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Productive Efficiency in Small Peasant and Capitalist Farms. Empirical Evidece Using DEA

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Abstract: Different regions and sectors of the Argentinean society depend on the consolidation of certain nontraditional productive chains; as a consequence, it would be necessary to achieve a productive transformation which allows a competitive participation of small agro industries in the dynamic markets. Efficiency has an essential role here. The caprine dairy sector in the province of Santiago del Estero constitutes an interesting case of study since, in spite of its competitive potential; it could not yet introduce its products into more dynamic markets than those of the province or region. This work aims to study the relative efficiency of the farms of the provincial caprine dairy area and to investigate about the relationship between efficiency and the main productive characteristics and styles of production. For the investigation, a mathematical programming technique known as Data Envelopment Analysis (DEA) was used on the grounds of data provided by the interviews carried out in each farm. The study was completed by the Cluster Analysis and the Discriminant Analysis. The results show an efficiency level of 59.5% for the area and apparently there are not indications to assume that certain production styles are a limiting factor for the productive potential of each farm.

Key words: Productive efficiency · small peasant and capitalist farms · data envelopment analysis · dairy goats

INTRODUCTION

Nowadays, the Argentinean economic situation is really different from that faced at the end of 2001. The main macro indicators show an extraordinary and sustained economics growing, along past four years [1, 2].

This growing is based upon a policy that had as its main goal the devaluation of the exchange rate and the exports of trading goods, being the land cropped area one of its most important tools. As a result, the agriculture, especially the agribusiness levels of activity, is present today as one of the most solid bases of the Argentinean economy. Actually, contributes 18% of Gross Domestic Product (US$ 33.000 millions), increases substantially incomes through the exports of goods (it represents approximately 57% of gross exports) and generates approximately one million and a half job positions (36% of total employment) [3].

Still, this prosperous situation is not homogenous across the national horizon. There are some provinces with low level of development, having been seriously spoiled on its productive capacity during the latest decades. Matters like sparing private big investments in the industrial area, the broken chains in traditional productive nets, the stagnancy of exports, the lost of market opportunities, the low rate of new small and medium enterprises creation (PyMES) and the lost of opportunities and quality of job, had promoted that these provinces have not taken advantage of the impulse given by the growing of the economy [4].

Neither the economic growing benefited equally the whole population and even less in rural population: in some Argentinean provinces the family allowances ("Jefas y Jefes de Hogar" plan) covered over 40% of the whole families by end of 2003. Even there is information that, at the beginning of that same year, the unsatisfied basic needs index reveled values of 14% in urban areas; in contrast the values for rural areas were around 33%. Verner [5] wrote: "…in certain way, this (rural poverty) is the result of several years of a high slant in the public investment distribution, which expelled some regions and

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rural population, combined this with low investment in agriculture and different policies that suppressed rural business terms."

In this context it is understandable that improvements in the economic performance of these regions depend almost on the priority given to the development of new productive activities, the recovery of in terms of their market value - unemployed natural and human resources, the development of a propitious business environment for the foreign investments arrival and a harmonized re-creation of province share and institutional capital.

In this sense, it is interesting to think about the presence of some non traditional activities, which integrate small and recent productive nets and count with a wide diffusion in large areas of the Argentinean territory. These activities are capable of the generation of potential competitiveness when integrated with agribusiness and should be taken into account for the design of rural development projects [6, 7], because they give to their products a high potentiality for increasing income and benefiting population in these marginal areas. Several of these activities, due to their dimensions and characteristics, have the potential to turn into an effective tool for the development of underdeveloped regions [8].

There is consensus about the idea that to get a reorientation in production in a successful way, it is essential to previously achieve a technological change which will allow to these little farms to participate in a competitive way in markets characterized for being extremely dynamic [9-11]. But, what are the steps to achieve this aim?

The economics bibliography upholds that for the existence of a competitive enterprise there should exist a kind of advantage which allows obtaining superior results compared to the sector's average. Generally, two kinds of competitive advantages are recognized: the minimization of costs (with the maintaining of an acceptable quality level) and the product's differentiation (without a significant growing of costs) [12]. Both aspects are strongly related to economics benefits and production.

Unavoidably, the concept of competitiveness lays on two other concepts: efficiency and productivity. Productivity is a less wide concept because it is related to productive area, while the concept of efficiency includes the dimension of profits maximization to the analysis.

Therefore, economic efficiency is a central concept, because competitiveness does not mean to reach a high productivity level, but to pursuit the highest possible profit at a given productivity level [13].

On the other hand, it must be taken into account that the firm competitiveness is encouraged by competitiveness of the whole group of firms which integrate the complex where it belongs [14], so it is important to determine and analyze those factors that affect in a negative way the general efficiency and each particular firm that integrate the last. This result is even more relevant if it is considered that each level in the productive chain must be competitive by itself in order to allow its next competitive level [15].

An excellent tool to analyze the way a firm is producing is by comparing its relative efficiency with other firms producing under similar conditions [16]. To know the relative efficiency degree of each firm contributes to determine the studied activity's general efficiency, giving elements of solid judgment to infer about the sector's capacity to penetrate with their products to competitive markets.

The caprine milk production presents itself as an interesting case for being analyzed as a complex agribusiness sector, because it is a relatively new activity in Argentina, showing a scarce development level and with a very reduced economic size, while having potentialities for the development of sustained competitive advantages [17].

In this sense, Santiago del Estero emerges as a territory that counts with a caprine milk cattle with dimensions and characteristics that allows it to be considered as a strategic resource for the region, because it represents the 13% of the national stock bulk and more than 24% of the total caprine farms, with 706.668 animals and 13.454 farms [1]. According to statistics, it is estimated that Santiago del Estero contributes around 53% of the national milk production. [18, 19]

Despite of the importance of this sector, the main provincial milky caprine basin is still looking for the necessary competitiveness and efficiency levels needed to penetrate into the main competitive markets. At present time, the basin is facing serious obstacles to trade its production and its products and can not reach more dynamic markets than those that belong to the province or regional context [20, 21].

