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RESEARCH ARTICLE

Strategies to mitigate economic hardship among family dairy farms of Central Mexico

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Abstract

The economic hardship of dairy producers has worsened in the last decade because of increasing costs of production. A field survey with 51 dairy farmers was conducted to explore strategies to mitigate economic hardship. Factor and cluster analyses were conducted to characterize the farmers and their farms. Differences among groups regarding changes adopted to increase incomes, to reduce costs, and to pay bills were tested using Fisher's exact test. Four factors explained 76.2% of the cumulative variance and four groups were identified: "*stagnant farms*" were in group 1, with the lowest daily income over concentrate feed cost (DIOCFC) and the least number of changes, "*effectively management farms*" were in group 2, with the highest DIOCFC and the highest number of income-increasing changes, the "*cost reducing farms*" were in group 3, with the smallest in size with a focus on cutting cost, and the "*mixed strategy farms*" were in group 4, with the largest herd size. Most prevalent income-increasing strategies included attempts to improve cow nutritional balance and milk composition, whereas the most prevalent cost-reducing strategies included reductions in input purchases of inputs (concentrates and fertilizers) and selected household expenses. Selling cows was a common strategy to generate cash in acute hardship situations. In conclusion, responses to economic hardship varied substantially among groups of farms, cost-reducing strategies were linked to lower cow productivity and lower technological levels, but income-increasing strategies were linked to higher cow productivity and higher DIOCFC. Our findings may contribute to the design of extension initiatives to promote useful strategies to help mitigate economic hardship on dairy farms.

Keywords: Multivariable analysis; Dairy farmers; Economic hardship; Mexico

Introduction

In 2103, milk was produced throughout the national Mexican territory in approximately 835,264 farms (LACTODATA, 2013). With an annual production of approximately 11 billion liters of milk per year, the country ranks 8th compared to other nations of the world (SIAP, 2019).

After the opening of the Mexican dairy market to free trade in the early 1990s, scholars have studied how the Mexican dairy industry has changed in order to remain competitive under the increasing pressures of globalization. For example, Rodríguez-Gomez (1999) and Cervantes *et al.* (2002) have documented the struggles of farmers and the role played by farmer organizations in the adoption of on-farm milk refrigeration (i.e., bulk tank) to meet quality standards expected by processors and consumers.

García-Hernández *et al.* (2000) compared the regions of *La Laguna* in northern Mexico to *Los Altos* of Jalisco located in the western part of the country. *La Laguna* has followed a path of intensification, selected technology adoption, and hired labor, whereas *Los Altos* of Jalisco is a region that has followed a path of semi-intensification, technology adoption, and heavy reliance on family labor. Authors pointed out that milk production in *Los Altos* of Jalisco has been resilient to the pressure of globalization in part because of its reliance on family labor and that 61% of farmers' income in the region remained dependent on governmental subsidies, primarily in the form of low electricity rates.

Milk prices in Mexico are low compared to other countries in the Americas in part because of the government's open policy to allow cheap imports (primarily as nonfat dry milk) in order to keep prices low for consumers (Berman *et al.*, 2012). Brambila-Paz *et al.* (2013) have documented the consistent decrease in milk price (after adjustment for consumer price index) between 1990 and 2010. Furthermore, the economic hardship of dairy producers has worsened in the last decade because of increasing costs of production, as feed and energy prices have been on the rise (Berman *et al.*, 2012). Although sectorial studies focusing on structural or organizational changes needed to support the competitiveness of domestic production are important, there is a lack of information on farmer's own strategies to address low profit margins and to mitigate their economic hardship. Thus, our research addressed the extent to which producers are relying on management decisions aimed at increasing revenue, lowering costs of production, or a combination of both, in order to maintain or improve their income from milk sale. In this study, we hypothesized that family-oriented dairy farmers of *Los Altos* of Jalisco have varying coping strategies that are associated with farmer's level of education and farm characteristics.

Materials and Method

Study area

The research was carried out in the state of *Jalisco*, which is the fourth most populated state in the country with a population of almost eight million (INEGI, 2015). *Jalisco* is the country's top dairy state producing 19% of the domestic supply with an annual output of 14.1 million liters of milk (SIAP, 2019). Within Jalisco, the region of *Los Altos* (the Highlands) is most important in dairy production, and this area is divided into two official administrative regions, *Los Altos* Norte (the Northern Highlands) and *Los Altos Sur* (the Southern Highlands). However, all farms sampled for this research are located in *Los Altos Sur*. Farmers from this zone rely on direct sales of unprocessed milk to consumers or contract with a local dairy processor.

