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The Economic Evaluation and Financial Analysis of Small Size Dairy Farms in Tunisia

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Abstract
The objective of this study is threefold. Firstly, we exam the profitability of dairy small scale farming system in the north west of Tunisia. Secondly, a Data Envelopment Analysis (DEA) method was used to analyze the performance level of dairy farms. And in last stage, the most factors affecting the farms efficiency are identified. Main results schow that average yiled is 3620 liter/cow and the gross production value is 4475 TDN and 63% from this is milk production value. Gross margin is 1262TND/cow which is equivalent to an average margin rate of 28%. The total cost of milk production was 1.13 TDN/liter which was higher than the market price (0.780 TND/Liter) inducing farms in major loses. The break-even analysis shows that milk yield must be at least of 13.5 liters/cow/day and the break-even measured in days will be of 234 days. The results obtained from the DEA analysis reveal that dairy farms have a potential of 38% to operate efficiently through a more efficient use of their production inputs. And the overall technical inefficiency is mainly related to scale inefficiency. Tobit analysis also shows that mastitis may be the major factors of farms' inefficiency. Empirical results indicated too, that efficient farms use more concentrated feed, Consequently the government should support farmers to provide this feed in order to improve their profitability. To enhance farm efficiency there is a need to improve farmers' access to extension services. The need to involve farmers more in the extension process itself should be encouraged.

Keywords: Arid Area, Break-Even, Dairy cost of production, Profitability, Technical efficiency.

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I. Introduction

Tunisian agriculture is confronted with declining world commodity prices and stronger competition from both subsidized and non-subsidized overseas products (Lachaal et al, 2002). Historically, Tunisia's agricultural system was based on small family farms that grew subsistence crops with little market integration.

Small scale dairy production and related backward and forward linkage activities in marketing; input supply, etc. have the potential for significant employment generation and poverty alleviation. Dairy generates more regular cash income and dairy production, processing and marketing generate more employment per unit value added compared to crops.

Tableau 1 : Evolution of cattle numbers in Tunisia(1000 cows)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Pure breed	223	220	220	223	222	224	228	240	259	266	253
Crossed local breed	231	229	220	216	208	202	196	197	191	192	184
Total	454	449	440	440	430	426	424	437	450	458	437

(GIVLait, 2018)

Dairy cattle production is an important industry of the animal production sector and has an important position in Tunisian economy with its employment rate and values of products. However, a decrease in total cattle population, number of cows, and milk production has been observed in 2018. As in most developing countries, products of animal origin (milk, meat) are considered as a strategic sector. It occupies an important place in the local economy. Since the dairy production in 2013 was 1175 000 T and 1428 000 T in 2016 to fall to 1424 000 T in 2017(GIVLait, 2018). More over the dairy sector is contributing by 11% of the value of agricultural production, 25% of the value of animal production and 7% of the value of the agri-food industry. This is the result of the given government encouragement to the sector. However, the sector remains very vulnerable. Knowing that 70% of herds are less than 3 female heads and 80% less than 5 heads and more over 59% of the livestock were off-land (Abdelhafidh et al, 2018).

Despite, the several policy reforms, given by the government to increase the supply of fluid milk products and ensure self-sufficiency, the farms' profitability remain substantially variables. The herds' food practices remain limiting factors that affect the dairy production (Cyrine Darej et al, 2017). Consequently the profitability of the dairy farms depends particularly on the food cost. (Abdelhafidh et al, 2019).

The objective of this study was to investigate The Economic Evaluation and Financial Analysis of Dairy Farms in the north west of Tunisia in the province of Jendouba to interpret the present situation and guidelines to improve investment for dairy farmers' and the government.The profitability of the Tunisian dairy sector is a subject that has not been fully investigated at farm level. It's useful for policy makers to measure the efficiency of agricultural production that can enhance policy decisions regarding subsidises or pricing regulation. To this end, a financial analysis is important insofar as this could be the first logical step in a process that leads to substantial resource savings. This paper is organized as follows. After, giving some definitions and concepts the material and methods are described. The results describe and discuss the most important findings about the profitability of dairy production farms among North West region of Tunisia. The conclusions indicate the purpose and the main findings.