The objective of this work is the study of relative efficiency between milky caprine firms of the basin located in the irrigation area of the Dulce River of Santiago del Estero province. Also to study the relation between each firm efficiency and their main productive characteristics and typology.

Accordingly, the study of the efficiency of caprine milk firms will allow orienting those with a lower efficiency to reach a more efficient level and guide its decisions in order to improve the basin's competitive capacity.

MATERIALS AND METHODS

Area of study: The irrigation area of the Dulce River is located in the province of Santiago del Estero, Argentina, between latitude 27°25' and 28°15' south and longitude 63°50' and 64°20'west. The area covers a surface of around 300,000 hectares, with an irrigable area of about 110,000 hectares. A completely coated main canal crosses the area. This canal is 21.8 km long and is capable of conducting up to 100 cubic meters per second (m^3/s). The canal is used to irrigate the neighboring lands every 30 days with a volume of water around the farm of 300 l/s. Slopes are smooth and a significant proportion of them have salinity problems. The climate is semiarid with high evapotranspiration, an annual mean temperature of 20°C and seasonal means of 7°C in winter and 34°C during summer months. The area presents a summer rainfall regime with an annual average varying in the range of 450 to 650 mm [22].

The majority of the caprine milk activity of the province is situated in this area. The production system that prevails is extensive and carried out in the open field where a natural pasture is the basic feeding. That is why this section presents a series of technological constraints (nutrition, management, health, sheepfold productivity, supplying and water distribution) as well as constraints related to producers' organization, especially in commercialization matters [4].

Regarding the caprine milk production levels reached in the area of interest, the quantities delivered to factories average 335,000 annual liters and it is estimated that the total production of the dairy farms almost reaches the double of this volume [23].

Sample size and data collection: This study attempts to estimate the relative efficiency for caprine dairy farms that constitute the main dairy area of Santiago del Estero. This area currently has 60 working farms delivering milk to factories on a daily basis. These set of working farms where identified from milk reception records of cheese factories located in the irrigation area and from sanitary and milk control records maintained by the Provincial Program of Small Ruminants of Santiago del Estero.

Once a farm was identified, the person in charge of the herd was interviewed and responses registered. The proportion of woman and man in charge showed to be similar ($p<0.05$). The responses were processed and coded on the base of definitions and operations of variables.

It was possible to visit only 42 of 60 identified farms, the main difficult being accessibility. Of the 42 farms surveyed 12 were rejected due to incomplete information and doubtful truthfulness. The caprine dairy farms showed a high degree of informality in holding updated administrative records, while statistics maintained by government are odd. That is why in order to determine the volume delivered by dairy farms in some cases it was necessary to resort to factories' records and producers' memory. This sort of problems was considered to eliminate those 12 surveys aforementioned.

The interviews registered information regarding the period August 2005 to July 2006 and were collected in November 2006.

Efficiency analysis: In order to evaluate the relative efficiency of farms, a mathematical programming technique called Data Envelopment Analysis (DEA) was used, allowing for the estimation of a technical efficiency index by solving an optimization mathematical problem [24-26].

Variables selection: Owing to the results' sensitivity of the DEA model specification and the data required by the DEA methodology it is relevant to describe the criteria adopted for the selection of variables [16].

In accordance with previous studies about efficiency on dairy farms, a physical production of milk (in kg) is selected as output. Since the only existent trustful data source in this sense constitutes the milk reception lists of cheese factories, this variable was registered from these records.

Although this last measure does not consider the whole amount of milk produced by dairy farms, it is considered appropriate from the technical efficiency point of view because captures the effects of producers who best comply with sanitary regulations and punishes those producers whose milk is rejected due to hygienic problems.

In relation to the incoming information, i.e. inputs, variables that offered a larger perspective of efficiency on medium and long term periods were selected so that results and conclusions of the study may support the farmers' long run decision making process. Besides, because of farms diversity, the lack of data related to the management of economic units and the high incidence of lack of commercialization of certain factors of production

(In order to exemplify this issue, it is usual to observe among dairy farmers the borrowing of breeding male goats during mating period while this kind of service is generally rented. Scrub fruits (carob, jujube, etc) used during milking as a supplement and assistance from the elderly and farmers´ children constitute other examples), it was decided not to use monetary variables. That is why the selection of high aggregation variables and variables of the structural type and those that offer clear guidelines on dairy farm and herd management, were privileged.

Thus, for instance, variables related to technological, sanitary and feeding questions were reduced to indexes especially elaborated according to general characteristics of the dairy farms of the region [18, 27].

Moreover, it was decided to realize the efficiency analysis using the least possible amount of inputs. In this sense, Tauer [28] found that as the amount of inputs rises, the medium efficiency level rises as well. So it was preferable to keep just those variables that, based on our criterion, could cause a significant impact on the estimated efficiency.

Five variables were selected as inputs: total number of goats, number of lactating goats (in December, 2005), labor (measured in relation to the amount of people who work in the dairy farm in average and per year), a technological index and a feeding index. These variables were chosen based on the following criteria:

- The number of goats has a direct effect on the total milk production of the farm. Moreover, many partial indicators of technical efficiency are built in direct relationship to the number of animals (for instance, liters/goat constitutes one of the most classic indicators) [29, 30].
- The number of milking goats provides a complete idea about the caring conditions and management during mating, pregnancy and kidding periods on the part of the producer.
- From the cost of production point of view, labor constitutes one of the most important variables to consider when any type of activity is studied [31]. Besides, from a historic perspective this variable arises as a quite controversial topic in the study of peasantry. There exist a number of studies on rural labor, the majority considering that there exists one point in common among this type of farms, which makes them different from capitalist farms, i.e. the farm is structured as a familiar economic unit, where family members are not wage-earning and where the unit of production and the domestic unit combine [32, 33]. At this point, the wage as an economic category in the modern sense is clearly absent. Taking this into account and considering that this study covers different types of farms, it was decided to define this variable as the number of days per year an adult man could work in the farm (300 days/year). In general, in the caprine dairy industry labor is usually performed by the head of the family, although there is a great participation of women. Many times, the woman is the one in charge of this activity and counts with her daughters' assistance very frequently.
- Technological Index: A technological index was used to evaluate the different grades of investment on infrastructure. The index proposed by Alvarez *et. al.* [34] was taken. The component variables were adjusted according to the specified needs of this study. The index collects information on the characteristics of the milking parlor, chilling equipment, pens, shelters, cleaning conditions, dairy farms' maintenance and location in relation to the family house. It ranges from 0 to 120 points.
- Feeding Index: The direct effect of feeding on animal productivity, the diversity of food management observed in the area and the uncertainty of producers about the inconveniences and benefits of each system lead to include this index as a variable. For this reason, data on food management (scrubland, pastures, or both), presence of a supplements in milking, composition of the ration and the use of an electrified wire fence were collected. The score for this index varies from 0 to 10.

