

TECHNICAL AND ECONOMIC PERFORMANCE OF DAIRY CATTLE FARMING IN MOUNTAIN AREAS IN TIZI-OUZOU, ALGERIA

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Abstract: The aim of this study is to explore the technical and economic aspects of cattle farms in mountain areas and to identify their technical constraints and potentialities. One hundred dairy cattle farmers were surveyed for seven months. The results show that the average farm size is 13 dairy cows and shows considerable variability at the sample level. For one-third of the farms, stabling is almost permanent and feed concentrate used as supplement (on average 7 kg /cow/day). 85% of the factors of production (useful agricultural area and possession of tractor) are owned by 45% of the breeders. Cow productivity averages is around 10.5 kg / day with two milkings / day. In addition, the average self-consumption of milk is 6 kg / day, which represents 2.8% of milk production. Feed expenses represent 90% of production costs. Annual income range from 99 909 AD / livestock unit (LU) nearly 148 421 AD / livestock unit. This variation is a function of the endowment of production resources. Subsidies for milk production represent 58% of the average income of farmers, what shows the low yield of dairy cattle farms. Today, with the drastic reduction in financial resources, dairy production development policies should focus on strategies to improve cow productivity and profitability in those areas.

Key words: dairy cattle, farm management, milk production, profitability, mountain area.

Introduction

In Algeria, milk is an important part of the food intake of populations, especially young ones. National production is still unable to cover a growing demand. Indeed, in 2007 the production reached 2.2 billion kilograms of milk equivalent, with a growth rate of 8% (*Temmar, 2007*). However, milk production

has averaged evolution of 2.6% since 2000 (*FAOSTAT, 2011*). This production has increased to just over 3 billion kg in 2012 (*Makhlouf, 2015*). Nevertheless, imports remain the only solution to the problem of national demand for milk. Dairy cattle farming is considered one of the most important in the agricultural sector in mountain areas. For a certain class of farmers, it is the main source of household income.

In terms of numbers, cattle breeding ranks second after sheep in the District of Tizi-Ouzou (*DSA, 2013*). Cattle farming accounts for 50% of agricultural value added (*MADR, 2007*). Its role in employment is significant in a region where unemployment reaches 18% of the active population (*DPAT, 2009*). In a region where the useful agricultural area (UAA) is insufficient (0.27 ha/inhabitant) (*Ferrah, 2005*), forage culture is undeveloped. Feeding cows, based mainly on purchased concentrate, constitutes a constraint to the development of these farms (*Kadi and Djellal, 2009; Mouhous et al., 2014*). Few scientific works is carried out with the aim of better understanding the economic performance of farms in mountain areas. Precisely, our study was to explore the technical and economic aspects of cattle farms. The main objective of this study is a technical-economic characterisation of dairy cattle farms, and the identification of the constraints and potentialities of current farming systems.

Materials and Methods

The study area (Tizi-Ouzou) is located in the northern part of the country (www.tiziouzou-dz.com/). It covers an area of 2 975.79 km² that is 0.13% of the national territory (The surface of the study area consists of 5 physical sets that give the region its mountainous character). The district of Tizi-Ouzou has a population of 1,133,349 inhabitants. In numerical terms, dairy cattle is ranked second after sheep, with 40,477 cows (local and improved cattle). Its production capacity would have reached more than 100 million kg (*DSA, 2013*). A stratified sample of 100 farms, based on the physical strata of the study area, was collected. Of the 100 questionnaires completed, 3 were eliminated and 97 were exploited. The analytical methods used are the descriptive analysis method (frequencies, standard deviations, etc.) and the discriminant analysis method. The aim is to determine the similarities that characterize the farms and to identify the factors of differentiation. It is performed by analyzing K-Means clustering on a set of variables relating to: useful agricultural area (UAA), Dairy cattle number, annual work unit (AWU) and possession of tractor. The results of this analysis were used to compare the management, production and economic performance of dairy farmers groups. To estimate the economic performance of milk production, some parameters were calculated as variable costs (feed, veterinary products, labor), estimation of the monetary value of milk production and gross margins according to *Desbois (2006)*.

Results and Discussion

All of the respondents have dairy cattle farming as their main activity. Less than 5% have a secondary activity (as an electrician, shopkeeper, etc.). The average age of farmers is 35 years. *Benidir et al. (2017)* reported the same results in the region of Sétif (Algeria). The number of permanent workers on the farm does not exceed 2 AWU (Table 1). In Moroccan dairy cattle farms, *Srairi (2004)* reports a similar number of AWU. It should be noted that among those exercising farming activities, 52% have an educational level that does not exceed the second level. In addition, 65% of our respondents cultivate their fodder. The most cultivated species are sorghum, clover, oats and the association vesce-oats. 30% of farmers are mowing only spontaneous fodder. The remaining 5% who do not make fodder crop, due to low UAA owned, proceed with the purchase of all fodder consumed by animals.

