

ANALYZING THE FACTORS INFLUENCING DAIRY COOPERATIVE AFFILIATION AND ITS ROLE IN ENHANCING FOOD RESILIENCE AMONG SMALLHOLDER FARMERS IN SOUTHERN MOROCCO

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Abstract:

This article addresses two main scientific questions. First, it examines the relationship between smallholder households' membership in dairy cooperatives and their resilience to food insecurity, measured by the Food Consumption Score, in the context of the Souss Valley. Second, using binary logistic regression, it analyzes how various socio-economic factors influence the likelihood of cooperative membership. It assesses how these determinants affect cooperative participation and identifies the underlying mechanisms of this effect. The study reveals that over 60% of smallholders are not members, while members own four times more livestock than non-members. Increased distance from milk collection centers significantly reduces membership. Non-agricultural income and migrant remittances substantially increase the likelihood of membership, while access to irrigation water, though beneficial, has a minimal effect. The availability of household labor quadruples the chances of membership, whereas access to credit, large land areas and extension visits do not significantly impact membership.

Keywords: Dairy Cooperatives, Food Consumption, Food Security, Smallholders, Souss Valley.

JEL Codes : O12, O13, Q12

1. Introduction

Local social networks have multiple functions for reducing vulnerability and strengthening adaptive capacity and resilience (T. Below et al., 2010; Bryan et al., 2009). This importance becomes more significant when dealing with various stress factors in dynamic contexts. Indeed, local institutions, which Jones et al.(2010) describe as informal, enable communities to respond to an evolving environment. According to them, having well-developed social institutions allows individuals and communities to adapt and build their resilience.

The importance of formal and informal local institutions can also be seen as a relevant factor in assessing the resilience of smallholder farmers. The study by Agrawal and Perrin (2009) on 16 African countries is one of the most renowned studies that have confirmed this concept. In Tanzania, through factor analysis and multiple linear regression models using latent variables, Below et al. (2012) attempted to study the determinants of farmers' adaptive capacity

and resilience. They concluded that the membership of one or more household members in a social, agricultural, or other group can be an important and determining factor of resilience to shocks. These authors emphasize that individuals with robust social networks have access to useful climate information, enabling them to better withstand shocks and rebuild their lives more quickly than those with less developed social ties.

However, extending one's social capital, such as by joining an association, does not always equate to an effective resilience measure for a smallholder household. In a study in Kenya, Bryan et al. (2013) found that membership in associations negatively influences the likelihood that a smallholder household will adopt crop variety change as a resilience measure. This aligns with findings by Roco et al. (2014) in the Maule region of central Chile. Their conclusion emphasizes that, although participation in farmer associations is important and positively correlated with the number of practices adopted, it has no impact on the decision to adapt, which is nevertheless important for building resilience.

In contrast, for vulnerable individuals, a social network is a valuable asset to mobilize both before and after the occurrence of a shock. However, some researchers, such as Matsalabi et al. (2020), have demonstrated a negative association between a social safety net and resilience. The authors found that access to a social safety net can serve as an indicator of vulnerability. Consequently, an increase in social networks occurs as resilience decreases. Thus, the more vulnerable a household is, the more it develops its social network as a livelihood and resilience strategy against food insecurity.

On the other hand, agricultural organizations, such as cooperatives, contribute to maintaining income levels and supporting rural livelihoods by establishing food supply dynamics and promoting job creation (Chambo, 2009). By doing so, agricultural cooperatives help to strengthen agricultural stability, facilitate market access for their products, and consolidate their position in the agri-food chain (Allahdadi, 2011).

The benefits and contributions of these entities position them as significant levers in local rural development policies, particularly in arid and semi-arid environments, by promoting increased agricultural productivity and poverty reduction. They are also well-situated to address other development challenges, such as food security and sustainable development. Several studies, including those by Ingutia and Sumelius (2022) and Zeweld Nugusse et al. (2013), have emphasized the positive and significant effects of cooperatives on food production. This is attributed to the access they provide to technology as well as to input and agricultural product markets.

Membership in agricultural cooperatives is often driven by an individual cost-benefit analysis of farmers. Fischer and Qaim (2012) pointed out that producers seek to balance perceived returns with membership costs. This provides an explanation for the low membership rates observed in many rural areas. Bernard and Spielman (2009) confirm this trend in Ethiopia, indicating that the decision to join a cooperative or another professional group results from a comparative assessment of benefits and costs.

In light of this, our main objective is to identify the key factors influencing the decision of local smallholder farmers to join or not join dairy cooperatives, in order to better understand the fundamental elements contributing to their adaptive capacity in the face of food insecurity. By analyzing the motivations and barriers to membership as well as the resilience of households to food insecurity through the Food Consumption Score (FCS), this research will significantly contribute to the development of more effective agricultural and social policies in the region. The aim is to focus on the agricultural production systems of smallholder farmers to enhance their resilience and improve their food security.

Considering the preceding points, our investigation is divided into two main parts: on one hand, we will examine whether there is a significant relationship between membership in a dairy cooperative and resilience to food insecurity, as measured by the Food Consumption

Score. On the other hand, we will analyze the determinants influencing the decision of smallholder households in the Souss Valley to join a dairy agricultural cooperative.

2. Materials and Methods

2.1. The Study Area

Agricultural activity in the region is significantly influenced by the inherent natural properties of the Souss Valley. The impacts of climate change on agriculture in the valley are clearly observable, exacerbating the semi-arid to arid nature of the region. The intrinsic characteristics of the valley's hydrological system, influenced by factors such as topography, geology, and climate, amplify its vulnerability. Environmental changes accelerate this trend toward a natural determinism characterized by the scarcity of water resources, which are also subjected to significant anthropogenic pressures.

