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Environmental constraints and sustainability of dairy cattle farms in the suburban area of the city of Blida (Mitidja, Algeria)

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The purpose of this study was to assess the agro-ecological sustainability of dairy cattle farms in the suburban area of the city of Blida. An investigation was carried out on 19 farms. The study area, located in the Mitidja plain, is well known for its farming tradition and has suffered over the last decades from countless environmental constraints. The assessment tool used is the *IDEA* method (Indicateurs de Durabilité des Exploitations Agricoles or Farm Sustainability Indicators). The agro-ecological scale comprises three components: domestic diversity, organization of space and farming practices, summing up 18 indicators. Analysis of the results showed that the surveyed farms are characterized by a low agro ecological sustainability (45.97/100) mainly explained by the limited diversity of perennial crops, lack of crop rotation, poor use of space and water, many failures in the management of fodder resources, the non-protection of soil resources, and high energy dependency.

Key words: Assessment, sustainability, indicateurs de durabilité des exploitations agricoles (IDEA) method, dairy cattle, Mitidja.

INTRODUCTION

Mitidja, long coastal plain of 1400 Km^2 located at the centre of Northern Algeria is one of the country's most fertile plains. Its economic and social importance is measured by the extent of its surfaces, to the actual labour and production values. The four departments who administer (Algiers, Boumerdes, Blida and Tipaza) those areas produce more than half of Algeria's citrus production and 20% of rosacea. This plain also houses 75% of tree seedlings production nurseries and horticultural plants in Algeria.

As an alternative for the cultivation adopted in the 70s, following the uprooting of vines in Mitidja, was to create a dairy shed. Thus, an import of high production cows program has been implemented which has resulted in significant growth of this speculation, hence the name of dairy shed attributed to this plain. Competition for farmland is considerable, especially since the 90s urban pressure becoming stronger.

This fast and diffuse urban growth disrupts the structures of this peri-urban agriculture. The land needs to meet urban socioeconomic demand, make difficult farming in this plain which became the place of projection cities of Algiers, Blida, Boumerdes and Tipaza. Farms and especially cattle farms meet several constraints

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that result from evolution characterized by deficiencies in the management of space, higher pressure on the natural environment and strong competition between sectors and stakeholders, economic and social.

To this can be added the combination of other phenomena such as inadequate farming practices, land fragmentation and pollution. These are all contributing factors to the deterioration of the environment and lead us to question the agroecological sustainability of these cattle farms. Various methods based on a quantification of sustainability indicators have been designed to assess the sustainability concept (Biewinga and Van Der Bijl, 1996; De Koning et al., 1997; Rossing et al., 1997).

The *IDEA* method (Indicateurs de Durabilité des Exploitations Agricoles or Farm Sustainability Indicators) (Vilain, 2008) was selected. This method was chosen for its ease of implementation and adaptability to a survey in limited time. It allows us to draw up an inventory of farms regarding the environment as part of this study to assess the agroecological sustainability of 19 dairy cattle farms in the peri-urban area of the city of Blida.

MATERIALS AND METHODS

The analysis of the agro-ecological sustainability of dairy cattle farms in the peri-urban area of the city of Blida was performed using the *IDEA* method (Farm Sustainability Indicators) (Vilain, 2008). IDEA is based on the assessment scores that establish an overall performance of the farm, from 42 indicators. It assumes that it is possible to quantify the various characteristics of farming systems by assigning a numerical score, and then aggregate the information obtained to get a score or overall performance. The aggregation is based on a rating between 0 and 100, each of the following three scales: i) Agro ecological sustainability that analyzes the ability of a system to combine local resources and includes 18 indicators describing three components: Diversity (4 indicators), Organization of space (7 indicators) and Farming practices (7 indicators); ii) Socio territorial sustainability measures the insertion of farms in its territory and includes 18 indicators describing three components: Quality of products and land (5 indicators), employment and services (6 indicators), Ethics and human development (7 indicators); and iii) Economic sustainability that helps to understand the economic performance beyond the short term and economic uncertainties; and includes six indicators describing four components: Economic viability (2 indicators), independence (2 indicators), transferability (1 indicator) and efficiency (1 indicator). The overall performances of each scale of sustainability are independent and cannot be added. In this study, the choice to address only the agro ecological dimension whose objectives refer according to Viaux (1999) to the principles of integrated farming in order to as low as possible ecological cost is based on the observation made by Imache et al. (2010) which show that agriculture in the Mitidja plain suffers many disadvantages mainly related to a massive and uncontrolled urbanization. This phenomenon creates environmental problems such as land fragmentation, destruction of irrigation systems, shrinkage of grazing areas, trampling plots, vehicle traffic, pollution... which are all factors that threaten sustainability of farms in the plain.

