

Genetic improvement to increase sheep meat production and profitability of sheep rearing*

The Helen Newton Turner Memorial International Workshop was a capstone on more than a decade of research in India on improved sheep meat production, supported by the Australian Centre for International Agricultural Research (ACIAR). The goal of the workshop was to review the current understanding of the *FecB* (Booroola) gene and re-evaluate from a practical perspective the possibilities it offers for genetic improvement of reproductive rate in sheep. *FecB* was the first major gene to be discovered that influenced animal production substantially. The Australian sheep geneticist, late Helen Newton Turner, CSIRO, headed the team that discovered the gene and studied its effects. She also traced the origin of the gene to 'Bengal' sheep, later identified by Nimbkar Agricultural Research Institute (NARI), Phaltan, Maharashtra to be the prolific Garole sheep of the Sundarbans, West Bengal. NARI's founder B. V. Nimbkar's correspondence with Turner led to Garole sheep being brought to NARI in 1993 and thus laid the foundation of the projects that culminated in the introduction of the gene into local Deccani sheep of Maharashtra, to increase the efficiency and profitability of sheep-rearing. It was thus fitting to dedicate the workshop to the memory of Turner. One of the major findings of the ACIAR-funded projects in India, based on extensive work with participating shepherds since 2003, was that 'Crossbred ewes carrying the *FecB*

gene had increased prolificacy, but the increase in ovulation rate and litter size was manageable under traditional management practices and of economic benefit to shepherds'. This finding was the major stimulus for this workshop. There were 82 participants in total, including 17 invited speakers (five India and 12 foreign).

This was the second international workshop dedicated to the *FecB* gene after the first one in Australia in 1980. It is now known that in addition to the Garole, the Javanese thin tail sheep of Indonesia, and the Hu and Han sheep breeds of China also carry the mutation naturally. The 19 invited scientific papers were divided into four sessions and covered the spectrum from the scientific aspects of the mechanism of action of the gene to the mechanics, experience, constraints and advantages of its practical use.

Background and history of the *FecB* mutation: George Davis (Invermay Agricultural Centre, New Zealand) described the origin, distribution, utilization and management of the *FecB* mutation. Subhansu Pan (West Bengal University of Animal and Fishery Sciences, Kolkata) reported the results of a questionnaire survey on management practices, production and current status of Garole sheep, conducted over a year in 60 randomly selected villages in the Sunderbans, covering about 2600 sheep farmers and their 10,000 sheep.

Physiological aspects of the *FecB* gene mechanism: A paper written by Bruce Campbell *et al.* (University of Nottingham) and presented by Geoff Hinch (University of New England (UNE), Australia) gave an overview of the current understanding of the possible mechanisms underlying the changes in ovarian function observed in sheep carrying the *FecB* mutation. The *FecB* mutation is a single-point mutation in the intracellular domain of the Bone Morphogenic Protein receptor 1B gene (*BMPR-1B*). The paper pointed out that the increase in prolificacy resulting from this mutation is due to an increased sensitivity to FSH mediated by the action of intra-follicular local

factors and that more work is required to confirm this speculative hypothesis. Vidya Gupta (National Chemical Laboratory (NCL), Pune) discussed aspects of the genetic modulation of the *FecB* gene expression. Neal Fogarty (New South Wales Department of Primary Industries, Orange, Australia) reviewed studies on the effects of *FecB* on the production traits in a range of genetic comparisons, environments and production systems. He also examined the role of management and opportunities for nutritional modulation of *FecB* expression. Geoff Hinch (UNE) examined the consequences of large litters on the physiology of the ewe and lamb, and addressed the impact of high ovulation rate on subsequent embryo loss, placental and foetal development, neonatal survival, colostrum production and lactation performance.

