



Socioeconomic factors influencing the quality of working life of small milk producers in Carchi, Ecuador



Luis Alfredo Carvajal-Pérez ^{a*}

Guillermo Fausto Montenegro-Arellano ^a

Gustavo Javier Terán-Rosero ^a

Gladys Primavera Urgilés-Urgilés ^a

Fermín Raúl Cobo-Cuña ^b

Magaly Herrera-Villafranca ^b

^a Universidad Politécnica Estatal del Carchi, Antisana y Universitaria. Tulcán, 040101, Carchi, Ecuador.

^b Instituto de Ciencia Animal. Mayabeque, Cuba.

*Corresponding author: luis.carvajal@upec.edu.ec

Abstract:

This study analyzes the socioeconomic factors influencing the perception of labor well-being of small milk producers in the province of Carchi, which is essential for ensuring the sustainability of the livestock sector. Producers operate in adverse structural conditions, characterized by labor informality, limited income, and poor access to basic services. With a quantitative approach, non-experimental design, and correlational scope, statistical techniques such as the following were applied: contingency tables with Chi-square test, principal component analysis (PCA), cluster analysis for economic variables, and ordinal logistic regression. The analysis was carried out on 516 productive units, constructing a composite index of Quality of Working Life (QWL) classified into three levels: low, medium, and high. The results show that the variables with the highest effects were housing condition ($P=0.030$), access to basic services ($P=0.036$), and perceived family needs ($P=0.075$). In contrast, variables such as sex, age, annual income, or number of head of cattle did not show statistical significance. It is concluded that the QWL in this rural context is more determined by social and family environment factors than by direct

productive and economic indicators. These findings reinforce the need for rural development policies that integrate human, family, and community dimensions. It is recommended to advance research that delves into psychosocial aspects, ergonomic conditions, and occupational safety, as well as regional comparative studies that validate the applicability of the proposed QWL index.

Keywords: Labor well-being, Rural family production, Rural development.

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Introduction

Quality of working life (QWL) refers to the degree of satisfaction and physical, psychological, and social well-being experienced by people in their workplace, which encompasses conditions related to the job (schedules, wages, environment, development opportunities)⁽¹⁾. It is essential to guarantee the productivity and sustainable performance of organizations, considering that work goes beyond economic remuneration and impacts personal and social development⁽²⁾. The topic has been little studied in dairy production, and due to its multidimensional nature and diverse operational conceptions, it lacks a theoretical consensus, which requires continuous empirical research for its understanding⁽³⁾.

The literature shows different approaches; nevertheless, they agree that the well-being of livestock workers is essential for the sustainability of the sector. In Antioquia, a study revealed that milkers perceive a good QWL, with integration into the workplace, subjective well-being, and personal development options, in a context of informality, low technification, and limited business management. The permanence of workers is conditioned by the possibility of living with their families on the farm, receiving a competitive salary, and exercising some control over tasks⁽¹⁾; in contrast, the risk to physical health is the main reason for abandoning the activity⁽⁴⁾. In addition, the productive units lack selection, evaluation, and training processes, as well as job security; workers with a low level of education face informality, working days of 9 to 18 h, and salaries below the legal minimum, without affiliation to Social Security, which makes their stability precarious.

In Ecuador, studies on women workers in the livestock sector of Rumiñahui show low levels of QWL due to a lack of contracts, physical risks, low income, and the absence of occupational safety and health⁽⁵⁾. Similarly, in dairy companies in Cotopaxi, a regular

work environment and low satisfaction are reported; however, a positive correlation was found between involvement, work organization, and the utilization of human talent, suggesting that organizational improvements can increase performance and well-being⁽⁶⁾.

At the international level, Chile has incorporated technology that reduces physical effort and improves ergonomics, but increases mental stress due to the cognitive overload of technical supervision. In Argentina, productive intensification and management changes have weakened family models, affecting social organization and family stability⁽⁷⁾. In the United States, Latino immigrant workers face high physical and mental fatigue in routine and demanding jobs, with health problems, insomnia, and chronic burnout⁽⁸⁾.