This study is based on surveys carried out in January, February and March, 2012 in 19 farms over 7 municipalities of the *Wilaya* of Blida. Sample selection criteria are based on the dairy vocation of the farm, availability and collaboration of farmers and the need to cover a wide range of farms in terms of herd size, farming land and productions. The raw data was collected using a questionnaire, inspired by the IDEA method and included 64 questions. Afterwards data was processed to calculate the indicators of agroecological sustainability. Information obtained was entered into an Excel spreadsheet to create a database file on which the analyses were performed using Excel (2007) for the descriptive statistics (mean and standard deviations) and SPAD software to build a typology based on a factor analysis of multiple correspondences and hierarchical cluster analysis.

RESULTS AND DISCUSSION

Descriptive analysis of farms

The average agricultural area (useable agricultural area; and forage area) is 13.51 ± 11.06 ha. Standard deviations are significant reflecting a wide variability between farms. The Useable Agricultural Area (UAA) of our sample is strongly related to their legal status. Thus, 78% of the farms holding above 10 ha of UAA are owned by collective farms (EAC) and individual farms (EAI) all from the dismantling of the old state-managed farms as a result of the land reform of 1987. Forage crops are present in all surveyed farms with an average area of 7.96 ha of which 22.64% is irrigated. Forage crops were clover (17 farms), oats (13 farms), sorghum (9 farms), maize (4 farms), alfalfa (1 farm) and barley (1 farm). 52% of the farms grow fodder alone. Farms that combine forages and fruit growing stood at 47% of the sample while only 15% of farms grow cereal crops, in addition to the forage and fruit.

The cattle were reared at only 79% of farms. Sheep and goat farming was only present in three farms with a herd size not exceeding 10 heads. One farm practiced turkey farming with 2 flocks / year. There was a significant difference in herd size between the farms. This ranged from 5-144 heads for total cattle and 4-64 heads for the dairy cows. The average of Livestock Units (LU) on the farms totaled 4.79LU / ha of forage area. It appears lower than that reported by Bekhouche (2011) for the same area or 5.44 LU/ but is higher than 2.13 LU / ha observed by Bouzida (2008) for farms of Tizi Ouzou region.

The grazing pattern is not common in the study area since it concerns only 21% of farms. Finally, over 74% of farmers surveyed use to purchase, in addition of the concentrate, roughage mainly oats and vetch hay and straw which shows the growing gap between the livestock needs and production permitted by these farms.

Typology of farms

Figure 1 shows the projection of the 17 variables characterizing farm structure (Land capital, Livestock number, Labour, Irrigation, Crops,..) in the main plane of the MCA (Multiple Correspondences Analysis) retaining the first two factors accounted for 28.72% of the total

