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INTROGRESSION OF FECUNDITY GENE (*FecB*) IN NON-PROLIFIC SHEEP BREEDS: A BOON FOR FARMERS

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Abstract: Booroola Merino (BM) ewes have a high ovulation rate and litter size which was due to the effects of FecB gene. FecB was due to a mutation (BMPR-1B) on chromosome 6. The mutation has been found in native sheep breeds in India and it is likely that FecB in the Australian BM was derived from importations of Garole sheep from India in 1792 and 1793. The introgression of this FecB mutation form highly prolific breeds like Garole and Kendrapada to the nonprolific but higher body weighted sheep breeds can enhance the productivity to the sheep industry and thus the socioeconomic condition of the farmers. The introgression of FecB mutation into a nonprolific breed through forced PCR-RFLP followed by backcrossing technique can be established after six generation and a nonprolific sheep breed can be converted into a prolific breed. The introgression of FecB mutation into higher body weighted sheep could be a boon for the farmers involved in sheep rearing.

Keywords: Booroola, FecB gene, Prolific, Gene Introgression.

Introduction

Sheep with its multi-facet utility for wool, meat, milk, skins and manure, form an important component of rural economy particularly in the arid, semi-arid and mountainous areas of the country. It provides a dependable source of income to the shepherds through sale of wool and animals and plays an important role in improving the socio economic conditions of rural people. The livestock sector alone contributes nearly 25.6% of Value of Output at current prices of total value of output in Agriculture, Fishing & Forestry sector (DAHD, 19th Livestock Census, 2012). The overall contribution of Livestock Sector in total GDP is nearly 4.11% at current prices during 2012-13. The total sheep in the country is 65.06 million numbers, which constitute 12.71% of total livestock of India in 2012. (DAHD, 19th Livestock Census, 2012).

India has diverse breeds of sheep (43 breeds) which were adapted to different agro-climatic zones of the country. Among them most of the breeds give single births and only few of breeds give birth to twins and triplets. If prolificacy of the sheep breeds increased this results in increase of the lamb production and ultimately gives profit to the farmers. By using

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traditional breeding strategies increasing prolificacy of the sheep is slow process as the heritability of the litter size is very low. Marker assisted introgression is the best technique to introduce this prolific gene into nonprolific sheep breeds.

FecB is an autosomal dominant gene located on chromosome 6, responsible for increasing the ovulation rate and litter size in sheep (Davis, 2005; Gootwine et al., 2006). It follows simple Mendelian inheritance. Detection of mutation in the *FecB* (BMPR-IB) receptor by forced PCR-RFLP opened a new gateway to increase the reproductive performance of the sheep without disturbing the adaptability and marketability of the sheep. Currently *FecB* gene has been introgressed from Garole to Deccani, Bannur, Malpura and Muzzaffarnagari revealed that high prolificacy gene can be transferred.

It has been reported that the effect of Booroola allele (*FecBB*) is additive for ovulation rate and each copy of the allele increases ovulation rate by about 1.6 and approximately one to two extra lamb in Booroola Merino (Piper et al., 1985; Piper and Bindon, 1996).

Origin:

The *FecB* mutation was first identified in Booroola Merino (BM) sheep originating from Australia, but recent DNA marker technology has revealed that its origins can be traced back to sheep in Asia. The BM was named by Dr. Helen Newton Turner after the property 'Booroola', located at Cooma in New South Wales, Australia, which is where brothers Jack and Dick Seears had identified a line of highly prolific Merinos descending from a ewe in the main flock that had triplets.

The high prolificacy of the BM could be traced back to either the Bengal or Cape sheep imported into Australia in the late 18th century (Turner, 1982). The first shipment of 12 of the so-called Bengal sheep arrived in Australia from Calcutta in 1792, followed by an illegal shipment of 100 in 1793. Early descriptions of these diminutive sheep fit the phenotype of the Garole breed from the coastal belt of the swampy Sundarbans delta of West Bengal near Calcutta(Ghalsasi and Nimbkar., 1993). Based on the evidence for a major gene for prolificacy in BMs, there has been strong international interest in using these sheep in crossbreeding programs. *FecB* is currently known to occur in at least 48 sheep breeds in 19 countries.