It is important to have in mind that the ways the data will be registered and the kind of information to obtain constitute significant aspects in the DEA analysis [25]. These matters directly affect the selection of variables stage, having a direct effect on the veracity of results and conclusions.

Data collection: Data collection was realized by means of open interviews with each of the persons responsible for the farms. The interview always treated key issues related to production:

- Herd composition.
- Management of pregnancy, kidding and lactation.
- Manipulation of milk in the storage and delivery to the factory.
- Liters of rejected milk and causes for rejection.

- Volume of seasonal production and labor requirements during the different months.
- People who currently work in the dairy farm, schedules, age, sex of workers and wage.
- Production volume planned for the next years.
- Presence of pastures.
- Characteristics of the facilities, maintenance and hygiene customs.
- Feeding management.

The data obtained from this interview were organized and registered on a data base. The information utilized as variables for calculation with the DEA technique was finally adjusted and compared to the existing records in the factories and in the Provincial Program of Small Ruminants of Santiago del Estero. Thus, references were only considered as valid variables when the results coincided, otherwise the information was discarded (For example: The information obtained about the "goats in lactation" variable was compared to the liters of milk delivered according to charts and average productivity of the herd which came from dairy control records).

Identification and specification of the DEA model: As it was indicated before, efficiency plays an important role in the search for reaching competitiveness. Maximization of benefit demands a farm to correctly make the following three decisions [13]:

- From all the possible levels of production, the one (output) that maximizes the benefit should be selected. This happens when the economic unit (EU) produces a quantity for which the marginal income equals the marginal cost.
- From all the possible supply combinations (inputs) that work in order to reach the previous level of production, the EU must select the combination that minimizes the costs of production.
- The EU must produce the selected level of production with the minimum possible amount of supplies or it should not waste resources. This would happen when the EU is working upon its limit of production.

Three types of efficiency can be distinguished:

- Technical efficiency: when the maximum possible output is obtained as a result of the combination of the inputs used.
- Scale efficiency: when the farm produces in an optimum size scale which allows it to maximize the benefit.
- Allocative efficiency: when inputs are finally combined in a proportion economic that minimizes the cost of production.

In high industrialized companies, the efficiency indexes can be calculated by means of relatively simple techniques since, in most of the cases, these companies count on an administration area that has all the necessary information for the calculation. There exist also official statistics on the section that offer support data. Moreover, the technology used by these companies in their productive processes allows a significant reduction of the incidence of the random factor on the production results.

However, in agricultural research and especially in cases where peasant production is involved, the calculation is more complicated. Kevryn [35] points out some characteristics inherent to peasant production that complicate this kind of studies, highlighting the followings:

- Heterogeneity of conditions (ecologic, cultural, geographic, of resources, etc.)
- Spatial dispersion between different units
- Random factors in production (climate, biological cycles, etc)
- Diversification of production
- Lack of markets for the main factors of production
- General interdependence between the different productive activities within the same farm
- Differences in the objectives between producers (and a consequent difference of behavior according to each objective)

The DEA [36] proposes the use of linear programming methods to construct a sort of surface or frontier based on specific collected data. Efficiency is measured in a way that is related to frontier where all deviations are considered inefficient. The plan consists in resolving a lineal program for each productive unit observed, based upon the following methodology:

Let us consider N number of farms, producing M number of products (outputs) and using H amount of different supplies (inputs). In this way we will get that Y is a matrix of outputs resulting from multiplying M*N and X is another matrix resulting from multiplying H*N. In between both matrixes, the information for all N farms is contained.

The mathematical problem can be formulated in the following way and resolved for each one of the studied farms:

$$\min_{\theta,\lambda}\theta - y_i + Y\lambda \geq 0, \theta \boldsymbol{x_i} - X\lambda \geq 0,$$
$$\lambda \geq 0 \quad \theta \in (0,1]$$

Where:

θ = Scalar that multiplies the vector of inputs.

y_i represents the only output of farm i

x_i represents the vector of inputs of farm i

λ = vector of constants N x 1

$X\lambda y Y\lambda$ = projections of the efficiency frontier.

The maximum possible value for θ_1 is one, indicating that the farm is completely efficient from the technical point of view. Thus, 1-θ_1 would indicate the degree of proportional reduction of inputs that a farm can reach without any loss in the output.

The technical efficiency (TE) is measured under the assumption of constant returns to scale (CRS); however, this assumption is valid as long as all farms are operating in an optimum scale [37]. There are some issues that may cause that a given farm does not operate on an optimum scale (for instance: difficulty to access financial sources or the personal objectives of the owner). Then, it is inferred that if the DEA model is used assuming constant returns to scale in order to compare farms which are not operating in their optimum scale, it would cause that the resulting technical efficiency measures would be influenced by efficiencies or inefficiencies to scale. Consequently, the results would be incorrect.

To solve this problem, a restriction of convexity is added to the previously exposed model and the varying returns to scale are also calculated as follows:

$$\min_{\theta,\lambda}\theta - y_i + Y\lambda \geq 0, \theta \boldsymbol{x_i} - X\lambda \geq 0,$$
$$N1'\lambda = 1 \quad \lambda \geq 0 \theta \in (0,1)$$

The new restriction introduced is $N1'\lambda = 1$, where $N1$ is a unit vector resulting from N x 1. This restriction causes the comparison of farms as similar in size as possible. In order to do this, a intersection of planes is made, constituting a kind of convex set that makes the data be grouped as precisely as possible. In this way, the boundary of the resulting technical efficiency measure under the restriction of varying returns to scale will always equal the result under the assumption of constant returns to scale.