Survey design

The survey was divided into five sections with closed and open-ended questions (Table 1). The first section gathered information regarding farmer characteristics. The second section captured basic farm information. The third section focused on nine suggested changes that farmers might use to increase in the face of economic hardship. The fourth section focused on nine suggested changes targeted at reducing costs both on the farm and in the household. Finally, the fifth section also included five strategies to pay bills. A draft version of the survey was tested with 15 dairy farmers in the region. Suggestions and clarifications were incorporated in the final survey.

Farmers identification and data collection

The sample was drawn from member lists of the Union of Cooperatives in *Los Altos Sur*. From all 10 cooperatives, a list of 5% of the farmers was randomly selected. Casián and Castillo (1987) recommended a sampling size ranging from 5 to 10% for studies conducted within rural communities. In addition, Vogt and Johnson (2016) pointed out that using random sampling reduces the

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Table 1. Variables considered in the survey

Section of the survey	Variables considered in the section
First section: farmers characteristics	Farmer's age, farmer's education, farmer's experience.
Second section: farm characteristics	Total of hectares, herd size, farm management, and technologies used in the farm such as milking machine, cooling tank, milking parlour, pre and post dip at milking, artificial insemination, farm records, vaccines, hybrid seeds, fertilizer, herbicides, and corn silage.
Third section: changes to increase incomes	Sell milk to a different cooperative, a different company, or to *Liconsa,* improve milk fat and protein content, lower milk bacteria content, lower milk somatic cell count, increase concentrate feed, improve cow nutritional balance, and improve cow health.
Fourth section: changes to reduce cost	Reduce veterinary visits, reduce concentrate feed purchase, reduce purchase of milking supplies, reduce workers salary, purchase less equipment, reduce fertilizer, pesticide, and insecticide, reduce education expenses, reduce clothing and beauty products, and reduce food purchase.
Fifth section: strategies to pay bills	Ask for payment extension, ask for an official loan, ask for an informal loan, sell cows to pay bill and nonfarm income.

likelihood of bias. Four of the farmers who were randomly selected refused to participate in the survey. Therefore, the final sample size was constructed with 51 farmers.

All surveys were conducted face to face with the farmers (head of household) during November and December of 2012. During each interview, the interviewers filled out a paper survey and made an audio recording in order to double check information. The interviews were conducted on the farm premises including the house in certain instances, or in the town's center. Sometimes, surveys took place while farmers carried out farm duties such as milking.

Statistical analysis

Variables referring to farmers and farm characteristics, productivity, and economic performance were considered based on previous studies of farm characterization in Mexico (Espinoza-Ortega *et al.*, 2007; Martinez-Garcia *et al.*, 2015), Ghana (Kuivanen *et al.*, 2016), and Europe (Herrera *et al.*, 2019). To characterize the 51 farmers, a factor analysis (FA) was performed. Twelve variables were originally selected; however, only those with a communality greater than 0.5 were retained (Field, 2013). Thus, nine variables were selected for the final analysis (technology level, daily income over concentrate feed cost (DIOCFC), farmer's education, daily milk yield per cow, cows per hectare, membership in cooperatives, cows in production, changes to increase incomes and changes to reduce costs) (Table 2). The technology level was treated as cumulative variable, which was formed by the 11 technologies considered in the research. It was hypothesised that the nine variables chosen could summarize adequately the diversity of the farming situation and were determinants of farmers' strategies to mitigate economic hardships on the farm. The nine variables were examined for potential outliers (box plots) and normal distribution (Kolmogorov test) (Kuivanen *et al.*, 2016; Martínez-García *et al.*, 2015); then they were subjected to multivariate techniques with SPSS Ver. 22. The variables DIOCFC and milk price per litre were expressed in US dollars at the exchange rate established by the Mexican Central Bank at the time of the study (on average 12.97 Mexican pesos per dollar) (Banco de México, 2019).

