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Characterization and typology of small-scale dairy farmers using artificial insemination in Senegal

Abstract

This study is aimed to characterize and establish a typology of small-scale dairy farmers using artificial insemination in Senegal. It has allowed us to propose a typology of small-scale dairy farmers using AI. Three groups have been highlighted; type I, II and III respectively 48%, 15% and 37% of all farmers surveyed. These groups are distinguished by the geographical location, farming system, the mode of herd management and practice of AI. Typology setting up has enabled us to understand the logic of these operations, problems and limiting factors of their own. It also allowed us to identify the most sensitive small-scale dairy farmers and more receptive to possible AI programs.

Keywords: characterization, typology, dairy farmers, artificial insemination, Senegal

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Introduction

Livestock plays an important role in Senegal's economy, accounting for about 35% of the value added in agriculture and 7.5% that it participates in the formation of national Gross Domestic Product (GDP). Nine out of ten households are involved in this activity, employing labor alongside the agriculture. Milk production is insufficient to meet demand, resulting in a heavy reliance on imports represent more than half of the milk supply. Thus, an important breeding program using artificial insemination (AI) has been initiated to improve the national milk production. Because of expected improvements and opportunities for development of the dairy sector, many development initiatives and research are implemented. However, this government commitment stirs debate raises controversy because of past failures in scaling. This raises the debate on the relevance of the broad guidelines of the program and increases its chances of success. In the planning phase, managers need information on producers, their working conditions, their practices in crop and livestock production, the constraints they face and their potential for development. To this end, the approach should collect and analyze information, identify workable solutions and set priorities for research and development. And for sustainable development of traditional breeding, there is an urgent first answer the question of what is the characterization of different small-scale dairy farmers using artificial insemination in Senegal? This study therefore aims to characterize and establish a typology of small-scale dairy farmers using AI in Senegal.

Materials and methods

Study area

This study was conducted in the regions of Kaolack and Kolda, respectively in the departments of Kaolack and Vélingara. Kaolack is located between 14°30' and 16°30 west longitude and 13°30' and 14°30 north latitude while Kolda is located in Upper Casamance, in the south-central part of the country.

Data collection and processing

A structured direct questionnaire was designed for interviews. The survey was conducted from May to June 2012 in 73 small-scale dairy farmers using AI, 41 of the Kaolack region and 32 of the Kolda region mainly in Velingara. They are composed of 59 men and 14 women.

The questions were properly selected to obtain a general description of small-scale dairy farmers (using AI) characteristics and overall management practices. From Area of the study mentioned, a number of villages were chosen according to reasoned criteria such as available databases on farmers, presence grouping farmers and presence of dairy group. Thus, in the department of Kaolack, they are famers using AI that are listed in the database of the Regional Executive Women in Livestock (DIRFEL). In the Kolda region, farmers surveyed mainly come from Vélingara department; they belong to dairies LAROUGAL and BURDOUGAL.

The survey was conducted by a team of Inter-State School of Science and Veterinary Medicine (EISMV) in collaboration with livestock technicians who have good experience in the methodology of data collection. These technicians have served as interpreters and guides throughout the investigation period. The interview was conducted in Wolof, Pulaar and French in some cases following a direct mode (without an interpreter) or semi-direct (with an interpreter) and took an average of 30minutes per person.

Data analysis

The data collected were entered into the software Sphinx plus2 V 4.0 and subjected to descriptive analysis. Subsequently, these data were reprocessed by the SPAD software V4.02 for cluster analysis.

Descriptive analysis: It has allowed us to obtain different proportions, means and standard deviations. The results are shown in tabular form.

Cluster analysis: Cluster analysis is a method for grouping aggregative individuals segments on the basis of similarities. It offers the advantage of simplifying the information while generating the main features. The following steps were monitored.

Choice of variables: The choice of variables is done based on the objectives of the typology. These objectives have been identified and classified in terms dummies active, additional nominal variables

and continuous variables illustrative. Analysis of the histogram of eigenvalues and choice of axes from the analysis of the histogram of eigenvalues, we have chosen the most important routes for the factor analysis. These are interpreted in terms of axes and variables that have the maximum information.

Description of the factorial axes: This description was made using the methods introduced in the analysis and we have retained terms whose contribution to the establishment of the axis is high. Hierarchical Cluster and cluster identification.

