53.7)b              | 0.53±0.23b                       |
| Supplementary feed per cow, g/d | 674.7±153.2 (75.1)b            | 1469.7±1654.6b                   |
| Supplementary feed, g/L         | 51.4±105.5 (89.1)b             | 157.5±146.9b                     |
| Structure of labour             |                                |                                  |
| Work unit, AWU                  | 3.06±1.86 (60.9)b              | 4.17±2.3a                        |
| Costs of labour, $/ha            | 162.7±104.1 (63.9)b            | 87.4±43.6b                       |
| AWU/100 ha                      | 2.9±2.1 (69.4)                 | 1.7±1.12                         |
| Depreciation, $/ha               | 46.8±26.9 (54.2)b              | 34.1±18.8b                       |
| Total income, $/ha               | 429.1±246.1 (57.4)             | 298.7±171.1                      |
| Sale of calves, $/ha             | 57.8±52.7 (91.5)               | 47.8±43.5                        |
| Sale of cereals, $/ha            | 13.4±57.9 (82)                 | 7.44±16.91                       |
| Sale of milk, $/ha               | 315.5±216.6 (88.6)             | 222.7±158.5                      |
| Structural expenditure, $/ha     | 96.9±55.2 (57.1)b              | 59.6±29.9b                       |
| Total expenditure, $/ha          | 438.2±199.3 (45.5)b            | 303.4±147.9b                     |
| Gross margin, $/ha               | 255.6±132.4 (51.8)b            | 133.9±106.2b                     |
| Net margin, $/ha                 | 111.8±135.9 (121.6)b           | 40.2±85.4b                       |
| Operating profits, $/ha          | 158.7±122.2 (70.9)b            | 74.3±90.4a                       |

Table 5. Comparison of farms according to the level of supplementary feed.

| Variables                        | Without supplementary feed | Mean±SD | With supplementary feed |
|----------------------------------|----------------------------|---------|-------------------------|
| Farms, %                         | 70.2                       |         | 29.8                    |
| TEsrs                            | 80±4.3b                    | 68±5.5a  |
| Farm surface area, ha            | 187±23.06b                 | 302±38.09b |
| Herd size, LU                    | 94±8.64b                   | 155±23.8b |
| Seasonal winter pastures, ha/LU  | 2.1±3.01b                  | 1.2±1.4b |
| Seasonal summer pastures, ha/LU  | 0.4±0.36b                  | 0.3±0.29b |
| Milk yield per cow, L/d          | 7.5±0.07b                  | 10.08±0.89 |
| Costs of supplementary feed, $/cow| 22.7±25.6b                 | 90.15±23.2 |
| Fixed unit cost, $/L             | 0.14±0.08b                 | 0.23±0.1 |
| Variable unit cost, $/L          | 0.10±0.12b                 | 0.26±0.18 |

Table 6. Input and output levels of farm 33, reference peers and targets.

|                   | Farm 33     | Strategy A | Strategy B | Target |
|-------------------|-------------|------------|------------|--------|
|                   | DMU 32      | DMU 46     |            |        |
| Output            |             |            |            |        |
| Milk yield, L     | 466,699     | 442,445    | 1,403,508  | 790,656|
| Inputs            |             |            |            |        |
| Total labour, AWU | 4.18        | 2.21       | 4.68       | 3.1    |
| Herd size, LU     | 120         | 57.5       | 230        | 120    |
| Pasture area, ha  | 201         | 156        | 130        | 146.6  |
| Supplementary feed per cow, g/d | 3476.7 | 322.9  | 1882.5 | 888.1  |

SD, standard deviation; VC, variation coefficient; LU, livestock unit; AWU, annual work unit. *Means within a row with different superscripts differ significantly (P<0.05).
higher (0.85 LU/ha), although values remained considerably lower than those laid down in EU organic production standards (European Commission, 2007) and under the 2.3 LU/ha registered in New Zealand’s pasture systems (Basset-Mens et al., 2009). While the use of supplementary feeds tends to be low in all pastoral systems, supplementary feeding was negligible in efficient farms (P<0.001). Efficient farms required 1 WU less to achieve the same output (P<0.05), although scale-adjusted expenditure per ha in monetary terms was greater for efficient farms (P<0.01).

On the other hand, their investments and depreciations were lower, in absolute terms (P<0.05); however, structural costs and total expenditure per ha were lower (P<0.05). Significant differences (P<0.05) were observed in costs per liter: on efficient farms, fixed costs per liter were 17% lower and variable costs 44% lower; overall unit cost was 32% lower. Finally, economic results per ha were higher for efficient farms (P<0.05) (Table 3).

Efficiency and feeding strategies

In Table 5 a comparison amongst the farms according to the level of supplementary feed is offered. A 70% of them lack of supplementary feed and show low levels of concentration, a production of 7.5 L/d and an efficiency of 80%; while farms with supplementary feed produce 10 L/d, provide 302 g of concentrate per liter of milk and maintain the grazing character. Farms lacking supplementary feed are smaller in number of animals and hectares (P<0.05), and develop an efficient management of forage resources: they use the winter cereals and summer crops to maintain food reserves and use them in periods of shortages. On the other hand they offer 34.9 g/L of concentrate and produce in balance with the forage supply depending on the resources of the system. According to Angón et al. (2013), they develop a strategy of minimum cost (P<0.005) that favours their remaining in the market. The efficiency of farms without supplementary feed exceeds in a 17%; their level of production is around a 2764±1487 L by lactating. Equally a 27.6% of the farms do not provide of concentrate by reaching a production of 2373±894 L by lactating (ellipse of Figure 1) depending on the level of technification.

