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# A genetic database tool for data capture in small ruminant community-based breeding programs

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## **A genetic database tool for data capture in small ruminant community-based breeding programs**

### **1. Introduction**

Genetic improvement on local breeds kept by small farmers in developing countries is challenging. Even though good pedigree and performance recording is crucial and an important component of breeding programs, it remain difficult or next to impossible under conditions of subsistence livestock farming (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). Currently, 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 available (Haile et al., 2019). Many other CBBPs has also been established throughout the countries by different institutions (Research Centers, Universities, and Biodiversity Institute); and African (e.g. Tanzania, Sudan, Uganda, Malawi) and Asian (e.g Brazil, Iran, Mongolia) countries are implementing sheep and goat CBBPs (Haile et al., 2019). It means pedigree and performance data recording is being accumulated and getting larger and larger. Though selection of best sires has been a routine practice in the CBBPs, retaining best animal for breeding challenged by many factors. Sale of animals by owners before selection event for pressing cash need tied with delay in data capture, analysis and giving on time feedback to the community is appeared as main challenge. With the recent advances in computer science, ICT and mobile technology, ICARDA is therefore developed a digital database system called AniCloud which can accelerate the data capture, analysis and feedback system which is crucial to assist the small ruminant breeding program at lower cost, high storage capacity, high fidelity and fast computing speed. Thus, the aim of this paper is to explain the current

data capture-analysis-feedback method, to indicate how gradually become more precise and promises of the digital database in Ethiopian and Tanzanian sheep and goat CBBPs.

## **2. Current data use in CBBPs**

Since the establishment of the Ethiopian CBBPs data collection has been handled by enumerators using herd books (Haile et al., 2019). In the current breeding program herd books are checked by researchers of the nearby research centers and entered into computer using EXCEL sheet as routine process. Then, the data has been analysed and used to rank animals for breeding purpose. At the beginning, ranking was based on phenotype recording adjusting for known environmental factors. Gradually, the accumulation of pedigree and performance data and growth of technical capacity has directed towards estimation of the genetic worth/estimated breeding values (EBVs) of animals using best linear unbiased prediction (BLUP) animal and maternal model using WOMBAT software developed by Meyer, (2007).

## **3. Why we need digital database system?**

The accuracy of genetic evaluations and animal ranking is highly dependent on data quality, small data size and the type of models used. Data recording and management using herd book (manual data entry) mentioned above 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 limits use of complex models that helps to improve the accuracy of animal ranking and genetic parameter estimations. The manual data entry tasks become more and more complex as the data size increases as observed in many of the CBBPs. Thus, a central digital database system is crucial to facilitate data capture, analysis and timely feedback to the community on animal rankings. Furthermore, digital database system encourages the use of more complicated models which would improve the accuracy of evaluations inconsiderably.

#### 4. Development and description of the 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 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. The main purpose of using AniCloud is to avail more accurate EBVs and helps to provide quick feedback to the community. Accuracy of EBVs mainly expected to come from reduced data errors thereby allows to use sufficient data size and due to use of complicated models which help to increase accuracy of genetic evaluation. Anicloud can also build reports, do analysis and create graphics. It can be integrated with other software like R to facilitate developing and testing test of prediction equations and animal ranking tools based on economic selection indices.

The AniCloud platform will be extended with an analytic dashboard to inform management decisions. It maps- 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 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.