The determination of clusters was performed by analysis of the classification tree or dendrogram. The classification is obtained by cutting the dendrogram. The level of the cut, meanwhile, is determined after consideration of the level diagram which shows the existence of early levels. The number of clusters is determined by the level of the cut. We then validated the number of classes selected by performing several classifications and observing the stability of the results.

Cluster analysis and cluster descriptions: Once the classification obtained performing a multiple correspondence analysis (MCA), and assigning colors (or symbols) to individuals depending on the cluster to which they belong. This gives an overall view of the positioning of clusters and variables from the variables representing the factorial axes, we characterized the classes.

The Chi-square test was used for comparison of different proportions. The significance level was set at 5%, this threshold represents the probability of making a mistake or the maximum risk. The application of this methodology yielded results which will be presented in the next chapter.

Results

Characterization of small-scale dairy farmers using artificial insemination

Sample composition: The proportion of women (19%) in the study population was significantly lower ($p<0.05$) compared to men (81%). The survey shows that the majority of small-scale dairy farmers using AI are Fulani ethnic group (92%) and many of them (71%) have no level of study Table 1.

General characterization of small-scale dairy farmers using AI: The majority of small-scale dairy farmers using AI (92%) practiced a semi-extensive where animals are taken to pasture during the day and receive a complementation in the morning and / or evening after returning from pasture. However, the study shows that 62% of these farmers have no fodder reserves Table 2. Analysis of this table shows also that 97% of small-scale farmers using AI make concentrate supplementation; however, this supplementation is reserved especially for lactating cows (51%). A significant difference in the frequency of concentrate supplementation is indicated between the two regions (Kaolack and Kolda). Indeed, supplementation with concentrate is done once a day (85%) and twice daily (75%) respectively in the regions of Kaolack and Kolda.

Typology of small-scale dairy farmers using artificial insemination

Identification of variables used in the analysis:

i. 26 variables were selected:

ii. 13 of them are dummy variables active (Table 3); 10 variables are projected additional dummy variables are illustrative (Table 4);

iii. 2 of them are continuous variables illustrative (Table 5).

Analysis of the histogram of eigenvalues and choice of axes: The analysis of the histogram of eigenvalues allowed us to select the most relevant axes factor analysis. Thus, we selected the first two factorial axes that bring at least 34% of all information.

Hierarchical cluster and cluster identification: Hierarchical Cluster allowed us to obtain the histogram of levels index and the classification tree or dendrogram. The histogram of levels index has a drop in the levels 3-4. This level indicates that the stall cutoff level of the dendrogram must be at level 3. After cutting the dendrogram at level 3, then we got three types of famers.

Table 1 Composition of survey sample

Variables	Terms	Kaolack	Kolda	Total
Gender	Male	28(68%)	31(97%)	59(81%)
	Female	13(32%)	1(3%)	14(19%)
Principal activity	Agro-breeder	41(100%)	32(100%)	73(100%)
Ethnic group	Fulani	39(95%)	28(88%)	67(92%)
	Serer	2(5%)	0(0%)	2(3%)
	Soninke	0(0%)	4(12%)	4(5%)
Age (year)	mean±standard deviation	48±13	46±14	46±14
Education level	Illiterate	29(71%)	28(88%)	57(78%)
	Primary	3(7%)	3(9%)	6(8%)
	Secondary	6(15%)	1(3%)	7(10%)
	University	3(7%)	0(0%)	3(4%)
Total		**41(56%)**	**32(44%)**	**73(100%)**

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Table 2 General characterization of small-scale dairy farmers using artificial insemination