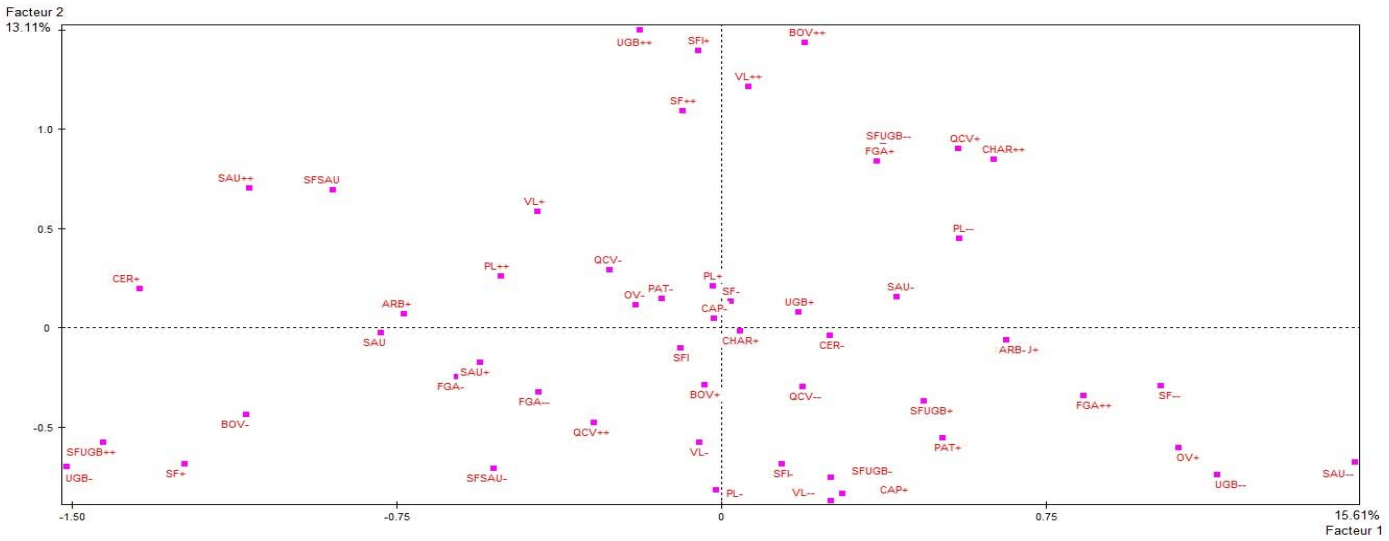

Figure 1. Projection of the variables in the plane 1-2 of the MCA.

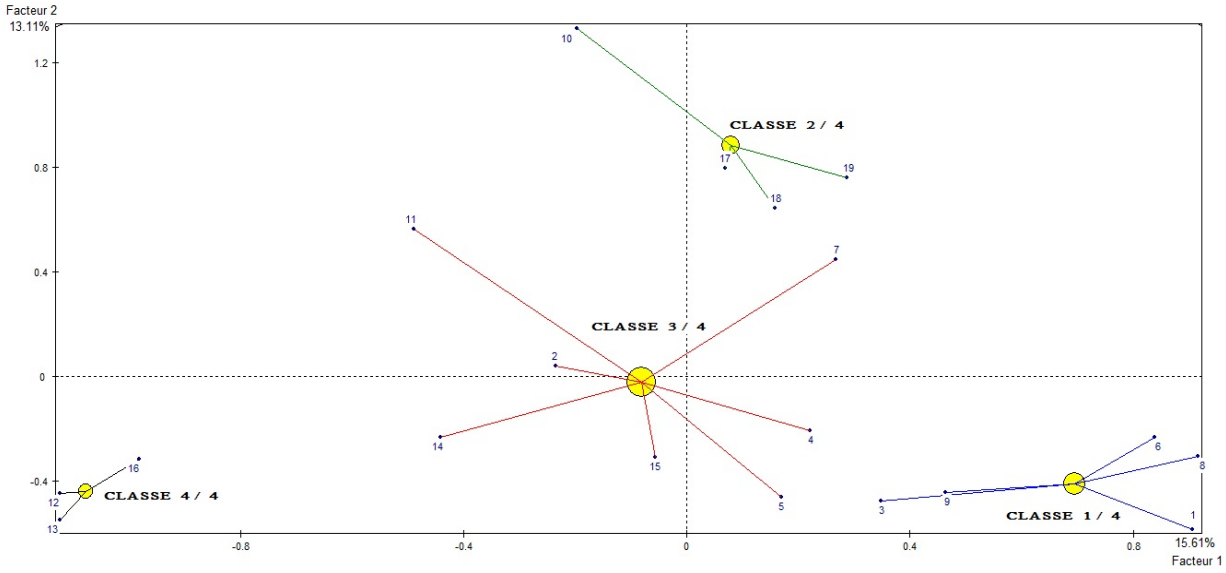

Figure 2. Paragons of the four cluster groups.

variability. Statistical analysis identified four groups (Figure 2):

Group 1 (small farms with relatively high stocking): Consisted of 5 farms (1, 3, 6, 8 and 9) is characterized by low UAA (3.75 ha) and by low forage acreage (2.20 ha). This group comprised the farms with a lower number of cattle and dairy cows respectively 8.00 ± 1.73 and 4.60 ± 1.67 heads but with a livestock load reaching 5.90 ± 5.99 LU / ha.

