Simple phenotypic indexes can bring data recording to life for smallholder farmers

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Abstract

Community Based Breeding Programs (CBBPs) which facilitate genetic improvement of livestock in smallholder systems have been impactful in Africa for many years. More recently, effort is being made to initiate CBBPs for women goat keepers in India, with a program established in the state of Bihar in 2018. In 2024, two new CBBPs were initiated in the Aravali hills region of Rajasthan and Gujarat states of India.

Enumerators and women goat keeping specialists called *pashu sakhi*s facilitate data capture into the Dtreo cloud-based database system as a key CBBP activity. The data captured allows program activity to be monitored in very close to real time while also generating valuable data on the performance of the local breeds in different villages and regions where both genetic and husbandry improvements are undertaken.

More importantly though, if the data recording can identify fast growing young male kids from desirable healthy does with region-appropriate litter sizes, there is a possibility to provide the opportunity of reward to smallholder farmers through purchase of these male kids to go on to become breeding bucks. Ideally, these elite breeding bucks are established at least 20km distant from their birth village and transferred to new villages every 12 months to avoid mating of close relatives.

Because each smallholder often owns a small number of animals, it is not practical to undertake complex multi-trait BLUP genetic evaluations. Instead, we have developed simple metrics that convert sequential kid weights into growth rate scores which are then integrated with additional trait scores based on characteristics of the kids' mothers (e.g. litter size and kid survival history, kidding interval, health, size, milk supply and desirability). Aggregated scores available prior to normal castration age then facilitate breeding buck selection. This paper describes our experience with and ongoing plans to deploy simple phenotypic scores for breeding buck selection in the CBBPs in Rajasthan and Gujarat.

Keywords: CBBPs, indexes, smallholder systems

Introduction

Use of selection indexes is widespread in modern day livestock breeding programs. These indexes combine estimated breeding values for breeding goal traits using linear weighting factors that ultimately determine the amount of selection emphasis applied to each trait making up the index. Prior to the introduction of modern genetic evaluation systems, substantial genetic gain in many breeds of livestock has been made. Natural selection and domestication of livestock occurred very slowly likely over thousands of years. However, breed formation has and continues to occur in animals over a much shorter timeframe, often without complex, well organised and expensive genetic evaluation systems. For example, many small ruminant breeding programs have successfully developed high performing breeds in New Zealand and Australia prior to the advent of BLUP genetic evaluation. High producing dairy cattle breeds have also been created. Accurate performance recording and rigorous record keeping were a key part of these pioneering genetic improvement initiatives.

Community Based Breeding Programs (CBBPs) have been instrumental in facilitating genetic improvement of livestock, particularly in smallholder systems. These programs have been impactful in regions such as Africa and India, where they have helped improve the performance of local breeds through systematic data recording and genetic selection. CBBPs typically involve the active participation of local farmers and institutions, ensuring that the breeding objectives align with the community's needs and resources. According to Wurzinger *et al.,* (2015), CBBPs are more frequent with keepers of small ruminants and are essential for low-input systems where conventional breeding technologies are not feasible. These programs have shown that with proper organization and support, significant genetic gains can be achieved even in resource-limited settings. Public investment is required to establish CBBPs, but with appropriate incentives, private investments can also play an important role in ensuring the long-term sustainability of CBBPs (Haile *et al.,* 2019).

Modern technologies such as BLUP genetic evaluation that more recently have incorporated genomic testing are often beyond practical application in CBBPs. However, it is possible to establish data recording systems that operate effectively in remote villages where the identification of high performing young males to be distributed for breeding purposes is an identified activity (Schurink*et al.,* 2025 and Nimbkar*et al.,* 2025 – this proceedings).

This paper describes an iterative process for the deployment of very simple selection principles to identify breeding bucks for dissemination using real-time updates of candidate selection scores.

Conventional wisdom

The conventional wisdom on breeding program operation is that selection candidates are measured for phenotypic attributes of interest for selection, these records are stored in a database and then processed using advanced statistical procedures to predict animal genetic merit for each trait. Resulting estimated breeding values are combined using an economic selection index or some alternative multiple criteria decision support process, and selections are made to either disseminate genetic merit beyond the breeding program or to become parents of the next generation of selection candidates within the breeding program. This structure is well proven as a major contributor to production efficiency gains in developed livestock farming industries, particularly when the breeding program is managed and controlled by a centralised breeding business or operation.

