The role of agriculture in methane emissions abatement

09 November 2025

Mokhele Moeletsi

Research Team Manager: Agrometeorology and Climate Science

Natural Resources and Engineering (ARC-NRE)

Agricultural Research Council

South Africa

Outline

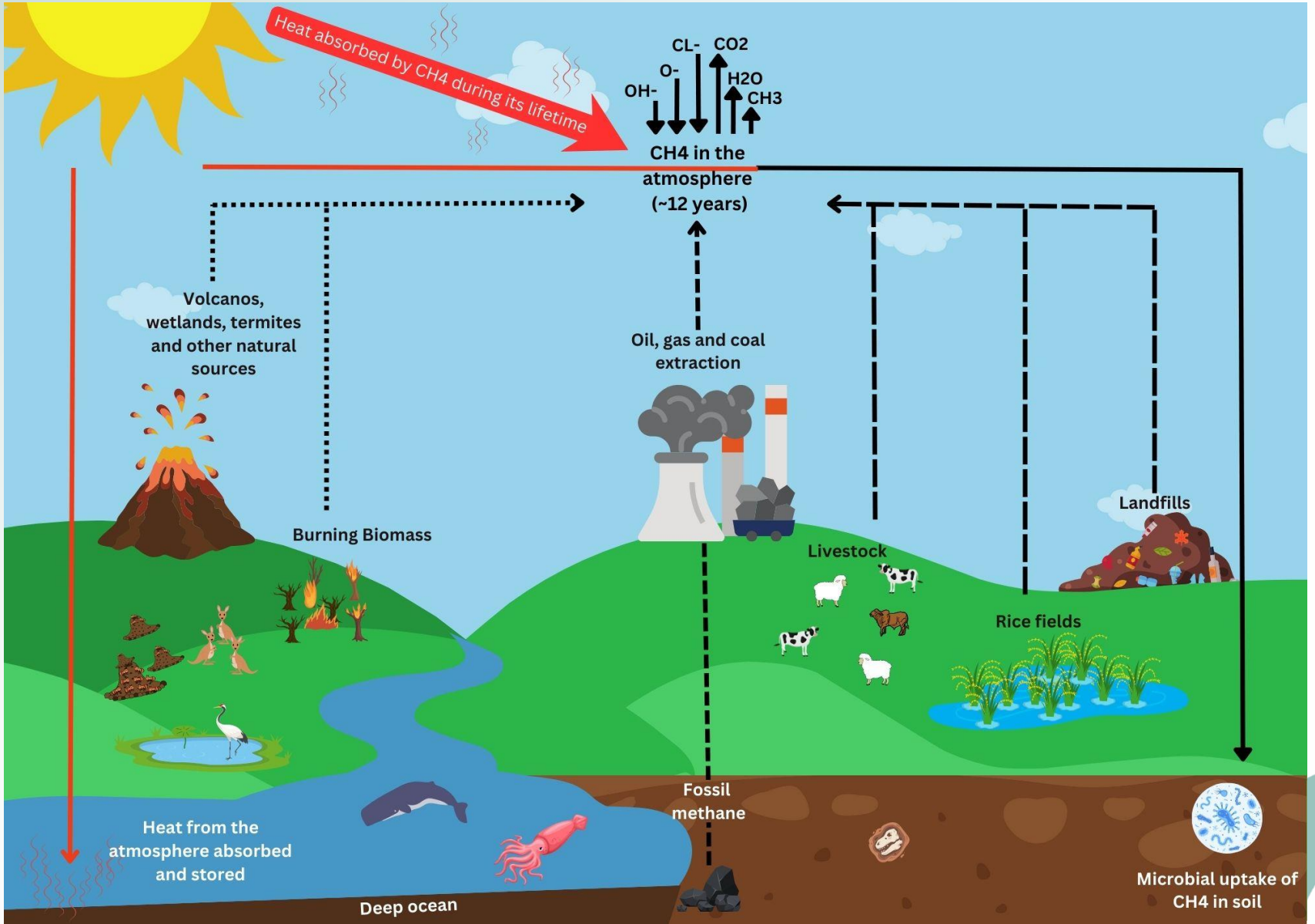
- Main sources of methane in Agriculture
- Key mitigation strategies applicable in South Africa
- Case studies

Introduction

- Methane CH_4 is a highly potent greenhouse gas (GHG) with a global warming potential of around 28 as compared to carbon dioxide (IPCC, 2021).