FA was conducted to examine the relationship among the nine variables, and principal component analysis (PCA) was used as factor extraction method (Field, 2013). To fulfil the conditions of parsimony and interpretability of the PCA, the Kaiser Meyer-Olkin index value of 0.5 or above was considered (Martínez-García *et al.*, 2015), and the sample suitability was confirmed with the Bartlett´s test of sphericity. All the principal components exceeding an eigenvalue of 1.0 were retained (Kuivanen *et al.*, 2016). To simplify the interpretation of the factors identified, the

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Table 2. Association among variables resulting from the factor analysis

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communalities
Farmer and farm characteristics					
Technology level	**.816**	−.302	.078	.139	.759
DIOCFC[1]	**.798**	.173	−.196	−.019	.802
Farmer's education, years	**.797**	.076	.184	−.064	.680
Daily milk yield per cow, litres	**.701**	.494	.134	−.092	.832
Cows per hectare, heads	.063	**.883**	−.116	.182	.777
Cooperative membership	.064	−.116	**.894**	.049	.826
Cows in production, heads	.330	−.077	.407	**.708**	.777
Adaptation changes					
Changes to increase income	**.567**	−.347	−.489	.246	.761
Changes to reduce costs	.217	−.238	.181	**−.787**	.758
Variance explained	32.39	14.97	14.96	13.88	

Coefficients ≥0.5 in each column indicate variables contributing to the rotated factor.
[1]DIOCFC = daily income over concentrate feed cost.

orthogonal rotation (Varimax) was applied (Hair *et al.*, 2014). The loading factors obtained from the PCA were used to conduct a hierarchical cluster analysis as recommended by Manly and Navarro (2017). The dendrogram and the agglomerative schedule obtained from Ward's method and plot of linkage distances (Figure 1) were used to establish the most meaningful number of clusters (Kuivanen *et al.*, 2016).

To identify differences among groups regarding farmers and farm characteristics, Kruskal-Wallis and Mann Whitney *U* tests were conducted, considering the non-normality of the data (Herrera *et al.*, 2019; Martínez-Garcia *et al.*, 2015). In order to have a better understanding of each group, the following seven additional variables were considered: strategies to pay the bills, farmer's age, farmer's experience, herd size, total of hectares, family labor and milk price per litre (Table 3). Significant differences among groups regarding the changes adopted to increase incomes, to reduce costs, and strategies to pay bills were tested using Fisher's exact test, which is recommended when sample size is small and the expected frequencies are lower than 5 (Field, 2013). The z-test was used to compare column proportions, and Bonferroni method was conducted to adjust the *P* values (Herrera *et al.*, 2019).

Results

Typologies of farms

FA identified that four factors explained 76.20% of the cumulative variance with a Kaiser-Meyer-Olkin coefficient of 0.66 and Bartlett's test of sphericity ($p < 0.001$) that confirmed the analysis trustworthiness. Factor 1 captured a positive association among technology level, DIOCFC, farmer's education, daily milk yield per cow and changes to increase incomes. Factor 2 captured the single variable characterising animal density per unit of land (i.e., cows per hectare). Factor 3 was also a single variable that identified farmer's membership in a dairy cooperative. Factor 4 captured an inverse relationship between the number of cows in production and the changes to reduce costs, i.e. the greater the number of cows in production, the lesser the changes to rely on a cost reduction strategy (Table 2).

From the cluster analysis carried out with the loadings of the four factors, four homogeneous groups were obtained (Figure 1).

Table 3 shows the general characteristics of each homogeneous group of farms. Group 1 was defined as *stagnant farms*. It was made up of nine farmers headed by the most senior individuals, who had also the lowest formal education. Four of these farmers (44%) belonged to a single cooperative (*Acatic*) whereas the remaining farmers (64%) were evenly spread amongst the other

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Table 3. Characteristics of the four groups resulting from the hierarchical cluster analysis