It should be noted though that many highly productive and useful breeds of livestock were developed prior to the advent of the modern genetic evaluation system approaches and infrastructure. These developments typically relied on recording, but adjustments for environmental biases, estimation of breeding values, and application of economic selection indexes were completely absent. These traditional approaches have been replaced because modern systems and approaches out-perform them in terms of rate of progress achieved, not because they were completely ineffective.

Community based breeding program in context

Global experience has been that the conventional breeding program structure can be challenging to apply in the context of small holder production systems. Particular challenges include:

- Financial constraints and low profitability make investment in improved genetics difficult.
- Young male candidates (bucks, rams and bulls) walk freely within the population of breeding females and individuals unsuitable for selection need to be castrated early in life for animal welfare, practical animal management, and avoidance of inbreeding reasons. Knowledge and equipment to support humane castration is often limited.
- There is no existing genetic improvement infrastructure, and establishment of this would require long term capacity building and financial commitment from government or donors which has seldom been sustained for long enough to have impact.
- The nuanced markets and production environment challenges arising from seasonal feed shortages and disease challenges mean that new improved livestock selected under more favourable environments often turn out to be unsuitable for use in existing smallholder systems.
- Smallholder systems where herd owners can only manage to run a small handful of animals of different species, sexes and age groups make it difficult to adjust for environmental biases that come about through differences in feeding management, disease control, and overall husbandry effort.

Novel approaches and thinking is required to overcome these challenges.

A new approach

Sufficiently accurate data recording and timely decision support are critical aspects of implementation of CBBPs. Ideally, information on which candidates to select should be available within a maximum of a few days of the latest relevant information having been captured. Because of a desire to perform castration by a certain age, there may not be time to complete a complex statistical analysis of data such as BLUP methods, and even when there is time, data details and realities of small contemporary groups may limit their value.

To facilitate a much faster and simpler method, a scoring system can be developed to enable any male kid whose mother had been assessed for litter size history and body size, and who itself had at least three weights taken prior to 90 days of age, to be allocated a selection score based on the results taken.

Bucks over a threshold score can be selected to become breeding bucks.

Example selection score application in Bihar, India

Bihar has a goat population of 12.8 million, predominantly of the Black Bengal breed, which is reared for meat production. Despite their high prolificacy, their small size and low weight limit production. Goats play a crucial role in supporting the livelihoods of socio-economically marginalized households by generating income and enhancing financial resilience.

Between 2016 and 2025, the Aga Khan Foundation was responsible for implementing Project Mesha in Muzaffarpur district to improve goat production, transform the lives of the rural poor, and empower women. The program focuses on improving goat nutrition, health, shelter, genetics, and marketing through community institutions. A pilot goat CBBP has been part of Project Mesha since 2018, involving the participation of a subset of goat rearer communities within the project. The deployment of a database using the Dtreo system has been a cornerstone of this CBBP. Despite Project Mesha being officially concluded, the Aga Khan Foundation has made a commitment to maintain the CBBP into the future with many steps taken to drive greater self-sufficiency and cost savings.

The breeding goals for Project Mesha were determined in consultation with goat rearers. These are: increased size and weight, faster growth up to 90 days, twinning but not litter sizes larger than twins, increased adaptation to local conditions and kid rearing ability of the dams. Goat owners are clear that despite the opportunity for extra revenue from sale of surplus kids arising from triplet litters (occur at very high frequency), in general they would much prefer twin litters. The risk of lack of thrift and/or mortality in at least one kid of many triplet litters, and the extra labour and inconvenience associated with ensuring all three kids get to suckle are major drivers of this preference for twins.

A scoring system to calculate an overall index score for buck kids was devised in consultation with the field team (Table 1). The criteria used in the scoring system are measured by trained enumerators and include the predicted weight of each buck kid at 90 days and four traits of the kid's dam which are, the dam's chest girth, its condition at the time of assessment, its litter size history and kid survival history. An example of how lists of candidate goats are presented along with their performance scores is shown in Table 2. Figure 1 presents a histogram of observed candidate buck scores.

The scoring system described in Figure 1 is a revised version because extra categories to reward increasingly faster growing goats needed to be added. While it is very hard to separate genetics from management effects when tracking the overall performance of these goats (Abeykoon *et al.,* 2025), the smallholder goat keepers in many of the villages with selected bucks are prepared to attest to the improved performance and convenience of finding bucks for matings.

