Typology, productivity and socio-economic profile of dairy farms in Mostaganem province, Algeria

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Abstract

The study purposes were to assess farms performance, describe socioeconomic profile, and create a farming system typology of dairy farms in Mostaganem province, Algeria. From January 2020 to March 2021, a survey of 56 dairy herds was conducted to evaluate general management and production in farms. Farmers were randomly selected and data was collected using face-to-face surveys. The majority of farmers had no training in dairy farming, 57% of them were over 45 years. Farmers had on average 11.44 dairy cows, with Holsteins being the most common breed. The average agricultural land used was 5.49 ±10.95 ha, while forage area averaged 0.6 ±1.42 ha. As a result, fewer farmers (21%) were able to provide their own feed. The mean daily milk yield per cow was 18.19 ±3.43 litres. Nearly 89% of farmers allowed a voluntary waiting period of 76.6 ±26.73 days, and the mean calving interval was 14.76 ±1.29 months. Cows were bred through natural mating, and oestrus detection was done occasionally without the use of heat detectors. Only 16% of farms maintained a herd control program with a veterinarian. In total, 41% of farmers sold calves aged between 1 to 2 years. The typology of surveyed farms indicated four clusters; big farms with substantial number of cattle; small farms with high cow population; small farms with high milk yield and medium-sized farms. Our research uncovered various flaws in the dairy farming systems in the assessed region that require a strategy to address in order to improve the dairy industry.

Keywords: Cattle, Dairy, Farm demographics, Herd, Survey
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Introduction

Algeria's dairy industry is a significant economic sector; dairy products imported in 2017 were valued at 465,000 tons. Milk powder accounted for 90% of the value which amounted to US$ 1.41 billion (Bessaoud *et al*., 2019), making Algeria one of the world's largest importers of whole milk powder (WMP) (FAO, 2021). According to the ministry of agriculture and rural development (MADR), Algeria has a cow population of 942,828 heads and a national cow milk production of 2.7 billion litres per year in 2016 (MADR, 2018). However, national milk production is insufficient to fulfil market demand, covering approximately 60% of consumption. Milk output and quality are a function of dairy farms' technical and production systems, as well as production scale, farming management, control procedures and milking hygiene practices. The lack of data concerning the dairy production system, characteristics and performance in Algeria are barriers to the country's dairy industry's development. Improving milk yield and quality need advancements throughout the whole production system. Through enhanced management strategies and adoption of cutting-edge technology, milk yield and quality, and animal welfare are constantly improving across the world. Farmers are motivated to seek more precise agricultural data in order to make informed decisions. The farming system concept, developed using a systems approach, is a comprehensive and multi-attribute explanation of extremely complex agronomic, social and ecological problems on the farm and inside the farm household (Kostrowicki, 1977; Dixon *et al*., 2001; Milán *et al*., 2003; Madsen & Adriansen, 2004; Ruiz *et al*., 2008). Because the success of each farm is based on its unique farming system, farm typology in a certain location refers to many forms of farming (Castel Gens *et al*., 2010). Typology is a categorisation strategy for agricultural systems that directs study on techno-economic concerns by evaluating the operational processes of these systems in their whole. A similar strategy would need a considerable investment in extension services in order to develop an efficient advice network for farmers, as well as all rural players and society (Madry *et al*., 2016).

The objective of this study was to provide information about the socioeconomic profile and performance of dairy farms in Mostaganem province, as well as to make data available on farm productivity, particularly the diversity of farming systems used, and thus to carry out a typology that

leads to a better understanding of current production systems and management practices. This will undoubtedly contribute to the development of Algeria's dairy industry.

Materials and Methods

Study region

The province of Mostaganem is located in the north of Algeria and has a total area of 2,269 km^2.It is separated into two different regions: the plateau and the Dahra highlands. The province's relief map shows that the territory is geographically separated into four morphological divisions: the West's low valleys, the Dahra Mountains, the Mostaganem plateau and the East's valleys.

