

TYPOLOGICAL ASSESSMENT OF DAIRY FARMS SYSTEMS IN SEMI-ARID MEDITERRANEAN REGION OF WESTERN ALGERIA

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Abstract: The present study aimed to characterize the dairy cattle farming systems in semi arid region in western Algeria. A typology of the farms was established following the description of livestock dairy farming practices and the assessment of their contribution to farm efficiency. The enquiry was conducted on 60 dairy farms during 2018-2019 agricultural campaign to determine structural, technical and economic parameters. The Results show a large diversity of farmer's strategies, particularly in feeding and economic indicators. The statistical analysis has identified 3 groups of farms. The first group contains 12 farms produce average milk yield about 4120 kg and promote use of forages. The participation of concentrates in total dry matter ingestion (DMI) is about 45.3 %, the average costs of milk production is of 37.1 DA/ liter \approx 0.52 € and charge of food in total production costs in the order of 62.8 %. 32 dairy farms of second group are characterized by average milk yields 3240 kg and the contribution of concentrated foods represents 49.2 % of total DMI. The cost of liter of milk is about 42.7 DA \approx 0.60 € and food costs in order of 68.7 % of total production costs. The third group contains 16 dairy farms whose illustrates farms with a significant contribution of concentrates in the global feed balance (54.3 % of total DMI). These concentrated foods were poorly converted into milk as recorded yields are the lowest (2010 kg). Production costs of liter milk and the percentage price of food in total cost production were respectively highest (49.4 DA \approx 0.69 €) and (80.2 %). The results of this typology indicate the diversity of dairy farms systems in semi-arid region in North Africa, which must be taken to ensure the profitability and sustainability of farms identified. The socio-economic factors are behind the genesis of sample farms, the technical feeding and rationing and no diversification of forage calendar make clear the variations in groups of dairy husbandry. To guarantee sustainability development of typological groups, a specific measure,

particularly in feeding management, will be applied for different livestock systems identified.

Key words: typology, livestock cattle, technical parameter, production costs, semi arid land.

Introduction

The dairy livestock policy in Algeria depends on a systematic knowledge of livestock systems, identifying the weak links in its technical-economic efficiency and finding compromises in terms of public aid to the different actors of the livestock sector of milk supply chain to improve its output. The milk sector is currently in a critical phase, with insufficient local production, aggravated by a very low collection rate and increase in prices of livestock inputs in international markets. Consequently, several actions are being taken by the public authorities to reduce this deficit and the latest one is a "national program for the rehabilitation of milk production" (*Cherfaoui et al 2003*). According to *Kacimi (2013)* and *Merdaci et al. (2018)*, consumption model of milk, is estimated at 147 liters/capita/year, which ranks Algeria as a country of major consumption of milk when compared to Maghreb state (Tunisia 83 liters, Morocco 64 liters). The programs to intensify milk production have not achieved the expected objectives (*Ghozlane et al., 2010*). Today, with a herd estimated at 1.9 million heads of cattle, including nearly one million dairy cows, domestic increasing demand for milk is not yet satisfied (*Kaouche et al., 2015*). The strategies applied to imports milk powder to fill the gap; were a major constraint on the development of local production. Through analyze of the Algerian milk sector (*Djermoun (2011)* and *Brabez (2012)*) indicate a weakness of the production and the insufficiency of collection which explain the very low rate of integration compared to the transformation system. According to *Benyoucef (2005)*, the main environmental factors that hinder the development of the dairy sector are socio-economic, agro climatic, sanitary, which constitute constraints to the development of animal productions, and organizational, related to livestock systems that are mostly extensive. The dairy farming systems remains a kind of speculation that is difficult to manage given the diversity of parameters that are linked to it. Very few aspects of dairy farming systems have been studied in semi arid region in western Algeria with an overview approach, as systemic studies were applied successfully to assess animal productions projects in other regions of developing and underdeveloped countries (*Landais, 1983; Srairi, 2003*). In addition, *Roeleveld and Van den Broek (1996)* emphasized the important role for livestock performances diagnosis, as a preliminary step to any promoting project, especially in underdeveloped countries. *Girard et al.,(2001)* and *Sairi (2003)* indicate that systemic approach based on husbandry practices can also be an

efficient way to examine the relations of farms to space utilization and time, which could be of significant interest for understanding farms evolution.

The present article aims to analyze dairy farms systems through a typological characterization of the producers involved in milk production, investigation of different practices and strategies in place to manage the units surveyed and finally, detection of constraints and potentialities of current systems. In context of very limited references on dairy farms in semi-arid Mediterranean region of western Algeria, typological characterization would be a practical tool for more development effort in the dairy cattle systems at the Mediterranean regional scale, as it would allow the implementation of adapted measures to targeted groups of farmers.