Technical benchmarking

One function of DEA techniques is to provide information on individual DMUs and their pairs of reference in the efficient frontier, identifying slacks or sources of inefficiency. Let us take as an example DMU 33, with a TEvrs of 59%, in comparison to its two pairs of reference, DMU 32 and DMU 46 that are considered as efficient farms (Table 6; Figure 1). DMU 33 can develop two strategies to achieve technical efficiency. On the one hand the strategy A is observed, where DMU 32 removes the supplementation and decreases the size by adjusting the load to the sustainable capacity of the pasture by eliminating the need of providing supplementary supply. Likewise in the ellipse of Figure 1 various DMU are located in the same point of the abscise that increases the farm load, and it ranges between a 0.14 LU/ha up to a 1.44 LU/ha, depending on the structure of the productive organisation and the management of the pastures. On the other hand, the strategy B is identified, with the DMU 46 that increases the size of the herd and the production by farm that increases from 467,699 to 1,403,508 L; in addition the farm load is increased from 0.29 LU/ha to 1.03 LU/ha, at the same time that the contribution support is reduced. A priori the productive results can be contradictory: how is it possible to produce more with less factors? From the economical perspective a change in the productive isoquant and a shift in the consumption of factors to the economic rational area takes place (Toro-Mujica et al., 2011). In this case the farm decides to develop a more technified extensive system; where the rationing of the milk yield is used, the strategic contribution support and a rational management of the use of pastures takes place according to crops rotation, production of reservations, etc. To put into action this strategy higher levels of technical knowledge in the organisation of the system and of financing availability are required. This also implies higher levels of risk assumption. Therefore, in order to improve efficiency without modifying size and attending their targets this farm needs to increase production in a 69%, cut labour use following income structure: milk yield (52%), fattening (27%), crops (12%) and other activities (9%).

Discussion

Competitive dairy farms studied in the Pampa respond to a pastoral family system with low levels of consumption of concentrates...
and the development of different strategies in the use of pastures and food supplementation. The agrosystem in La Pampa tends to involve several different productive operations, which compete for land and interact with each other (milk yield, cattle fattening and agriculture). Just as in New Zealand, pasture Argentinian systems of low inputs and costs are efficient (Altieri et al., 2012); however, nowadays there is a continuous process of productive specialisation, concentration of farms, increase of size and reduction on the land base of farms (Basset-Mens et al., 2009) that highly contribute to the environmental degradation in South America as Peyraud et al. (2014) indicate.

The measure of the efficiency of dairy pastoral farms in La Pampa has allowed us to determine their mean levels of pure and overall technical efficiency and to adopt strategies to achieve their feasibility. The values obtained in La Pampa reflect a heavy local reliance on pasture and very limited use of external inputs. The results obtained were, TECrs=71.7% and TErvs=77%, that are lower than those reported by Jaforullah and Whiteman (1999) in pastoral systems in New Zealand (TECrs= 83%; TErvs=89%). However, they are better than those reported by Stokes et al. (2007) in intensive dairy systems. This suggests the ability to improve the feasibility of the dairy pastoral system.

Unlike the scenario outlined by Theodoridis et al. (2012) in Greece, increased farm size and feed consumption in La Pampa would not lead to greater technical efficiency; i.e. the use of economies of scale would not benefit productivity. Tauer (2001) has suggested that small dairy cattle farms may be as competitive as the larger ones. The intensification also entails greater funding as well as structural and organisational changes (farm size, shed construction)

Efficient farms take advantage as a strategic capability of their pastoral nature and their resilience to the turbulences showed by the inputs in the international markets (Angón et al., 2013). The dairy pastoral system of La Pampa requires of relatively small modifications in the management of farms to potentially enhance positive performance and improve the use of resources according to Groot et al. (2012). Implementation of such innovation modifications requires of specialised technical assistance and a thorough knowledge of the system. To achieve this, a greater focus on the training of farmers and technical staff should be promoted, especially in areas such as nutrition, pasture improvement, the organisation of production, and the use and conservation of natural resources. At the same time, the administration should encourage the development of interprofessional associations with a view to addressing the issues facing the farm as a whole (e.g. agriculture, livestock, conservation, management) and examining the various facets of the system and the interactions between them (Toro-Mújica et al., 2011; Viglizzo et al., 2011).

Finally, efficient dairy farms in La Pampa, like the organic dairy farms described by Sauer and Park (2009) and Oudshoor et al. (2011), are pasture-based systems presenting close social and economic links to their environment (López-Alonso et al., 2012). Switching to organic production could lead to a price increase up to 20%, while Flaten and Lien (2009) report that conversion to organic farming in Norway increased farm incomes between 7 and 12%. They also implement a minimum cost strategy, adjusting milk yield to forage supply, and making highly specialised use of the system’s resources, so that viability is dependent on the ability of cows to efficiently convert pasture into product (Buckley et al., 2007). The whole system is adapted to sustainability over time, by achieving a balanced use of internal resources that does not endanger the future of the agrosystem (Toro-Mújica et al., 2011).

Conclusions

The low input pasture dairy farms of La Pampa show an average in technical efficiency of 80%, although they require an adjustment in the milk yield to the forage supply in the pasture system. On the other hand, farms without supplementary feed respond to a family efficient and economical feasible model, which shows a small size and implements different strategies for the use of pastures, technologies, and forage reserves. Inefficient farms could take several pathways towards the maintenance of those systems as a motor of sustainable development. Those pathways are mainly the intensification to a minimum cost or the increase of the level of technology adoption. To achieve this, there needs to be a greater focus on the training of farmers and technical staff. Special improvement in the management of natural resources should be performed to enhance results and find a balance between the use of feeding supplements and the cow productive capacity should be promoted. The implementation of such changes requires specialized technical assistance and a thorough knowledge of the system that enables the maintaining of sustainable production of low dependence of external inputs under circumstances of risk and change.

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