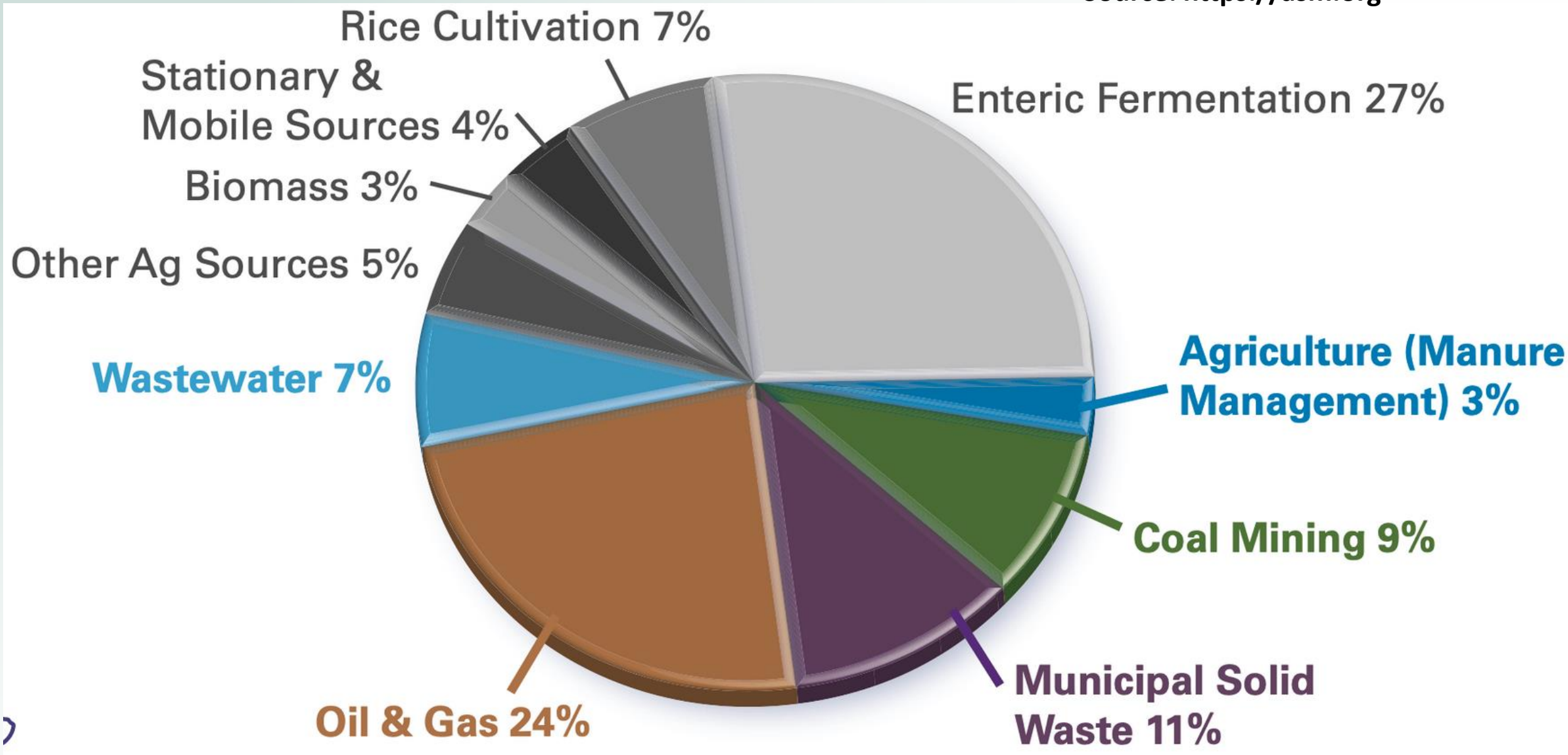
Gas	AR6 GWP 100	Lifetime (Yrs)
Carbon Dioxide	1	
Methane (biogenic)	27	11.8
Methane (Fossil)	29.8	11.8