Mostaganem province has a total agricultural area of 177,310 hectares, of which 132,268 ha is usable agricultural land, 42,870 ha is irrigated agricultural land, 15,970 ha is fodder land. Vetch-oats, maize, sorghum, barley and oats are the principal fodder crops grown in the region. The district of Mostaganem has a total of 31,900 cattle, including 21,100 dairy cows (DSA, 2021).

Data collection

From January 2020 to March 2021, a survey was conducted on dairy cattle farms in Mostaganem province. Farms were chosen using a stratified random sampling approach. The farmers were randomly selected from a list of dairy producers supplied by the agricultural services office. A total of 56 farms with 1,141 cattle, including 641 dairy cows agreed to participate in the survey. The survey was designed to collect information about dairy farm management and performance. To collect data and describe the diverse techniques employed by farmers in dairy herds, a face-to-face interview with the farmers using a structured questionnaire and a visit to the barns were done. The questionnaire was divided into the following sections: farm demographics; housing and hygiene; cow feed management; milking and milk yield; and, lastly, reproduction and culling rate.

Statistical analysis

All data gathered was organised into a database using Excel software (2016). To determine the most representative variables, data was processed using a multiple factor analysis (MFA) utilising the program FactoMiner under the R environment. To carry out the typology of the dairy cow farms in Mostaganem province, a total of 12 qualitative and quantitative variables were chosen. Age of farmers (ABR), total agricultural area (TAA), utilised agricultural area (UAA), forage area (FA), rate of forage area in UAA (FA/UAA), human work unit (HWU), cattle population (CP), dairy cow population (DCP), amount of concentrate (Q.con), milk production (MP), zone and type of building (TB) were the quantitative and qualitative variables chosen. Based on the MFA results a Hierarchical Ascending Classification (HAC) was done.

Results

Socioeconomic profile

The age of the farmers in the surveyed region ranged between 28 to 75 years old, with an average of 48.23 ±12.44 years. Almost 43% of farmers were under the age of 45, while 57% were above it (Table 1).

In terms of educational level, 25% of farmers were illiterate, 72% had a primary and secondary education, while only 4% had a university degree (Table 1). Despite this, about 46% of farmers have been in the dairy cattle farming industry for more than ten years.

Almost half of farmers (48%) identify as primarily dairy farmers, compared to 46% who identify as land farmers and 5% worked on other professions. In 36 farms, all farming activities were carried out solely by the farm owner while in the remaining 20 farms, the farmer either got assistance from family members or used hired labour. The average number of workers per farm was 1.5 ±0.8 with 55% working with family members while the remaining 45% used only hired labour. The vast majority of farmers (93%) had no training in dairy farming, only 7% had completed an animal husbandry training program. In general, 84% of all farms had a service provider with the veterinarian, which mean they consulted a veterinarian only in critical health problems of their animals, compared to just 16% of farms that had a partnership service or a herd health program.

Table 1 Profile of surveyed farms in Mostaganem province

Variables	Rate (%)
Age of farmers (year)	
≤ 35	23
36 to 45	20
46 to 65	50
> 65	7
Education levels	
Illiterate	25
Elementary	25
Secondary	47
University	4
Experience	
≤ 5	34
6 to 10	20
>10	46

Almost all farms (98%) housed cows in a conventional barn system, and only a few farms (2%) used a free-stall barn. The number of barns per farm ranged from 1 to 4, with an average of 1.21 ±0.59 barn per farm. It should be noted that 86% of farms contain only 1 barn. Barns were classified into three types: open (barn with only a roof), semi-open (barn with three walls and a roof), and closed (barn closed on four sides and with a roof). The closed type was the most regularly utilised barn type (75%), while the open type was the least usually used (4%).

Holsteins were the most dominating breed in the surveyed farms in the Mostaganem region, constituting 88% of reared cows (Figure 1).