Materials and Methods

The study area is located in the center of Mascara town, limited in the North by the mountains of Béni-Chougrane, in South by the mountains of Saïda; in west by the mountains of Bou-Hanifia and in East by the Tighennif plateau. It covers 12 municipalities, with a total area of 1401 Km² (27.3 % of the total area of Mascara) and a density of population of 181 habitants / km². It receives on average 450 mm / year with semi arid climate. The total number of farms is around of 11624 divided into 3 categories of status. The distribution of farms shows the dominance of private farms in number 8165 farms which represents 70 %, with an area of 45568 ha, but the collective farms (EAC) accounted for 16 %, with an area of 38157 ha, in number 1890 collective farms. As well as EAI (individual farms) number of 1569 exploitation, represent 14%, with an area of 5217 ha. The Province of Mascara is one of the west regions that has benefited from a large financial envelope of the development program of the dairy cattle sector. These effects remain poorly evaluated. Indeed, no study has been conducted to determine the situation of dairy cattle breeding in relation to the practices of the farmers.

Data collection and statistical analysis

A benchmark survey of dairy cattle breeders was conducted during 2018-2019 agricultural campaign. The overall sample of our study consists of 60 randomly selected cattle farms out of a total of 1011 dairy cattle farms with 6722 cows that have a sanitary approval issued by the veterinary services of Agricultural Direction. All breeders were interviewed and their flock performances were followed-up. The data collected during the monitoring of farms surveyed treat the structural (surface, herds, agricultural surface, and equipment), management (feeding resource) and technical economic indicators. The estimation of rations was based on the quantities of forages and concentrates in the ration distributed to

the dairy cows. Nutrient intakes were determined according to data given by INRA (2007). A typology of cattle dairy farming systems was identified from collected data, the statistical analyzes of data were performed using the Statistica 8.0 software (2008). A total of 10 quantitative parameters were identified to describe dairy farms and their activities (table 1).

The observations were divided into three main parts. The first one covered cattle farms structural parameters (herd, agricultural surface, equipment), while the second dealt with dairy cattle feeding and cows' management. The third part investigated into economic results of dairy herds, after the analysis of total inputs and global animal sales (milk, cattle and manure). A principal component analysis (PCA) was used to detect the most important variables characterizing farms sample. A typology made of 3 groups was finally retained to synthesize the global diversity of dairy farming in this region, assuming that sample gives an acceptable representation of the 1011 cattle farms in the region.

Table 1. Parameters used to describe sample dairy farms

Variables	Abbreviation
Surface Arable Land use	ARL
Forage Land (ha)	FOL
Number of Cows	NCW
Average production (kg milk per cow per year)	APM
Energy from concentrates /kg of milk (UFL)	UFL c/kg milk
Forage units milk concentrates per cow	UFL c/cow
Share of concentrates in total ration (% total DMI)	SCR
Food cost total inputs	FCT
Production Cost of 1 liter of milk (DA)	PCM
Benefit per cow (DA)	BC

Results and discussion

Dairy farm characteristics

The parameters that characterize the dairy farms are illustrated in table 2. Surveyed dairy farms are characterized by an average land use of 11.6 ± 39.4 ha per farm. Because of variability in structural parameters between sampled farms (from 0.5 ha to 35 ha), standard deviation (39.4 ha) was superior to mean value for this parameter. More than 65 % of farmers use their entire useful agricultural land for forage crops, mainly dry forages such as oats and barley and alfalfa. The study included a total of 312 heads of dairy cows with an average of 10.4 ± 0.65 cows per farm and an average density of 3.2 cows/ha of forage. As for arable land, there was variability in cattle number per farm due to the selection of structural parameters in our sample of different types of dairy farms. Genetic structure was dominated by

imported breeds (Frisonne Pie noir 94 percent of total cattle and Montbeliarde 6 percent). Mean milk yield per cow was 3400 ± 1250 kg. The analysis of cattle feeding showed that forage represented 51.6 ± 48.3 percent of the energy ingested by cows. The base feed consists essentially of oat hay and straw and the practice of silage is absent. Grazing is practiced on natural grass lands and in cereal fallow after the harvest.

Concentrates are represented by industrial compound feed specially made for dairy cows. They are distributed in various quantities for all farms, from 5.5 to 10 kg per cow per day. Feed costs were up to an average of 85 percent of total inputs. This important use of concentrates often resulted in their abuse, as they contributed to maintenance requirements, in a situation when forages were absent and with frequent unbalanced rations. Economic results of the dairy farms were characterized by wide variations, from positive to deficit. When average profitability generated by one cow was 25.850 DA (approximately 185 Euros), it fluctuated from -55.800 to 163.200 DA.

