FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

ESTIMATING METHANE EMISSIONS FROM DJALLONKE SHEEP USING GREENFEED IN BURKINA FASO

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Plan

- **Introduction (3/3)**
- **Objective (1/1)**
- **Materiels & Methods (4/4)**
- **Results and Discussion (4/4)**
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Introduction (1/3)

- Global climate change (GCC) is a main concern and manifestations are becoming more and pronounced
- Impact for Africa : 22% drop in crop yield by the year 2050 (IPCC, AR5 (2014); AR6 (2021))
- Global effort against Climate change is vital
- GCC is primarily caused by greenhouse gas (GHG) emissions (IPCC, 2013) : CO_2, CH_4 and NO_2

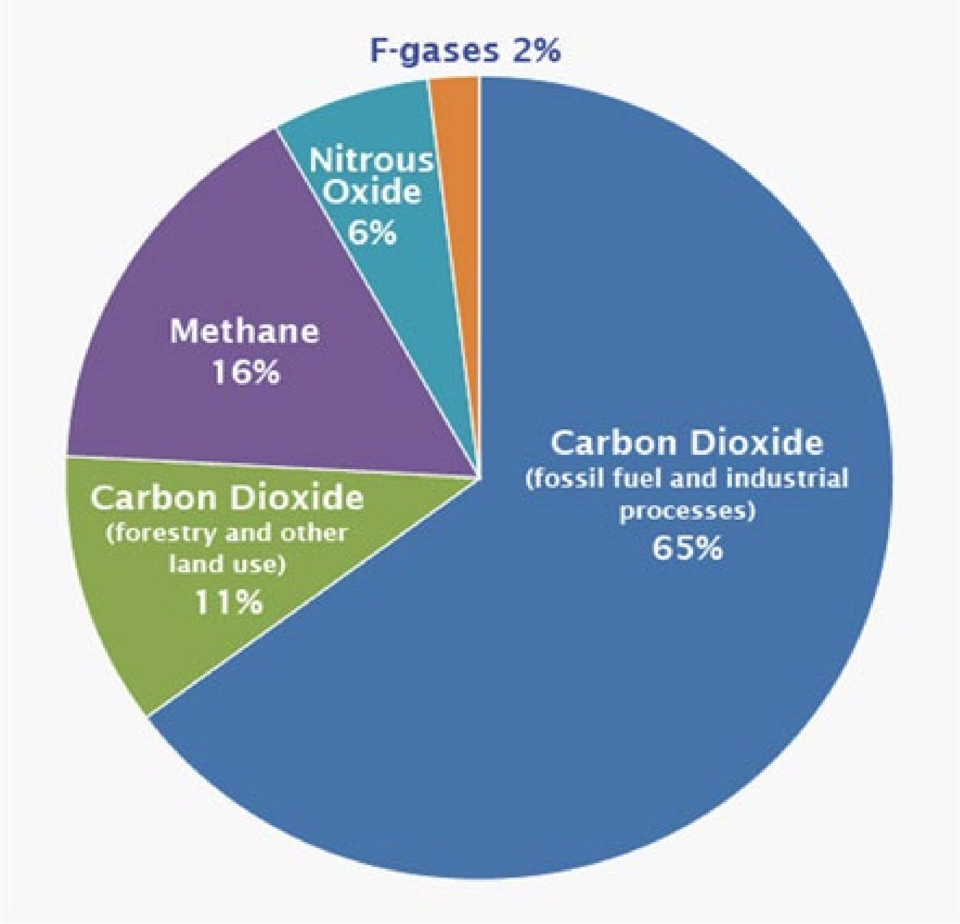

Figure 1: Major GHG and contributions by various sectors (Zaman et al., 2021)

Introduction (2/3)

- Global effort against Climate Change : GHG emission needs to be reduced

Why enteric CH_4 emissions are of major importance in the global effort against climate change?

- CH4 contributes significantly to global GHG emissions : estimated 14% of worldwide GHG (Tubiello et al., 2014)
- Global Warming Potential (GWP) : 28 times that of carbon dioxide over a 100-year period (Kebreab and Fouts, 2021)
- Emissions rose more than 50% in the last 60 years and are expected to continue rising (FAO, 2017)
- Negative impact on productivity : losses to the animal of 3 –12% of digested energy (Johnson and Johnson, 1995)

Introduction (3/3)

- It's crucial to measure enteric CH4 emissions , to develop a robust inventory or to develop strategies

- Considerable research in accurately predicting enteric methane in ruminant production systems, in developing countries:

  - little is known of Sub-Saharan Africa (SSA) :
  - Mainly focus on cattle
  - However, effectiveness of the strategy is more likely to differ between ruminant types (Gastelen et al., 2019)

→ Paucity of data for Small Ruminants (SR) which contributes about 6.5% of the world emissions

Few data available : direct quantification methods are needed for more accuracy in CH4 emissions (Ndao et al., 2018).

