ФВМ
Факултет ветеринарске медицине
FVM Faculty of Veterinary Medicine

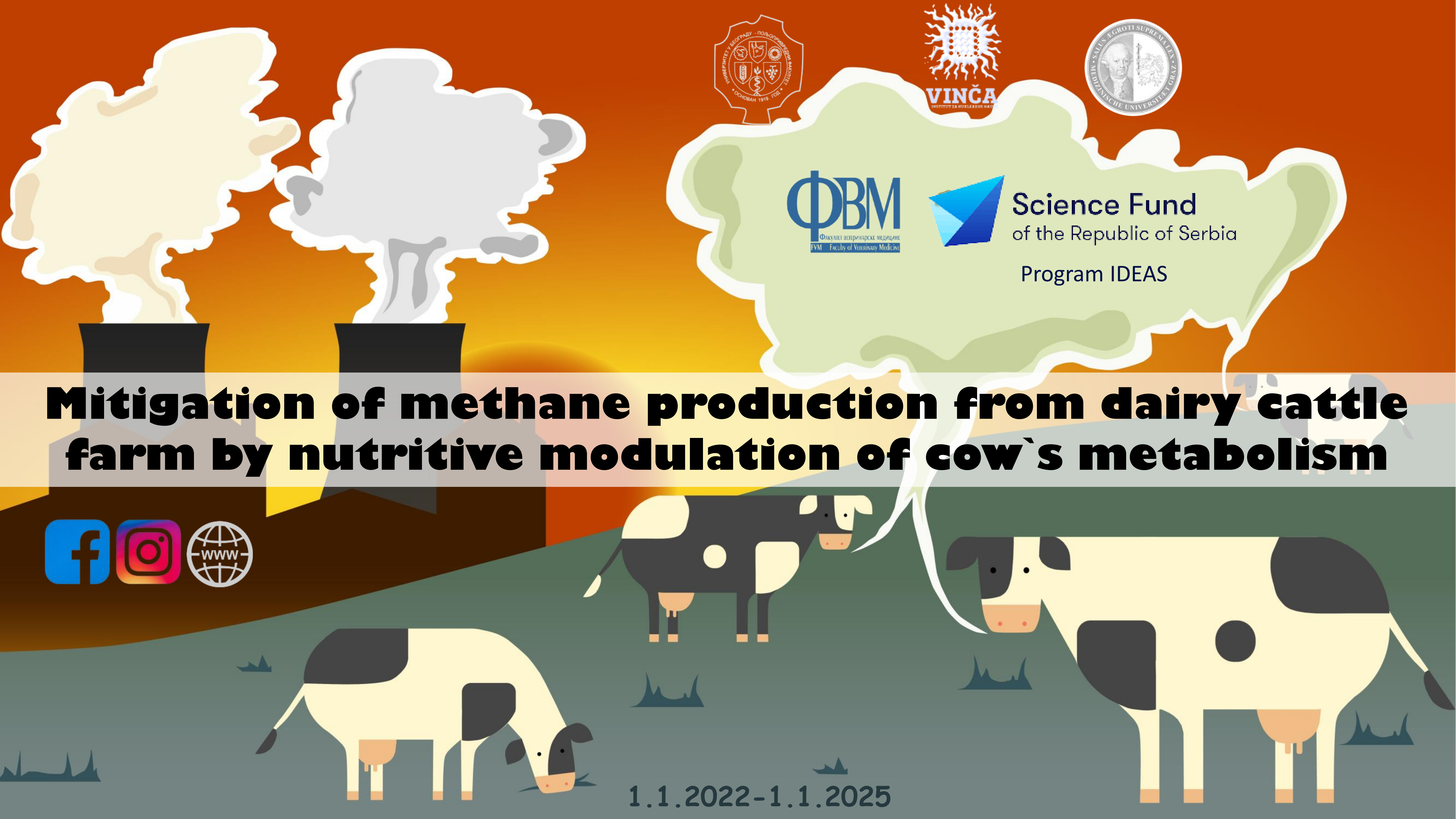
Science Fund
of the Republic of Serbia

Program IDEAS

CH_4

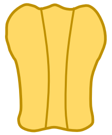
Danijela Kirovski

MODULATION OF COWS METABOLISM AS A TOOL FOR THE ENVIRONMENTALLY FRIENDLY CATLLE PRODUCTION



VINČA
ФВМ
Факултет ветеринарске медицине
FVM Faculty of Veterinary Medicine
Science Fund
of the Republic of Serbia
Program IDEAS
Mitigation of methane production from dairy cattle farm by nutritive modulation of cow`s metabolism
www
1.1.2022-1.1.2025

Our team has investigated:



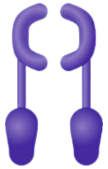
GLUT4

pIRS-1 Ser^{307}

pAkt Ser^{473}

Our publications

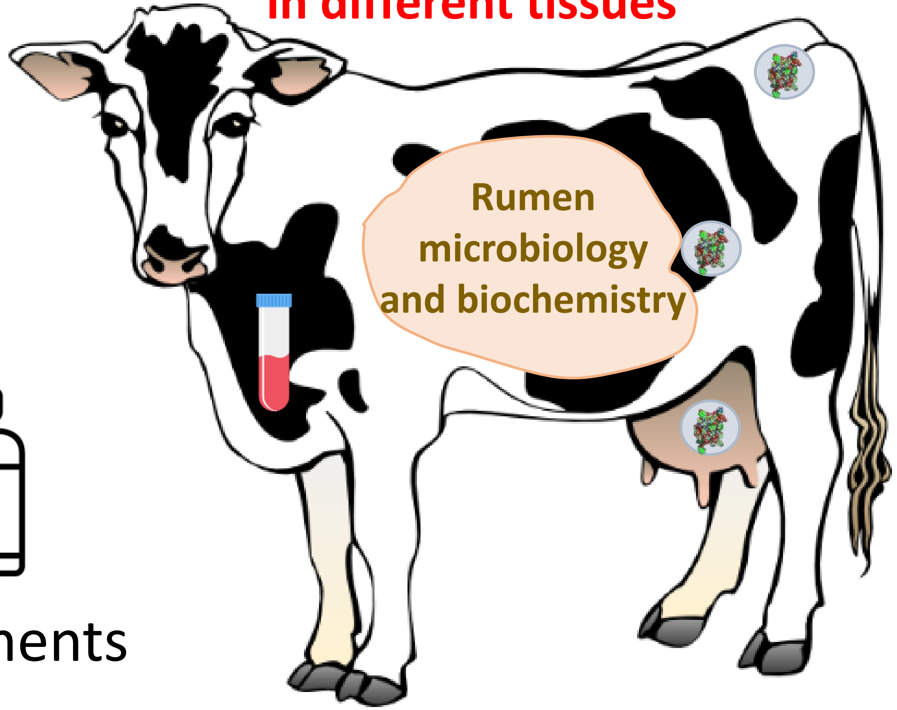
SREBP-1

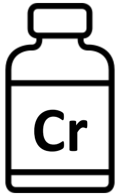


IR

Signal molecules in different tissues

Biopsy





Supplements

J. Dairy Sci. 93:3114–3127
doi:10.3168/jds.2009-2743

Regulation of protein synthesis in mammary glands of lactating dairy cows by starch and amino acids

A. G. Rius,*[1] J. A. D. R. N. Appuhamy,* J. Cyriac,* D. Kirovski,† O. Becvar,‡ J. Escobar,§ M. L. McGilliard,* B. J. Bequette,# R. M. Akers,* and M. D. Hanigan*[2]
*Department of Dairy Science, Virginia Polytechnic Institute and State University, Blacksburg 24061
†Faculty of Veterinary Medicine, University of Belgrade, Belgrade, Serbia
‡Department of Large Animal Clinical Sciences, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Polytechnic Institute and State University, Blacksburg 24061
§Department of Animal and Poultry Science, Virginia Polytechnic Institute and State University, Blacksburg 24061
#Department of Animal and Avian Sciences, University of Maryland, College Park 20742

