Location: University of the Philippines Los Baños, Laguna, Philippines

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Description of facility:

UPLB's headbox facility comprise

- Features elevated metabolism stalls fitted with fully enclosed headboxes made of polyacrylic and stainless-steel materials.
- Headboxes isolate the animal's head and are sealed using adjustable vinyl tarpaulin neck coverings/hood
- A pipe network equipped with blowers and flow meters maintains consistent airflow and directs captured gases to the gas analyzer (SmartCEMS Multiplexer Gas Analyzer)

Principle of operation:

Summary:

The UPLB headbox respiration facility includes four sealed headboxes operating independently to measure GHG emissions from cattle. During measurements, air is continuously drawn from the enclosed head area of each animal through two vertical intake pipes positioned near the breathing zone that merge into a main pipe connected to a blower system. As air is drawn out, ambient air enters the headbox through the adjustable neck shroud. A portion of the airflow is continuously sampled via small tubes inserted after the airflow meters, which lead to a multi-channel gas analyzer. In this system, four headboxes and one ambient air channel are monitored sequentially. Negative pressure is maintained inside each headbox to prevent leakage and ensure accurate sampling of exhaled gases

Headbox details: The metabolism stalls are elevated approximately 50cm above the ground and measure 365cm in length, 95cm in width, and 145cm in height (without the box). Each headbox is detachable from the stalls and measure 90cm in length, 105cm in width, and 160cm in height. They are constructed using stainless steel frames combined with polyacrylic panels to create a rigid and sealed environment around the animal's head area. The animal's neck passes through a black vinyl tarpaulin shroud fitted with adjustable drawcords, allowing a loose but controlled entry of ambient air while maintaining negative pressure inside the box. Each stall is designed with a slatted floor with rubber padding to allow waste to pass through and be collected below. Feed bins and automatic waterers are provided inside each headbox to ensure that animals have access to feed and water during confinement. To restrict movement and prevent the animals from leaving the headbox, a neck collar system is used, with the collars secured externally to prevent pushing.

Air flow: Air is continuously drawn from each headbox by side-channel blowers operating at an approximate flow rate of 500L per minute per headbox. The intake begins at two one-inch vertical pipes on the sides of the box with multiple perforations, positioned close to where the animal exhales, merging into two-inch diameter main pipes. Flow rates through each channel are monitored by ATZTA TBX-D digital flow meters and adjusted manually via flow valves. Prior to experiments, airflow rates across all headboxes are equalized as closely as possible to minimize system variability. Temporary sampling ports located along the pipes allow the measurement of air temperature and pressure when necessary for corrections.

Air Temperature and Pressure: The air flow meters and gas analyzer readings are affected by temperature and pressure conditions so measurements must be corrected to STP to ensure accurate calculations of gas emissions. During the experiments, the sampling ports after the

airflow meters are used for manual insertion of a temperature and pressure probe. These values are recorded and used to adjust the measured airflow rates and gas concentrations using Boyle's Law. Corrections ensure that all gas volumes and concentrations are reported under STP conditions, minimizing variation caused by environmental fluctuations inside the pipes.

Gas analysis.
Gas concentrations are measured using a SmartCEMS Multi-gas Analyzer manufactured by AquaGas. This analyzer is equipped with an automatic multiplexer capable of sequentially measuring gases from four animal channels and one ambient air channel. The system operates in flip-flop mode, with each cycle lasting 15minutes, comprising 5 minutes of ventilation (zeroing phase), 2.5 minutes of infusion (purging phase), and 7.5 minutes of active measurement. The analyzer measures methane in ppm, carbon dioxide in percentage, and oxygen concentration. The analyzer is placed inside a separate, ventilated analysis room to prevent contamination from external methane sources.

Gas recovery procedure:

Before conducting experiments, a gas recovery test is performed to assess the integrity of the system. Pure methane gas (99.99% CH4) is released from a high-pressure gas cylinder through a two-stage regulator and mass flow controller, set to deliver gas at 30 Ncc/min under normalized conditions. The methane gas is injected directly into the headbox system via one of the pipe's perforations. The mass flow controller is configured to reduce the inlet pressure to a safe operational pressure of around 30 psi. After a brief stabilization period, readings from the gas analyzer are taken and adjusted for ambient temperature and pressure using Boyle's Law. Ambient methane levels, measured before the infusion of the known gas, are subtracted from the experimental readings. The recovery percentage is then calculated by comparing the measured concentration to the theoretical concentration derived from gas flow rates. A recovery range between 95% and 105% is considered acceptable. If the recovery rate falls outside this range, the system is inspected for leaks using smoke tests, visual inspection, or soapy water application. Identified leaks are sealed using appropriate sealants, and in cases of significant damage, replacement of affected piping sections is performed.