II. Theoretical framework

2.1Definition and Concepts

Cost of production

Cost of production is the sum of both cash and non-cash expenses and includes both operational costs that occur irrespective of how the business is funded or owned, and funding costs reflecting business ownership and financing. The difference between the cost of production and returns is termed the entrepreneur's profit. The greater the farm's profit, the stronger the business is positioned for future growth and wealth creation. It also allows the company to face eventual risks. While costs are often expressed on a per enterprise, per hectare basis, the most relevant measure is cost per unit of output, as this can be readily compared against the returns per unit of output to determine the entrepreneur's profit. Factors such as milk production per cow, variable and fixed costs and net income from livestock all impact on cost calculations.

The cost of milk production is a net cost, that is, the total costs of the dairy enterprise (operating costs and funding costs) less the returns from non-milk returns. The non-milk returns include calves and manure.

$$CP/Liter = \frac{(TC-NMR)}{Q} \quad (1)$$

Gross Production: Value of gross production has been compiled by multiplying gross production in physical terms by output prices at farm gate. Thus, value of production measures production in monetary terms at the farm gate level. Since intermediate uses within the agricultural sector (seed and feed) have not been subtracted from production data, this value of production aggregate refers to the notion of "gross production". The dairy farms gross production consists of the values of milk, dung and appreciation of calves.

GBV= Milk production + NMR (2)

Gross Margin: The gross margin produced by the activity "milk production" can be expressed in terms of number of dairy cows. It's calculated by the difference between the gross Production and variables costs.

GM= GPV- VC (3)

Farm Income: Agricultural economics uses the term "farm income". This is the amount remaining to the farmer and farm family after operating expenses. Such income therefore serves to remunerate the labour and capital supplied by these people. Farm income differs from available income because part or even all of it may have been used during the year due to a variation in stocks or to investment expenditure. On the other hand, it includes costs which are not translated into actual expenditures of money such as depreciations.

Farm income = net profit + non disbursed expenses (4)

2.2 Technical efficiency

The technique of data envelopment analysis (DEA) is a non-parametric approach, involving mathematical programming in its estimation, which was developed by the authors Charnes, Cooper and Rhodes (1978) for the relative efficiency analysis of producing units, known in the literature as DMUs (decision making unit). By producing unit is meant any system that transforms inputs into products. DEA aims at finding the best production unit, i.e. the one that combines resources more efficiently, so that it reaches the optimal production level (Pareto-Optimum). A production unit is efficient when there is no other unit maintaining the same level of output with lower level of inputs, or when there is no other unit achieving a higher level of output with the same level of inputs. Units with the highest efficiency are located on the efficient frontier (at the boundary of efficiency). The purpose of the DEA method is to construct a nonparametric envelopment frontier over the data points such that all observed points lie on or below the production frontier. The technical efficiency (TE) estimates vary between 0 and 1.

The DEA models for estimating technical efficiency were based upon the assumptions of constant returns to scale (CRS) and variable return to scale (VRS) (Charnes et al., 1978; Banker et al., 1984). Overall technical efficiency measure (TECRS) was decomposed into pure technical efficiency (TEVRS) and scale efficiency (SE) for determining the source of inefficiency. The issue of returns to scale concerns what happens to units' outputs when they change the amount of inputs they are using to produce their outputs. Under the assumption of variable returns to scale, a unit found to be inefficient has its efficiency measured relative to other units in the dataset of a similar scale size only. The initial assumption of the approach is that the measure of efficiency requires a common set of weights that will be applied to all DMUs. In order to select the optimal weights, a mathematical programming problem is specified for the i-th DMU. Under the non-parametric approach (DEA), to estimate the production frontier, we consider the "input oriented" model, according to Coelli (1996) : n farms (i=1,⋯⋯n), each producing M outputs y_{mn} (m=1,⋯M) by using K different inputs x_{kn}(k=1,⋯..K), each farm becoming the reference unit. For the i^{th} firm, we have vectors xi (K×1) and y_i (M×1). For the entire data set, therefore, we have a K×N input matrix X and M×N output matrix Y. The technical efficiency (TE) measure is obtained by solving The CCR model which was initially proposed by Charnes et al., (1978). The CCR model is indicated in Eq. (5):

$$\begin{aligned} &\mathrm{Min}_{\theta,\lambda}\ \theta_i \\ &\mathrm{St} \\ &-y_i + Y\lambda \geq 0 \\ &\theta x_i - X\lambda \geq 0 \qquad (5) \\ &\lambda \geq 0 \end{aligned}$$

Where θ_i is a variable representing the efficiency of the Reference Farm i and hence the percentage of reduction to which each input must be subjected to reach the production frontier. λ is a vector of (k*1) elements representing the influence of each farm in determining the efficiency of the i^{th} farm.

