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An animal genetic database tool launched in small ruminant community-based breeding programs

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Rationale

Breeding programs for local breeds kept by small farmers in developing countries are a major challenge. Animal recording of pedigree and performance under conditions of subsistence livestock farming is remain difficult or next to impossible (Cardellino and Boyazoglu, 2009; Sölkner et al., 1998). This means that standard genetic evaluations, as well as selection and planning of mating based on estimates of the animals' genotypes, cannot be done at any level in the population of the target breed or genetic group. However, the International Center for Agricultural Research in the Dry Areas (ICARDA) partnering with the National Agricultural Research Systems (NARS) has been implemented sheep and goat community-based breeding programs (CBBPs) in Ethiopia since 2010 (Aynalem Haile et al., 2018). A total of about 40 CBBPs each with average of 80 household and 1000 flock size in four sheep (Menz, Bonga, Doyogena and Horro) and three goat (Abergelle, konso and Borena) breeds are involved in Ethiopian CBBPs (Haile et al., 2019). Apart from the above mentioned, many CBBPs has been established throughout the countries by different institutions (Research centers, Universities, and Biodiversity Institute); and, many other African (e.g. Tanzania, Sudan, Uganda, Malawi) and Asian countries (e.g Brazil,Iran, Mongolia) are implementing sheep and goat CBBPs (Haile et al., 2019). It means pedigree and performance data recording is being accumulated and an integral component in all the breeding programs.

Data collection has been handled by enumerators using herd books. Herd books are checked by nearby researchers and entered into computer in EXCEL sheet. Then, the data has been analysed and used to rank animals for breeding purpose. The accuracy of genetic evaluations and animal ranking depends on data accuracy, data size and the method of evaluation. At the beginning, ranking was based on phenotype recording adjusting for known environmental factors. In the last two to three years best linear unbiased prediction (BLUP) animal and maternal model in WOMBAT (Meyer, 2007) has been used to estimate the genetic worth/estimated breeding values (EBVs) of animals following accumulation of pedigree and performance data. Of course, manual data recording and management is less efficient mainly in providing timely feedback to the community. It also subjected to large size of omitted data which are also one of the major concern in the breeding programs. This significantly reduced

data size and discouraged use of complex models that helps to improve the accuracy of animal ranking and genetic parameter estimations. Manual data entry challenges become more and more complex as the data size increases. Thus, a central digital database system is vital to facilitate data capture, analysis and timely feedback to the community on animal rankings. Furthermore, it encourages use of more complicated models which would improve the accuracy of evaluations inconsiderably.

Development and description of a digital database

Easy and applicable data recording and utilization system fitting the low input system is crucial for the sustainability of breeding programs (Sölkner et al., 1998; Haile et al., 2018). At the beginning ICARDA tried to develop DREMS in collaboration with Brazilian Agricultural Research Cooperation (Embrapa). However, its implementation was hampered by poor internet connection in most part of the rural areas where breeding programs has been implemented. Later, ICARDA's and Embrapa's effort realized AniCapture digital database in collaboration with AbacusBio plc. AniCloud is a cloud based digital genetics data base developed with AbacusBio. It is a new database tool for data capture (performance, pedigree, health and environment data), store, analyze and send feedback to the community for breeding and management decisions. It integrates with the AniCapture smart device software designed for offline gathering of data in situation where internet connectivity is poor. Anicloud can also build reports, do analysis and create graphics.

Purpose and scope:

- Allows timely EBV estimation and quick feedback to the community
- Allows to develop and test prediction equations and animal ranking tools based on economic selection indices
- Reduces performance and pedigree data errors thereby reduce omitted data
- Encourages the use of complicated models which help to increase accuracy of genetic evaluation
- The AniCloud platform will be extended with an analytic dashboard to inform management decisions

- It will also map the distribution of animals and their performance and create a permanent multi-country source of information
- The up-to-date information provided by the platforms on breeding value estimates and animal ranking will be channeled to the community/breeder organizations through NARS and used for selection decisions
- Ultimately, the platform helps to breed high genetic merit animals, provide information for policy makers and support long-term sustainability

AniCloud analytical dashboard

AniCloud has analytical dashboard which have been used to display breed level information. This include geographic location of sites, data summary based on our interest and detail animal pedigree, performance and offtake records (Fig 1). This will be used to promote breeds, inform management decisions and map distribution of animals and their performance, creating a permanent multi-breed and multi-country source of information.

