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# *Technical note:* A simple back-mounted harness for grazing dairy cows to facilitate the sulfur hexafluoride tracer gas technique

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## ABSTRACT

We describe here a cattle harness to attach a gas collection vessel to facilitate the sulfur hexafluoride ($SF_6$) tracer gas technique. The harness consists of 2 major components: (1) a lightweight, robust body fabricated from an equine surcingle or lunge roller with padded thoracic trapezius pressure points, a bespoke shaping shaft for spine support, and adjustable buckles on both sides; and (2) an elastic flank-strap to prevent the harness from dislodging. The spine support consists of stainless steel laminated with carbon fiber. This support minimizes the contact area with the animal's skin, relieves the spine area of pressure, and creates free flow of ambient air below the platform, reducing sweat accumulation and hence preventing skin lesions. The harness weighs approximately 1.2 kg, allows for attachment of 2 gas collection vessels (animal and background sample), and is cost effective.
**Key words:** sulfur hexafluoride ($SF_6$), methane measurement, enteric $CH_4$, equipment, harness

## Technical Note

Enteric methane emissions from individual grazing ruminants can be measured using the sulfur hexafluoride ($SF_6$) tracer gas technique developed by Zimmerman (1993) and first adopted by Johnson et al. (1994). Since 1994, various implementations of the original technique have been published in more than 120 peer-reviewed papers. In an attempt to standardize the $SF_6$ technique, a few guidelines on the use thereof have been made available over time (Johnson et al., 2007; Berndt et al., 2014; Williams et al., 2016), with the latest modification for dairy cattle described in detail by Deighton et al. (2014). These guidelines concentrated profoundly on the fundamental elements of the $SF_6$ technique, such as the slow-release device (permeation tube) and sampling line with flow restrictor and gas collection vessel (sample and background). The gas collection vessel has changed from a stainless steel sphere suspended by a neck strap attached to the halter apparatus (Johnson et al., 1994) to a V- or U-shaped neck yoke molded from polyvinyl chloride (PVC) pipe (Johnson et al., 2007) and, most recently, to a stainless steel or PVC cylinder fitted to the animal's back (O'Neill et al., 2011; Deighton et al., 2013, 2014). The mounting position of the gas collection vessel depends mainly on the species and breed (size and temperament) as well as the operating environment (extensive or intensive) and the available resources to manufacture the vessel. For example, the neck position for the gas collection vessel will function for most extensive animals, whereas it is dysfunctional in a milking parlor or feed stall equipped with a baling system. The back-mounting options for the gas collection vessel are, however, usually described superficially, often not cost effective, and not standardized. In our opinion, the position and quality—in terms of support, minimal skin contact area, and pressure points—of the mount on the animal are critical as these factors will affect animal welfare and the number of representative gas samples lost.

This note presents a cost-effective, robust, back-mounted harness with minimum skin contact area for grazing dairy cows that facilitates the $SF_6$ technique for measurement of enteric methane emissions. We hypothesize that grazing dairy cows equipped with this novel harness will not show signs of skin lesions on the spine area or behind the thoracic limb. Although the harness described in this note applies to dairy cows, the apparatus could be adapted for use in other ruminants as well. Institutional animal care and use was obtained from Western Cape Department of Agriculture (Elsenburg, South Africa) before commencement of the study, and unnecessary discomfort to the animals was avoided at all times.

The harness consists of 2 major components: (1) a lightweight, robust body fabricated from an equine surcingle or lunge roller with padded thoracic trape-

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**Figure 1**. Harness body showing the perforated neoprene padding with built-in support shaft to ensure breathability and comfort to the trapezius area of the cow while acting as a platform for attachment of the gas collection vessel. Color version available online.

**Figure 2**. The U-shaped trapezoidal support shaft crafted from stainless steel rod laminated with stringed carbon fiber. Color version available online.

zius pressure points, a bespoke shaping shaft for spine support, and adjustable buckles on both sides, that acts as a platform for gas collection vessel attachment; and (2) an elastic flank-strap to prevent the harness from sliding over the neck of the animal. The padded surcingle used is commercially available and is specifically designed to relieve pressure on the spine and to avoid sideways movement of the harness. The surcingle is equipped with attachment rings running from the ribcage up to the spine area and usually has a girth range of 160 to 220 cm. Nylon is recommended over leather for the surcingle because of the lighter weight and enhanced breathability, keeping sweat accumulation to a minimum. The trapezius padding is covered by perforated neoprene material to ensure breathability and comfort (Figure 1). We found that the standard padded surcingle did not relieve sufficient pressure on the spine due to the Jersey cow's pointed thoracic spinous process, which is more profound in a grazing system compared with a TMR system where energy supply is not limiting and body condition is improved. As observed in our previous unpublished $SF_6$ trials, more than 40% and 20% (n = 72) of pasture-based Jersey cows equipped with the standard padded surcingle without protective felt wrapping, covering an average distance of 800 m twice daily around milking for 6 consecutive days, showed signs of skin lesions on the spine area and behind the thoracic limb, respectively, ranging from slight to severe cases. Unfortunately, exact values of skin lesion incidences from other research establishments for comparison purposes are difficult to obtain due to the sensitive nature thereof.

To alleviate the problem, a U-shaped trapezoidal support shaft was crafted from stainless steel rod (6 mm diameter) laminated with 1 layer of stringed carbon fiber per side to create a flat area with rounded edges. The lengths of the sides are 170 mm, the top base 70 mm, and the width of the laminated shaft 40 mm (Figure 2); the support shaft weighed approximately 177 g. The inner base angle of the support shaft can range from 120° for cows with BCS <2.5 to 150° for cows with BCS >3.0. The BCS system used was the 5-point scale developed by Wildman et al. (1982). The shape and size of the support shaft was based on a gypsum mold of the thoracic vertebrae area of a Jersey cow with a BCS of 2.0. The support shaft is inserted within the surcingle between the 2 nylon layers, above the trapezius padding, and stitched secure. This support relieves

**Figure 3**. A Jersey cow equipped with a simple back-mounted harness for gas collection vessel attachment to facilitate the $SF_6$ tracer gas technique. Adjustable buckles and elastic band over the flank avoid dislodgment of the harness. Color version available online.