Introduction

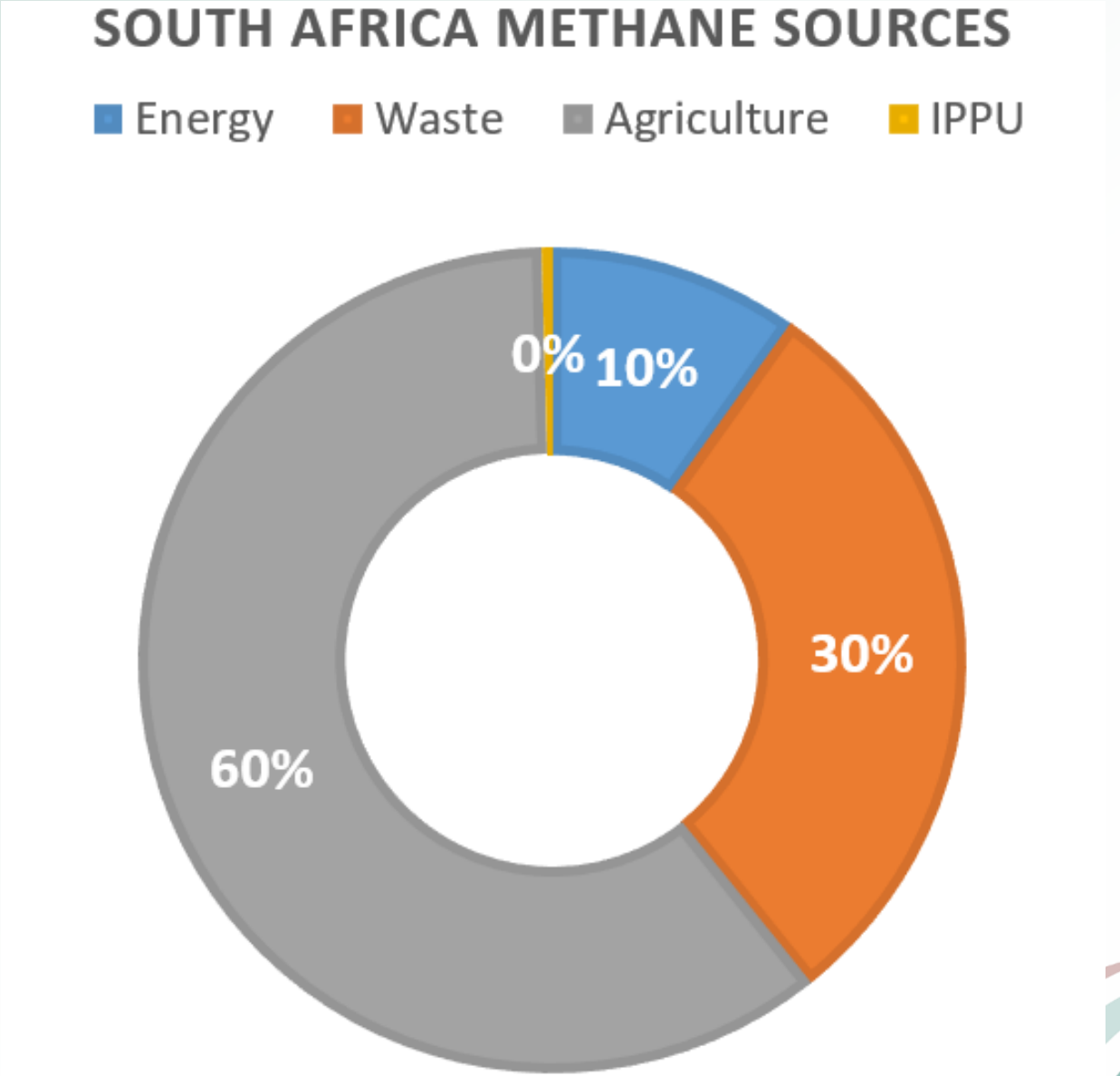


Global methane emissions sources

Source: https://asm.org



South Africa methane emissions sources



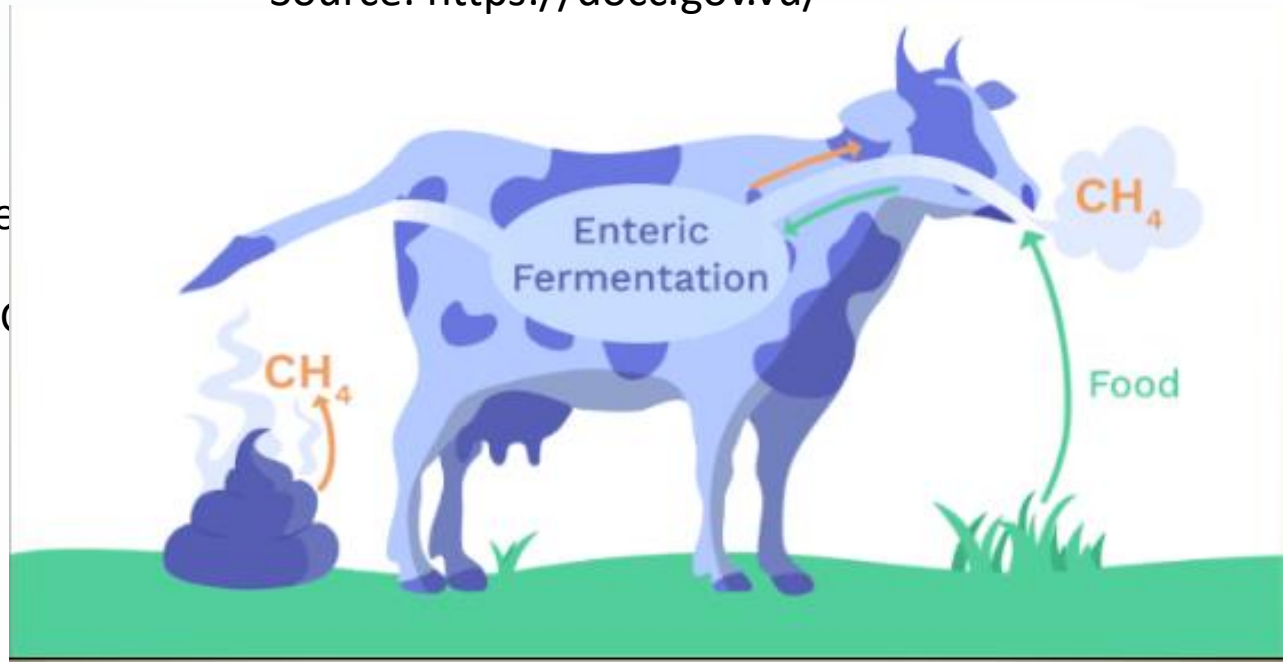
Source: DFFE

Main sources of methane in agriculture

- Enteric Fermentation – a natural digestive process in ruminant animals like cattle, sheep, and goats, where microbes in their stomach break down and ferment food, releasing methane as a byproduct. Key processes

Ingestion of Feed
Animal eats plant-based feed (e.g., grass, silage).
Feed contains carbohydrates like cellulose.
Microbial Fermentation in the Rumen
Microbes digest the feed anaerobically (without oxygen).
This produces volatile fatty acids (for energy), carbon dioxide
Methanogenesis
Specialized microbes called methanogens convert H_2 and C
Methane Emission
Methane is expelled primarily through belching (eructation).
A small amount may also be released via flatulence.