Taking into account the characteristics of the farms, it was considered advisable to estimate the relative in/efficiency of the dairy farms of the area using the model of constant returns to scale (CRS) and the model of varying returns to scale (VRS). The estimated results for the models are Input and Output-oriented and the multi-stage method was used for the calculation of slacks (It consists of a method that requires a computer for the calculation. The advantage of this method lies in the fact that it identifies those efficiency points oriented to a specific combination of inputs and outputs and looks for a measure as similar as possible to the one of the closer inefficiency points. In this way, the resulting slacks are also invariable in relation to measurement units [25]) [13, 37, 38].

This methodology of analysis provides an initial estimate of Global Technical Efficiency (GTE), Pure Technical Efficiency (PTE) and scale efficiency (SE). It is also obtained an estimation of the level of inefficiency of each farm, based upon if it is working in an area of Decreasing Returns to Scale (DRS) or in an area of Increasing Returns (IRS).

In relation to the usefulness of this methodology adopted to conduct studies where peasant production intervenes, it is necessary to emphasize that this is a non-parametric method. This characteristic allows the researcher to estimate a frontier of production based only on some specific data, even in cases where the random factor complicates the prediction of values through calculations that presuppose certain linearity.

Relative comparison is another aspect which results interesting. When referring to efficiency, it is appropriate to consider a reference parameter so the obtained observations can be compared. Each economic unit is subject to different determinants and in many occasions this situations have nothing in common and exceed the management capacity of each of them. The DEA method allows adaptation of estimations by calculating the relative efficiency between the obtained samples which, in general, are inserted in a unique environment (geographic, of market, political, work-related, social, etc.) and thus avoiding the use highly general census data.

Comparison in pairs is a property that also deserves to be distinguished. In a DEA study, the methodology allows for the calculation of efficiency in relation to even units (which have a similar scale regarding inputs and outputs). This characteristic is very useful because it allows including units of different sizes in the sample without generating distortions in the results.

Complementary analyses: Taking into account the DEA's results, some complementary analyses were realized in order to improve data interpretation. A Cluster Analysis is used to form homogeneous groups (efficiency groups, in this case) in relation to a variety of attributes (efficiency indexes resulting from DEA). Later, s Discriminating Analysis is conducted to explain the fact that a given farm belongs to a certain group based upon the observed variables, quantifying the relative importance of each one of them and the prediction of belonging to a particular group of an individual that is not part of the analyzed data and from which the value of variables is known but the group to which it belongs is unknown [34, 40-42].

Cluster analysis: The Cluster Analysis is a grouping technique based on similarities or differences between the observations or variables. There are no assumptions about the number of groups or their structure. Since the basic goal of this study is to calculate the association among objects, it is necessary to establish a measure of similarity. This choice depends on the nature of the variables (binary, discrete, continuous) or of the measuring scale (nominal, ordinal, interval, quotient). When constituting groups, proximity is established by some kind of distance. Variables are grouped according to correlation coefficient or association measures [43, 44].

The present study will use a hierarchical clustering method known as Ward method (It takes the average of all objects in a central cluster, or centroid, to measure the distance between other objects or groups with respect to the centroid and, in order to join clusters it realizes a weighting of all clusters involved, using the size of each group as weight. The distance between two groups is defined as the sum of the sums of squares of the variance analysis between the two groups over the variables) and the Euclidean mean square distance interval. The results of the clustering will be exposed through a dendrogram.

Discriminant analysis: The discriminant analysis is a multivariate statistical technique. Its goal is to describe in an algebraic way the relationships between two or more populations (groups), maximizing or evidencing the differences among them. It is generally used with predictive objectives to classify new observations in pre-established groups by using a classification rule built according to the independent variables. It is also used to discriminate predefined groups according to variables of interest and to represent the observations in a space where differences among groups are maximum.

The discriminant function is used to define a classification rule. The discriminant analysis is similar to the regression analysis. The objective is to find a linear combination of independent variables that minimizes the probability of a wrong classification of individuals. Contrary to what occurs in the regression, independent variables are considered to be normally distributed and the dependent is fixed.

It is presupposed in this analysis that the dependent variable is nominal and that independent variables are metrical (continuous, measured in intervals or quotient). The grouping variable locates each observation of the data table in one group [45, 46].

RESULTS

Characteristics of farms in concern: In order to characterize the farms which are objects of study, the dairy farmer classification identified for the caprine dairy area of the irrigation area is helpful [18]. This classification divides the farms in:

- Peasant farms,
- Capitalized family businesses and
- Capitalist farms.

In this work, the author also contemplates some dairy farmers' characteristics within each type that are worth mentioning:

- a) It is observed that peasant farming generally present a partial integration to the markets and just oriented a small part of their production to sale (the rest of the production is used for self-sufficiency). The productive process is partially mercantilized and the farms' income is much diversified. The labor utilized is familiar during the whole productive process and foray in the activity emerges from a project of productive restructuring (associated with money that comes from subsides and/or financing from non-governmental organizations (NGOs) like Fundapaz and the State).
- b) For capitalized family businesses, the characteristics are different since in this case the whole production is allocated to the market. These farmers are partially integrated to markets and have a

Table 1: Main statistical indexes of the surveyed variables

Variable	N	Average	S.D.	Coefficient of variables	Min.	Max.
l. delivered to factories	30	6,478.95	11,264.97	126,899,495.21	368.00	50,450.50
Number of goats	30	97.57	116.15	13,491.56	24.00	535.00
Lactating goats	30	43.13	52.93	2,801.57	7.00	270.00
Technological index	30	74.23	17.69	312.89	45.00	115.00
Labor	30	2.23	0.81	0.66	1.00	4.00
Feeding index	30	4.83	3.11	9.69	0.00	10.00

Source: Our own elaboration according to a survey done taking 2005 as a reference year

Chart 1: Record of caprine farms in production in January 2005, in the irrigation area of the province, according to the type of farm

Number of farms	Location by department	Type of farm
37	Robles	* Peasant farm (35)* Small and medium businesses (2)
14	Capital	* Peasant farm (11)* Small and medium businesses (3)
8	Banda	* Peasant farm (3)* Small and medium businesses (5)
1	Silípica	* Peasant farm (0)* Small and medium businesses (1)
Dairy farms total: 60	* Rural farm (49)* Small and medium businesses (11)	

Source: On the base of research done by Paz *et. al.* (2002) and updated according to data provided by Fundapaz and to milk reception lists of factories (period from 2001 to 2005)

fairly mercantilized productive process. In the total income of the farm, a certain diversification is observed, although milk represents an important amount among them. The presence of wage-earning personnel is observed in many of the dairy farm activities, but the most important activities of the productive process are in charge of the members of the family itself. They enter the activity as a result of a familiar investment project and the money used comes from their own funds, which combines with some financing and/or subside from the State or NGOs.

