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Scaling up and sustaining genetic improvement for increased milk production and productivity in Ethiopia: lesson and policy recommendations from the African dairy genetic gain program

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Background

Ethiopian dairy production is subsistence, mainly dependent on local Bos indicus cattle breeds which are characterized by low production and profitability. More than 95% of milk produced is dominantly from local breeds (CSA 2019). The demand for milk and milk products is increasing, driven by changes in demography, a growing economy, underserved markets, conducive policies and enabling environments, and globalization and market opportunities (Shapiro et al. 2017). To improve milk production, smallholder farmers were provided with inputs, artificial insemination (AI) using semen from exotic dairy breeds, and extension services. However, access to high yielding, tropically adapted genetics that suit the different production systems remained as a constraint.

Building a sustainable genetic improvement program requires a robust national animal identification and registration system including collection of phenotypic data, data on relationships among animals through genotyping and pedigrees, appropriate analyses of the data collected for genetic evaluation and selection of top-ranked bulls and cows with aggressive promotion for wider use. The results and feedback are used by farmers to improve their herds, make informed herd management decisions and link farmers to key breeding and animal health service providers and markets leading to sustained animal and herd productivity gains.

Key messages

- In the tropics, dairying is constrained by lack of high producing breeds that are also adapted to tropical conditions and the different production systems. Therefore, there is a need to design a country-specific sustainable breeding program with long-term and committed government and private sector support aimed at continuously identifying and promoting suitable dairy genetics.
- Animal identification and registration are key to implementing sustainable genetic improvement, traceability of animals and animal products, disease control, management of animal movement and use of animals as collateral for loan acquisition. Identification and registration must, therefore, be scaled up and institutionalized within government structures.
- Genetic improvement through selection requires continuous phenotypic and genomic data generation and use. Hence, sustaining the existing dairy data capture system from smallholder farmers and medium and large commercial dairy farms in the national dairy database is essential.
- Phenotypic performance and genomic data captured from smallholder and commercial farms together with genotypes are used in the single-step genomic prediction of the genetic merits of all bulls and cows under recording. These results are used to select superior dairy animals with the top-ranked bulls recruited for national AI schemes and their semen widely used to improve the nation's herds; while the second tier of top-ranked bulls are duly certified and used for natural service in place of the uncertified village bulls.
- The human capacity, particularly in AI delivery, dairy cattle genetics and breeding, and infrastructure developed at the federal level could be used as a springboard for scaling up dairy and for beef cattle genetic improvement.

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Smallholder farmers have not been implementing animal identification and pedigree recording after calves are born from the AI service provided. This would have to enabled subsequent follow-up on the anticipated performance. In addition, data has not been recorded as the calves grow to maturity and start production. The AI services were provided without taking into consideration pedigree information, implying that planned and controlled mating is not feasible, which leads to continuous upgrading of animals to a level of exotic breed composition that is generally beyond what the smallholder farmer systems can profitably support, and a high risk of inbreeding. For example, the exotic breed composition of cows under smallholder farmers in Ethiopia averages at 0.78±0.2, which is very high for smallholder farmers to manage (Strucken et al. 2017) under the existing feeding, animal health and extension services.

The dairy genetic improvement platform

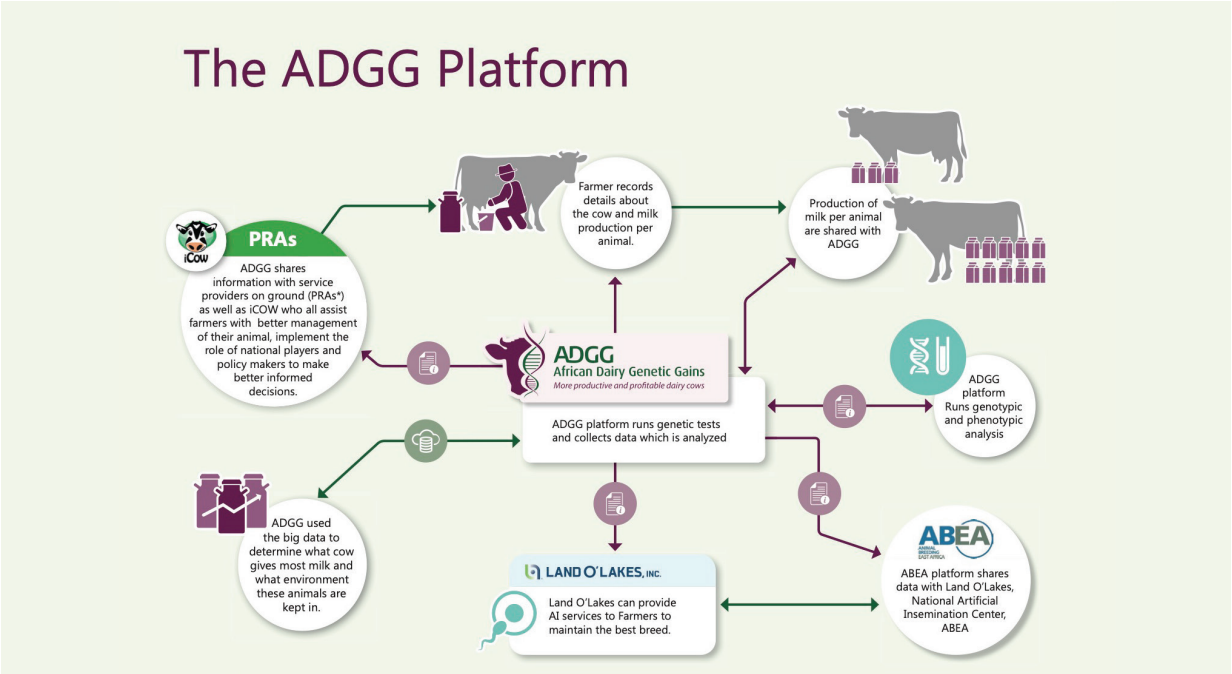
The dairy genetic gain platform was initiated by the African dairy genetic gain (ADGG) program in 2016 in Ethiopia and Tanzania. The goal is to develop and support data capture, analytics and feedback systems that are underpinned by public-private partnerships and that have a clear route to long-term sustainability of genetic improvement and profitability of dairy cattle production in Africa. The Ethiopian component of the program supports a farmer-focused partnership that routinely records on-farm performance, pedigree and genetic information on dairy cattle, synthesizes and analyzes the data generated, and digitally shares feedback of the results alongside related educational messages with the farmers.

