The last data point. Experience with Dtreo data capture for impact in smallholder ruminant systems

A. Schurink[1], D. Bjelland[2], C. Nimbkar[3], N. Kumar[4], S. Parai[5], C. Singh[6], V.M. Vaghani[7], M. Haigh[8], B. Santos[8] and P. Amer[8]

[1]AbacusBio Edinburgh, Roslin Innovation Centre, University of Edinburgh, EH25 9RG Edinburgh, United Kingdom
[2]AbacusBio Edmonton, Agri-Food Discovery Place, 6020 118 St. NW Edmonton, Alberta, T6G 2E1, Canada
[3]Nimbkar Agricultural Research Institute, Phaltan, 415 523, Maharashtra, India
[4]Aga Khan Foundation (India), 6 Bhagwan Dass Road, New Delhi, 110 001, Delhi, India
[5]Tata Trusts, Bombay House, 24 Homi Mody Street, Mumbai 400 001, Maharashtra, India
[6]Centre for Microfinance, N-102 (South), Adinath Nagar, J.L.N Marg, Jaipur, 302018, Rajasthan, India
[7]Collectives for Integrated Livelihood Initiatives, No:3 Sanidhya Bunglows, Opp Hotel Landmark, ISKON – Bopal Road, Near Ashok Vatika, Ahmedabad, 380058, Gujarat, India
[8]AbacusBio Dunedin, Level 5, Cargill House, 333 Princes Street, Dunedin 9016, New Zealand
Corresponding author: aschurink@abacusbio.com

Summary

Ruminant meat, milk and dairy products take up a significant portion of food consumed globally and are therefore extremely valuable food sources, even more so when considering the ability of these species to thrive on low quality crop land that has few alternative agricultural uses. Ruminants improve local socioeconomic activities in many geographies, including both developed and developing countries.

On-farm data capture is of utmost importance though often challenging in smallholder ruminant systems. Standardized, practical protocols should be in place to ensure timely and useful data collection. A good record-keeping system can further contribute to data quality control through checks and should be tailored to the often-diverse production systems ruminants are kept in.

Dtreo is a cloud-based data capture, integration, and analytics platform primarily designed to support genetic improvement in livestock breeding programs. It aids production, value chain integration, and R&D by providing a centralized repository of data and insights. It is also deployed to create useful insights to support management and decision-making in livestock production systems and policy making. Dtreo offers flexibility and can be customized to meet the needs of various species and production systems.

The analysis of high-quality data and subsequent reporting can significantly benefit stakeholders in ruminant supply chains. The Dtreo platform has been instrumental in enhancing the livelihoods of smallholder farmers by improving ruminant productivity across various regions and production systems. It supports community-based breeding programs (CBBPs) and advanced genomics breeding programs for high-value livestock industries. Rural development programs should consider supporting farm animal data collection through platforms like Dtreo.

Keywords: Community-based breeding programs, data-recording, ruminants, smallholder systems.

Introduction

Approximately 20% of the world's dairy products are derived from sheep and goats (Mazinani and Rude, 2020), while 4% of global milk production comes from goats, sheep, and camels (OECD and FAO, 2024). The majority of consumed meat is sourced from poultry and pork, followed by beef, sheep, and goat meat (OECD and FAO, 2024). In India, where the population is projected to grow to 1.515 billion people by 2030 (United Nations, 2024), about 25% of meat produced in 2024 came from sheep and goats, with 18% from buffalo. Cows produced just over 50% of milk, buffalo 43.6%, and goats are responsible for just over 3% (Government of India, 2024; Table 1). Large variability in these percentages is observed between states, with goats making up 40.1% of meat produced in Rajasthan versus 1.7% in Gujarat. Ruminant production systems are incredibly valuable food sources, particularly because these animals can thrive on land with limited or no alternative agricultural uses. They play a significant role in the agro-economy of many developing countries in Africa, Asia, and Latin America.

CBBPs have the potential to genetically improve livestock in developing countries where the infrastructure for national breeding schemes are absent and centralized government-controlled schemes are not effective (Haile *et al.,* 2020). These programs actively engage with and incorporate the needs of end users, which is crucial for their success. CBBPs typically focus on improving locally adapted animals to prevent the erosion of genetic resources (ICARDA, 2018; Haile *et al.,* 2020).