Source: https://docc.gov.vu/



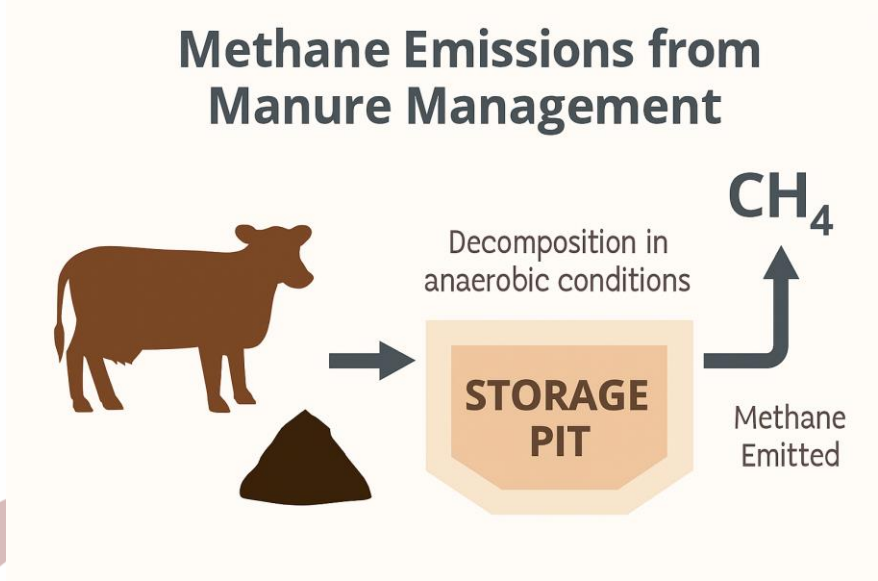
Main sources of methane in agriculture

- Manure management - Methane (CH_4) is produced when livestock manure decomposes under **anaerobic conditions** (lagoons, pits, tanks, etc)
- Key processes

Animal Excretion - Livestock produce manure as part of their normal digestion
Storage or Treatment - Manure is collected and stored in facilities that often lack oxygen.
Anaerobic Decomposition - Microbes break down organic matter in the manure. In the absence of oxygen, this process produces methane.
Methane Release - Methane escapes into the atmosphere

Amount of methane depends

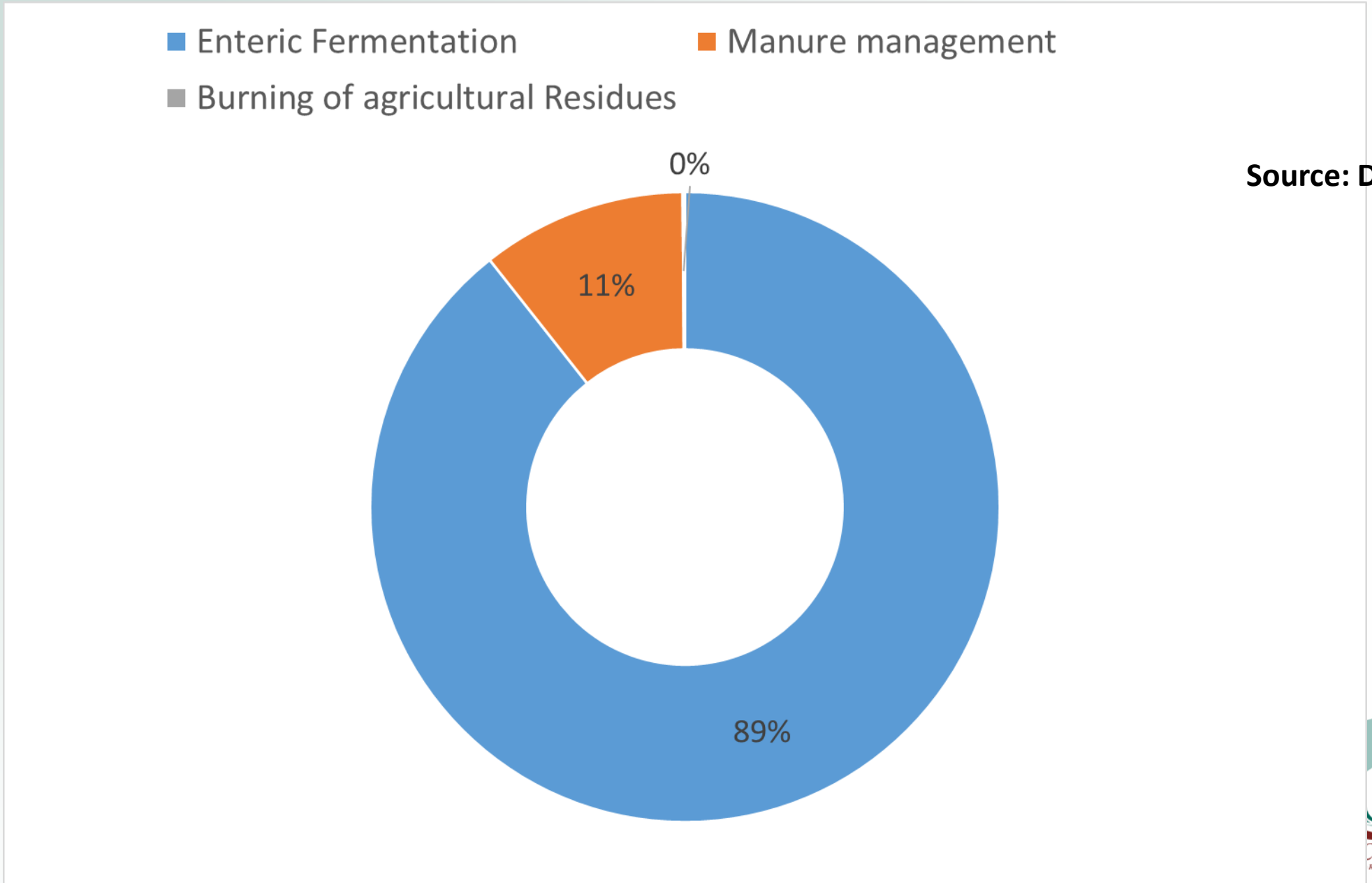
- Manure management system
- Climate and temperature
- Duration of storage



