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Research Article

Family milk production systems in the Ecuadorian Amazon comparative performance of the different typologies

Sistemas familiares de producción de leche en la Amazonía Ecuatoriana desempeño comparado de las diferentes tipologías

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Abstract: In this work, family milk production systems are individual agricultural operations of a reduced but not limiting extension with herds' size that can be handled by the family. The structure and functioning of different typologies identified in previous work were quantified to determine needs and intervention strategies. Canton Centinela del Condor, Zamora Chinchipe, Ecuador, is located southeast of the Ecuadorian Amazon. Mountainous terrain, warm and humid climate, and a predominance of agricultural activity characterize the region. The land, mostly privately owned, supports 0.80 AU/ha, 19 AU per farm, and produces 4.1 liters of milk/cow/day, on average. The participant population was 42 producers that provide milk for the same dairy. They voluntarily completed 27 forms. XLSTAT-Base3DPlot 2.0 of Excel 2007 performed descriptive statistics, ANOVA, and Fisher LSD test to distinguish between typologies. The Ecoanálisis form was applied to estimate financial results, cost/liter, and equilibrium prices. The budgeting to analyze the dairy economy is simple, valuable to the producer, allowing comparing the productive and economic performance of different rationales. In a formal market, milking is competitive. Conglomerates are not different, productive, or economically. Only some incorporated techniques make the differences; such changes contribute in similar proportion to costs and revenues without affecting Profit. Such poor results lead to the interruption, lack of diffusion, and testing of alternative options in an itinerant process of trial and error. To achieve the adoption requires integrating the application of knowledge to the economy.

Keywords: Conglomerates, economy, innovation, intervention, typology.

Resumen: *Sistemas familiares de producción de leche en este trabajo son operaciones agrícolas individuales de extensión reducida pero no limitante con un rebaño manejado por la familia. La estructura y funcionamiento de diferentes tipologías identificadas en trabajos previos, fueron cuantificadas para determinar necesidades y estrategias de intervención. El Cantón Centinela del Cóndor, Zamora Chinchipe, Ecuador, se encuentra al sureste de la Amazonía ecuatoriana. Terreno montañoso, clima cálido y húmedo y predominio de la actividad agrícola caracterizan a la región. La tierra, propiedad privada en su mayoría, sustenta 0.80 AU/ha, 19 AU por explotación y produce 4.1 litros de leche/vaca/día, en promedio. La población participante asciende a 42 productores que proporcionan leche para la misma lechería. Completaron voluntariamente 27 formularios. Se utilizó XLSTAT-Base3DPlot 2.0 de Excel 2007 para realizar estadísticas descriptivas, ANOVA y prueba Fisher LSD para diferenciar tipologías. Se aplicó el formulario Ecoanálisis para estimar resultados económicos, costo/litro y precios de equilibrio. El presupuesto para analizar la economía lechera es herramienta sencilla, valiosa al productor que permitió comparar el desempeño productivo y económico de diferentes racionalidades. En un mercado formal, el ordeño es competitivo. Los conglomerados no son diferentes, productiva ni económicamente. Solo algunas técnicas incorporadas marcan la diferencia; tales cambios contribuyen en igual proporción a costos e ingresos sin afectar utilidad. Resultados tan pobres llevan a la interrupción, falta de difusión y prueba de opciones alternativas en un proceso itinerante de prueba y error. Para lograr la adopción se requiere integrar la aplicación del conocimiento a la economía.*

Palabras clave: *Conglomerados, economía, innovación, intervención, tipología.*

1 Introduction

The family milk production systems (FMPS) referred to in this work are operations that happen in individual agricultural production units (APU), with access to relatively small, but not limited land areas, with herds as large that can be managed by the family labor force (Apollin & Eberhart 1999; Wiggins *et al.*, 2001) whose production is intended for the market. Additionally, at least ideally, family farming should be prosperous and provide the family with autonomy in decision-making without barriers to new producers' entry, particularly young ones (Nehring, Gillespie, Sandretto, & Hallahan, 2009). However, as a livestock activity, FMPS are held responsible for water and soil contamination in intensive production systems, land degradation, and desertification due to overgrazing in drylands and livestock-induced deforestation in the humid and subtropical tropics. In contrast, grazing FMPS has been identified as desirable for causing less contamination than intensive systems, maintaining a higher degree of animal and operator welfare (Nehring *et al.* 2009), remaining competitive (Ordóñez, 1998) and other attributes such as resilience, flexibility or ability to adjust to changing scenarios (Arriaga, Espinoza, Albarrán, & Castelán, 2000, cited by Wiggins *et al.*, 2001), and to operate with a frequent and continual source of cash. As Espinoza (1999) points out, no other small-scale lawful activity has such a dynamic cash flow.

FMPS to stay productive, profitable, competitive, and environmentally sustainable, must adapt to contextual political, institutional, social, and environmental changes that hinder or promote the satisfaction of their interests and objectives (Hellin, Groenewald, & Keleman., 2012). The strategies to adapt to such changes will result from the interaction between said changes on the one hand and the rationality, location, endowment, and structure of resources and their management capacity, particular to each producer, foreshadowing options strategies very heterogeneous. Dixon, Gulliver, & Gibbon (2001) cited by Hellin *et al.* (2012) present categories of farmers' approaches to alleviate or escape poverty:

- Intensification, increasing productivity by applying external inputs, labor, or other resources more efficiently, but becoming more dependent on external resources.
- Diversification, expanding market opportunities by exercising new products, or adding value to an existing product to increase revenue and reduce risk in exchange for dispersing attention to the operation.
- Expansion, expanding the endowment of available resources such as the herd's size or deforesting new areas, with adverse effects on the environment.
- Increase in non-farm income, temporarily or permanently employed outside the farm, with reduced attention to the operation, although the revenue generated may be reinvested in agriculture with a favorable effect, or finally
- Abandonment of agriculture, disregarding the farm to work in another system, lifestyle, or emigrate.

Addressing the best possible option for both the producer and society is a huge challenge where exogenous factors have a simultaneous impact: from trade and fiscal policy, price policy, inter-sectorial distortions, the factor market (land and wages), public goods, in short, everything that affects the availability and accessibility of resources (Osan, 2003); going through the structure and functioning of the dairy circuit itself: lack of specific policies, absence of international markets, insufficient agro-industrial and commercial development, atomization of production, inter-sectorial disarticulation to end up in the production units themselves. It is evident then that the corrective measures are not disciplinary, nor are the solutions agronomic or financial. As Wiggins, Kirsten, & Llambí (2010) point out, this approach is relevant because small producers' future may not be in agriculture. However, measures to stimulate the rural non-agricultural economy and provide work to those who leave agriculture –a favorable climate for rural investment, a supply of public goods, institutional development– are mainly the same as encouraging agricultural development.