Considering the potential of CBBPs and the value of ruminants as a food source, several CBBPs are operating in India. The first systematic and organized program was launched in Bihar in 2018 as part of Project Mesha, which is supported and managed by the

Table 1. 2024 meat and milk production in four states and India (Government of India, 2024) – AP = Andhra Pradesh, BR = Bihar, GJ = Gujarat, and RJ = Rajasthan.

Production Tonne % of total	State				India
	AP	BR	GJ	RJ	
Meat	1,067,880	404,303	37,450	247,980	10,252,650
Buffalo	163,780 15.3%	134,250 33.2%	1,120 3.0%	55,480 22.4%	1,854,640 18.1%
Sheep	393,540 36.9%	1,140 0.3%	340 0.9%	56,750 22.9%	1,141,450 11.1%
Goat	102,780 9.6%	129,890 32.1%	630 1.7%	99,320 40.1%	1,588,940 15.5%
Milk	13,994,400	12,852,990	18,311,800	34,733,000	239,298,990
Cow					
Exotic	4,927,290 35.2%	3,828,350 29.8%	6,365,900 34.8%	5,647,640 16.3%	77,197,620 32.3%
Indigenous	1,151,390 8.2%	4,475,650 34.8%	3,319,640 18.1%	9,159,260 26.4%	49,907,520 20.9%
Buffalo	7,912,450 56.5%	4,268,880 33.2%	8,215,930 44.9%	16,789,550 48.3%	104,388,290 43.6%
Goat	3,270 0.02%	280,110 2.2%	410,330 2.2%	3,136,550 9.0%	7,805,560 3.3%

Aga Khan Foundation. In 2024, another CBBP was initiated in Gujarat and Rajasthan through the Climate Change Mitigation Initiative Managed and Led by Women Farmers (CCMIM-LWF), funded by Tata Trusts and implemented by the Collectives for Integrated Livelihood Initiatives (CInI) and the Centre for Microfinance (CmF). The Vijayavahini Charitable Foundation (VCF) plans to deploy a CBBP in Andhra Pradesh in the near future under the same initiative.

The aim of these CBBPs is to transform and improve the quality of life of often landless, marginal, and small farm households. These local smallholder farmers, most of whom are women, possess extensive knowledge about their goats. By leveraging the Dtreo platform and the data it captures, we can support these women by enhancing the genetics of their goats through the insights gained from this data and ultimately improving their livelihoods. As the superior performance of the genetically improved locally adapted breeds becomes obvious, opportunities for buck breeding and breeding buck keeping entrepreneurs to realise life changing empowerment and financial security also emerge.

Dtreo platform features

The Dtreo platform captures, stores, and reports individual animal-level data. Developed using Microsoft's technology stack and delivered via the cloud, it ensures high data storage security. Accessible through both an internet browser and a mobile application, Dtreo offers flexibility and immediate implementation of changes. The mobile app is designed for offline data collection in areas with limited connectivity and removes the need to purchase a laptop or tablet for field activities.

Pedigree, performance, health, and environmental data can be recorded through forms, direct entry, or file uploads, and is tailored to the user needs. Dtreo is flexible and can be configured for various data capture scenarios without being hard-coded. The data is transferred into a client dedicated Cosmos DB Table API which uses entities like location, flock or herd, and animal, as well as events like birth, weaning, and sales that are customizable by the user. Users can define a hierarchical order of entities and sub-entities based on their operational requirements, with events linked to the lowest level of sub-entities. Before data is saved and stored, user-defined filters for these events allow for data validation or even quarantine, if necessary.

Dtreo leverages Microsoft's PowerBI for reporting, transforming user data into various visual formats like graphs, cards, decision-trees, maps, and tables. Additionally, the platform offers custom analytics and advanced R or Python integration where required, to support data-driven decisions based on user needs.

Individuals, collectives of farmers, researchers, and breeders can use Dtreo due to its bespoke permission settings. Its strength lies in the capacity to balance the needs of various stakeholders. Dtreo provides, for instance, commercial suppliers with phenotypic data analytics to support management decisions, as well as breeders with genetic evaluations generated with high quality data. Summary statistics and inventory is also used by policymakers.

The flexibility of Dtreo enables the creation of various input data types for other software and the integration of third-party data. To enhance usability, the platform's interface is available in multiple languages, so far including English, Hindi, Gujarati, Arabic, Urdu, Portuguese, Amharic, and French.