Objective

- Make accurate data available on enteric CH4 emissions of SR in west Africa
- Enteric methane emissions of Djallonke sheep
- Effect of feed energy concentration on enteric CH4 emissions

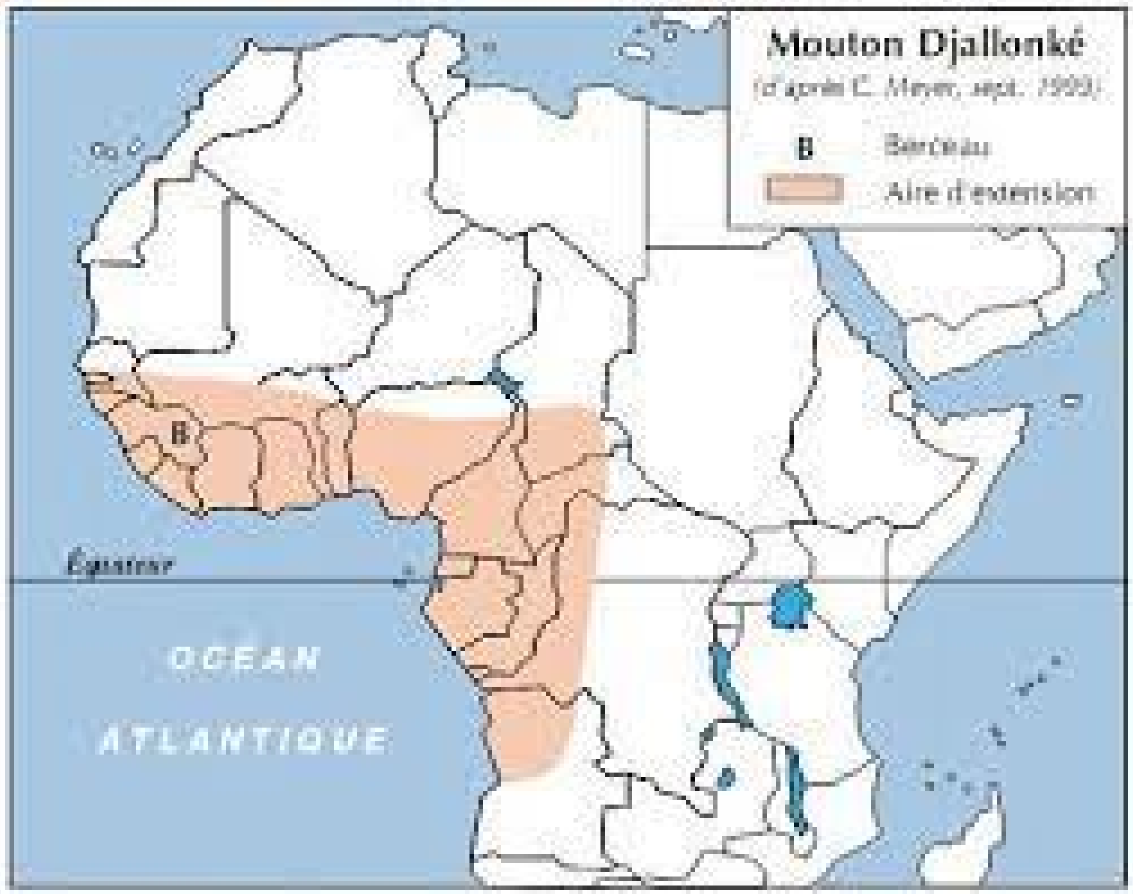

Figure 2: Geographical distribution of Djallonke sheep in Africa (Meyer, 2002).

Materials & Methods (1/4)

✓ **GreenFeed technology to directly measure emissions**

- One of the 3 main measurement techniques for CH_4 inventories Respiration Chambers (RC), the Sulfur HexaFluoride (SF6) tracer (Hristov et al., 2018).

- Its an automated head-chamber system, using bait to encourage voluntary visit (3 to 7 min), emissions detected by non-dispersive near-infrared analyzer of breath spot sampled

- Data accuracy : confirmed by several authors (Hristov et al., 2018; Huhtanen et al., 2019; McGinn et al., 2021).

