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Beef farming: farmers' strategies in the Grand Cheliff plains of Algeria

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Abstract. *Beef production is an important activity in Algeria, mainly located in the coastal and plains areas in the North of the country. In order to determine the strategy of beef farmers, a survey of 102 bovine farms was carried out in the Grand Cheliff plains of Algeria. Through this survey, three major classes of farms were identified: 1) small-scale livestock farmers with moderate means of production, an average Bovine Livestock Unit (BLU) of 3.18 and a production cost of 572 AD/Kg; 2) medium-scale livestock farmers, selling their production directly on the market, with a BLU of 10 and a production cost of 623 AD/Kg; 3) large-scale milk-meat farmers, with an average BLU of 22, and a production cost of 581 AD/Kg. Despite good organizational and financial performances, beef production in Algeria remains fragile, subject to climatic changes and dependent on foreign markets for the supply of raw material and inputs which constitute a threat to its sustainability (1 € = 140 Dinars).*

Keywords: Cattle breeding, meat, income, Cheliff plain, Algeria

Introduction

The Algerian red meat industry is exclusively based on cattle and sheep farming and is a strategic sector of the Algerian economy, helping to satisfy the protein requirements of a burgeoning population (Bencharif, 2001). This activity has recorded growth of 50%, from 220,000 tons of red meat produced in 1990 to 350,000 tons in 2011; an increase that concerns both cattle and sheep. The average red meat consumption by Algerians exceeds 10 kg per person per year (MADR, 2018). In fact, population growth and the deterioration of purchasing power have resulted in a 20% drop in red meat consumption during the 2000s, particularly, for the low-income class. This level of red meat availability is lower than that of neighboring countries and much lower than that of the European countries. This is partly due to the low fodder production, but mainly due to the high prices of red meat which have become quite dissuasive for a large part of the population (UBIFRANCE, 2013). Of the total red meat consumption, beef represents a proportion of 40%, while the remaining part is shared between sheep and goat meat (Chehat and Bir, 2008). Cattle breeding is one of the most important priorities of Algerian agricultural policies: subsidies for the import of heifers, investments in farms, extension of milk collection, broad support for artificial insemination and mobilization of water resources are the main measures taken to improve red meat production (Djebbara, 2008). Beef remains the primary activity of livestock farmers, although this sector remains fragile; it is subject to climatic changes and dependent on foreign markets for the supply of raw materials (barley, corn, soya, etc.); the prices of which are constantly increasing. This sector is facing major changes that represent a real challenge to its survival.

The first objective of this research was to analyze official data at the national level to better characterize Algerian red meat production and its evaluation. The second objective of this study was to characterize cattle farms in Northern Algeria (Cheliff), which supply the

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local population with beef. The study area, namely the Cheliff, was chosen based on the importance of cattle farming, animal handling structures and our knowledge of the social environment. In this region, livestock farming occupies a very important place in the Grand Cheliff, which is considered a place of shipment and transit of animals between the various parties. In the Grand Cheliff, cattle breeding is distributed around the major urban areas where most of the water resources are located.

Material and methods

The Grand Cheliff region

The Grand Cheliff is located in the North of Algeria (Figure 1), it covers an area of 4981.22 km^2, including 3849.06 km^2 of utilized agricultural area (UAA) (ONS, 2012). It is characterized by a semi-arid Mediterranean climate with variable annual rainfall ranging from a minimum of 300 mm to a maximum of 800 mm. It is an irrigated area with high potential and is the site that was chosen for the implementation of an intensive development model that meets the needs of the population in animal protein. This model was designed on the basis of an integrated agricultural production system using an association of cereal and cattle breeding and, therefore, on the complementation of plant and animal production thanks to the introduction of wheat varieties with high genetic potential, such as the Mexicali variety and imported European cattle breeds, such as Pie rouge, Pie Noir, Montbéliarde.

