Contributed paper

GENETIC IMPROVEMENT OF GOATS OWNED BY SMALLHOLDER GOAT KEEPER WOMEN IN BIHAR, INDIA, WITH THE HELP OF A DATABASE TOOL

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SUMMARY

A community based pilot goat breeding program (CBBP) is being implemented under Project Mesha which seeks to improve goat production in Muzaffarpur district of Bihar state in India. Goat performance recording and selection of male kids for breeding have been carried out since 2018. The breeding goal established through consultation with rearers, targets improved kid growth rate and twinning. Birth weight, weight at 3 and 6 months, average daily gain (ADG) up to 120 days and adult doe weights were analysed with fixed models. There is wide variation in each trait, indicating potential for selecting animals with very high values for breeding goal traits. The progress of the CBBP is encouraging.

INTRODUCTION

Bihar is one of the poorer states of India. The per capita net state domestic product of Bihar was US$663 in 2019, 31% of India's per capita gross domestic product (MOSPI 2019). Eighty nine per cent of Bihar's population lives in rural areas, and about 34% of this rural population live below the poverty line. The literacy rate is 64%, but women's literacy is only 54%. In Muzaffarpur district, 36% rural houses are temporary structures (Census of India 2011). As some villages get inundated by flood waters during the monsoon, residents have to move with their livestock to higher ground for varying periods every year.

Bihar state has a goat population of 12.8 million out of 149 million goats in India (BAHS, 2019). The predominant goat breed type is the highly prolific Black Bengal (BB) reared for meat production (Dey *et al*. 2007). Small size and low weight of these goats are constraints on goat production (BLSA 2019). The importance of goats to support livelihoods of socio-economically marginalized households through income generation and enhancing financial resilience is well recognized (Barooah *et al.* 2016). The Aga Khan Foundation is therefore implementing a community based program called Project Mesha since 2016 for about 50,000 households in 240 villages of 4 out of 16 blocks of Muzaffarpur district of Bihar to improve goat production, transform the lives of the rural poor and bring about rural women's empowerment. Any increase in income from goat rearing is expected to lead to an improvement in the well-being and status of women as they primarily care for goats.

Project Mesha's approach is improvements in goat nutrition, health, shelter, genetics and marketing through community institutions. As a part of Project Mesha, a community based pilot goat breeding program (CBBP) is being implemented with participation of the goat rearer communities since 2018.

This paper describes the participatory processes of the CBBP including the effective use of the database tool Dtreo (https://abacusbio.com/ventures/dtreo/) and findings from an analysis of the records collected.

MATERIALS AND METHODS

Participatory processes. A cadre of trained women community based small ruminant health workers (*pashu sakhis*) has been established by Project Mesha. *Pashu sakhis* provide a range of fee-

based preventive health services for goats and also castration of male kids to be raised for meat production. Each step in the CBBP was taken in consultation with the goat rearer women by holding several meetings with the 'producer groups' established under Project Mesha.

Production system. The average number of adult does per household in the project area is 2 and goats are mostly grazed or tethered in harvested fields, fallows or other common property grazing grounds (Barooah 2016). Goat nutrition and other management vary greatly among households. Before the start of the CBBP, does were mostly mated by roaming bucks let lose as a customary ritual or by young male kids that go grazing together with does. Before Project Mesha and the advent of *pashu sakhis*, mortality rates of up to 40% in adult goats and 50% in kids were reported (Population Council 2018).

Selection of villages to establish recording. Individual goat identification with numbered tags (with a unique number for each goat) and performance recording were started in 4 villages in 2018 and then increased to 8 after 2 years. The criteria used for village selection were partly external such as reasonable availability of goat feed resources. Community-related criteria were also important, such as willingness of the community to participate, at least 200 breeding does with reasonably even ownership, average or above average performance of goats compared to the general goat population in the Project Mesha area, indicating reasonable proficiency in goat rearing and substantial income being obtained from goat rearing.

Determination of breeding goals and selection criteria. 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 (although at this stage only a small number of kids have an identified sire), increased adaptation to local conditions and kid rearing ability of the dams. A scoring system to calculate an overall index score for buck kids was devised in consultation with the field team. The criteria used in the scoring system are measured by trained enumerators and include the predicted weight of each buck kid at 100 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.

Recording and evaluation system. The Dtreo (dtreo.io) software application has been customized to capture performance data (online and offline), store data while ensuring its integrity and convert it into information based on the needs of goat rearers, the CBBP and genetic analysts. Data recording can be done in English or Hindi which is the language used in the CBBP area. Dtreo has been set up to calculate the index score for each buck kid and make it available in a report for the field team to use for primary selection. Data entries are usually made by the veterinarians in the Project Mesha field team. They also monitor the data, assess the buck kids attaining the requisite index score and maintain a continuous dialogue with the goat rearing community.

