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Eskardillo: a platform based on individual animal data collection to improve decision making in dairy goat farms

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Abstract. Dairy goat sector is experiencing the intensification process observed in dairy cattle systems consisting on maximizing productivity, efficiency and profitability. To achieve this ambitious goal Cabrandalucía Federation has implemented a new concept of farming based on the use of the 'Eskardillo', a smart phone-based platform which relies on three principles: i) systematic individual data recording (milking control, productivity, genetic value, morphology, phylogeny, prolificacy), ii) big data processing and interpretation and iii) interactive feed back to the farmer to optimize decision making. In this case study twelve farms belonging to the Murciano-Granadina goat breeding association (Caprigran), which implemented the Eskardillo in 2014, were monitored from 2013 to 2016 in terms of genetic value and productivity of individual animals to determine the effectiveness of this platform. The results demonstrated that the implementation of the Eskardillo platform implied a holistic and data-driven management, which aided to optimize the first kidding age, dry period length and culling strategy which helped to minimize "invisible loses" derived from unproductive periods. Eskardillo management also accelerated the genetic progress and milk yield due to a better identification and monitoring of animal productivity. This platform could also provide additional benefits derived from implementing precision feeding practices or sustainability parameters integration. Thus, a more detailed study is required to fully evaluate the impact of Eskardillo platform on farm profitability over the years to come.

Keywords. Dairy goats – Eskardillo – Farm management – Milk production – Precision livestock farming.

Eskardillo: une plateforme basée sur la collecte de données par animal pour améliorer la prise de décision dans les élevages de chèvres laitières

Résumé. *L'industrie de caprin laitier subit une intensification similaire à celle du bovin laitier visant ainsi à maximiser la productivité, l'efficience et la rentabilité. Pour atteindre cet objectif ambitieux, la Fédération Cabrandalucía a élaboré un nouveau concept de gestion du bétail basée sur l'utilisation de 'Eskardillo', une plateforme via smart-phone qui repose sur trois principes: i) la collecte systématique des données individuelles (contrôle laitier, de la productivité, la valeur génétique, la morphologie, la phylogénie, la prolificité); ii) le traitement et l'interprétation des données sur une grande échelle; iii) l'impression interactive de l'éleveur afin d'optimiser la prise de décision. Dans cette étude de cas et dans l'objectif d'évaluer l'efficacité de cette plate-forme, douze fermes appartenant à l'association des éleveurs de race Murciano-Granadina (Caprigran) et qui a d'ailleurs mis en œuvre le Eskardillo en 2014, ont été choisi pour un suivi individuel de valeur génétique et de productivité des animaux et ce, de 2013 à 2016. Cette étude a montré que l'implantation de la plateforme Eskardillo impliquait une gestion holistique et axée sur des données, ce qui a contribué à l'optimisation de l'âge à la première mise-bas, la durée du tarissement et la stratégie de réforme permettant ainsi de minimiser les «pertes invisibles» résultant de périodes improductives. Cette plate-forme pourrait également fournir des avantages supplémentaires découlant de la mise en œuvre des pratiques d'alimentation de précision et de l'intégration des paramètres de durabilité. Ainsi, une étude plus détaillée est nécessaire pour évaluer complètement l'impact de la plate-forme Eskardillo sur la rentabilité agricole au cours des années à venir*

Mots-clés. *Caprin laitier – Eskardillo – Gestion de ferme – Production laitière – Élevage de précision.*

I – Introduction

Livestock production today has to combine several requirements such as food safety, animal welfare, animal health, and environmental and economic sustainability in a wide sense. The consequence is a growing need to monitor many variables during the production process. One alternative consists on using Precision Livestock Farming (PLF) which consists on the use of forward-thinking technologies to optimize the contribution of each individual animal. Through this "individual animal management", the farmer aims to deliver better results in livestock farming in comparison to those which manage the flock as a whole. These results can be quantitative, qualitative or addressing sustainability concerns.