Photo library of your system:

Photo of headbox:

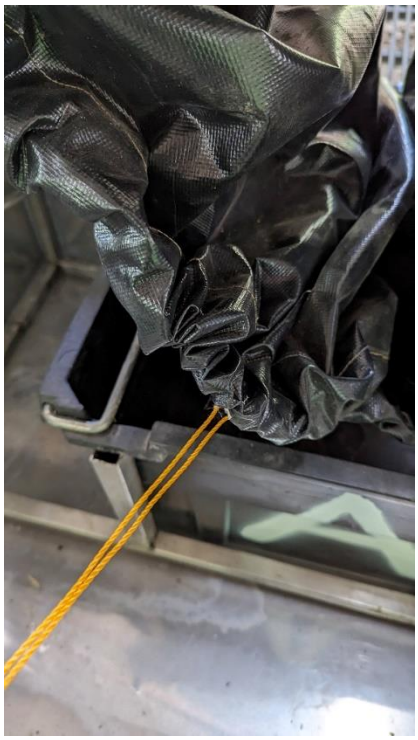
a. Exterior and interior of the headboxes

b. The four metabolism stalls equipped with headboxes at the facility



c. Rear of the headbox, slatted flooring of the stalls, and the ramp used for transferring animals


d. Automatic waterer and feed bin installed inside the headbox

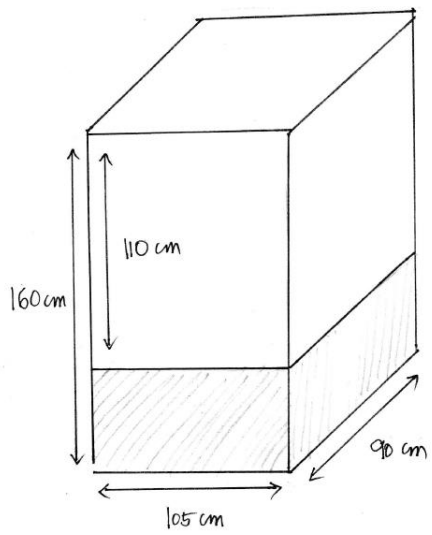



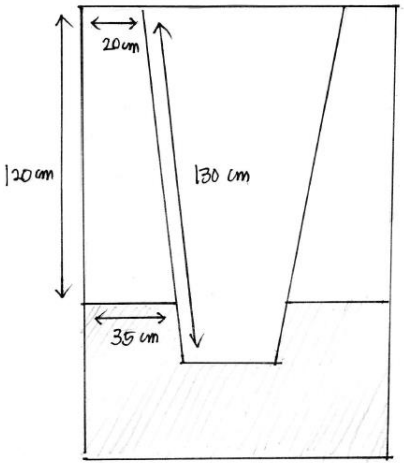
e. Shroud made of vinyl tarpaulin, and its drawcord