Table 1. Socio-economic profiles of farms

	Statistics	Standard error
Number of farms	97	
Average age of household head (years)	34.97	1.00
Average household size (persons)	8.85	0.42
Number of assets (greater than 15 years)	3.05	0.16
Number of permanent workers	1.72	0.11
School level (% of sample):		
Unlettered	5.15	
Primary and middle levels	51.55	
Secondary level	38.14	
University level	3.09	
Professional training	2.07	

Animals feeding

Feed is the biggest expense item in dairy farms in the mountain area. The poverty of the region in soil constitutes a constraint for the extension of the forage-cultivated areas. Therefore, to meet the feed needs of the animals, farmers are forced to fall back on animal feed markets for supplies. The results show that 35% of breeders practice permanently tied stabling due to lack of pasture or steep slope. The basic ration is strongly supplemented by the concentrate, that is distributed daily and throughout the year, with an average of 7 kg/head/day (Table 2). In the same study area but in 2007, *Kadi et al. (2007a)* reported that this amount could reach 10 kg/cow/day. In the western region, *Yerou et al. (2019)* report that the concentrate distribution varies from 5.5 to 10 kg/cow/day. But in the eastern region of India, *Gupta et al. (2014)* reports that cows receive small amounts of concentrate, on average less than 3 kg / head / day. To a small degree, pastures are

an important source of feed, especially in spring and summer. On average, a herd passes on pasture 3.5 hours/day.

Table 2. Share of different sources in the feeding of cattle herds in Tizi-Ouzou area

	Autumn	Winter	Spring	Summer
Concentrated (kg / head / day)	7.46 (0.31)	7.62 (0.31)	5.45 (0.37)	7.36 (0.33)
Hay (boots / flock / day)	6.24 (0.57)	6.4 (0.57)	1.46 (0.29)	5.03 (0.55)
Straw (boots / flock / day)	1.12 (0.20)	1.13 (0.20)	0.93 (0.17)	1.1 (0.20)
Natural pastures (hours / d)	2.33 (0.30)	1.67 (0.27)	5.93 (0.45)	4.11 (0.45)

(): Standard error

Typology of farms

Discriminant analysis of farms

To test the hypothesis of inequality in allocation of factors of production, we used the following variables: AWU, total UAA (ha), tractor ownership and dairy cattle numbers. The discriminant analysis showed that the variables used in the analysis contribute significantly to the classification of farmers (Table 3). There is some heterogeneity in the population of dairy cattle farmers.

Table 3. Wilks' Lambda and Univariate Fischer Test of Discriminant Analysis

Variables	Wilks	F	Signification
Possession of tractor	0.775	12.018	0.000
AWU	0.846	7.549	0.001
UAA	0.838	8.042	0.001
Number of dairy cattle	0.784	11.465	0.000
DDL	2	83	

AWU: annual work unit; UAA: useful agricultural area; DDL = degree of freedom (the first value corresponds to DDL1, and the second value to DDL2; Wilks and F are Lambda statistics from Wilks and Fisher.

The dynamic clustering analysis (Table 4) showed 5 different types of breeders compared to product factors endowment. The different types can be grouped into 3 groups. The first group consists of types 1 and 2. Their factor endowment is below the sample average, accounting for nearly 70% of the farms in the sample.

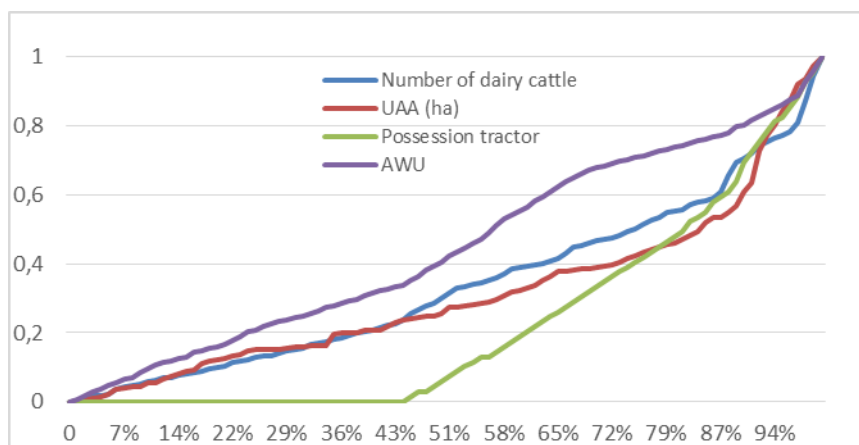
Table 4. Average Breeders resource classes