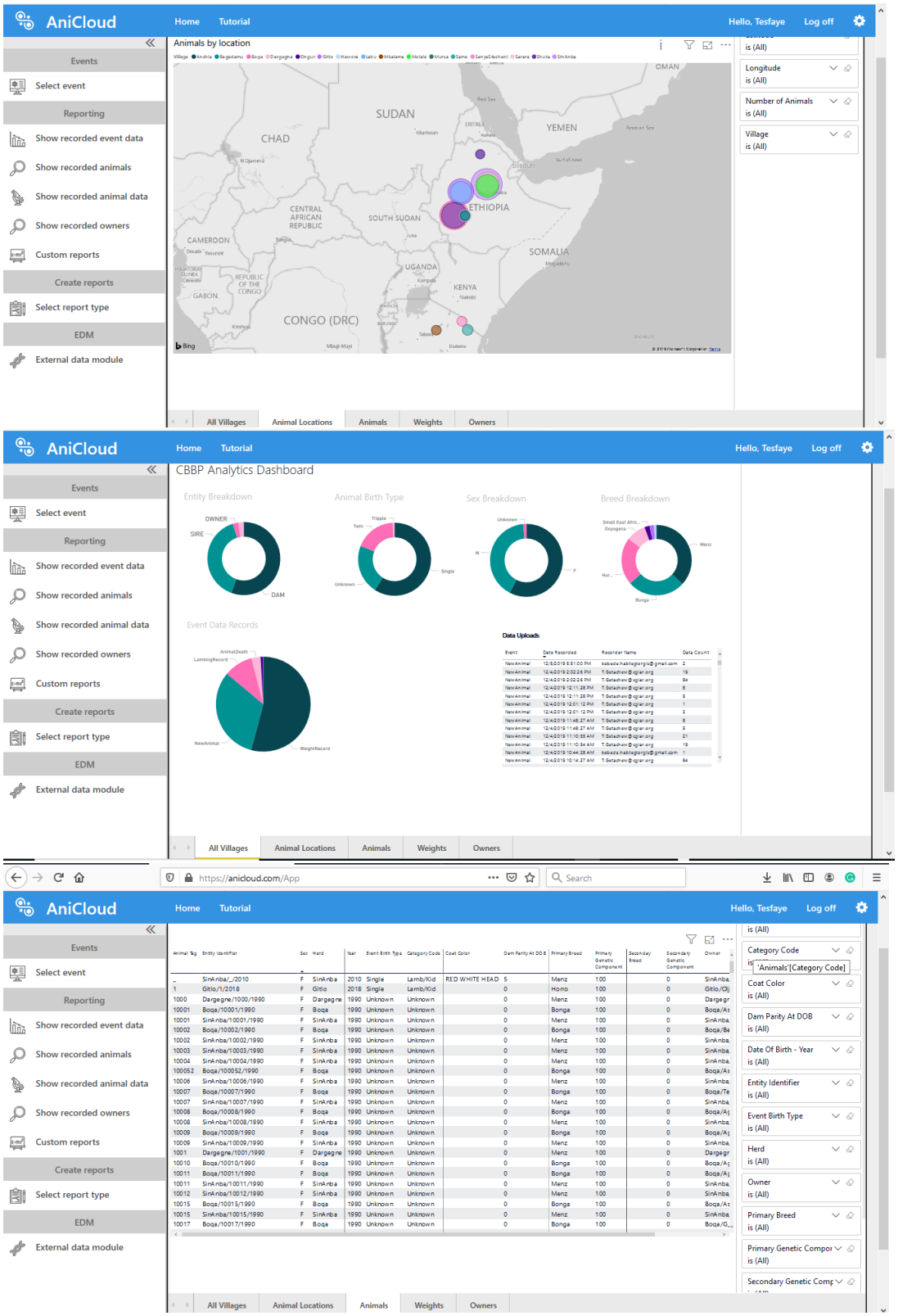

Figure 3. AniCloud analytical dashbouard showing geographic locations of CBBPs (top), data summary (middle) and detail data spreadsheet (bottom)

Where are we?

Loading historic data

Huge size of pedigree and performance data is being collected from different CBBPs since the inception of CBBPs. We were targeting to load data from about 28 CBBPs (25 in Ethiopia and 3 in Tanzania) collected from 4 sheep (all in Ethiopia) and 6 goat (4 in Ethiopia and 2 in Tanzania) breeds. So far about ~61k lambing records (pedigree, lambing/kidding details) and ~104K weight records (birth weight, weaning, six months and yearling weights) from 4 sheep CBBPs (Bonga, Doyogena, Menz and Horro) in Ethiopia and three goat CBBPs (Mkalama, Sanya Stesheni and Same) in Tanzania were loaded to the system successfully (Table 1). This was from a total of 15 CBBPs and 1,317 households. Yet, more data from different breeds, villages and households on sheep and goat waiting for upload. We are working hard on that. This will help to generate up-to-date information on breeding value estimates and allow animal ranking to be channeled timely to the community/breeder organizations through NARS and used for selection decisions.

Table 1. Online available data on sheep CBBPs in Ethiopia and Tanzania

Country	**Breed**	**Village**	**HHs**	**Lambing records**	**Weight record**
Ethiopia	Bonga sheep	2	359	17,333	22,899
	Doyogena sheep	5	477	6,192	7,709
	Menz sheep	3	208	21,835	58,306
	Horro sheep	2	140	13,308	14,757
Tanzania	Small east Africa goat	2	77	1779	-
	Pare goat	1	56	836	-
	Total	**15**	**1,317**	**61,283**	**103,671**

Field data capture

Capturing data using smart device (tablet) was started in Ethiopian Bonga, Menz and Doyogena sheep CBBPs since October 2019. So far 10 tablets were handed over to the enumerators. Enumerators were trained on usage of the application. Every day we are receiving on spot pedigree and performance data record from the enumerators of each site (Fig 1).

