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Efficiency analysis of the dairy value chain in Tunisia

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Abstract
Dairy value chain analysis is strategic considering its economic importance, social role, and degree of industrialization as well as the strong interrelationships between its various stakeholders. Despite all deployed efforts to promote the dairy value chain at regional level, there are still several difficulties mainly in sharing benefit and the lack of organisation of the different stakeholders. This article aims to emphasize dairy chain imperfections and its cost factors. It also proposes corrective actions and ways of adjusting the unbalance between stakeholders especially breeders. The data used in this study was collected from national surveys in four principal dairy regions in Tunisia and classified according to their size and organization status. The results obtained have showed that the benefits are still very low and that they are very variable depending on the actors and the different stages of the chain. As an implication of the research, it becomes necessary to establish short value chains that add value to local products with better quality at the level of small operators and throughout the territory.

Keywords: value chain (VC), costs analysis, dairy, stakeholders, Tunisia

Introduction

The livestock sector plays an important role in the country's economy by creating employment and contributing to food security (Vall *et al*., 2021) [16]. It also contributes to fixing farmers in the rural areas. This role is more important as livestock is held by small farms.

The dairy sector in Tunisia is also very important in terms of employment, with 112,100 farmers in 2019, generating more than 40% of agricultural jobs in the sector, to which must be added the jobs of the dairy industry and the jobs generated throughout the chain (Zlaoui *et al*., 2019) [17]. The sector also contributes to the country's food security and has an important role in spatial planning and natural resource management.

The main production regions are in the governorates of Bizerte, Jendouba, Béja, Sidi Bouzid and Mahdia (in total 60% of the national production). As in many countries in the arid region, milk production is seasonal, following changes in forage availability, with high production in spring and low production in summer and autumn. Most farms practicing livestock farming are small or family-run. Milk production has not grown to the extent of industrial processing capacity, which is the main reason of the industry disconnection from local production. In addition, feed prices rose by 210% in 2017, hampering dairy production among cattle farmers.

Another problem is the perishability of milk, which requires strict hygienic conditions to preserve and transport to avoid any bacterial contamination that would be harmful to consumer health. The profitability of investing in this sector is often in question because of high operating costs and unsatisfactory sales prices (Msaddak *et al*., 2020) [12].

Moreover, milk producers and professionals in the dairy industry have reported enormous difficulties in marketing milk because of the reduced capacity of collection centers, lack of coordination at the processing center, as well as difficulty managing excess milk during peak production periods.

There is a lack of contracting between the different stakeholders in the value chain (VC) especially between collection centers and producers. The informal nature of this relationship is perceived as a constraint for the general organization of the sector. In addition, subsidies are allocated on the basis of volume, regardless of quality, even as collection centers are urged to play a central role in improving the quality of milk. Laws governing property rights, contracts, and even informal norms differentiate in transactions between stakeholders in both cost and quality. Thus, informal rules based on trust and reciprocity override any potential gain of using formal rules such as contracts.

In the dairy VC, cooperation and coordination are important issues in maintaining the sustainability of dairy production. The sector's activity has broken down due to the large number of stakeholders involved in producing milk on a farm: farmers, collection centers, large private producers, service unions, intermediaries, etc... In Tunisia, some studies in the literature dealing with dairy value chain have attempted to analysis the Social Networks of the dairy Sector, the contractural arrangements and trust among dairy value-chain actors (Ben Sassi

and Soussi., 2015 [3]; Salah *et al*., 2016 [15]; Boudiche., 2015 [4]; louhichi., 2017 [10], Zlaoui *et al*., 2019 [17]; Ayari and Zaibet., 2019 [1]; Ayari and Boulila., 2022 [2]. However, to our knowledge, no studies evaluated the levels of costs and incomes of various actors in the dairy value chain.

