Studies on Dairy Cattle Reproduction Performances in Morocco Based on Analysis of Artificial Insemination Data

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Summary

The main objective of this study is to assess dairy cattle reproduction performances from artificial insemination (AI) database, using inseminators' records from 1992 to 1998, in three AI circuits established in Settat province in Morocco. Simultaneously, a field survey was conducted in the same region, from January to April 1999, to determine main structural parameters of dairy farms which influence AI. Data set analysis has shown an increase in total number of AI performed from an average of 160 to 640 per circuit. Average conception rate was 48.1%, with a continuous increase from 44.3 to 58.6%, despite growing number of performed AI. Statistical analysis reveal a significant variation of conception rate between years, in agreement with previous works on cattle reproduction performances in harsh conditions. Mean calving interval was 404.8 days. It was significantly different between circuits (P< 0.05). This result was explained by AI history in the three circuits (date of implementation) and by their structural characteristics (number of cows and length in km). The overall improvement of AI activity (more AI performed and better conception rate) could be explained by a greater inseminators' adaptation to their working environment, combined to the progressive elimination of farms with poor dairy cattle reproduction management. This trend was confirmed by discriminant analysis of field survey results, as cattle breeders with real specialisation in milk production (more than 65% of total land devoted to forages and few sheep) have been found to be fervent AI demanders, whereas farms with more interest in cereals and sheep often stop AI. Those observations show that a continuous AI programs evaluation is urgent, in order to select dairy breeders which are really interested in that technique and to avoid the dissipation of the inseminators limited time and resources.

Résumé

Etude des performances de reproduction des bovins laitiers au Maroc à partir des données de l'insémination artificielle

L'objectif de ce travail a consisté en l'établissement d'un diagnostic de la reproduction des bovins laitiers à partir des informations collectées par les inséminateurs dans trois circuits établis dans la province de Settat, au Maroc, de 1992 à 1998. En parallèle, l'attitude des éleveurs de la même région vis-à-vis de l'organisation de l'insémination artificielle (IA) a été détaillée, moyennant une série d'enquêtes de terrain de janvier à avril 1999. L'analyse de la base de données a montré un accroissement de l'activité par circuit, qui a atteint plus de 640 actes en 1998 contre 160 en 1992. Le pourcentage moyen de réussite de l'insémination est de 48,1%. Il a connu un accroissement continu de 44,3 à 58,6%, en dépit de l'augmentation du nombre d'actes. Les analyses statistiques ont montré que le pourcentage moyen de réussite de l'insémination était significativement affecté par l'effet des années, en accord avec d'autres observations dans des milieux d'élevage dominés par l'aléa climatique. Par ailleurs, l'intervalle moyen entre vêlage était de 404,8 jours; et il était significativement différent selon les circuits (P< 0,05). Ce résultat est dû à la chronologie de l'implantation de l'IA dans les trois circuits et aux variables structurelles qui les composent (nombre de vaches et surtout longueur en km). Globalement, l'amélioration des prestations des inséminateurs (plus d'actes avec une meilleure réussite) est expliquée par leur adaptation à leur environnement de travail, après plus de cinq années de démarrage de l'IA, tout comme il témoigne de l'exclusion progressive par les inséminateurs des éleveurs peu impliqués dans la gestion de la reproduction de leurs vaches. Ceci a d'ailleurs été confirmé par l'analyse factorielle discriminante des résultats de l'enquête de terrain. En effet, les éleveurs réellement impliqués dans la production de lait, avec peu d'ovins et plus de 65% de la Superficie Agricole Utile (SAU) consacrés aux fourrages sont les plus touchés par les services d'IA, tandis que les exploitations agricoles plus investies dans l'élevage ovin ont tendance à arrêter la pratique de l'IA. Ces observations plaident pour une évaluation continue de l'IA, afin de n'en faire bénéficier que les éleveurs réellement demandeurs et de ne pas dissiper les moyens déjà limités des inséminateurs.

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Introduction

In Morocco, dairy cattle are an important part of the country's agricultural policy as they represent a means of developing smallholders farms by creating wealth and labour (9). Hence, an important plan to enhance dairy production has been launched at the beginning of the seventies. It aimed self sufficiency in milk products by the year 2000, through a panel of economic and technical state interventions. In the field of animal breeding, intensive imports of dairy cows and artificial insemination (AI) were retained as the major tools to develop a nucleus of dairy cows adapted to local conditions and to improve dairy potential of local breeds (6).
Thirty years after the launching of this dairy plan, milk production has yet achieved a remarkable growth from 457 million litres to 1.1 billion litres in 1999, but this is still far from original expectations (8). This could be an explanation for the stagnation of productivity levels these late years, combined to more acute drought which affected the country (2). Meanwhile, like in many other underdeveloped countries, milk productivity of dairy exotic cows and their crosses remains weak (12). Moreover, farmers show few enthusiasm to adopt these strains of cows, even when free AI services are offered by government agents (5). Therefore AI is not evaluated, as field data are available but rarely used for any purpose.
Thus, the aim of the present work is to study the reproduction performances of dairy cattle herds in three Moroccan AI circuits, by analysing their data from 1992 to 1998, and to assess relationship between AI practice effectiveness and structural parameters of dairy farms, through field surveys.