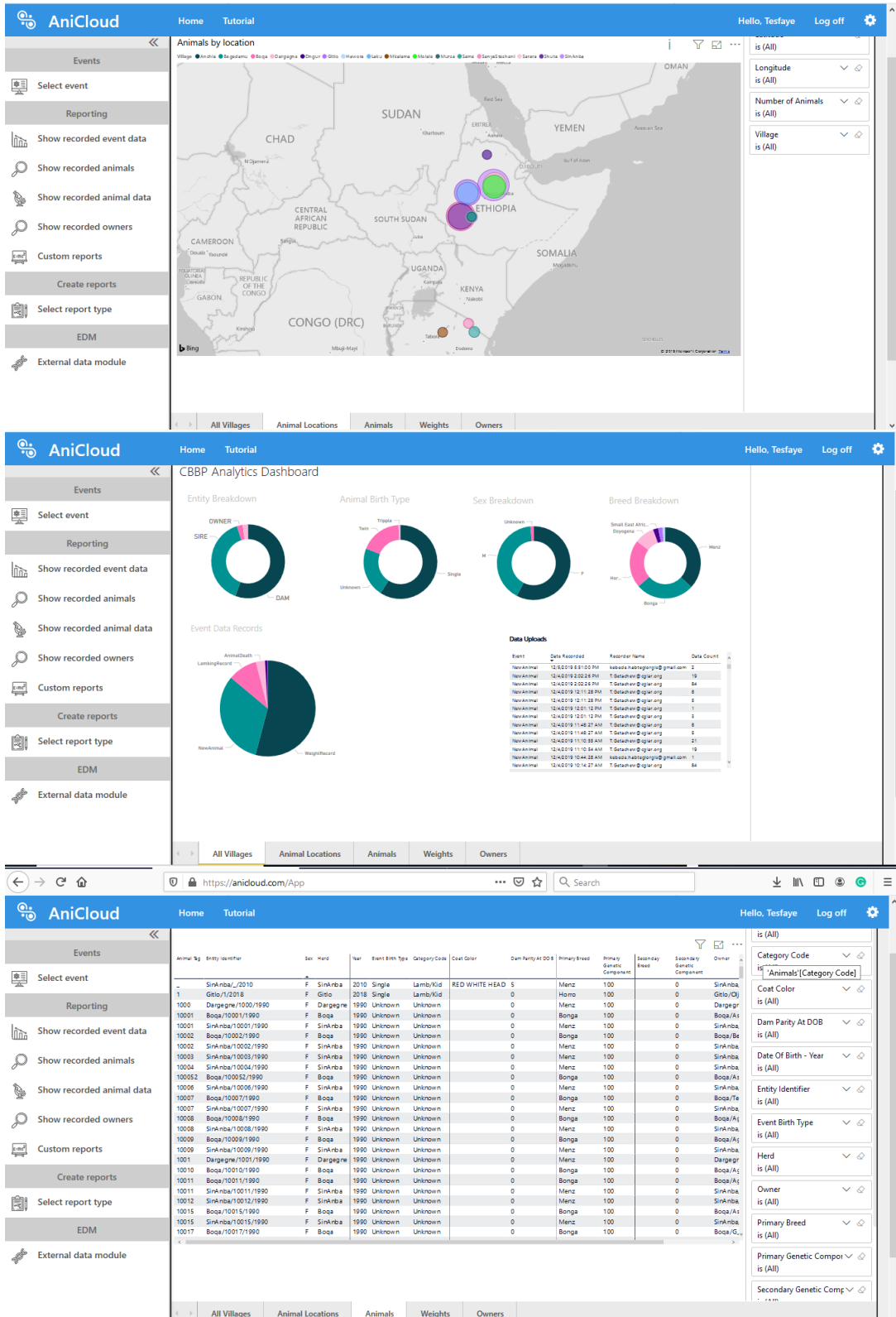


Figure 3. AniCloud analytical dashboard showing geographic locations of CBBPs (top), data summary (middle) and detail data spreadsheet (bottom)

### 5. Import historic data

All pedigree and performance data recorded so far using herd book or available in EXCEL sheet have to be uploaded to the system. add owner, add animal, weight records, sale and disposal records, milk records are the major components. All owner and founder animal need to be loaded in their order as prerequisite. Once the owner and founder sire and dam are in the database, offspring born in the flock and other events associated with the animals (weight at different age, sale, disposal) loaded. Select event can be used to select type of events we need to load. Each event has two options to load the data. Entering data one by one or load all data at a time using a template customized for each event in CSV format. Error reports are displayed which helps to fix errors on CSV import sheet.

## **6. 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 ~67.4K lambing records (pedigree, lambing/kidding details) and ~125.5K 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). In addition, 22.7K milk records from Abergelle goat were also loaded. This was from a total of 27 CBBPs and 1875 households. Yet, more data from different breeds, villages and households on sheep and goat waiting for upload. 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	Milk
Ethiopia	Bonga sheep	3	413	15,486	23,094	
	Doyogena sheep	7	528	5,622	7,709	
	Menz sheep	4	287	23,090	60,998	
	Horro sheep	2	140	11,404	14,757	
	Abergelle goat	5	157	6,614	16,903	22654
	Konso goat	2	181	1,722	2,102	
	Borana goat	1	36	967	-	
Tanzania	Small east Africa goat	2	77	1,492	-	
	Pare goat	1	56	1,092	-	
	<b>Total</b>	<b>27</b>	<b>1,875</b>	<b>67,489</b>	<b>117,821</b>	<b>22,654</b>

## 7. Loading new data

Once all accumulated data loaded to the system, each event happening need to be recorded at spot in the field. Trained enumerators can load it easily using AniCapture app which is available in goggle play store. Smartphone or tablets can be used for the purpose. The system did not allow entering values beyond the specified range set at the beginning. Enumerators can easily choose event type, enter as many data as they want and save offline. They can simply upload the data in to the cloud by clicking the “send” button when they get internet. Following upload of historic data, capturing data using smart device (tablet) has 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. Currently, tablets are ready for all the CBBP sites and we will disseminate and train enumerators as soon as the COVID-19 situation allows field work. Every day we are receiving on spot pedigree and performance data record from the enumerators of each site (Fig 1).