Buck purchase and rotation. After the primary selection, the buck kid's owner's consent has to be obtained to keep the buck uncastrated until the second selection point. The buck is weighed and its soundness for breeding assessed every month up to the age of 6 to 8 months. If approved, the buck is purchased by Project Mesha at a price premium over its market value for meat. It is then transported to a village, at least 20 km away where it is placed with a willing buck-keeper household. Thirteen bucks have so far been placed for mating does in different villages. The bucks are moved again to another village at the end of a year to control inbreeding in accordance with rules specially formulated by genetics advisers to Project Mesha.

Data and models. Average daily gains (ADG) of kids that were weighed $\geq$3 times up to the age of 120 days, were estimated with a regression of weight on age for each kid. Kid weight at birth (BWT), 3 months (3WT), 6 months (6WT), ADG and adult doe weights (DOEWT) were analysed. The number of records was 93 for BWT, 148 for 3WT, 151 for 6WT, 353 for ADG and 301 for DOEWT. Fixed models were fitted with the effects of village (6 classes), year of birth (2018, 2019, 2020), season of birth (rainy, summer, winter), kid birth type (single, twin, triplet, quadruplet) and

kid sex (male, female). The effect of dam parity (first and 'later or unknown') could be fitted only for ADG as almost all the records for the other traits were for the 'later or unknown' parity. Only the effect of village was fitted for DOEWT as data for other effects was not available. No interactions were fitted because of the limited number of records. Least squares means (LSM) were estimated with only significant effects in the model.

RESULTS AND DISCUSSION

Twenty per cent of the does had singles, 51% had twins, 26% had triplets and 3% had quadruplets, yielding an average litter size of 2.14, similar to Dey *et al*. (2017) who reported an average litter size of 2.1 under field conditions in Bihar. The BB field unit of the All India Coordinated Research Project on Goat Improvement (AICRP 2017) has reported an average litter size of about 1.8 in BB goats in West Bengal state.

There was substantial variation in each trait. BWT ranged from 0.5 to 3 kg, 3WT from 2.5 to 11.1 kg, 6WT from 6 to 20 kg and ADG from 10 to 140 g. There is thus a good chance of identifying candidates superior for the breeding goal traits and using them for further breeding.

Table 1. Significance of fixed effects for the traits analysed

	Fixed effects					
Traits	Village	Year of birth	Season of birth	Kid birth type	Kid sex	Dam parity
BWT	*	*	not significant	*	not significant	not fitted
3WT	*	*	*	*	not significant	not fitted
6WT	*	*	not significant	*	*	not fitted
ADG	*	*	*	*	not significant	*
DOEWT	*	not fitted	not fitted	not fitted	not fitted	not fitted

*Significant

6WT of bucks was higher by about 14% than that of does. BWT, 3WT and ADG declined from 2019 to 2020. This could be because of the addition of new villages for data collection.

The LSM (kg) for BWT, 3WT, 6WT and DOEWT were 1.5±0.2, 6.3±0.4, 9.1±0.5 and 23.5±0.7 respectively. The LSM for ADG was 57.5±4.5 g. Dey *et al*. (2017) report BB goat ADG of 30 g and adult doe weight of 12 kg. AICRP (2017) has reported BWT, 3WT and 6WT to be 1.23 kg, 5.30 kg and 7.50 kg respectively for BB goats. It is likely that weights in this study are higher because of the way villages were selected for recording. There may also have been selection of more cooperative households or of larger does for recording.

Thirteen bucks have been selected based on their index scores being above the set threshold and used for breeding in different villages. About 500 does have so far been mated with these bucks. Observations of their progeny have shown excellent vigour and growth, indicating that the improvement may be due to reduction in inbreeding.

The CBBP has created awareness among the community about the basic principles of genetic improvement, inbreeding and its impact. Before the CBBP, it was thought here that for genetic improvement, 'good' breeding bucks had to be brought from outside the state. It was also felt that no one would be willing to maintain a breeding buck. The Project Mesha team has now compiled a list of households in several villages ready to maintain breeding bucks. There are still challenges for the CBBP but the progress is encouraging. As data accumulates over time and pedigree records build up, more accurate genetic evaluations will be possible, leading to more progress. The success of Project Mesha's CBBP is likely to lead to expansion of the program in more blocks of Muzaffarpur district and then many more districts of Bihar.

CONCLUSIONS

The CBBP reported here is likely to be the first systematic CBBP for goats in India. Many difficulties have been overcome and the goat rearer community has cooperated well with the CBBP implementing team. There is good opportunity to exploit hitherto untapped genetic variation in the highly adapted local breeds to improve goat productivity genetically.

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