TYPOLOGY OF DAIRY FARMING SYSTEMS IN RABAT SUBURBAN REGION, MOROCCO

TIPOLOGÍA DE LOS SISTEMAS DE PRODUCCIÓN DE LECHE BOVINA EN LA REGIÓN PERIURBANA DE RABAT, MARRUECOS

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ADDITIONNAL KEYWORDS

Gross margin. Cattle sales. Milk yield. Cluster analysis. Principal components analysis.

PALABRAS CLAVE ADICIONALES

Margen bruto. Ventas de bovinos. Productividad lechera. Análisis de componentes principales.

SUMMARY

The characterisation of dairy cattle farming systems in the Rabat-Salé region, was achieved through regular enquiries of fourty eight farms representing the global variety of herding, during 2000/2001 agricultural campaign. Results show a broad variety of farmers strategies, particularly in feeding management and in cattle sales. Five groups of cattlemen have been distinguished based upon principal components and cluster analysis. First one is represented by 10 farms with limited dairy yield (2472 kg per cow) due to restricted consumption of concentrates. Average gross margin per cow was negative (-1686 Dh ≈ -168 Euros). Second category is dominated by profitable farms (gross margin per cow= 3057 Dh) with better milk yield per cow (3725 kg) combined to more important cattle sales. Third category illustrates farms which could not cope with limited forages area and therefore relied on intensive concentrates purchases, badly converted to milk. Evidently, their average gross margin was negative (- 928 Dh per cow), even though they had lost 3 heads of cattle by intensive sales (cattle represent 83.3 percent of the value of milk sales). At the opposite situation of the third group, the fourth one relies on forages, in a balanced way to satisfy cows requirements. These farms, with a milk yield per cow equal to 3258 kg, took advantage of a good valorisation of concentrates, which resulted in a production cost per kg of milk rather low (2.67 Dh). Fifth group is representative of specialised farms in suburban dairy production, because of intensive milk yield per cow (4024 kg) coupled with important use of concentrates. This was achieved even with limited sales of cattle, at the opposite of all the other categories of farms (variations in cattle stock was positive, with 12.8 cattle heads, indicating endogenous growth, due to calving). Historic and social factors behind the genesis of such farms in suburban areas of Morocco, and moreover technical skills to feed cows explain the variations in types of dairy husbandry. 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. Generalisation of uniformed promoting programs should thus be avoided, as each group is characterised by specific technical extension needs.

RESUMEN

Mediante encuestas en 48 fincas se caracterizaron los sistemas de producción bovina lechera en la región suburbana de Rabat-Salé en la campaña 2000-2001. Se detectó gran variedad de estrategias especialmente en lo relacionado con alimentación y ventas de bovinos. Mediante un análisis de componentes principales y una clasificación jerárquica ascendente, se identificaron cinco grupos de producción. El primero (10 fincas) con bajo rendimiento lechero (2472 kg/vaca), por consumo reducido de concentrados. El margen bruto por vaca fue negativo (-1686 Dh ≈ -168,8 Euros). En el segundo, predominaron establos rentables (margen bruto por cabeza de 3057 Dh) con rendimiento más elevado (3725 kg) y mayor venta de animales. El tercero lo constituyen explotaciones que no logran compensar los efectos de las deficiencias de forraje con el suministro de concentrados. Esto provoca una valorización poco eficiente de estos alimentos en leche, por lo que el margen bruto por cabeza es negativo (-928 Dh), debido a una variación de inventario negativa de 3 bovinos durante la campaña, por ventas elevadas (las ventas de bovinos representan 83,3 p.100 del valor de las ventas de leche). Opuestamente, el grupo 4 adoptó una estrategia de uso intensivo de forrajes, que representan 98,9 p.100 del valor energético de los concentrados, para cubrir las necesidades nutricionales de las vacas. Con un rendimiento lechero medio de 3258 kg por vaca, estos establos valorizan eficazmente los concentrados, puesto que obtienen un costo de producción por kg de leche relativamente bajo (2,67 Dh). El grupo 5 es representativo de un manejo de producción lechera especializado. El rendimiento por cabeza elevado (4024 kg) se asocia con un suministro de concentrados importante. El margen bruto por vaca fue elevado (3152 Dh), aún cuando estos establos hubiesen vendido bovinos (al contrario, tuvieron variaciones de inventario positivas de 12,8 animales mostrando así ganancias endógenas).