A conceptual framework for African dairy genetic gain is summarized in Figure 1. A national database, animal identification and registration, and a digitalized online and offline data capture system have been established to collect performance and pedigree data from the field. Hair sampling protocol and genotyping strategy were developed for genotyping and predicting exotic and local breed compositions of animals. Both phenotypic and genomic data have been used to generate genomic breeding values, which have been used to rank and select purebred and crossbred bulls and cows. The top-ranked bulls are then recruited and promoted for artificial insemination or natural mating.

The project is being implemented in six regions in Ethiopia—Oromia; Amhara; Southern Nations Nationalities, and peoples; Sidama; Tigray; and Addis Ababa City administration—encompassing 65 districts. By the start of 2021, 72,514 herds and 116,615 animals (mostly cows) have been registered on the ADGG platform for national use. Among the animals registered, 6,000 were genotyped in 2019. Additionally, 241,000 test-day milk records have been captured on the platform.

About 8.9 million extension text messages have also been delivered to smallholder dairy farmers via the platform through Green Dreams Tech (i-cow). Follow-up extension advice to farmers has been delivered by trained performance recording agents and AI technicians since 2017. A sister project, the Public-Private Partnership for AI Delivery (PAID), provided 741,846 inseminations, which have been captured on the same platform.

The national capacity to provide the enhanced breeding services has been strengthened through provision of



training, digital tools and motorbikes to facilitate access to farms to enable collection of field data. Training has also been provided on data management and analyses and provision of feedback to smallholder farmers.

In 2021, data on milk production and the results from the genomic evaluation were analyzed to generate genomic breeding values (gEBV) for the registered animals. Bulls and cows evaluated were ranked, top performers selected, photographed and displayed in the first national virtual dairy animal exhibition. These are also presented in an electronic dairy animals' directory: https://hdl.handle.net/10568/113558. Selected top-ranked bulls were bought by PAID project and donated to the National Animal Genetic Improvement Institute (NAGII) for mass semen production and distribution to farmers in the country. The other top-ranked bulls have been certified for use in provision of controlled natural service. A cell phone-based application is now available that allows farmers and AI technicians to scan through the list of these elite bulls, cows and AI sires and select the ones that are desirable to them.

Recommendations

- Use the ADGG platform and approach to scale up animal identification and registration to support genetic improvement of dairy and other livestock species.
- Institutionalize and sustainably support national genetic improvement program within public institutions and programs, where Ethiopian National Animal Improvement Institute (NAGII) has the main responsibility for the sustainability of the national genetic improvement system.
- Create awareness among key dairy value chain actors in order to get buy-in and sustainably leverage resources from development partners and private sector actors for uninterrupted and long-term implementation of the genetic improvement program.
- Strengthen national capacity in performance data collection, genotyping, genomic data collection and analysis.
- Routinely publish and share bull and cow catalogues to support decision making by farmers, policymakers and development partners.
- Link program activities and outcomes with bank and insurance services so that smallholder farmers get loan for farm expansion and new investment.
- Undertake an aggressive human capacity building program locally, particularly in the areas of AI delivery and dairy cattle breeding, which ensures the sustainability of results achieved even after time-bound projects and programs have ended.
- Establish new and strengthen existing civil society such as dairy cattle breeder associations and dairy cooperatives which serve as important tools for extending promising dairy cattle technologies (performance recording, selective breeding, etc.) and proven management practices.

ADGG Ethiopia project partners

Partners contributing to the success of ongoing activities under the ADGG program include the University of New England, Land O'Lakes v37, Public artificial insemination centers, the National Animal Genetic Improvement Institute, the Natural Resources Institute of Finland (LUKE) and Green Dreams Tech. More information is available at https://www.ilri.org/research/projects/african-dairy-genetic-gains; https://africadgg.wordpress.com/; and https://portal.adgg.ilri.org/.

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Figure 1. The African dairy genetic gain platform conceptual framework

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