Precision Livestock Farming is made possible by monitoring each individual animal which although sounds futuristic, it has been made during millennia. In olden days when flock sizes were small, farmers could identify animals by name and point out who the parents were and sum up other important morphological and productive characteristics. As a result, they could select those offspring born from the most productive animals. Thus, each animal was approached and managed as an individual given the inherent diversity among them. However, during the last three decades the ruminant livestock sector has experienced a vast intensification and farms have scale up their size and have incorporated highly automated processes for feeding and other tasks which manage the flock as a whole. Farmers generally work with average values per group without taking into consideration each animal particularity and the inter-animal variation is perceived as an impediment to achieve economies of scale. On the contrary PLF is taking advantage of this inter-animal variability to enhance farm productivity. Using modern tools for data collection and information technologies, farmers now can easily measure and monitor numerous attributes of each animal such as age, reproduction, health, pedigree, performance and product quality. Three key aspects are needed to unlock the potential of PLF: 1) Electronic Identification (EID): each animal gets a unique number (equivalent to the ear-tag) which can be read by a handheld "reader". 2) Consistency in the data collection from each animal. 3) A piece of software to instantaneously transmit and process the data on servers and provide the feed-back to the farmer´s terminal. When this platform is available and easy to apply several economic and societal goals could be achieved in terms of higher quantity, quality and food safety, efficient production, sustainability, animal health and well-being, low footprint of livestock and farmer professionalization. However the level of effectiveness of implementing these PLF platforms has not been studied yet.

To date, most of the PLF concepts have been developed for monogastric livestock such as pigs (e.g. improve ventilation in buildings, cough recognition, thermal control, weight estimation, sensor placement robot, precision feeding), poultry (e.g. egg counting and identification, hatching synchronization, carcass inspection) and fish (optimizing sizing and sorting) (Banhazi *et al*., 2012). In ruminants PLF has mainly focused in very specific aspects of dairy cattle such as implementation of automatic milking robots (John *et al*., 2016), oestrus detection (Mottram, 2016) and health prevention (Bull *et al.*, 1996). The dairy goat sector is currently experiencing the intensification process observed in dairy cattle however, to our knowledge, very little PLF concepts have been implemented yet. The dairy goat sector has a series of peculiarities such as low net margin per animal, relatively low automatization in feeding and milking systems, absence of dynamic buildings, and frequent utilization of grazing-based systems which limit the implementation of PLF concepts. Thus, a more holistic approach is needed that focuses in the monitoring of individual animals and their performance if PLF-like concepts are to be implemented in the dairy goat sector.

Cabrandalucía Federation (www.cabrandalucia.com) has implemented a new concept of farming based on the use of "Eskardillo", a smart phone-based platform which incorporates PLF-like principles. Thus, the aim of this paper is to monitor 12 case study farms which implemented the Eskardillo in 2014 in order to reveal the effect of this platform on key parameters related with animal productivity and ultimately the farm sustainability.

II – Materials and methods

Eskardillo itself is an Android smartphone-like terminal which incorporates 4 elements: An Electronic Identification reader to identify animals *in situ.* A barcode reader to identify milk tubes for the milk control, blood tubes for genotyping, biopsy tubes for post-mortem analysis or drugs/vaccines used. A digital camera to take pictures for post-mortem certificates. And a mobile-phone SIM card to store data with Wi-Fi connection for data transfer.

However, Eskardillo platform is a broader term which relies on three principles: 1) systematic individual data recording such as milk yield and composition every 4 weeks, genetic value, morphology, phylogeny, prolificacy, etc., 2) big data processing and interpretation and 3) interactive feedback to the farmer to optimize decision making. A management index is calculated for each animal based on its genetic value, morphology and productivity which summarizes the quality of each animal in comparison with the flock average. Thus this management index represents an easy-to-use approach to discern between animals with high potential (which should be inseminated with high merit billy goats) to those with low potential which should be discarded from the farm. Table 1 summarizes the main inputs and outputs in the Eskardillo platform.