2.2. Sampling and Data Collection

For this research, we adopted the smallholder household as the primary unit of data collection, as it is the level where key decisions regarding adaptation to climatic stresses and livelihood processes are made. In the absence of a reliable survey base, we employed quota sampling, forming a sample based on specific distribution criteria. In each of the seven sampled municipalities, lists of villages with predominant irrigated and rain-fed lands were established. These lists were processed using Excel 2016 with simple random sampling to identify the first representative irrigated and rain-fed village.

To determine the sample of households to be surveyed, we used the following formula, as proposed by C. R. Kothari (2004):

$$\mathbf{n} = \frac{\mathbf{Z}^2 * \mathbf{p}(1-\mathbf{p}) * \mathbf{N}}{\mathbf{Z}^2 * \mathbf{p}(1-\mathbf{p}) + (\mathbf{N}-1) * \mathbf{e}^2} \quad (1)$$

Where **n** is the required sample size, **Z** is the confidence level, **e** is the desired precision level, **p** is the estimated proportion of villages exposed to extreme drought, and **N** is the total number of rural households living in the study area (the rural Souss Valley):

$$\mathbf{n} = \frac{1.96^2 * (0.5 * 0.5) * 54214}{(1.96^2 * (0.5 * 0.5)) + ((54214 - 1) * (0.05^2))} = 381.46 \approx \mathbf{382} \text{ Households.}$$

Our sample initially comprised a total of 382 households to which we administered a pre-tested structured questionnaire. A preliminary statistical processing of the data entered into SPSS26 allowed for the detection of multivariate outliers using a Mahalanobis distance test (Tabachnick et al., 2013). Twenty-two multivariate outliers were identified and removed to avoid any negative impact on the forthcoming statistical analysis.

2.3. Estimation of the Effect of Membership in a Dairy Agricultural Cooperative on Food Security

Agricultural producer organizations, such as cooperatives, consist of farmers who come together primarily to purchase inputs, sell their products collectively, and pool their resources. Membership in a dairy agricultural cooperative can influence the food security of its members in several ways. First, it provides members with increased access to knowledge about farming practices and inputs, thereby improving technical efficiency and agricultural productivity

(Kumar et al., 2018; Michalek et al., 2018). An increase in agricultural productive potential enhances the availability of various food products, thus contributing to food security (Baldos and Hertel, 2013).

Membership in an agricultural cooperative can enhance both food diversity and security by providing better access to market information and increasing agricultural prices. According to Ma et al. (2018) and Ma & Abdulai (2016), agricultural professional organizations strengthen farmers' competitiveness by providing them with essential information on input and product prices. Their members benefit from higher agricultural incomes (Hoken & Su, 2018), which bolsters their resilience to food insecurity and stimulates the local economy.

To assess the impact of smallholder households' membership in a dairy agricultural cooperative on food security, we use the Food Consumption Score. The calculation of the score is based on eight food groups, taking into account dietary diversity, nutritional quality, and the significance of food consumption by household members in the seven days preceding the survey. The score combines dietary diversity and consumption frequency (Kennedy et al., 2010; UN World Food Programme, 2020). It is derived by performing a weighted sum, incorporating the type of meal and consumption frequency, with weights assigned based on the relative nutritional value of each food group.

Based on the responses of the household head, the Food Consumption Score (FCS) is estimated using the formula proposed in "Emergency food security assessment handbook" (WFP, 2009). The method for calculating the Food Consumption Score (FCS) involves multiplying the weight assigned to each food group by the number of days these foods were consumed (Table 1). The formula can be expressed as follows:

$$SCA = a_1 \times f_1 + a_2 \times f_2 + a_3 \times f_3 + a_4 \times f_4 + a_5 \times f_5 + a_6 \times f_6 + a_7 \times f_7 + a_8 \times f_8 \quad (2)$$

Where *f* represents the frequency (the number of days each food group was consumed during the past week), and *a* is the weighting factor reflecting the nutritional value of the different food groups consumed.

Table 1. Foods, Groups, and Weights in the Food Consumption Score (FCS)

Foods	Food groups	Weighting Factors
Rice, Wheat, Potatoes	<i>f</i> ₁ : Cereal-based foods and edible root crops	<i>a</i> ₁ = 2
Beans, Peas, Lentils	<i>f</i> ₂ : Pulses	<i>a</i> ₂ = 3
Vegetables	<i>f</i> ₃ : Vegetables	<i>a</i> ₃ = 1
Fruits	<i>f</i> ₄ :Fruits	<i>a</i> ₄ = 1
Eggs, Meat, Fish	<i>f</i> ₅ : Eggs and Meat	<i>a</i> ₅ = 4
Dairy Products	<i>f</i> ₆ : Milk	<i>a</i> ₆ = 4
Sugar	<i>f</i> ₇ : Sugar	<i>a</i> ₇ = 0.5
Edible Oil	<i>f</i> ₈ : Oil	<i>a</i> ₈ = 0.5

Source: Nie et al., (2011).

Table 2. Thresholds for food security groups according to the Food Consumption Score (FCS)

	Food security groups	FCS
Food insecurity	Poor food consumption	0-21
	Borderline food consumption	21.5 - 35
Food security	Acceptable food consumption	>35

Source: WFP (2009).

This research aims to address a central question: Is there a significant difference between households of smallholder farmers who are members and non-members of dairy agricultural cooperatives in terms of food consumption score?