- c) For capitalist farms, there exist almost total mercantilizations where the whole production is allocated to the market and producers act according to market tendencies (total integration). In their productive processes, a high mercantilization is observed, production and, therefore, income are not much diversified and labor is wage-earning almost in the whole productive process. These companies emerge from private investment projects that use equity to pay for the investment.

Approximately 82% of the total of the producers is estimated to be settled in the peasant farms and only 18% of them make up the group of capitalist small and medium farms and capitalized family businesses (Chart 1).

The coordination between primary production and cheese factories then constitutes an incipient productive network though of a small scale if compared to traditional agro industrial chains such as the cow milk agro industrial chain.

Regarding the productive characteristics of rural farms, prior studies show that in general these are medium scale farms with a certain degree of diversification in the cattle raising component and with an important presence of goats. With an average of 38 ha in total, only 3 ha are cultivated. Alfalfa predominates and thus most of the land is covered with scrub or swamp. The structure of average familiar labor is of 2.97 men and in some cases it presents wage-earning labor for some of the dairy farm tasks.

The relationship with the market is established mainly through milk and goat-kid sale (the sale of bellies and males is also observed at a minor scale) totalizing an average annual income of US$ 1,390 with an average production of 172 l per adult goat delivered to factories (milk factories) while milk represents 81% of the total income.

Efficiency evaluation

Main indicators: Some of the technical and structural indicators are summarized (Table 1); INFOSTAT program was utilized for calculations. The level of processing allows for the first approach to the characteristics of the farms integrating the dairy area.

It is interesting to observe the high dispersion in the data collected. This clearly reflects the existent diversity and differential in the productive structure between farms.

Table 2: Efficiency indexes obtained for farms in the caprine dairy area of the Santiago del Estero irrigation area

DMU	GTE	PTE	Scale	
1	0.923	1.000	0.923	irs
2	0.899	0.910	0.988	irs
3	1.000	1.000	1.000	-
4	0.467	0.531	0.879	irs
5	1.000	1.000	1.000	-
6	0.218	0.291	0.748	irs
7	0.238	0.327	0.729	irs
8	0.547	1.000	0.547	irs
9	1.000	1.000	1.000	-
10	0.394	0.523	0.753	irs
11	0.212	0.262	0.808	irs
12	0.352	1.000	0.352	irs
13	0.217	1.000	0.217	irs
14	0.473	0.877	0.540	irs
15	0.204	0.280	0.730	irs
16	0.314	0.478	0.657	irs
17	1.000	1.000	1.000	-
18	0.392	0.439	0.893	irs
19	0.353	0.461	0.765	irs
20	1.000	1.000	1.000	-
21	0.072	0.093	0.773	irs
22	0.278	0.362	0.768	irs
23	0.465	0.487	0.955	irs
24	1.000	1.000	1.000	-
25	0.942	1.000	0.942	irs
26	0.395	0.552	0.715	irs
27	0.747	1.000	0.747	irs
28	0.759	0.759	1.000	-
29	1.000	1.000	1.000	-
30	1.000	1.000	1.000	-
Average	0.595	0.721	0.814	

The average of goats by dairy farm (94 adult goats) shows the predominance of medium scale farms. When relating the value obtained for lactating goats for the summer season (46.63%) with the kidding rate of 82% average for the area the high seasonal nature in production is observed (In some cases, the ratio between summer milk and winter milk is 10 to 1 [47]).

The labor used is around 2.2 people a year and a medium to low level of technology investment is noticed (Even though the average for the dairy area reaches 58.33% of the total score, the technological index provides a score for certain variables (such as chilling equipment, pens, regular hygiene conditions and milking parlor outside the pen) that constitute a minimum requisite demanded to deliver milk to factories. Because of that, in order to evaluate the level of technology investment in an isolated way, these questions should be deduced since they represent 40 points of the 120 that the index contemplates. Using this methodology, the final result would be 42.5%). As regards food management, we verified a low complexity in the utilized system where animals mainly have a scrub-based diet and there is absence of supplementary rations during milking.

The average production per goat is estimated at 181.69 l., but if analyzing this according to the produced milk that follows the sanitary conditions to be delivered to the factories, a mean value of 138.75 l. is obtained. This coincides with the average of rejections observed for the area which is approximately 17.69% of the annual production. All this indicates that there are some errors in the sanitary-hygienic management of production that cause important losses.

Efficiency indexes: To calculate the efficiency indexes for the 30 farms (Table 2) *DEAP version 2.1software* developed by Tim Coelli was used. The analysis is based on the supposition of constant returns to scale and varying returns to scale with input and output-oriented results using the multi-stage method to calculate slacks.

The first column indicates global technical efficiency (GTE) values. The second one indicates the pure technical efficiency (PTE) and the third, scale efficiency (Scale). Finally, in the fourth place, we calculate if the farm is working in increasing returns to scale (Increasing returns to scale. These take place when increasing the factors of production in a determined proportional quantity and thus an increase which is proportionally greater than the quantity produced is obtained. Mathematically: $f(kx_1, kx_2) > kf(x_1, x_2)$) (irs), constant returns to scale (Increasing returns to scale: When varying the quantity of factors used in a determined proportion, the quantity produced varies in the same proportion $kf(x_1, x_2) = f(kx_1, kx_2)$) (-) or decreasing returns to scale (drs) situation.