Table 1. Summary of the main inputs and outputs required for the Eskardillo platform regarding to individual animals

INPUT	OUTPUT / FEEDBACK TO FARMER
At birth	**At birth**
Date of birth	Genetic value and accuracy
Type of partum (single/tweens/caesarean/miscarriage)	Management index
Provisional ID Ear-tag / Tattoo / Blood tube barcode	Records for future paternity / maternity DNA
Sex	Appropriateness as reproductive female
Mother ID (one or various)	Appropriateness as reproductive male
Father ID (one or various)	Appropriateness as high merit male for insemination centre
During growin	**During growin**
Permanent ID	Updated genetic value for animals to be sold as replacement
Assessment of animals into groups for treatments	Sorting and grouping animals for treatments / measurements
Sanitary records	Updated genetic / sanitary information from animals bought
Movement of animals from farms / slaughtered	Notification of animal movements/treatments to authorities
Slaughtered animal ID	Animal traceability and fulfilment of drug withdraw period
Deaths and reasons	Optimal time for first matting / Artificial Insemination (AI)
During the productive life	**During the productive life**
Morphological evaluation	Updated morphological value and management index
Date lactation begins	Updated days in milking and productivity
Prolificacy	Recording reproductive problems
Number of partum (productive cycles)	Identify top animals for artificial Insemination (AI)Milk yield and quality every 4 weeksIdentify bottom animals for culling
Number of milk controls per lactation	Identify unproductive animals for culling
Total milk yield/quality in certified lactations	Updated genetic valueLactation curveIdentify the optimum moment for AI/matting based on milk yield
Sanitary treatments	Grouping of animals for sanitary treatments and records
Location (pen)	Updated location of animals in the farm
Echography results for pregnancy	Estimated day for delivery or relocation for further AI/matting
Day dry period begins	Updated census of lactating / pregnant + lactating / dry animals
Day and reason of culling / death (ID / biopsy / photo)	Post-mortem analysis and updated census of total animals

In order to evaluate the effectiveness of the Eskardillo platform on the farm productivity, a total of 12 Spanish dairy goat farms were selected based on several aspects:

1. They belong to the same Murciano-Granadina breeding association (CAPRIGRAN), therefore data were collected and processed using the same standards.
2. They implemented the Eskardillo platform in 2014, thus they can be considered as pioneers in this innovation and have available data from 2013 to 2016.
3. They are managed by forward thinking farmers who consistently use the Eskardillo as a key management tool in the farm.
4. They have maintained a similar production system during the course of this study and have not suffered relevant health issues which could comprise data interpretation.

Three data files per farm were generated compiling the key information from two years before (2013) to two year after (2016) the Eskardillo platform was implemented:

The **milk control file** compiles information about each animal (ID, mother ID, father ID), relevant dates (day of birth, day in which each lactation begins, day dry period begins, date of death / culling and reason), reproductive information (number of partum, type of partum, litter size, etc.) and milk yield based on the milk control performed every 4 weeks during the lactation (days on milk, milk yield and composition). Since most dairy goat farms have lactations starting all year around, it was decided to use day in which the lactation finishes as the factor which determines lactation allocation to each natural year.

The **productive ranking file** compiles all those goats which successfully achieved an certified lactation consisting on a minimum 210 days in milking (150 days for primiparous goats) having not missing more than 2 milk controls (1 for primiparous goats).

The **genetic value file** compiles the updated genetic merit of each individual animal each year. This genetic value is calculated based on the productivity (milk yield and quality) of each animal and its relatives. Only those animals present in the farm with a genetic value with accuracy above 50% were considered.

Each farm was considered as experimental unit, thus data from animals belonging to each farm were averaged. Data were analysed by ANOVA considering each year (from 2013 to 2016) as fix factor and each farm as a block. Since the age to the first partum and the dry period length did not follow a normal distribution, data were grouped into intervals and a further ANOVA was performed for each individual interval. Differences among means were compared with the LSD when $P<0.05$, while P values between 0.05 y 0.10 were considered as trends. The impact of the Eskardillo on a given parameter was also expressed as the proportion of the 2016 data with respect to the year the platform was implemented (2014).