	Group 1		Group 2		Group 3		Group 4		
	($n = 9$)		($n = 16$)		($n = 11$)		($n = 15$)		
Variable	M[2]	IQR[3]	M[2]	IQR[3]	M[2]	IQR[3]	M[2]	IQR[3]	P[4]
Farmer and farm characteristics									
Technology level	6.0[b]	4.0	10.0[a]	1.8	7.0[b]	3.0	10.0[a]	2.0	<.001
DIOCFC[15]	0.7[c]	5.1	4.1[a]	20.5	0.9[c]	2.1	2.6[b]	2.5	<.001
Farmer's education, years	3.0[b]	7.0	9.0[a]	5.0	6.0[b]	3.0	9.0[a]	5.0	<.001
Daily milk yield per cow, litres	15.8[b]	5.6	19.0[a]	3.7	13.5[b]	3.3	18.7[a]	6.0	<.001
Cows per hectare, heads	6.4[a]	10.1	2.5[b]	3.6	1.2[c]	1.1	1.1[c]	1.4	<.004
Cooperative membership, %	100	–	100	–	100	–	100	–	–
Cows in production, heads	31.0[b]	35.5	51.0[ab]	58.8	25.0[b]	10.0	75.0[a]	89.0	<.001
Adaptation changes									
Number of changes to increase income	1.0[b]	1.5	4.0[a]	1.8	2.0[b]	3.0	2.0[b]	3.0	<.001
Number of changes to reduce costs	1.0[c]	1.5	3.0[b]	3.0	5.0[a]	3.0	3.0[b]	2.0	<.001
Additional variables									
Number of strategies to pay the bills	3.0	1.0	3.0	1.0	3.0	1.0	3.0	2.0	.543
Farmer's age, years	58.0	20.0	43.0	14.8	41.0	25.0	40.0	19.0	.393
Farmer's experience, years	17.0	25.0	18.0	14.8	15.0	12.0	15.0	13.0	.769
Herd size, head	80.0[b]	54.0	91.5[ab]	126.3	67.0[b]	35.0	149.0[a]	195.0	<.002
Land, hectares	3.0[c]	8.8	7.9[a]	16.3	10.9[a]	22.2	40.0[b]	62.5	<.001
Family labor, number	3.0	3.0	2.0	2.8	3.0	3.1	2.0	2.0	.281
Milk price per litre[5], dollars	0.38[b]	0.04	0.40[a]	0.01	0.37[b]	0.0.3	0.40[a]	0.06	<.036

[1]DIOCFC, daily income over concentrate feed cost. [2]M, median, [3]IQR, interquartile range. [4]P, Kruskal–Wallis test ($p < 0.05$). [a,b,c] Medians within a row not sharing a common superscript differ, Mann–Whitney *U* test ($p < 0.05$). [5]Price on USD, on average 12.97 at November–December 2012.

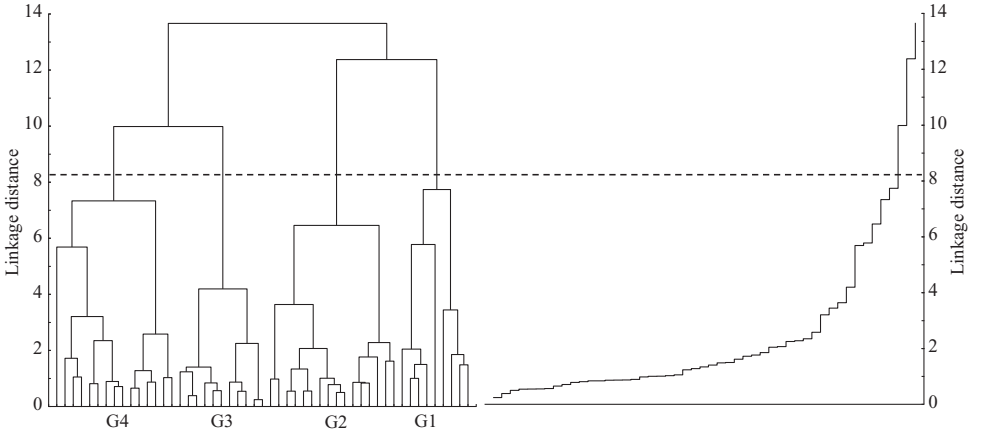

Fig. 1. Dendrogram identifying groups (left) and plot of linkage distances across steps of the cluster analysis (right).

cooperatives. Farms in group 1 had the second lowest number of cows in production and herd size, the lowest availability of land and the greatest concentration of cows per hectare. Farms in group 1 had also the lowest technological level, the lowest DIOCFC, the lowest daily milk yield per cow and they received the lowest milk price per litre (similar to group 3). Farmers had adopted the least number of changes to increase incomes and to reduce costs on the farm (Table 3).