Thus, the linear programming problem with constant returns can be modified to meet the assumption of variable returns by adding the constraint of convexity, N1'λ=1, where N1 is a vector (n x 1) of unit numbers.

For each inefficient unit, DEA models provide their respective benchmarks, determined by the projection of these units at the efficiency frontier. This projection is done according to the orientation of the model, being orientation to inputs when it is desired to minimize the resources, keeping the values of the products constant, or orientation to products when it is desired to maximize the products without reducing the inputs (Abdelhafidh et al, 2017).

Solution to (1) provides information about the production efficiency of each individual farm of the sample and does not imply irrational behaviour of non-efficient farmers (Lachaal et al, 2002). The failure of farmers to produce potential output could be the result of factors linked to the farmer's technicality or not. From a policy point of view, it is interesting to investigate the sources of inefficiency and to identify farm attributes potentially related to it. In some studies, production efficiency has been linked with a numerous of socioeconomic variables. However, more empirical research is still needed to highlight the relationship between efficiency and these attributes. Since, in this analysis, several variables are identified as potential determinants of technical efficiency.

These variable reflect the time present, the feed quality, the farmer age (Age), the education level of farmer (NINS), the green fodder feed per dairy cow (GF), fodder area devoted per dairy cow (FAC) and the fight against mastitis (FM). To this end, the efficiency scores obtained are regressed on these farm attributes using the linear Tobit model in (6).

$$ET = \beta_0 + \beta_1 Age + \beta_2 NINS + \beta_3 GF + \beta_4 FAC + \beta_5 FM + \varepsilon \qquad (6)$$

Where:

ET: is the efficiency of dairy farmers.

ε: is the error term.

III. Data collection

The necessary primary data were obtained from the sample dairy farmers through personal interview with breeders during April 2018 from 3district in the province of Jendouba, Tunisia. The data collected from a sample of 32 farmers respondents included general information about dairy farmers, productive performance of dairy cows, cost of farming and returns from farming. The sample size was determined by means of simple random sampling method (Newbold, 1995). A structured questionnaire was used in collecting the data by personal interview. Basic descriptive statistics used in the analysis are presented at Table2.

Tableau 2: Basic statistics of the variables used in the analysis of efficiency/farm/Year

Variables	Description	Mean	S.D	MIN	Max
output	Output Value(TND)	41306	46687	4900	220000
inputs	Cows presented : P (Nb of heads)	11.4	8.9	2.0	47.0
	Concentrates Feed Expenses :CC (TND)	22563	20622	2300	110000
	fodder feed Expenses: F (TND)	12016	9872	4700	54000
	Veterinary Charges :FV (TND)	1001	263	420	1400
	Material Input :M (TND)	872	296	200	1300
	Labour Expenses : L (TND).	5281	1778	3600	8500
Specifics factors	Age (years)	49	13	22	68
	Education level: NINS (0 if the education level was lower or equal to primary , 1 : if secondary, 2: if University level)	0 : 41% 1: 38% 2: 7%			
	Quantity of green fodder given to the herd: GF (kg)	228209	241812	0	1216125
	Fodder area devoted per dairy cow : FAC (ha)	0.49	0.52	0	3
	Fight against mastitis: FM (1: if yes, 0: if no).	0,59	0,50	0	1

Regarding data required they are particularly related to milk production value as well as expenses of inputs used. Six broad categories of milk production inputs were considered. These were: herd population measured in heads (P), concentrate feed input (CC), fodder feed (F), veterinary charges (FV), material input (M) and labour input (L). The labor input included permanent and hired labor. The material input included equipments depreciation.

IV. Results and Discussion

4.1 Financial analysis

As a Result, on the farms there was an average of 11.4 dairy cows. We found that 88% of the breeders have a herd whose number varies from 5 to more than 10 cows. However, only 13% of herders have herds composed of 1 to 5 cows. On average the daily ration consisted of 40% of concentrate and 60% of forages. The major part of cattle population on the examined farms consisted of 60% Holstein, 25% Brow Swiss, 10% Tarentaize and 5% Montebilliard.