The aim of this paper is to analyse the dariy VC and map the pattern of value added distribution along the chain. This information on distribution of value added over various actors is useful to identify the ineffectiveness along the chain with a view to correcting the imperfections by beneficial solutions for the various actors of the dairy sector. The purpose of this study is to identify the socioeconomic determinants of these inequalities such as food security policies focused on the intensification of the production and the subsidies in Tunisia or the management choices (price liberalisation, and deficiencies at professional organization, among others). Finally, we try to propose alternative strategies to guarantee a sustainable development of the dairy value chain based on innovation and the support of local products for a territorial development in Tunisia.

1. Theoretical framework

A thorough understanding of the food system (structures and operation) requires pragmatic methods: network and VC approaches. The VC concept was introduced by Porter (1985) who established links between the issue of development and the growth of business performance. This performance is strongly influenced by the particular business environment in which they operate. The VC is defined as a linear succession of independent operations and transfers of the product from an actor to another where at the level of every link, a value will be added (Kinha *et al*., 2009) [7]. It divides the sector into strategically relevant activities to understand the breakdown of costs and margins and identify value-creating activities.

The concept of added value is central in this approach. It is defined as the difference between the non-labour costs incurred to produce and deliver a food product and the maximum price the consumer is willing to pay for it. It can be added to an intermediate agri-food product not only by processing it, but also by storing it (value increasing over time) and transporting it (value increasing over space).

The objectives of the VC analysis are to explain inefficiencies along the chain, to identify factors that add costs and to correct market imperfections and imbalances through cost-effective solutions.

2. Methodology of value chain analysis

The methodology used for the analysis of the dairy VC is based on the FAO's approach. It is articulated in three phases: (i) the presentation of the sector and the typology of the actors, mapping of the main actors and understanding the strategies of each one of them. ii) the accounting analysis, based on a survey addressed to a representative sample of the different actors in the chain, which allows to bring a breakdown of costs, prices and margins throughout the VC and along the various phases of production (agricultural production transformation and marketing) and for the main dairy products such as milk UHT, yogurts and cheese. iii) The analysis of the organization of the sector which will allow us to understand the relations between actors and the rules that govern these relationships (Niven, 2013; FAO, 2016) [13].

At first, the mapping of the VC will be drawn to give a global view of the chain. Then, the focus will be put on the main actors in this chain and on their functions. Finally, the analysis involves the estimation of the various effects of the operations of the chain and the relations of power preventing a fair distribution of the margins between them.

The analysis of the VC includes two stages and various dimensions to be handled in each of the stages.

Stage 1: Mapping of the chain

The objective is to draw up a schematic representation of the chain allowing to obtain an overview of the actors and their functions and the flow of products along the chain. A map of the VC illustrates the way the product takes place from the raw material to the final markets and indicates how the sector works. "To map" means drawing a preliminary visual presentation of the structure of the VC and revealing its main characteristics (Niven, 2013) [13].

Stage 2: Diagnosis of the value chain

The objective of this section is to analysis the economic performance of the dairy VC through an accounting analysis based on production costs, margins, linkages, sustainable production and consumption, VC finance and the business environment. This implies examining the constraints and the existing possibilities relative to the development of this chain.

The production cost is defined by the total expenses incurred to produce a unit of a given product, which consists in this case in calculating the cost of production of a litter of milk. These costs mainly relate to labour costs, land, barn, equipment, heifers, feeding, veterinary fees and other miscellaneous expenses.

Since dairy farming is an activity that produces several products, milk is considered as the main production and the others (veal and manure) are considered as by-products. The value of the by-products must be subtracted from the total charges.

The method used to calculate the production cost of a litter of milk is presented as follows:

$$CP = (CT - VBP)/N$$

With,
CP: Production cost of the main product (milk) (Tunisian Dinars)
CT: Total Costs of milk = Fixe costs + variable costs (Tunisian Dinars)
VBP: Value of by-products (Tunisian Dinars)
N: Production level (Litters)

- **Fixed costs (CF):** or called structural costs are related to long-term decisions. They include tenant farming, building maintenance, equipment maintenance, permanent labour, veterinary fees, insurance, water, electricity and depreciation.
- **Variable costs (CV):** termed operational costs, are linked to short-term decisions and are therefore reversible. They correspond to the use of the existing capacity. They consist of input supplies for the production of fodder (mechanization, occasional labour, water, seeds, fertilizers, treatment products, transport, etc.), food for livestock feed (concentrated, bran, cereals, straw, hay, alfalfa cork, bread, etc.).
- **The value of the by-products:** corresponds to the value of the calf at birth but not the manure. Considering the calculation of the cost of production of a litter of milk and the level of milk production, it is advisable to calculate the annual costs of the dairy activity, the gross income and the net income of this activity on the farm.