Los factores históricos y sociales subsiguientes a la implantación de establos suburbanos en Marruecos, y más aún las aptitudes de gestión técnica de alimentación del rebaño, explican las variaciones entre los sistemas de producción lechera. La diversidad de estos sistemas de producción debe ser tenida en cuenta para fines de desarrollo agrícola, especialmente en lo referente a la alimentación, para garantizar su sostenibilidad. La generalización de programas uniformes debe evitarse, puesto que cada grupo muestra exigencias muy distintas.

INTRODUCTION

Since the early 70's, an ambitious plan of dairy production development has been launched in Morocco to secure milk availability for a fast growing population (MARA, 1975). Its main target was farmers located in irrigated perimeters, as they could take benefice from regular forage production provided by secured harvests. However, with the rapid growth of Moroccan cities, simultaneous settlings of dairy barns next to consumers in suburban areas have been reported (El Khyari, 1987). As pointed out by many authors, animal husbandry in suburban perimeters often take place in conflicting contexts, mainly in developing countries: lack of surface to satisfy animals needs of forages, no proper wastes management and health hazards

(Centrès, 1996; Ben Salem *et al.*, 1998). Nevertheless, animal productions in such environments are vital for many urban inhabitants, as they provide them with regular cash, and they contribute to satisfy demand for fresh products (Moustier and Pagès, 1997; Debrah *et al.*, 1995). On another hand, very few aspects of dairy farming systems have been studied in Moroccan suburban regions with an overview approach, as systemic studies were applied successfully to assess animal productions projects in other regions of developing countries (Landais, 1983; Schiere et de Wit, 1993). Moreover, Roeleveld and Van den Broek (1996) emphasised the important role for livestock performances diagnosis, as a preliminary step to any promoting project, especially in underdeveloped countries. Systemic studies based on husbandry practices can also be an efficient way to examine the relations of farms to space utilisation and time, which could be of significant interest for understanding farms evolution (Girard *et al.*, 2001). Hence, lack of information on cattle husbandry practices and on cows performances can only hinder relevant efforts to enhance milk yield at farm-scale. In Morocco, existing references focused solely on high-input farms (Lakhdissi *et al.*, 1988; Sraïri et Kessab, 1998), practically ignoring the situation of smallholders, which represent 83 percent of the global number of dairy farms, as they detain more than 60 percent of the country number of cows. The present article aims to analyse farmers' strategies and management to produce milk, in order to elaborate a typology of dairy farms in the suburban perimeter of Rabat-Salé, in a context of very limited references on dairy production in suburban areas in Morocco. Such a typology would be a practical tool for further development effort in the dairy cattle industry at the regional scale, as it would allow the implementation of adapted measures to targeted groups of farmers (Sraïri, 2001).

MATERIAL AND METHODS

DATA COLLECTION

A benchmark survey of dairy cattle breeders was conducted in the Rabat - Salé perimeter from September 2000 to July 2001. A total of 48 cattle owners were interviewed and their herd performances were followed-up. Farms were chosen in coordination with local dairy breeders association (Chellah Association of Dairy Breeders). Main objective behind this selection was to get consequent number of different types of farms with diverse structural parameters and dairy practices and enough representative of the actual agricultural situation in the Rabat-Salé region (86 percent of total farms in the region with less than 10 ha of arable land and less than 5 cows, as reported by MADRPM, 2000). Data about dairy cattle barns structural parameters (surface, number of cows), management (feeding and reproduction) and economic results were collected. A ten-page data form was filled for each dairy cows unit. It was completed by four specific visits to each farm. These were separated by approximately 80 days in order to determine costs and income generated

Table I. *Variables describing dairy cattle farms and their symbols.* (Variables descriptivas del ganado lechero y sus símbolos).