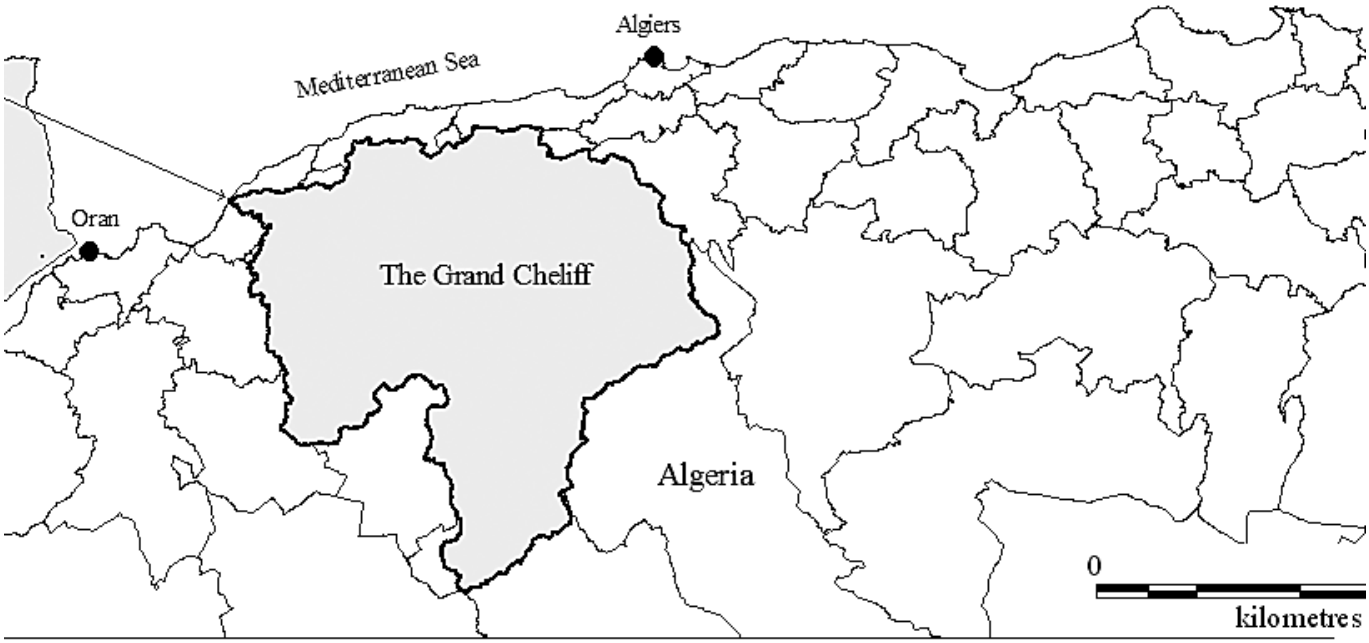


Figure 1. Location of the study area

On-farm surveys

In order to carry out an in-depth exploratory diagnosis, data were first collected from official Algerian documents of the Ministry of Agriculture and Rural Development, the National Statistics Office, the agricultural services and the Regional agricultural chamber. These data enabled us to characterize the beef livestock population and thus establish a list of representative farmers.

In order to characterize the agricultural holdings practising cattle breeding, a two-section questionnaire was then designed to determine several farm indicators in relation to meat production.

The first section covered general farm characteristics such as size, land use and distribution, location, crop production, stocking density and type of livestock.

The second section was related to the characteristics of the livestock system such as total number of animals, type of cattle breed, fodder supply, and mechanization.

The key indicators selected to measure the performance of the farms surveyed were: Total Livestock Unit (TLU), Bovine Livestock Unit (BLU), Ovine Livestock Unit (OLU), importance of imported food, zootechnical parameters related to reproduction (age at first calving, calving interval, insemination, fertilization), feeding behaviors, health of dairy cows and the most relevant economic parameters (total production, cost of production, cost price and gross margin).The surveys concerned a sample of 102 farms spread over the plains of the Middle and Upper Cheliff, better known as the “irrigated perimeter of the Middle and Upper Cheliff “, offering the possibility of intensive livestock farming.

Statistical analysis

The data collected were subjected to a principal component analysis (PCA) to characterize the structure of the farms. The analyses were performed under Xlstat®. This multivariate statistical analysis has been proven to be useful in explaining the high heterogeneity observed in existing beef cattle farms (Destefanis et al., 2020). Indeed, PCA first highlights the relationships between variables and then reorganizes the information into a new data set of variables that explains most of the variability. In other words, PCA can reduce the dimensionality of a data set originally described with a very large number of variables without significant loss of information. In practice, PCA makes it possible to calculate new variables, called principal components, which account for the variability in the data. This enables the information to be described with fewer variables than originally. Principal components are linear combinations of the original variables. The first principal component is the combination of variables that explains most of the variability in the data. The second and subsequent principal component, describes the maximum amount of remaining variability and must be independent of (orthogonal to) the first principal component. Principal component analysis is based on the study of covariances and correlations between variables. The main steps of the calculations are: (i) transformation of the data into centered and normalized values, (ii) calculation of the correlation matrix of the variables, (iii) search for the proper vectors, i.e., the best independent combinations of the variables studied which explain the highest proportions of the variability, and finally (iv) projections of the variables and individuals on the basis of the proper vectors (score plot). The results are presented in a 2D projection graph where variables near each other at the periphery of the circle are positively correlated, orthogonal variables are independent and variables separated by 180º are negatively correlated. The closer to the periphery of the circle, the higher the correlation coefficient between the variables.