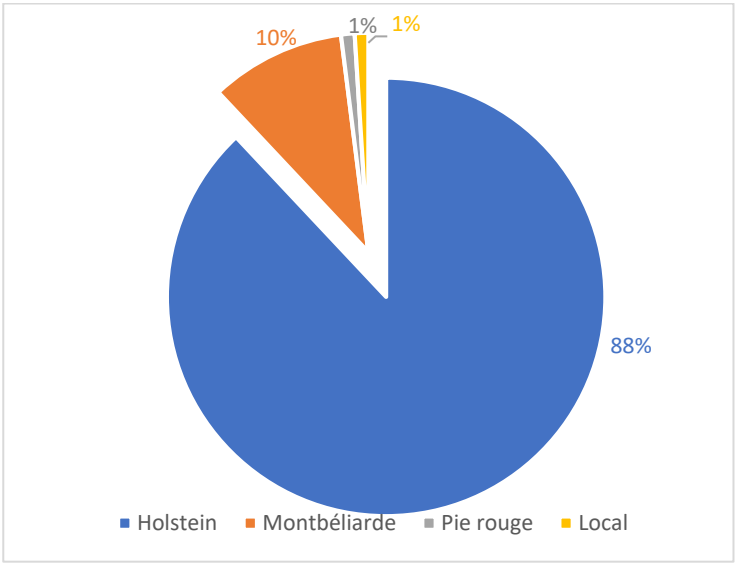

Figure 1 Cattle breeds raised in surveyed region

In addition, 66% of farmers raised just Holsteins, 2% of farmers reared only Montbéliarde and in 25% of farms both kinds were present.

The size of the dairy herd on the surveyed farms ranged from 2 to 194 cattle, with an average of 20.37 ±32.38 heads, while cows in the herd averaged 11.44 ±16.74 heads per farm (Table 2). The utilised agricultural area ranged from 0 to 70 ha, with an average of 5.49 ±10.95 ha. About 36% of farmers did not possess any agricultural land, 46% had a total agricultural area of less than 10 ha and 18% had a total agricultural area of more than 10 ha.

The forage area was small and varied between farms, ranging from 0 to 7 ha with an average of 0.6 ±1.42 ha, and the forage area rate was 14% in both the total agricultural area and utilised agricultural area. Only 55% of the farms studied irrigated their land, on average 2.75 ±5.09 ha was irrigated per farm.

Table 2 Characteristics of the surveyed farms in Mostaganem province

Variables	Mean± SD	MIN	MAX
CP	20.37 ± 32.38	2	194
DCP	11.44 ± 16.74	2	85
DCP/CP (%)	59 ± 17	27	100
TAA (ha)	5.52 ± 10.96	0	70
UAA (ha)	5.49 ± 10.95	0	70
FA (ha)	0.6 ± 1.42	0	7
IAA (ha)	2.75 ± 5.09	0	25
DA (ha)	2.74 ± 7.29	0	48
FA/TAA (%)	14 ± 26	0	100
FA/UAA (%)	14 ± 26	0	100
IAA/UAA (%)	40 ± 42	0	100
DA/UAA (%)	27 ± 37	0	100

CP: cattle population; DCP: dairy cow population; TAA: total agricultural area; UAA: utilised agricultural area; FA: Forage area; IAA: the irrigated agricultural area; DA: dryland area

Dairy farms productivity performance

The daily milk yield was on average 18.19 ±3.43 litres. The average lactation length was 293.5 ±12.4 days. Most farmers used the natural breeding method, 14% bred their cows through artificial insemination while 23% used both artificial insemination and natural breeding. Cows were infrequently detected in oestrus without the use of heat detectors. The average calving age was 24.32 ±0.93 months. A majority (89%) of farmers used a voluntary waiting period that varied from 30 to 120 days, with an average of 76.6 ±26.73 days. The calving interval was 14.76 ±1.29 months on average. A majority of 52% of the surveyed farms purchased the totality of livestock feed, 21% of farmers produced their fodder requirement, 27% of farms hadn't an efficient fodder production and purchased partially their feed. Oats, hay, sorghum, barley and alfalfa were the most commonly planted forages.