Variables	Symbol
Arable Land	ALA
Number of cows	NOC
Variations in cattle number	VCN
Milk yield	MYI
Concentrates Energy per cow per year	CEC
Concentrates Energy per kg of milk	CEK
Forages/Concentrates Ratio	FCR
Average Milk Selling Price	AMS
Cattle/Milk Sells Ratio (percent)	CMS
Feed/Total Inputs	FTI
Production Cost per kg of milk	PCK
Gross Margin per Cow	GMC

from cows during a whole agricultural campaign. 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' reproduction. The third part investigated into economic results of dairy herds, after the analysis of total inputs and global animal sales (milk, cattle and manure).

Data analysis

A typology of cattle farming systems was set up from collected data. It took into account different elements of a farming system, i.e., the farmer (income, patrimony and history), the herd (composition and technical and economic performance), and the resources involved in dairy farming (Gibon *et al.*, 1999). The analyses were run with the statistical software package SAS. A total of 12 quantitative parameters were identified to describe dairy farms and their activities during 2000/2001 agricultural campaign **(table I)**. A principal component analysis (PCA) was used to detect main variables characterising farms sample while a cluster analysis was made to elaborate a final distribution of farms into homogenous groups. To achieve this, both PRINCOMP and CLUSTER procedures were used (SAS, 1998). A typology made of five groups was finally retained to synthesise the global diversity of cattle farming in the Rabat-Salé suburban region, assuming that farms sample gives an acceptable representation of the 3290 cattle farms in the region.

RESULTS

Herd structure and production efficiency

Average parameters describing the dairy farms sampled are summarised in **table II**. All together, there were important variations in parameters describing farms (i.e., structural variables such as land and number of cows, and technical and economic results). For example, there were an average of 18.4 ha of arable land per farm. Because of variability in structural parameters between sampled farms (from smallholders units with less than 1 ha to state farm with 386 ha), standard deviation (61.4 ha) was superior to mean value for this parameter. More than 80 percent of the farms used less than 26 percent of total land. There were as many as 13 farms with more than 10 ha of arable land. Forage reserved areas represented 31.7

percent of total land and were mainly made of oat, barley, and lupines followed by alfalfa and maize.

There was also an average of 12.6 ± 15.6 cows per farm. As for arable land, there was a huge variability in cattle number per farm due to the selection in our sample of different types of dairy barns (smallholders, specialised farms and state farms). Genetic structure was dominated by Holstein Friesian (98 percent of total cattle), followed by crossbred local x Holstein Friesian cows (2 percent). Mean milk yield per cow was 3218 ± 1087 kg. The analysis of cattle feeding showed that forages only represented 46.3 percent of the energy derived from concentrates ingested by cows. Feed costs were up to an average of 81.0 percent of total inputs. This important use of concentrates often resulted in their misuse, as they contributed to maintenance requirements, in a situation when forages were lacking and with frequent unbalanced rations.

Reproduction performances, calculated for only 45 cows, as there was an important lack of information on reproduction data in farms, were rather unsatisfactory, with an interval between calving of 428.6 days. Even if artificial insemination (AI) was widely adopted (46 from the 48 farms), only few farms had regularly updated files, with correct data. Economic results of the dairy farms were characterised by wide variations, from positive to deficit. When average profitability generated by one cow was 1553 Dh (approximately 155 Euros), it fluctuated from -8706 to 12133 Dh.

MULTIVARIATE ANALYSIS

Main purpose of the multivariate statistical analysis was to emphasise type of links between descriptive variables that characterise dairy farms economic and technical results and to

Table II. *Dairy farm characteristics in the Rabat-Salé region (N= 48 farms).* (Características de las explotaciones lecheras en la región de Rabat-Salé (N= 48)).