The QWL in the livestock sector still has gaps in its comprehensive measurement, regional comparability, and linkage with public policies. Dairy sustainability depends on the well-being of workers, incorporating the human dimension as a central axis for equitable and resilient rural development⁽⁹⁾.

This study focuses on the province of Carchi, Ecuador, a key area in national milk production, with family farms that face challenges in terms of profitability, working conditions, and social inclusion⁽¹⁰⁾. The lack of empirical evidence on the relationship between socioeconomic factors and QWL limits the design of policies and interventions in a context characterized by intermediation, low technification, and weak institutional articulation.

Given the gaps identified, this study applies a rigorous statistical approach that integrates data mining, multivariate analysis, and ordinal logistic regression to explore the relationship between socioeconomic factors and QWL in productive units of Carchi. Unlike research focused on perceptions or descriptive approaches, a composite index of QWL is constructed based on quantifiable and validated indicators, making it suitable for analyzing working conditions in rural contexts.

Material and methods

The research was conducted in the province of Carchi, located in northern Ecuador on the southern border of Colombia, characterized by high-altitude agricultural areas and a cold temperate climate⁽¹¹⁾. A quantitative, descriptive, and correlational approach was used, with a cross-sectional design⁽¹²⁾.

The sample included 516 milk producers, selected proportionally from the six cantons of the province. A five-level Likert survey was applied, which included social variables (age, sex, educational level, family structure, and household conditions) and economic variables (income, expenses, productivity, and indebtedness). The database was refined,

scales were standardized, and representative indices were constructed. Contingency tables and the Chi-square test were used to analyze significant associations. Subsequently, a principal component analysis was applied to build QWL⁽¹³⁾, classified into three ordinal levels: low, medium, and high. Finally, an ordinal logistic regression model was used to estimate the influence of predictive factors on the QWL index. The statistical analysis was run with Python 3.10 on Google Colab.

Results

The results obtained after applying the instrument, validated with a Cronbach's alpha of 0.74 and acceptable reliability criteria⁽¹⁴⁾, reveal a critical reality about the socio-educational conditions that affect the QWL of producers in the province of Carchi.

Table 1: Relationship between educational level and canton

Educational level Canton	Illiterate		Primary		Secondary		University	
	No.	%	No.	%	No.	%	No.	%
Bolívar	13	0.65 ^{jk}	29	1.45 ^{ijk}	10	0.5 ^{jk}	1	0.05 ^k
Montúfar	48	2.39 ^{ghi}	155	7.73 ^d	173	8.63 ^c	25	1.25 ^{ijk}
Espejo	76	3.79 ^f	171	8.53 ^c	112	5.59 ^e	28	1.40 ^{ijk}
Huaca	25	1.25 ^{ijk}	170	8.48 ^c	118	5.89 ^e	43	2.14 ^{ghi}
Tulcán	29	1.45 ^{ijk}	337	16.81 ^a	248	12.37 ^b	66	3.29 ^{fg}
Mira	23	1.15 ^{ijk}	60	2.99 ^{fgh}	34	1.7 ^{hij}	11	0.55 ^{jk}
Standard error	± 0.45							
Significance	$P < 0.0001$							
Total	214	10.67	922	45.99	695	34.66	174	8.68

^{a-k} Distinct letters indicate significant differences ($P < 0.05$).

The analysis of the educational level reveals that 45.99 % of the producers have only primary education, and only 8.68 % reach university studies, which reflects historical gaps in the rural educational level. Tulcán shows polarization with high percentages in primary (16.81 %) and secondary education (12.37 %), in contrast to Espejo and Huaca, where the primary level predominates. The significant differences between cantons ($P < 0.0001$) show structural territorial inequalities that affect QWL. Low educational levels in the livestock sector constitute barriers to the adoption of technologies, access to differentiated markets, and participation in value-added chains⁽¹⁵⁾. These limitations reflect lower productivity, reduced bargaining capacity with intermediaries, and limited access to specialized financing programs, which progressively deteriorate the QWL of producers⁽¹⁶⁾. This contrasts with the demand for global competitiveness, where technical knowledge and the capacity for technological adoption are decisive for the economic sustainability of producers⁽¹⁷⁾. These limitations suggest the need for differentiated

interventions according to the territory, with a focus on strengthening human capital to improve QWL and reduce cycles of socioeconomic vulnerability.