Group 2 (medium-sized farms with high stocking): Consists of four farms (10, 17, 18 and 19) which are characterized by a relatively average UAA and forage areas respectively 14.44 ± 16.56 and 8.50 ± 7.19 ha. This group is characterized by the presence of irrigated fodder production and herd size for cattle and dairy cows with respective averages of 76 and 38 animals per farm which implies a high stocking rates averaging 9.88 LU ± 7.74/ ha of forage grown on the farm.

Group 3 (medium-sized farms with low stocking): Consists of seven farms (7, 4, 5, 7, 11, 14 and 15) with an average UAA of 16.75 ± 8.03 ha of which 10.89 are reserved for fodder crops. Cattle number is on average 9.88 ± 7.74 heads which results in a low stocking rate of

Table 1. Notes of agro-ecological sustainability.

Components	Indicators	Scores	Bounds (Min-Max)	Percentage of the theoretical maximum score (%)
Diversity	A1. Diversity of annual and temporary crops	6.68±1.57	0-14	47.71
	A2. Diversity of perennial crops	3.31±4.11	0-14	23.64
	A3. Animal diversity	08±2.43	0-14	57.14
	A4. Enhancement and conservation of genetic resources	00±0.00	0-6	00
	Total of Component	**17.68±4.83**	**0-33**	**54.51**
Organisation of space	A5. Cropping patterns	0.36±0.53	0-8	04.50
	A6. Dimension of fields	4.42±1.02	0-6	73.66
	A7. Organic matter management	1.78±0.63	0-5	35.60
	A8. Environmental buffer area	1.15±1.07	0-12	09.58
	A9. Contribution to environmental issues of territory	00±0.00	0-4	00
	A10. Enhancement of space	1.05±1.68	0-5	21.00
	A11. Fodder area management	0.21±0.42	0-3	07.00
	Total of Component	**8.97±1.52**	**0-33**	**27.18**
Farming Practices	A12. Nitrogen balance	3.52±3.47	0-8	44.00
	A13. Effluent processing	02±0.00	0-3	66.66
	A14. Pesticides	9.36±2.99	0-13	72.00
	A15. Veterinary treatment	1.78±0.42	0-3	59.33
	A16. Soil resource protection	0.52±0.50	0-5	10.40
	A17. Water resource management	0.89±1.00	0-4	22.25
	A18. Energy dependence	0.94±1.50	0-10	09.40
	Total of Component	**19.01±6.10**	**0-34**	**55.91**
	Total	**45.97 ±5.03**	**100**	**45.97**

2.72 ± 1.55.

Group 4 (large farms with low stocking): Includes three farms (12, 13 and 16) is characterized on the one hand, the relative importance of the UAA with an average of 21.00 ± 10.44 ha of which nearly half (10 ha) is restricted to forage and, secondly, by the small size of cattle population is on average 12 heads per farm which translates into a very low stocking rate (1.02± 0.28). This group is also characterized by the presence of the orchard occupying an average of 11 ha of UAA.

Analysis of the agro-ecological sustainability

Scores on the scale agro-ecological sustainability vary from 34 to 60% with an average of 45.97% of the theoretical maximum (Table 1 and Figure 2). This value confirms those reported by Bekhouche (2004) and Bekhouche-Guendouz (2011) for the same study area 45, 14 and 45.20% respectively. It is against much lower than those recorded by Yakhlef et al. (2005) and Far (2007) for dairy cattle farms in the semi arid region of Setif 70.00 and 67.6% respectively. Benatellah (2007) obtained a higher value for the livestock farms of the Algiers suburban area or 55.70%.

