Dtreo, a flexible cloud-based data-recording platform for data-driven decisions in sheep and goat industries

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Abstract

Sheep and goat production systems are extremely valuable sources of income, food and by-products, especially when considering their ability to use land with few alternative agricultural applications. These livestock systems positively impact local socioeconomic activities, both in developed and developing countries.

Regardless of the geographical context, on-farm data recording is one of the main challenges sheep and goat farming faces in the context of sustainable and profitable livestock production systems. The availability of good quality data, collected by standardised systems, is crucial for the development and implementation of technical interventions and genetic services. Data flow through the supply chain can support market structure and has an impact on farmers, traders, processors, businesses, and revenues.

A good record-keeping system should be suited to the conditions in which it is used and to the expected use of the collected data. If properly defined, a good system can enable farmers to make informed data-driven business and management decisions.

The cloud-based platform, Dtreo, has been developed for data capture, storage, and reporting in many different farming scenarios. The platform transforms livestock performance data collected at the farm level into actionable information, supporting farmers in making data-driven decisions and connecting producers to markets. Thanks to its flexible structure, Dtreo is customizable in terms of data collected, validation criteria, and user interface language. This applies not only to small ruminants, but also to pigs, cattle, and aquaculture recording requirements. The platform has also been considered for supply chains either in vertical enterprises or horizontally across an industry.

To date, the Dtreo platform has proven to be a valuable support tool in sheep and goat community-based breeding programs in Ethiopia and India, as well as in advanced small ruminant operations in developed countries.

Our paper highlights how the Dtreo platform has supported sheep and goat farmers with data and information to drive decision making.

Keywords: sheep, goat, performance recording, database.

Introduction

Globally, about 20.8% of dairy products come from sheep and goats and they make up 1.3% and 1.9%, respectively, of the total milk produced (Mazinani & Rude, 2020). Sheep and goat meat consumption are fourth and fifth after pork, poultry, and beef meat. Wool, being four to seven times more expensive to produce than manmade fibres, is now often marketed as a luxury product (Doyle et al., 2021).

Sheep and goat production systems are therefore extremely valuable sources of income, food and by-products, especially when considering their ability to use land with few alternative agricultural applications. They play a remarkable role in the agro economy of countries in the Mediterranean area, and developing countries in Africa, Asia, and Latin America.

Regardless of the geographical context, on-farm data recording, processing, and storing, is one of the main challenges that sheep and goat farming faces in the context of a sustainable and profitable agribusiness.

In developing countries, the lack of infrastructure, the absence of basic tools to capture data, and the highly fragmented production system limit the opportunity to provide support to farmers, develop advisory services and establish genetic improvement programs (Santos et al., 2021). In developed countries, the absence of standardized record-keeping systems and low accuracy of data recording have been recognised as factors limiting profitable sheep and goat production and the efficiency of genetic selection programs (Aldridge et al., 2018; Salaris et al., 2018). Due to the generally small scale of the breeding initiatives for small ruminants, it is hard to distribute the development and operating costs of a bespoke data platform over modest numbers of animals with low individual value. For small ruminants, automatic weighing and milk recording systems may capture live weight and daily milk records quite efficiently but are not easily customisable to also capture other functional aspects of the animals of interest when making individual animal management, culling and genetic selection decisions.

A good record-keeping system should be suited to the conditions in which it is used and to the expected use of the collected data. If properly defined, a good system can enable farmers and the wider supply chain to make informed data-driven decisions and generate value. Flexible solutions are therefore needed to fulfil the needs of the farmers in different production systems.

The cloud-based data and information platform Dtreo (www.dtreo.io) has been developed to overcome the aforementioned issues, supporting data collection, storage, analyses, and reporting in different situations. In this manuscript we describe the main features of the platform, providing case studies and examples in which Dtreo has been shown to be a valuable support tool to farmers and communities in both developed and developing countries.