NB: 1 € = 140 Dinars

Results and discussion

Bovine livestock evolution (2003-2016)

Bovine livestock evolution is highly conditioned, on one hand, by the level of seasonal and annual fodder availability that constrains the livestock farming systems and, on the other hand, by governmental decisions. Using data from official Algerian documents collected from different national organizations, we first reviewed the bovine livestock evolution from 2003 to 2016. During this period, the size of the herd remained constant with a slight evolution from 2009 onwards, reflecting the actions that have been implemented in recent years, such as the importation of female cattle which has led to the reconstitution of the herd. Also, among the total cattle population, the proportion of dairy cows (50%) (Figure 2) has remained constant throughout the period, except between 2013-2014 and 2015 when dairy cows reached a level of 60%. These cows originally imported for milk production have a high turnover rate and do not stay on the farm for more than three to four lactations. In this case, these farms are mostly mixed farms producing both meat and milk, and less specialized dairy farms, which explains the growth in beef production recorded in recent years.

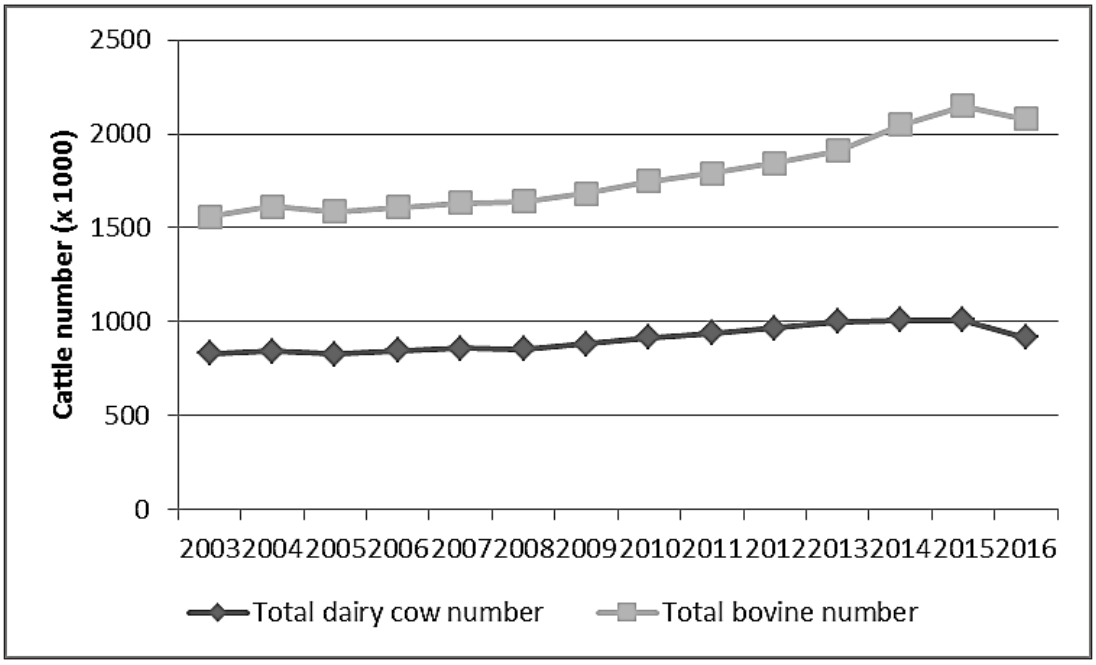


Figure 2. Bovine livestock evolution (2003-2016) in thousands of heads according to MADR, agricultural statistics, Series B.

The weak evolution of the bovine livestock population is the result of several causes, such as the inadequacy policies to support livestock farming and develop fodder crops (Tahani, 2009; Bessaoud, 2019); livestock management deficiencies; the length of the drought cycle recorded in recent years and outbreak of infectious animal diseases (tuberculosis, foot-and-mouth disease), which sometimes lead to compulsory slaughter campaigns (Benfrid, 1998).

Evolution of the structure of red meat production (2010-2018)

Algeria consumes an average of 340,000 tons of red meat, whereas the average annual production is around 300,000 tons of red meat from sheep and beef. In recent years, red meat production has grown faster than the evolution of the livestock population. This growth is the result of improvements in carcass weight to better meet food supply requirements and the use of more productive ovine breeds, while improved dairy cows tend to be converted into a combined meat-milk production system. However, the major change is the shift in meat imports by private operators. Indeed, they now prefer to import live animals to the detriment of beef, which increases the number of live animals slaughtered, especially those imported now recorded in local meat production since they are slaughtered locally (Sadoud, 2017).

