Proc. Assoc. Advmt. Anim. Breed. Genet: 24: 349-352

SUPPORTING DATA-DRIVEN SUSTAINABLE LIVESTOCK INDUSTRIES IN DEVELOPING COUNTRIES

B. Santos[1], G. Jenkins[1], T. Byrne[2], M. Teviotdale[1], A. Haile[3], C. Nimbkar[4] and P. Amer[1]

[1]AbacusBio Limited, PO Box 5585, Dunedin 9058, New Zealand
[2]AbacusBio Int. Limited, Roslin Innovation Centre, Edinburgh EH25 9RG, United Kingdom
[3]Int. Cent. for Agric. Res. in the Dry Areas (ICARDA), Addis Ababa, Ethiopia, PO Box 5689
[4]Nimbkar Agricultural Research Institute (NARI), Phaltan 415 523, Maharashtra, India

SUMMARY

The absence of data capture systems and structures to produce information is a chronic problem of many livestock industries, particularly in developing countries. Information can be a key driver of transformation for these industries and could be created through data collection and integration across livestock supply chains, resulting in more efficient, profitable, and sustainable production systems. A technology platform, Dtreo, has been developed to transform livestock performance data, initially captured to promote breeding initiatives, into actionable information, supporting farmers and connecting producers to markets. The availability of data also has the potential to address a major issue for establishing breeding programs in unstructured livestock industries – namely the lack of phenotyping systems to support genetic evaluation models including genomic selection initiatives. The Dtreo platform has now been deployed in community-based breeding programs in Ethiopia, India, and Uganda with an initial focus on genetic improvement. Our current objective is to expand its implementation to facilitate better coordination of decision making across the supply chain.

INTRODUCTION

The livestock sector in many countries is affected by the absence of basic structures to capture data and enable flows of information, impacting farmers, traders, and processors. In most developing countries around the world there is limited ability to provide support, advisory services, and to create functional information systems, thus weakening the market leverage of small holder farmers, and creating many inefficiencies in supply chain function.

Genetic improvement initiatives are a critical component of developed livestock industries. The infrastructure required to establish these initiatives rely on data and information systems. These same information systems are frequently used to inform other areas of the livestock production sector, including the market. Unsurprisingly the livestock sector of most developing countries can be unstructured, lacking availability of data and information which limits their ability to provide support to their farmers in key areas, such as extension and animal health. Similarly, information on volume and quality of supply to the market is frequently absent in such unstructured industries.

In many developing countries livestock markets have been operational for centuries. In most cases however, such markets provide minimal returns to smallholder farmers. In these cases, it is common that traders and intermediaries capture most of the value that could be otherwise destined to farmers, especially if there were supporting data and information systems in place.

Prediction of livestock performance can be reasonably accurate when phenotypic measures of performance, production system (including traditional practices and environmental data), and parentage information datasets are available. However, when none of these exist, predicting and understanding productivity in each population is challenging.

A technology platform has been developed to support improvements in livestock production outcomes and boost self-sufficiency in rural communities. The Dtreo platform combines breeding

principles with livestock production initiatives through data and information, enabling farmers globally to generate genetic insights for tangible improvements. The system was developed to have a low fixed cost, to be presented in local languages, and to be easy to use.

A subset of case-studies is presented in this paper to illustrate the mechanisms through which principles of genetic improvement can be used to support development of livestock industries in countries which lack the basic infrastructure to support their farmers.

MATERIALS AND METHODS

The platform enables online and offline data collection and flow of information to support decision making at multiple levels in specific production systems, or across one or multiple supply chains. It enables capturing animal characteristics and performance recording of quality data. The data collected in remote locations, where connectivity is often limited, is transferred into a designed Microsoft Azure table storage and Cosmos DB SQL API which uses entity (e.g. location, flock/herd, animal, etc.) and event (e.g. birth, weaning, sales, etc.) associations to produce information based on analysis of the relationships within and across multiple entities and events.