Few farmers (11%) sold calves a few days after calving, 14% raised and sold calves at less than a year old, 41% sold them between 1 and 2 years old, and 34% sold their calves more than 2 years old. Approximately 11% of farmers housed calves in individual pens, compared to 73% who gathered and housed calves in communal pens. Calves were chained to a wall on 11% of studied farms, while 4% of farmers raised calves on individual pens before transferring them to communal pens. None of the farmers utilised milk replacer for their calves. The average weaning age was 5 ±1.56 months.

In total, 34% of farmers reared another animal species in addition to cattle, sheep was the most common. Almost 93% of farmers reared their heifers for replacement and herd expansion.

Description of dairy cattle clusters

Data obtained was used to create a typology of dairy production systems. We used the FactoMiner package in the R environment to do a multiple factor analysis (MFA) to identify the most representative variables. To perform the typology of dairy farms in the Mostaganem region, 12 qualitative and quantitative characteristics were chosen.

Total agricultural area (TAA), utilised agricultural area (UAA), forage area (FA), rate of forage area in utilised agricultural area (FA/UAA), human work unit (HWU), cattle population (CP), dairy cow population (DCP), amount of concentrate (Q.con), milk production (MP), farmers age (ABR), type of building (TB), and zone were the quantitative and qualitative variables chosen. The variable projection accounted for 45.29% of the overall variation (Figure 2).

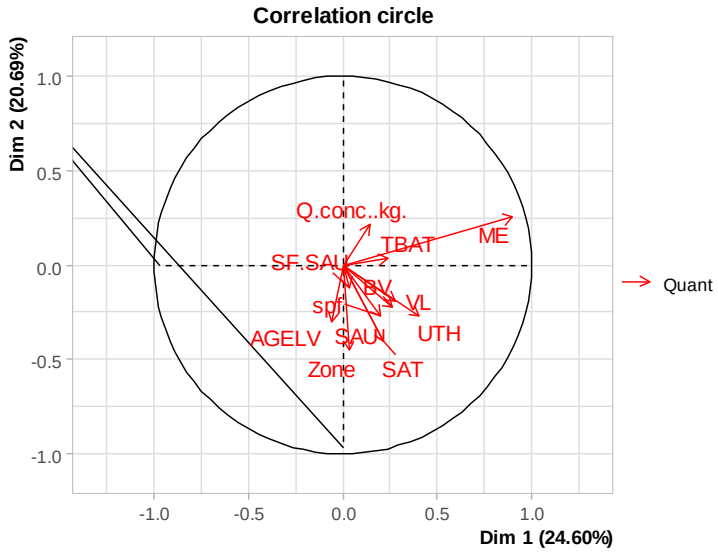

Figure 2 Projection of variables according to total variance

The multiple factor analysis findings were subjected to a Hierarchical Ascending Classification (HAC). A dendrogram depicts the conclusion (Figure 3). The typology indicated four groups, with two farms standing out as outliers. Figure 3 and Table 3 represent the main groups and their characteristics.

Cluster 1: includes 21 farms in total, accounting for 37.5% of the farms examined. Farmers in this group had an average age of 47.71 ±8.19 years. This cluster is made up of big farms with an average UAA of 6.75 ±8.07 ha; and a substantial cattle population of 20.09 ±40.26 heads on average, including 9.19 ±17.7 dairy cows. The forage area was small 0.6 ±1.36 ha on average, the rate of forage area comprised 13% of agricultural land. Farmers fed a daily concentrated diet of 9.33 ±1.93 kg per cow (Table 3). This group's yearly milk yield was the lowest near 4928.5 ±1096.4 L. In sum, 90% of these farms had a closed barn. Hired labour were on average 1.52 ±0.81 HWU per farm. In total, 81% of farms in this cluster were mainly located in the western region of Mostaganem.