In this context, sheep production increased from 26,000 tons in 2010 to 41,000 tons in 2018, which corresponds to an annual average rate of 1.5%. At the same time, bovine meat production, stimulated by high remunerative prices, increased from 19,000 tons in 2010 to 21,000 tons in 2018, which corresponds to an average annual rate of almost 0.3%, which is low. This low growth is explained by the fact that the majority of beef produced comes from dairy calves from small farms which represent 80% of cattle farms. Slaughtering barely covers two-thirds of Algerian beef needs (Sadoud et al., 2015), (Figure 3).

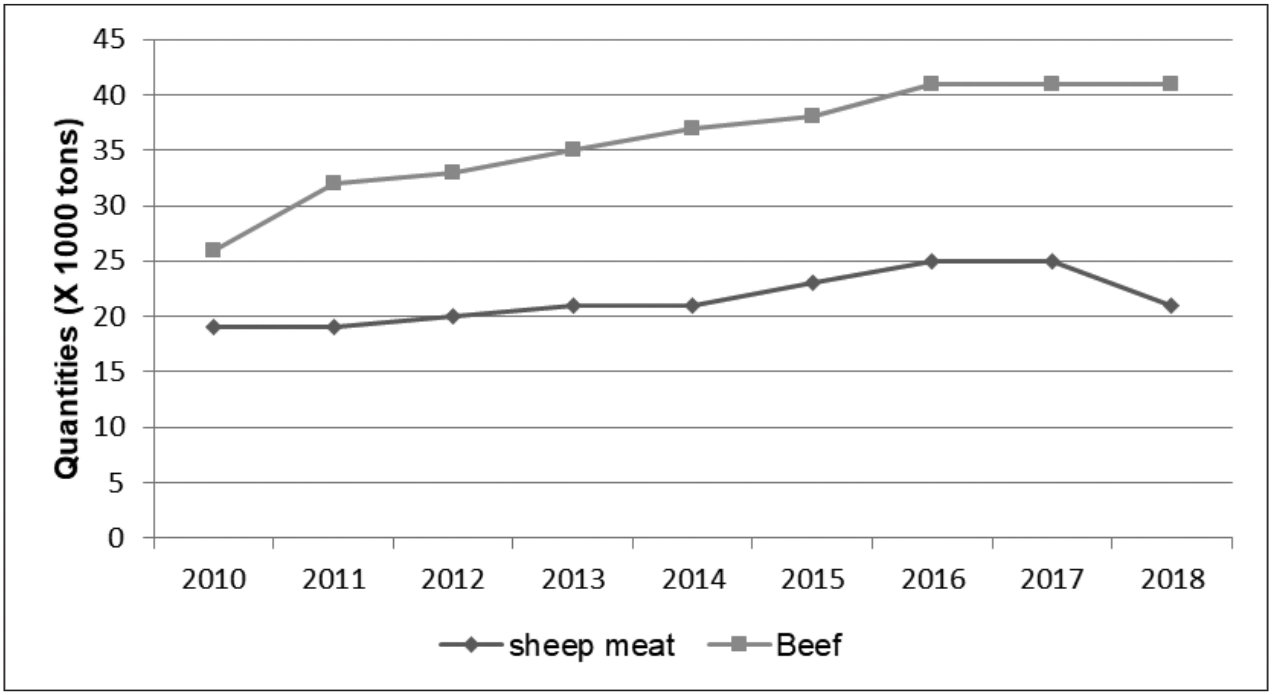


Figure 3. Evolution of national red meat production (in tons) according to MADR, agricultural statistics, Serie B. (2010-2018)

Characteristics of beef farms in the Grand Cheliff

The total area covered by the 102 farms studied is 2295 ha, which corresponds to an average area of 22.5 ha per farm, with a minimum of 2 ha and a maximum of 200 ha. In addition, 40% of these farms have an area of less than 10 ha (Saidi et al, 2013) while the proportion of farms with an area greater than 40 ha does not exceed 12%, which indicates a large disparity between farms in terms of exploited areas.

Within these 102 farms, the herd size ranges from 2 to 146 heads of cattle, with more than 10 heads in 60% of farms, which demonstrates the importance of this activity in the Cheliff region. Out of a total number of 1784 bovines and an average of 17 bovines per farm, the percentage of reproductive cows in the 102 farms represented approximately 40%, the remaining 60% being divided between calves, heifers and bull calves.

Most of the 102 farms had insufficient agricultural equipment: only 28% (29 farms) were equipped with tractors, 16% with tillage machinery (moldboard, cover-crop engine) and only 15% with forage equipment (harvester, baler, synthetic baler twine, Tedder-rake, mower and silage harvesters), while almost 80% need to hire agricultural equipment, which in turn increases the total operating costs. Finally, only 11% of farms were equipped with milking machines.

