Agroecological performance of smallholder dairy farms in Central Mexico

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Introduction

The small-scale dairy farms of Mexico are facing environmental, social and economic challenges. They contribute significantly to national milk production (37%) but they lack agroecological performance evaluations. High dependence on external inputs and heterogeneity amongst farms. The hypothesis of this research considerate the small-scale dairy farms from central Mexico present hight agroecological performance. The objetive our aim was to conduct a multidimensional assessment of agroecological performance of smallholder dairy systems of Mexico and their contributions to food systems sustainability. Characterise small-scale dairy farms considering the 10 agroecological elements (TAPE Step 1) and Identify the agroecological performance of the small-scale dairy farms.

Materials & Methods

The survey portion (steps 1 and 2) of the FAO Tool for Agroecological Performance Evaluation (TAPE) was administered to 60 smallholders from the municipality of Aculco, State of Mexico selected through non-probabilistic snowball sampling. The 10 agroecological elements (AE) of TAPE step 1 survey results were subjected to a factor analysis and a cluster analysis that allowed us to create a typology of farm types (groups). The characteristics of each group in regard to the 10 AE, the 10 core criteria of performance (TAPE step 2 variables linked to multiple sustainable development goals) and a set of 12 variables that characterized the household, the farm and its biological diversity (plants, animals, and trees) were compared using non-parametric statistics (Kruskal-Wallis or Games-Howell post-hoc tests) with significance declared at $P < 0.05$.

Results

Three factors were identified (Table 1), which explain 64.77% of the total variance, with a Kaiser Meyer Olkin coefficient (KMO) of 0.717, Factor 1 described the positive association between four agroecological elements: efficiency, diversity, synergy and recycling. Factor 2 presented a positive relationship in three elements: culture and food traditions, circular and solidarity economy and human and social values. Factor 3 indicated a positive relationship between resilience, co-creation and sharing of knowledge and responsible governance.

Table 1. Results of the factor analysis with the 10 elements of agroecology

Elements of agroecology	Factor 1	Factor 2	Factor 3	Communality
Efficiency	**0.856**	0.067	-0.013	0.750
Diversity	**0.825**	-0.013	0.228	0.733
Synergies	**0.805**	-0.029	0.140	0.669
Recycling	**0.562**	0.485	0.063	0.555
Culture and food traditions	-0.092	**0.874**	0.017	0.772
Circular and solidarity economy	0.145	**0.731**	0.251	0.618
Human and social values	0.047	**0.700**	0.296	0.580
Resilience	0.318	-0.067	**0.727**	0.633
Co-creation and sharing of knowledge	-0.060	0.363	**0.726**	0.662
Responsible governance	0.024	0.299	**0.644**	0.504
Explained variance (%)	32.646	21.386	10.740	**64.77%**

Extraction method: Principal component analysis. Rotation method: Varimax with KMO normalization.

In step 1 (Table 2), to categorise small-scale dairy farms according to their level of agroecological transition, the CAET score was used, which was compared with the following scale: 1) 0 to 39 points, conventional farms; 2) 40 to 49 points, conventional farms; 3) 50 to 59 points, farms in initial transition to agroecology; 4) 60 to 69 points, farms in transition to agroecology and 5) 70 to more points, agroecological farms (Lucantoni et al., 2022).

Table 2. Typology of CAET and the percentage of farmer per group

Typology of CAET	Group 1 (n=12) % farms	Group 2 (n=16) % farms	Group 3 (n=22) % farms	Group 4 (n=10) % farms	[1]p
1. Conventional farms (39 or less)	0.0[c]	69.0[a]	23.0[b]	60.0[a]	0.001
2.Conventional farms with sustainability elements (40-49)	25.0[a]	31.0[a]	59.0[a]	40.0[a]	
3.Farms in initial transition to agroecology (50-59)	50.0[a]	0.0[c]	18.0[b]	0.0[c]	
4.Farms in transition to agroecology (60-69)	17.0[a]	0.0[a]	0.0[a]	0.0[a]	
5. Agroecological farms (70 or more)	8.0[a]	0.0[a]	0.0[a]	0.0[a]	
Total %	100.0	100.0	100.0	100.0	

[1]P value of the chi-squared test (P<0.05). Different superscripts (a, b and c) indicate significant differences among groups, according to z test with Bonferroni adjustment (p<0.05).

Conclusions & Implications

This study suggested that greater cow milk performance in smallholder systems, although not correlated with the AE, had positive association with desirable socio-economic, environmental, and human health outcomes. Farms can be grouped into 4 distinct clusters with different agroecological performances.

Group 1 showed the highest transition levels. Groups 2 and 4 were predominantly non-agroecological. It is necessary to propose strategies focused on the needs of each group of farms.

TAPE is a useful tool for evaluating and promoting agroecological transition in small-scale dairy systems.