- 1st use of GF for SR in Africa

Materiels & Methods (2/4)

✓ **Sites description, treatments and experimental design**

- Farako-Bâ's Research Station: southwestern region of BF,South Sudanese's climate , 2 seasons (dry and rainy),Rainfall ranged from 723.7 to 1303.7 mm

- 4 Iso-nitrogenous dietary treatments, formulated based on energy supply :Diet 1=Maintenance(M), Diet 2= M*1.25, Diet 3= M*1.5 and Diet 4=M*1.75

- 4×4 Latin square design, one week's data collection per period Hristov et al. (2015) and Martin et al. (2020).

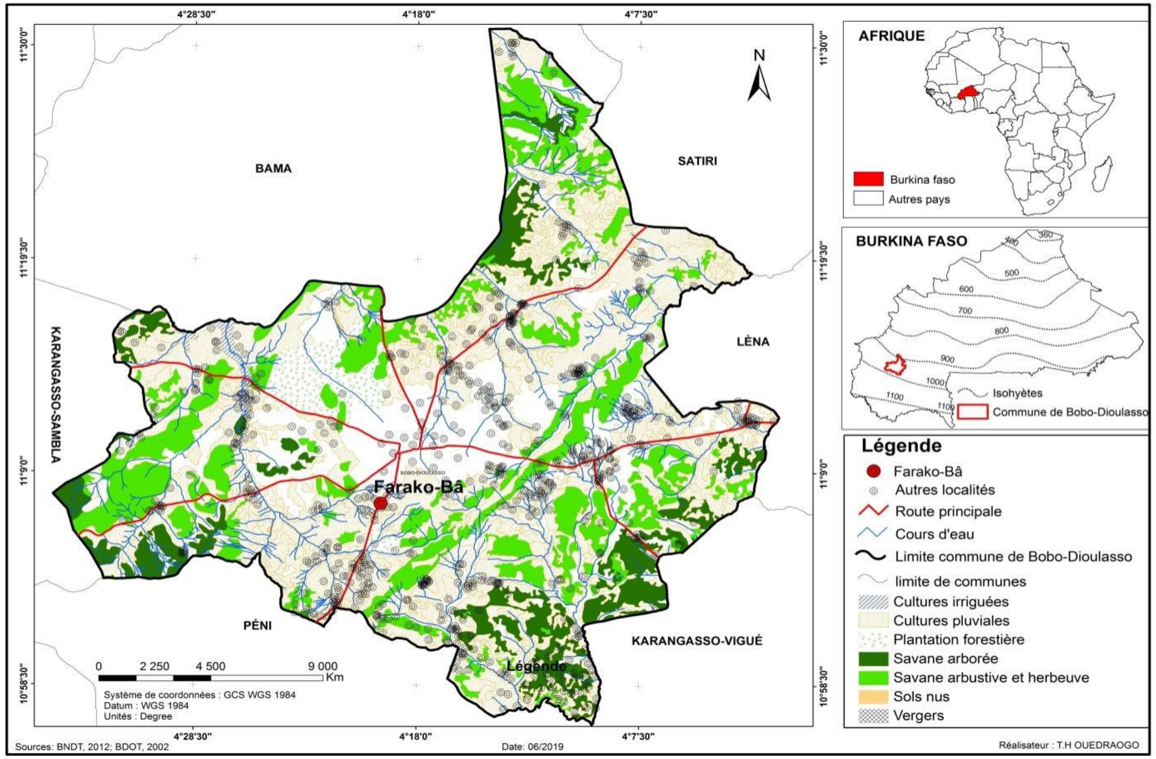

Figure 3: Geographical location of Farako-Bâ's Research Station (Ouedraogo, 2019)

Materiels & Methods (3/4)

✓ **Animals and trial implementation**

- Sixteen (16) males of Djallonke sheep tagged with RIFD Tag, 8 months old, body weight close to 20 kg, horns have been trimmed

- Covered barn with open sides, 16 metabolic cages, an alleyway and GF unit

- Two weeks' adaptation period to GreenFeed unit and metabolic cages

Materiels & Methods (4/4)

✓ **Data collected and Analyses**

- Feed intake measurement and Animals Performance

- Gas emission measurement : CO_2, H_2 and O_2
Calibration and CO_2 recovery test performed, 2 set of gas emissions recorded per period, 8 measures in a 24 hour feeding cycle, staggered in time over a 3-day period (Hristov, 2015)

- Chemical analyses : Energy (Gross and Metabolizable), Proteins , Fibers, ….

- Statistical analyses : Excel (Microsoft corporation). R (Statistical Sofware).