In the context of cattle feeding, the ratio of forage area to total area decreases with increasing farm size. Thus,

farms with less than 10 ha grow forage crops on 90% of their total agricultural area, while those with more than 20 ha use only 20% of their total agricultural area for forage production. On average, forage crops are grown on 45% of the Utilized Agricultural Area (UAA) in the 102 farms. The main forage crops grown by farmers in this area are oats, berseem (Egyptian clover), sorghum, green barley, corn and clover, but berseem and sorghum are the most widely grown green fodders. Berseem, grown in both rain-fed and irrigated areas is cultivated from mid-August to mid-September and used from November to June. Sorghum covers the period from June to September. It should also be noted that oats, barley and wheat straw, are widely used as coarse nutrients throughout the year, although oats, berseem, sorghum and vetch are frequently used in proportions of 70%, 25%, 24% and 19%, respectively, in the total animal diet.

Regarding reproduction, slightly more than half, 55% of the farmers use natural mating, whereas artificial insemination accounts for only 33%, and 12% of the farmers use both, indicating the reluctance to artificial insemination. Indeed, a large number of farmers are not satisfied with the results of this technique because of its frequent failures due to lack of mastery of this technique, irregularity of the inseminator, insemination after the heat period and poor sperm quality. Among those opting for natural mating, many farmers do not own a breeding bull; the main reason is to reduce costs. Thus, they usually use the breeding bull of the neighborhood, which may delay the mating. In this context, bulls are not selected since the choice is based on the relationship of the farmer with his neighborhood and not on the bull characteristics.

In general, farms with a large number of cattle always own a bull for reproduction, which is kept from 5 to 6 years, while farms with a small number of cows rent the neighborhood breeding bull.

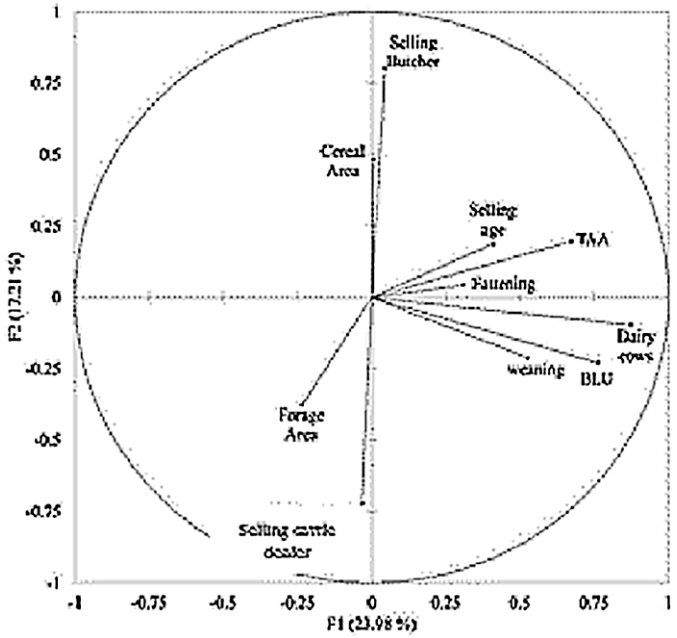
The first breeding age is about 18 months and the age of first calving is around 30 months for improved breeds and 36 months for crossbreeds. This relatively late age could be explained by poor growth performance due to weaknesses in nutritional management, so that heifers do not reach the appropriate weight for reproduction in time but only at advanced ages.

Undernourishment and nutritional imbalance also affect the appearance of heat and mating success, resulting in excessively long calving intervals. Indeed, in 73% of the farms studied, the calving interval was 1 year and more than 1 year in the remaining 27% of farms. Furthermore, in tie stall farms, heat detection is very difficult, which leads to mating delays and may contribute to an increase in calving interval.