Classes/variables	AWU	UAA total (ha)	Possession of tractor (Number)	Number of dairy cattle
Sample	1.73	12.09	0.71	12.950
N=97	(0.11)	(1.62)	(0.08)	(1.52)
Type 1 (N=43)	1.326	6.456	0.000	6.907
	(0.07)	(1.04)	(0.00)	(0.51)
Type 2 (N=24)	2.333	7.250	0.917	11.708
	(0.12)	(1.19)	(0.06)	(1.30)
Type 3 (N=18)	1.000	10.833	1.111	13.889
	(0.00)	(1.77)	(0.08)	(3.24)
Type 4 (N=9)	2.000	48.167	2.111	21.000
	(0.17)	(8.69)	(0.26)	(3.91)
Type 5 (N=3)	6.333	31.000	2.667	80.000
	(0.67)	(8.96)	(0.33)	(5.77)

AWU: annual work unit; UAA: useful agricultural area; () : Standard error

The second group is represented by type 3. Nearly 19% of the sample is considered to be average farmers. Finally, the last group consists of types 4 and 5 which represents more than 12% of the sample and are the most affluent breeders. Their factor endowment level is well above the sample average.

In addition, the Lorenz curve (Figure 1) shows the distribution of product factors on the breeders of the sample. With the exception of labor, nearly 85% of the resources (UAA and tractor ownership) are owned by 45% of the farmers. The remaining 15% of resources are shared on 55% of breeders.

**Figure 1. Distribution of production factors (Lorenz curve).**

For cow numbers, 85% are held by 55% of breeders. While the remaining 15% are spread over the 45% of breeders. Indeed, these results show an inequality in the distribution of product factors on the breeders of the sample.

Livestock structure

The analysis of the structure indicates the breeding strategies followed by the breeders to ensure the sustainability of their activity. For breeding females, on average in a herd, there are nearly 13 breeding females (12.96) (Table 5). This result is similar to that reported by *Belkheir et al. (2011)* which is 13.9. Crescendo, herds of type 1 have 6.9 breeding females and those of the type 5 reach 80 females.

Table 5. Comparative average structure of the cattle herd in head count

Categories Type	Dairy cows	Heifers	Bulls	Bull calves
Type 1	6.9	3.95	2.32	2.44
	(0.51)	(0.43)	(1)	(0.28)
Type 2	11.7	8.37	3.37	4.04
	(1.3)	(1.15)	(0.85)	(0.51)
Type 3	13.88	6.88	2.66	5.05
	(3.24)	(0.82)	(1.08)	(1.17)
Type 4	21	14.55	2.77	7.33
	(3.91)	(2.73)	(2.17)	(1.35)
Type 5	80	30	14.66	8
	(5.77)	(2.89)	(7.42)	(4.16)
Sample	12.96	7.38	3.07	3.95
	(1.52)	(0.69)	(0.63)	(0.36)

() : Standard error

In addition, the results show that there is a difference in the herd structure between types 1, 2, 3, 4 and type 5. Indeed, breeding females represent 45% of the herd of the first four types, while they constitute 60% of type 5. For breeding males, there is no difference and contribute to the herd structure up to 11% for the 5 types. This is explained partly by the development of the practice of artificial insemination incited and subsidized by the government. Nevertheless, in the state of Khartoum, *Mohamed et al. (2014)* report that more than 78% of the farms have one or no breeding bull.

Some parameters of the production and management of milk.

Milk productivity is estimated at 10.52 kg / cow / day for all sample breeders (Table 6). This yield doesn't seem to evolve since it is similar to that recorded in the same mountainous region 10 years ago by *Kadi et al. (2007b)* and 15 years ago by *Adem (2003)*. In addition, *Kučević et al. (2015)* report that milk yield is influenced by factors such as year of birth, length of lactation, calving season, and breeding area. However, in a dairy basin constituted by plains located in the study

area, *Si Tayeb et al. (2015)* reported a higher yield of 15 kg/cow/day. In addition, it should be noted that nearly 55% of the farms have productivity below average; it seems that types 2 and 3 mark the lowest levels of productivity and represent 42% of farms that are below average. Type 5 has the highest productivity at 13.5 kg/day. However, in Central Uganda *Nalubwama et al. (2016)* recorded a productivity of crossbred cows that do not exceed 8 kg / cow / day.