It is not enough to describe the different types of farms. The diagnosis, as proposed by Apollin & Eberhart (1999), must allow understanding of the "why" of what is observed and identify the "cause-effect" relationships from the perspective of diversity, heterogeneity of strategies, and the interests of the actors, allowing the formulation of differentiated proposals for each type of producer based on qualitative criteria of homogeneity.

In the first publication of this series, Carrera, Fierro, & Ordóñez., (2017) used multivariate techniques to explain the variability of the FMPS and form homogeneous groups to make harmonious recommendations with each group's particularities. Satisfaction, Risk affinity, and Determination were the factors extracted through factor analysis, traits that allowed discriminating through the analysis of conglomerates, three types of producer: Conservative, Pragmatic, and Innovative are the expression of different economic rationales.

Identified the categories that group the FMPS in the Ecuadorian Amazon, this work's objective was to explain the structure and differentiated functioning of the categories and quantifies them to identify intervention needs and, if necessary, make harmonious recommendations with the particularities of each group.

2 Methodology

This section describes the economic and statistical procedures used or the bibliographic citation where they can be found. A block diagram of the methodology applied is shown in figure 1. Stage I was the object of a previous publication (Carrera *et al.*, 2017), as mentioned before. This paper corresponds to Stage II.

Once validated the composition of the different types of farms, it turns to the original and constructed variables to describe their differences in rationality, location, endowment, structure, resource allocation, and management capacity. Often, among the factors that affect heterogeneity, the producer's rationality is ignored: the differences in interests and economic objectives that are critical in deciding what to do and how to do it. Location distinguishes differences in land productivity levels and climatic conditions. The first analysis of only 16 observations allowed to rule out Latitude, Longitude, and Altitude, as differentiation elements, consistent result as the area under study is limited to 290 km^2 were no significant differences in the levels of productivity of the land, nor of the climatic conditions of the areas dedicated to milk production.

Endowment refers to the dimension or scale of production. Simultaneously, the resources' structure is associated with the relative participation of the own factors used: debt, land tenure modalities, own or leased, and the proportion of the hired or family labor. Management capacity allows differentiating types of farms based on their skill in applying production technology and managerial practices such as the organization of production and accounting records, attention to formal duties (invoicing and taxation), calculation of results, and formulation of operating plan and budget. The differential adoption of production and economical technology explains the variability in physical productivity and financial results.

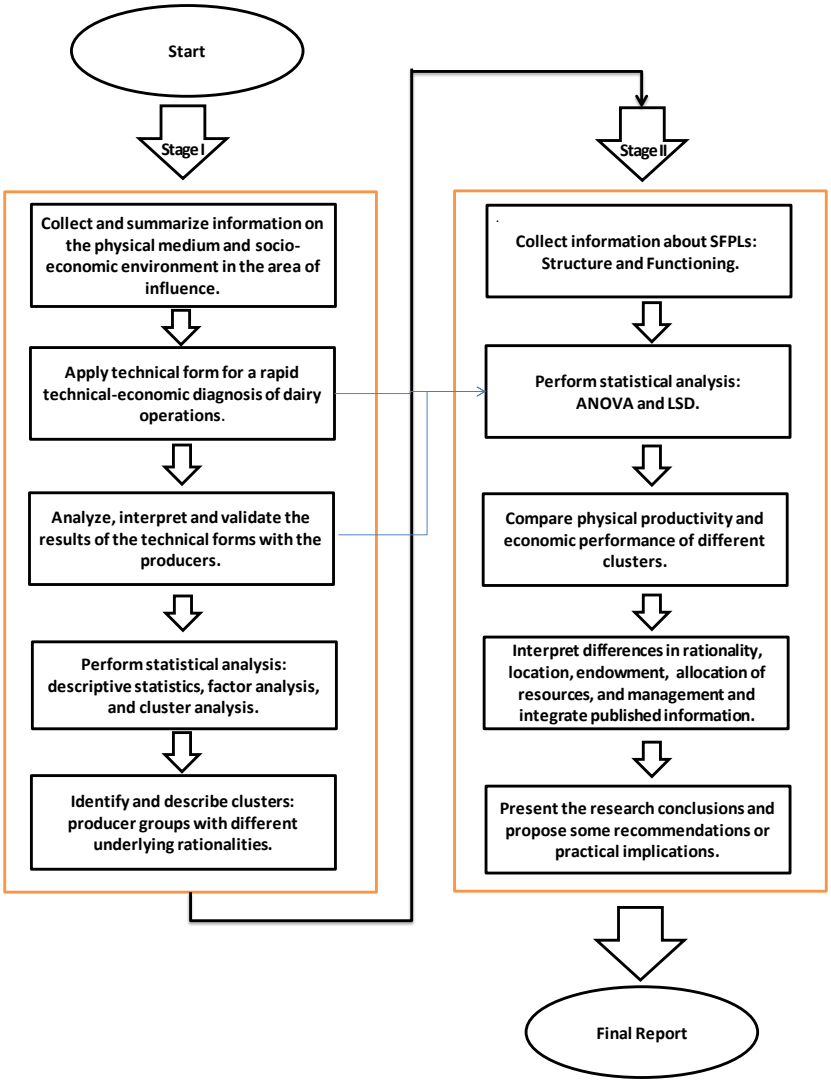

Figure 1: General diagram of the methodology used.

2.1 Study area

The province of Zamora Chinchipe, Ecuador, is located in the southeastern Ecuadorian Amazon, limiting the north with Morona Santiago's province, to the west with Loja's province, and with Peru to the south and east. It has 10556 $km^{2,}$ which includes a unique mountainous orography that distinguishes it from the rest of the Amazonian provinces.

For its part, Centinela del Condor is the smallest of the cantons that make up the Zamora Chinchipe province. The Development Plan and Territorial Planning 2010-2020 and its update completed in 2015 (Cantón Centinela del Cóndor GAD, 2015) contains a detailed diagnosis of the Canton Centinela del Condor. Their most relevant aspects are summarized below.