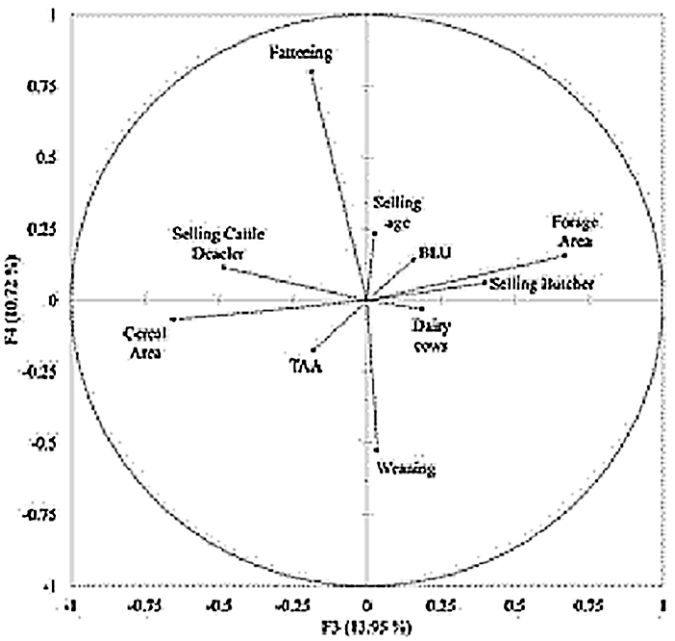
Relationships between beef farm characteristics

The method of principal component analysis was used to generate a reduced set of variables, which are called principal components and are much easier to analyze and interpret than the original ones. The total variance explained by the first four axes was 65.87% (Table 1), whereas the other axes with an eigenvalue of less than 1 were excluded from the analysis.

The first axis that explained 23.98% of the variance was mainly related to the number of dairy cows, BLU and Total Agricultural Area (TAA) meaning that farms with a large agricultural area were characterized by a large number of dairy cows and a high bovine livestock unit (Figures 4 and 5).



Variables (Axes F1 vs F2)



Variables (Axes F3 vs F4)

Figure 4. Principal Component Analysis of farm characteristics

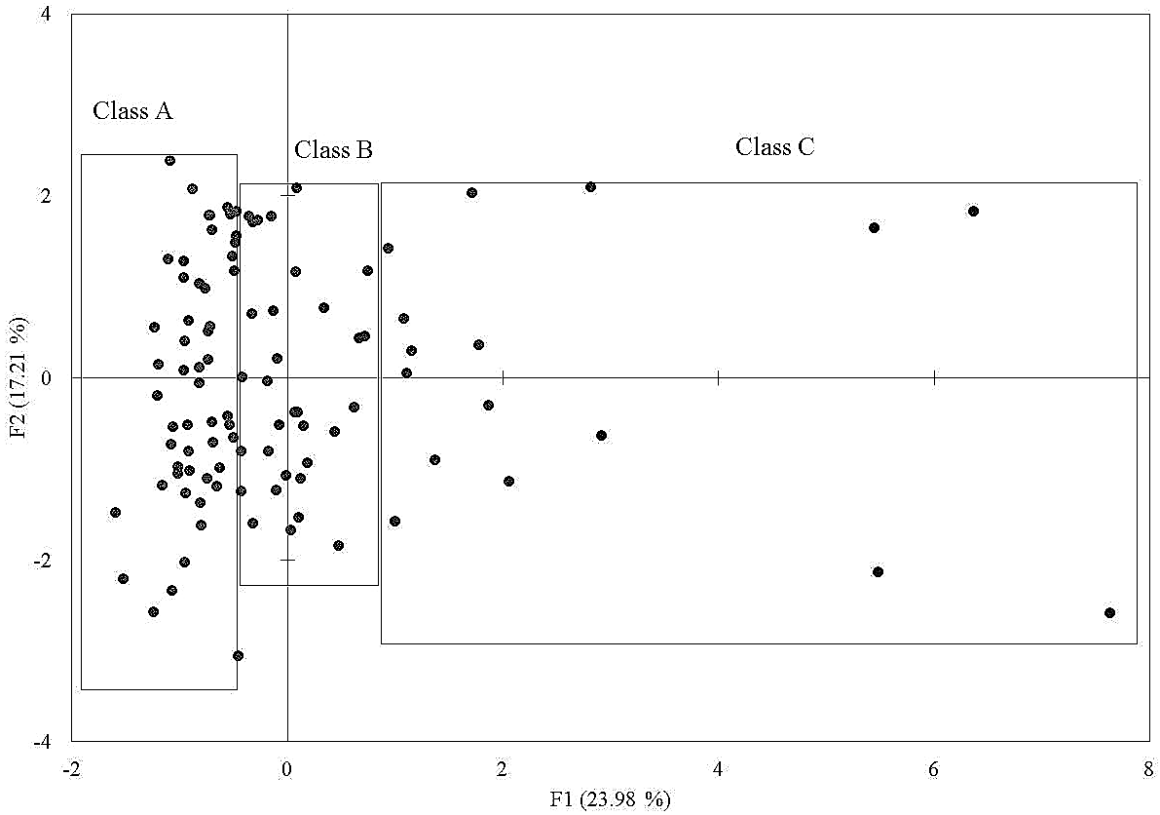


Figure 5. Principal Component Analysis of farm characteristics as in Figure 4: Projection of observations (farms) in the plane defined by F1 and F2

The second axis (17.21% of the variance) was mainly explained by the main activities of the farmers. This axis reflects the negative correlation between farmers cultivating large cereal areas and/or selling cows most often to butchers, on the one hand, and farmers cultivating large forage areas and/or selling cows to cattle traders, on the other.