III – Results and discussion

(Pleguezuelos *et al*., 2013) described the situation of the Spanish dairy goat sector based on the analysis of 68.352 lactations of a total of 31.859 Murciano-Granadina goats before the Eskardillo implementation. This study revealed the presence of "invisible loses" which are not registered in the farm accountability due to its measurement difficulty. The main drivers of these invisible loses are the unproductive periods in which the animal do not produce such as the first partum age or the dry period, and those periods in which the animal is not able to cover its production cost such as the late lactation stage. Pleguezuelos *et al*., revealed that up to 74% of the dairy goats have a first partum age above the optimum (13-14 months), moreover 42.9% of the animals had it above 17 months which can be considered excessive and thus an unproductive period. Our data (Figure 1) based on the study of 12 farms revealed a substantial decrease (-24%) in the proportion of animals which have an excessive first partum age (15-16 months) as well as an increase (+49%) in the proportion of animals with an optimum age (13-14 months) resulting on a tendency to decrease the average first partum age (P=0.076). Moreover, these primiparous goats experienced a substantial increase in the milk yield over the total lactation (+13%) and 150d-length certificated lactation (+11%).

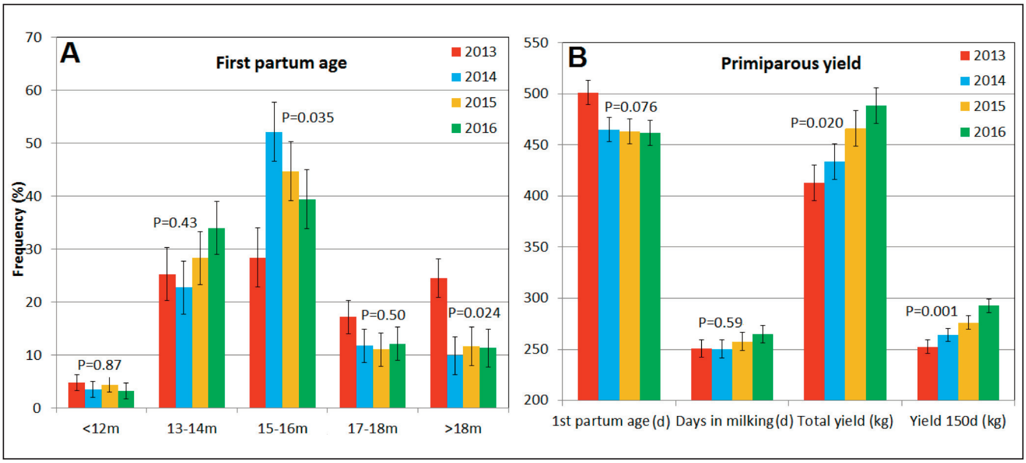

Fig. 1. Frequency distribution of the 1st partum age (A) and milk yield of primiparous goats from 2012 to 2016 (n= 12 farms).

Pleguezuelos *et al*. (2013) also revealed that up to 85% of the dairy goats have a dry period above the optimum length (61d). Moreover 44% of the animals had a dry period length above 91d which can be considered as unproductive period. Our study revealed that the 12 farms evaluated already have a relatively low dry period length in 2012 (81 days), thus a narrow margin for improvement was expected. Nevertheless, Eskardillo implementation promoted a decrease in the proportion of animals with a dry period length above 151 days (-93%), between 121-150d (-79%) and between 91-120d (-15%), with the subsequent improvement (+21%) in the proportion of those between 61-90d, which can be considered as the optimum length (Figure 2). This improvement in the dry period length could be achieved due to the implementation of a well-defined reproductive plan which estimates the optimum moment for the conception according to the milk yield of each individual animal with a target dry-period length equal to 60d (Caja *et al*., 2006). Eskardillo management also led to an increase in the milk yield per total lactation (+10%) and 210d normalized lactation (+7.1%) over the 2 year-course since this platform was implemented.

Eskardillo also allowed to better monitor the productivity of each individual animal resulting on a substantial increase in the number of certificated lactations per year (+33%) since this platform was implemented (Figure 3). These certified lactations showed a similar increase in milk yield than previously described for the total lactations (+9.3%). Several factors could explain this increased productivity such as a strict culling strategy based on identifying unproductive animals as well as the execution of a well-defined genetic selection program as was showed by a substantial increase in the genetic value for milk yield (P=0.003) and milk components such as milk fat (P<0.001), protein (P<0.001) and solids (P=0.008).