Located to the northeast of Zamora Chinchipe, sub-Andean zone, it encompasses ecosystems of the sub-tropic and tropic. The canton's climate is warm humid, corresponding to a humid and humid forest, both premontane and low montane. The proportion of the economically active population dedicated to the primary agricultural sector is 47.4%. The cantonal area amounts to 262 km^2, 53.3% dedicated to agriculture, mainly occupied with natural and cultivated pastures for cattle production. At the same time, forests populate 44.6% of the surface and the remaining 2.13% for water bodies (1.61%), anthropic areas (0.25%), and shrub and herbaceous vegetation (0.12%). The canton has 855 productive units (APU). The most crucial land concentration is in the stratum between 5 and 50 ha; this makes up 576 APU, occupying 13062 ha. The bovine population amounts to 7740 bovine units (UB) in 403 farms that maintain an average of 0.80 UB/ha and 19 UB per farm, while milk production averages 4.1 l/cow/day. Cattle are managed by roping or free grazing. On the rope, each animal is tied with a rope and moves once or twice a day. *Brachiaria decumbens* Stapf., *Setaria sphacelata*, and *Axonopus scoparius* (Flüggé) Kuhlm predominate; few producers supply cutting-grass, although sugar cane is used for forage purposes together with molasses and mineral salts. Regarding land tenure, the III National Agricultural Census indicates that 79.4% of the land has its property title.

2.2 Market

ECOLAC, a dairy company based in the city of Loja, contiguous province of the same name, collects in Zamora Chinchipe more than 120 thousand liters/month, just over 40% of the total milk produced in its area of influence, Yantzaza, El Pangui and Centinela del Condor cantons (FEDES, 2015). Milk is paid weekly by individual transfer to each supplier's account, depending on the volume of the product registered. Suppliers bear the costs and risks of transporting milk from the farm to the collection center. The milk price received is US$ 0.42/l, that established by Agreement No. 394 (Ministerio de Agricultura, Ganadería, Acuacultura y Pesca, 2013), price on which prizes or discounts should be applied, according to the milk quality (FEDES, 2015).

Between January and August 2015, ECOLAC had four raw milk collection centers in Zamora Chinchipe: Chicaña, Chamico, Zumbi, and Yantzaza. During that period, only 88 suppliers delivered milk to ECOLAC, less than those existing in previous years, with the consequent reduction in the volume of milk collected. The reasons indicated point to evasion of formal duties and displacement towards informal markets, less demanding and without sanitary control, or directly processing it. The informal market collects milk for local processors at a variable price between US$ 0.38 and 0.45/l depending on location, season, and demand for cheese (FEDES, 2015).

2.3 Collection of information

The study's initial population subject comprises about 100 members of farming communities located in different milk routes that collected the cooperating company's different gathering centers. In two cases, the unwillingness of the collection center administrators and the providers' collective decision in another limited the population participating in the project to the Zumbi collection center, where 42 producers gathered their milk. Due to apprehension, unfortunate previous experiences, or intentional or involuntary ignorance of the required information, only 16 providers completed the survey in April 2015. Refusal to complete the survey prevented the respondents' systematic choice; all the providers who accepted it voluntarily were interviewed. The second cycle of interviews took place in April 2016, after a few suppliers from other closed collection centers joined the cooperating company.

The information was collected through the application of a form prepared based on Ordóñez & McGrann (1992), to record production coefficients, estimate income components, and organize costs to analyze farms' economic performance.

Each observation contemplates original variables grouped into descriptors of identification, location, production coefficients, resources, and costs, segregated into fixed and variable, monetary and non-monetary. The original 49 variables were combined to calculate income, economic costs, gross margin, the total cost per cow and herd, and costs per liter of milk and equilibrium prices. The

projected gross income per cow adds milk and cattle sales, estimated at equilibrium. The variation of inventory or advance or deferred sales is neutralized by calculating the number of culled bulls and cows, males, and heifers sold out of the herd at equilibrium, based on the coefficients and demographics indices provided by the respondent, multiplied by the average market price of each category. Finally, the group type of farm detected through the application of multivariate methods and the code that identifies each provider were incorporated to complete a database made up of 80 variables and 27 observations.

2.4 Characterization procedure

2.4.1 Statistic analysis

The statistical analysis and edition process were performed using the XLSTAT-Base3DPlot 2.0 complement of Excel 2007. Statistics of central tendency and dispersion were obtained for the variables. Variance analysis identified those variables where the differences between the means of the different clusters were statistically significant. Fisher's LSD test was applied since the three groups have different numbers of observations (Barón & Tellez, 2004). These means were used to describe the different typologies.

2.4.2 Economic Analysis

The economic analysis differs from the financial analysis in its application. The financial analysis only considers the monetary income from sales, does not account for opportunity costs. The economic analysis considers the opportunity costs of the resources used in production and the operating costs. The Ecoanálisis form (Ordóñez & McGrann, 1992) was applied to execute the economic analysis.

Costs are organized into six categories and classified into monetary or cash and non-monetary. Non-monetary costs represent the opportunity costs for each of the evaluated production factors: land, labor, capital, and management, as follows:

- Costs of inputs and services to operate (C.ISO): monetary costs include all expenses considered as inputs or services to operate during the year. Non-monetary costs include the opportunity costs of the inputs produced, on the farm, at market values.
- Capital investment costs: include both the payment of interest on borrowed capital and the opportunity cost of own working capital: It includes investment in livestock, machinery, and equipment, and working capital. Interest on borrowed capital results from the average value of the "active" interest rate during that period. For non-monetary costs, the "passive" interest rate is applied.
- Costs of ownership reflect the costs that occur because of owning the assets that make up working capital. Monetary costs include payments of property taxes, patents, and Insurance. Non-monetary costs include the depreciation generated by these assets at market values.
- Labor costs: include family and hired labor, both temporary and permanent. The monetary costs concern the payroll of the hired personnel. Non-monetary costs meet the opportunity cost of family labor at market prices.
- Land costs: consider the remuneration for using the land and the improvements dedicated to milk production. Land taxes include the Rural Land Tax (SRI, n.d.), whose collection corresponds to the central government, and the Property Tax (Cantón Centinela del Cóndor GAD, 2013), values of rural properties under the jurisdiction of the municipality where the property is located. Cash spending from other people's land is included as monetary costs. The opportunity cost for land use was estimated as an equivalent rent, that is, the one canceled by land in similar use in the region.
- Administration costs: corresponds to the contracted administration's salaries, or the opportunity cost that the owner would perceive when performing management activities outside the farm (purchases, sales, collections, banks, management of formal duties).