Table 2. Characteristics of sample dairy farms

Parameters	Min	Average \pm SD	Max
ARL (ha)	0.5	11.6 ± 39.4	35
FOL (ha)	0.25	7.3 ± 1.34	14
NCW	4	10.4 ± 0.65	27
APM	2070	3400 ± 1250	5950
SCR (%)	9.5	51.6 ± 48.3	81
UFLc/kg milk	0.38	0.51	0.60
UFLc Kg/cow	5	6.5	9.5
FCT	47.5	$85.0 \pm 20,7$	100
PCM (DA)	36	44.6 ± 6.3	46
BC (DA)	-55.800	25.850	163.200
1 DA	=0.14 €		

Typology of farms according to their characteristics

The purpose of the multivariate statistical analysis is to identify the groups of dairy farms that are technically identical and to create homogenous groups of sample surveyed in relation to predominant variables. Results of PCA showed that 3 axis accounted for 52.4 percent of total variation in the farms sample (table 3).

Table 3. Results of PCA and axis of variation determined

Axis	Variables	Correlation r to axis	Total variability (%)
Axis 1	- ARL	0.72	26.7
	- NCW	0.78	
	- FOL	0.55	
Axis 2	- UFLcc/cow	-0.58	16.1
	- UFLcc/kg milk	-0.61	
	- SCR	-0.59	
Axis 3	- APM	0.32	9,6
	- BC (DA)	- 0.40	
	- PCM (DA)	- 0.65	
	- FCT (DA)	- 0,41	

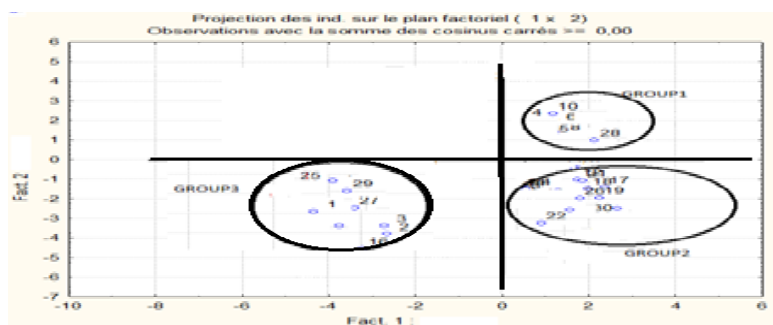
The correlation between chosen variables and the most important factors indicates that the variables are agricultural use land, number of cows and average milk production (structure parameters); the forage units milk concentrates per cow, forage units milk concentrates per kg of milk and forage / concentrates in energy balance (variables related to food strategy); benefit per cow, production cost of liter of milk and food cost total inputs (variables related to management settings of milk production and the production economics). The first axis accounts for 26.7 % of the total variation and is positively correlated to the variables ARL ($r = 0.72$), NCW ($r = 0.78$) and to FOL ($r = 0.55$). This axis differentiates between groups with important structural parameter and farmer's managed use agricultural land for crops with opposite characteristics. The second axis accounts for 16.1 % of the total variation and is negatively correlated to the variable UFLc/cow ($r = - 0.58$), UFLc/kg milk ($r = - 0.61$) and SCR ($r = - 0, 59$). This axis provides information on the possibilities of valorizing the energy resources of concentrated foods for dairy production and the ratio of energy use of forage/concentrates.

Farming systems are usually defined through the interactions of breeders, herds and environmental conditions and resources (*Lhoste, 1984; Srairi, 2003*). The multivariate analysis conducted in this study showed that variables reflecting breeding practices, feeding strategies and cattle sales, were predominant. The characteristics of three typological groups are presented in Table 4 and Figure 1.

Table 4. Characteristics of groups identified

Groups Parameters	1	2	3	Average
N.of farms	12	32	16	60
ARL (ha)	20,4	8,6	2,2	11,6
FOL (ha)	12,2	4,3	1,25	7,3
NCW	16,3	10,1	6,2	10,4
APM (kg)	4120	3240	2010	3400
SCR	45.3	49.2	54.3	51,6
UFLcc/kg milk	0.34	0.45	0.56	0.51
UFLcc/cow	5.5	7,6	9,7	6,5
FCT (%)	62.8	68.7	80.2	85,0
PCM (DA)	37.1	42.7	49.4	44.6
BC (DA)	121.300 ^a	85.100 ^b	-10.700 ^c	25.850
Significance				

a, b, c Groups without common superscript differ significantly (P<0.005).