Three variables (forage area, cereal area, fattening and weaning period) are well represented in the 3x4 plane. The third axis (which explains 13.95% of the variance) is positively related to forage area and negatively related to cereal area. Finally, the fourth axis is highly positively related to fattening period and negatively related to precocious weaning meaning that farmers practising fattening practise late weaning.

The variable "number of animals sold" is positively correlated with other variables such as "weaning period", "duration of fattening" r= X2, "amount of fodder produced" r= X2, "animal age at sale" r= X2 and also "number of dairy cows" r= X2. There is an opposition between total agricultural area and total number of cattle, on the one hand, and the fodder and cereal areas, on the other. This suggests that the diversification of crop and animal production is closely related to farm size.

Typology of farms

The comparison between the circle of correlation of the variables of the first two axes (1) and (2) and the map of individuals (following diagram) makes it possible to identify the main classes of individuals (farms) according to their position in relation to the axes. Thus, on the basis of the 10 variables selected in the first analysis, we managed to describe the structural and economic diversity of farms in the study region. On the planes of the axes (1) and (2), 4 individuals appeared to be very strongly capricious since they deviated a lot according to three variables (BLU, number of dairies, total agricultural area). These are the largest farms.

In addition, based on the distribution of farms along the first axis, three main groups of farms were identified mainly according to their size and number of animals.

The analysis was performed with all the studied variables with projection of variables in an "xy" plane defined by the axes for the first four principal components (F1 and F2, on the one hand, F3 and F4, on the other hand).

Small-scale livestock farmers, beef and milk production (Class A)

This class includes small producers with less than 10 dairy cows and a small-size area of less than 10 ha, 65% of which is used for forage crops giving them 50% of the livestock's feed autonomy. They represent multi-purpose micro-farms with 2 or 3 permanent employees and an average bovine livestock unit (BLU) of 3.18 ranging from a minimum of 0.59 BLU to a maximum of 10 BLU. These farms sell calves born on the farm at the age of 18 to 24 months, following a fattening

period of 2 to 6 months. Meat production is the main source of income for this middle class of farmers who produce bulls weighing between 400 and 450 kg, with a production cost estimated at 572.5 AD per kg of meat, of which feedstock represents 2/3 of total expenses (almost 381 AD /Kg), while structural costs account for 1/3 (190 AD/Kg). The average unit selling price is 600.7 AD/Kg. Finally, this class records a cost price of 482 AD/Kg and a gross margin of 88,000 AD/Bovine.

Mid-sized livestock farmers selling directly on the market (Class B)

This class accounts for 30% of the overall sample and is represented by producers with less than 10 dairy cows and a farm size ranging between 10 and 30 ha. This category of farms is characterized by the diversification of agricultural activities such as sheep breeding, grain farming, vegetable crops, beekeeping and poultry farming. The fattening period for calves born on these farms and sometimes bought from outside, ranges between 4 and 6 months and the sales occur at the age of 18 to 24 months and sometimes after 30 months of age. The cost of production per Kg of meat is estimated at 623 AD, including 481 AD/kg of feedstock and 142 AD/Kg of structural expenses. The average cost price of this class is 563 AD/Kg and the gross margin is 91400 AD/head.

Large-scale milk-meat farmers (Class C)

About 40% of the farms studied belong to this class. These are large-size farms with an UAA of more than 30 ha, an average of 15 dairy cows and an average BLU of 22.24 (between a minimum of 9.4 and a maximum of 36.8 BLU). This class is also characterized by the diversification of agricultural activities, livestock as well as crops. Sheep and poultry are common to almost all the farms in this category, these farms practise mixed milk-meat production and fatten and sell different categories of livestock at different ages from 6 to 18 months. The proportion of UAA reserved to forage crops is 41%, ensuring 70% of the livestock's feed autonomy, the rest is allocated to grain, vegetable crops, and arboriculture. Family workers and seasonal farm laborers are the main workforce in these farms. The cost of production per kg of meat is estimated at 581 AD, of which 26% are structural expenses. The cost price of this class (572 AD/Kg) is higher than the two previous classes, due to the cost of mechanization, labor and the purchase of concentrated feed. This reduces the gross margin to a minimum of 60700 AD/Head, compared to classes A and B.