Main sources of methane in agriculture

- Burning of agricultural residues – methane is emitted during the burning of agricultural residues when plant biomass is combusted in open fields, releasing methane (CH_4) along with other gases due to incomplete combustion under low-oxygen conditions

South Africa agriculture methane emissions sources



Source: DFFE

Enteric Methane mitigation options

Technology/Practice	Cost Level	Effectiveness (CH4 Reduction)	Scalability	Applicability
Feed Additives	Medium	Medium to High	High	Viable in intensive systems like feedlots
Precision Livestock Farming	Medium	Medium	High	In commercial setting
Selective Breeding	Low	Medium	High	Applicable in small-scale and commercial setting
Improvement of animal health	Low	Medium	High	Highly applicable

Manure management mitigation options

Technology/Practice	Cost Level	Effectiveness (CH4 Reduction)	Scalability	Applicability
Anaerobic Digesters	High	High	Low - Medium	Applicable in small-scale and commercial
Precision Livestock Farming	Medium	Medium	Medium - High	In commercial setting
Manure Composting/Drying	Low	Medium	High	Applicable in small-scale and commercial

Livestock improvement schemes in South Africa

Participation in the Schemes qualifies the participants to receive science-supported services that include information dissemination and technology transfer sessions about various livestock farming topics, ranging from basic animal husbandry practices, animal health, veld condition assessment, record keeping, market access, etc., to enhance the capacity of farmers