Group 2 was defined as *effectively management farms*. Its main distinguishing feature from other clusters was the farmer's managerial skills. The 16 farmers in group 2 had the highest formal

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education (secondary school, similar to group 4). Farmers were members of three different cooperatives: *Acatic* (38%), *Capilla* (31%) and *Cerro Gordo* (31%). Group 2 farms were similar to those in group 4 in terms of daily milk yield per cow, milk price per litre and technological level. Farmers used 10 out of a set of 11 possible listed technologies such as milking machine, cooling tank, milking parlour, pre and post dip at milking, artificial insemination, farm records, vaccines, hybrid seeds, fertilizer, herbicides, and corn silage. Group 2 farms had the highest DIOCFC. Most importantly, farmers in group 2 adopted the highest number of changes to increase incomes but adopted the second lowest number of changes to reduce costs (similar to group 4).

Group 3 was named the *cost reducing farms*. This group of farms ($n = 11$) was managed by farmers that adapted to economic hardship by taking measures to limit expenses and cut costs. These farmers had a primary school education and they were spread among eight cooperatives. Group 3 farms had the lowest number of cows in production and the smallest herd size (a shared characteristics with farms in group 1). Group 3 farms did differ from group 1 farms in terms of hectare of land and cows per hectare. Group 3 farms had the second lowest number of cows per hectare and the second highest number of hectares of farmland. Farmers in groups 1 and 3 shared the number of changes aimed at increasing income. The main distinguishing feature of farms in group 3 was the owner's persistent attempt to reduce expenses and costs.

Group 4 was named the *mixed strategy farms*. It was comprised of 15 farms that were homogenous in regard to the large size of the herd, the number of cows in production, the availability of land and the technological level. Farmers were in the youngest age category. They belong to two cooperatives only (*San Julian* and *San Miguel*). Daily milk yield per cow and milk price per litre for farms in group 4 were similar to farms in group 2, but greater ($p < 0.05$) than for farms in groups 1 and 3. Farms in group 4 had the second highest DIOCFC and farmers in this group adopted the same low number of changes to increase income as those in groups 1 and 3, but they adopted also the second highest number of cost reducing strategies as those in group 2.

Changes adopted to increase income

Seven out of the nine listed changes to increase income did not show statistical differences ($p > 0.05$) among the four groups. Interestingly, few farmers, regardless to the group they belong to relied on an attempt to increase income by changing milk buyers (i.e., cooperative, commercial company, or government-supported *Liconsa* organisation). The same was observed for an increase in concentrate feed, which would likely increase milk production of the cows. However, changes to improve milk components (fat and protein content) and to improve cow nutritional balance showed statistical differences ($p < 0.05$) among groups (Table 4). These two changes were most frequently used in farms of group 2, followed by farms of groups 3 and 4. There were no statistical differences ($p > 0.05$) among the four groups regarding changes to increase incomes through lowering milk bacterial content, lowering milk somatic cell count or improvement of cow health. Group 1 had the lowest percentage of farmers who made changes to increase incomes.

Changes adopted to reduce costs

Changes to reduce purchase of milking supplies, to reduce educational expenses and to reduce food purchase did not show statistical differences ($p > 0.05$) among the groups. However, six of the nine listed strategies to reduce cost were statistically different ($p < 0.05$) among the groups (Table 4). Group 1 had the lowest proportion of farmers who made changes to reduce costs on the farm. Farmers in group 1 were similar to groups 2 and 4 to in reducing the purchase of clothing and beauty products as a cost-reduction measure. Farmers in groups 2 made changes to reduce the purchases of concentrate feed and equipment (similar to groups 3 and 4). Farmers in group 3 were the most likely to reduce workers salary, to reduce fertiliser, pesticide and insecticide, and to

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Table 4. Farmers' adaptation strategies to mitigate economic hardship