Table 6. Interclass comparison of some milk production parameters

Class/Parameters	Type 1	Type 2	Type 3	Type 4	Type 5	Sample
Productivity (kg/cow/day)	10.54	9.93	9.69	12.66	13.5	10.52
	(0.58)	(1.00)	(0.68)	(1.68)	(1.80)	(0.42)
Number milking/day	1.88	1.92	1.89	1.89	2	1.9
	(0.05)	(0.06)	(0.08)	(0.11)	(0.00)	(0.03)
Milk exploitation time (months)	9.56	9.33	9.11	9.22	9.33	9.38
	(0.13)	(0.10)	(0.14)	(0.15)	(0.33)	(0.07)
Concentrate feed kg / cow / day	6.83	6.33	7.22	8	10	6.99
	(0.50)	(0.60)	(0.48)	(1.11)	(2.00)	(0.31)

() : Standard error

What should also be mentioned is the productivity of type 3 which is 9.69 kg/day, the lowest level of productivity of the 5 types. Nevertheless, it records a consumption level of the concentrate of 7.22 kg/cow/day. This is probably due to the difference in the mastery of production techniques with a waste of feed.

Sale and self-consumption of milk

The general average of self-consumption is 2.85% of milk production (Table 7). Daily consumption represents 5.22% among breeders of type 1 (less affluent). For types 2, 3 and 4, the share of self-consumed production varies between 2 and 3% of production. This self-consumption reaches its highest level among breeders of type 5 (10 kg/day) which represents only 0.6% of self-consumed milk from daily production.

Table 7. Household self-consumption and sale of milk (kg / day / household)

Class/Parameters	Type 1	Type 2	Type 3	Type 4	Type 5	Sample
Self-consumption	5.44	6.25	6.39	6.67	10.33	6.08
	(0.38)	(0.5)	(0.58)	(0.97)	(0.88)	(0.27)
Consumption per capita	0.7	0.84	0.86	0.8	1.73	0.81
	(0.06)	(0.10)	(0.12)	(0.16)	(0.64)	(0.05)
Size of households	8.76	8.88	8.67	10	7.66	8.86
	(0.58)	(0.75)	(1.35)	(1.49)	(2.33)	(0.42)
Sale	104.86	180.83	211.22	322.56	1666.67	211.9
	(8.97)	(22.35)	(40.85)	(54.31)	(166.67)	(29.83)

() : Standard error

In others, farmers sell 211.9 kg/day of milk. We note that 70% of breeders (type 1 and 2) cannot reach this average sales. Indeed, the lowest amount of milk sold is registered in type 1 farms (104.9 kg/day). Only types 4 (322.6 kg/day) and 5 (1666.7 kg/day), which are the most endowed with production resources but which represent only 12% of the sample, come to exceed the average (211.9 kg/day).

Economic performance of dairy cattle farms.

Proposed analysis focuses on the structure of production costs, incomes and gross margins. Estimated cost of production indicates that food expenses represent 90% of the production cost for all farmers. The same situation is described throughout the Maghreb by *Srairi et al. (2013)*. However, *Ghozlane et al. (2009)* report much lower food expenditures than our results on farms with more than 100 ha of UAA. Local production of fodder and concentrate seems to cover a small part of the livestock feed. Therefore, breeding expresses a very dependent relationship market (*Kadi and Djellal, 2009*). For veterinary care and labor, there is no significant difference between the different types (Table 8). They represent each of them on average 5% of the total cost of production. But type 2 shows relatively high health expenditures that are close to 18% of total expenditures.

Table 8. Cost structure of milk production (AD)

	Type 1	Type 2	Type 3	Type 4	Type 5
Food (%)	89.25	79.32	96.05	90.14	90.80
Veterinary products (%)	4.28	17.87	2.01	2.34	1.37
AWU (%)	6.47	2.80	1.94	7.52	7.82
Total variable costs (AD / kg of milk)	34.55 (1.95)	36.38 (2.3)	39.26 (2.3)	37.19 (3.8)	27.53 (3.02)

AD: Algerian Dinar. 1 AD= 0.0075 Euro

In addition, the average production cost of one kg of milk is 35 AD / kg. This cost is similar to that reported by *Yerou et al. (2019)* in the western region of Algeria, which is 37.1 AD/kg. Farmers of type 5 (more affluent) report the lowest cost of production compared to other groups at only 27.5 AD/kg. This level of performance is striving for a distributed more rational consumption, and benefits of economy of scale. Also, the size of the budgets is significantly different between the classes of breeders identified on the basis of their endowment of production resources (Table 9). The richer farms (type 5) invest the most and get the best results. They are followed respectively by farms of types 4, 3, 2 and 1. The latter being the least resource-rich.

