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Supplementary Material S1

The Italian Simmental breed, also known as 'Pezzata Rossa Italiana', has witnessed a steady increase in terms of population size, transcending its traditional rearing areas in northeastern Italy. According to the Italian Simmental Cattle Breeders Association (ANAPRI, 2021), this population is nowadays composed of approximately 90 000 registered cattle, of which 63 000 under official milk recording. About 9 000 of them are under cow-calf management system. In recent years, this breed has notably expanded especially in challenging/confined regions, such as mountainous areas (AIA, 2023), where it holds substantial value (Corazzin et al., 2020). This breed is distinguished by an average milk production of 7 304 kg with 3.93% fat and 3.41% protein content (AIA, 2023), making it particularly suitable for cheese production due to its high casein percentage, estimated at around 2.74% based on AIA data (2023). Notably, the Italian Simmental breed also holds significant value in meat production. Market preferences lean towards culled animals, particularly male calves. According to ANAPRI (2021) and Cesarani et al. (2020), male calves of this breed exhibited an average daily gain of 1 400 g/d. By 18 months of age, they reached a live weight of approximately 700 kg, with a carcass yield of 56%. This showcases commendable carcass quality in terms of conformation and fatness, with a high percentage of carcasses classified as "U" on the EUROP grid (ANAPRI, 2021; Frigo et al., 2013). The Italian selection program, in place since 1990, relies on artificial insemination and revolves around the use of certified sires for own performance (meat traits) and progeny-based evaluations (milk traits). Genomic testing is also carried out on young males for preselection of candidates. The official breeding goal of Italian Simmental breed is called Sustainable

Dual-Purpose index, where emphasis is for traits related to: dairy (fat and protein quantity), beef (daughter muscularity, and performance test weight at 12 months, average daily gain, muscularity and feed efficiency), functional (fertility, longevity, somatic cell count, and milkability), and morphology (udder conformation and feet and legs).

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