Results and Discussion (1/4)

✓ **CH4 production**

Average CH_4 production : 18,7 g CH_4 / head / day

Value lower than literature : BW, DMI….

- Pelchen et Peters, 1998 : 22,15 g/day
- Pinares-Patiño et al., 2013: 24.6±3.2 g/day
- Rowe et al., 2019: 24.0±8.3 g/day

CH_4 was significantly different in the treatments except between M1.25 and M1.5, same between M1.5 and M1.75

CH_4 production followed the DM intake
Muetzel and Clark (2015) : DMI explained 80% of CH4 production variation per animal

Mean CH_4 (g/d) in the 4 treatments of the study and comparison between treatments

	Mean	SE	
Maintenance (M)	15.1	1.014	
Maintenance × 1.25 (M1.25)	18.9	0.999	
Maintenance × 1.50 (M1.50)	20.5	0.999	
Maintenance × 1.75 (M1.75)	21.3	1.032	
Contrasts	estimate	SE	P value
M – M1.25	-0.586	0.0934	0.0002
M – M1.50	-1.89	0.0934	<.0001
M – M1.75	-2.97	0.0981	<.0001
M1.25 – M1.50	-1.31	0.0911	0.1863
M1.25 – M1.75	-2.38	0.0959	0.0265
M1.5 – M1.75	-1.07	0.0962	0.7495

Results and Discussion (2/4)

✓ **Relationship between CH4 production and Dry Matter Intake**

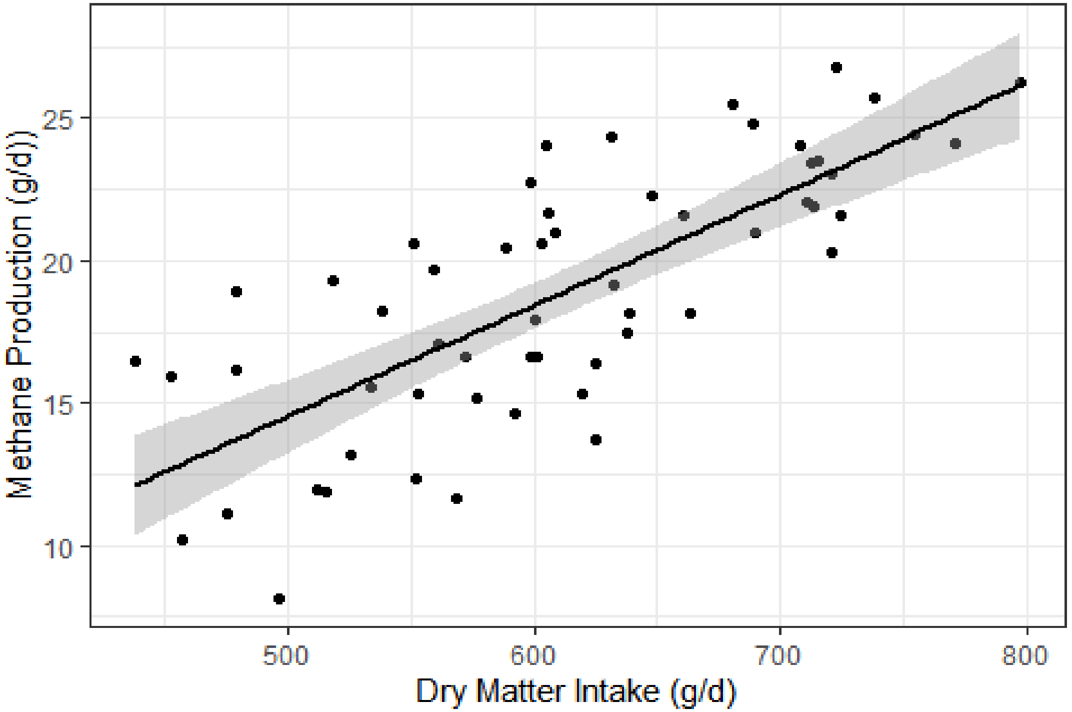

Figure 4: Linear relationship between Methane production and Dry matter intake

- Linear increase in CH_4 emissions as a function of dry matter intake

Ellis et al. (2007 → **DMI is a key driver of CH4**

Results and Discussion (3/4)

Comparison of gas exchange, intakes of dry matter (DMI), metabolizable energy (MEI) and gross energy intake (GEI)