The Garole is also the most likely source of *FecB* in JTT sheep in Indonesia and the BM in Australia (Davis et al. 2002). In China *FecB* is fixed in the Hu breed, which is the source of *FecB* in the Chinese Merino prolific meat strain and also probably the source of *FecB* in the prolific Small Tail Han breed. Most of the spread of *FecB* to other breeds

worldwide has resulted from crossbreeding with the BM during the last 30 years, using either rams or artificial insemination.

Source of *FecB* gene in Indian breeds:

Genotyping of *FecB* locus in various breeds of sheep revealed that there was presense of *FecB* mutation in Garole and Kendrapada sheep breeds which were highly prolific. The genotype and gene frequency of $FecB^{BB}$ carrier are higher in Kendrapada sheep than Garole.

1) Garole: This breed is originated from sunderban delta in West Bengal of our country. Breeding tract of Garole is comprising the southern part of West Bengal, particularly in the coastal saline belt of Sunderban region.

2) Kendrapada: This highly prolific breed is originated from Odisha. Breeding tract comprising the coastal districts of Odisha like Puri, Jagatsinghpur, Cuttak and Kendrapara. High frequency of the *FecB* mutation in Kendrapada sheep revealed that the mutation has arisen many generations ago, but the gene is not fixed in the population.

Detection of *FecB* gene:

About 5ml of blood can be collected from animal for genotyping of *FecB* gene. Genomic DNA may be isolated by Phenol Chloroform extraction method (Sambrook et al, 2001). A set of following primers should be used: Forward: 5' GTCGCTATGGGGAAGTTTGGAT 3'and Reverse: 5' CAAGATGTTTTCATGCCTCATCAACACGGTC 3'. By using the above primers amplify the 140bp fragment of exon-8 of *FecB* (BMPR-1B) gene will be used as reported by Wilson et al, 2001. The amplified product will be digested by using Ava-II enzyme. After digestion, if single fragment of (110bp) yielded – Homozygous ($FecB^{BB}$), if two fragments (140bp, 110bp) yielded – Heterozygous ($FecB^{B+}$), if single fragment of (140bp) yielded - non-carrier ($FecB^{++}$), these fragments should be visualized using 3% metaphore agarose gel electrophoresis.

Breeding plan for introgression of *FecB* gene:

Out of sheep breeds of India Garole and Kendrapada breeds possess the *FecB* gene; they can be used as source of *FecB* gene to increase prolificacy and bodyweight of non-prolific breeds of sheep using marker assisted introgression (MAI) through backcrossing with higher body weight recipient breed for producing prolific mutton breeds. Forced PCR-RFLP technique is the best test for genotyping of the carrier ($FecB^{BB}$, $FecB^{B+}$) and non-carrier ($FecB^{++}$) animals.

Steps:

- Select the recipient breeds which have heaviest bodyweight with best adaptability to the local conditions viz. Deccani, Mandya, Nellore, Muzzaffarnagari, patanwadi. Minimum of 200 ewes of 6 months age will be selected from about 20 flocks of native breeding tract based on their bodyweight, breed characterists. All these animals should be screened for non-carrier (*FecB*$^{++}$) of non-prolific breeds.
- About 20 homozygous animals as a donor (Kendrapada and Garole) for *FecB* gene should be selected from base population of native breeding tract after genotyping using forced PCR-RFLP technique.
- By crossing the Recipient and Donor breeds introgression of the *FecB* gene will be done and F1 animals.
- Genotyping of F1 animals, selection of *FecB* carrier females and culling on non-carrier animals from flock will be done.
- F1 carrier females will be backcrossed with elite rams of Recipient breed and F2 animals are produced. Recording of growth, production and reproduction performances will be done.
- Again F2 animals will be screened by genotyping using forced PCR-RFLP technique and carrier females will be selected and non-carriers will be culled.
- Above steps will be repeated until the *FecB* gene fixed in population i.e upto 6-7 generations. After fixation of the fecundity gene production of fecund rams and ewes of the recipient breed will be planned.

Conclusion

The *FecB* mutation in prolific sheep breeds will facilitate the use of *FecB* allele in improving the prolificacy of non-prolific sheep breeds of India. The introgression of *FecB* allele in non-prolific breed with higher bodyweight can significantly increase the productivity of sheep industry and subsequently farmers will be benefitted. The Kendrapada sheep would be a better choice since the bodyweight of this breed is higher than the Garole breed. A large scale marker assisted introgression programme is needed for all the non-prolific breeds of India so that farmers may get additional benefit from sheep rearing.