ABSTRACT

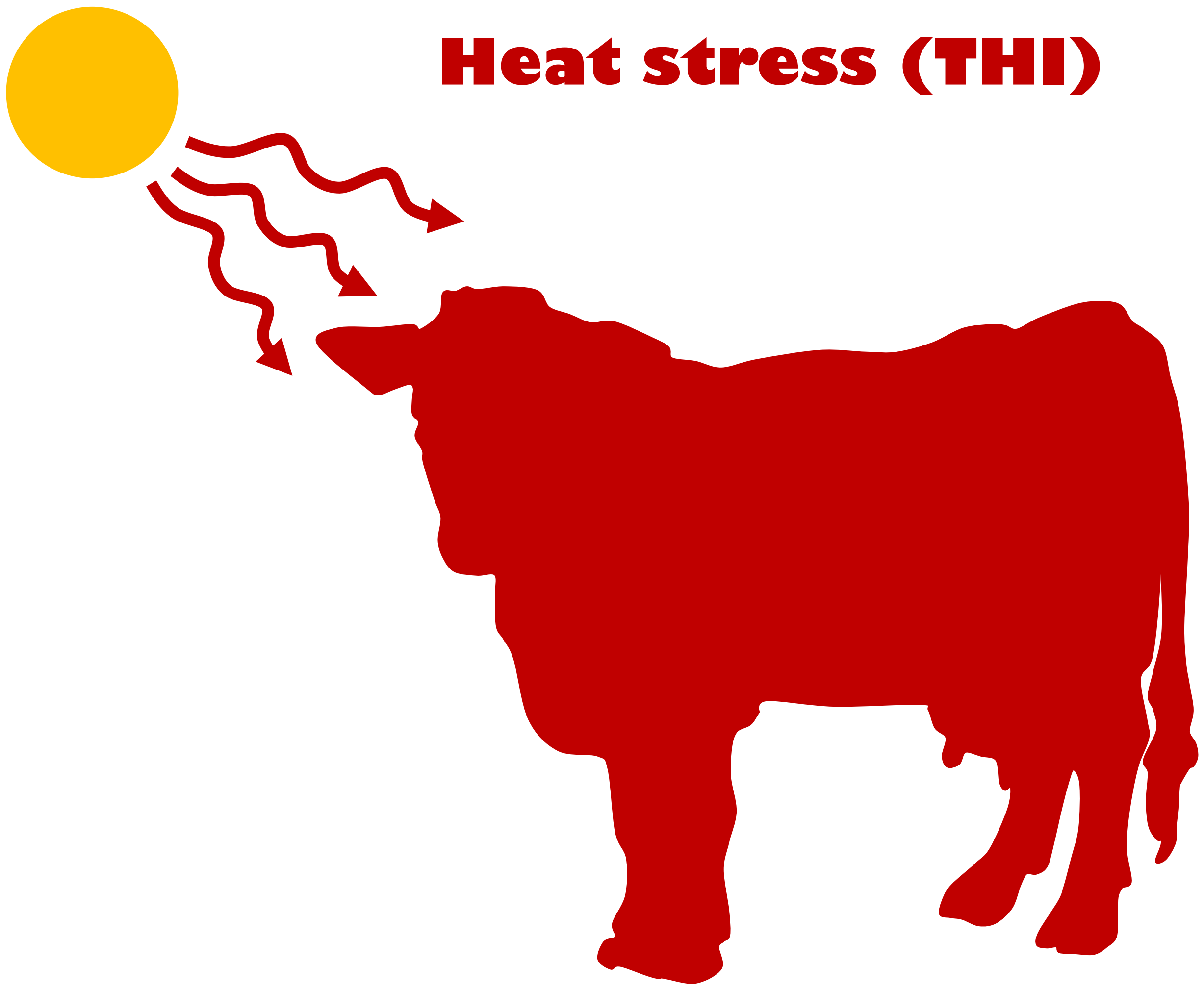
The objective of this study was to evaluate local molecular adaptations proposed to regulate protein synthesis in the mammary glands. It was hypothesized that AA and energy-yielding substrates independently regulate AA metabolism and protein synthesis in mammary glands by a combination of systemic and local mechanisms. Six primiparous mid-lactation Holstein cows with ruminal cannulas were randomly assigned to 4 treatment sequences in a replicated incomplete 4 × 4 Latin square design experiment. Treatments were abomasal infusions of casein and starch in a 2 × 2 factorial arrangement. All animals received the same basal diet (17.6% crude protein and 6.61 MJ of net energy for lactation/kg of DM) throughout the study. Cows were restricted to 70% of ad libitum intake and abomasally infused for 36 h with water, casein (0.86 kg/d), starch