Dtreo Platform overview

Dtreo captures, stores, and reports individual animal level data. It has been developed in the Microsoft stack of technologies and delivered in the cloud, affording a high level of data storage security. Dtreo is accessed via an internet browser and mobile application, making it highly accessible and flexible, so changes can be implemented almost immediately.

The platform allows pedigree, performance, health, and environment data recording through forms, direct entry, or files. Data entry is tailored to the user's data collection requirements. Dtreo is not hard-coded, and it can be configured for many different data capture situations. The data, recorded either online or offline (where connectivity is limited, with support of mobile app smart device software), is transferred into a designed Microsoft Azure table storage and Cosmos DB SQL API which uses entities (e.g., location, flock/herd, animal, etc.) and events (e.g., birth, weaning, sales, etc) which are customizable by the user.

A hierarchical order of (multiple) entities and sub-entities can be defined by the user based on the specifics of the operation, then events are associated with the lower level of sub-entity.

Before being saved, the data is validated by applying user-defined filters for the event, quarantined if necessary, and ultimately stored.

Quantitative geneticists and livestock breeders rely on accurately recorded phenotypes to drive genetic progress. However, phenotypic data must often be collected by commercial suppliers who may have little interest in genetic improvement. One of Dtreo's strengths lies in its capacity to balance the needs of both 1) commercial suppliers, who value the ability to make management decisions based on analytics produced from phenotypic data, as well as 2) stud breeders, who value the genetic evaluations generated by accurately recorded data.

In Dtreo, clean and normalised data are therefore available for internal analysis within the platform or externally (e.g., in a genetic evaluation or delivered to a third party).

Dtreo reporting exploits the visualisation capability of Microsoft's PowerBI. PowerBI aggregates and transforms a user's data into pictures as graphs, cards, decision-trees, maps, tables, and other visuals. Moreover, bespoke analytics aimed at supporting data-driven decisions are implemented on the platform, depending upon users' requirements.

Dtreo can easily be contextualized to create any type of input data for other software, if needed, or to integrate third party data. The platform's user interface has been translated into various languages (English, French, Portuguese, Hindi, Amharic, Arabic to date) to make it easier to use.

Thanks to bespoke permission settings, Dtreo is suitable for both individuals and collectives of farmers.

Case studies

Community-based breeding program (Ethiopia)

The Ethiopian government, in collaboration with the International Center for Agricultural Research in the Dry Areas (ICARDA), the International Livestock Research Institute (ILRI) and the Brazilian Agricultural Research Corporation (EMBRAPA), has initiated sheep and goat community-based breeding programs (CBBP) in different locations of the country to support communities of smallholder farmers in improving flock performance and addressing market demand (Haile *et al.,* 2020).

Despite the different production and ecological systems in which the communities operate, the use of Dtreo, supported by the New Zealand Ministry of Foreign Affairs

and Trade (MFAT), has allowed the collection, storage, and reporting of uniform data to be used in selection decisions (Haile et al., 2019). Initially, 19 local enumerators/ technicians were trained and equipped with tablets, with data capture starting from 2019.

Birth, 6-month, and yearling weights, as well as functional conformation, body scores and litter size data were collected by these technicians, who also managed animal identification and breeding program activities.

In each community, the households' flocks were pooled and treated as one entity. The outcome from data analyses in Dtreo was used in a two-stage ram selection process: between 4 and 6 months of age, based on the adjusted weight of lambs and twinning rate of ewes; and before the reproductive age based on a set of agreed selection traits. To improve acceptance of the breeding program by the community and to build commitment, a selection committee (whose members were appointed by the community) oversaw the final selection of the young sire candidates.

At early 2023, a total of approximately 100,000 animals with over 67,000 lambing/ kidding records, 125,500 live weight records at different ages, and 23,000 milk records were available on Dtreo. As described in detail by Haile et al. (2020), the CBBP has positively impacted animal performance as well as market participation by the communities involved, improving their income. Thanks to its success in Ethiopia, the possibility of implementing CBBPs in other pastoral communities is well and truly underway (Getachew et al., 2018). However, investments from both the public and the private sector in strategic areas around CBBPs (e.g., technology, infrastructure, organisation) are of crucial importance for the long-term sustainability of the programme (Haile et al., 2019).