General results show that the dairy area reaches GTE values of 59.5% which result from the combination of a Scale of 81.4% and a PTE of 72.1%. It was also observed that the quantity of DMUs which are efficient from the technical view point is greater (14) than that considered from the scale view point (9). This is more striking if related to the last point, since it indicates a greater dispersion between the dairy farms for PTE values than for Scale values. In this sense, it is important to verify that most of the farms are in an increasing return to scale situation which invites to think about a sub-dimensioning in the size of the dairy farms.

Table 3: Farms from the dairy area ordered according to their level of global technical efficiency

Efficiency group	DMU	ETG	ETP	ES	Group
High	1	0.923	1.000	0.923	1
	2	0.899	0.910	0.988	1
	3	1.000	1.000	1.000	1
	5	1.000	1.000	1.000	1
	9	1.000	1.000	1.000	1
	17	1.000	1.000	1.000	1
	20	1.000	1.000	1.000	1
	24	1.000	1.000	1.000	1
	25	0.942	1.000	0.942	1
	28	0.759	0.759	1.000	1
	29	1.000	1.000	1.000	1
	30	1.000	1.000	1.000	1
	Average	0.960	0.972	0.988	1
Medium	8	0.547	1.000	0.547	3
	12	0.352	1.000	0.352	3
	13	0.217	1.000	0.217	3
	14	0.473	0.877	0.540	3
	27	0.747	1.000	0.747	3
	Average	0.467	0.975	0.481	
Low	4	0.467	0.531	0.879	2
	6	0.218	0.291	0.748	2
	7	0.238	0.327	0.729	2
	10	0.394	0.523	0.753	2
	11	0.212	0.262	0.808	2
	15	0.204	0.280	0.730	2
	16	0.314	0.478	0.657	2
	18	0.392	0.439	0.893	2
	19	0.353	0.461	0.765	2
	21	0.072	0.093	0.773	2
	22	0.278	0.362	0.768	2
	23	0.465	0.487	0.955	2
	26	0.395	0.552	0.715	2
	Average	0.308	0.391	0.783	2

Theocharopoulos *et. al* [48] work, that tries to determine the global technical efficiency in a group of caprine farms distributed in Greece, shows values which are similar to the present work. The level of global technical efficiency is of 60.7%, reaching a pure technical efficiency value of 76.9% and a scale efficiency of 78.2%. It was concluded that only a third of the farms are economically feasible since the majority are operating under low increasing returns to scale and need to grow in size to obtain costs' saving.

In conclusion, the strategy pursued by the dairy area producers is to increase their scale as the milk demand on the part of the market increases. All these coincide with the manifestation of the dairy farmers surveyed regarding the existent uncertainty in the reception of the milk produced by factories. In the past, when factories faced problems to commercialize their cheeses, they suddenly stopped buying milk which made dairy farmers direct their production to self use or to waste part of their production.

Cluster analysis and relation with efficiency: As a complementary analysis, the producers were divided into groups according to the PTE and SE values calculated for the sample (Before selecting Ward method to show the results, some tests were realized grouping the farm by other methods (Centroide, Average and Medium distance between groups). The results obtained were similar in all the cases showing that the groups of data obtained are strong) (Fig. 1).

Thus, three groups of producers are identified: a high efficiency group (Group 1), a medium efficiency group (Group 3) and a low efficiency group (Group 2). (Table 3).

From this grouping it can be appreciated that inside the high efficiency group there are 12 farms, the medium efficiency group is made up of 5 farms and the low efficiency one includes the remaining 13 farms.

The results allow the inference that, despite the great existent dispersion, a medium or low ETP level predominates in most of the farms of the dairy area.

The mean values obtained for each grouping show values near 1 for the high efficiency group and values near 0 for the low efficiency group. This can be expected, however the high PTE value for the medium efficiency group-even higher than in the high efficiency group – reveals that with an increase in their productive scale, these farms could enter the high efficiency group and significantly enhance the global efficiency level of the dairy area. This situation is different for farms that belong to the low efficiency group, since their PTE value is much lower than that of the other groups.

However, when analyzing the high efficiency group more deeply, it is observed that it includes farms with different production styles.

- 4 capitalist farms,
- 2 capitalized family businesses and
- 6 peasant farms.

First evidence thus emerges from this. When finding different types of farms within the greatest efficiency group, it is demonstrated that different styles of production do not represent a limiting factor towards the potential of the farm. A very general hypothesis is that