Variables	Group 1 ($n = 9$) % farmers	Group 2 ($n = 16$) % farmers	Group 3 ($n = 11$) % farmers	Group 4 ($n = 15$) % farmers	P^2
Changes to increase income					
Change to sell to cooperative	0	6	0	0	.999
Change to sell to company	11	13	27	0	.153
Change to sell to *Liconsa*[1]	0	13	0	0	.308
Improve milk fat and protein content	0	69[a]	27[b]	47[b]	<.004
Lower milk bacteria content	22	63	45	27	.141
Lower milk somatic cell count	22	56	18	40	.185
Increase concentrate feed	0	13	0	7	.767
Improve cow nutritional balance	11[c]	75[a]	27[b]	53[b]	<.008
Improve cow health	22	56	27	33	.313
Changes to reduce costs					
Reduce veterinary visits	22[b]	25[b]	55[b]	67[a]	<.043
Reduce concentrate feed purchase	11[b]	50[a]	64[a]	33[a]	<.045
Reduce purchase of milking supplies	11	13	36	7	.240
Reduce workers salary	0[c]	25[b]	45[a]	13[b]	<.043
Purchase less equipment	11[b]	63[a]	82[a]	67[a]	<.011
Reduce fertilizer, pesticide, and insecticide	0[c]	31[b]	73[a]	27[b]	<.006
Reduce education expenses	0	13	18	0	.272
Reduce clothing and beauty products	44[b]	38[b]	91[a]	40[b]	<.023
Reduce food purchase	11	13	45	33	.182
Strategies to pay the bills					
Ask for payment extension	78	69	73	73	.999
Ask for an official loan	22	38	36	47	.731
Ask for an informal loan	100	69	55	80	.115
Sell cows to pay bill	100[a]	81[b]	100[a]	100[a]	<.048
Nonfarm income	33	44	27	33	.878

[1]*Liconsa*: Mexican company founded in 1944 as a part of the social programs to supply and commercialize industrialized milk to the more vulnerable people.
[2]*P* value of Fisher's exact test ($p < 0.05$). Percentage within a row not sharing a common superscript (a, b, and c) differ, z-test ($p < 0.05$).

reduce clothing and beauty products for the household members. Farmers in group 4 reduced veterinary visits compared to other groups.

Mechanisms adopted to improve cash flow

Farmers relied heavily on strategies to pay their bills under economic hardship. More than 50% of farmers in each group relied on three of the five listed strategies to pay their bills (Table 4). The most common strategy was to sell cow (94% of all farmers); a practice adopted by all farmers in groups 1, 3, and 4 and 81% of famers in group 2. The other two most common strategies were to ask for payment extension (73%) or to ask for informal loan (75%). Reliance on official loan (37%) and nonfarm incomes (35%) were the two least common strategies to pay farm bill.

Discussion

Farm typologies

Typologies can be used as tools for dealing with farming systems heterogeneity, and these allow the identification of type-specific farm opportunities and constrains for the targeting of agricultural interventions and innovations (Kuivanen *et al.*, 2016). Typologies may also be used as starting point for the design of extension approaches and recommendations based on farmers' and farms' characteristics (Martinez-Garcia *et al.*, 2015). Although all farmers in the present study

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were cooperative members the FA and cluster analysis yielded four specific groups that reflected distinct strategies to cope with economic hardship. Thus, the typology proposed here (i.e., stagnant farms, effectively managed farms, cost-reducing farms, and mixed strategy farms) could be used to design effective recommendations that will be in alignment with a farmer's intuition of the proper course of action, but may also challenge them to consider other options.

The groups 1 and 3 were very similar in terms of farm size, availability of technology, and limited milk yield per cow; however, DIOCFC may be major impediment for farms in groups 1 and 3 to consider the more effective management decisions found among farmers of group 2. Farmers in group 1 were stagnant in the face of economic hardship; may be in part because farmers in group 1 were the oldest farmers with the fewest years of formal education. Thus, age and illiteracy need to be carefully considered when developing initiatives. Espinoza-Ortega *et al.* (2007) pointed out that the most senior farmers with lack of education were more traditional and less open to change and willingness to incorporate new ideas and farm management innovations compared to younger farmers with more years of formal education. Furthermore, our data showed that farmers in group 3 who have adopted significantly more cost-cutting strategies than farmers in other clusters and shared the lowest DIOCFC with those of group 1.

Farms in groups 2 and 4 shared some farmer and farm characteristics. Farms in group 2, however, showed the best performance to generate DIOCFC while having the second lowest availability of land. The superior economic performance of farms in group 2 may be attributed to a series of farmer and farm characteristic. In contrast, farms in group 4 had the largest availability of land and herd size; but, they did not have the best milk yield performance. Martínez-García *et al.* (2015) pointed out that farmer's personal attributes and farm situation may play an important role in the performance, management, and the propensity to engage in training programs.