Parameters	Minimum	Average ± standard deviation	Maximum
Arable land (ha)	0,0	18.4 ± 61.4	386
Number of cows	1	12.6 ± 15.6	90
Total milk production per herd (kg)	1408	43850 ± 89766	594186
Milk yield per cow (kg	1130	3218 ± 1087	6602
Concentrates*/per cow/year	1209.4	3755 ± 1289	6556.9
Concentrates*/kg of milk	0.66	1.41 ± 0.48	2.69
Forage/Concentrates Ratio (percent)	8.9	46.3 ± 40.2	95.0
Cattle/milk in gross product (percent)	0.0	52.3 ± 86.1	406.2
Feed/total costs (percent)	47.8	81.0 ± 15.1	100.0
Gross margin per cow (Dh)**	- 8706.0	1553.5 ± 4286.9	12133.2

*Amounts of concentrates expressed in Mcal of Net Energy. **Dh: Moroccan Dirham: 1 Dh ≈0.1 Euro.

create homogenous groups of farms in relation to predominant variables. Principal Components Analyses were made in a two-steps process. In a first PCA, it was obvious that two farms were totally out of scale, because of structural parameters much different from average farms (in fact, it was a state detained barn with 386 ha of arable land and 90 cows, and a farm with no arable land, i.e., 1 cow in a private house). Thus, axis explanations were fully linked to structural parameters (arable land and cows number), not permitting to define classes of dairy farms according to breeding practices. This is why those two farms were ignored for a second principal components analysis. Results of the second PCA showed that three axes accounted for 63.3 percent of total variation in the farms sample, and axes were mainly explained by feeding and cattle products marketing, with no important correlation (>0.60) to structural parameters variables (arable land and number of cows) and milk selling price **(table III)**. Correlation between principal plan (defined by axis 1 and 2) and quantitative variables is reproduced in **figure 1**.

The primary axis, which represented 28.1 percent of the total variation, was interpreted as an axis differentiating between farms with important concentrates use and high production cost per kg of milk, with high feed/global inputs ratios and with residual forages in total supply of energy to cattle, from farms with opposite characteristics.

The second axis explained 19.2 percent of total variation and was mainly correlated to MYC (r= 0,74), CEC (r= 0,85) and FCR (r= - 0,66). Hence, it was considered as an axis which contributed to a better analysis of cattle feeding strategies.

The third axis (15.6 percent of total variation) reflects the economy of milk production. Thus, this axis will

Table III. *Results of the principal components analysis-axis definition.* (Resultados de la definición de ejes del análisis de componentes principales).

Axis	Axis definition Variables	Correlation to axis	Proportion (p.100)	Cumulative variation (p.100)
	Concentrates Energy per kg of milk	-0.81		
	Feed/Total inputs	-0.72		
1	Production cost per kg of milk	-0.62	28.1	28.1
	Forages/concentrates in energy supply	0.65		
	Concentrates per cow per year	0.86		
2	Milk yield per cow	0,74	19.2	47.3
	Forages/concentrates energy ratio	- 0.66		
3	Gross margin per cow	-0.86		
	Cattle/milk in gross product	-0.68	15.6	63.3

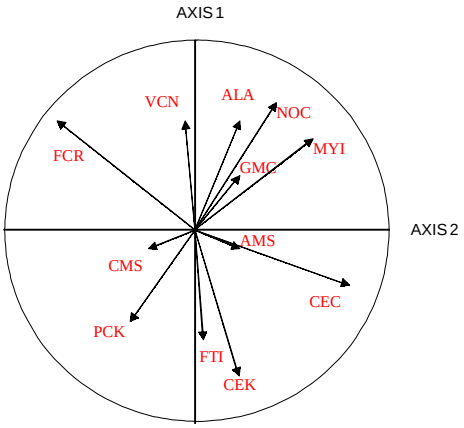

Figure 1. *Projection of technical and economic traits of dairy farms on axes 1 and 2 defined by the principal components analysis.* (Proyección de caracteres técnicos y económicos de las granjas lecheras en los ejes 1 y 2 del análisis de componentes principales).

emphasise differences between farms with negative gross margins per cow and with losses of numbers of cattle and farms with positive gross margins with accumulated animal wealth.

A cluster analysis was then conducted to establish the typology of farms. Five groups were finally selected, representing 45.9 percent of total variability **(figure 2)**.