**Figure1. Graphical representation of farmers groups**

The first typology group, contains 12 farms, which favors forages compared to concentrates in the energy balance of their flock (45.3 percent of forage/concentrates in energy balance). Food cost total inputs are minimal (62.8 percent of total inputs), due to the low cost of forage production. The benefit per cow is positive (121.300 DA), as milk yield per cow is higher than the average (4120 compared to 3400 kg). The production cost of milk is 37.1 DA. This is a group of breeders that characterizes the start of specialization in the field of dairy bovine milk production. This is the group of farms considered as privileged group in milk production with a good feed management to cover the needs of the animals. The second group is represented with 32 farms, "medium farms characterized by milk yields below average (3240 kg). Concentrates in the energy balance represent just 49.2 % of DMI. These concentrates were poorly converted into milk as yields were recorded under average of farms simple. This group of farms records intermediary average production costs (42.7 DA/liter of milk) and food cost total inputs (68.7 %). The benefit per cow is positive (85.100 DA).

The 3rd group containing 16 farms, "small's farms", whose main characteristics are low average yield (2010 kg) and the elevated cost of production (49.4 DA/liter). A significant concentrates contribution in the global energy balance (80.2 % of DMI). These concentrates were poorly converted into milk as yields were recorded as the lowest and the benefit per cow is negative (- 10.700 DA). The results of this study confirm the importance of the effect of diet on the diversity of farming systems in the study area.

Discussion

In a context of absent references on dairy practices and economic indicator in interior region of western Algeria, this investigation of 60 dairy livestock farms in semi-arid Mediterranean region, has confirmed a large diversity of groups dairy farming. It can be explained mainly by strategies adopted by breeders to manage livestock and search technical-economic scale acceptable. All farms surveyed have dairy cows with high genetic performances (imported cows, Pie Noir and Pie rouge), average milk yield per cow remain weak (3400 kg) with a wide variation from 2070 to 5950 kg, and gross margin per cow varies from negative situations to positive ones. Multivariate statistical analyses have allowed the identification of three different groups of farmers, based on milk yield per cow, feeding strategies and economic parameters. The contribution of concentrates in the feed balance indicates a significant effect in dairy production 51.6 % of DM intake. According to *Kadi et al. (2007)* the dairy farms in Tizi ousou region use of concentrates were practices in all farms with varying degree. These feeding practice to use concentrate were inadequately converted into milk as recorded yields are the lowest (3400 kg). Production Cost of 1 liter of milk are uppermost (44.6 DA \approx 0.62 €) and relation price of food/total cost of production is very elevated (average 75 %). A similar situation to ours were signaled by *Madani et al. (2004)* in semi-arid region with 42 and 53% of DMI and *Ghozlane et al. (2009)* in the farms of Eastern Algeria 40.9 and 70.5 % of DMI. For intensive farms dairy in Morocco, *Srairi and Kessab (1998)* a maximum contribution was signaled 73.1 % and *Srairi and Khattabi (2001)* rapport 72.9 %. According to *Kaouche et al. (2015)* in the north center region of Algeria an average of 42.4 % of DM intake lower then to our results. As a result there are areas for development via land reorganization and the adoption of well feeding practices in order to ensure the profitability and sustainability of farms identified in this study. The variability of milk yield found in our studies is largely related to the structural and practice management for the simple farms and it was lower than obtained by (*Kaouche et al, 2012*) in the farms in the region of Médéa in Algeria. Our results for the production prices is higher than signaled by *Ghozlane et al. (2009)*, *Kaouche et al. (2015)* in dairy farms in Algeria. The elevated production prices observed largely on farms where the

concentrate was used at a rate higher than 50 % of total dry matter intake by cows and the results showed that practically in interval between 50 to 70 % of the cost of production of one liter of raw milk is allocated to food. However the difference between the sale price and the production cost is compensated by the help of the State estimated at 12 DA for each liter of milk produced by the farmer and 1 DA additional for each gram of fat beyond 34 g/liter.

For development perspectives, it is obvious that adapted research to dairy farms in interior plain region is immediately required in west Algeria. Technical recommendation in feeding strategies and adapted rations with calendar forager, complementation with concentrates, diversification of forages species and integrate conservation by ensiling means should be efficient. Since concentrates are widely used, it is mainly their mixing in adapted formulas to variable forages that could provide significant results. Prophylactic methods should also be set up for various parasitic diseases, in a context where few herds get preventive treatments.