Table 2: Age by canton related to milk production

Age Canton	15-14		25-54		55-64		Over 65		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Bolívar	0	0	8	1.55	5	0.97	8	1.55	21	4.07 ^c
Espejo	0	0	57	11.05	27	5.23	14	2.71	98	18.99 ^b
Huaca	2	0.39	57	11.05	17	3.29	23	4.46	99	19.19 ^b
Mira	2	0.39	28	3.88	11	2.13	9	1.74	42	8.14 ^c
Montúfar	0	0	58	11.24	29	5.62	12	2.33	99	19.19 ^b
Tulcán	3	0.58	88	17.05	31	6.01	35	6.78	157	30.43 ^a
Significance	$P=0.0774$								SE	± 1.91
									Signif.	$P=0.0001$
Total	7	1.36 ^c	288	55.81 ^a	120	23.26 ^b	101	19.57 ^b	516	100
SE	± 1.91									
Significance	$P=0.0001$									

^{abc} Distinct letters indicate significant differences ($P<0.05$).

The distribution showed a predominance of the group from 25 to 54 years old (55.81 %), followed by those from 55 to 64 yr old (23.26 %) and those over 65 yr old (19.57 %). The scarce presence of young people under 25 yr of age (1.36 %) reveals a worrying generational gap, which reflects limited educational and employment opportunities.

Tulcán concentrates the highest proportion of producers of working age (17.05 %), followed by Montufar, Huaca, and Espejo (approximately 11 %), which reinforces the centralization observed in factors such as education and sex. In contrast, the significant presence of older adults poses a dilemma; although they provide experience⁽¹⁸⁾, they are less likely to adopt technology⁽¹⁹⁾, which limits the development of the sector.

This situation coincides with regional studies that report similar age averages in livestock systems in Ecuador and Peru⁽²⁰⁾. The interaction between age, educational level, and sex forms a socioeconomic framework that affects QWL, demanding differentiated policies that promote the inclusion of young people and the professionalization of the sector⁽²¹⁾.

Most of the livestock households in Carchi are made up of medium-sized nuclei of 1 to 4 people (68.41 %), followed by families of 5 members (30.43 %) and a minimum proportion of extended households (1.16 %). This family structure reflects rural demographic transformations that, while relieving economic pressure on income, reduce the availability of labor, intensifying the burden on active members. Comparative studies in Mexico and Ecuador confirm this trend towards small family nuclei in livestock systems⁽²²⁾. In this context, small families face greater limitations in diversifying activities

(educational gaps and gender inequality), which negatively affect the productive efficiency and QWL of rural households engaged in livestock farming⁽²³⁾.

Table 3: Responsible for the family's economic support

Provider	No.	%	SE and P-value
Father	211	40.89 ^a	± 1 P=0.001
Wife	168	32.56 ^b	
Children	17	3.29 ^d	
A close relative	83	16.09 ^c	
All members	37	1.17 ^d	
Total	516	100	

^{abcd} Different letters indicate significant differences ($P < 0.05$).

The data reveal that the father mostly assumes the role of economic provider (40.89 %), followed by the wife (32.56 %). The co-responsibility of all members barely reaches 1.17 %, which reflects a traditional hierarchical structure that places economic pressure on a single individual, affecting their well-being and QWL.

The high female participation in supporting the family evidences their multifunctional role in livestock, domestic, and conservation activities, which strengthens household resilience⁽²⁴⁾. In contrast, in Mexico, women are still not very visible in livestock farming⁽²⁵⁾. Collaborative family schemes tend to favor QWL by distributing burdens and improving sustainability in rural contexts⁽²⁶⁾.

The Categorical Principal Component Analysis (CATPCA) allowed the social variables to be grouped into two explanatory dimensions⁽²⁷⁾ that represent 62.75 % of the total variance. The index showed excellent internal consistency ($\alpha=0.925$), validating the integration of the selected factors. Factor loadings greater than 0.50 guarantee the statistical relevance of the indicators in the analysis of QWL⁽²⁸⁾. This result supports the construction of the composite index and justifies its use in subsequent models.

