ABSTRACT

The agricultural tractor is the most commonly used vehicle on farms and one of the most prominent sources of noise in agriculture. Unfortunately, many engaged in agricultural tasks overlook noise protection, risking potential hearing loss from prolonged exposure to tractor noise. A solution involves installing exhaust mufflers in tractors—an uncomplicated yet effective method to diminish exhaust noise. A study was proposed to design an improved muffler for achieving reduced noise level.

In a study evaluating six commercially available muffler designs and the existing muffler of a test tractor, the sound pressure level (SPL), exhaust back pressure (EBP), and fuel consumption were measured across various engine speeds (700-2560 rpm) under no load conditions. None of the tested muffler designs achieved a SPL below 90 dBA between 1900-2200 rpm, a critical range for tractor operations. Given the occupational safety limit of 90 dBA, the existing muffler was further investigated using finite element method (FEM) through ANSYS software. The study aimed to enhance noise reduction in the mid-low frequencies (1–2000 Hz) typical of diesel engines, proposing three modified designs for the existing muffler—DM1, DM2, and DM1 with a resonator based on their transmission loss (TL) effectiveness. In the frequency range of 0-2000 Hz, DM1 with resonator demonstrates a mean transmission loss of 40.37 dB, significantly surpassing the existing muffler's mean transmission loss of 17.62 dB. The features include three chambers, two plugs, open area ratios of 1.043 and 1.275 for perforated pipes, and two perforated baffle plates, and a resonator.

A test tractor with a power output of 35 kW was selected to evaluate the noise pollution, exhaust back pressure, and fuel consumption of the developed mufflers with various implement combinations. The test involved three replications, conducted using a completely randomized design and factorial analysis. The DM1 with a resonator reduced sound pressure levels of the test tractor by a range of 2.26–3.03 dBA. It exerted exhaust back pressure ranging from 3.23 kPa to 4.5 kPa and resulted in fuel consumption within the range of 3.5 to 7.17 l/h. Engine speed, gear, muffler type, and implements emerge as significant factors influencing the noise, exhaust back pressure, and fuel consumption of the test tractor at a 5% probability level.

Keywords: Hearing loss, Sound pressure level, Exhaust back pressure, FEM, Developed mufflers, Transmission loss.