Recording and phenotyping strategies in Indian smallholder ruminant systems

A typical smallholder household in the Gujarat and Rajasthan CBBP regions consists of 6 to 7 household members who own 5-8 goats and about 3 bighas of land (= 1.2 hectares). Many of the households own other livestock too, such as cattle, buffalo or chickens (baseline assessment of goat rearing for CCMIM-LWF; Nagi, 2025). Basic shelter is provided for goat safety and security reasons as well as ease of management. About ¾ of women goat owners take their goats for grazing on communal lands during the day and most provide supplementary grains or concentrates to their goats. Twinning rate is limited, with an average of 1.1 kids per kidding in Gujarat and 1.4 kids per kidding in Rajasthan. Breeding is very seasonal, with many does only kidding once per year. Financial necessity is the main reason for selling goats (for meat), mainly through market traders and farmer producer companies. As of this financial necessity, 20-30% of sold goats are <1 year old, delivering a lower price when compared to adult goats. About half of the households consume a small proportion of their own goats' meat and almost all households drink their doe's milk.

Field team. A strong and motivated field team is the backbone of any CBBP. The CCMIM-LWF field teams included members of CInI and CmF managing, supporting, and overseeing program activities. Pashu sakhis ("friends of animals" in Hindi) are local women trained and employed to support goat health. They also tag goats and record data, with subsequent data entry into the Dtreo platform. Community mobilizers engage with new communities and villagers, expanding the reach of the CBBP. Farmer producer companies or organisations help in marketing goats, purchasing breeding bucks, and selling fodder.

Village selection. The deployed CBBP includes two types of villages. Those where extensive data recording is taking place, training and support is provided to households, and superior bucks and does are bred. The second type of villages are in the same vicinity and where unrelated elite selected bucks are placed to contribute genetic gains but in the absence of any additional recording effort. Awareness campaigns on selective breeding are run and promote the use of superior bucks to produce improved progeny.

Particular characteristics of the villages producing superior goats contribute to the success and uptake of the CBBP. When these villages are somewhat isolated, it is easier to control the goat genetics and population. Also, existing rapport with villagers through other interventions by the field teams is considered beneficial as well as culturally suitable ways of engaging new villages and women goat keepers. In the Gujarat and Rajasthan regions, a team of actors and community mobilizers spread the word about the CBBP through local folk media using musical drama, and in a question and answer format.

Breeding goal and selection criteria. Through active engagement with the field teams, pashu sakhis, and women goat owners during online meetings and field visit meetings it is possible to co-develop a selection merit score, which is crucial for the success of the CBBP. We are in the process of identifying and testing this selection merit score that incorporates and balances the needs of productivity and survivability, which is important in the face of climate change like erratic rainfall patterns. As this score uses phenotypes only, the biggest or fastest genetic improvements are to be expected for traits that can be measured and with moderate to high heritability.

To improve goat productivity, the proposed selection criteria are growth rate (average daily gain) own performance, dam twinning percentage and kidding frequency. Milk yield is included because of its importance for household consumption. Several conformation traits are considered for inclusion. Bucks with a particular colour pattern and conformation can render high prices when sold for sacrificial purposes.

In domestic goats, polledness (absence of horns) is genetically associated with the polled intersex syndrome (PIS) causing infertility (Simon *et al.,* 2022). Although polledness is favourable from an animal welfare perspective and is considered safer when handling goats, an increase in infertility in the population would be disastrous. A well-planned mating scheme is required to avoid PIS-affected goats. The recommendation is therefore to use only horned bucks for breeding, whilst making sure the temperament of goats is acceptable to mitigate against the challenges of handling horned goats.

Recording and evaluation system. To help with quality assurance when phenotyping goats and uploading data into the Dtreo platform, several approaches are followed. For phenotyping goats, pragmatic standard operating procedures (SOPs) were developed. These contribute to achieving consistency in on-field activities like ear tagging and data recording, as well as enhance autonomy of field teams, and increase efficiency by reducing training time and errors. For example, sheets with images of goats representing particular coat colours and breeds are part of a pashu sakhi's kit. A basic measuring cup was recently added to the kit to be able to quantify a "glass of milk" in the field when measuring doe milk production.

The Dtreo platform and app can and are updated based on feedback and the needs of the Gujarat and Rajasthan field teams and pashu sakhis. Warning messages, default input requirements, and outlier reporting are incorporated in the Dtreo platform as data entry checks. For example, goat unique identification (ID) needs to be alphanumeric, starting with either GA or RA, representing the state, followed by 4 numbers.