Table 4: Social variables of greatest importance in the CATPCA

Variables	Dimension	
	Associativity	Canton, customer, supplier
Canton	0.477	-0.580
Age	-0.215	0.080
Sex	0.042	-0.253
People in the household	0.226	-0.327
Family economic support	0.212	-0.088
Type of housing	0.193	0.352
Customers	-0.201	0.757
Suppliers	-0.229	0.801
Current situation of the family unit	0.055	0.397
Situation after the pandemic	-0.217	0.116
Affiliation with a guild	-0.106	0.038
Political interests, community	0.813	-0.008
Political interests, parish	0.797	0.204
Political interests, province	0.811	0.128
Political interests, country	0.799	0.259
Government management, community	0.837	-0.040
Government management, parish	0.837	0.158
Government management, province	0.854	0.082
Government management, country	0.808	0.185
Participation in a development project	0.057	0.155
Need for land access	0.374	-0.280
Role of women in livestock farming	-0.057	0.295
SPF affecting the quality of life	0.097	0.003

SPF= socioeconomic and productive factors.

The results of the CATPCA show two key dimensions. The first, *Associativity* (45.13 %), groups variables related to political interests and government management at different levels, reflecting the importance of collective participation as a way to improve QWL through access to state assistance, inputs, and markets⁽²⁹⁾.

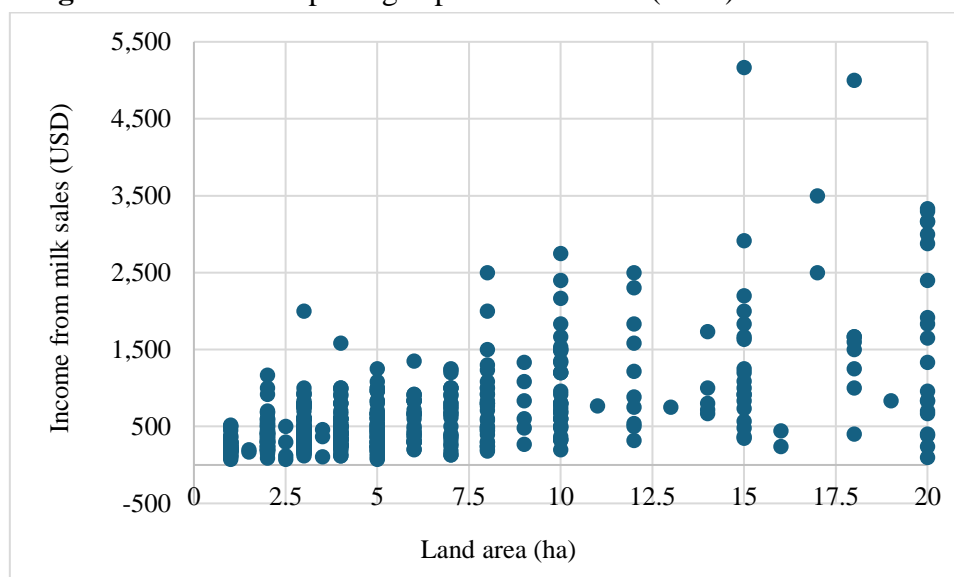
The second dimension, *Canton, Customer, Supplier* (17.62 %), shows an inverse relationship between territorial location and commercial connectivity, suggesting that producers located in certain cantons with limited infrastructure face greater logistical barriers, which generates labor overload and lower profitability⁽³⁰⁾.

Organizational weaknesses also affect the effectiveness of associations, which require institutional strengthening to protect QWL⁽³¹⁾. Finally, although productive diversification can cushion economic vulnerability, it increases the workload, so associativity continues to be a key sustainability strategy⁽³²⁾.

