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Residual Feed Intake towards Efficient Animal Production: A Paradigm Shift?

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Modern methods of selection have contributed greatly to the genetically superior high yielding animals of current animal production systems [1]. While this being the case of the developed world, animal production in the tropics is constrained by the everlasting deficit in feed supply [2]. Therefore, a method based on lower feed intake without affecting mature weight and production will have a greater implication in agri-food industry. This was initially conceptualized in 1963 by Koch et al. [3], who introduced Residual Feed Intake (RFI), and defined it as the difference between actual intake and the expected requirements of feed for maintenance and body weight gain, in beef cattle. Assumption behind using RFI as a selection tool is that the biological processes regulating feed consumption and efficiency are similar in younger and older animals (as there exist high genetic correlation between post-weaning intake and maturity) [4]. RFI is a moderately heritable trait in cattle (h^2=0.25-0.48) which is independent of body size and production [5]. One approach for measuring RFI is by recording individual animal data on intake and growth for a minimum period of 35 days [5], while the second is by pre-screening for blood metabolites such as insulin like growth factor-1 followed by selection through RFI for increasing growth rate, feed efficiency and proportion of lean meat [4]. Expected dietary intake is estimated by means of a multiple regression equation of consumption, as determined by the metabolic live weight and weight gain [4,6].

Animals differing in RFI (i.e., low *vs.* high) differ in their efficiency for utilizing nutrients for maintenance and production, and those with low or negative RFI are most efficient [6]. Physiological basis for such varied efficiency has been ascribed to a range of factors including intake, digestion and metabolism of feed, physical activity, thermoregulation, synthesis and breakdown of proteins, genes encoding different biochemical processes, gene expression of gut microorganisms and hypothalamus, reticulo-rumen functions and mitochondrial respiration rate etc. [7-9]. Furthermore, RFI did not adversely influence blood metabolites in beef cattle [10] and Sahiwal calves [6], while maintaining optimum growth rate. Though majority of RFI studies have focused on beef cattle, it is plausible that the efficient dairy cows be identified based on RFI [11]. Expected intake of cows can be determined by regressing intake on metabolic body weight, change in body weight and energy corrected milk yield. Efficient cows in RFI test exhibited decreased feed/energy intake, slower rate of consumption and its flow rate leading to an improved nutrient digestibility [11] with the simultaneous reduction in manure nutrient losses [5].

One of the potential environmental benefits demonstrated in low RFI cattle is the decreased methane (CH_4) emission, which was noted in temperate [12] as well as tropical regions [6]. Factors like lower maintenance requirement and thus lower dry matter intake, reduced ruminal retention of feed, higher ruminal fermentation rate [5] and a changes in methanogen genotype abundance [13], altogether favorably decreasing methanogenesis. As CH_4 production is positively correlated with RFI and has low to moderate heritability and repeatability, it is possible to select and breed cattle for low CH_4 emission for environment friendly livestock production [5].

As livestock are largely considered to be unsustainable [14], considering RFI in selection process, may offer scope for sustainability, as efficient animals will have economic growth and milk production with minimum CH_4 emission. Furthermore, it is advised to improve animal productivity rather than maintaining large unproductive herds [2]. In this direction, as RFI selects animals for higher efficiency, it's possible to maintain a low number of efficient stocks in the herd requiring low inputs, whilst minimizing carbon foot print of cattle enterprises.

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