Dtreo is now deployed in several countries (including Ethiopia, India, and Uganda), where most users are smallholder low-input farmers and the technicians (enumerators) that provide support. Farmers, technicians, and breeders use the platform and its analytics to make decisions in support of traditional practices that have been established for many years, whilst the flow of information supports other stakeholders. The platform facilitates the digitalization process, enabling users to record, store and analyse animal performance, reproductive management (including artificial insemination), and animal health interventions. It delivers analytic reports for decision making associated with these events, as well as data integration for genetic evaluation and access to market.

Examples of development projects in which Dtreo is currently used are:

1) Community-based breeding programs, CBBP (Ethiopia), supporting smallholder farmers organized in breeding cooperatives to address market demand for small ruminants by tailoring genetic improvement programs to local pastoral systems (Getachew *et al*. 2018).
2) Project Mesha (India), supporting village production of goats and establishing a genetic improvement strategy in Bihar state in collaboration with Nimbkar Agricultural Research Institute (NARI) and the Aga Khan foundation. Project Mesha aims at improving the quality of life for marginalized landless people and empowering and raising the incomes of women goat keepers through improving productivity of their goats.
3) PigBoost (Uganda), bridging the gap between pig farmers, veterinarians, and extension service-providers, providing a platform to capture data and produce information. Pig production has been largely influenced by increased demand for pork in Uganda. Different research and development initiatives have been associated with PigBoost to leverage the value of the data and information produced.

RESULTS AND DISCUSSION

By February 2021, 70,753 animals have been recorded in the Dtreo platform (Table 1). A total of 4,091 households have been impacted in the referred programs - CBBP, Project Mesha, and PigBoost. Outcomes are still early stage, and these results are based on projects that have only recently been established, or initiated usage of Dtreo as their main data platform.

Since its inception the CBBP in Ethiopia has directly benefited more than 3,200 households in more than 40 villages and over 18,000 people across the supply chain. Increased productivity (more births, better growth, and reduced mortality), as well as increased income from small ruminant production has been achieved. Breeder cooperatives have been formed to commercialize rams and bucks from the program, building on the initial revolving funds supported by the project (Haile *et al*. 2020). The CBBP communities have a sufficiently large and equally distributed sheep/goat

flock/herd, frequently with more than 500 ewes/does in the combined flock/herd of the village. More than 68,000 animals have been included in the Dtreo platform so far. The flock is composed of local breeds, mainly Bonga, Doyogena, Horro, Konso, Menz and Pare. The data recorded has been used to inform within-flock (village) selection of young sire candidates based on a set of agreed selection traits. The retained individuals are then further judged based on weights (at birth, weaning, six months and one year), functional conformation, and body scores reflecting carcass value, relative to contemporaries, all adjusted for maternal information. The aim is that selection decisions align with traditional practices (i.e. where selection was based only on size and colour), improving acceptance within the community, and eventually enabling new market channels and/or supply agreements to be established.

Project Mesha has established individual goat identification and initiated performance recording in a limited number of villages. An overall index score for buck kids was created including the criteria of 100-day weight, dam chest girth, condition at the time of assessment, litter size and kid survival history. Dtreo calculates and reports the index score for each buck kid as one of the selection criteria. So far, thirteen bucks have been selected based on their index scores and about 500 mated with these bucks. Further details on the achievements and context of Project Mesha can be found in Nimbkar *et al*. (2021).

PigBoost has developed a package of services to support pig-farmers in Uganda, focusing on animal identification and data collection. Since early in 2021, approximately 200 pig owners were recruited, with over 1,000 pigs included in the database. The most common breeds are Camborough (46%), Landrace (32%), and Large White (17%), all crossed with local breeds. Data on inseminations and matings, farrowing, weights and animal health interventions have been collected. There is high awareness of biosecurity, given the incidence of serious diseases in some of the herds, and the impact of pig mortality to the overall farm profitability. Major challenges reported by farmers are incidence of diseases (68% of farmers), finances (57%), poor growth rates (30%) and poor fertility/abortions/still births (16%). Most striking was that African Swine Fever was reported to have affected 25% of herds in the last 12 months. Other diseases of major concern are skin lesions, gastrointestinal, and nervous syndromes. Main services required by farmers are disease treatments (85% of farmers), management support (75%), diagnostic services (72%), artificial insemination (38%), and improved breeding (26%). Almost all farmers intend to expand their activities in the next 12 months (96%), with strong emphasis on better genetics (98%), and market access (98%).