For this article, we propose a hypothesis stating that there is no significant difference between households of smallholder farmers who are members and non-members of dairy agricultural cooperatives in terms of food consumption score (H_0). Conversely, the alternative hypothesis (H_1) posits that there is a significant difference between these two groups.

Before conducting any analysis to verify the existence of a significant relationship between cooperative membership and food security, we employed the Mann-Whitney U test (Table 7) to assess the differences in food consumption scores between households that are members and non-members of dairy agricultural cooperatives.

2.4. Binary logistic model

The Odds model is based on the logistic probability distribution. The binary logistic model is relevant in econometrics for analyzing the relationship between a binary dependent variable and various independent variables, whether continuous or categorical (Garson, 2016). The binary logistic regression model is employed in this study to analyze the effects of certain socioeconomic characteristics of households on their membership or non-membership in a dairy agricultural cooperative.

The analytical framework of the binary logistic regression model is well-suited for modeling this dichotomous variable. This model allows for the selection of a set of explanatory variables (predictors) and describes their relationship with a binary response variable (the dichotomous dependent variable) (Allison, 2012; Hosmer Jr et al., 2013). In our case, membership in a dairy agricultural cooperative is a dichotomous variable (membership or non-membership). It thus provides a suitable framework for detecting the probability that a household is a member of a dairy agricultural cooperative or not. The parameters of this model are estimated using the maximum likelihood estimation technique.

The relationship between the membership status in a dairy cooperative and the explanatory variables is modeled using logistic regression. This approach utilizes the logarithm of the odds, or odds, to facilitate the interpretation of the impact of each independent variable on the odds. This approach is formalized as follows:

$$\text{logit}(P) = \log(p / (1 - p)) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k \quad (3)$$

Where:

- β_0 stands for the constant term;
- P represents the probability that a household is a member of a dairy cooperative;
- X_1, X_2, \dots, X_k correspond to the independent variables;
- $\beta_0, \beta_1, \beta_2, \dots, \beta_k$ indicate the coefficients to be estimated.

This logistic function estimates the probability that a household is a member of a dairy agricultural cooperative while quantifying the impact of each independent variable on the logarithm of the odds (log odds) of the membership decision.

2.5. The dependent variable and the independent variables

In this study, we consider that several factors explain a household's decision to join a dairy agricultural cooperative to meet its economic needs and diversify its livelihood strategies. Accordingly, membership in a dairy agricultural cooperative is a dichotomous dependent

variable. To analyze the factors influencing this decision, we will employ a binary logistic regression model.

Therefore, the explanatory (independent) variables introduced into the binary logistic regression model to determine the factors influencing households' decision to join a dairy agricultural cooperative include tropical livestock units (TLU) owned by the household, agricultural experience, distance to milk collection centers, non-agricultural income, remittances, access to irrigation water, household assistance, access to credit, farmed land area and visits from agricultural extension agents. These factors are hypothesized to influence the likelihood that a household will choose to join a dairy cooperative.

Tropical livestock units (TLU): Livestock, whether practiced alone or in combination with crop cultivation, plays a central role for many rural households by ensuring subsistence, income, and nutrition, particularly during periods of food scarcity. Livestock is essential in the fight against poverty and the promotion of development in disadvantaged rural communities (Nin et al., 2007). Ownership of livestock supports food security by enabling the sale of livestock to quickly obtain food resources and by providing dairy products that improve nutrition and generate additional income. Consequently, livestock ownership has a positive impact on food security. We assume that households with livestock are better positioned to join a dairy agricultural cooperative than those without such assets.

Distance to milk collection centers: Milk collection centers, by gathering the production from smallholder farmers, play a vital role in the development of the dairy sector. They represent a key stage in the dairy value chain for small-scale producers. The distance to these collection centers is often used as an indicative measure of access to dairy markets for these producers. Consequently, it is plausible that household membership in a dairy agricultural cooperative is strongly correlated with the accessibility and proximity of these centers, thereby facilitating their participation in agricultural product and input markets.

Non-agricultural income: The majority of households adopt a diversification strategy by combining income sources from agricultural activities, commercial ventures, and both skilled and unskilled non-agricultural activities. Income from sources such as non-agricultural wages is expected to provide financial supplementation, often used to transition from extensive to intensive agriculture and to purchase livestock. Similar to the work of Fischer and Qaim (2012), we anticipate a positive relationship between off-farm employment and the likelihood of joining a dairy cooperative. Income generated from non-agricultural activities encourages cooperative membership while also contributing positively to the food security of smallholder households.

Remittances: As part of income diversification strategies, household members who remain in place receive more or less regular monetary transfers, which constitute an alternative source of income. These remittances from migration allow rural households to expand their food insecurity resilience strategies. McCabe et al. (2014) observed that, through migration, pastoral households in northern Tanzania used transfer income to acquire livestock and increase their herd sizes. Consequently, we assume that income generated from migration transfers influences rural households' decision to join dairy agricultural cooperatives.

Access to irrigation water: Access to irrigation water is closely linked to agricultural activities and is a fundamental determinant of their sustainability. The availability of water for agricultural operations directly stimulates agricultural and livestock productivity. Irrigation enables farming households to diversify their crops and shift from low-value subsistence production to high-value market-oriented production. This transition has the potential to boost

agricultural productivity and, consequently, improve household food security. Therefore, a positive influence of access to irrigation water on the membership of smallholder farmers in dairy agricultural cooperatives is anticipated.