Table 5: Descriptive statistics of productive and economic indicators

Variables	Mean	Standard deviation	Coefficient of variation (%)
Land area, ha	3.14	1.91	61
Total number of cows, n	6.83	4.56	67
Milking cows, n	4.51	2.74	61
Total daily liters of milk, L	47.59	32.72	69
L/cow/day, L	11.12	3.62	33
L/ha/year, L	6,245.73	3,109.35	50
Total annual income, USD	6,041.46	3,835.89	63
Monthly household income, USD	718.08	439.07	61
Price per liter of milk, USD	0.39	0.07	18
No loss price of milk, USD	0.52	0.06	12
Total profit, USD	302.88	311.70	103

The analysis reveals a predominant smallholder system, with an average area of 3.14 ha and high structural vulnerability (CV= 61 %), which conditions the economic stability of the productive units. The average total monthly profit of 302.88 USD is highly dispersed (CV= 103 %), showing polarization between producers with positive margins and others with minimal or negative profitability, which affects QWL. Although individual productivity (11.12 L/cow/d) exceeds the minimum standards of 10 L of milk on average⁽⁹⁾, the average price received per liter (0.39 USD) does not always cover the costs, as a result of the instability in marketing conditions and quality penalties⁽²⁰⁾.

Figure 1: Relationship of agro-productive units (APU) size and income

Quality incentive policies⁽³³⁾, which establish a price of 0.50 USD per liter of milk, are not respected in practice. The analysis suggests that factors such as management, access to markets, and application of GAPs have a greater impact on income than farm size⁽³⁴⁾, as evidenced by the dispersion in Figure 1. These economic conditions, combined with

structural limitations and lack of technical support, aggravate labor inequalities and compromise the sustainability of the sector⁽²⁹⁾.

A non-linear relationship is observed between the size of the APU (ha) and the income from milk sales. Despite expectations, there is no direct correlation between larger areas and higher incomes. Some producers with small farms achieve high incomes, suggesting that factors such as technification, efficient management, cattle genetics, and intensive land use have a greater impact on economic results than the available area. This dispersion confirms that the size of the farm alone does not determine profitability, and that QWL is strongly conditioned by technical and organizational capacities rather than by structural factors⁽³⁵⁾.

Table 6: Total variance explained and matrix of principal components, according to productive and economic indicators

Variables	Components		
	Production and Economy	Efficiency, Productivity, and Market	Area
Land area, ha	0.528	0.293	-0.755
Total number of cows, n	0.497	0.701	-0.070
Milking cows, n	0.689	0.668	0.098
Total daily liters of milk, L	0.934	0.289	-0.040
L/cow/day, L	0.392	-0.670	-0.240
L/ha/year, L	0.428	0.052	0.851
Total annual income, USD	0.974	0.089	0.036
Monthly household income, USD	0.896	-0.009	-0.017
Price per liter of milk, USD	-0.118	-0.724	0.266
No loss price of milk, USD	-0.019	0.418	-0.020
Total profit, USD	0.850	-0.163	0.065
Eigenvalue	5.07	1.98	1.38
% Variance	46.10	18.00	12.55
% Cumulative variance	46.10	64.10	76.65

The PCA applied was statistically validated (KMO= 0.77; Bartlett $P < 0.001$) and allow to condense eleven productive and economic variables into three components that explained 76.65 % of the total variance, indicating a high capacity of the model to synthesize information and reduce dimensionality⁽¹⁴⁾. The first component, called *Production and Economy* (46.10 %), groups variables such as milking cows, total daily liters of milk, total annual income, monthly household income, and total profit, reflecting the productive economic capacity of the family unit, which is essential to improve working conditions⁽³⁴⁾.

Regarding the second, *Efficiency, Productivity, and Market* (18 %), the inverse relationship between the number of cows and individual yield (L/cow/day) suggests that

systems with higher stocking rates are not always efficient, which can lead to work overload and low pay. The third, *Area* (12.55 %), highlights how small areas can have high productivity per hectare, although with greater labor demands. This confirms that QWL is influenced by a complex interaction between income, technical efficiency, and operational scale, which requires differentiated state policies according to productive profile and access to markets⁽³⁶⁾.