Group 1 corresponds to 10 farms, which favour forages comparatively to concentrates in the energy balance of their herd (forages represent an average of 53,3 percent of energy derived from concentrates). There is an average of 2745.5 Mcal from concentrates per cow, which is less than the average amount of concentrates per cow for all farms (3755 Mcal). Feed inputs (both for forages production and for concentrates purchases) are however important (92.2 percent of total inputs), due to the high cost of forage production. Gross margin per cow is negative (-1686 Dh), as milk yield per cow is lower than the average (2472 compared to 3218 kg), and also because of a positive variation of cattle numbers, which means that those farms had few cattle sales (cattle represent less than 23 percent of milk sales).

The 15 farms of group nº 2 have milk yields superior to the average (3725 kg) and consumption of energy from concentrates per cow (4333 Mcal) higher than the mean value of 2209 Mcal. Economic results are positive due to cattle sales.

The third group is made of 9 farms. Their main characteristic is a massive consumption of concentrates per cow (4757 Mcal), which are not efficiently converted in milk (2583 kg per cow). Energy from concentrates per kg of milk is very high (3.76 Mcal), which means that roughage availability per cow is too limited (only the equivalent of 2.9 percent of the energy supplied by concentrates). Hence, concentrates are used primarily to satisfy maintenance requirements of cows, with negative economic results (-928 Dh/cow).

The fourth group, with 7 farms, is distinguished by a relatively higher proportion of energy derived from roughage comparatively to concentrates than the other groups (98,9 percent). The average gross margin per cow (3795 Dh) is obviously better than the mean value of 1553 Dh calculated for all cows in the studied sample. This result can be explained by good management in cows feeding and cattle sales practices.

The fifth group is made of 15 farms, all of them profitable, with an average gross margin per cow of 3151 Dhs. Average milk yield per cow (4024 kg) and feeding parameters show a clear intensification in milk production. These farms, with relevant aspects of economic sustainability, can be considered as specialised dairy units. An overall economic comparison of the 5 groups of farms identified through cluster analysis is presented in **table IV**.