Production Cost of milk = Production cost of a litter of milk ×Quantity of milk produced /year
Income from dairy activity = (Milk production - Quantity of milk given to the calf)× Sale price of a litter of milk to the peddler
Gross Margin=Income-Cost of Milk Production
Net Margin= Gross Margin- Amortization

Stage 3: Governance analysis
Cost's study is completed by the governance analysis through of the examination of interrelationships between the various actors in the dairy VC. The governance structure describes the process by which some actors exercise control over other participants and how they appropriate or distribute the value created along the CV. In the case of diary VC, the aim of this step is to identify the sources of losses in each actor of the VC. These losses will be translated afterward in the form of economic, social or environmental impact (Niven D., 2013). The resolution of these problems should be the origin of employment, the creation of income, the development of companies, economic growth or environmental sustainability.

3. Data collection
Primary data and information on dairy sector were collected from the annual national surveys conducted by the inter professional group of red meats and milk of Tunisia (GIVLAIT) and the agricultural ministry. To complete the data required for VC analysis, three surveys on agricultural level, collect centres and Transformer plants were realised with collaboration of investigators from research institutes (INAT, ESIAT). These surveys were carried out over 2 years, from 2018-2019 on actors of dairy products from farmers to distributor channels in aim to provide information on costs, benefits and quantities of milk.
The study area is the region of Bizerte which constitutes one of the main zones of milk production in Tunisia (13 % of the total production) (GIVLAIT, 2019). The data concerning government subsidies were completed by interviewing actors involved in Agricultural ministry with GIVLAIT. Farmers' survey concerns 300 breeders selected by the direction of agricultural development of Bizerte (CRDA) to reflect better the real distribution following the size of breeders, surfaces, the mode of conduct and the juridical status (private or public exploitations). Due to their limited number, all the collecting centres (27) and all the transform plants (15) are included in the survey elaborated for both actors.
Surveys were made from April 2018 to November 2019. The socio-economic survey for breeders involves four main aspects i) Description of the profile of the producer, size of exploitation iii) economic data of production (prices and costs of the factors of production and iv) destination of the sale of the milk. The survey for collection centres focuses on costs of transports, cooling, quality analysis. The survey for dairy pants involves different parts i) Production capacity, quantities transformed by product, the purchase prices, and the costs of production, ii) Supply: quantities and price (iii) Marketing: organization, sale price and subsidies, distribution costs, strategies and general politics.

Results and Discussion
1. Mapping of value chain: case of the Bizerte region
Despite the abundance of natural resources and the large number of dairy breeders, the dairy VC development in the region of Bizerte (Tunisia) remains limited. This northern agricultural region makes up 25% of the country's farm land area. The soil is fertile and rainfall is generally adequate. Forage crops are often planted on both irrigated and natural rain-fed farms. Even though conditions are favourable, average annual production is as low as 2574 litters / animal / lactation against an average of 8000 litters in some European countries such as France and Holland.

The secondary data from the local representatives of the regional office of agricultural development of Bizerte attached to Ministry of agriculture and the primary data collected from the different actor's surveys enable us to analyse the milk VC in the governorate of Bizerte.
The VC map (figure 1) illustrates how the product moves from raw material to end markets and how the sector operates. It is therefore essential to define the various parameters that are useful for understanding the latter.