Household assistance: The availability of human capital within the household is reflected in the labor resources available for both agricultural and non-agricultural activities. As demonstrated by Bogale and Shimelis (2009), households with a significant labor reserve are more likely to ensure their food security. This productive potential allows them to perform their primary agricultural activities in a timely manner and additionally engage in subsistence crops. Indeed, household size can influence smallholder farmers' membership in a dairy cooperative. The availability of labor within households (household assistance) fulfills a significant role and is a favorable factor for household membership in these cooperatives. We therefore anticipate a positive contribution of this labor availability to household membership.

Access to credit: Access to credit is recognized as an essential factor in improving the adaptation and resilience capacities of smallholder farmers against climatic shocks. By improving their financial capacity, access to credit increases the likelihood that farmers will join cooperatives. Conversely, financial constraints can limit this membership. This relationship has been identified in studies by Bernard and Spielman (2009) in Ethiopia and Fischer and Qaim (2012) in Kenya. Tsegaye et al. (2018) observed that households with access to credit are more likely to achieve food security compared to those without. Consequently, it is reasonable to expect that access to credit will have a positive influence on smallholder farmers' decision to join dairy agricultural cooperatives.

Farmed land area: Due to climate change, farm size varies with shifting climatic conditions. But what is most important to farmers is the proportion of land that can be actively cultivated, which largely depends on available resources, especially water. In any case, agricultural income increases with farm size, enhancing farmers' adaptability and resilience. The interdependence between agriculture and livestock is mutually beneficial, as livestock benefit from crop residues while also positively influencing agricultural productivity. This leads us to conclude that there is a positive correlation between farm size and the likelihood of a household joining a dairy agricultural cooperative.

Visits from agricultural extension agents: The propensity of farmers to join agricultural cooperatives is substantially influenced by agricultural extension services. These services, which are considered fundamental for the development of the sector, influence key factors affecting cooperative membership: they disseminate knowledge, enhance skills, and facilitate market access. Access to information and extension services enables farmers to better understand improved agricultural management practices, technology, and innovations. In Kenya, Bryan et al. (2009a) found that farmers with access to agricultural extension are not only more aware but also better informed about environmental issues and other factors that may affect their agricultural activities. Access to agricultural extension services is also identified as a catalyst for the adoption of various resilient practices, including effective livestock management (Alemayehu and Bewket, 2017; Deressa et al., 2009). Therefore, we can hypothesize that regular visits from agricultural extension officers promote smallholder households' membership in dairy agricultural cooperatives.

Table 3. Dependent variable and independent variables of the binary logistic regression model

Variable	Variable types	Variable description	Expected sign	VIF
Dependent: - <i>Joining a dairy cooperative</i>	Qualitative nominal (Binary: Yes/No)	Affiliation of the household head (or a member) to a dairy agricultural cooperative; 1 if the household is a member, 0 otherwise.		
Independents :				
- <i>TLU</i>	Continuous variable	Total tropical livestock units owned by the household.	+	1.453
- <i>dist_collcent</i>	Continuous variable	Distance between the household residence and the nearest milk collection center (in km).	-	1.023
- <i>nonagr_inc</i>	Qualitative nominal(Binary: Yes/No)	Whether the household has a non-agricultural income source; 1 = Yes, 0 = No	+	1.437
- <i>remitt</i>	Qualitative nominal (Binary: Yes/No)	Whether the household receives remittances; 1 = Yes, 0 = No.	+	1.072
- <i>irrig_water</i>	Qualitative nominal (Binary: Yes/No)	Whether the household has access to irrigation water; 1 = Yes, 0 = No.	+	1.435
- <i>hh_assist</i>	Qualitative nominal (Binary: Yes/No)	Whether the household has household assistance among its members; 1 = Yes, 0 = No.	+	1.737
- <i>credit_acc</i>	Qualitative nominal (Binary: Yes/No)	Whether the household has access to a credit mechanism; 1 = Yes, 0 = No.	+	1.229
- <i>farmland_area</i>	Continuous variable	Agricultural land area cultivated in 2022 (hectares).	+	1.404
- <i>visit_extagents</i>	Qualitative nominal (Binary: Yes/No)	Whether the household receives visits from agricultural extension agents; 1 = Yes, 0 = No.	+	1.068

Source: Authors' own calculations (2024).

To study smallholder farmers' membership in dairy cooperatives in the Souss Valley, we propose two working hypotheses. The first hypothesis posits that smallholder farmers lacking resources or assets are less likely to join cooperatives. Conversely, the second hypothesis suggests that diversifying income sources, whether agricultural or non-agricultural, is essential for promoting membership in these cooperatives.

We will empirically test the validity of these hypotheses within the scope of our research. To this end, we will employ binary logistic regression modeling to identify the key factors influencing smallholder farmers' membership in dairy cooperatives. The expected results from this analysis will provide insights into how socioeconomic factors, along with other determinants, may influence smallholder farmers' decisions to join these cooperatives.

The previously described variables represent the factors believed to affect the probability Y that a household joins a dairy agricultural cooperative; β_k are unknown parameters to be estimated.

$$Y = f(\beta_1 TLU + \beta_2 dist_collcent + \beta_3 nonagr_inc + \beta_4 remitt + \beta_5 irrig_water + \beta_6 hh_assist + \beta_7 credit_acc + \beta_8 farmland_area + \beta_9 visit_extagents) \tag{4}$$

3. Results and Discussion

3.1. Descriptive Statistics

The comparison of socio-economic and agricultural indicators between dairy cooperative members and non-members reveals significant advantages for the members (Table 4). On average, members are older, more experienced, and have larger households. Economically, they cultivate more land (+45% compared to non-members), have higher annual incomes, and are more engaged in livestock farming, owning an average of 9.60% more cattle. Although they spend more on food, their Food Consumption Score is slightly better. Membership in a dairy cooperative is therefore strongly correlated with an overall better economic situation.