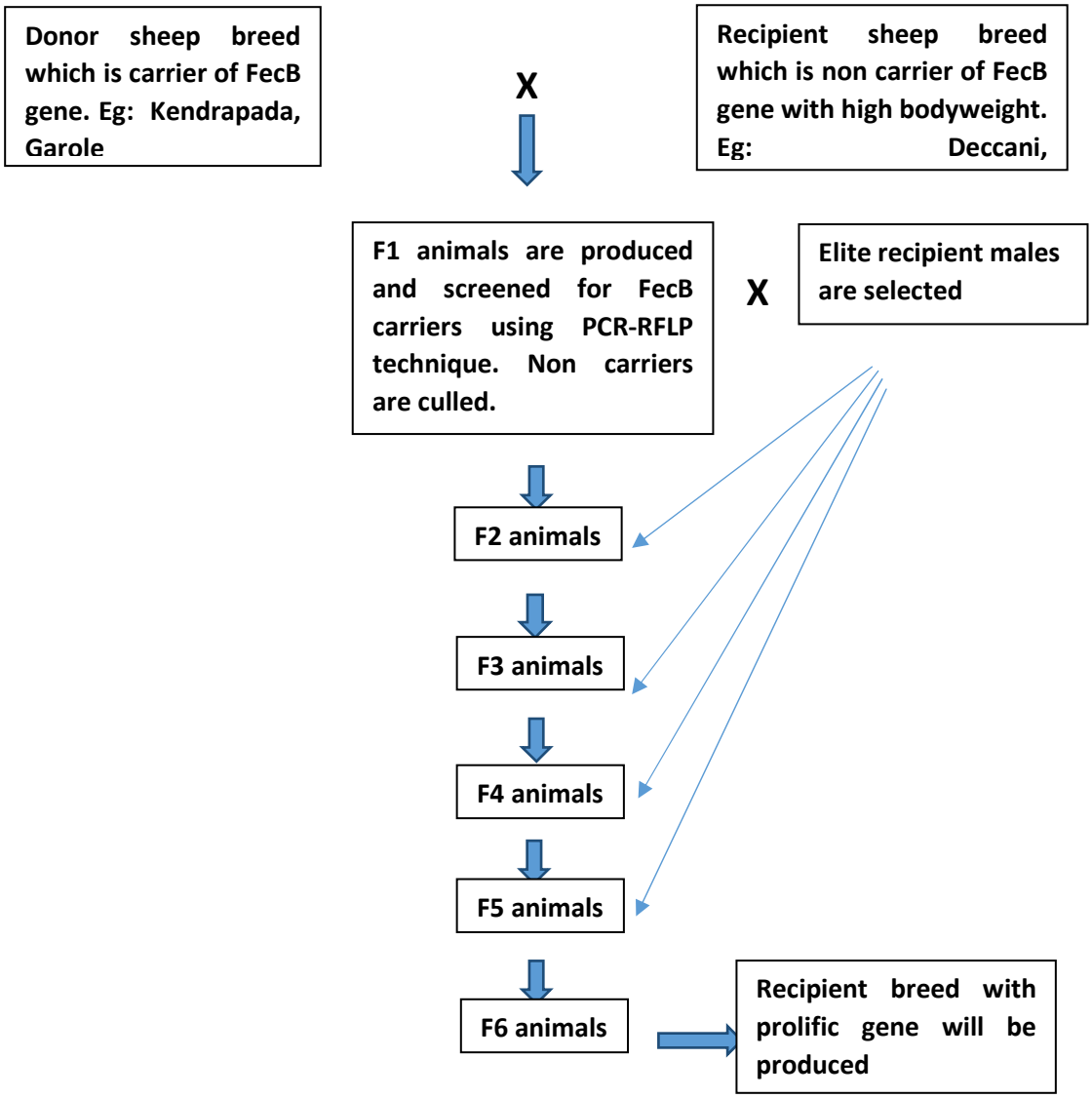

Fig.1 Breeding plan for development of high prolific breed through Marker Assisted Inrogression.

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