Project Mesha (India)

Project Mesha, a programme of the Aga Khan RSP Foundation with further funding from the Bill and Melinda Gates Foundation, commenced in 2016. It aims to improve the quality of life of marginalized communities by improving the productivity of their livestock (goats), empowering women goat keepers in the Muzaffarpur district of Bihar state in India, and improving incomes (Schurink et al., 2022). As a part of the project, in 2018 a community-based goat breeding program was implemented focusing on goat identification, performance recording, and the selection of superior male kids for breeding (Nimbkar et al., 2021). The program initially involved 4 recording villages (with at least 200 breeding does each) and expanded to 8 villages in 2020 and 16 in 2021. The 16 recording villages are expected to generate selected breeding bucks for recording as well as non-recording villages in the vicinity.

Dtreo has been used as both a recording and evaluation system. The user interface has been customised to allow the collection of the following data: animal identification, location, ownership, kid weight at birth, 3 months, 6 months, adult (doe) weight, dam's chest girth, dam's condition at the time of assessment, dam's litter size history, and dam's kid-survival history.

Hindi (and English) was implemented as the user interface language to facilitate data recording performed by the veterinarians and para-workers of the Project Mesha field team. The mobile Dtreo application platform has enabled the field data collectors to collect data offline with ease, on their tablets or mobile phones while in the villages. The data, after being validated and stored, is used by Dtreo in the calculation of an overall index score for buck kids. The criteria used in the scoring system include the 100 days weight of each buck kid plus four traits of the kid's dam: chest girth, condition at the time of assessment, litter size, and kid survival. The outcomes are made available through a Dtreo report to the field team for primary selection.

At early 2023, 91 bucks have been selected based on the index scores and placed for mating. The average daily gain up to 100 days of age of the progeny of selected bucks was found to be 26.8% higher than the progeny of free-roaming bucks (weighted average based on number of progenies per buck). Improved traits of the progeny sired by the breeding bucks as opposed to the progeny born from mating does to the roaming bucks in the villages has motivated several villages to join the program. There is also an increased demand for selected breeding bucks within the villages for mating.

Dairy Sheep operations (New Zealand)

Dtreo has proven useful for private operations in the New Zealand dairy sheep industry. Dairy sheep is a rapidly growing industry in New Zealand; however, compared to other livestock industries, the field is still relatively niche, with few established options for flock recording. Since 2021, one of the largest sheep milking groups in the southern hemisphere has been using Dtreo as their breeding platform to integrate data collection on-farm, genetic evaluations, and selection indexes. By leveraging Dtreo's strengths, accurate genetic evaluations have been provided, with high level of engagement from commercial suppliers involved with the dairy sheep operation. Consequently, Dtreo is now set with the goal of assisting commercial suppliers to improve phenotypic culling decisions using analytic tools, and novel traits data recording.

Other species

Thanks to its flexibility, the Dtreo platform has been shown to be a valuable support tool for other livestock systems e.g., cattle, pigs, and aquaculture also. Brief examples of how Dtreo supports farmers in cattle and pig operations are provided below.

Cattle

Several private-owned beef cattle operations in developed countries have invested in Dtreo as a decision support tool for the management of their business.

Data collected at farm level includes pedigree, weights (at birth, weaning, yearling age, and at slaughter), and disease and treatment events, as well as mating, sale, and slaughter dates. These are validated, stored, and summarised in real-time reports for supporting the decision-making process. The reports are location, management group, breed (in case of multi breed or crossbred), and animal specific, according to each farmer's need.