Cluster 2: contains 13 farms, which account for 23.21 % of the farms surveyed. This cluster consist of small farms with an average UAA of 2.01 ±3.66 ha; and a high cow population of 11.53 ±20.78 dairy cows and19.61 ±33.02 cattle heads on average. The forage area was the smallest 0.28 ±0.37 ha on average. The mean daily concentrate ration distributed per cow was 9.92 ±2.46 kg. Farms in this group had an average yearly milk output of 5423 ±580.4 L (Table 3). Lowest number of labour units was employed, an average of 1.07 ±0.27 HWU. Barns in farms were of the closed type. Farms in this cluster were located in the east of the study area.

Cluster 3: constituted by 12.5% of all farms. This cluster comprises small farms with average UAA of 1.85 ±2.91 ha; and a high yearly milk output of 6171.4 ±731.9 L. Farmers in this group were the youngest 34.28 ±5.15 years on average. The cattle population was the smallest on average 11.85 ±4.52 head, including 10.14 ±4.59 dairy cows. The mean forage area was 0.64 ±1.10 ha, and the FA/UAA rate was the highest (18% on average). The average number of human labour units employed was 1.4 ±0.53 (Table 3). Farmers in this group fed the most concentrate, on average 13.42 ±1.51 kg per cow. The closed style of barn dominating. Approximately, 86% of farms in this cluster were located in the eastern area of Mostaganem.

Cluster 4: This category contains 13 farms, accounting for 23.21 % of all farms. Farms in this category were medium-sized, owning on average 3.42 ±6.72 ha of utilised agricultural land; and mean cattle population of 16.3 ±14.24 heads, including 10.38 ±8.79 dairy cows. Forage area was medium averaging 0.38 ±0.46 ha. This group's farmers fed a small daily quantity of concentrate per cow, on average 8.69 ±2.05 kg. Farms in this group had a mean yearly milk production of 5700 ±940.7 L. The greatest HWU employed was 1.53 ±0.96 unit (Table 3). The Eastern area of Mostaganem was the location of 92% of farms included in this cluster.

Exceptions: Farms E.2 and E.24 differed from the previously identified clusters (Figure 3). Farm E.2 had the highest number of cattle compared to all surveyed farms, with 105 heads including 60 dairy cows, and the highest yearly milk output of 7500 L. Concerning farm E.24, it had the most used agricultural and forage land of 70 ha and 7 ha, respectively, as well as a herd of 62 cattle and a significant milk output of 6900 L.