Strategies of farms to increase income or reduce costs

A breakdown of the types of adaptation strategies addressed in the survey reveals that there were significant differences ($p < 0.05$) among groups in terms of emphasis on increasing income and reducing costs. The depressed milk price received by farmers in groups 1 and 3 could be attributed to the attention to the milk quality. The lack of knowledge or attention to the relationship between cow nutritional balance and milk production may have contributed to low milk production of cows in these groups. Farmers' resistance to adopting changes has been linked to lack of extension services and lack of information about economic advantages for the farm. Thompson *et al.* (2019) indicated that farmers' motivation in participating in extension services was the economic benefits to the farm.

Farms in group 2 had the greatest DIOCFC by combining cost-reduction measures with a strong emphasis on changes aimed at increasing incomes by adopting measures to increase milk quality, as well as cow nutrition and health. Therefore, practices on these farms could be used by extension services as a model to improve DIOCFC in the other groups. Valeeva *et al.* (2007) suggested that the improvement of mastitis management was mainly driven by factors that were internal to the farm and the individual farmers, such as economic losses, animal health, and welfare awareness. Thomson *et al.* (2019) suggested that extension services should be conducted through universities, since farmers found that university experts are kind, sociable people who understand and take care of them. This approach can be useful to conduct extension services to farmers from groups 1, 3, and 4.

As exemplified by farmers in group 3 primarily, measures to cut costs occurred both at the farm and household level. Some cost-cutting measures, such as a reduction in the purchase of clothing or beauty products (group 3), did not impact farm production. In contrast, other cost-cutting measures such as a reduction in concentrate feed purchase, purchase of less equipment (groups 2, 3, and 4), reduction in fertilizer, pesticide, and insecticide (group 3), and reduction in veterinary visits (group 4) were potentially detrimental to farm profitability. These measures, however, were

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associated with low milk price, milk production, and DIOCFC. It ensures that extension services should be focused less on cost-reduction and more on strategies to increase incomes to mitigate the low economical returns on farms.

Mechanisms adopted to increase cash flow

Dairy producers in this study used a variety of strategies and multiple fall-back options to pay their bills if they did not have sufficient cash; however, the four groups were fairly uniform in terms of strategies to pay bills. Stroebel *et al.* (2011) pointed out that livestock is used by farmer to cope with risk, and it is considered as living saving account that can be converted into cash as needed and also provide and instrument of liquidity, for example, bulls and steers are sold for cash income and financial security. It was interesting to note that overall selling dairy cows (i.e., one's own assets) was the most widely adopted strategy for paying bills in all four groups. Herrero *et al.* (2012) pointed out that the livestock are often one of the main assets that rural households possess to generate incomes since assets are stores of wealth that can be sold to finance investments such as school fees or in time of need such as an illness or drought. Assets can also facilitate access to credit and financial services. A heavy reliance on selling dairy cows could have a negative effect on incomes in the long term due to decapitalization of the farm. Reaching out to relatives and other farms for informal loan was almost as frequent as requesting payment extension, both of which occurred in approximately three-fourth of the farms in the study. In contrast, the least frequently used strategies were those associated with reliance on external sources of funding (asking for official loans and the use of nonfarm income, which nevertheless occurred in 37 and 35% of the farms, respectively).

Conclusions

This study explored the income-increasing and cost-reducing strategies of dairy farmers to mitigate economic hardship on the farms. In spite of sharing the common trait of being cooperative members, the results showed evidence for heterogeneity of dairy farms in regard to farmer and farm characteristics, changes adopted to increase income, and changes adopted to reduce cost. Our analysis provided evidence for at least four distinct types of responses to economic hardship, which were mainly associated with farmer's level of education and farm characteristics. Income-increasing strategies such as attempts to improve milk composition, nutritional balance, and cow health were linked to higher economic returns compared to the cost-reducing strategies that were linked to lower cow productivity and lower technological levels. Although more research is needed to better understand farmers' strategies to mitigate economic hardship, our results suggest that extension services should be focused less on cost-reduction and more on strategies to increase incomes to mitigate economic hardship on farms.

The main limitation of the study is the sample size ($n = 51$). It was acceptable to conduct the multivariable analysis; however, the small sample size limits the representativeness of the study, for which it is suggested that future research studies need to take into account more farmers to obtain the data necessary for more in-depth analyses. In addition, it is also suggested that studies should be conducted on the field to evaluate and to analyze the strategies to increase income such as changes to improve milk components (fat and protein content) and to improve cow nutritional balance since they were the most effective strategies to improve the daily income over concentrate feed cost on farm.

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