DISCUSSION

Farming systems are usually defined through the interactions of breeders,

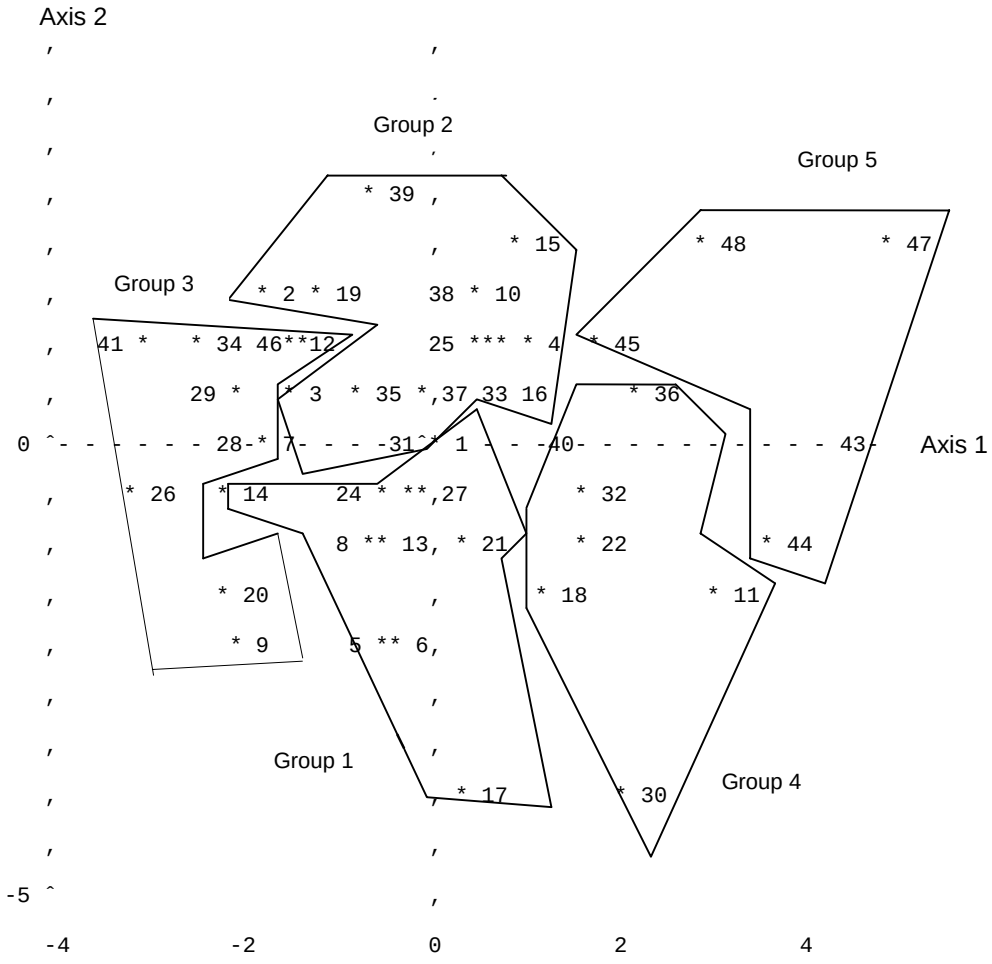

***Figure 2**. Projection of dairy farms in the primary space (defined by axes 1 and 2).* (Proyección de las granjas lecheras en el espacio primario (definido por los ejes 1 y 2)).

Table IV. *General comparison of parameters describing dairy farms groups shown by cluster analysis.* (Comparación general de parámetros descriptivos de las granjas lecheras según el análisis de cluster).

Parameters	Group				
	1	2	3	4	5
Number of farms	10	15	9	7	5
Arable land (ha)	4.34	4.16	5.25	7.43	58.6
Cows number	4.45	9.60	9.05	9.18	35.9
Milk yield (kg/cow/year)	2472	3725	2583	3258	4024
Concentrates*/cow/year	2747	4333	4757	2827	3488
Concentrates*/kg of milk	1.11	1.63	1.84	0.87	0.87
Cattle/Milk Sells Ratio (percent)	22.9	35.9	83.3	61.8	27.6
Forages/concentrates ratio (percent)	53.3	18.5	2.9	98.9	59.0
Feed/Total costs (percent)	80.1	69.7	87.0	67.7	73.7
Gross margin/cow (Dh)	- 1686	3057	- 928	3795	3152

*Amounts of concentrates expressed in Mcal of Net Energy.

herds and environmental conditions and resources (Lhoste, 1984). The multivariate analysis conducted in this study showed that variables reflecting breeding practices, i.e., feeding strategies and cattle sales, were predominant.

The focus should then be on the multivariate global typology that includes both structural technical and economic performances of different herd sizes. Kaminiecki *et al.* (1999) have pointed out in a recent study conducted in Poland, a significant difference in family dairy cattle farming. Laval *et al*. (1998) have also made a study to assess the diversity of camel farming systems in Rajasthan (India), using multivariate analysis as a tool to describe variations between groups of farms.

Farmers of groups 2, 4 and 5 were the most frequently observed in the sample. Those three groups represented 27 of the 48 farmers sampled, and they all have a mean milk yield per cow superior to 3200 kg per year. Forages contribution to total energy supply may be different in the three groups (respectively forages/concentrates ratio is 18.5, 98.9 and 59.0 percent), but they all show positive gross margin per cow. In group n°2, this was due to important sales of cattle combined to an efficient valorisation of concentrates, whereas in group 4, economic profitability relied on important forages distribution per cow. In group 5, it was due to a marked specialisation in dairy production (higher milk yields per cow due to intensive concentrates use), coupled to a low value of cattle sales. The state farm which has been taken away of the sample to achieve principal components analysis, has 90 cows, with a milk yield of 6602 kg per cow, and 386 ha of arable land. It can be

described as a peak of this dairy farms specialisation. In previous studies related to other farms belonging to the same state society, similar dairy practices were also identified (Sraïri and Kessab, 1998).

In the third group, there are 9 farms that are not profitable anymore, as average gross margin per cow is -928 Dh. These farms typically illustrate the case of smallholder dairying worsened with reduced technical know-how, mainly in the field of cows feeding. Even though concentrates consumption is important, milk yield is lower than the average value (2583 versus 3218 kg). In this category, typical concentrates waste occurs, as there are 1.84 Mcal of energy derived from concentrates per each kg of milk. This means that concentrates are also used for cows maintenance requirements, unless there are unbalanced nitrogen/energy ratios or mineral deficits in total feed ingested by cows (Jarrige, 1988).