Table 4. Socio-Economic and Agricultural Indicators of Members and Non-Members of Dairy Agricultural Cooperatives

Category	Members of a dairy cooperative (Averages)	Non-Members (Averages)	Proportion (Member by Non-Member)
-Dairy Cooperative Member	Yes	No	-
-Gender (Female: 0; Male: 1)	0.9930	0.9723	1.02
-Age (Years)	57.16	54.76	1.04
-Household Size	6.77	5.82	1.16
-Cultivated Area (ha)	1.5441	1.0641	1.45
-TLU	6.151	1.666	3.69
-Number of Cattle	6.4126	0.6682	9.60
-Livestock Practice (No: 0; Yes: 1)	0.9371	0.2350	3.99
-Monthly Income (Moroccan Dirham:MAD)	4031.03	3371.44	1.20
-Monthly Food Expenditures (MAD)	3397.90	2666.36	1.27
-Food Consumption Score (FCS)	45.60	43.38	1.05

Source: Authors' own calculations (2024).

Analysis of the food groups for calculating the Food Consumption Score (FCS) reveals significant differences between members and non-members of dairy agricultural cooperatives, underscoring the potential impact of membership on dietary choices and nutritional habits (Table 5). For cereal and starchy roots (f_1), the standard deviation is zero, indicating uniform consumption in both groups. Regarding legumes (f_2), non-members consume significantly more legumes than members, with reduced variability within this group. For vegetables (f_3), non-members show higher consumption compared to members, with more uniform consumption among the latter. In terms of fruits (f_4), members have slightly higher consumption, though both groups exhibit nearly similar variability. For eggs and meats (f_5), members consume more eggs and meats compared to non-members, with higher variability among the members. Regarding milk (f_6), members consume slightly more milk, but with marked variability. For sugar (f_7), non-members consume more sugar, with slight variability, while consumption among members is more uniform and lower. Finally, for oil (f_8), members consume more oil with slight variability, whereas non-members show more uniform and lower consumption.

Table 5. Descriptive statistics of FCS food groups by dairy agricultural cooperative membership status

	Members				Non-members			
	Avg.	SD	Max.	Min.	Avg.	SD	Max.	Min.
f_1 : Cereal-based foods and edible root crops	4	0	4	4	4	0	4	4
f_2 : Pulses	2.31	0.8	3	1	3.6	0.5	4	3
f_3 : Vegetables	3.84	0.37	4	3	2.33	0.59	4	1
f_4 : Fruits	2.58	0.67	4	1	2.46	0.84	4	1
f_5 : Eggs and Meat	2.63	0.89	4	1	2.23	0.7	3	1
f_6 : Milk	2.59	1.02	4	1	2.42	0.9	4	1
f_7 : Sugar	3	0	3	3	3.64	0.49	4	3
f_8 : Oil	3.87	0.35	4	3	3	0	3	3

Source: Authors' own calculations (2024).

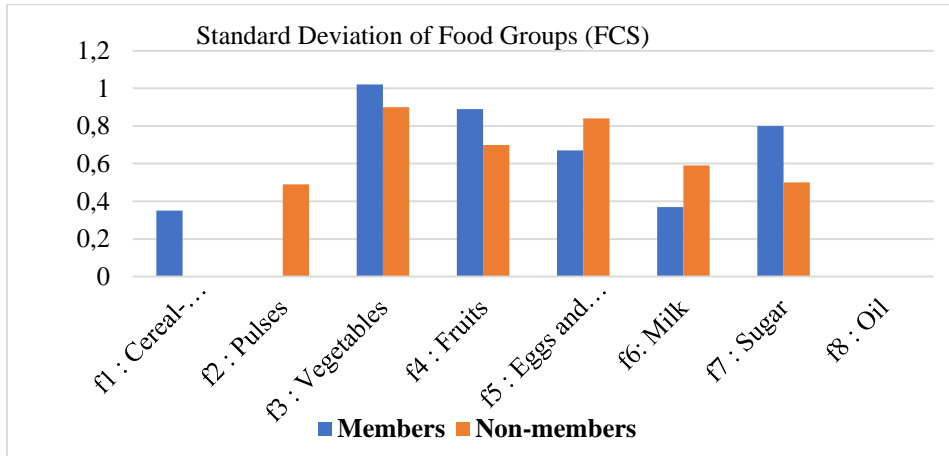
In summary, members demonstrate a higher intake of vegetables, fruits, eggs, meats, and oil, with greater variability for some food groups. Conversely, non-members consume more legumes and sugar. These differences may reflect variations in access to foods, dietary preferences, and consumption practices between the two groups.

The Food Consumption Score (FCS): Households affiliated with dairy agricultural cooperatives (n=143; 39.72% of the sample) record higher scores for food groups such as eggs, meats, and milk. These foods, which are assigned high coefficients in the Food Consumption Score (FCS) calculation due to their substantial nutritional contribution, result in an average FCS of 45.60 for these households. Additionally, these households also achieve high scores for fruits, despite their relatively high cost. In comparison, non-affiliated households (n=217; 60.28% of the sample) have an average FCS of 43.38. These households primarily meet their food needs by consuming legumes and vegetables, which are less expensive and contribute modestly to the FCS (Table 5).