Infusions of starch increased plasma concentrations of glucose, insulin, and insulin-like growth factor-I. Starch infusions increased phosphorylation of ribosomal protein S6 and endothelial nitric oxide synthase, consistent with changes in milk protein yields and plasma flow, respectively. Phosphorylation of the mammalian target of rapamycin was increased in response to starch only when casein was also infused. Thus, cell signaling molecules involved in the regulation of protein synthesis differentially responded to these nutritional stimuli. The hypothesized independent effects of casein and starch on animal metabolism and cell signaling were not observed, presumably because of the lack of a milk protein response to infused casein.
Key words: amino acid, cell signaling, mammary gland

INTRODUCTION

Our team has investigated:

Heat stress (THI)



Our publications

International Journal of Biometeorology (2018) 62:1097–1108
https://doi.org/10.1007/s00484-018-1514-6

ORIGINAL PAPER

CrossMark

Influence of different seasons during late gestation on Holstein cows' colostrum and postnatal adaptive capability of their calves

Julijana Trifković[1] · Ljubomir Jovanović[2] · Miloje Đurić[3] · Snežana Stevanović-Đorđević[2] · Svetlana Milanović[2] · Miodrag Lazarević[2] · Željko Sladojević[4] · Danijela Kirovski[2]

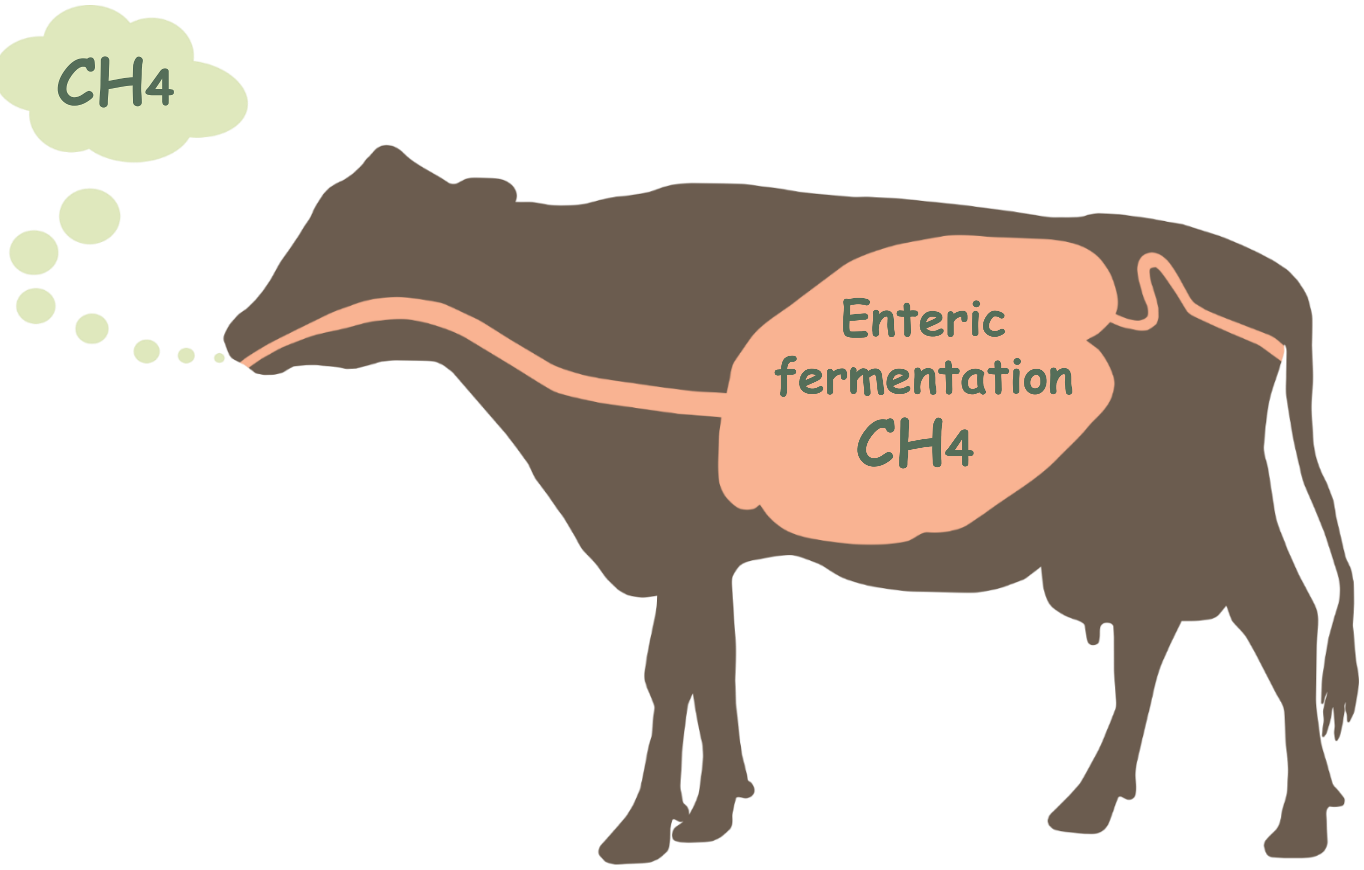
Received: 19 June 2017 /Revised: 25 December 2017 /Accepted: 11 February 2018 /Published online: 26 February 2018

Abstract
Season may affect calves' thermal comfort and behavior, but the data related to the overall influence of seasonal variations on dams' colostrum and postnatal adaptive capability of calves are limited. The aim of this study was to measure the effects of a 49-day-long low air temperature (LAT) season (5.20 ± 0.46 °C mean air temperature) and a 53-day-long high air temperature (HAT) season (27.40 ± 0.39 °C mean air temperature) on dams' colostrum quality and physiological, biochemical, hormonal, and oxidative stress parameters of their calves during the first 7 days of life. The dams' colostrum was sampled at 2, 14, and 26 h after calving, before feeding of their calves. Calves' blood samples were taken before the first colostrum intake and on days 1, 2, 3, and 7 of life. Calves' physiological parameters were measured on days 0 and 7. HAT season significantly reduced the quality of dams' colostrum. The ingestion of the low-quality colostrum, combined with the thermal discomfort during HAT season, probably provoked impaired physiological, biochemical, hormonal, and oxidative stress parameters in samples taken from the post-colostral calves. Additionally, intravenous glucose tolerance test was performed on day 7, which suggested an enhanced insulin response in HAT season calves. This study highlights the importance of adequate supporting strategies for the care of the late gestation cows and postnatal calves during the HAT season.