The results are presented by the Cow Herd Unit (UVR) and for the Total Herd and include the following totals:

- Total Projected Gross Income (GI): includes, as previously indicated, the production of milk and livestock, estimated at equilibrium at market price.
- Total Projected Production Cost (TC): it is the result of the sum of all costs.
- Profit: is the difference between GI and TC.
- Total Variable Cost of Production (VC): includes the costs of supplies and services to operate, the operating capital, and the temporary labor.
- Gross Margin (GM): GI - VC
- Total Monetary Costs (MC): it is the result of the sum of all cash costs and the depreciation of the purchased livestock.
- Monetary Income minus Monetary Costs: It results from the difference between the GI minus the MC.
- Reason for Income to Cost in cash: obtained by dividing the GI by the MC.
- Annual Return to Operating Capital: corresponds to the remuneration received for the investment of that capital expressed as a percentage. It includes all payments to working capital (Profit + non-monetary cost of capital) expressed as a percentage of own working capital.

- Annual Return to Family Work: Wiggins *et al.* (2001), point out how the return to family labor results from adding to the gross margin, the opportunity costs of family labor, expressed in US$ per year because, in their work, the opportunity cost of family labor was assigned as a variable cost. The argument is that the family can suspend milking to dedicate their time to another activity. For this work, the opportunity cost of labor in the family milk production business is treated as a fixed cost since livestock milking and care are unavoidable. Although carried out by different family members, the work is permanent. Because it is an opportunity cost, the cost of family labor counts as a non-monetary cost.
- Margin per family workday: It results from dividing the GM by the number of days worked by the family labor force, expressed in US$/family wage.

For the equilibrium point analysis, the by-products' value, which corresponds to the income from the sale of animals, is subtracted from the corresponding cost, assuming animals' sale does not generate Profit. The amount under consideration minus the value of by-products divided by the total number of liters of milk produced per cow and year estimates the liter's price required to cover each cost.

Finally, the results are discussed with the description of the types obtained, their technical-economic logic, and some recommendations regarding the intervention strategy.

3 Results

3.1 Description of the production units of the different typologies

3.1.1 Use of resources

The similarity in their intensity of use of resources between typologies is notable. Table 1 compares the use of resources between typologies. The number of wages occupied by UVR reached a certain level of significance (P<0.1), being lower for the Conservatives (16.39 ± 5.74). They show their high level of satisfaction or conformity using little family labor, encountering situations where even not all lactating cows are milked.

Although the differences did not reach significant levels (P>0.1), the cost of operating capital was manifestly higher for the Innovator group (342 ± 10), which corresponds to a higher C. ISO, as indicated below, even with a similar number of cows, hectares and animal units per cow.

3.1.2 Productive performance

As evidenced in table 2, the vast differences (P<0.05) in the duration of the calving intervals and the disparities (P<0.1) in lactation yield translate into a notable advantage in milk production per cow per year of the Innovator group (1686 ± 172) over the Pragmatic (1026 ± 109) and Conservative groups (984 ± 172). Even more noticeable difference (P<0.05) is found in milk production per hectare and per year, where the Innovator group (1376 ± 237) exceeds Pragmatic (506 ± 150) by 172%. This superiority results from the simultaneous effect of a higher milk production per cow per year and a lower surface available by UVR of the former, which is explained, at least partially, by the greater use of working capital in the Innovative group, which was previously analyzed.

3.1.3 Production costs

Table 3a presents the differences in the costs of supplies and services to operate, capital costs, ownership costs, labor costs, land costs, and administration costs between typologies.

That Innovative exceeds in Animal Units per hectare (AU/ha), application of fertilizers, cleaning of electric fences and weed control even though it has a smaller surface area, could explain part of the superiority (P<0.01) of maintenance expenditure of fences and paddocks (1791 ± 393). The reduced amount for this concept of Pragmatic (49 ± 249) and Conservative (130 ± 393) is because fences and paddocks' maintenance is limited to manual control of weeds. That amount is attributed to labor, being higher the surface by Conservative farm. Although the differences in C. ISO do not reach a level of significance (P>0.1), the difference in the amount used is notable, where Innovative (6063 ± 1 286) almost doubles the other two categories.

Table 3b shows the differences in ownership costs, labor costs, land costs, and administration costs between typologies. The same comment deserves the opportunity cost of family labor. In this case, Conservative was notably less (2644 ± 1672) than Pragmatic (6142 ± 1058) and Innovative (6711 ± 1672), confirming the previous comment that a high level of satisfaction induces not to apply more family labor to increase income, even at the expense of not milking all the lactating cows. The interest paid for the purchase of livestock speaks of the affinity for risk and genetic improvement expectations by Innovative.

3.1.4 Economic results

Table 4 reveals the differences in economic results between typologies. The proportion of gross income from milk results from low milk production and little

emphasis on meat production, as confirmed by the early age of dismissing (12.8 ± 1.6 months). The limited number of heifers sold is a consequence of a low weaning percentage (68.4 ± 17.1%), a high percentage of heifer mortality (5.19 ± 7%), and a high rate of cow replacement (24.3 ± 6.9%). Apart from the UVR gross income, the differences between groups for this set of variables did not reach significance levels (P>0.1).

Gross income per cow was higher in Innovative (P<0.1) because of the superior production/cow/year mentioned above. However, this higher income per cow (1089 ± 120 US$) of Innovative is not reflected in a higher gross margin/UVR (P>0.1), gross income minus cash outflows/UVR (P>0.1), or Profit/UVR (P>0.1). This behavior is a consequence of the higher amount of cash destined for supplies and services, mostly variable costs, and monetary costs of Innovative, as mentioned above. Similar consideration corresponds to the Profit per cow (P>0.1) that was negative for the three types, although more favorable for Conservative, who uses little labor (16.39 ± 5.74 wages/UVR), particularly family labor, as noted above. It is important to note that 23 of 27 (85%) of the producers presented a negative profit. The rate of return to working capital was equally negative value for the three typologies, without the differences between them reaching significance levels (P>0.1) although being more favorable for Conservative (-13 ± 9%).

Table 1: Means of the resources used by typology: Pragmatic, Innovative, and Conservative.