For gross margin, the allocation of production resources determines the economic performance of the breeders. Gross margin values are positively correlated with the investments allocated to production. The same observation is made for income, type 1 breeders have an average annual income of (666 100.3

DA, or 103 001.95 DA/LU), it is the lowest income of the 5 types. The highest income is received by breeders of type 5, which averages 11.95 million DA/year, or 148 421.56 AD/LU.

Table 9. Gross margin released by the different groups of farms (AD)

	Type 1	Type 2	Type 3	Type 4	Type 5
Total expenditure (AD*10 ⁶)	0.65 (68 021.35)	1.05 (185 708.33)	1.11 (332 243.5)	1.83 (553 995.5)	8.51 (1 762 244.6)
Total sale (AD*10 ⁶)	1.21 (104 678.8)	2.18 (271 752.2)	2.21 (477 201.9)	3.92 (653 862.9)	20.47 (1 922 400.8)
Gross margin (AD*10 ⁶)	0.66 (70 065.35)	1.13 (193 329.9)	1.09 (216 790.08)	2.09 (423 165.3)	11.95 (1 520 367.9)
Gross margin AD / livestock unit (LU)	94 909.70 (6 448.12)	101 600.49 (10 598.72)	116 568.53 (9 632.97)	103 129.05 (17 791.30)	148 421.56 (11 044.09)
Share subsidy of milk in incomes (%)	62.48	66.94	51.74	61.67	48.15

AD: Algerian Dinar. 1 AD= 0.0075 Euro

In addition, among the milk production incentive policies that the government has established, there is mention of milk production subsidies (15 AD/kg) for approved breeders. This grant contributes significantly to total income. Indeed, subsidies for milk production account for 58% of total income. In addition, breeders of type 2 report the share of the largest subsidy among the 5 types, which amounts to close to 67%. This proportion is close to that reported by *Mouhous et al. (2014)*, which is 71%. Type 5 breeders report the lowest proportion of the subsidy (48%) in the formation of their income.

Farms Dairy cattle remain family, medium sized (13 females/livestock). There is also an unequal distribution of the means of production. The succession is assured since young breeders manage these farms. Cow productivity remains low with concentrate distribution not exceeding 7 kg/cow/day.

The analysis of production costs indicates that food expenditures represent 90% of production costs. With the weakness of UAA in mountain areas, a large part of livestock feed is bought at the market. The estimated income is based on the investments made in the farms. The average annual income is 103 001.95 AD/LU.

Finally, subsidies for milk production represent more than half of the average income of breeders. For this purpose, the share of subsidies in income goes from 48% (the most affluent) to nearly 67% (less affluent). It seems that the government, through the transfer of wealth, provides half of the income of breeders through subsidies.

Tehničke i ekonomske performanse mlečnog govedarstva u planinskim predelima Alžira - Tizi-Ouzou

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Rezime

Cilj ovog istraživanja je bio da se ispituju tehnički i ekonomski aspekti mlečnog govedarstva na farmama u planinskim predelima i da se identifikuju njihova tehnička ograničenja i potencijali. Tokom sedam meseci anketirano je sto farmara muznih krava. Rezultati pokazuju da je prosečna veličina farme 13 muznih krava i pokazuje značajnu varijabilnost na nivou uzorka. Za trećinu farmi grla se gotovo stalno drže u objektima, a koncentrat za životinje se koristi kao dodatak (u proseku 7 kg/krava/dan). U pogledu proizvodnih faktora (korisna poljoprivredna površina i posedovanje traktora), 85% je u vlasništvu 45% uzgajivača. Prosečna produktivnost krava je oko 10,5 kg/dan uz dve muže dnevno. Pored toga, prosečna samopotrošnja mleka je 6 kg/dan, što predstavlja 2,8% proizvodnje mleka. Troškovi stočne hrane predstavljaju 90% proizvodnih troškova. Godišnji prihod kreće se od 99.909 do 148.421 AD/uslovnom grlu (LU). Subvencije za proizvodnju mleka predstavljaju 58% prosečnog dohotka poljoprivrednika, što pokazuje nizak prinos mlečnih farmi. Danas, sa drastičnim smanjenjem finansijskih sredstava, politika razvoja mlečnog govedarstva treba da se usredsredi na strategiju za poboljšanje produktivnosti i profitabilnosti krava u tim oblastima.

Ključne reči: mlečna goveda, upravljanje farmama, proizvodnja mleka, profitabilnost, planinsko područje.

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