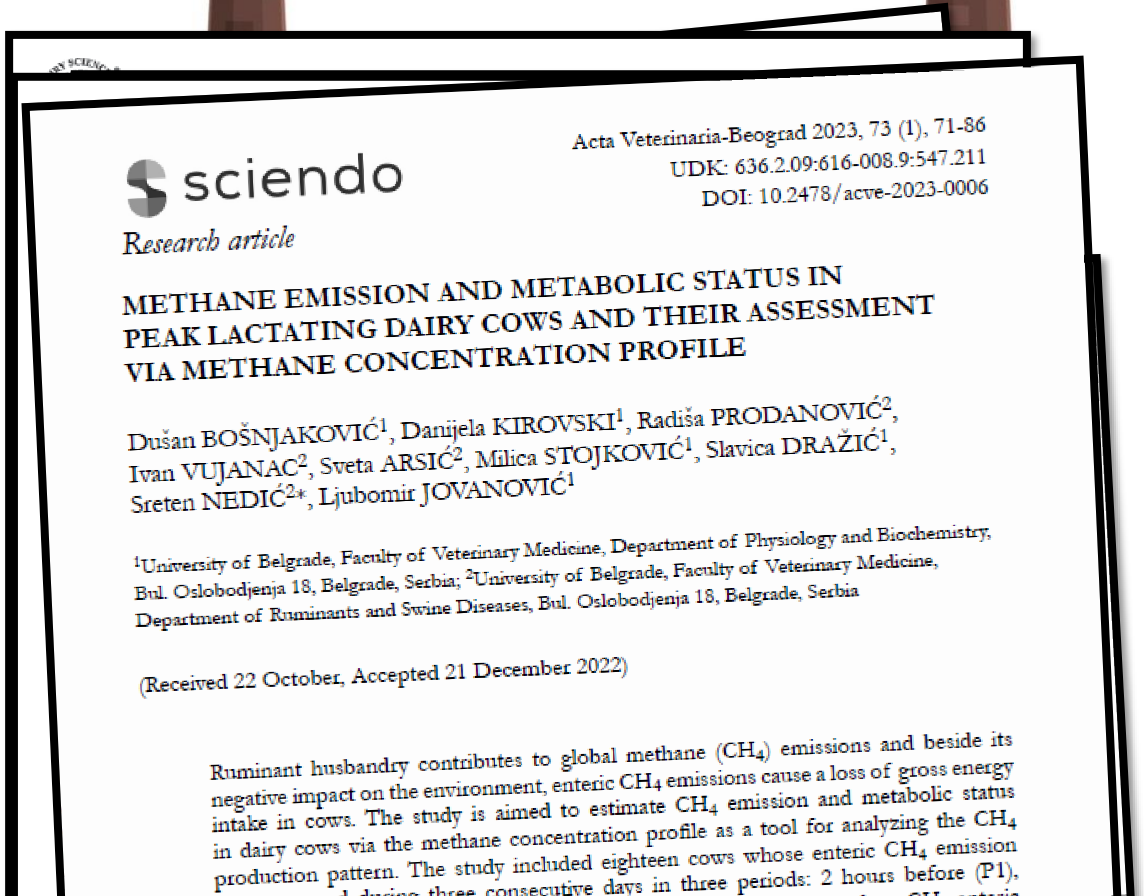
Keywords Seasons · Dairy cattle · Colostrum · Postnatal adaptive capability

Our team has investigated:

Enteric methane emissions



Our publications


Acta Veterinaria-Beograd 2023, 73 (1), 71-86
UDK: 636.2.09:616-008.9:547.211
DOI: 10.2478/acve-2023-0006

sciendo

Research article

METHANE EMISSION AND METABOLIC STATUS IN PEAK LACTATING DAIRY COWS AND THEIR ASSESSMENT VIA METHANE CONCENTRATION PROFILE

Dušan BOŠNJAKOVIĆ[1], Danijela KIROVSKI[1], Radiša PRODANOVIĆ[2], Ivan VUJANAC[2], Sveta ARSIĆ[2], Milica STOJKOVIĆ[1], Slavica DRAŽIĆ[1], Sreten NEDIĆ[2]*, Ljubomir JOVANOVIĆ[1]

[1]University of Belgrade, Faculty of Veterinary Medicine, Department of Physiology and Biochemistry, Bul. Oslobodjenja 18, Belgrade, Serbia; [2]University of Belgrade, Faculty of Veterinary Medicine, Department of Ruminants and Swine Diseases, Bul. Oslobodjenja 18, Belgrade, Serbia