	Pragmatic	Innovative	Conservative	SEM	Pr > F
Area, ha	41.1	32.0	33.7	3.89	0.579
N° cows	18.5	18.2	20.7	1.86	0.887
N° milking cows	8.8	10.1	9099	1.05	0.892
N° cows per bull	9.7	8.4	11.5	1.79	0.857
N° cows per horse	8.9	9.0	14.7	2.01	0.513
Hectares / UVR	2.5	1.8	1.8	0.26	0.454
UA / UVR	1.55	1.5	1.4	0.05	0.568
Wages / UVR	30.3[ab]	36.0[a]	16.4[b]	2.92	0.059
Cost of Operating Capital / UVR	99	342	100	50.50	0.135

SEM - Standard Error of the Mean

[ab] Means in the same row with unequal letters are different P <0.10

Table 2: Productive performance averages by typology: Pragmatic, Innovative, and Conservative.

	Pragmatic	Innovative	Conservative	SEM	Pr> F
Calving interval, days	465[b]	408[b]	551[a]	17.50	0.017
Duration of lactation, days	219[b]	229[ab]	260[a]	8.17	0.130
Average age at weaning, months	5.3	7.0	5.8	0.40	0.258
Weaning percentage, %	66.3	77.1	64.8	3.30	0.376
Age at sale of bulls, months	15.1	10.0	9.8	1.61	0.276
Age of 1st calving, months	28.5	29.8	30.0	0.62	0.559
Percentage of mortality in heifers, %	3.9	6.1	7.4	1.44	0.616
Percentage of mortality in bulls, %	12.5	8.5	5.3	3.94	0.766
Percentage of mortality in cows, %	6.4	6.5	7.2	1.34	0.974
Cow replacement percentage, %	24.1	27.7	21.6	1.32	0.311
Production per cow, l / day	5.9[b]	7.9[a]	6.6[ab]	0.38	0.094
Production per lactation, l	1304[b]	1794[a]	1656[ab]	90.10	0.053
Production / ha / year, l / ha	506[b]	1376[a]	727[ab]	127	0.017
Production / cow / year, l / cow	1026[b]	1686[a]	984[b]	95.20	0.008
Proportion of replacement cows purchased, %	5.89	19.10	0.0	3.89	0.242
Useful life of breeding bulls, years	2.1	1.8	2.0	0.33	0.938

SEM - Standard error of the mean

[ab] Means in the same row with unequal letters are different P<0.10

Table 3a: Average production costs (C.) in US$ by typology: Pragmatic, Innovator, and Conservative.

	Pragmatic	Innovative	Conservative	SEM	Pr> F
C. Calf feed	146	55	198	80.4	0.844
C. Feed for cows	1073	1269	1307	342	0.955
C. Milking hygiene	69	58	15	13.3	0.278
C. Veterinary medicines	804	1059	489	147	0.448
C. Tools and supplies	67	78	50	16.9	0.864
C. Fuels and lubricants	141	245	196	58.7	0.781
C. Gas and electricity	88	48	245	40.5	0.211
C. Freight and transportation	635	1119	378	145	0.223
C. Maintenance of fences and paddocks	49[b]	1791[a]	130[b]	227	0.003
C. Mach & Equip Maintenance	39[b]	323[a]	147[ab]	53.6	0.103
C. Maintenance of facilities	10.0	16.7	4.2	6.57	0.829
C. Vehicle maintenance	81.6	0	70.5	46.7	0.793
Total C. Inputs and services to operate	3321	6063	3418	623	0.198
C. Interest on livestock debt	44[b]	744[a]	117[ab]	117	0.045
C. Interest on debt of Mach & Equip	56	0	0	31.1	0.687
Total C. Interest on debt	100[b]	744[a]	117[ab]	119	0.076
Opportunity C. Livestock investment	915	769	1169	102	0.424
Opportunity C. Mach & Equip investment	189	340	194	56.5	0.563
Opportunity C. operating capital	106	173	127	21.1	0.470
Total opportunity C. Working capital	1210	1282	1490	150	0.772
Total C. Capital	1310	2026	1607	219	0.439

SEM - Standard error of the mean
[ab] Means in the same row with unequal letters are different P <0.10

Table 3b: Average production costs (C.) in US$ by typology: Pragmatic, Innovator, and Conservative.

	Pragmatic	Innovative	Conservative	SEM	Pr> F
C. Taxes and livestock insurance	17.5[b]	70.3[a]	11.3[b]	9.24	0.041
C. Taxes and insurance Mach. & Equip	21	53	120	24.9	0.297
Total C. Monetary ownership	39	124	131	29.1	0.330
Depreciation of livestock	489	491	419	87.4	0.949
Depreciation Mach. & Equip	961	1700	969	295	0.601
Total C. Non-monetary ownership	1450	2192	1388	300	0.592
Total C. Ownership	1489	2315	1519	318	0.582
C. Temporary labor	1007	874	419	310	0.765
C. Permanent labor	420	826	1875	376	0.316
Total C. Monetary labor	1427	170	2294	526	0.818
Total C. Opportunity. Family workforce	6142	6711	2644	815	0.171
Total C. Labor	7569	8411	4938	800	0.313
C. Land tax	150	40	68	45.2	0.577
Rent of land	364	717	450	185	0.764
Total C. Monetary land	514	757	518	183	0.869
C. Opportunity of own land	4333	2593	5217	754	0.508
Total C. Land	4847	3350	5735	724	0.554
Total C. Opportunity Administration	1541	1136	1869	472	0.882

SEM - Standard error of the mean
[ab] Means in the same row with unequal letters are different P <0.10

Table 4: Averages of financial results by typology: Pragmatic, Innovative, and Conservative.

	Pragmatic	Innovative	Conservative	SEM	Pr> F
Milk share in gross income,%	56.7	65.2	57.7	2.30	0.339
Gross income / UVR, US $ / UVR	781[b]	1089[a]	673[b]	61.4	0.050
Gross margin / UVR, US $ / UVR	532	624	479	63.3	0.754
Gross income - C. monetary / UVR, US $ / UVR	451	499	354	62.4	0.743
Profit / UVR, US $ / UVR	-351	-352	-294	67.0	0.944
Working capital rate of return,%	-19.9	-17.4	-12.8	4.26	0.813

SEM - Standard error of the mean
[ab] Means in the same row with unequal letters are different P <0.1

3.1.5 Breakeven analysis

The equilibrium point analysis expresses the price of milk that the producer must receive to cover the different costs: Variable, Monetary, and Total, once the income from the sale of animals has been subtracted from the corresponding value.