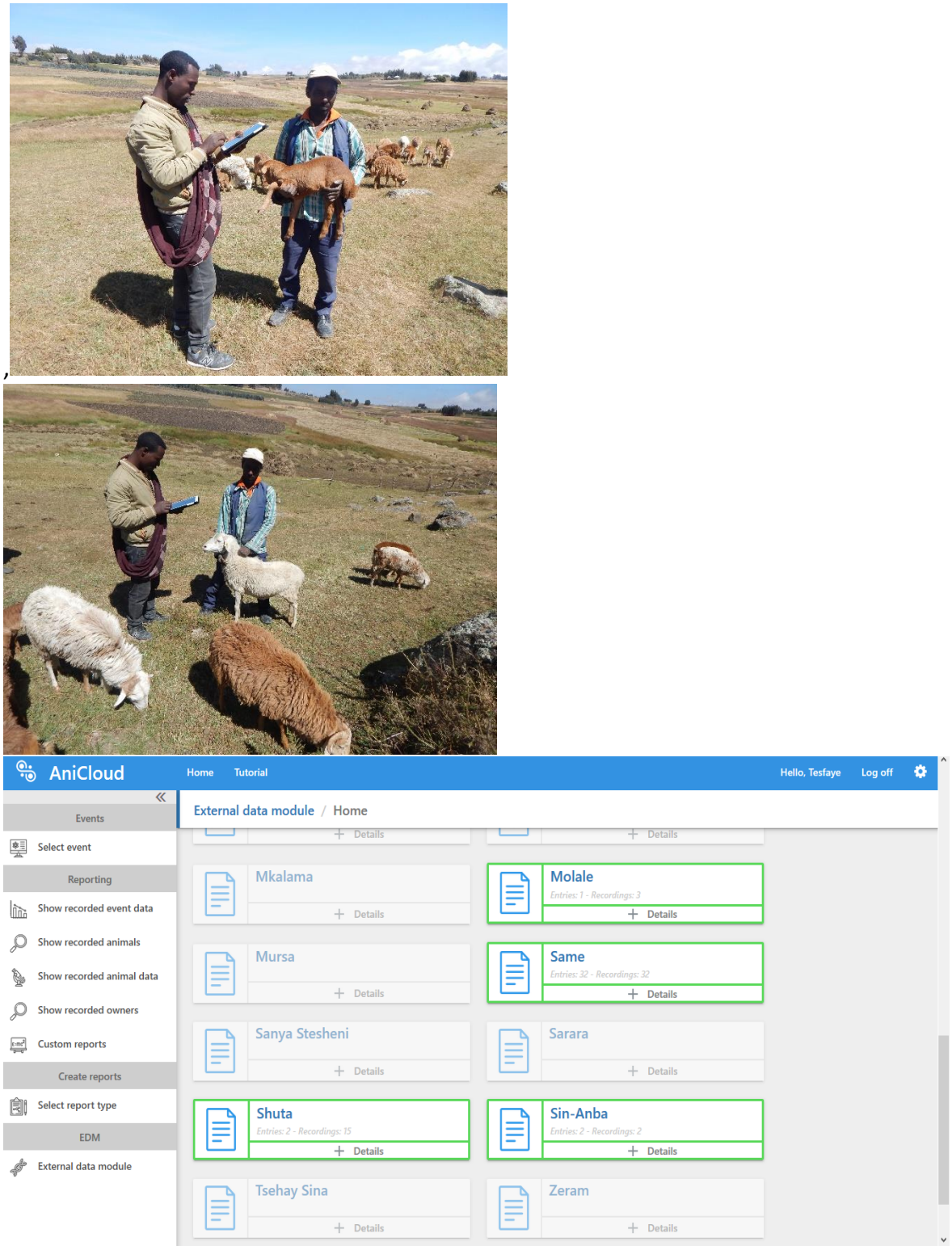

Figure 1. Field data capture by enumerator in one of the village in Menz CBBP (above) and AniCapture features while receiving data for approval from different sites

Challenges

- As it is in testing phase a lot of work remained to finalize
- Its usage has been limited to some CBBPs due to lack of resources (tablet). Particularly the national system need to allocate resources to avail tablets for their CBBPs.
- National Animal Genetic Improvement institute (NAGII) is a national institute in Ethiopia could be a potential responsible institute to participate and gradually take over the responsibility of national database. However, the institute is under re-structuring and establishment. The capacity (infrastructure, human resource) is not yet fulfilled to take responsibilities though we are working closely.

Future work:

- Upload remaining data from other CBBPs.
- Upload data collected by other National institutions in Ethiopia
- Integrating EBV estimation to the system
- Breed specific prediction equations and animal ranking tools will be developed based on economic selection indices
- Refining tool to fit our situation is underway
- Involving national institutions like NAGII for the sustainability

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