Material and methods

Raw data were collected from inseminators monthly reports from January 1992 till December 1998 in three AI circuits situated in the Settat province, 60 km south of the city of Casablanca.
They were encoded in order to create a data set which included herds' identification, insemination and calving dates, and dates of pregnancy control.
The AI activity in three circuits began at different years, due to progressive implication of technical agents in the province. In the first circuit (Jacma, 120 km long, 1538 cows) it started in 1992, while in the second one (Trifia, 80 km long, 1350 cows) it was enhanced in 1994. In the last circuit (Berrechid, 100 km long, 1078 cows) it was introduced in 1995. Many developments of AI activity occurred since those dates and they are described in this paper.
Data permitted to determine parameters related to AI practice at the scale of the region, such as the numbers of inseminations per year, the conception rate for an insemination and the percentage of cows necessitating more than three inseminations to be effectively pregnant. They were also used to determine calving interval as it represents the most important parameter to evaluate dairy cattle reproduction.
Results were submitted to analysis of variance using the General Linear Models (GLM) procedure of the SAS (13) in order to understand whether reproduction performances were influenced by AI circuit or by years.

The statistical linear model was as follows:

$$M_{ijk} = M + C_i + Y_j + AB_{ij} + E_{ijk}$$

M_{ijk} = mean for observation k
M = general mean
Ci = circuit effect
Yj = year effect
Ab_{ij} = interaction (circuit x year) effect
E_{ijk} = residual error

Another goal of this study was to assess whether AI performances were linked to structural parameters of dairy farms. This is why a field survey was conducted in the same regions, and it has covered 108 farms, of which 72 still practice AI and 36 have stopped it. Results were submitted to a multivariate analysis by the means of a factorial discriminant method. The SAS DISCRIM procedure (13) was used to identify the relationship between AI indicators and structural characteristics of dairy farms.

Results and discussion

A) Variations of AI records, non return rates and calving interval

The analysis of the structure of data set showed that average inseminations per circuit in 1998 is 646. This is better than average results found in Africa and Asia (respectively 443 et 543 AI) reported by Chupin and Thibier (5). However those figures are far from mean results at the Moroccan level where 1272 inseminations are accomplished per circuit per year (1). A progressive increase in the level of accomplished AI per year has occurred in the three circuits (Table 1), and it indicates that AI is progressively getting adopted at local level.

Table 1
Annual AI realisations per circuit from 1992 to 1998

	1992	1993	1994	1995	1996	1997	1998
Jacma	161	350	467	494	541	837	913
Trifia	-	-	234	229	525	507	566
Berrechid	-	-	-	405	382	380	458
Average per circuit per year	161	350	351	376	483	574	645

Table 2
AI conception rate and number of services per year

Circuit	1995	1996	1997	1998
Jacma				
AI services	494	541	837	913
Non return rate (%)	48.8	50.4	43.9	47.7
Trifia				
AI services	229	525	507	566
Non return rate (%)	41.4	45.2	48.0	55.5
Berrechid				
AI services	405	382	380	458
Non return rate (%)	40.4	35.4	61.3	62.3
Average non return rate (%)	44.3	43.2	54.7	58.6

The analysis of AI effectiveness shows an average conception rate of 48.1%, on a total of 6237 inseminations

(Table 2). This is quite poor result compared to recommendations by Enjalabert (7), who considers that there might be herd infertility when conception rate is under 60%. But because of the hot and arid conditions which prevail in the region, these are acceptable results as pointed out by Thatcher and Collier (17), who found a conception rate of 47% in tropical conditions of Florida. These results also reveal a continuous increase in conception rate from 1995 to 1998, as it has passed from 44.3 to 58.6%. While considering circuit per circuit, quite a similar pattern is observed (Figure 1), which can be attributed to regular improvement of inseminators adaptation to their working environment combined to better AI adoption by breeders.