The price of milk needed to cover all variable costs averaged -0.06 ± 0.05 US$/l. Differences between groups did not reach significance levels (P>0.1). Negative values indicate that the income from the sale of discarded animals, cows, bulls, and heifers covers all the variable costs. On the other hand, the price of milk necessary to cover monetary costs averaged 0.02 ± 0.05 US$/l, and the differences between groups also did not reach significant levels. These figures confirm the producers' appreciation when they indicate that they are "producing at cost," as they receive the benefit when they occasionally have animals for sale. Finally, the price of milk necessary to cover the Total Cost averaged 0.79 ± 0.08 US$/l, 90 % higher than the amount paid to the producer for the liter of fluid placed in the receiver. Innovative accumulated the lowest total cost per liter of milk (0.68 ± 0.18), although the differences between groups did not reach significance levels (P>0.1).

3.1.6 Family work remuneration

As table 5 examine, the implicit return to family labor amounted to US$ 9908 ± 1344 per year per farm, which remunerates an average of 402 ± 59.4 wages/year, equivalent to 24.6 ± 9.11 US$/day worked, which corresponds to what the worker would cease receiving if he discards the dairy activity on the family farm.

Said amount is equivalent to 1.15 times the minimum wage established by Ministerial Agreement 0233-2015 (Ministerio del Trabajo, 2015) that Regulates Special Labor Relations in the Agricultural Sector, amounts to US$ 21.41/day worked. These results surpass those reported by Chauveau (2007), who states that the best-endowed families can ensure US$ 500 or more per month for the sale of milk in Cayambe, Ecuador. Udo *et al.* (2011) confirm that, in terms of "returns," the most significant benefits come from dairy cattle. The differences between typologies reached significance levels (P<0.10) for family wages/UVR, confirming that the Conservative group (10.6 ± 3.38) makes little use of family labor in milking, possibly because it occupies part of their time on a job outside the farm.

The remuneration for family work of 23 of the 27 farms analyzed (85%) exceeds the annual cost of the vital family basket (INEC, 2016), while 78% (21/27) manages to exceed the amount of the essential family basket. These results coincide with those of Willot (2006), cited by Brassel & Hidalgo (2007), who, in several parishes in the southern Andean region of Ecuador, concludes that milk production is the only activity that allows an agricultural income comparable to or higher than wages of a day laborer.

3.2 Milk production cost structures of the different typologies

The cost structure reflects for each item or expense account; the average annual amount disbursed as a proportion of TC expressed as a percentage.

3.2.1 Input and service costs to operate

The disbursements applied to the acquisition of inputs and the hiring of services used in milk production are variable and monetary in their entirety. C.ISO represents 19.2% of TC, the most significant contribution after labor. C.ISO is also the more substantial component of cash costs, with the workforce being mostly family. The leading members of this account are the feed of cows (5.68%), typically mineral supplement, veterinary medicine (3.84%), freight and transportation (3.33%) represented by the payment of the transfer of milk to the reception, fences, and paddocks maintenance (2.21%) and 3.63% for other costs such as detergents, fuels, and general supplies. The most notable difference between typologies is the greater participation of this segment in total expenses by Innovative, which amounts to 26.0%, as opposed to 16.54% by Pragmatic and 17.9% by Conservative. On the other hand, while all (100%) producers apply vaccines, parasiticides, and medications, only two-thirds of Innovative and Conservative incur freight and transportation costs, indicating that the rest have their vehicle as opposed to Pragmatic, were 93.3% pay freight.

3.2.2 Capital costs

The average share of capital costs in TC amounts to 7.46%, with only 1.20% are attributable to the payment of interest on the debt, that is, monetary. The interest paid on the debt contracted by Innovative, mainly in livestock, far exceeds (744 US$) the amounts paid by Pragmatic (100 US$), and Conservative (117 US$), being the contribution of this item to TC of 3.19, 0.50, and 0.61%, respectively. The remaining 6.26% corresponds to the opportunity cost of its capital. The most significant proportion of working capital (livestock, machinery, and cash flow) corresponds to cattle. That item contributes 4.56% of TC, with no significant difference between conglomerates.

Table 5: Means of family work remuneration indicators by typology: Pragmatic, Innovator and Conservative, and general mean.

	Pragmatic	Innovative	Conservative	Mean	SEM	Pr> F
Gross Margin, US $	9061	11428	10506	9908	1344	0.774
Total family wages	456	494	175	402	59.4	0.118
Gross Margin / family wage, US $ / wage	19.9	23.1	60.0	24.6	9.11	0.115
Family Labor proportion, %	94.2	74.6	69.6	84.4	5.37	0.115
Family wages / UVR	28.7[a]	29.8[a]	10.6[b]	24.9	3.38	0.072

SEM - Standard error of the mean
[ab] Means in the same row with unequal letters are different P <0.1

3.2.3 Ownership Costs

Monetary costs of ownership are negligible from a practical standpoint, contributing less than half a percent to TC. The depreciation of machinery and equipment corresponds to 5.48% of TC. A more significant contribution to TC can be seen in Innovative. The participation amounts to 7.30%, against 4.79 and 5.08% from Pragmatic and Conservative, respectively. Ownership costs ultimately contribute an average of 8.16% of TC.

3.2.4 Labor Costs

The cost of labor is the most significant component of TC in FMPS (34.9%). In the FMPS, the amounts used in hired labor are proportionally small (15.6% of wages) but economically important due to the magnitude of their participation in TC (8.17%), particularly in Conservatives with 12.0% participation, compared to 7.11 and 7.29% of Pragmatic and Innovative respectively. On the other hand, since it is a valuable resource, family labor is applied extensively, as demonstrated by both indicators of the intensity of use: 28.4 ± 2.9 wages/UVR or ten cows per man equivalent per year TC (26.7%). Particularly notable is the reduced participation of this concept in the Conservative structure (13.9%). In comparison, it amounts to 30.6 and 28.8% in Pragmatic and Innovative.

3.2.5 Land Costs

Few properties exceed 70 hectares, so the rural land tax is of little significance. However, all the farms pay the property tax to the municipality, contributing 0.52% of the TC. 50% of Innovative pay cash rent, while only 26.7% of Pragmatic and 33.3% of Conservatives do so. However, the amount canceled does not differ significantly between conglomerates and amounts to 2.24% of TC, which, added to land taxes, completes monetary land costs by 2.77%. Zhunaula (2013) analyzed the costs of milk production in family units in the same province of Zamora Chinchipe, reporting a 71.4% share of labor in TC, a value much higher than that reported here, a disparity attributed to methodological differences.

The opportunity cost for using its land is the most significant TC's component, with 20.1%. The differences between groups are marked, with the contribution of Innovative being notably low (11.1%), which makes greater use of leased land. Meanwhile, all Pragmatic and 83.3% of Conservatives contribute 21.6% and 27.3% to TC.