Group 1, is very different from the others, as it is dominated by farms who do not use enough concentrates (2747 Mcal from concentrates per cow versus mean value for all sampled farms of 3755 Mcal). In fact, average milk yield per cow is by far under mean value (2472 versus 3218 kg). This kind of farms suffers from limited financial means to be able to purchase concentrates, which affects badly their milk yield per cow and consequently their economic results.

For development perspectives, it is obvious that adapted research to dairying in suburban regions (scarce forage availability and high animal load per ha) is urgently needed in Morocco. Technical advice in the field of feeding and conceiving adapted rations with poor roughages and locally available concentrates, and forages exploitation and conservation by ensiling means should be effective. As concentrates are widely used, it is mainly their mixing in adapted formulas to variable forages that could provide significant results, as it has been observed that both group 3 and at a lesser level group 2 use a lot of concentrates. On another hand, modern facilities in the field of reproduction (hormone treatments) and AI generalisation can be effective tools to enhance herds breeding value, at a time when few farms keep regular control on their herds reproductive health. Prophylactic methods should also be set up for various parasitic diseases, in a context where few herds get preventive treatments. All categories of breeders should be handled, with a special reference to smallholders, with less than 5 ha, which represent 36 of the 48 studied farms (groups 1, 2 and 3), and which are more present in reality. But targeted measures are necessary, to avoid the failure of technology transfers, as it has happened with urea-treatments for straw or leyfarming in the Mediterranean region (Christiansen *et al.*, 2000; Wanapat *et al.*, 1998). Therefore, high capital needing techniques should be avoided. 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 Roelevled and Van Den Broek (1996). Then, those farmers could show the way to others. This should be considered properly by development decision-makers.

CONCLUSION

In a context of lacking references on dairy practices and economy in suburban regions in Morocco, this survey of 48 cattle farms in the region of Rabat-Salé, capital city of the Kingdom, has confirmed that a broad variety of styles of cattle farming exists. It can be explained mainly by strategies adopted by farmers to feed their herd and cattle sales. Even though 98 percent of cows are of high genetic merit (Holsteins and Friesians), average milk yield per cow remain weak (3218 kg) with a wide variation from 1130 to 6602 kg, and gross margin per cow varies from negative situations to positive ones. Multivariate statistical analyses have allowed the identification of five different groups of farmers, based only on milk yield per cow, feeding strategies and cattle sales, with no link to structural parameters. A large amount of farms are grouped under the category of relatively profitable farms (groups 2, 4 and 5 in the present typology, which represent 27 farms), but could get better results with enhanced milk productivity, by the means of intensive dairy breeding techniques (feeding, milking, mating plans...). As our results show that feeding strategies are crucial to discriminate between profitable and deficit farms, any development measure should focus in priority on the improvement of the current limited feed formulation practices and untargeted use of concentrates. On another hand, there are 19 farms with economic losses (groups 1 and 3). In third group, this is due to unadapted animal load coupled to heavy purchases of concentrates, not converted in milk. Unbalanced feeding rations are surely responsible for this situation. In first group, there is at the contratry unsufficient concentrates use. As a matter of fact, it appears finally that the elaboration and extension of local feed (not only concentrates but also forages) nutritive value databases is urgently needed, as it would allow all farmers and technicians in charge of dairy production to design balanced feed formulas for cattle, which is the only way to reach sustainable dairying in suburban conditions.

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REFERENCES

Ben Salem, H., N. Moujahed et F. Beji. 1998. Les systèmes d'élevage bovin laitier intensifs hors-sol: rentabilité et reproductibilité?. Cas de la région de Sfax. *Médit.*, 4: 22-26.

Centrès, J.M. 1996. L'élevage et l'agriculture en zones urbaines et périurbaines dans deux villes sahéliennes: Bamako et Bobo-Dioulasso. *Cahiers Agricult.*, 5: 373-382.