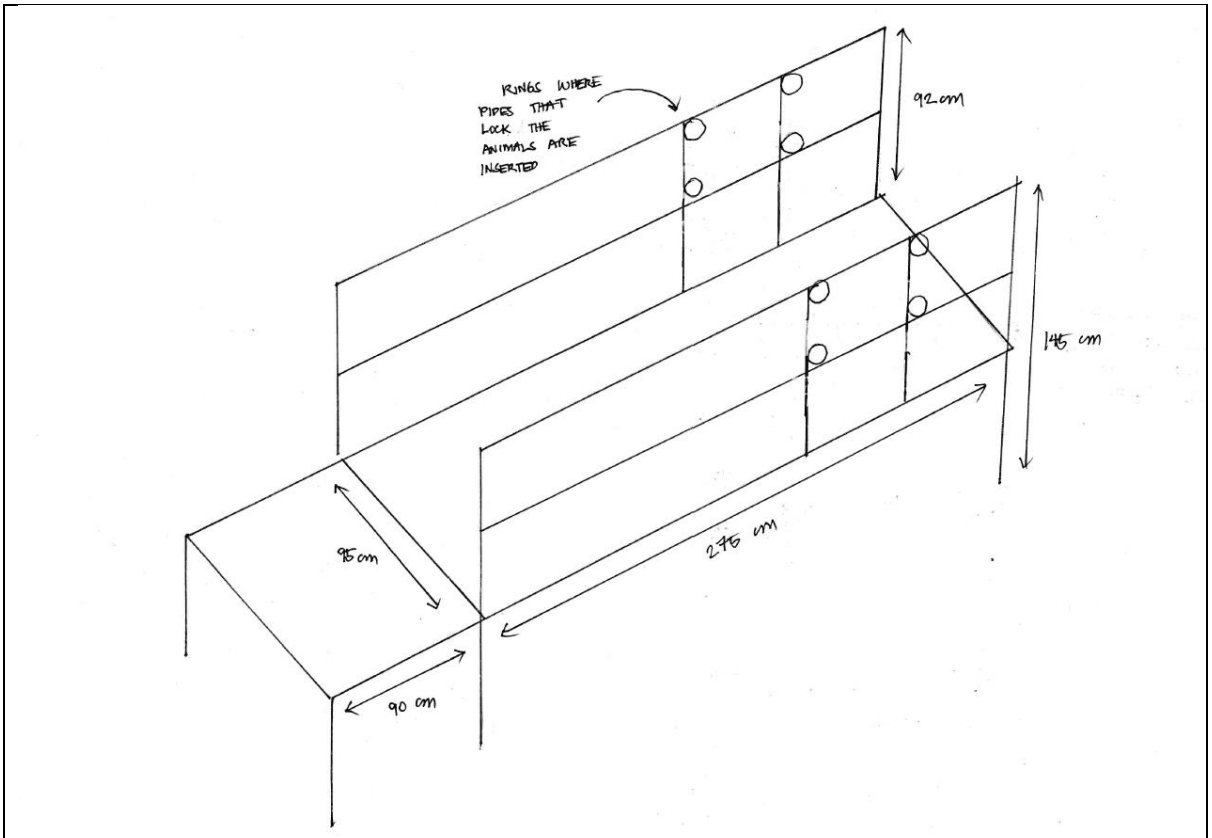

f. Vertical 1-inch pipes with holes for the entry of air to be analyzed

g. Main pipes (2-inch diameter) which direct the air towards the analysis room

Sketch with measurements of headbox:







Manufacturer's template for neck shroud construction:

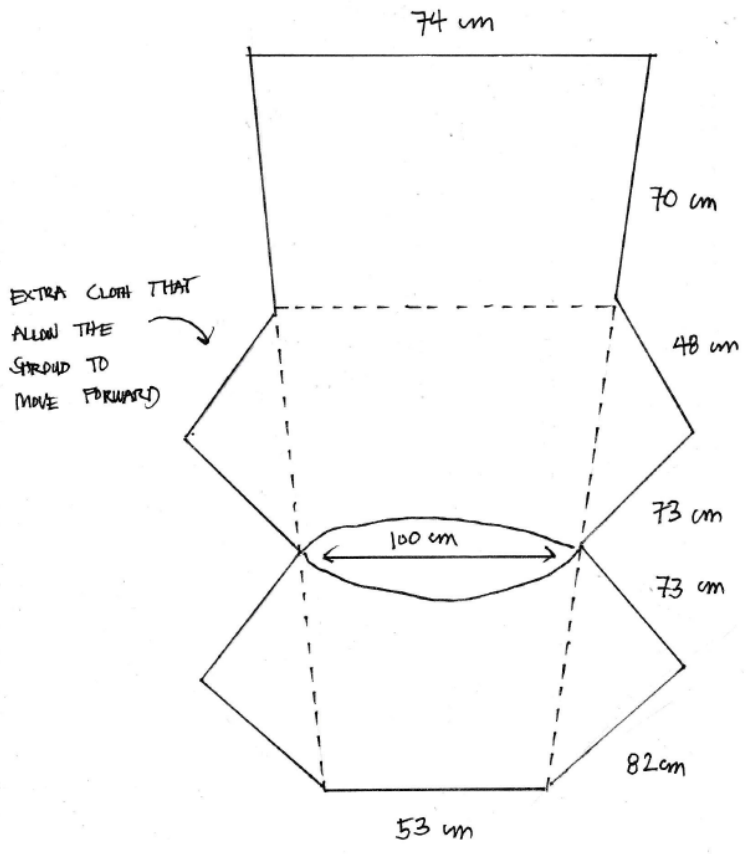


Photo of airflow components:

- Blower fan and any air bleed-in valves:

h. The blowers that draw air from the headbox into the gas analyzer, and out towards the environment

- Flow meter:

i. Airflow meters responsible for measuring the airflow in the pipes

Photo of gas analyser & and filter/dryer components:

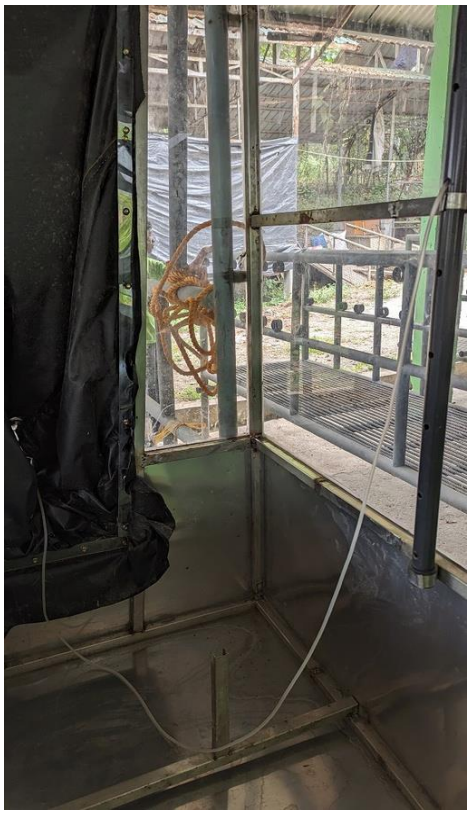
j. Air filters

k. Sampling points and sampling tubes that lead to the gas analyzer

l. The gas analyzer with multiplexer used at DTRI - UPLB

Photo of gas recovery in action.

m. The mass flow controller used to infuse a known and steady amount of gas into the system



n. Set-up of recovery test wherein the gas is directly infused into one of the inlet pipes.

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