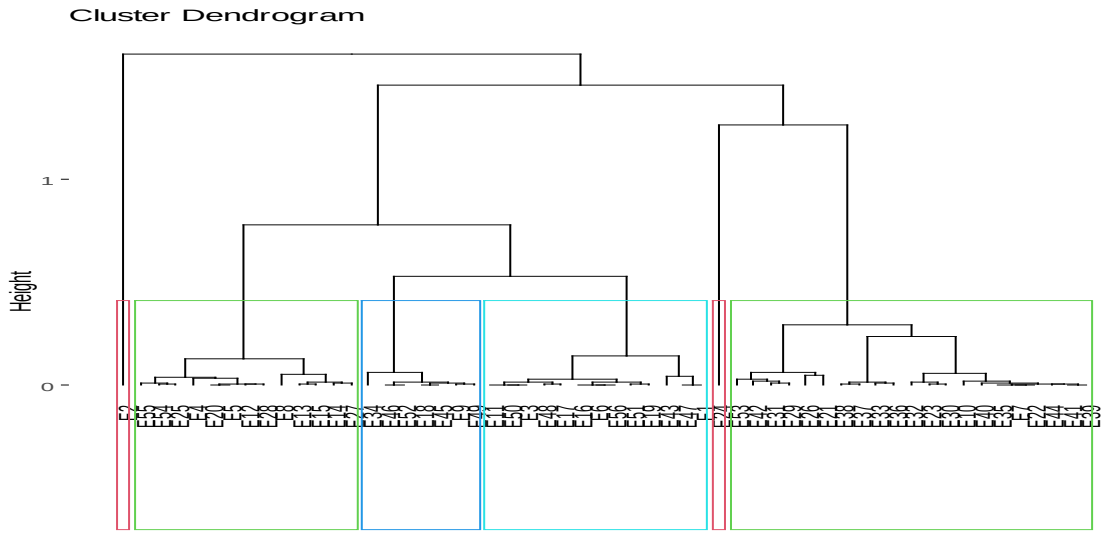

Figure 3 Dendrogram of different clusters with the same characteristics in the Mostaganem province

Table 3 Characteristics of different identified groups

Variables	Cluster 1	Cluster 2	Cluster 3	Cluster 4	E.2	E.24
	Mean ± SD					
TAA (ha)	6.75 ± 8.07	2.01 ± 3.66	2.14 ± 3.53	3.42 ± 6.72	12	70
UAA (ha)	6.75 ± 8.07	2.01 ± 3.66	1.85 ± 2.91	3.42 ± 6.72	12	70
FA (ha)	0.6 ± 1.36	0.28 ± 0.37	0.64 ± 1.10	0.38 ± 0.46	5	7
FA/UAA (%)	13 ± 31	16 ± 29	18 ± 26	10 ± 12	42%	10%
CP	20.09 ± 40.26	19.61 ± 33.02	11.85 ± 4.52	16.30 ± 14.24	105	62
DCP	9.19 ± 17.7	11.53 ± 20.78	10.14 ± 4.59	10.38 ± 8.79	60	32
HWU	1.52 ± 0.81	1.07 ± 0,27	1.4 ± 0.53	1.53 ± 0.96	5	3
Q.con (kg)	9.33 ± 1.93	9.92 ± 2,46	13.42 ± 1.51	8.69 ± 2.05	8	12
MP (L)	4928.5 ± 1096.4	5423 ± 580.4	6171.4 ± 731.9	5700 ± 940.7	7500	6900
ABR	47.71 ± 8.19	54.61 ± 8,19	34.28 ± 5,15	50.07 ± 11.40	33	65

CP: cattle population; DCP: dairy cow population; TAA: total agricultural area; UAA: utilised agricultural area; FA: forage area; DA: dryland area; HWU: human work unit; Q.con: concentrate feed; MP: milk production; ABR: age of farmers

Discussion

Dairy industry demographics, such as herd size, extension plans, farmer age and education level can give vital information on what is presently happening and what will happen in the future of the industry (VanLeeuwen & Keefe, 2001). According to our findings, the average age of farmers was 48.23 years, 57% of them were over the age of 45, which was almost similar to the proportion of Canadian farmers who, according to Luby *et al*. (2020), about half of them (52.7%) were over the age of 50 years. In addition, they were older than the average age of Malian farmers (40 years) reported by Touré (2020). In the investigated region, the dairy farms were practically held by an older generation.

A few farmers (4%) had a university degree, and the majority had no training. This is notably different from Canadian farmers, who had a university degree in 63% of cases (Renaud *et al*., 2017). Dairy farming management necessitates a particular degree of knowledge and training, farmers require high skills or competent consultants in order to successfully manage various dairy farm systems (Eastwood *et al*., 2017). Furthermore, the farmers' positive attitude, knowledge and abilities were a consistent important component in high-performing farms (Bone, 2005).

The examined region's herd size was less than that of Relizane province, which was 33.6 cattle (Meskini *et al*., 2020). It was also very small compared to Wisconsin average herd size of 851 dairy cows (Cook *et al*., 2016). Mostaganem average utilised agricultural area was 5.4 ha, which is lower than the 42.7 ha

of utilised agricultural area in North Algeria (Boukhechem *et al*., 2019), and significantly lower than the agricultural area of Pennsylvanian dairy farms which was 115 ha (Holly *et al*., 2019). The average fodder area of surveyed farms was 0.6 ha, which was less than the 7.60 ha forage area of farms in Algeria's east (Bir *et al*., 2014).