The average annual income and food expenditures: Households affiliated with dairy agricultural cooperatives report an average annual income per household member of 6351.38 MAD. In contrast, non-affiliated households have an average annual income of 5876.4 MAD per household member. As for annual food expenditures, affiliated households average 4031.03 MAD per household member, compared to 3371.44 MAD for non-affiliated households (Table 6).

The data reveal that households affiliated with dairy agricultural cooperatives tend to have higher Food Consumption Scores compared to non-affiliated households, suggesting better dietary quality. This observation is supported by their higher annual income and food expenditures per household member (Table 6). The standard deviations also indicate greater variation in Food Consumption Scores and income among affiliated households (Figure 1),

while annual food expenditures show moderate variation in both groups (Table 6). These findings underscore the effect of dairy agricultural cooperatives on both the dietary quality and economic conditions of affiliated households.



Source: Authors' own calculations (2024).

Figure 1. Standard Deviation of Food Groups (FCS) by Cooperative Membership Status

Table 6. FCS, Income, and Food Expenditures by Cooperative Membership Status

	Members					Non-members				
	Nb. House holds	Avg.	SD	Ma x.	Min .	Nb. House holds	Avg.	SD	Ma x.	Min .
FCS	143 (39.72%)	45.60	7.40	59.5	32	217 (60.28%)	43.38	6.37	60.5	32
Annual income (per household member)		6351.38	2683	16200	2400		5876.4	2516.45	17250	2400
Annual food expenditures (per household member)		4031.03	1407.68	7300	2190		3371.44	1056.45	7300	1825

Source: Authors' own calculations (2024).

Table 6 presents data on food insecurity and food security for both affiliated and non-affiliated households within our sample. Analysis of these data provides several key insights. No household, whether affiliated or non-affiliated, falls into the category of "Poor" food consumption (0-21). Regarding "borderline" food consumption levels (21.5-35), affiliated households are less represented, with only 10 cases compared to 22 among non-affiliated households. The majority of households in both groups display "acceptable" food consumption levels (>35). However, 93% of affiliated households fall into this category, compared to 90% of non-affiliated households. This difference suggests a slight tendency towards better food consumption among affiliated households, while both groups remain within generally acceptable ranges.

This difference is corroborated by the median food consumption, which is 44.5 for affiliated households compared to 42 for non-affiliated households (Table 7). This suggests that affiliated households tend to have a slightly higher food consumption compared to non-affiliated households. Additionally, the Mann-Whitney U statistic, which is 12947.00, the Wilcoxon W statistic of 36600.00, and the Z value of -2.661444, which is significant at $p=0.008$, indicate a statistically significant difference between the two groups ($p<0.01$).

Our results indicate that households affiliated with cooperatives exhibit better food security compared to non-affiliated households, with statistically significant differences in overall food consumption between the two groups. Statistical analyses confirm that affiliated households show a higher overall food consumption (Table 7). At a significance level of $p < 0.01$, we reject the null hypothesis. The negative Z value suggests that affiliated households generally enjoy higher levels of food consumption compared to non-affiliated households.

Table 7. Food Security According to Dairy Cooperative Membership Status

		Members	Non-members
Food Insecurity	Number of households in the " <i>poor food consumption</i> " category: 0-21	0	0
	Number of households in the " <i>borderline food consumption</i> " category: 21.5 - 35	10	22
Food Security	Number of households in the " <i>Acceptable food consumption</i> " category: >35	133	195
Median		44,5	42
<ul style="list-style-type: none"> • <i>Mann-Whitney U Statistic: 12947.00</i> • <i>Wilcoxon W Statistic: 36600.00</i> • <i>Z: -2.661444</i> • <i>Asymptotic Significance (Two-Tailed): 0.008</i> 			

Source: Authors' own calculations (2024).

3.2. Regression Results

To assess the presence of a significant correlation between the dependent variable and the explanatory variables, we conducted a bivariate analysis. The results of this analysis (Table 8) indicate that all variables are significant at the 5% level, except for the variable "*remit*" which is not significant, and the variable "*dist_collcent*" which is slightly outside the conventional significance threshold ($p<0.10$). Due to their significance as highlighted by the literature and the lack of collinearity ($VIF<2$), these variables were retained in the model (Table 8).

Before running the binary logistic regression model, the significant variables from the bivariate analysis were subjected to a collinearity check. The variance inflation factor (VIF) values (Table 2), resulting from a collinearity diagnostic, are well below the threshold of 5 suggested by Hair et al. (2014). According to the criteria established by these authors, we can conclude that these variables do not exhibit any multicollinearity issues.

Table 8. Spearman’s Correlation Rho Test

		Correlation (Spearman)									
		Joining A Dairy Cooperative	TLU	Dist_Colcent	Nonagr_Inc	Remitt	Irrig_Water	Hh_Assist	Credit_Acc	Farmland_Area	Visit_Extagents
Dependent Variable: Joining A Dairy Cooperative	Correlation Coefficient	1.000	0.631	-0.099	0.441	0.017	0.351	0.405	0.178	-0.223	0.125
	Sig. (Two-Tailed)	-	0.000 (***)	0.061 (*)	0.000 (***)	0.744 (NS)	0.000 (***)	0.000 (***)	0.001 (***)	0.000 (***)	0.018 (**)
	N	360	360	360	360	360	360	360	360	360	360

Source: Authors' own calculations (2024).

Note: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$ and ^{NS} Non-significant.