Christiansen, S., M. Bounejmate, H. Sawmy-Edo, B. Mawlawi, F. Shomo, P.S. Cocks and T.L. Nordblom. 2000. Tah village project in Syria: another unsuccessful attempt to introduce ley-farming in the Mediterranean basin. *Experiment. Agric.*, 36: 181-193.

Debrah, S., K. Sissoko et S. Soumaré. 1995. Étude économique de la production laitière dans la zone périurbaine de Bamako au Mali. *Revue Elev. Méd. Pays. Trop.,* 48: 101-109.

El Khyari, T., 1987. Agriculture au Maroc. Ed. Okad. Casablanca, Maroc. 327 p.

Gibon, A., A.R. Sibbald, J.C. Flamant, P. Lhoste, R. Revilla, R. Rubino and J.T. Sorensen. 1999. Livestock farming systems research in Europe and its potential contribution for managing towards sustainability in livestock farming. *Livest. Prod. Sci.*, 61: 121-137.

Girard, N., S. Bellon, B. Hubert, S. Lardon, C.H. Moulin and P.L. Osty. 2001. Categorising combinations of farmers land use practices: an approach based on examples of sheep farms in the south of France. *Agronomie*, 21: 435-459.

Jarrige, R. (Ed.). 1988. Alimentation des bovins, ovins et caprins. INRA. Paris, 476 p.

Kamieniecki, K., J. Gnyp and J. Trautman. 1999. Technical and economic characteristics of dairy farms in Central-East Poland. *Livest. Prod. Sci.,* 61: 301-306.

Lakhdissi, H., A. Lahlou-Kassi et M. Thibier. 1988. Conduite de la reproduction en grands troupeaux laitiers dans les conditions marocaines. I. Influence du programme d'action vétérinaire intégré de reproduction sur les bilans de fertilité. *Rev. Elev. Méd. Vét. Pays Trop.*, 41: 293-299.

Landais, E. 1983. Analyse des systèmes d'élevage bovin sédentaire du nord de la Côte d'Ivoire. Maisons-Alfort, France. IEMVT, Volume 1 and 2, 789 p.

Laval, G., N.D. Khanna and B. Faye. 1998. A typology of camel farming systems in Bikaner and Jaisalmer districts of Rajasthan, India. *Rev. Elev. Méd. Vét. Pays Trop.*, 51: 147-154.

Lhoste, P. 1984. Le diagnostic sur le système d'élevage. Cahiers de la Recherche-Développement, Volume 3-4, 84-88.

MARA (Ministère de l'Agriculture et de la Réforme Agraire). 1975. Plan Laitier. Rabat, Maroc. 87 p.

MADRPM (Ministère de l'Agriculture, du Développement Rural et de la Réforme Agraire). 2000. Recensement Général de l'Agriculture. Résultats par Commune. Rabat. Maroc. 55 pages.

Moustier, P. and J. Pagès. 1997. Le périurbain en Afrique: une agriculture en marge?. Courrier de l'Environnement (INRA France) 32: 87- 98.

Roeleveld, A.C.W. and A. Van Den Broek. 1996. Focusing livestock systems research. Royal Tropical Institute, Amsterdam. 151 p.

SAS. 1998. SAS/SAT User's Guide (Release/ 7.0). SAS Institute Cary, NC. USA.

Schiere, J.B. and C.T. De Wit. 1993. Feeding standards and feeding systems. *Anim. Feed Sci.Technol.*, 43: 121-134.

Sraïri, M.T. 2001. Déterminisme et applications de la recherche systémique pour l'étude de l'élevage laitier. Courrier de l'Environnement de l'INRA (France). 42, pp. 29-46.

Sraïri, M.T. et B. Kessab. 1998. Performances et modalités de production dans six étables laitières intensives au Maroc. INRA *Prod. Anim.*, 11: 299-304.

Wanapat, M., M. Chenost, F. Muñoz and C. Kayouli. 1998. Methods for improving the nutritive value of fibrous feed: treatment and supplementation. *Ann. Zootech.*, 45: 89-103.

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