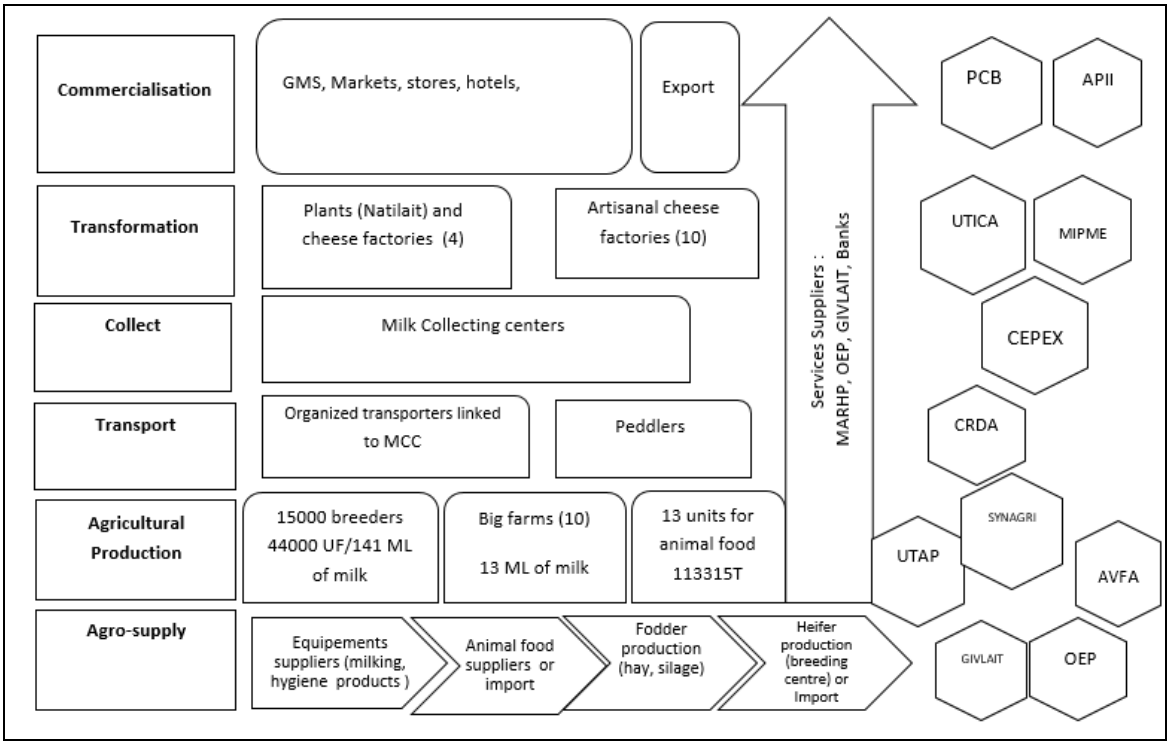

Fig 1: Map of the milk VC in the governorate of Bizerte

According to this map, five contractual arrangements are identified for commercial Interactions:
Breeder – Peddler; Transporter - collection center; Transporter-artisanal processors (type creamery); Collection Center - Central Dairy; Informal tour: peddlers-creameries, breeders-creameries.
Concerning services, in our case, the services mainly concern input suppliers (cattle feed, fodder seeds, phytosanitary products), institutions under the supervision of the Ministry of Agriculture (Regional Commissariat for Agricultural Development (CRDA) and the regional directorate of the Breeding Office (DROEP), which have a role in controlling the sector and supporting producers.

1. At the Micro level

a. Input suppliers are mainly

- **Veterinary service providers:** In the governorate of Bizerte, there are 55 veterinaries installed for their own account and who work in perfect synergy with the Veterinary Services of the the ministry of agriculture.
- **Equipment suppliers:** These are the sellers of milking equipment such as tanks and other equipment needed for milking activities.
- **The suppliers of heifers:** The breeders get their supplies from the private vendors or from the services of the ministry of agriculture.
- Livestock feed suppliers: These actors directly influence the cost of milk production as prices fluctuate, which are directly related to the behavior of intermediaries rather than the law of supply and demand. Indeed, the absence of a clear regulation governing this input combined with a forage deficit in drought periods opens the door for speculation on prices.