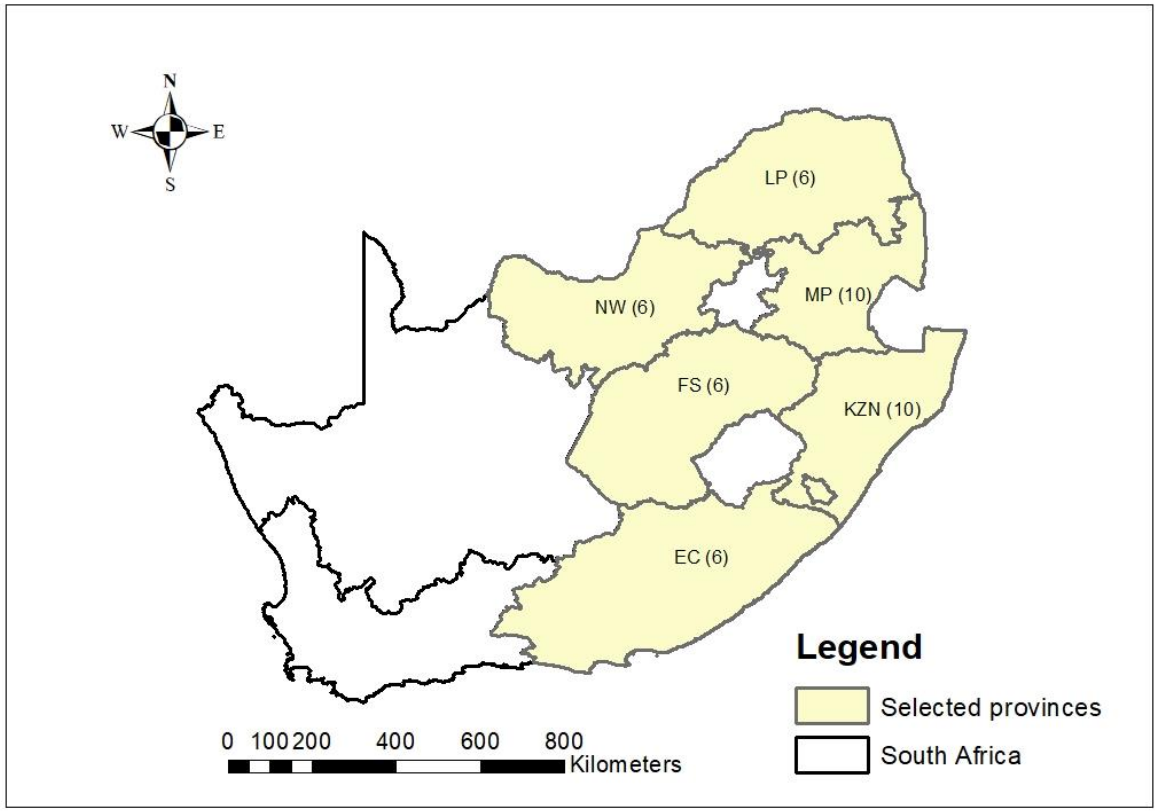


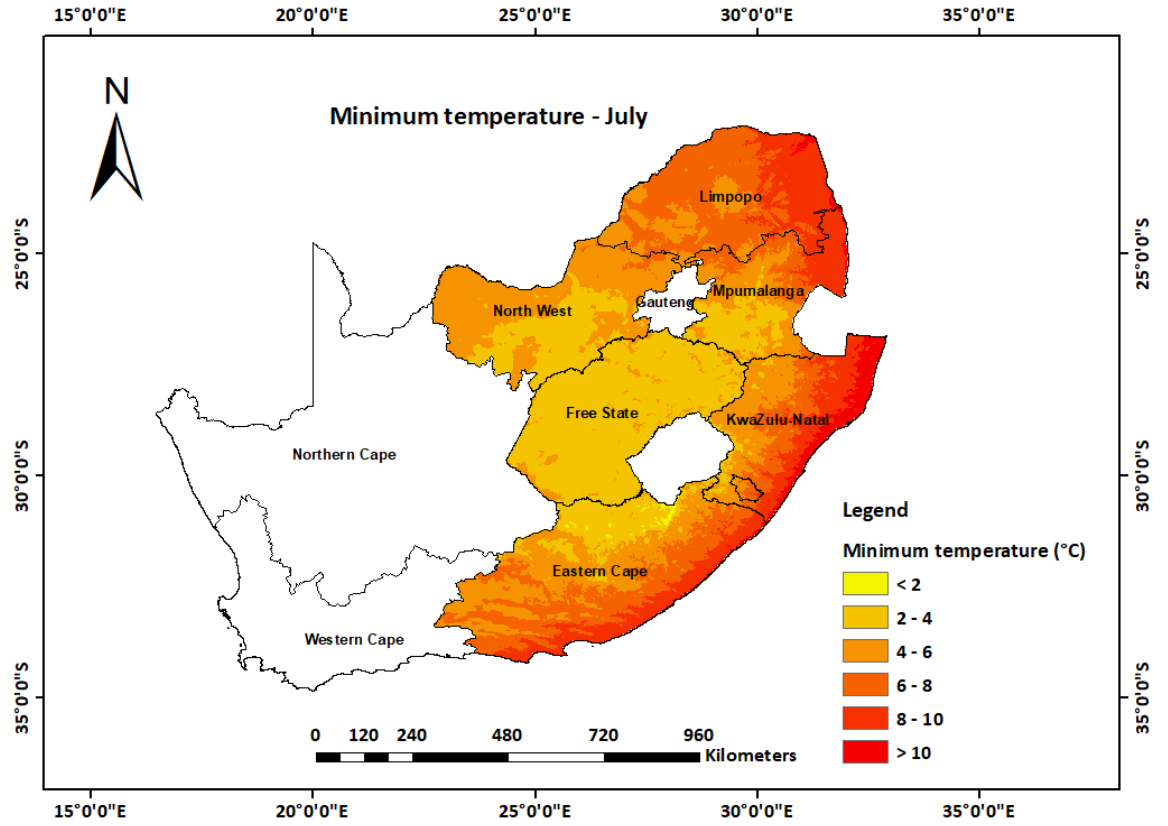

ARC • LNR
Excellence in Research and Development

top EMPLOYER South Africa 2025
FOR A BETTER WORLD OF WORK

Piloting small-scale Biodigesters in South Africa

Study sites


N
W
E
S
LP (6)
NW (6)
MP (10)
FS (6)
KZN (10)
EC (6)
0 100 200 400 600 800
Kilometers
Legend
Selected provinces
South Africa


15°0'0"E
20°0'0"E
25°0'0"E
30°0'0"E
35°0'0"E
25°0'0"S
30°0'0"S
35°0'0"S
N
Minimum temperature - July
Limpopo
North West
Gauteng
Mpumalanga
Free State
KwaZulu-Natal
Northern Cape
Eastern Cape
Western Cape
0 120 240 480 720 960
Kilometers
Legend
Minimum temperature (°C)
< 2
2 - 4
4 - 6
6 - 8
8 - 10
> 10

Perceived Benefits

- Reduced GHG emissions from manure management, deforestation and electricity use
- Reduced fuel costs and indoor air pollution.
- Time savings for women and children.
- Year-round vegetable production.
- Improved soil fertility from bio-digestate.
- Higher vegetable yields & reduced chemical fertilizer use.
- Improved nutrition and dietary diversity.
- Income generation from selling surplus produce.

Challenges

- Limited technical capacity for maintenance.
- Variable access to cow dung and water.
- Cultural preferences for traditional fuels.
- Influence of gender roles and local champions.

-Limited awareness and understanding of biogas technology.

-Availability of water leading to buying water or use boreholes.

-Availability and access to feedstock limiting adoption - cows not returning home on some days.

-Stove blockages.

-Water in the gas pipe

-Overflowing digesters outlets

Drivers for adoption ..

