Location: Indonesian Research Institute for Animal Production (IRIAP), Ministry of Agriculture, Indonesia

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Description of facility:

IRIAP's headbox facility comprise

- Four (4) individual headboxes for large ruminant and four (4) individual headbox for small ruminant
- Large Animal Respirometry System for Ruminants from Sable System® which is consist of:

a. 5-2000 L Flow Generator (4 units)
b. Fixed Rate Pressure Pump (1 units)
c. Eight Channel Respirometer Multiplexer (1 units)
d. Gas Subsampler/Pump/ Mass Flow Meter (1 units)
e. Water Vapor Analyzer (1 units)
f. Carbon Dioxide Analyzer (1 units)
g. Methane Analyzer (1 units)
h. Oxygen Analyzer (1 units)
i. Computer for data acquisition and processing
j. Nitrogen UHP, pressure 150 Bar with purity >99.99%
k. Methane UHP with purity 99.95%
l. Methane
m. Carbon dioxide
n. Gas filter placed on the top of each individual headbox.

Principle of operation:

Summary: In a multiplexed large animal respirometry system using the Sable platform, each animal is placed in a sealed, ventilated chamber through which a known flow of fresh ambient air is continuously drawn. Air enters the chamber via a controlled inlet and exits through an exhaust outlet, where the outflow is routed through a mass flow controller to measure the exact airflow rate. A multiplexer unit sequentially selects one chamber at a time and directs the outflow air to high-precision gas analyzers that measure concentrations of oxygen (O_2), carbon dioxide (CO_2), and methane (CH_4). Simultaneously, ambient air samples are also drawn in for baseline comparison. The gas concentration differences between inflow and outflow, combined with airflow measurements, allow for the calculation of respiratory gas exchange and methane emissions. The switching between chambers is fully automated and controlled by the system's software, with built-in flush cycles to prevent cross-contamination. All data, including gas concentrations, airflow, temperature, and humidity, are recorded and processed in real-time using Sable's ExpeData software to determine metabolic rates and emission profiles for each individual animal. System details are described below:

Headbox details: The headbox used measures approximately 200 x 120 x 300 cm (W x L x H) and is raised 30 cm off the ground to facilitate cleaning. It is constructed from welded stainless steel with varying thicknesses in different sections. In general, the headbox is divided into two main parts: the body and the head. The head section is equipped with a thick fabric partition that helps isolate air exhaled from respiration and eructation. The front and side panels are fitted with acrylic glass (approximately 1 cm thick), with the front panel designed to open for easy feed and water replacement. Above the head section, an air mixer and gas outlet are installed to collect exhaled gases, which are then directed to the gas analysis system.

Air flow: Ambient air is drawn into each sealed chamber through an inlet at 150L/minute, passes around the animal, and exits through an exhaust outlet. The outflow air moves through a mass flow controller and is pulled by a side-channel blower or vacuum pump. Airflow is continuous in all chambers. A multiplexer sequentially directs exhaust air from each chamber to the gas analyzers, while non-sampled chambers vent to the atmosphere. Flow rates are logged and corrected for temperature, pressure, and humidity.

Air Temperature and Pressure:
Air temperature and barometric pressure are continuously measured using dedicated sensors placed near the airflow system. These measurements are recorded alongside gas concentrations and flow rates. Data from the sensors are used for real-time correction of gas volumes and flow, ensuring standardized conditions across all chambers.

Gas Analysis:

a. Air Routing: Exhaust air from each chamber is routed through the multiplexer, which selects one chamber at a time to direct its air to the gas analyzers.
b. Gas Measurement: The gas analyzers continuously measure the concentrations of gases: Oxygen (O_2), Carbon Dioxide (CO_2), and Methane (CH_4) in the exhaust air.
c. Concentration Difference: The system measures the difference in gas concentrations between the incoming fresh air (inflow) and the outgoing exhaust air (outflow). This difference reflects the gas exchange happening within the chamber.
d. Calculation of Gas Exchange Rates: The gas exchange rates are calculated based on the concentration differences:
    - O_2 consumption (VO_2) is determined by the depletion of oxygen.
    - CO_2 production (VCO_2) is determined by the increase in carbon dioxide.
    - Methane emission (VCH_4) is measured directly.
e. Real-Time Data Logging: Gas concentration data from the analyzers are continuously logged and stored by the ExpeData software, which time-stamps and synchronizes the readings for each chamber.
f. Temperature, Pressure, and Humidity Corrections: The gas measurements are corrected for environmental conditions, including temperature, barometric pressure, and humidity, using dedicated sensors. These corrections ensure that the gas volumes are measured under standardized conditions for accuracy.

Data Processing using ExpeData: ExpeData software continuously acquires real-time data from gas analyzers, flow meters, and environmental sensors, such as temperature, pressure, and humidity. The software synchronizes these data streams, ensuring that readings from different sources are time-stamped and aligned for each chamber during its turn in the multiplexing cycle. Calibration factors are applied to correct the raw data, adjusting for any drift in gas analyzers or flow meters. The software then calculates gas exchange rates, including oxygen consumption (O_2), carbon dioxide production (CO_2), and methane emission (CH_4), based on the differences in gas concentrations between inflow and outflow air, corrected for airflow. Real-time monitoring is facilitated by ExpeData's graphical display, showing dynamic changes in gas exchange rates and environmental conditions. Once the data is processed, ExpeData allows for the export of results in formats such as CSV or Excel for further statistical analysis and reporting. The software also includes diagnostic tools to monitor the system's performance, ensuring data quality and system integrity.