Variables	Terms	Kaolack	Kolda	Total
Type of farming	Intensive	1(2%)	1(3%)	2(3%)
	Extensive	4(10%)	0(0%)	4(5%)
	Semi-intensive	36(88%)	31(97%)	67(92%)
Nomber of present cows	Mean±standard deviation	28±20	68±46	45±39
Breeds used	Ndama	24(28%)	32(49%)	56(37%)
	Gobra	35(40%)*	9(14%)*	44(29%)
	Morish Zébu	1(1%)	0(0%)	1(1%)
	Djakolé	8(9%)	1(1%)	9(6%)
	Crossbreed	19(22%)	23(35%)	42(28%)
Fooder reserves	Yes	17(42%)	28(87%)	45(62%)
	Non	24(59%)*	4(13%)*	28(38%)
Reserved fooders	Maize straw	4(12%)	10(16%)	14(15%)
	Rice straw	0(0%)	20(32%)	20(21%)
	Millet straw	4(12%)	1(2%)	5(5%)
	Bush straw	11(33%)*	1(2%)*	12(13%)
	groundnut haulms	6(18%)	28(44%)	34(35%)
	Cowpea haulms	3(9%)	3(5%)	6(6%)
	Mowed grasses	4(12%)	0(0%)	4(4%)
Concentrate Supplementation	Yes	39(95%)	32(100%)	71(97%)
Animals receiving supplémentation with concentrate	Lactating cows	23(35%)*	32(72%)*	55(51%)
	Cows candidates for IA	2(3%)	1(2%)	3(3%)
	Inseminated cows	2(3%)	0(0%)	2(2%)
	Crossbreed	1(2%)	3(7%)	4(4%)
	Weakned cows	27(41%)	7(16%)	34(31%)
	Bull(s)	0(0%)	1(2%)	1(1%)
	The whole herd	10(15%)*	0(0%)*	10(9%)
Concentrates used	Peanut meal	32(33%)	4(8%)	36(24%)
	Cotton seed meal	0(0%)*	12(23%)*	12((8%)
	Soybean meal	0(0%)	1(2%)	1(1%)
	Sesame oil cake	0(0%)	2(4%)	2(1%)
	Cotton seed	4(4%)*	23(45%)*	27(18%)
	Cereal bran	35(36%)	9(18%)	44(30%)
	Commercial feed	26(27%)	0(0%)	26(18%)
Concentrate supplementation frequency	Once a day	33(85%)	8(25%)	41(57,7%)
	Twice a day	6(15%)*	24(75%)*	30(42,3%)
Water source	Well	29(55%)	32(100%)	61(72%)
	Pond	2(4%)	0(0%)	2(2%)
	Drilling	4(7%)	0(0%)	4(5%)
	Tap	18(34%)*	0(0%)*	18(21%)

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Table Continued..

Variables	Terms	Kaolack	Kolda	Total
Common diseases in livestock	Parasitic diseases	7(6%)*	24(38%)*	31(17%)
	Lumpy skin	34(29%)	6(10%)	40(22%)
	Foot and mouth disease	35(30%)	0(0%)	35(19%)
	Pasteurellosis	39(33%)	18(29%)	57(32%)
	Blackleg	1(1%)*	15(24%)*	16(9%)
	Brucellosis	1(1%)	0(0%)	1(1%)
	Bronchopneumonia	1(1%)	0(0%)	1(1%)
Total		**41(56%)**	**32(44%)**	**73(100%)**

* Significant difference between the regions of Kaolack and Kolda

Table 3 Dummy variables active

Variables	Terms
Informations sources	Regional veterinary service
	Private veterinary cabinet
	Famers association
	NGOs
	Other famers
	School
Mean of informing	Regional Council
	Meeting
Methodology to inform	Very satisfactory
	Modelately satisfactory
	Unsatisfactory
Knowledge of the difference between two types of IA	Yes
	No
Choice between two types of AI	AI on natural heart
	AI on heart-induced
Reason for the choice	Simple
	Cheaper
	Easy
Importance of AI	Milk
	Milk and meat
AI campaigns organizers	State programs
	Private programs
Motivation for AI campaigns	free service
	Quality of service
AI campaigns seasons	Dry season
	Rainy season
willing to pay for AI	For
	Against
Housing of cows candidates for AI and inseminated cows	Yes
	No
Fooder reserves	Yes
	Non

Cluster analysis and cluster descriptions: This partition is coupled to the description of the factors provided by ACM to describe famers using AI, and the distribution of classes in the factorial 1.2. (Table 6)

Description of the different types' small-scale dairy farmers using artificial insemination in Kaolack and Kolda: Cluster analysis revealed three types of famers using AI whose characteristics are shown in Table 7.