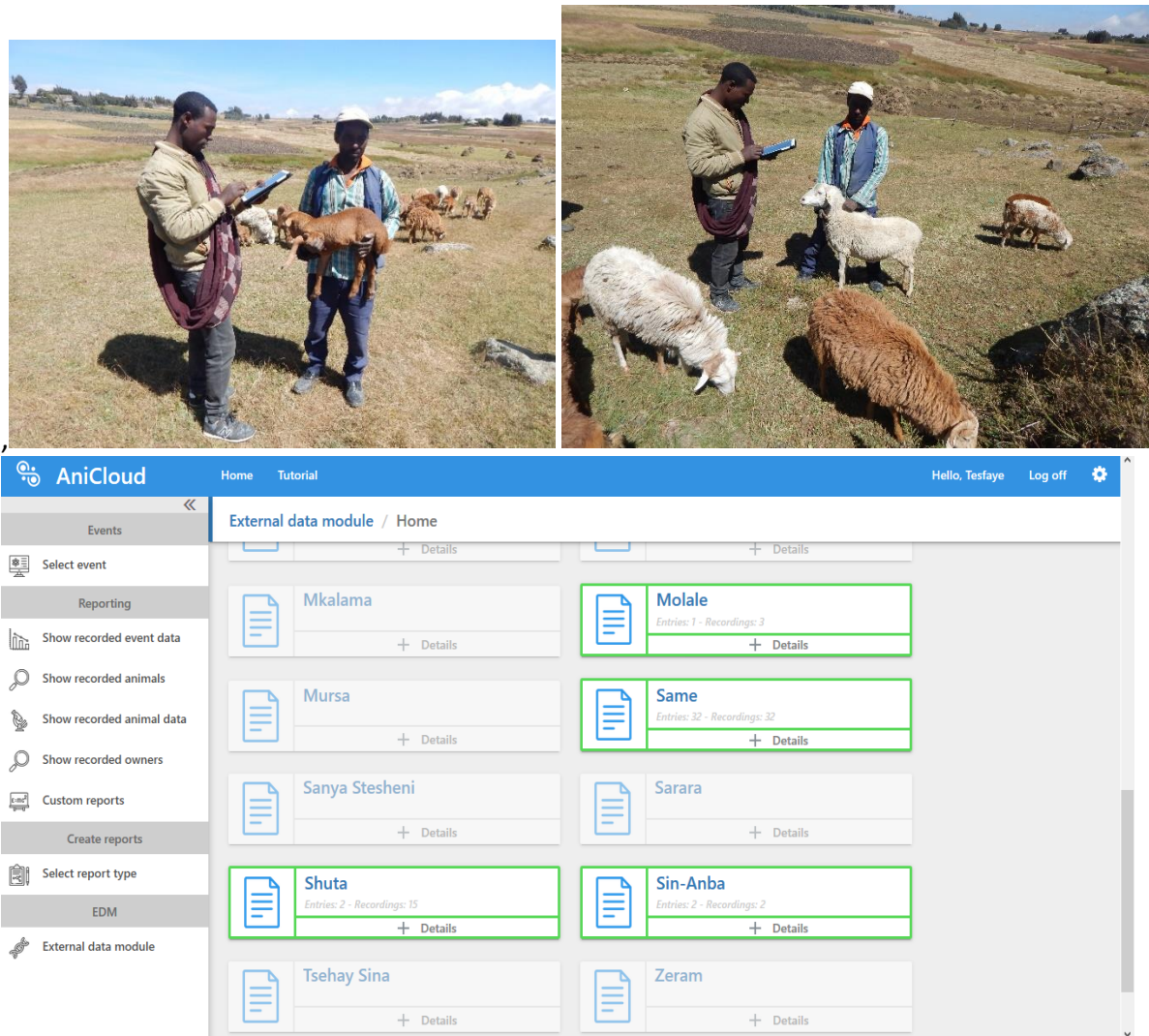


Figure 1. Field data capture by enumerator in one of the village in Menz CBBP (above) and AniCapture features while receiving data for approval from different sites

## 8. Future work:

- Enumerator training and transfer of more tablets to all the CBBPs in different sites.
- Upload remaining data from other CBBPs.
- 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.
- 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. Involving the NAGII is very crucial for the sustainability

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