b. **Collection centers:** The collection centers are 32 in number. They are formed by 2 cooperatives, 23 private enterprises and 7 private collection centers. The large number of stakeholders involved in the disposal of milk produced on the farm (collection centers, large private or state producers, service cooperatives, peddlers, etc.) has led to a malfunction in the industry's activity and affects the quality of milk. This situation provoked the intervention of the State which subordinated the milk collection premium to specifications and submitted the hawkers to a health certification guaranteeing the quality of the milk collected.

c. **Transformers:** The main dairy plant Natilait created in 2014 and Delice industry since 2011 are the major destinations for fresh milk in the strategy of enlargement of these plants in the country. The main activities

are sterilization of UHT milk in addition to the transformation into yogurt and cheese. As far as the valorization of milk in by-products is concerned, the region of Bizerte counts 14 cheese factories with 10 artisanal ones of which the most known are: SOTULAIFROM (Mateur), NECHMA (Rasjebal), BOUCHIBA (Utique) & ALOUCHE (El Azib).

The increase in the demand for fresh milk for the industrial transformations relies on the persistence of the shortage of milk which is influenced by the strong presence of the informal sector (self-consumption and artisanal producers and other forms of distribution).

d. Distributors: The distribution is carried out by supermarkets with a network of groceries and dairies that remain artisanal and atomized with all the problems in the cold chain.

2. At the Meso Level

Meso-level support organizations may include public and private advisory bodies or financial providers whose aim is to improve access of all the various players to innovations and services as well as to ensure sustainability. This approach is called the "central enterprise approach" because it mainly supports commercial relations between local businesses and farms and selected companies, most of them cross-border. However, there are many mixed forms, which combine these two approaches.

At the meso level, there are different organizations and institutions that collaborate with micro level actors who support them or offer services to them in other forms. Professional organizations, which act as coordinating bodies for dairy VC actors, are the Department of Animal Husbandry and Pastureland (OEP), the Inter-professional Group for Red Meat and Milk (GIVLait), the Tunisian Union of Agriculture and Fisheries (UTAP), the Union of Tunisian Farmers (SYNAGRI) and the Tunisian Union of Trade and Industry (UTICA). These structures involved in support services are, for the most part, state-owned. Their main role is to support smallholder farmers and build technical capacity, support organization of the sector, in particular collection and regulation of certain centres and finally promote research and development to study milk quality.