The relatively low Agro-ecological sustainability of these farms is caused by zero or very low scores assigned to 11 of the 18 indicators informed (Figure 2). This is: 1) diversity of perennial crops (score:3.31±4.11), and 2) enhancement and conservation of genetic resources (score: 0) of diversity component, 3) cropping patterns (score: 0.36±0.63), 4) organic matter management (score:1.78±0.63), 5) environmental buffer area (score:1.15±1.07), 6) contribution to environmental issues of territory (score:0), 7) Enhancement of space (score : 1.05 ± 1.68) 8) management of forage area (score: 0.21±0.42), of the space organization component, 9) soil resource protection (score: 0.52±0.50), 10) water resource management (score: 0.89±1.00) and 11) energy dependence (score: 0.94±1.50) of the farming practices component. The zero score recorded by all farms is explained by the lack of specifications which the farmers undertake to respect and protect the natural heritage while the zero score for development and conservation of genetic resources indicator is caused by the total

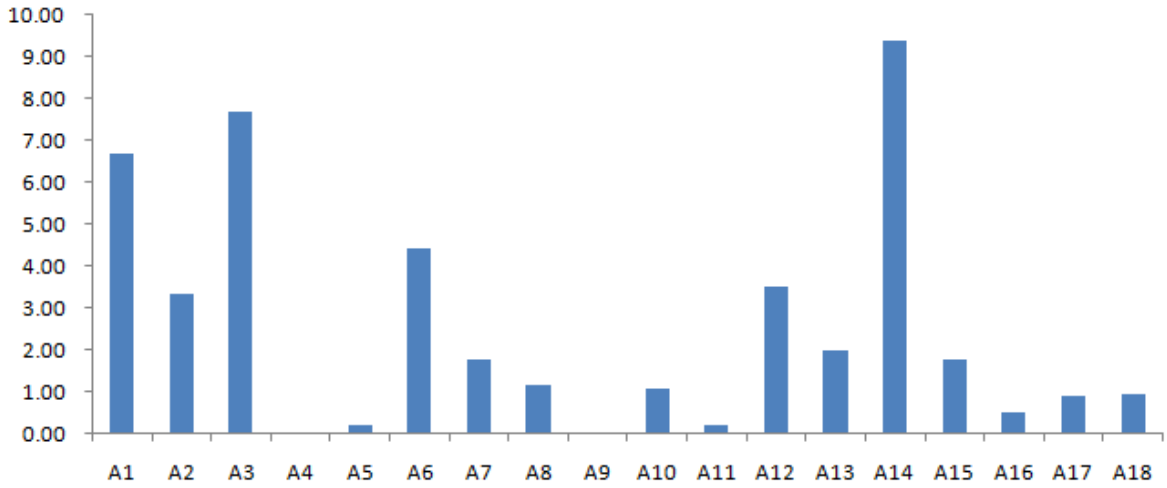

Figure 3. Average values of indicators.

absence of any regional, rare or endangered variety or breed (Figure 3).

The indicator scoring the diversity of perennial crops was low because the occurrence of permanent or temporary grasslands over 5 years of age is very small or more often absent because of the low UAA of farms and lack of water resources and irrigation equipment. The very low score for the cropping patterns indicator refers to the fact that 60.5% of surveyed farms do not practice crop rotation and 10% spent more than 50% of the cultivated surface to the main annual crop (oats). The survey results showed that the surface of environmental buffer area on farms was often lacking due to the absence of rivers, forest areas and small dams. It was also noted that the majority of farmers did not provide for erosion control measures. 50% of farmers use manure while others prefer to sell or exchange with mowed grass from orchards. There is an absence of slurry barn systems in the region. In addition, the use of nitrogen catching crops is scarce, and there is no compost is made from crop residuals. The low score for the protection of soil indicator is related to the lack of soil protection techniques such as mentioned by in the questions from IDEA (Vilain, 2008) (no-tillage technique, straw burning). Soil protection is limited in the majority of farms to a few trees as windbreaks. However, the practice of tillage is systematic in all surveyed farms as the regional soil type (heavy soils) requires loosening of the soil. The amount of irrigation on the farms depends on surfaces, water resources, the crop type and technical and financial resources available to farmers. The low score recorded by this indicator is due to the lack of use of waste water systems and the use of exhaustible water resources such as drillings with a depth of over 110 m, while the law limits their depth to 90 m. The energy dependence of the surveyed farms is very high. Fossil fuel oil consumption per hectare as much as 500 L can be explained by the lack of renewable energy sources (wind, solar ...).