Inbreeding management. The Dtreo platform also facilitates practical inbreeding management. Specific breeding buck recording capability, including village transfers, mean that the platform can notify the field teams whenever a buck is close to finishing a one year stay within a village and is due to be relocated to another village (at sufficient distance to minimise the risk of mating to immediate relatives).

Reporting impact

Since its implementation in 2018, Project Mesha's CBBP has expanded its impact, with goat data now being recorded in up to 16 villages (Nimbkar *et al.,* 2021; Schurink *et al.,* 2022) and at time of writing, 180 superior breeding bucks had been placed in villages and managed as a business with buck keeping women entrepreneurs. An impact study by the Aga Khan Foundation, surveying over 350 households participating in the CBBP, demonstrated increased awareness among resource-poor women goat owners on genetic improvement and (in)breeding concepts, leading to their empowerment.

Breeding bucks are selected at 100 days of age based on a selection merit score that combines criteria such as average daily gain, dam health, fecundity, and birth type (e.g. single, twinning). Abeykoon *et al* (2025) used these phenotypes captured in the Dtreo platform to show that progeny of selected breeding bucks had a significantly higher average daily gain (13.6%) compared to progeny of unselected or free-roaming bucks, although some of the village-specific results were inconclusive and some of the benefits could have been due to the combination of simultaneous management and genetic improvements over time.

While the qualitative impact of Project Mesha's CBBP is evident, quantitatively validating genetic improvement remains challenging. More generations and data are needed, and a proper testing strategy might be required to statistically prove the superior performance.

Conclusions

Insights obtained through the proper analysis of a sufficient amount of high-quality data, with subsequent reporting, impact many, if not all, stakeholders in ruminant supply chains. Such insights and shared data can, for instance, support farmers in their decision-making processes, breeders when implementing genetic improvement strategies, and processors in understanding product origination, availability, market access, and demands. The Dtreo platform has proven to be a valuable tool in supporting initiatives aimed at enhancing the livelihoods of smallholder farmers by improving ruminant productivity across various geographies and production systems. For example, it supports CBBPs in a rapidly growing number of regions and countries while being flexible enough to accommodate state-of-the-art genomics breeding programs for high-value livestock industries. Rural development programs should consider supporting farm animal data collection through platforms like Dtreo. While the impact of CBBPs on smallholder farmers and communities is evident, quantitative validation of genetic improvement in a truly scientific sense remains challenging. However, on the ground, the feedback from CBBP participants provides resounding support for the impacts, both in the performance of the animals, but also in the income and empowerment of the livestock farmers.

List of references

Abeykoon S., Amer P., Wilcox P., and Nimbkar C., 2025. A comparison of progeny of selected and unselected sires within the setting of a community-based breeding programme catering to women smallholder goat rearers in Bihar India. Submitted for the 26th Conference of the Association for the Advancement of Animal Breeding and Genetics (AABGC), Queenstown, Australia.

Government of India, 2024. Basic Animal Husbandry Statistics. Last visited: 13 March 2025, https://dahd.gov.in/sites/default/files/2025-01/FinalBAHS2024Book14012025.pdf.

Haile A., Getachew T., Mirkena T., Duguma G., Gizaw S., *et al.,* 2020. Animal 14:7, pp 1362-1370, https://doi.org/10.1017/ S1751731120000269.

International Center for Agricultural Research in the Dry Areas (ICARDA), Guidelines for setting up community-based small ruminants breeding programs, 2018. Last visited: 18 March 2025, https://cgspace.cgiar.org/rest/bitstreams/172182/retrieve.

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

Nagi M.K., 2025. Baseline assessment report for project Climate Change Mitigation Initiative Managed and Led by Women Farmers (CCMIM-LWF). Assessment by ImpactDash, India.

Nimbkar C., Amer P., Schurink A., Sawhney T., and Azam R., 2021. Genetic improvement of goats owned by smallholder goat keeper women in Bihar, India, with the help of a database tool. Proceedings of the 22nd Conference of the Association for the Advancement of Animal Breeding and Genetics (AABGC), 24, pp 272-275.

OECD and FAO, 2024. OECD-FAO Agricultural Outlook 2024-2033. Last visited: 11 March 2025, https://doi.org/10.1787/4c5d2cfb-en.

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

United Nations, 2024. 2024 Revision of World Population Prospects. Last visited: 23 April 2025, https://population.un.org/wpp/.