Destination of meat animals

Animals from farms in the Grand Cheliff are commercialized through livestock slaughterhouses (Sadoud, 2009), cattle traders and butchers at the livestock markets or in the cow shed (Sadoud and Chehat, 2011). Animals from farms in the Cheliff region are intended for:

- the cattle collector at the cattle market or at the farm level,
- butchers at the livestock market or at the farm level,
- to wholesale butchers at the Algiers slaughterhouse.

The figure below (Figure 6) shows the circuits used by the animals. According to this diagram, we will distinguish two types of circuits which are:

- the short circuit: the butcher goes to the market and buys the animal directly from the producer and slaughters it himself.
- the long circuit: this involves a maximum of operators; producer, cattle collector, butcher (Figure 6).

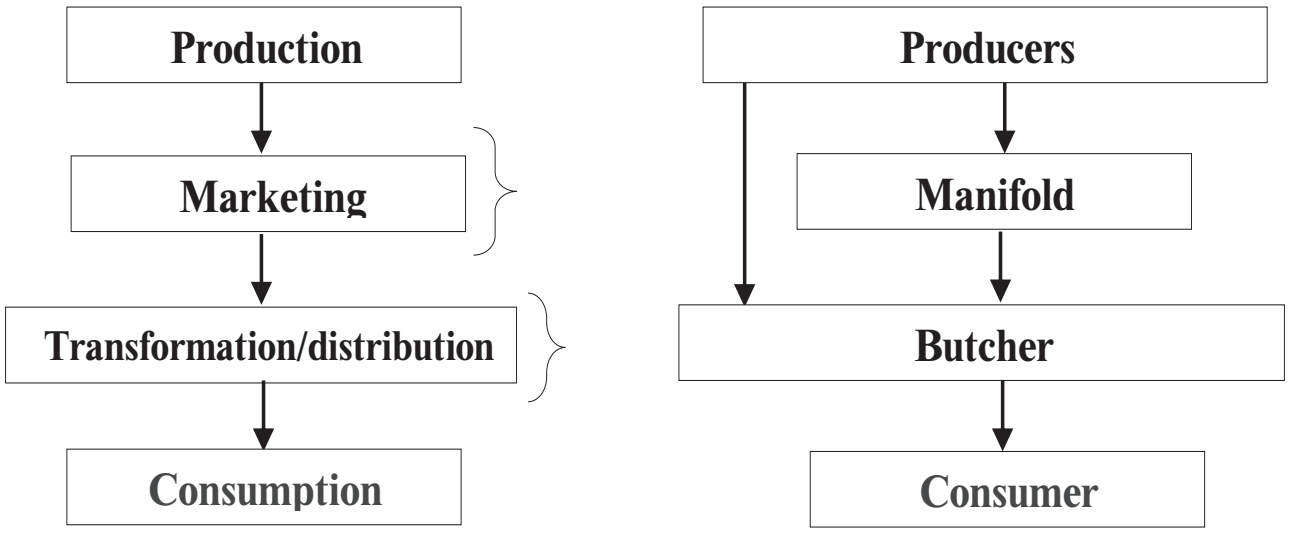


Figure 6. Diagram of the beef supply chain in the Grand Cheliff region

Conclusion

The study of the structure of the beef sector in the Cheliff region reveals a great heterogeneity between the stakeholders thanks to the use of statistical tools which discriminate between different farm groups. Indeed, beef cattle farming in the Cheliff region is present on farms that are very heterogeneous in structural terms. We observed the existence of small, medium and large farms. Farmers' incomes come mainly from pluriactivity. Not all production is marketed, as self-consumption being important. The majority of farms are in unfavorable production conditions, with insufficient technical skills and management methods, which affects their yields. Under these conditions, beef cattle farming can only be in a fragile position and can only lead to low yields.

Demographic and urbanization trends suggest that local production will not be able to cope with population growth and may lead to dependence on external sources. The development of beef cattle farms in the Grand Cheliff region is hampered by an insufficient agricultural area and by production methods which remain extensive and traditional. Also, productivity per unit area and labor productivity are low. In addition, there is a lack of organization of beef cattle producers, and little technical and financial support for beef production. Indeed, little effort has been devoted to analyzing the constraints on herd sizes and assessing the adaptation capacities of animals to produce meat and reproduce under local farming conditions. The only strategy used by beef cattle farmers in Algeria is a defensive strategy to ensure their survival. However, some farms remain viable by adapting to the market because they are open to innovation, while others only survive thanks to additional income such as market gardening and arboriculture to supplement low livestock production. The prospects for demographic change and urbanization give rise to fears that local production will not be able to keep pace with demographics, which could lead to greater dependence on the outside.

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