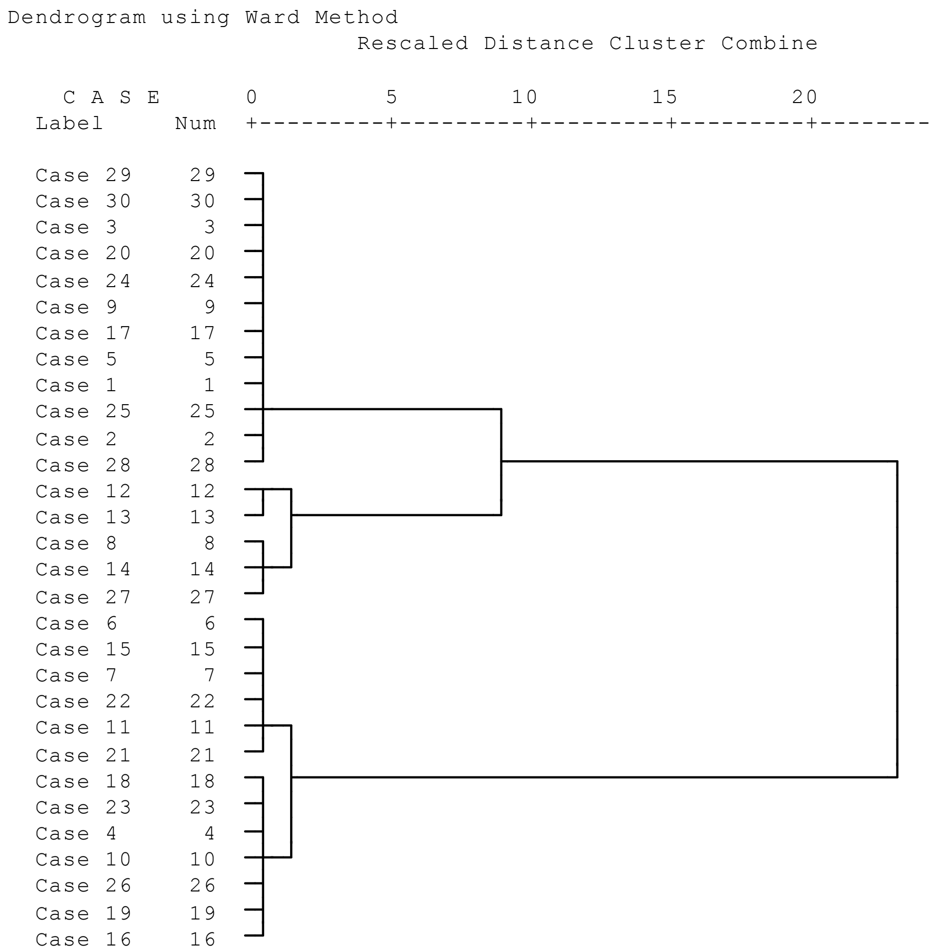

Fig. 1: Dendrogram-hierarchical cluster analysis

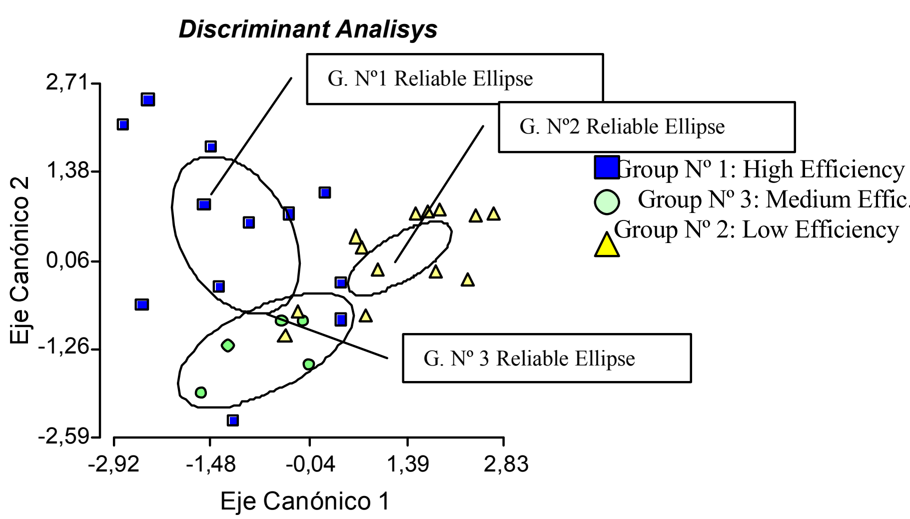

Fig. 2: Farms' location in the canonical dis criminant axes

the capitalist farms are usually more efficient. From this work, the idea that there are no reasons to suppose that a farm should present a specific style of production to be highly efficient in the Santiago del Estero caprine dairy area arises.

In fact, when considering the analysis of only those farms whose GTE index is equal to 1.000 it is discovered that 5 of the 8 farms that constitute this segment are peasant farms and the remaining are capitalist small and medium businesses.

In this sense, the results are related to some theories of authors specialized in rural production studies which hold that peasant production can be carried out competitively despite the physical and productive restrictions and the shortage of financial resources that characterize [49-52].

In contrast, there exists a line of thought that places peasant farms in inferior conditions as regards the competitive potential with their capitalist pairs. Thus, Armando Bartra [53] wonders: "¿...is it really possible for smallholders or associative farmers to develop projects which guarantee family subsistence, business profitability and ecological sustainability from the beginning?" Samín Amir [54] considers: "¿What will happen if farming and food production is treated as any other form of production and subject to the rules of competence in open and deregulated markets?".

When working on Table 3 once more, it can be appreciated that the groups of medium and low efficiency farms are totally constituted by rural farms.

Predominant general characteristics in the groups: This section is intended to identify the inherent characteristics of each of the groups in particular and thus to try to determine the factors causing that a dairy farm be situated in one or another degree of efficiency.

High efficiency group: In the survey carried out for this study, a very low milk rejection level owing to quality is observed. 50% of the dairy farms had no rejections during the year and in the rest of the farms rejections made a 6% of the total production of the year.

Average production per animal is 219 l and 75% of the dairy farmers provide their goats with a ration during milking in which corn and cotton predominate in most of the cases and which also includes some scrub fruit and commercial balanced food. Besides, it is interesting to notice that in 33% of the cases, herds are fed exclusively on scrub and that in the remaining 66%, herds are fed on farmers own pastures and scrub/pastures combination systems in the same proportion.

It is observed that efficient dairy farms have an average of 1.98 laborers per herd per year and that all of them possess chilling equipment (a freezer or cooling tank) in their facilities. The general conditions of these dairy farms could be classified as regular to good and the technological index shows a relatively important investment level (81/120).

Medium efficiency group: Regarding milk rejection for the medium efficiency group, only 25% of the dairy farms had total reception of the production in factories, whereas the remaining 75% had an average rejection of 18.4% of the total of the produced milk.

In this group, the average production per animal is of 159.28 l for the 2005 farming year y 50% of the dairy farmers feeds their goats on supplements during milking that consist of a ration made up mainly of cotton pellets and some corn. Dairy farms with feeding systems based only on pastures are not observed: 75% uses a scrub/pasture combination system and the remaining 25% uses scrub as the only feeding resource.

Approximately 1.87 laborers work in the dairy farm per year and all the farms of this group feature a chilling equipment to store their production. As regards the general conditions of the dairy farms integrating this group, these could be qualified as good and the technological index shows an interesting investment value (79/120).

Low efficiency group: 32.5% of the production of the farms belonging to this group is rejected due to sanitary-hygienic reasons. There is not any dairy farmer to whom the factories had accepted the total milk production during the annual farming year.

Average productivity is only 98 l per animal and 42% of the producers provide their goats with supplements (mainly with a ration based on corn and cotton pellets). Most of the dairy farmers use a scrub/pastures combination system and more than 1/3 of the dairy farms feed their animals only on scrub.