Table 7: Relevant variables of the ordinal logistic regression model

Variable	Coefficient	P-value	Significance
Housing condition index	77.67	0.030	Significant
Basic services index	-464.25	0.036	Significant
Family needs index	37.72	0.075	Marginal
Threshold 1/2	-253.51	0.017	Threshold QWL low-medium
Threshold 2/3	4.83	0.000	Threshold QWL medium-high

The ordinal logistic regression model identified three socioeconomic variables significantly associated with QWL: housing condition (77.67; $P=0.030$), access to basic services (-464.25; $P=0.036$), and family needs (37.72; $P=0.075$). This shows that better housing conditions and fewer needs are associated with a higher probability of achieving a high QWL. On the contrary, the lack of basic services significantly reduces this probability.

Variables such as age, sex, annual income, number of cows, and health and food expenditures were not significant. This can be explained by the complex and multidimensional nature of QWL, which does not depend exclusively on productive or demographic factors but rather on a comprehensive environment that connects the material conditions of the home, the satisfaction of family needs, and the perception of well-being in the work environment.

The estimated thresholds of the model (-253.51 and 4.83) indicate a clear statistical differentiation between low, medium, and high levels of QWL, which validates the proposed ordinal structure and reinforces the robustness of the model.

Discussion

Producers in the province of Carchi face structural limitations that negatively affect QWL. Among them, restricted access to formal markets, unstable prices, adverse geographical conditions, low technification, and dependence on intermediaries stand out, which are factors influencing their economic sustainability⁽³⁷⁾. Recent studies have revealed that the

psychosocial conditions of agricultural work have a substantial impact on workers' health and job satisfaction⁽³⁸⁾. In addition, work overload, lack of autonomy, and perception of insecurity cause widespread discontent among rural workers⁽³⁹⁾. Similarly, in rural agricultural contexts, the lack of job stability, exposure to physical risks, and the pressure to meet goals without supervisory support exacerbate emotional distress and affect motivation at work⁽⁴⁰⁾.

The statistical analysis identified significant differences between producers according to schooling, access to basic services, and living conditions; 45.99 % have primary education, which limits access to technologies and opportunities for productive improvement. In this sense, low schooling in the agricultural sector, compared to national averages in Colombia, generates direct consequences of social exclusion⁽¹⁾, since low levels of education correlate with limited job opportunities, reduced income, and the perpetuation of informality and precariousness of rural employment⁽⁵⁾.

Likewise, the low participation of women in productive management shows persistent cultural barriers. To reverse this situation, it is necessary to strengthen their technical and leadership capacities⁽⁴¹⁾. For this reason, the rural socioeconomic fabric must actively engage in training and development, especially in technical and management skills, to boost its competitiveness and improve general well-being. On the other hand, associativity appears as a protective factor of QWL, since it facilitates access to resources, markets, and support⁽²⁹⁾. Systematic exclusion and geographical or infrastructure barriers in isolated areas limit access to commercial networks, which leads to extended working hours and intense marketing efforts that affect income, job insecurity, and occupational frustration⁽⁴¹⁾.

Multivariate analyses (PCA and cluster) made it possible to segment producers according to their economic conditions, establishing differentiated well-being profiles⁽⁴²⁾. The construction of a composite index of QWL allows to categorize the standard of working life (low, medium, high) and showed that access to basic services and the quality of housing are statistically significant determinants⁽⁴³⁾. In this categorization, disparities must be identified, and the working conditions in the sector must be understood, since, in rural areas, the lack of knowledge of risks at work, the lack of formal hiring, as well as the absence of health and safety, lead to a low perception of QWL⁽⁵⁾.

Conclusions and implications

The QWL in rural contexts does not depend solely on income, but on a complex interaction between structural conditions, individual capacities, access to services, and collective participation. Therefore, differentiated policies are required to promote the well-being, inclusion, and sustainability of the dairy sector. The application of the

methodological approach and the ordinal logistic regression model allow to establish that such factors have a significant or marginal impact on the perception of occupational well-being. It is confirmed that, in rural contexts with adverse structural conditions, QWL is configured from a multidimensional perspective, requiring a comprehensive analysis of the family, social, and physical environment of the producer. Future studies should explore psychosocial and occupational health variables, as well as regional comparisons, to validate and expand understanding of the proposed index of quality of life.

Acknowledgements and conflict of interest

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