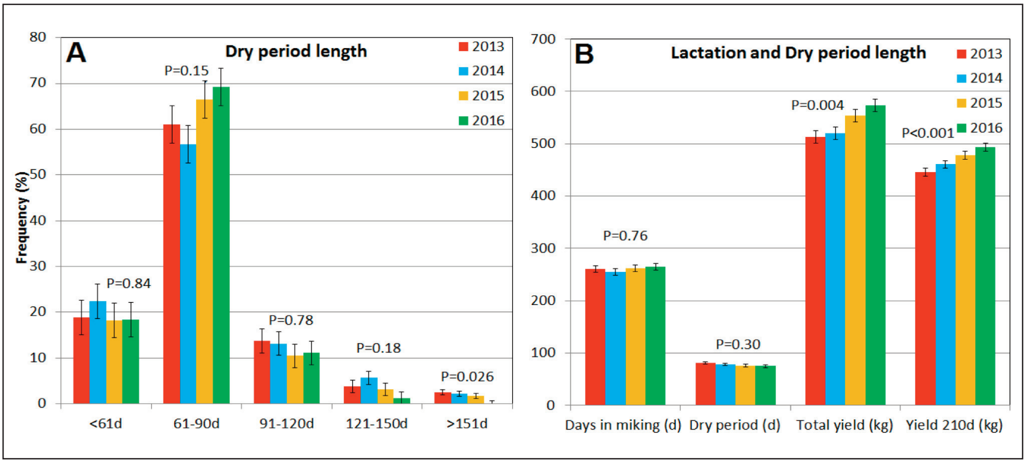

Fig. 2. Frequency distribution of the dry period length (A) and milk yield (B) from 2012 to 2016. (n=12 farms).

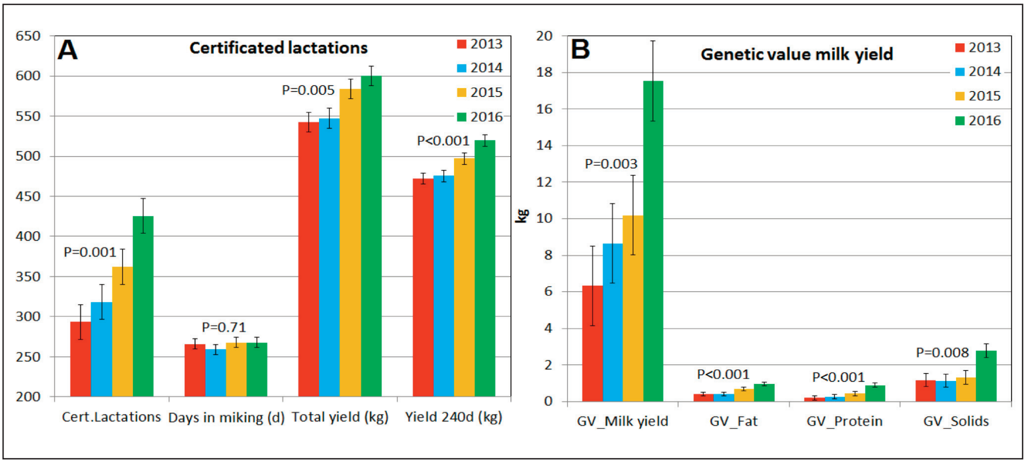

Fig. 2. Number of certified lactations per farm (A) and average genetic value (B) from 2012 to 2016. (*n*=12 farms).

IV – Conclusions

The implementation of the Eskardillo platform implied a holistic and data-driven farm management. This platform helped to optimize the first kidding age, dry period length and culling strategy and thus minimized the “invisible loses” derived from unproductive periods. Eskardillo management also accelerated the genetic progress and milk yield due to a better identification and monitoring of animal productivity. This platform could also provide additional benefits derived from implementing precision feeding practices or integrating sustainability parameters.. Thus, a more detailed study is required to fully evaluate the impact of Eskardillo platform on farm profitability over the years to come.

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