The main breed in the study region was Holstein. In agreement, most farms in western Algeria were reported raising Holstein breed (Meskini *et al*., 2021; Yerou *et al*., 2019). The vast majority of farms (84%) hadn't any animal health management systems in place in partnership with veterinarians to increase animal welfare, herd performance and decrease production losses caused by different diseases. Winder *et al*. (2016) found that 90% of Ontarian farmers had a regular herd health check with their veterinarian, and 42% had veterinary visits at least every two weeks. Almost all farmers kept dairy cows in traditional barns, in contrast to other countries where the most common housing system was the tiestall system (Popescu *et al*., 2013).

None of the farms investigated used a milk replacer. Only 4% of the farmers used individual pens before transferring calves to communal pens. According to Medrano-Galarza *et al*. (2017), the majority of Canadian farmers using both automatic and manual feeding systems utilised milk replacer for calves. Furthermore, according to USDA (2016), the majority of pre-weaned calves in the United States were kept primarily in individual hutches before being transferred to group pens. The weaning age was relatively late in surveyed herds compared to United Kingdom farms, where the usual weaning age was between 6 and 8 weeks (Palczynski *et al*., 2020). In contrast to Canadian farmers (59%), who sold calves within 2 weeks of birth (Luby *et al*., 2020), around 41% of farmers reared and sold calves between 1 and 2 years of age.

Milk output was greater in surveyed farms than in the research of Boubekeur and Benyoucef (2014) in South Algeria, where the average milk yield was 11.4 l/cow. The milk production was much below the potential of farmed cows; also, the average milk production per cow per year in the United States was 10,785 kg (USDA, 2021). The low productivity of dairy cows in surveyed farms can be attributed to insufficient feed rations and a lack of forage land. Indeed, the cows ration wasn't based on any formula, in addition, just 21% of farmers produced their own fodder. According to Cela *et al*. (2014) study in New York state, farms generated 75% of feed in farms, and 39 % of tillable land was planted with maize, 57% with hay, and 4% with other crops.

The high usage of natural breeding reported in this survey was similar to the east area of Algeria, where 80.33% of farmers adopted this strategy (Benidir *et al*., 2020), and unlike 81% of Canadian farmers using timed artificial insemination (Denis-Robichaud *et al*., 2016). The voluntary waiting period of 76.6 ±26.73 days in surveyed farms was higher than the optimum of 60 days, in general, a voluntary waiting period above 6 weeks is less profitable (Inchaisri *et al.*, 2011). In addition, the reproductive performance of the investigated farms was lower compared to Canadian herds; having an average voluntary waiting period of 58 days in milk, as well in 89% of farms visual oestrus detection was used 3.5 times/d on average, with an observation duration of 36 minutes (Denis-Robichaud *et al*., 2016).

Conclusion

According to this study, dairy farms were managed by aging farmers with minimal training. Only a few farmers maintained a herd control program with a veterinarian. Farms have little agricultural land and insufficient fodder space. Farmers in the survey area require a comprehensive training program or highly skilled workers. In addition, there is a strong desire to extend forage area through crop diversification in order to meet the fodder needs of herds. Farm output fell short of expectations, necessitating an improvement in productive and reproductive performance. Furthermore, in order to produce a high milk output, farmers must increase feed rationing and management by using an adapted contemporary ration for dairy cows. Our research uncovered numerous crucial aspects connected to poor dairy farming and performance that must be addressed in order to contribute to the growth of the dairy sector in the assessed region in particular and the country as a whole.

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Conflict of interest declaration

The authors have no conflicts of interest to declare.

Ethical statement

The aim of the study was stated to the dairy cattle farmers and their participation was voluntary and anonymous.

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