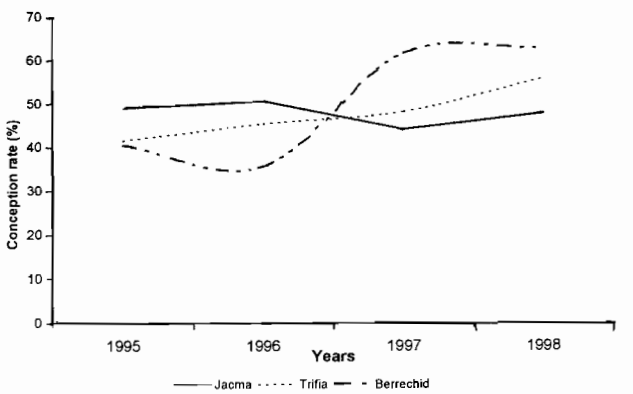


Figure 1: Annual evolution of AI conception rate in the three circuits

On the other hand, data were used to determine the number of cows necessitating more than three inseminations to get effectively pregnant. This ratio has varied from 2.39% in 1992 to 7.10% in 1994 (Table 3). The analysis of variance for that reproduction parameter revealed no statistical differences among circuits (P= 0.733). However, there was a significant effect between years (P= 0.017). Such annual variations of dairy cattle reproduction performances have been reported in previous studies in Morocco (14) and they can be explained by direct effects of annual climatic phenomena on cattle (i.e heat stress) and by their indirect affections on forage production. These observations are much more frequent in semi-arid and harsh conditions (4), like those in the Settat province (average rainfall less than 250 mm from 1990 till 2000).

Results also show that average of cows necessitating more than three AI to be pregnant is less than 7.1% in the worst situation. This would indicate an improvement of the conception rate at the second and third AI, in comparison to the first one. At this stage, these results are also in agreement with biological norms for a successful reproduction in dairy herds (4). However, a more precise analysis to inseminators' monthly reports combined with field surveys show that breeders often refuse to call the inseminator for repeat breeding cows, as they prefer to mate them with their own bulls. This way of proceeding is very common in Moroccan herd, as AI is still slowly adopted by breeders, and some still suspect it to be less efficient than natural mating (15).

Average calving interval was 404.8 ± 76.7 days. There were no differences among years, but it varied significantly from a circuit to another (Table 4). This mean value is very close to the one found in the neighbour province of Ben Slimane with similar herds' structure (15). It is not in total agreement with general recommendations for good management in dairy cows breeding (11), but it could be considered satisfactory as worse results have been found in other contexts of production, such as in commercial dairy farms in Florida (17) or even in irrigated zones in Morocco (16).

Table 3
Analysis of variance for factors affecting cows needing more than three AI

Years	Means ± Standard Error (%)	N*
1992	2.39 ± 0.60[b]	6
1993	6.72 ± 3.40[a]	12
1994	7.06 ± 3.90[a]	24
1995	6.13 ± 1.30[ab]	36
1996	5.64 ± 3.90[ab]	36
1997	5.33 ± 4.00[ab]	36
1998	6.38 ± 5.20[a]	36
Circuits		
Jacma	6.21 ± 6.90	78
Berrechid	6.02 ± 3.80	60
Trifia	5.49 ± 3.30	48
	5.96 ± 5.20	186

* N: Number of observations
[a, b] Variables with different superscript are significantly different (P< 0.05).

Table 4
Analysis of variance for factors affecting calving interval

Years	Means ± Standard Error (%)	N*
1993	404.3 ± 53.6	41
1994	404.4 ± 74.9	142
1995	421.5 ± 91.3	89
1996	402.9 ± 87.0	185
1997	399.3 ± 69.8	298
1998	406.7 ± 79.2	311
Circuits		
Jacma	409.9 ± 77.3[b]	659
Berrechid	443.3 ± 129.7[c]	73
Trifia	386.2 ± 60.8[a]	334
	404.8 ± 76.7	1066

* N: Number of observations
[a, b, c] Variables with different superscript are significantly different (P< 0.05).