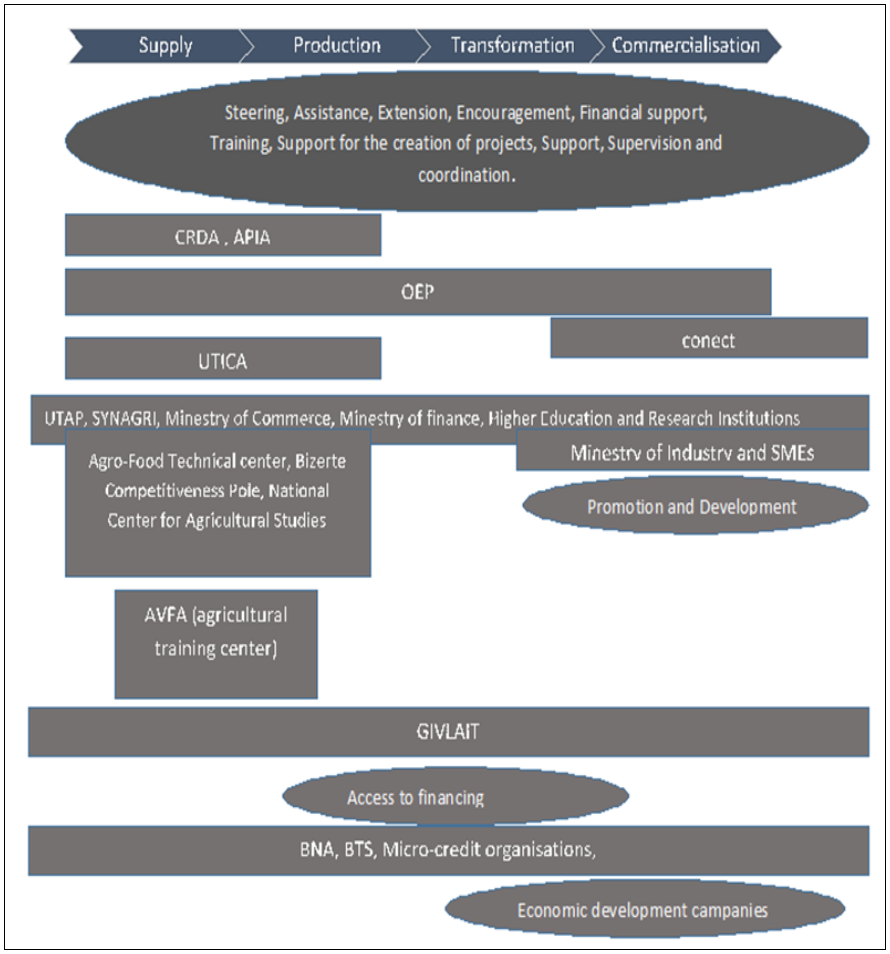

Fig 2: Meso-level maps of the dairy VC in Bizerte

Mapping the sector flows is just as important as the actions proposed above. Indeed, highlighting those flows will make it possible for decision-makers to better stimulate intervention through links in the chain as well as to plan strategically at the governorate level, or the master plan. This analysis should also assess the profitability at each level of the chain and outline opportunities for development and integration through a spatial analysis of the chain.

3. At the Macro level

At the macro level, since 1962 the state has put into place strategies, which have enabled Tunisia to achieve self-sufficiency in milk as from 1999. This dairy policy adopted in the 1960s and 1970s has encountered a number of difficulties (Ministry of Agriculture, 2004) such as:

- Herders' lack of technical skills in herd management, feeding, reproductive management and animal health;
- Lack of supervision to be able to apply the strategies;
- Lack of organization of milk collection chains;
- Prices imposed on breeders by collectors.

This policy has resulted in stagnated production while, at the same time, consumption of dairy products continues to increase due to urbanization, an improved standard of living, greater purchasing power and subsidized consumer goods (Khaldi *et al*., 2004).

2. Results of the accounting method of the milk and derivatives value chain analysis in the region of Bizerte

The analysis of production costs in the dairy VC carried out by GIVLAIT shows that for the integrated system of Bizerte region, the cost of production varies between a minimum of 1.101 and a maximum of 1.241 d / l to be an average of 1.160 dinar / litter. This work, in collaboration with various agronomic research institutions in Tunisia (the Tunisian National Agronomic Institute, INAT and the Higher School of Food Industries of Tunis, ESIAT), is done on a representative sample of small, medium and large farms (ranging from 2 to 600 cows) showing that feeding is usually the largest load, about 60% of the total. These expenses are distributed as follows:

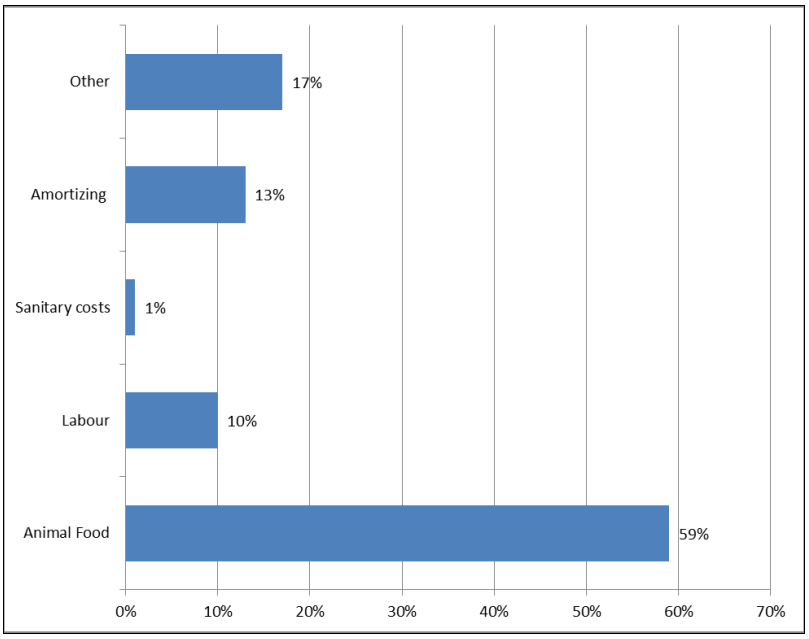

Fig 3: Distribution of production costs

According to existing data and indicators, the price of livestock feed is the essential cost component, particularly the prices of the mainly imported high coarse grain feed which have negatively affected the profitability of this important sector and forced a number of breeders to abandon this activity. According to farms and the profession, it is necessary and urgent to revise the selling price of milk at production level, which could affect the final price, subsided to consumers. According to the Tunisian Union of Agriculture and Fisheries (UTAP), the cost of production is very high for small farmers (80% of producers of milk). Indeed, the average cost of a litter of milk is about 1.140 TD. This value is a result of our calculations based on the values of the cost of Greenery and / or silage and Dry forage quantity respectively equal to 13.5 and 9.8 DT/KG/t, feeding and total animal cost of about 5807 dt/cow and this for an average of 4739 litter/ animal (GIVLAIT and UTAP, 2021).

1. Production cost analyses

At the production level, there are two types of farms: Family-type farms (-5 female units) in integrated production systems and the big farmers generally composed by public exploitation with more than 300 female units. The analysis showed that the small private farms perform better than those belonging to the big public production system called "*agrocombinat*" with higher costs (1.265 DT/L) (table 1). This result seems to be opposite to the expected efficiency for the large-scale production in terms of unitary cost according to (Darej *et al*., 2017). The social charges linked to this public system explain the low productivity that remains low even if it is positive and does not guarantee its sustainably.

Table 1: Cost at the level of small and big farms (1 liter of fresh milk)

	Average cost	Min	Max	Selling price	Margin
Integrated system	1.205	1.101	1.241	1.140	-0.065
Large farms	1.265	1.145	1.303	1.140	-0.125
formal circuit	1.204	1.160	1.220	1.180	-0.024
Informal circuit	1.187	1.145	1.215	1.180	-0.007
Small CCL (<10000l/day)	1.272	1.240	1.290	1.190	-0.082
CCL 15000l/day	1.296	1.278	1.318	1.195	-0.101
Packaged semi-skimmed milk	1.702	1.694	1.742	1.319	-0.383

Source: Our calculations from the survey

At the level of transport, two types of circuits are identified: the primary circuit composed of formal transports from the collecting centres and the informal transports, which in various cases do not have agreements from the Ministry of Health. In both cases, the transport level is the level that represents the least loss compared to the other stages.

According to table 2, collecting centers costs are higher than the average selling price. Negative margins are observed either for big centers or for small centers indeed with the fixed minimum guaranteed selling price. Table 4 showed a negative margin (a loss of 0,082 to 0,101 TD/ litter) for this actor despite its importance as an intermediary acting between farmers, the industry and those who are most responsible for the quality of milk received by transformation plants.

The higher level of demand of consumer is for milk after transformation (pasteurization), at this level, results show a loss of 93 to 158 millimes/liter as an average for industrial firms in the country. This negative margin can be more significant in the low lactation period (autumn and winter) due to the regression of farms production and the arise of buying costs (GIVLAIT, 2017).

Considering the different stages for producing drinking milk, a synthesis of the accounting method to analyze the breakdown of margins between actor is presented (table3). Results show that it is only at the stage of distribution that actors obtain positive added value. However all the previous actors had losses which could reach (-0,062 TD/L) at level of breeders (-0,399 TD/L) for industry and (-0,091 TD/L) for collecting centers.