The table 9 presents the results of a logistic regression analysis aimed at identifying the factors that might explain the membership of smallholder households in the Souss Valley to dairy cooperatives. This table reports, for each explanatory variable, the *coefficients*, *standard errors*, *Wald statistics*, significance levels (*p-values*), and *odds ratios*. The determinants examined include access to basic services (distance to milk collection centers, agricultural extension visits, access to credit), access to social safety nets (migrant remittances), and socio-economic indicators (tropical livestock units (TLU), non-agricultural income, household assistance, access to irrigation water, cultivated area).

The results of the binary logistic regression model (Table 9) reveal that the *Nagelkerke Pseudo-R²* is 0.700, indicating that the model is robust and that the independent variables explain 70% of the variance in the dependent variable. This high Pseudo-R² value suggests that the model has strong explanatory power, reflecting the relevance of the selected variables in the analysis. Furthermore, the overall correct prediction rate reaches 88.1%, demonstrating the model's effectiveness in predicting the outcome under study.

Following explanatory variables demonstrate a statistically significant difference at the 1% level and are identified as determinants of smallholder households' membership in dairy cooperatives: Tropical Livestock Units (TLU), non-agricultural income, distance to milk collection centers, household assistance, and cultivated area. Regarding the variable of migrant remittances, it is significant at the 5% level.

The analysis of logistic regression coefficients and associated statistics presented in Table 9 identifies several key factors influencing smallholder households' membership in dairy cooperatives.

Tropical Livestock Units (TLU): Over 60% of smallholder households in our sample are not members of a dairy agricultural cooperative. This situation likely suggests that membership in these cooperatives is not accessible to all smallholders, as 23% of non-members in our sample, despite engaging in livestock farming, are not affiliated with any cooperative. This limited membership may be attributed to various factors, including the reluctance of cooperatives to

expand their membership base, as well as the decision of households not to join the organization.

However, the assets possessed in terms of Tropical Livestock Units (TLU) remain a crucial determinant for membership in these cooperatives. Members in our sample own more livestock than non-members, with an average of 6.15 units compared to 1.67 units. In other words, members hold, on average, nearly four times more livestock than non-members. Our results also indicate that an increase of one unit in TLU doubles the likelihood of joining dairy cooperatives, with an odds ratio of 2.094, signifying a significant and positive effect on membership ($p < 0.001$). These findings are consistent with those of Verhofstadt and Maertens (2015) in Rwanda, which demonstrated that an additional unit of livestock increases the probability of cooperative membership by 9.1 percentage points.

Distance to milk collection centers: An increase of one kilometer in the distance to milk collection centers reduces the odds ratio to 0.720, indicating a significant 28% decrease in the likelihood of joining a cooperative ($p < 0.001$). As anticipated by our initial hypothesis, the distance to the collection center, used as an indicator of access to the milk market, showed a negative and significant impact at a 1% probability level for smallholder farmers. An increase in distance leads to higher transportation costs and greater risks of quality deterioration in milk, thereby reducing sales volumes and restricting market access.

Non-agricultural income: Consistent with our initial hypothesis, our results indicate that participation in off-farm income-generating activities has a significant and positive effect on the likelihood of joining a cooperative. Specifically, non-agricultural income has a notable influence, with an odds ratio of 4.796, making households with such income nearly five times more likely to join dairy cooperatives ($p < 0.001$). These findings are supported by the research of Abebaw and Haile (2013) in Ethiopia, which also observed a positive relationship between non-agricultural income and cooperative membership. Furthermore, engagement in non-agricultural employment and other off-farm activities also contributes to the expansion of individuals' social networks and improves their access to information. As demonstrated by Ito, Bao, and Su (2016) in China, expanded social networks through non-agricultural activities positively influence the decision to join a cooperative. The social capital gained in this process enhances interest in membership and facilitates decision-making.

Remittances: Remittances have a significant and statistically validated impact on the likelihood of smallholder households joining dairy cooperatives, with an odds ratio of 3.646 ($p < 0.05$). This association indicates that households receiving remittances are nearly four times more likely to join a cooperative compared to those who do not receive such transfers. Mazzucato (2009) argues that these remittances substantially improve the economic situation of households, thereby facilitating their access to the resources necessary for cooperative membership. At the same time, Haas (2010) reinforces this observation by noting that remittances frequently bring new knowledge and perspectives, which stimulate both interest in and participation in cooperative structures.

Access to irrigation water: Our results indicate that access to irrigation water is positively associated with membership of agricultural cooperatives, with an odds ratio (odd-ratio) of 2.257, although this effect is only slightly outside the traditional significance threshold ($p < 0.10$). This relationship suggests that access to irrigation water has a substantial impact on the probability of farmers joining cooperatives.

The influence of irrigation on cooperative membership can be attributed to several key mechanisms. Firstly, irrigation significantly improves crop productivity, increasing average yields compared to rain-fed agriculture, as noted by Xie et al. (2014). This improvement in

productivity, as described by Hussain and Hanjra (2004), strengthens the economic situation of farmers, increasing their ability to integrate cooperatives. In line with these observations, Meinen-Dick et al. (2012) reveal that farmers with access to irrigation water are 2.3 times more likely to join a cooperative than those without.

Household assistance: The presence of household help in a household in our sample reveals a strongly positive and significant effect on membership of dairy cooperatives, with an odd-ratio of 4.511 ($p < 0.01$), quadrupling the chances of membership of dairy cooperatives. This relationship suggests that the availability of labor within the household reduces the dependency ratio and limits the need to recruit additional personnel for the management of livestock, particularly cattle.

This positive relationship between household size (number of household members) and the probability of joining a dairy cooperative was also observed in Ethiopia by Chagwiza et al. (2016). In addition, the variable representing labor input is positive and significant, indicating that households devoting more labor to production are more likely to join a cooperative, as demonstrated in China by Ma, W., and Abdulai, A. (2016).