The labor used is greater than in the case of the other two groups, approximately 2.56 laborers per year per dairy farm and most of them feature chilling equipment (14.2% of the farms that constitute this group do not possess chilling equipment to store their production).

The general conditions of these dairy farms could be classified as regular and the technological index shows an

Table 4: Wilks' Lambda (U-statistic) and univariate F-ratio with 2 and 27 degrees of freedom

Variable	Wilks' Lambda	F	Significance (0.05)
ALIM_INDEX	0.86326	2.1383	0.1374
TECHOL_INDEX	0.90491	1.4187	0.2595
PRODUCTION (LTS)	0.72054	5.2359	0.0120
LABOR	0.78010	3.8056	0.0350
LACT_GOATS	0.79905	3.3951	0.0484
TOTAL_GOATS	0.74178	4.6994	0.0177

Table 5: Results of the classification obtained from the analysis

		Predicated group membership		
Actuall group	No. of cases	1	2	3
Group 1	12	7.0	2.0	3.0
		58.3%	16.7%	25.0%
Group 2	13	0.0	11.0	2.0
		0.0%	84.6%	15.4%
Group 3	5	0.0	0.0	5.0
		0.0%	0.0%	100.0%

average result of 60%, reflecting a lower investment level than in the case of the other 2 groups.

Discriminant analysis: As a first measure the factorial discriminant analysis will be run and, as a result, it can be appreciated here that the most important variables are milk liters delivered to factories (PRODUCTION (LTS)), total goat number (TOTAL_GOATS), total lactating goats (LACT_GOATS) and labor (LABOR).

On the contrary, the feeding index (ALIM_INDEX) and the technological index (TECHNOL_INDEX) are non-significant variables in the grouping; it means that the efficiency groups (high, medium and low) do not differ in those indexes in average (Table 4).

Later, the canonical discriminant function program was run. When completing the functions obtained with the corresponding values observed for each farm in the sample, the following graphic can be elaborated:

The graphic shows that, despite the high heterogeneity existent in the population studied, the program managed to gather the producers in each of the groups in an acceptable way and the variables used for the calculation of the DEA considerably predict the efficiency group to which the producers will belong.

The analysis also shows that, according to the variables used as input and output in the DEA, the degree of grouping of the sample is highly strong (76,67%). (Table 5)

The data suggest that within the high efficiency group, 7 of the 12 cases were correctly classified (58.3%), in the medium efficiency group 100% of the data were correctly classified and in the low efficiency one, 11 out of 13 cases were correctly classified (84.6%) (The statistically correct and definite grouping would be 7 farms in the high efficiency group, 13 in the low efficiency group and 10 in the medium efficiency one (Fig. 1 for details)).

CONCLUSIONS

There is not still an important amount of works in this line that allow for the construction of reference in relation to the efficiency indexes for the caprine milk sector in Argentina. However, taking the variables (inputs and output) used in the model into consideration, the Global Technical Efficiency (GTE) mean value for the dairy area is of 0.595.

Results allow us to infer that without altering the level of inputs used, the general milk production could be increased in a 40.5%. This arises from the fact that efficiency in the productive management determines that productivity could be increased without the need of adopting new technologies: it would be enough if the available technologies were used more efficiently: this would result in a very interesting alternative from the economic point of view since it would make possible to increase production in a relatively short term and thus, income will also increase [55].

The inefficiencies in the scale reach a mean value of 18.6% with increasing returns to scale, which indicates a sub-dimensioning of the size of herds. It can be said that these scale values are related to the uncertainty of milk demand on the part of factories and that, when that demand increases, farms will show an increase in production scales.

It can be concluded that there are real possibilities of improving the herds' productivity and production by investing on the traditional aspects of feeding, sanitation, genetics and management as well as on the cold chain and sanitary-hygienic aspects, without making great investments.

This issue is related to the result of the Discriminant Analysis in the sense that mean values of techological and feeding indexes do not reveal significant differences among efficiency gruops and consequently, are not indicators which possess discriminatory capacity.

Subjetivity on the part of researcher at the moment of selection of indexes that will be part of the calculation process cuold be an aspect to consider, especially when values and punctuations are added (regardless of the fact that the punctuaction had technical backing). However, the main issue is that said indexes reflect certain structural homogeneity on the one hand and also a differentiated functional management on the other; and it is precisely on this last point where differences on efficiency levels appear.

Despite that, the indexes present elements that arerelated to the kinds of management or production styles that make farms more or less efficient. For example, the use of an electrified fence, from the economic point of view (more objetive) or from the technical value point of view, is not very important: an electrified fence is around US$ 100. Still, the efficient management of scrublands whit or whitout an electrified fence is notably different in terms of production returns.

Highly efficient farms (High efficiency group) should be taken as productive models with a certain level of success that could be constituted as leaders of strategic decision making for the inefficient economic units. This requires studies that be deeper in the recognition of some production strategies, use of resources and their allocation.

The method of efficiency analysis used (DEA) is appropriate for the efficiency study in rural production sectors. The degree of success with which this method classifies producers is confirmed by the discriminant analysis, which shows an important percentage of correctly classified cases (76.67%) in its results.

One of the most discussed questions among livestock economists who are related to rural development was and still is today if modern capitalist farms (intensive in their capital and production scales and highly specialized) are more efficient than the most traditional ones that include the sector generically called familiar agriculture (intensive in the use of familiar labor, low investment levels and with strategies oriented to reduce costs by decreasing the use external supplies). The relationship between the different styles of production (capitalist, familiar and peasant) and the different degrees of efficiency, especially for the high efficiency group, show a lack of correlation between these two dimensions.

The data provided in this study, taken from the DEA, open again an old discussion that arouses the attention of many investigators in the field of rural sociology. That discussion is related to the agricultural development and to the role that peasant farms can have in this process.

However, the answer to the question goes beyond the objectives of this study but opens a new perspective of the concept of efficiency in the familiar agriculture sector that can be taken up again with new methodological and conceptual approaches, where efficiency, in the rural style framework, can constitute the basis for new integration designs in this globalized world.

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