4.1.1 Milk production cost: Production costs related to milk production were analyzed by classifying production costs as variable and fixed costs. Variable costs are costs that occur when production is made and they increase or decrease depending upon the production volume. Fixed costs are costs that do not change with respect to the production volume or costs that occur whether production is made or not. The variable costs are composed by feed, veterinary, hired labor expenses and variables opportunity costs. They were 3212 TND/dairy Cow representing 78% of the total cost. The fixed costs are composed by family labor and depreciation cost. They were 888TND/dairy cow. The exam of the table1 shows that feed expenses represented 73% of the total cost and 94% of the variables costs. Thus it can be stated that feed costs were the highest item of milk production and variable costs.

The share of the concentrate is 48% of the total cost, regarding its high price (0.744TND/kg) it consisted the main component that affect the total production cost. Consequently, farmers must be more rational when feeding cows. This will affect both the quantity and the quality of milk production and consequently the farms profitability.

The table3, also, shows that the average cost of milk production was 1.13 TDN/liter which was higher than the market price (0.780 TND/Liter) inducing farms in major loses.
In this situation, farms recompose these loses by non-milk returns (NMR) in first stage. Secondly, and in order to alleviate this ship farms must improve their efficiencies. This will improve yields and consequently reducing milk production cost.

4.1.2 Returns from Dairy production and farms income:

The average milk yield for a cow was found to be 3620 kg/year. It ranged from 1592 to 6663 kg/year. These gaps were due to variability of the farmers' technicality, feed quality and breeding conditions.
Gross production is the summation of milk production value, and non-milk return as well as calves value and manure value. Table3 shows that the average gross product value for farms was 4475TND/cow/year.

Tableau 3: Annual cost-Benefit Analysis/Cow in study areas.

Elements	**Amount**
%	100%
Mean herd size	11,4
A.Varaible costs	**3212**
concentrate (kg)	1961
hay (bales)	218
Straw	366
Green feed	403
Veverole	61
Veterinary expenses	87
Hired labor	115
B.Fixed cost	**888**
a.family Labor	313
b.Cow depreciation	500
c.Deprciation	75
C.Total Cost (A+B)	**4101**
D. yields (Liter/cow)	**3620**
Cost /kg (C/D)	**1,13**
E. Milk Production value	**2824**
F. NonMilk Retun	**1651**
Manure	420
Cow appreciation	400
Calves	831
G. Gross Broduction Value (E+F)	**4475**
H.Gross Margin (G-A)	1262
d.Gross Margin Rate	28,2%
I.Net Profit (H-B)	374
J.Farm Income/cow (I+a+b+c)	1262
Net cost/Liter	0,68

The income from milk sale accounted for 63% whereas the non milk returns accounted for 37% of the gross production which cover the losses generated from the milk production. Regarding this, the net milk production cost as determined by the equation (1) will be equal to 0.680 TND/liter allowing the farmers to make a gross margin of 1262 TND/cow. The realized gross margin rate ranges from 13 to 33% with an average of 28%. The average net profit here is 374 TND/cow. Since the net profit / farm will be on an average of 4264 TND which is judged not sufficiently reassuring and may expose farms to losses' risks. The farm income as given by equation 4, account on an average of 1262/cow which is equivalent to 14435 TND/ farm. This is not very remunerative because productivity is low.

4.1.3 Break-even analysis of dairy farming

Regarding the fixed costs of 888 TND/cow the break-even which is equal to the ratio of fixed cost to margin rate will be of 3150 TND/Cow. This means that a milk yield of 4038 liter/cow/year at least is required to cover the total cost production. Regarding the average of the lactating duration of 300 days the milk yield must be at least of 13.5 liters/cow/day and the break-even measured in days will be of 234 days.

4.2 Technical efficiency analysis

Table 2: Technical, scale, efficiency measures

Efficiency measures	Mean	Standard deviation	Efficient farms(%)
Overall technical efficiency	0,62	0,19	13%
Pure technical efficiency	0,95	0,09	69%
Scale efficiency	0,65	0,18	13%

Using the DEA methodology outlined above, non-parametric analysis of relative technical efficiency is performed for dairy production in the farms of the sample. Average overall technical efficiency is about 62%. This means that the farms can increase their milk production by as much as 38% using the same production inputs more efficiently. Pure technical and scale efficiency measures indicated that overall inefficiency was mainly due to scale inefficiency. Technical efficiency was possible to have been increased from 0.62 to 0.95 if scale inefficiency did not exist. Results schow too, that 13% of farms are operating CRS scale against 87% operating in VRS and all of them are in increasing return to scale. Scale efficient farms (Constant return to scale-CRS) had higher gross production value in comparison to farms with increasing return to scale (IRS). Table 3.