Gas recovery procedure: The gas recovery procedure is performed by releasing high-purity methane (CH_4; purity >99.95%) into each chamber for a defined duration. Recovery efficiency is quantified by calculating the difference between the total volume of methane introduced

and the volume recovered, with concentration measurements used to verify gas capture accuracy.

Photo library of your system: ***Please give us a good overview of your system with lots of photos- write any explanation of photos you like.***

Photo of headbox

Front view of headbox chamber

Feed bunk and water container

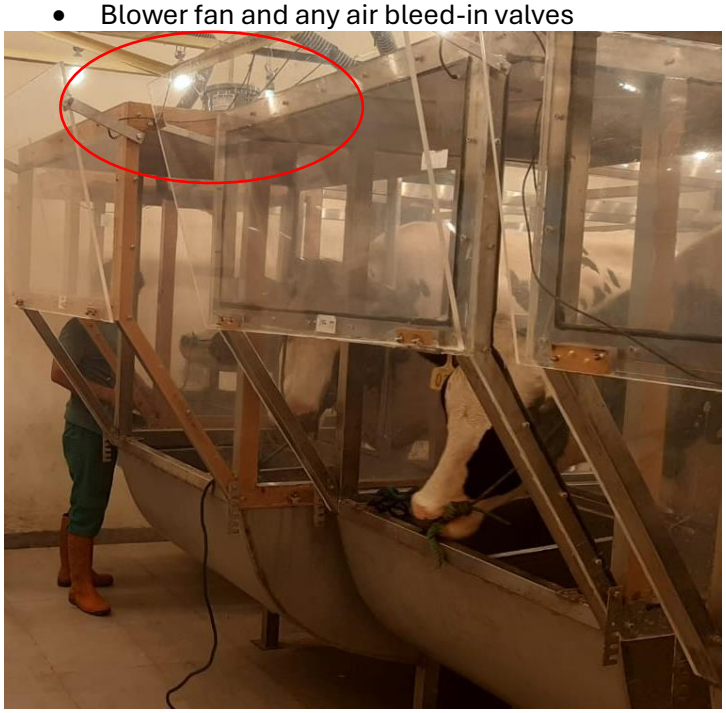
Rear view

Sketch with measurements of headbox – so somebody can copy design

Manufacturer's template for neck shroud construction

Photo of airflow components

- Blower fan and any air bleed-in valves



Blower and fan for air inlet

- Flow meter

Photo of gas analyser & and filter/dryer components

Control room

Photo of gas recovery in action.

END

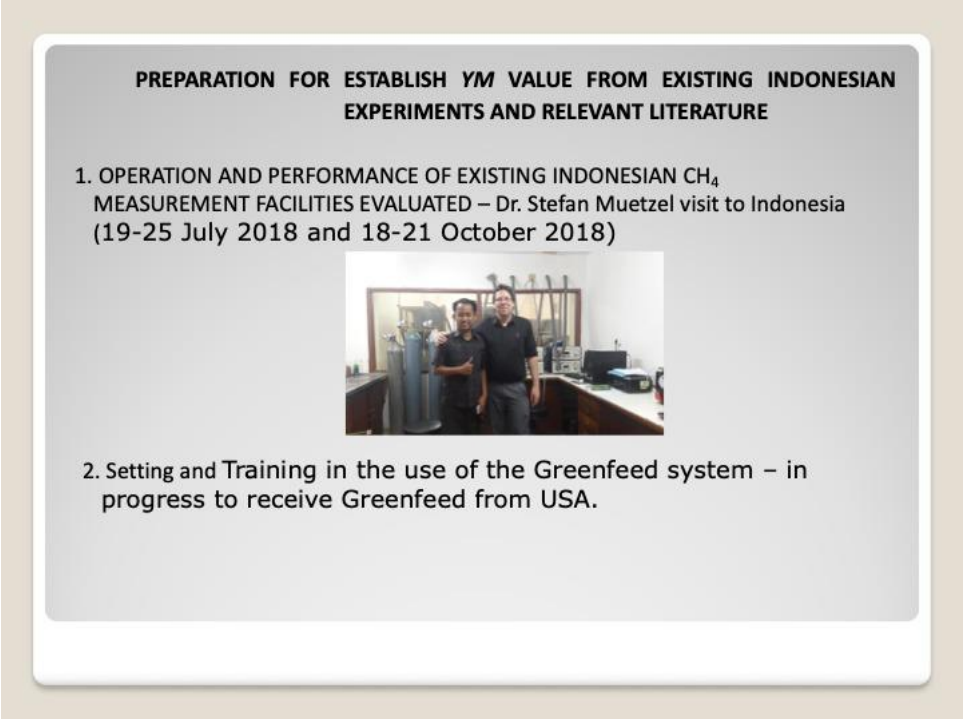
A. Sable system installation at IRIAP


RH-300
MA-10
CA-10
PA-10
MUX
FLOWKIT
FLOWKIT
FLOWKIT


FLOWKIT
FLOWKIT
FLOWKIT

Dr. Stefan Muetzel (AgResearch NZ) as a trainer. Participants were scientists from research institutes and universities

Training in how the head box system work and calculation then analyzed the results



For comparison, the experiment was conducted by using a head box chamber connected to a methane analyzer, with the same diets offered as performed in the Greenfeed and Smartfeed Pro systems

B. Methane measurement using a portable headbox chamber during field research on beef cattle

Farmer group (Yogyakarta Province)

Private sector (Jambi Province – Sumatera)