Table 2: Synthesis of the accounting results for 1 liter oh UHT milk

Actor	Breeder	Transporter	Collection	Industry	Wholesaler	Retailer
Price (DT)	**1.140**	**1.180**	**1.195**	**1319**	**1326**	**1,350**
Margin (mil/l)	**[-163, +39]**	**[-7, -24]**	**[-82, -101]**	**[-375, -423]**	**[+7]**	**[+24]**
Costs	Labor Land Equipment Heifers Food Veterinary Fees Other Expenses	Vehicle Can Tank Fuel Repair Driver	Buildings Tank Equipment Truck Electricity Labor Analyzes Other	Buildings Machinery Packaging Electricity Marketing Labor Analyzes Other	Store Storage Labor Publicity VAT Other	Consumer pays all the added costs

3. Value chain analysis for Yoghurt and cheese

The same calculation for yoghurt showed that margins are also lower for breeders, transporters, collecting centers. However, for industry and distribution, margins are positive and higher than the drinking milk chain. This advantageous situation could be explained by the liberalization of the yoghurt prices (from 0.350DT/unit to 0.600 DT/unit) depending on quality and differentiation.

For the analysis of the cheese VC with the accounting method, we choose the processed ricotta as a common product for consumers. Results showed that positive margins at the several levels were higher for distribution and plants (Table 3). In the region of Bizerte, we choose the local Edam cheese and white cheese (table 3) as two typical products for this rural zone. The aim is to analyze the difference with the common products. Results showed a higher value for all actors comparatively with drinking milk, yoghurts and cheese.

Table 3: Analysis of Artisanal processed Edam and white Cheese's value chain of Bizerte

Actor	Breeder			Industrial			Distribution (consumer)		
	Edam Cheese	White Cheese	Ricotta	Edam Cheese	White Cheese	Ricotta	Edam Cheese	White Cheese	Ricotta
Sale price (TD)	1.300	1.300	1.300	22.500	20.500	6.500	28.000	25.000	7.500
Costs (TD)	1.205	1.205	1.205	18.650	17.120	5.725	21.300	21.200	6.250
Margins (TD)	+0,095	+0,095	+0.095	+3.850	+3.380	+0.775	+6.700	+3.800	+1.250

Conclusions

Dairy activity constitutes an opportunity for creating employment in rural regions in Tunisia (Farmers, transporter, veterinarian, inseminators, agrifood producers, etc.). However, the economic and social impact of this value chain is lower than expected due to the imbalance margins between actors in favour of distributers.

This paper analysed the dairy chain imperfections and its cost factors in Bizerte region of Tunisia. It also proposed corrective actions and ways of adjusting the unbalance between stakeholders especially breeders. The obtained results showed that added value are still very low and its benefits are unequal among actors. Therefore, it is necessary to establish short value chains valorising local products with higher quality at small operators' level and throughout the territory.

Despite the periodic review of the sale price of milk to the consumer, the price imposed by the state does not cover the costs of the different levels in the value chain (collectors, dairy plants, distributors). The state intervention therefore reduces the margin and minimizes investment opportunities in the sector because of the setting of prices at the level of production and consumption. To develop performance in the dairy value chain in Tunisia, several strategic measures should be adopted

- Introducing organization to the sector through contracts, breeding laws, organizing collectors, and so forth.
- Creating small to medium-sized milk processing units for the production of traditional dairy derivatives (cheese, lben, Smen, etc.) these could provide benefit by improving producer income (by buying a liter of milk at a more attractive price).
- Extending the milk collection network.
- Promoting high lactation by making a regulatory stock of drinking milk and creating a milk-drying unit.
- Managing herders more closely and expanding health coverage of herds.
- Orienting efforts to improve productivity and quality.
- Updating the price of milk to match production costs. Despite these recommendations and incentives by the State to promote the dairy sector, several problems have persisted which have led to dysfunction in the dairy value chain.

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