Based on the different characteristics of small-scale dairy farmers using AI, three types of farmers have been identified (Type I, II and III):

A. **Type I**

Farmers of type I represent 48% of all surveyed farmers. A large majority (97%) of them comes from Kaolack. These farmers have experienced AI through veterinary practices and the association of other famers. All know very well a difference between the two types of AI, but 97% of them prefer the AI on natural heat. These are farmers interested in AI because they are willing to pay for AI. The majority of farmers (86%) practice AI in order to have milk and meat, but 51% practice stalling of cow's candidates for AI and inseminated cows. All these farmers have participated at least once in the AI campaigns, especially during the rainy season.

B. **Type II**

Famers of this type represent 15% of all surveyed farmers. Some of these farmers come from the region of Kaolack (48%) and others from the Kolda region (52%). These farmers have experienced AI through other famers.

All famers of type II

i. fail to distinguish the natural heat of AI and AI on heat-induced

ii. are motivated by AI as a free service and also they do not agree with the payment of the benefit of AI

iii. do not make concentrate supplementation of their cows

Although they participated at least once in the AI campaigns, especially in the dry season, the majority of them (81%) do not practice stalling of cows candidates for AI and inseminated cows.

C. **Type III**

Farmers of type III represent 37% of all surveyed farmers. 84% of them come from the region of Kolda. Despite the fact that farmers have participated in at least 4times in the AI campaigns (96% in the dry season), nobody knows the difference between the AI on natural heat and AI on heat-induced. More than half of them (63%) practice

AI for milk. Stalling of cows candidates for AI and inseminated cows is provided in 100% of cases.

All famers have fodder reserves. However, 44% of them make concentrate supplementation of their cows. This supplement is for lactating cows in 96% of cases. In most cases (59%), the used concentrate is cottonseed. Concentrate supplementation is executed twice a day in 70% of cases. Furthermore parasitic diseases in 59% of cases, blackleg is found in 26% of cases. Most farmers (59%) had AI through veterinary services.

Table 4 Dummy variables illustrative

Variables	Terms
Region	Kaolack
	Kolda
Gender	Male
	Female
Ethnic group	Fulani
	Serer
	Soninké
Study level	Illiterate
	Primary
	Secondary
	University
Used breeds	Ndama
	Gobra
	Morish Zébu
	Djakolé
	Crossbreed
Reserved fooder	Maize straw
	Rice straw
	Millet straw
	Bush straw
	groundnut haulms
	Cowpea haulms
	Mowed grasses
Used concentrate	Peanut meal
	Cottonseed meal
	Soybean meal
	Sesame oil cake
	Cotton seed
	Cereal bran
	Commercial feed

Table Contiuned..

Variables	Terms
Concentrate supplementation frequency	Once a day
	Twice a day
Animals receiving concentrate supplémentation	Lactating cows
	Cows candidates for IA
	Inseminated cows
	Crossbreed
	Weakned cows
	Bull(s)
	The whole herd
Common deseases in livestock	Parasitic diseases
	Lumpy skin
	Foot and mouth disease
	Pasteurellosis
	Blackleg
	Brucellosis

Table 5 Continuous variables illustrative

Variables	Terms
Age (year)	mean±standard deviation
Number of participation in AI campaigns	Private program
	State programs
	On heat-induced
	On natural heat

Table 6 Definition of the factorial axes

Factorial axe	Positive	Negative
1	Region of Kaolack	Region of Kolda
	Knowledge of two types of AI and prefer AI on natural heat	No difference between two types of AI
	Willing to pay for AI	No stalling of cows
	stalling of cows, supplementation of cows candidates to AI & inseminated cows:once day	Supplementation of lactiting cows twice a day
		Number of cows
2	AI campaigns participation:at least once, in rainy season	Region of Kaolack and region of Kolda
	AI importance:milk&meat	No willing to pay for AI
	Fooder reserves	No fooder reserves
	Ndama & Gobra breeders	No supplementation
	Motivation for AI campaigns:free service and quality of service	No motivation for AI campaigns
	Veterinary cabinet, farmers association	Other farmers, veterinary services

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Table 7 Description of different types of small-scale dairy farmers using artificial insemination in Kaolack and Kolda regions