Only two indicators have high scores. This is dimension of fields of space organization and pesticides of farming practices component. According to Mesli (2007), the majority of farms in Algeria are small with average size of about 6 ha which explains the score of 4.42±1.02 points on average a maximum of 6 assigned to the dimension of fields indicator. Finally, the survey revealed a low use of pesticide (fruit and vegetable crops) due to high cost price of chemicals.

Analysis of the sustainability of identified livestock farms types

Group 4 shows the highest level of agro-ecological sustainability (48.29±5.03 points) thanks to the better score recorded by the space organization component (12.32±1.53 points) (Table 2). The scores recorded by the indicator A10 (enhancement of space) explains the good performance of this component. Indeed, the stocking is an important element that provides information on the balance between the number of animals and forage areas that supplies them. The standard is around 1 to 2 Livestock Units per hectare of forage area (LU / MFA) is most often not met due to the small size of farm land. However, this group had the lowest score for sustainability regarding farming practices component mainly because of low ratings assigned to the indicators: A16 (soil resource protection), A17 (water resource management) and A18 (energy dependence).

The sustainability scores of the groups 2 and 3 are not statistically different, 45.75±5.44 and 45.31±5.87 points respectively. The sustainability level of the group 1 is lower; 43.6±3.36 points. These three groups are penalized by poor scores recorded by the space

Table 2. Notes of agro-ecological sustainability of identified livestock farms types.

Groups	Diversity	Organisation of space	Farming practices	Agro-ecological sustainability
1	15.20±3.42	7.40±2.30	21.00±5.29	43.60±3.36
2	19.20±7.33	8.25±1.89	18.00±7.70	45.75±5.44
3	16.17±4.15	8.70±2.56	20.44±6.75	45.31±5.87
4	21.66±2.31	12.32±1.53	14.31±4.72	48.29±5.03

organization component mainly because of the dominance of monoculture whose consequences are lack of pastures, poor management of farm land with simplified crop rotations. This diversity of livestock farming systems is also reported by Bekhouche (2011) for the dairy basin of Annaba. The author indicated that livestock systems encountered prefer the simplified crop rotations while sustainable farming systems seeking rather complex rotations (Vilain, 2008). The implementation of the IDEA method is a diagnostic and assessment tool has enabled an inventory of the current situation of cattle farms surveyed in the viewpoint of sustainability and highlighted the strengths and the weaknesses of different livestock systems identified.

Conclusion

The analysis of the agro-ecological sustainability of 19 dairy cattle farms in the suburban area of the city of Blida showed a variety of results. With an average of 45.97% of the theoretical maximum, the surveyed farms are below the threshold of sustainability of agro-ecological scale. Farms sustainability is based on livestock farming systems that are influenced by production region in which they are located. Thus, these livestock farming systems are characterized by an increased fragmentation of land, undeveloped fodder crops, improper use of concentrate, an appeal to the market to purchase a portion of roughage and very important competitiveness in water between livestock, home consumption, more profitable crops and industrial use.

If cattle occupy a strategic position in the agricultural and economic development of the Mitidja plain, sustainability seems to be compromised in the medium and long term by a set of environmental constraints such as the reduction of agricultural land, water resources and poor organization of space. Methodologically, the method does not purport to be perfect because the relationship between livestock and its context are little discussed. Furthermore, several indicators seem to lack precision in their methods of determining or overestimate the scores scales. Thus, in addition to the changes to be made to some indicators, it should also include other indicators such as urban and industrial expansion at the expense of agricultural land and give more importance to the water availability and origin factor.

Thus, in view of future validation of this method in the context of the Algerian agriculture, it is necessary in the component “improvement” to put into action a group of researchers, experts and farmers to study in detail the amendments to the IDEA matrix. These amendments must cover both the choice of indicators and ratings that variables that make up each indicator. However, this method is functional and allows operational approach for environmental constraints designed to educate farmers and policy makers to the concept of sustainability and the concept to better take into account the protection of natural environments.

Conflict of Interest

The authors have not declared any conflict of interest.

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