Table 1. Numbers of households and livestock impacted by development projects as of February 2021 using the data platform Dtreo for data capturing and information flow

Program	Country	Species	Households included	Animals included	Target households	Target animals
CBBP	Ethiopia	Sheep/Goats	2,073	68,365	11,000	250,000
Project Mesha	India	Goats	1,812	1,319	50,000	500,000
Pigboost	Uganda	Pigs	206	1,069	10,000	50,000
Total	-	-	4,091	70,753	71,000	80,000

There are important challenges to overcome before wider adoption of data recording is observed, and before delivery of genetic improvement impact is realized. These challenges are:

1. Extension & education – support and training to smallholder farmers is required, such thatfarm management practices, feeding strategies, and animal health interventions are provided, optimising traditional production systems, whilst maintaining sustainable interaction with local environmental conditions.

2. Infrastructure – unstructured livestock industries frequently lack the required data and information systems, genetic improvement pipeline, and market access. Basic systems for developed industries (such as animal identification, phenotyping tools, breeding organizations, and market information) are inexistent in most developing countries.

An important limitation in establishing structured smallholder systems is defining breeding schemes that are suitable for the low-input, smallholder farming (Gizaw *et al*. 2014). The small size and weak genetic connectedness amongst flocks/herds is challenging to support approaches that allow separation of genetic and environmental effects in these conditions (Selle *et al*. 2020). A centralized dataset that combines animal performance records, and parentage information, from smallholder farms introduces a potential alternative to the paradigm of dealing with traditional breeding approaches in these systems. For instance, genetic evaluation models in which contemporary groups or herd effects are defined using production levels derived from data might be a feasible solution for smallholder farming systems (Ojango *et al*. 2019). These examples assume that a minimal structure to mitigate the absence of routine phenotyping exists, something that could be a reality with the use of a data platform for data capture and collation.

According to (Ojango *et al*. 2019), the need for a simple approach to data capture from smallholder systems is critical to support estimation of genetic parameters for these systems. This should be coupled with tangible incentives for continued recording and longer-term monitoring of the livestock population as a basis for implementation of sustainable genetic improvement programs. These systems would also support establishing a new paradigm of market integration through data and information, using digital technology.

CONCLUSIONS

Digitalisation of performance records and information is a requirement that should be met if livestock industries of most developing countries intend to improve output, efficiency, and sustainability. Data can influence farm management, application of principles of genetic improvement, and access to market. There are several challenges involved in this process, particularly given smallholder farmers normally maintain a low number of animals in their herds and flocks. Nevertheless, the large number of smallholder farmers operating under specific groups, sharing similar environmental conditions, provide a sufficiently large population to be used as a source of information for breeding programs, and volume/scale for commercialisation.

The case-studies presented in this short summary demonstrate that smallholder farmers in developing countries, when assisted by proper infrastructure and digital technology, can be stimulated to participate in initiatives that will ultimately result in improved livelihoods through better structured livestock supply chains.

REFERENCES

Getachew T., Haile A. and Rischkowsky B. (2018) *Proceedings of the World Congress on Genetics Applied to Livestock Production, 11, p.858*.

Gizaw S., Rischkowsky B., Valle-Zarate A., Haile A., van Arendonk J.A.M., Mwai A.O. and Dessie T. (2014) *J. Anim. Breed. Genet.* **131:** 341.

Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner, J. and Rischkowsky B. (2020). *ICARDA - Tools and guidelines*, No.1.

Nimbkar C., Amer P., Schurink A., Sawhney T. and Azam R. (2021) *Proc. Assoc. Advmt. Anim. Breed. Genet* (In submission).

Ojango J.M.K., Mrode R., Rege J.E.O., Mujibi D., Strucken E.M., Gibson J. and Mwai O. (2019) *J. Dairy Sci.* **102** No. 6.

Selle M.L., Steinsland I., Powell O., Hickey J.M. and Gorjanc G. (2020). *Genet Sel Evol,* **52**: 69.