Variables	Type I	Type II	Type III
Pourcentage	48%	15%	38%
Concerned regions	-Kaolack:97%	-Kaolack:48%	Kaolack:16%
	-Kolda:3%	- Kolda:52%	Kolda:84%
Gender	Male:80%	Male:71%	Male:95%
	Female:20%	Female:29%	Female:5%
Study level	illiterate:71%	illiterate:41%	illiterate:88%
Information sources on AI	Veterinary cabinet Famers associations	Other famers	Veterinary services
Importance of IA	Meat and milk:86%	Milk (100%)	Milk:63%
Knowledge of the difference between two types of IA	100%	0%	0%
Choice between two types of AI	AI on natural heat:97%	-	-
Number of participation in AI campaigns	>1	>1	>4
Motivation for AI campaigns	free service:41%	Free service:90%	free service:44%
	Importance of AI:42%		Importance of AI:48%
AI campaigns seasons	Rainy season:69%	Rainy season:38%	Rainy season:4%
	Dry season:31%	Dry season:62%	Dry season:96%
Willing to pay for AI	90%	1%	89%
concentrate Supplementation	91%	0%	44%
Animals receiving concentrate supplémentation	Lactating cows 40%		Lactating cows:96%
	The whole herd:29%		
Concentrate supplementation frequency	Once a day:71%		Once a day:30%
	Twice a day:29%		Twice a day:70%
stalling of cows candidates for AI and inseminated cows	51%	19%	100%
Fooder reserves	29%	0%	100%
Used breeds	Ndama:54%	-Ndama:34	-Ndama:100%
	Gobra:42%	-Gobra:64%	- crossbreed:70%
Number of cows	30±21	< >	73±47

Based on the different characteristics of small-scale dairy farmers using AI, three types of farmers have been identified (Type I, II and III)

Discussion

Characterization of small-scale dairy farmers using artificial insemination

The majority of surveyed farmers were male (81%). The preponderance of men (68%) in the Kaolack region is consistent with the results found by Asseu[1] in the same area. However, these results are lower than Nkolo[2] with a relatively high proportion in Thies where 98.1% of men hold farms. Results in the Kolda region (91%) are higher than the Kaolack region but are in agreement with those obtained by Nkolo[2] in the region of Thies.

All surveyed farmers are agro-pastoralists. A study by Nkolo[2] showed that the type of agro-pastoralists was ideal for the success of the AI. According to Ba (2001) cited by Diadhiou.,[3] this form accompanies sedentary recent advances in livestock intensification and contributes to the stabilization of pastoral migration. In general, the combination of agriculture and livestock results in the use of animal traction, use of animal manure to fertilize the fields and use of crop residues for animal feed.[1]

Our study shows that farmers using AI in the region of Kaolack and Kolda Fulani are mainly (92%), which is in agreement with the data ethnological Ansd.[4] The Fulani are traditionally pastoralists for centuries, what explains the first place in the possession of the farms. The work of Somda et al.[5] made in Gambia, in Guinea and in Guinea Bissau shows respectively that 43.3%, 98.9% and 96.2% were Fulani herders. These results are also consistent with those of Ba which showed that agro-pastoral farming is practiced in the Casamance region by the Fulani (90%).

The average age of farmers is 46±14years in the two regions thus relatively able to carry out the activities of herd. This is an asset in the intensification policy. This result is similar to Alary[6] in Reunion Island. However, these results differ to those of Somda et al.,[5] who reported the famers' average age of 54±17years in Gambia, 58±11years in Guinea and 53±14years in Guinea Bissau.

Many of them (78%) are illiterates. This result is in agreement with the results of Somda et al.[5] who reported that 52.2% of famers in Gambia and 54.6% of famers in Guinea Bissau are illiterates. Likewise, Beyene et al.[7] related that in Ethiopia, 55% of famers are

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illiterates. However in Bangladesh, Major percentage of farmers study level is Higher Secondary level (60%).[8]

The majority (92%) of farmers in the region of Kaolack and Kolda practice semi-extensive. With this mode of conduct, the animals are taken to pasture during the day and receive a complementation in the morning and/or evening after returning from pasture. This is consistent with the work of Seré et al.[9] which showed a predominance of semi-intensive system in sub-Saharan Africa. By cons Badji[10] in Louga, Kaolack and Fatick showed that inseminations were made mainly in extensive farms (72.2%). These results differ from those obtained by Asseu[2] in the region of Kaolack, where 87.2% of farmers practiced extensive system. This difference can be explained partly by the fact that farmers abandon more traditional extensive systems and transhumant and another part by the balance of agro-pastoralists in our sample.