All farms of the study area should be handled, with a special technical economic reference to group 1. Extension of feed formulation techniques would probably have significant results. However, choosing relevant farmers (educated and motivated ones) is a necessary condition to achieve success, as pointed out by *Roevled and Van Den Broek (1996)*. Then, those farmers could show the way to others. This should be considered properly by development decision-makers.

Conclusions

The typological assessment of surveyed farms shows a diversity of farming systems in semi-arid region of west Algeria with different constraint related to structural and technical parameters and their elimination need an arsenal of human and financial resources. Historic and social factors behind the genesis of such farms and additionally technical organization of alimentation and reproduction explain the variations between the groups of farms identified. In general, groups 1, of farms surveyed, illustrate higher milk yields (4120 kg) and lowest cost of liter milk production. The low yields under the average sample (3240 and 2010 kg) for the 2nd and 3rd group, may be due to the excessive use of concentrates that are not valued in their entirety, linked with substantial purchases of fodder that are inadequately exploited in the absence of rationing and food formulations, which led to important costs.

In addition the performance of dairy farms are low, while 98 % of the cows are imported and consequently of high genetic value. For all farms, the constraints consist in the first place food factor which represents the major handicap of the entire dairy production farms. It was concluded, that this diversity of farming systems should be taken into account for development purposes, as specific measures, especially in the field of cattle feeding, need to be applied to each one of

the livestock systems identified, to guarantee their sustainability. The generalization of uniformed promoting programs should thus be avoided, as each group is characterized by specific technical extension requirements. So there are areas for improvement through the reorganization of land use in order to dimension the farms with sufficient forage area, improvement of forages calendar with diversification of species, and integrate silage practice food rationing and formulations in order to make sure the technical economic productivity and sustainability of farms identified in this study.

Tipološka procena farmi za proizvodnju mleka u polu-sušnom mediteranskom regionu zapadnog Alžira

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Rezime

Ova studija imala je za cilj da okarakterise sisteme uzgoja mlečnih goveda u polu-sušnom regionu zapadnog Alžira. Tipologija farmi uspostavljena je nakon opisa odgajivačke prakse i procene njihovog doprinosa efikasnosti farmi. Istraživanje je sprovedeno na 60 farmi za proizvodnju mleka tokom poljoprivredne sezone 2018-2019 radi utvrđivanja strukturnih, tehničkih i ekonomskih parametara. Rezultati pokazuju veliku raznolikost poljoprivrednih strategija, posebno u pogledu ishrane i ekonomskih pokazatelja. Statističkom analizom su identifikovane 3 grupe gazdinstava. Prva grupa sadrži 12 farmi koje imaju prosečan prinos mleka od oko 4120 kg i promovišu upotrebu krmiva. Učešće koncentrata u ukupnom unošenju suve materije (DMI) iznosi oko 45,3%, prosečni troškovi proizvodnje mleka su 37,1 DA / l \approx 0,52 €, a udeo hrane u ukupnim troškovima proizvodnje od 62,8%. Drugu grupu koja uključuje 32 farme za proizvodnju mleka karakterise prosečni prinos mleka od 3240 kg, a udeo koncentrovane hrane je 49,2% ukupnog unosa suve materije (DMI). Trošak litra mleka je oko 42,7 DA \approx 0,60 €, a troškovi hrane čine 68,7% ukupnih troškova proizvodnje. Treća grupa sadrži 16 farmi za proizvodnju mleka koje predstavljaju farme sa značajnim doprinosom koncentrata u ukupnoj stočnoj hrani (54,3% ukupnog unosa suve materije - DMI). Ova koncentrovana hrana slabo je pretvorena u mleko, jer su zabeleženi prinosi najniži (2010 kg). Proizvodni troškovi 1l mleka i udeo troška hrane u ukupnim troškovima proizvodnje bili su respektivno najveći (49,4 DA \approx 0,69 €) i (80,2%). Rezultati ove tipologije ukazuju na raznolikost sistema mlečnih farmi u polu-sušnom regionu Severne Afrike, šta se mora preduzeti kako bi se osigurala isplativost i održivost ovih farmi. Društveno-ekonomski faktori se nalaze u pozadini izbora farmi, tehnička rešenja u ishrani i obročavanje i odsustvo diverzifikacija u proizvodnji krmne stočne hrane odražavaju razlike u grupama farmi za proizvodnju mleka.

Kako bi se osigurao razvoj održivosti tipoloških grupa, primenjivaće se posebna mera, posebno u menadžmentu ishrane, za različite identifikovane sisteme odgoja stoke.

Ključne reči: tipologija, goveda, tehnički parametar, troškovi proizvodnje, polusušna teritorija.

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