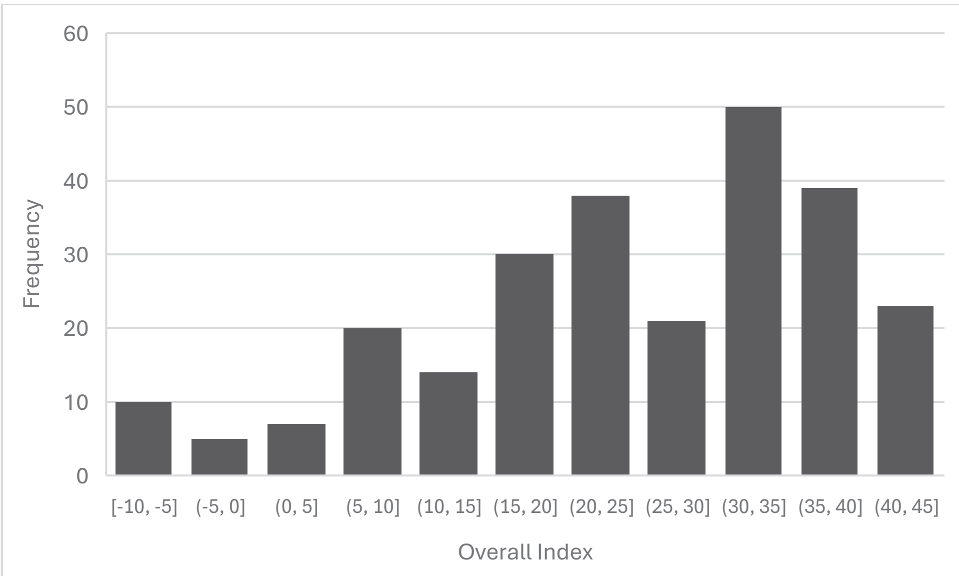
Figure 1. Summary of the buck selection scores (bold font) for recorded categories being used in Project Mesha.

Criterion	Category and index weighting							
Kid growth (predicted weight kg at 90 days)	Above 12	11 to 12	10 to 11	9 to 10	8 to 9	7 to 8	Below 7	No data
	16	14	12	10	8	5	-10	-20
Doe's girth (measured in cm)	Above 35	33 to 35	31 to 33	29 to 31	25 to 29	20 to 25	Below 20	No data
	9	8	7	6	4	2	0	0
r size history of the kid's Doe	Doe has had singles and twins					Doe has had triplets or higher, or only singles		
	10					0		
's kid survival history	All of doe's kids have survived					One or more of doe's kids has died		
	5					0		
's condition	Recorded as good condition					Not recorded as good condition		
	10					0		

Table 2. Example overall index scores for male kids sorted by date of birth as reported in the Dtreo cloud software platform.

Sex	Age (days)	Date Of Birth	P 90 day weight	Index Kid Weight	Index Doe Chest Girth	Index Doe Condition	Index Doe Litter History	Index Doe Survival Score	Overall Index
M	117	26/11/2024	5.60	-10	8	10	10	5	23
M	113	30/11/2024	6.54	-10	8	10	10	5	23
M	113	30/11/2024	7.87	5	8	10	10	5	38
M	113	30/11/2024	8.11	8	8	10	10	5	41
M	112	1/12/2024	10.53	10	4	0	0	5	19
M	112	1/12/2024	7.94	5	8	10	0	5	28
M	112	1/12/2024	6.94	-10	8	10	0	5	13
M	108	5/12/2024	8.50	8	4	10	10	5	37
M	103	10/12/2024	9.93	10	8	10	10	5	43
M	101	12/12/2024	12.63	10	8	10	10	5	43
M	101	12/12/2024	8.50	8	0	10	10	5	33
M	95	18/12/2024	5.60	-10	4	10	0	5	9
M	93	20/12/2024	5.94	-10	2	0	0	5	-3
M	93	20/12/2024	5.49	-10	4	0	0	5	-1
M	92	21/12/2024	5.59	-10	4	10	10	5	19
M	92	21/12/2024	4.62	-10	0	0	0	0	-10

Table 1. Example histogram of index scores.



Conclusions

Performance recording is a fundamental pre-cursor to genetic gains in any livestock genetic improvement context. While modern genetic evaluation technologies can accelerate genetic gain, they are often not practical in a development setting. In this paper we have described a situation in which a simple selection score combined with a highly functional data recording platform have been sufficient to enable a successful community-based breeding program implementation in the Bihar state of India. Following this success due to focus on foundation principles, there is scope for expansion of this model into many other small ruminant systems. This will then provide a strong base for future introduction of sophisticated genetic evaluations and genomic testing tools and use of reproductive technologies to aid dissemination.

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