Item (units)		Treatment*			
		M	M1.25	M1.5	M1.75
CO_2	(g/day)	586^{a}	651^{bc}	689^{c}	759^{d}
O_2	(g/day)	434^{a}	478^{ab}	514^{b}	557^{bc}
CH_4	(g/day)	15.1^{a}	18.9^{bc}	20.5^{cd}	21.3^{d}
DMI	(g/day)	541^{a}	612^{bc}	632^{c}	665^{d}
GEI	(MJ/d)	9.78^{a}	11.10^{bc}	11.41^{cd}	11.80^{d}
MEI	(MJ/d)	4.20^{a}	4.79^{b}	6.10^{c}	7.17^{d}
CH_4/GEI	(g/day)	2.38	2.07	1.99	1.92

- Linear decrease of CH_4 emitted per unit of energy consumed

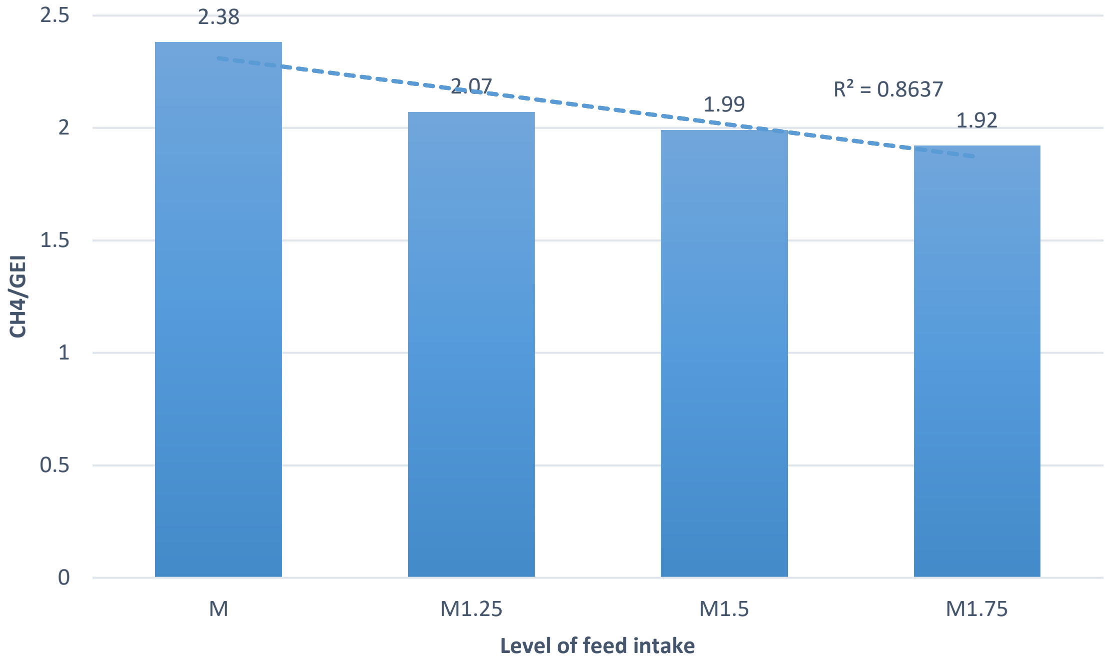

Figure 5 : Linear decrease of CH_4 emitted per unit of energy consumed

Results and Discussion (4/4)

✓ CH_4 conversion factor (CH_4 /GEI ; Ym)

Descriptive statistics of measured and calculated data

	Mean	Median	SD	Minimum	Maximum
Dry matter intake (g/d)	611	605	88.1	438	797
Gross energy intake (MJ/d)	**11.0**	10.9	1.56	7.98	14.1
Metabolizable energy intake (MJ/d)	5.50	5.36	1.33	3.54	8.55
CH_4 production (g/d)	**18.9**	19.1	4.53	8.15	26.8
CO_2 production (g/d)	668	670	131	422	1000
O_2 consumption (g/d)	494	478	97.4	291	719
Bodyweight (kg)	22.9	22.4	3.50	16.6	30.1
Adjusted MEI (MJ/kg $BW^{0.75}$)	0.532	0.520	0.117	0.362	0.726
Adjusted HP (MJ/kg $BW^{0.75}$)	0.688	0.686	0.092	0.494	0.871

- Methane energy accounted for **9.6%** of the GE

High compare to **7.4%** (Zhao et al., 2016).

the amount and quality of forage

NDF: 75.1% VS 39.2% (Zhao et al., 2016).

High NDF → high CH_4 emissions: Niu et al., 2018

Conclusion

- Valuable data to estimate enteric CH_4 emissions from Djallonke sheep
- Valuable data on enteric CH_4 Conversion Factor (CH4/GEI)
- Contribute calculating national inventory of emissions in West Africa

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