3.2.6 Administration Costs

Finally, the administration or management costs were entirely non-monetary since they do not use employed administration. The entire Conservative group claimed management functions and assigned it a significant value. At the same time, only 53.3% of Pragmatics and 66.7% of Innovators did so. In the end, administration costs contributed 7.41% of TC.

4 Discussion

Contrasting the results obtained in Centinela del Cóndor with other works published in Latin America, or even in the Ecuadorian Sierra itself, is complicated due to the diversity of the integration of the dairy chain (FAO-FEPALE, 2012). The average size of the farms, the meaning of "small family producer," the chain's organization to the consumer, the destination of production, and the relationship between the producer and the industry, are aspects that contribute to the heterogeneity. To this is added the diversity of methodologies applied by the different schools.

4.1 Use of resources

From the comparison of the use of resources between typologies, the similarity in the intensity of use is notable. This behavior brings up the observation of Apollin & Eberhart (1999), who pointed out that a typology by ranges of dimensions (0 to 1 ha., 1 to 2 ha., 2 to 3 ha.) "is useless if the scope does not express different economic and logical rationalities of agricultural production techniques."

The number of wages employed by the UVR reached a certain level of significance (P <0.1), resulting notably lower for the Conservative group, evidencing

their high level of satisfaction by not making use of a more significant amount of family labor, finding situations in which even not all the lactating cows are milked. As it is an available resource, family labor is applied extensively, as shown by the intensity of use indicator of 28.4 ± 2.9 Wages / UVR or ten cows per Man Equivalent per year, as the amount contributed to the TC (26.7%).

As it is a usable resource, family labor is applied extensively, with similar results to those obtained by Maroto *et al.* (2018). Particularly noticeable is the reduced participation of Family labor in the Conservative structure (13.9%). In comparison, it amounts to 30.6 and 28.8% in Pragmatic and Innovative, respectively.

The fact that Innovator exceeds in Animal Units per hectare (AU / ha), application of fertilizers, cleaning of electric fences, and weed control; although it has less land area, it could explain part of the superiority (P <0.01) of the expenditure on maintenance of fences and paddocks. The reduced amount for this concept of Pragmatic and Conservative, with the area per farm being greater than Conservative, is because fences and paddocks are limited to manual weed control and, that amount is assigned to labor.

Although the differences did not reach significant levels (P> 0.1), the cost of operating capital or working capital was higher for the Innovator group, even with a similar number of cows, hectares, and animal units per cow.

4.2 Productive performance

Regarding the productive performance, the large differences (P <0.05) in the duration of the calving interval and the disparities (P <0.1) in production per lactation translate into a notable advantage in milk production per cow per year of the Innovative group over the Pragmatic and Conservative groups. An even more notable difference (P <0.05) is found in milk production per hectare and per year, since the Innovator group surpasses Pragmatic by 172% as a result of the simultaneous effect of higher milk production per cow per year and lower surface available per UVR of the first, which is explained, at least partially by the greater use of working capital in the Innovator group.

4.3 Production costs

The fact that Innovator exceeds in Animal Units per hectare (AU/ha), application of fertilizers, cleaning of electric fences, and control of weeds, although it has less surface area, could explain part of the superiority (P<0.01) of the expenditure on maintenance of fences and paddocks. The reduced amount for this concept of Pragmatic and Conservative is because fences and paddocks' maintenance is limited to manual control of weeds. That amount is attributed to labor, being the area per Conservator farm greater.

Although the differences in C.ISO do not reach a significance level (P>0.1), the difference in the amount used is noticeable, where Innovator almost doubles the other two categories. The main component of C.ISO is the cost of feed for cows, represented almost exclusively by the mineral supplement. These results confirm the appreciation of Espinoza, Álvarez, Del Valle, & Chauvete's (2005), who conclude that the costs generated by feed within livestock activities and specifically in milk production constitute the most component (Espinoza *et al.*, 2005).

The opportunity cost of Family Labor was notably lower for Conservative than Pragmatic and Innovative, confirming that a high level of satisfaction induces not to apply mire family labor to increase income, even at the expense of not milking all lactating cows. According to Jiménez, Espinoza, & Soler (2014), family labor is one of the variables that negatively influence production units' profitability. Zhunaula (2013) analyzed the costs of milk production in family units in the same province of Zamora Chinchipe, reporting a participation value that was vastly higher than that reported here.

The amount of the interest paid due to the purchase of livestock, Taxes, and Insurance paid for the same livestock speaks of the affinity to the risk and the expectations of Innovator's genetic improvement.

4.4 Economic results

The low proportion of income from milking results from low milk production and little interest in meat production, as evidenced by the young bulls' selling age. The low number of heifers sold is due to the simultaneous effect of a low weaning percentage, a high percentage of heifer mortality, and a high rate of replacement of cows.

Gross income per cow was higher in the Innovator group (P<0.1) due to the higher production/cow/year. This higher income per cow for Innovator is not reflected in a higher Gross Margin/UVR (P>0.1), Gross Income minus cash outflows / UVR (P> 0.1) or Profit / UVR (P>0.1), as a consequence of the greater amount of cash allocated to inputs and services, mostly variable costs and of course monetary from Innovator. These results contrast with studies by Robison & Barry (1987) and Torero (2010) cited by FAO (2014), for whom a decrease in

the demand for inputs causes lower expectations of profitability and lower levels of production.

The Profit per cow (P>0.1) was negative for the three types, although more favorable for Conservative, which employs very little labor, particularly family labor, as indicated above. 23 out of 27 (85%) of the producers presented negative Profits.

The return rate to working capital was negative for the three typologies, without the differences between them reaching significance levels (P>0.1). However, it was more favorable for Conservatives. These results confirm the conclusions of Arias *et al.* (2011), Arias & Vargas (2010), and Cafferata (2010), that profitability will depend on how both the prices of final products and the prices of agricultural inputs evolve and how intensive is the use of inputs.

4.5 Breakeven analysis

The breakeven analysis expresses the milk price that the producer must receive to cover different costs, Variable, Monetary or Total, once the income from the sale of by-products has been deducted from the corresponding cost. They result from subtracting from the different production costs (variable, monetary, or total) the value of the sales of discard animals, bulls, and heifers and dividing this result by total milk production. Thus, equilibrium prices respond to variation in production costs, as indicated by the study carried out by the National Council for Economic and Social Policy (Consejo Nacional de Políticas Económicas y Sociales, 2010) and the production levels achieved.