- Access to clean and affordable cooking fuel minimizing health issues
- Reduced deforestation and soil erosion
- Food security
- Rural livelihoods

Lessons learnt &Recommendations for scaling

- Importance of community involvement and ownership.
- Need for robust training and support programs.
- Integration of biogas projects with other sustainable agricultural practices.
- Move the narrative beyond energy and cooking to bring in the benefits from other value addition available from using a micro-digester especially waste management and fertiliser from digestate.
- Integrate biogas with water and horticulture solutions.
- Provide gender-responsive training and capacity building.
- Develop local service ecosystems (technicians, spare parts).
- Design financing models (subsidies, microcredit).
- Encourage participatory monitoring for sustainability.
- Long-term operational support, and focusing on value-added products like fertilizer, biogas bottling

Enablers for abatement

- Subsidies and Incentives are required for adoption of mitigation strategies
- Accessible local and international carbon markets can improve mitigation initiatives
- Increase in awareness, capacity building and extension is required
- Research and data platforms

Conclusions

- Enteric fermentation is a key methane producing subcategory
- It is key that agricultural mitigation does not compromise food security
- Agriculture still present high cost-effective mitigation options
- Enabling environment is required for adoption of mitigation strategies in the agriculture sector

Thank you

Mokhele Moeletsi

ARC-NRE

Contacts: moeletsim@arc.agric.za

+27 12 310 2537