Access to credit: In our sample, around 61% of cooperative members use credit, while over 77% of non-members have no access to these financial services. However, our statistical analysis reveals that access to credit does not exert a significant effect on cooperative membership ($p > 0.05$). This lack of significance may be attributed to risk aversion, which leads some farmers to avoid taking out loans. This reluctance to take out loans, even at the expense of potentially substantial sources of financing, is corroborated by the work of Bastiaensen and Marchetti (2007) on several Latin American countries. Their study shows that this debt-avoidance behavior can limit farmer membership of cooperatives, despite the financial advantages such memberships could offer.

Farmed land area: Overall, the estimation results reveal that better-off farmers are more likely to join cooperatives. In particular, the probability of joining a cooperative is significantly higher among landowners with large farms, as demonstrated by Abate et al. (2014) in Ethiopia and Ma, W., and Abdulai, A. (2016) in China. However, our results contradict this hypothesis. We observed a negative relationship between land size and the probability of cooperative membership. Indeed, a larger cultivated area reduces the odd-ratio to 0.416, indicating a significant decrease in membership odds of 59% ($p < 0.001$). These findings are supported by the work of Chagwiza et al. (2016) in Ethiopia. These results are confirmed by empirical evidence from research carried out by Verhofstadt, E., and Maertens, M. (2015) in Rwanda. They concluded that an additional hectare of land decreases the probability of joining a cooperative by 19%.

Visits from agricultural extension agents: Although extension visits show an apparent positive effect, our results reveal that they are not statistically significant ($p > 0.05$). Nevertheless, the empirical literature underscores the considerable impact of agricultural extension services on cooperative membership. These services significantly facilitate membership by acting on several dimensions: information, productivity, innovation and social cohesion. For example, Abate et al. (2014) observed a 25% increase in the probability of cooperative membership among Ethiopian farmers benefiting from regular visits by extension agents. This influence unfolds through various mechanisms, including raising awareness of the benefits of cooperatives (Mojo et al., 2017), improving technical skills and productivity (Ma and Abdulai, 2016), promoting innovative farming practices (Verhofstadt and Maertens, 2014), and strengthening social capital (Ragasa and Golan, 2014).

Table 9. Maximum likelihood estimates derived from the study model

Variables	Coefficients (B)	Standard error	Wald	Sig.	Exp (B)	95% confidence interval for Exp (B)	
						Lower	Upper
Intercept	-2.038	0.948	4.627	0.031**	0.130		
-TLU	0.739	0.094	61.899	0.000***	2.094	1.742	2.517
- dist collcent	-0.328	0.083	15.681	0.000***	0.720	0.612	.847
- nonagr inc	1.568	0.408	14.780	0.000***	4.796	2.157	10.665
- remitt	1.294	0.568	5.185	0.023**	3.646	1.197	11.100
- irrig water	0.814	0.447	3.309	0.069*	2.257	0.939	5.424
- hh assist	1.507	0.438	11.839	0.001***	4.511	1.912	10.641
- credit acc	-0.193	0.411	0.221	0.638 ^{NS}	0.824	0.368	1.846
-farmland area	-0.877	0.185	22.574	0.000***	0.416	0.290	0.597
-visit extagents	1.684	1.096	2.359	0.125 ^{NS}	5.387	0.628	46.197
• Number of observations			360				
• -2 Log-Likelihood			221.425				
• Cox and Snell R ²			0.517				
• Nagelkerke R ²			0.700				
• χ^2 (8 df)			262.321 (P : 0.000***)				
• Global Correct Classification Rate			88.1%				
The Hosmer-Lemeshow test yields a χ^2 value of 9.92 with 8 degrees of freedom and a p-value of 0.271, indicating a good fit of the model.							

Source: Authors' own calculations (2024).

Note: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$ and ^{NS} Non-significant.

4. Conclusion

The analysis of our results reveals a potentially beneficial effect of membership in dairy cooperatives on food insecurity resilience for smallholder farmers in the Souss Valley. This observation is primarily based on the finding of superior food security among cooperative members, as measured by the food consumption score in our study. Consequently, dairy cooperatives may be considered effective institutions for promoting improved living conditions, food security, and rural economic development in the valley.

Factors facilitating membership in dairy cooperatives among smallholder farmers in our sample include several key elements. Firstly, non-agricultural income is a critical factor, significantly enhancing the likelihood of joining a cooperative; households with such income are nearly five times more likely to become members. Additionally, migrant remittances also facilitate household integration into cooperatives by enhancing their financial capacity. Access to irrigation water, although close to the significance threshold, has a positive association with membership by improving crop productivity. The presence of household labor quadruples the chances of membership, thereby facilitating livestock management. Furthermore, cooperative members own on average four times more livestock than non-members, which is an important factor for joining these organizations.

Several factors limit membership in dairy cooperatives. Over 60% of smallholder farmers in our sample are not members of dairy cooperatives, partly due to the reluctance of cooperatives to expand their membership and the individual choices of households. Increased distance from milk collection centers significantly reduces the likelihood of joining, as it raises transportation costs and limits market access. Access to credit does not show a significant effect on membership, which may be attributed to risk aversion among farmers. Additionally,

contrary to some hypotheses, a larger area of cultivated land is negatively associated with cooperative membership. Finally, although extension visits show an apparent positive effect, they do not have statistical significance in our study. In conclusion, membership in dairy cooperatives is influenced by a multitude of socio-economic factors, which has considerable implications for smallholder farmers in the studied region.

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