The possibility of handling groups of sires simplifies the mating strategies and pedigree recording for farmers using stock bulls in their herds. The integration of third party data allows the upload of breeding values (including GEBVs) computed by external genetic evaluation centres or breed societies. This information is processed by Dtreo providing reports tailored to the user requirements.

Dtreo has allowed these beef operators to discover insights about their data that were not possible previously. They specified relevant analytics to be promptly developed through the flexible structure of the platform, uncovering new information and supporting more informed decisions.

Pigs

Dtreo has been adopted as the data collection and information platform by PigBoost, a collaboration for boosting development of the pig industry in Uganda. The project involves Vetline Services, with support from the Pig Improvement Company (PIC), the Roslin Institute (UK), Makerere University (Uganda), and AbacusBio. The initiative is aimed at empowering pig farmers in Uganda by improving animal production, health, and welfare through a digital transformation of the pig production supply chain.

Dtreo has been customized to store animal identification, weights, artificial insemination data, farrowing, and health data which are directly uploaded by farmers and Vetline Services technicians. With real-time monitoring of animal performances at the farm level, Dtreo enables pig farmers and Vetline to make data-driven decisions about animal management and breeding.

By connecting different actors of the supply chain, Dtreo has increased transparency and ensured the return of value to farmers.

Conclusions

The amount and the quality of available data affects all the steps of any livestock supply chain: from management decisions at farm level, implementation of genetic improvement strategies, to market access.

A flexible digital database system combining performance data recording, analysis, and reporting has been shown to increase livestock productivity and enhance the competitiveness of farmers for different species and situations.

Farmers in both developing and developed countries are supported in the decision-making process by the availability of informative and straightforward reports, obtained by analysing validated data.

References

Aldridge, M. E., J. E. Fearon, B. P. Haynes, H. M. Miller, K. Y. Sanford, R. R. Scott, ... and B. R. Franks. 2018. Solutions for grand challenges in goat and sheep production. Biotropia, 26:1, pp 55-64.

Doyle, E. K., J. W. V. Preston, B. A. McGregor, and P. I. Hynd. 2021. The science behind the wool industry. The importance and value of wool production from sheep. Animal Frontiers, 11:2.

Getachew, T., A. Haile, and B. Rischkowsky. 2018. How to tailor community-based breeding programs for small ruminants to pastoral production systems. Proceedings of the World Congress on Genetics Applied to Livestock Production, 11, pp 858.

Haile A., S. Gizaw, T. Getachew, J.P. Mueller, P. Amer, M. Rekik, and B. Rischkowsky. 2019. Community-based breeding programmes are a viable solution for Ethiopian small ruminant genetic improvement but require public and private investments. J. Anim. Breed. Genet., 136:5, pp 319-328.

Haile A., M. Wurzinger, J. Mueller, T. Mirkena, G. Duguma, M. Rekik, J. Mwacharo, O. Mwai, J. Sölkner and B. Rischkowsky. 2020. Community-based sheep breeding programs generated substantial genetic gains and socioeconomic benefits. Animal, 14:7, pp 1362-1370.

Mazinani, M. and B. Rude. 2020. Population, world production and quality of sheep and goat products. American Journal of Animal and Veterinary Sciences 15:4, pp 291-299.

Nimbkar, C., P. Amer, A. Schurink, T. Sawhney and R. Azam. 2021. Genetic improvement of goats owned by smallholder goat keeper women in Bihar, India, with the help of a database tool. Proc. Assoc. Advmt. Anim. Breed. Genet, 24, pp 272-275.

Santos B., G. Jenkins, T. Byrne, M. Teviotdale, A. Haile, C. Nimbkar, and P. Amer. 2021. Proc. Assoc. Advmt. Anim. Breed. Genet, 24.

Schurink, A., S. Kumar, R. Chakraborty, T. Sawhney, C. Nimbkar and P. Amer. 2022. Learnings and experiences from a community-based goat breeding program in India. Proceedings of World Congress on Genetics Applied to Livestock Production, 12, pp 1897.