Case studies on introgression of *FecB* in local breeds: The following is a list of the authors and the breeds/countries they spoke about – Chanda Nimbkar (Deccani sheep in Maharashtra), Stephen Walkden-Brown (Merino sheep in Australia), A. L. Arora (Malpura sheep in Rajasthan), Elisha Gootwine (Awassi and Assaf sheep in Israel), David Notter (various breeds in USA), Ismeth Inounu (Indonesian thin tailed sheep in Java, Indonesia), Hua Guohua (Chinese prolific breeds such as Hu, small tail Han, Cele, Duolang and Chinese Merino) and Loys Bodin (French Merino d'Arles sheep). The introduction of *FecB* in Deccani and Malpura sheep in India and Chinese Merino prolific strain in China was successful in increasing lamb production and income. In Israel, introduction of the *FecB* carrier Afec Awassi and Afec Assaf into flocks under intensive management improved flock profitability. Similarly, heterozygous Indonesian thin-tailed ewes under high level of feeding management gave a higher gross margin than non-carrier or homozygous ewes. In France, *FecB* carrier Merino d'Arle ewes produced more lamb meat per ewe than non-carrier ewes, although the lambs of carrier ewes needed a few more days to achieve a fixed slaughter weight. In contrast, *FecB* has had little

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impact on the commercial sheep industry in Australia, where it was discovered. This was mainly due to poor lamb survival of twins and triplets under extensive Australian management systems. In USA, *FecB* was introduced into relatively highly prolific breeds and therefore was found to confer a level of prolificacy that was too high to be profitable.

The way forward: introgressing FecB in the wider population: Julius van der Werf (UNE) described the genetic aspects of introducing the *FecB* gene from a donor breed into a commercial recipient breed. Andrew Swan (UNE) emphasized the importance of considering the relationship between litter size, feed cost and lamb survival. Chanda Nimbkar (NARI) discussed the potential pathways and strategies for wider utilization of the *FecB* gene in Maharashtra and other parts of India. Pradip Ghalsasi (NARI) presented the paper by Julian Prior *et al.* on 'Shepherds' views on the value and management of Deccani crossbred *FecB* carrier ewes with a higher twinning percentage and the implications for a future introgression extension program'. It was found that shepherds considered twin lambs more profitable than single lambs, but they emphasized that twin lambs needed supplementary feeding and special care to ensure their survival and adequate growth rate. Karen Marshall (International Livestock

Research Institute, Nairobi) presented a work that introduced the sustainable livelihoods framework as a useful tool in translating animal breeding research into livelihood improvement for the world's rural poor.

On the second day of the workshop, all the participants were brought to the NARI Animal Husbandry Division Office near Pune. *FecB* carrier rams, ewes and lambs from NARI's flock were displayed there. Ghalsasi provided information on all the animals displayed and answered questions. In the afternoon, the participants were taken to visit a flock belonging to Dattatray Sopan Pisal, Bhadali village, about 15 km from Phaltan, where *FecB* carrier rams were introduced by NARI in 2003. There are now more than 25 *FecB* carrier ewes in this flock; some of the lambed ones had twin lambs. The benefits of *FecB* under local shepherds' management were shown to the participants.

At the end of the workshop there was a two-hour panel discussion, facilitated by Stephen Walkden-Brown (UNE) on 'The policy implications for wider dissemination in India of sheep containing the *FecB* gene arising from the ACIAR projects'. The members of the panel were officers from the Animal Husbandry Departments of Maharashtra and Andhra Pradesh, David Notter (Virginia Tech University, USA), Elisha Gootwine (Volcani Centre, Israel) and Neelkantha Rath

(Indian School of Political Economy, Pune).

There was broad support to the view that there is a positive benefit in increasing fecundity in most sheep meat production systems and this depended on the rearing environment and management conditions. It was agreed that the benefit is likely to be the highest where the current level of fecundity is low (around 100% lambing rate) and an increase up to 160% lambing rate is likely to be the most profitable. It was recognized that the homozygous *FecB^{BB}* genotype may be undesirable in many cases. Results at NARI seem to indicate problems in the Deccani case to be of a lesser extent. However, there is clearly a need to confirm this with more evidence. The heterozygous genotype seems to be advantageous. It was agreed that the uncertainty about the homozygous genotype should not be an impediment to use carrier rams in shepherd flocks or to start using *FecB^{BB}* rams in other centres.

As a result of the workshop farmers and shepherds have started showing interest in the newly developed 'NARI Suwarna' strain of twinning Deccani sheep.

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