The main breed exploited in the Kaolack region is the zebu Gobra (40%). This is in agreement with the results obtained by Asseu in 2010 (82%) in the same region and Nkolo (86.4%) in 2009 at Thies and by Sery (68%) in 2003 at Thies and in Dakar.[11]

On the contrary in the Kolda region, the bullfighting Ndama (49%) is the most exploited. This is explained by the fact that this region is enzootic bovine trypanosome and is trypanotolerant Ndama and it fits well in the region. This is in agreement with the results of Diop[12] where he showed that most of the cattle in the southern region consist of the Ndama.

The study shows that most farmers (62%) have fodder reserves and 97% make complementation, which is a favorable aspect to the practice of AI. For, indeed food is a major factor of success or failure in reproduction according to Chicoteau[13] and Moudi.[14] Food provides the cow all elements energy, protein and minerals it needs to meet both needs upkeep, gestation and production Bofia.[15] These results are similar to those obtained by Nkolo[2] at Thiès where 97.4% of farmers have fodder reserves and 72.9% make concentrate complementation.

The reserve consists mainly of groundnut haulms (35%) and rice straw (21%), this in agreement with the data of agricultural activity in two regions studied (groundnut in Kaolack and rice in Kolda).[4] According to Bouyer,[16] proper nutrition is a prerequisite for any attempt to AI, otherwise the results will be very disappointing fertility. Therefore one hand develop fodder reserves and in forage programs, especially when they occur in the dry season and on the other have an idea of the amount of fodder reserves according to the size of his herd .

Food supplements are used in most cases groundnut cake (24%) and cereal bran (30%). Animals receiving concentrate supplementation are lactating cows (51%) and weak cows (31%) in agreement with the results obtained by Asseu[1] in Kaolack. This supplement is 85% once a day in Kaolack as farmers in this region have not the means to be able to concentrate twice a day. By cons in the Kolda region concentrate supplementation is done twice a day. These results are similar to those of Nkolo[2] at Thiès where most of the surveyed farmers who make complementation, 65% distributed concentrate twice daily (morning and evening).

The source of water is essentially the wells (55%). This result could be explained by a large number of wells constructed in Senegal during the past two years. These results different from those obtained by Beyene et al.[7] in Ethiopia, where the main sources of water during the dry season were rivers, springs and pond (River is about 92%).

The dominant pathology in all operations is pasteurellosis (32%) that strongly affect the fertility of the herd. These results could be explained by the fact that our study was performed in the favorable season to this disease. These results differ to those obtained by Tebug et al.,[17] in Malawi where the most common diseases is mastis (39, 3%). Furthermore, mastitis was the most reported cause of morbidity in 65 studies carried out in smallholder dairy farms in East and South African (ESA) countries Lema et *al*.,[18] Phiri et al.[19]

Typology of small-scale dairy farmers using artificial insemination

Our results show that the different types of famers are formed according to geographical location, farming system, the mode of herd and practice of AI. This is in agreement with the results obtained by Nkolo[2] at Thiès on the typology of farms using IA where geography seems crucial factor. The same results were found in Mali by Faly[20] on the typology of farmers. Faly[20] found that farmers are divided into groups according to areas. Famers'type II correspond to those practicing extensive pastoral system is a typical production system where one or more inputs are limiting in terms of quantity, which imposes severe pressure continues or variable on animals, resulting in low survival, reproduction or production level Isra.[21] According to Bouyer,[15] this group makes it very difficult to achieve AI. Indeed, it is very difficult to meet the dates of appointment for insemination plans since the farmer and his herd to move sandstone seasons and available pasture. In addition, the presence of males "vagrants" sometimes disturbs the results of artificial insemination. Farmers' type I and III have similar characteristics to those described in the agro-pastoral system by Taché.[22] According to Diop,[23] the system evolves towards sedentary animals with the use of agricultural by-products. These two classes are more suitable to the achievement of AI, since there are no transhumance animals, and they are often better fed than pastoral. However, this study shows that there is a significant difference ($p<0.05$) between the famers'type I and those of type III in fodder reserves and practice of AI on natural heat. This difference is the result of their geographical location.

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Conflict of interest

Author declares that there is no conflict of interest.

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