Table 3: Gross production values for different scales

Return to Scale	% of farms	Gross production value (TND/Cow)
Constant return to scale	13%	5050
Increasing return to scale	87%	3058

Results presented in table 4 show that average herds owned by efficient farms is three times more than those owned by the inefficient ones. Efficient farms use 16% of concentrates feed/cow more than those inefficient.

Table4: Comparison between efficient and inefficient farms

Inputs	Economic efficiency	
	Efficient Farms	Inefficient Farms
Cows presented	27	9
Concentrates Feed Expenses (TND)	59250	17321
fodder feed Expenses (TND)	26550	9939
Veterinary Charges (TND)	1120	984
Material Input (TND)	950	861
Labour Expenses (TND).	5725	5218

Comparison of current and optimum uses of major inputs showed that it was possible to maintain the current gross output value while decreasing the number of cow, Concentrated feed (kg), Fodder Feed, veterinary expenses, materiel expenses, labor.(Table **5).**

It is recommended for inefficient farms to benchmark in an effort to achieve similar efficiency levels of efficient farms with minimum input levels or by improving Gross production values with the same amount of inputs. Inefficient dairy farms should be encouraged by convenient state policies in this regard.

To identify factors associated with technical inefficiencies, the Tobit regression defined in equation (6) is estimated using Stata package and results are presented in table 6.
Regarding the Tobit model results, the likelihood ratio test rejects a null hypothesis that all slope parameters are simultaneously null. This confirms that the Tobit model is statistically valid. Overall technical efficiency is positively affected by all explaining factors.

Table 5: The comparison between current and optimum input levels per cow and possible changes

	P	CC	F	FV	M	L
Current	11	22563	12016	1001	872	5281
optimum	10	19378	10299	912	750	4825
changes	14%	14%	14%	9%	14%	9%

The Tobit model results also indicated that fighting Mastitis has the most marginal effect on technical efficiency with a coefficient of 0.208 and significant at the 1% level. This result indicated that when farmers give more attention to avoid mastitis with in his herd may enhance his efficiency by about 21%. Results also show that education level (NINS), has an important effect on technical efficiency. Since its coefficient is 0.088 and significant at 5% level implying that the change of the education level by one point enhances efficiency by 8.8%. This means that government has to improve farmers' knowledge and information by execution of specifics formation sessions and narrow technical support especially for non educated farmers. While age and Fodder area devoted per dairy cow tend to increase efficiency but are not significant at the 10% level. Despite it is significant at 1% level, the quantity of green fodder given to the herd has poor effect because its coefficient is slightly superior to zero.

Table 6: Tobit estimation results of factors affecting technical efficiency scores

variables	Coefficients	SD	t-statistic
Age (years)	0.003	0.002	1.30
Education level: NINS	0.088**	0.035	2.47
Quantity of green fodder given to the herd: GF (kg)	0.0001*	0.0001	2.89
Fodder area devoted per dairy cow : FAC (ha)	0.085	0.054	1.54
Fight against mastitis: FM (1: if yes, 0: if no).	0.208*	0.063	3.28
Constant	0.137	0.145	0.94
LR chi2	26.58		
Prob> chi2	0.0001		
Log-likelihood	9.208		

*Significant at 1% level; ** significant at 5% level

V. Conclusion

Despite that the dairy farmers in the rural areas of Tunisia are the major supplies of milk for the rural and urban consumers they are constrained to many difficulties. It's observed that the milk production cost is higher than the sell price and farmers realized a positive profit thank to the NRM. It's showed too that the farm income is not sufficiently reassuring and the break-even is high which does not allow a great security margin versus losses. However, the dairy production in the study area has excellent opportunities to improve family income and employment generation through improving efficiency, and use of more productive technologies.

The rural extension technicians and family farmers interaction should combine knowledge produced by educational and research institutions, be guided by market demands, and catalyzed by cooperative ideals, for family farming to become a protagonist in the productive arrangement of dairy supply chains.

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