The milk's price must cover the variable cost averaged -0.06 ± 0.05 US $/l without differences of significance (P> 0.1). The negative values indicate that the income from the sale of discard animals, bulls and heifers, covers all variable costs. For its part, the price of milk necessary to cover monetary costs averaged 0.02 ± 0.05 US $/l without significant differences between groups. These figures confirm the producers' appreciation when they indicate that they are "producing at cost" since the benefit is received when they occasionally have animals for sale. The price of milk necessary to cover total costs averaged 0.79 ± 0.08 US$/l, 90% higher than the price paid to the producer for the liter of milk placed at the dairy. Innovators accumulated the lowest total cost per liter of milk (0.68 ± 0.18 US$/l) even though the differences between groups did not reach levels of significance (P> 0.1).

4.6 Compensation for family work

The implicit return to family labor amounted to 9908 ± 1344 US $ average per year per farm, which remunerates an average of 402 ± 59.4 wages/year, equivalent to 24.6 ± 9.11 US $/day worked, which corresponds to what the worker would cease to receive if he gave up attending the dairy activity on the family farm.

This amount is equivalent to 1.15 times the minimum wage established by Ministerial Agreement 0233-2015 (Ministerio del Trabajo, 2015) that Regulates Special Labor Relations in the Agricultural Sector; an amount that amounts to 21.41 US $/day worked. These results exceed those reported by Chauveau (2007) that states that the best-endowed peasant families can secure US$ 500 or more per month for the sale of milk in Cayambe, Ecuador. Udo *et al.* (2011) confirm that the more significant benefits come from dairy cattle in terms of returns. This is also confirmed by Long (1966), indicating that income from dairy farming is essential for families.

The differences between typologies reached levels of significance (P<0.10) for family wages/UVR, confirming that the Conservative group (10.6 ± 3.38) makes little use of family labor in milking work, possibly because it occupies part of their time in work outside the property, as pointed out by Maroto *et al.* (2018) who indicates that almost 40% of livestock farmers obtain more than half of their income from activities not related to livestock. Of these, half work in the public sector, notably commercial and veterinarians. A third of the families receive a retirement pension. For her part, Rubio (2000) mentions that work outside the production unit is part of "survival strategies." In short, the rural employment profile in the Ecuadorian case is quite diversified; close to half of the rural employment occurs in various modern activities such as commerce and "non-agricultural" activities (Martínez, 2000).

The remuneration for family work of 23 of the 27 farms analyzed (85%) exceeds the annual cost of the Vital Family Basket (INEC, 2016) while 78% (21/27) manages to exceed the cost of the Basic Family Basket. These results coincide with those of Willot (2006) cited by Brassel & Hidalgo (2007). In several parishes of the South - Andean region of Ecuador, they conclude that milk production is the only one that allows an agricultural income comparable or higher than the salary of a day laborer.

5 Conclusions

Grazing FMPS are valued as less polluting than intensive systems, meet the animal and operator welfare requirements, remain flexible to adjust to changing scenarios, and provide frequent cash to the household. In extensive pasture areas existing in the Ecuadorian Amazon, cattle breeder communities

have been intentionally attracted through colonization policies. Today, they represent a good part of the economically active population. They have the infrastructure; provide meat, milk, and environmental services to the community. They consciously link to the consumer through an elementary dairy chain and do so with satisfactory results.

To alleviate or get out of poverty, farmers adopt different strategies with opposite consequences for the environment, the economy, society, and culture. Faced with the options of Intensification, Expansion, or Abandonment of agriculture, one cannot be indifferent.

Formal dairy enterprises such as cooperatives are examples of what the private sector can do to boost the region's dynamism and contribute to its suppliers' well-being. Receipt guarantee, known price, timely payment, quality bonus, and technical support have been, with the ups and downs of agriculture, highly significant contributions, as evidenced by the progress made by producers organized around their collection centers. Under the prevalent scenarios in Centinela del Condor, with a formal market guarantee, milking is competitive.

The methodology used allowed describing and comparing the different typologies of farms detected by applying multivariate methods. For its part, the economic analysis technique by preparing a budget to analyze the dairy economy is simple. Costs and income are detailed to summarize financial results that are of value to the producer and compare companies' performance from different areas, systems, scales, and rationales. The methodology requires elementary accounting records or producers aware of the inputs and products of their activity.

It is appropriate to recognize that the figures obtained are difficult to compare with previous work. In addition to applying different accounting methodologies, they deal with production systems that differ in rationality, location, endowment, resource structure, and management capacity.

From dairy farming exclusively, the identified conglomerates are not differentiated, productively, or economically; only some incorporated techniques make the difference. In the Innovative group, different producers individually incorporate some innovations. The changes contribute to the same proportion to costs and income without affecting Profit, although they improve working conditions. The poor results lead to their interruption, the absence of diffusion, and the attempt of different novel options in an itinerant trial and error process.

The growth of family dairy in the Ecuadorian Amazon is limited by the lack of a market for milk and the absence of technology that mitigates the severity of hard work and increases labor productivity. The option is not to expand the area to milk more cows but to increase the yield of forage crops to reduce grazing land and liberate marginal terrain with steep slopes and fragile soils. To do so requires integrating the application of knowledge to the economy.

The application of the results in the selection of the intervention strategies goes through 1) recognizing the differences of interests and objectives of the families and their resources; 2) use the Innovator group's natural curiosity, risk affinity, and credit experience to establish demonstrative trials on the farms themselves; 3) to test "families" of complementary practices, including those of economic management; 4) favor the manifestation of the properties that determine the adoption rate of the innovation: relative advantage, compatibility, complexity, verifiability, and observability (Rogers, 2003); 5) facilitate subjective evaluation by the Pragmatic group; to finally synthesize coherent technological arrangements.

The economic analysis allows us to identify the production strategies applied by each typology; however, it is necessary to analyze marketing options (Posadas *et al.*, 2014). Some producers divert part of the milk produced to other destinations as a risk reduction mechanism, margin increase, or simply place the product from evening milking.

Finally, in terms of trade openness, the recommendations made by Salgado (2007) remain in force, only now more urgent: "Any internal schema implemented must seek to adapt producers to more open market conditions, make more efficient domestic production, expand opportunities for products with exportable potential, increase yield to lower unit costs, focus assistance policies on small producers."

Conflicts of Interest

All the authors made significant contributions to the document, and those who agree are its publication and state that there are no conflicts of interest in this study.

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