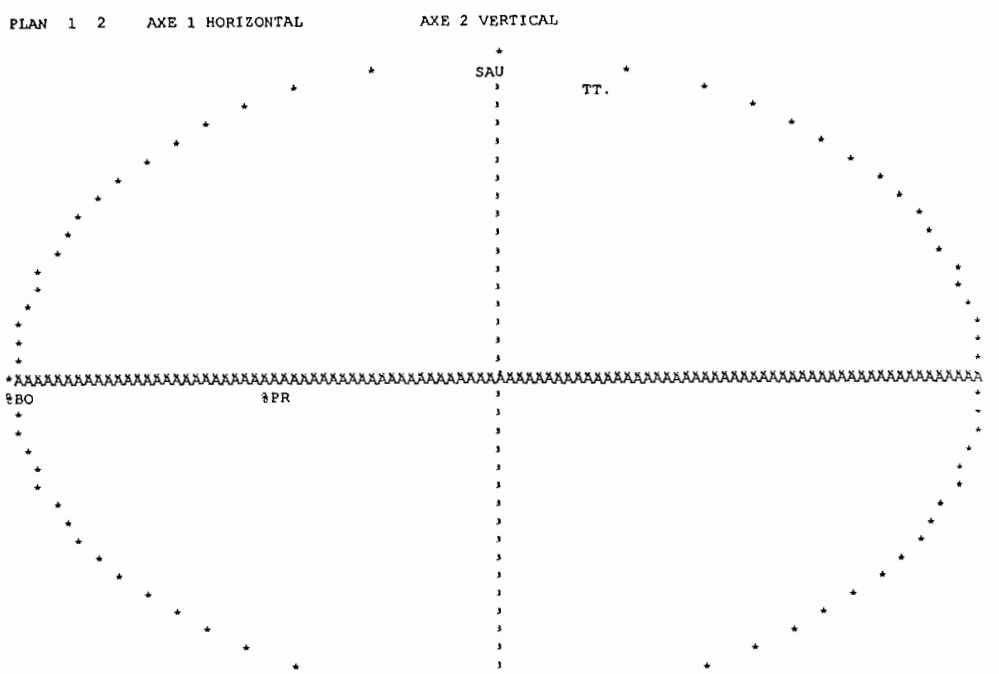
Significant differences between circuits can be effectively explained by the history of AI in the region and by each one's characteristics. For example, it is observed that the worst results are obtained in Berrechid circuit, which is the latest one to be implemented in the region (AI began in 1995, for only 4 years). Hence, the short period of AI practice could be a decisive factor to explain its low efficiency, as it has been stated by Bastiaensen (2) in an AI evaluation program conducted in Suriname. This author cited inseminators' adaptation to their circuit as a crucial factor affecting the success of their activities. In another hand, Trifia circuit only covers 80 km compared to 120 km in Jacma circuit. Short distances are also associated with better breeders' coverage and more efficient AI, as reported by Nabel and Walker (10).

B) AI performances and structural parameters of dairy farms

Field surveys in dairy farms belonging to the three AI circuits have shown that 64.9% of breeders rely exclusively on AI as a means of reproduction for their cattle while 34.1% use natural mating as a complement to AI, especially in the case of repeat breeding cows. AI is highly appreciated by smallholders because of its economic advantages, as it makes it possible to add another cow to the herd instead of a bull (6).
However, some 55.6% of breeders have decided to get rid of AI because they think that this technique is not efficient to ensure convenient reproduction in the herd. According to the dairy farmers this is mainly due to the inseminators' frequent absences combined with high incidences of dystocia when AI is used on crossbred cows.
Discriminant factorial analysis first plan composed of axis 1 and 2 explains 80.9% of total sample variance. Percentage of cows in the herd size determines 96% of axis 1 variance, whereas agricultural land with forages represents 85% of axis 2 total variance (Figure 2). Hence, the discriminant factorial analysis reveals that breeders with regular AI services are those who are specialised in dairy activity, with more than 65% of their agricultural land devoted to forages, and with residual numbers of small ruminants in comparison to cattle. On the other hand, those who have abandoned AI are characterised by less investments in dairy production, as agricultural surface is mainly occupied by cereals (Berrechid circuit), and herds comprise mainly suckling sheep. Therefore, it seems that with the current terms of market for dairy cattle and milk in Morocco, a general specialisation in such production is occurring, with a more acute need for technical assistance (AI for instance) and it just causes the retirement of farmers who do not stand it (15).

Conclusion

The study of AI activity and achievements in three circuits at the scale of Settat province, in Morocco, shows that its actual progress. This has been effectively observed through an intensification of the number of inseminations per circuit (from 160 in 1992 to 645 in 1998) and by progressive increase of conception rate. Average calving interval (404.8 days) was significantly affected by circuit effect and this was explained by the history of AI and by circuits general parameters (length and number of cows). On the other hand, the percentage of cows needing more than 3 AI to be effectively pregnant varied significantly among years. This was attributed to the impact of annual climatic variations on forage production, and on stresses affecting cattle (i.e. heat stress). However, performances are still to be improved, even if general results are quite satisfactory, considering the type of environment where AI is practised. It's obvious that AI is helping dairy farmers to increase the number of cattle and to benefit from high merit genetic material, which is part of dairy specialisation, as pointed out by factorial discriminant analysis. But it would be more profitable if AI data could be automatically used by development and extension agents, in order to promote feedback information to the cattlemen. Hence, it could be used as an effective tool for better monitoring of dairy herds, once the inseminators get enough time and facilities to establish themselves in their circuits.



TT: Total herd size
SAU: Agriculture land with forages
% BO: Percentage of cattle in the herd
% PR: Percentage of small ruminants in the herd

Figure 2: Correlation circle between variables in the discriminant factorial analysis

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