(Received 22 October, Accepted 21 December 2022)

Ruminant husbandry contributes to global methane (CH_4) emissions and beside its negative impact on the environment, enteric CH_4 emissions cause a loss of gross energy intake in cows. The study is aimed to estimate CH_4 emission and metabolic status in dairy cows via the methane concentration profile as a tool for analyzing the CH_4 production pattern. The study included eighteen cows whose enteric CH_4 emission ... during three consecutive days in three periods: 2 hours before (P1),

GUEST APPEARANCES IN THE MEDIA

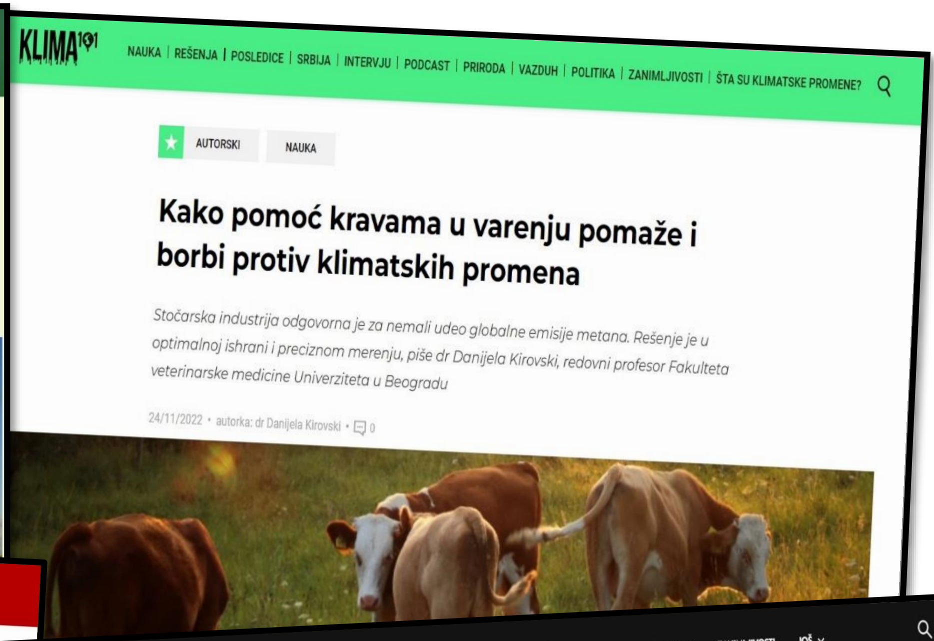

agroklub
(R)Evolucija poljoprivrede

AGROKLUB SRBIJA
POLJOPRIVREDNI PORTAL
Poljoprivredne teme
Ratarstvo
Stočarstvo
Voćarstvo
Vinogradarstvo
Povrtarstvo
Ukrasno i lekovito bilje
Ribarstvo
Pčelarstvo
Prehrambena industrija
Eko proizvodnja
Novosti i dešavanja
Agro Plus

Gde se nalazim? Agroklub.rs » Stočarstvo » Za metan iz buraga krava odgovorna hrana - ali koja?
KRAVE I METAN 03.12.2022. 16:30

Za metan iz buraga krava odgovorna hrana - ali koja?

Stočarska industrija odgovorna je za nemali udeo globalne emisije metana. Rešenje je u optimalnoj ishrani i preciznom merenju.


KLIMA101
NAUKA | REŠENJA | POSLEDICE | SRBIJA | INTERVJU | PODCAST | PRIRODA | VAZDUH | POLITIKA | ZANIMLJIVOSTI | ŠTA SU KLIMATSKE PROMENE?

AUTORSKI NAUKA

Kako pomoć kravama u varenju pomaže i borbi protiv klimatskih promena

Stočarska industrija odgovorna je za nemali udeo globalne emisije metana. Rešenje je u optimalnoj ishrani i preciznom merenju, piše dr Danijela Kirovski, redovni profesor Fakulteta veterinarske medicine Univerziteta u Beogradu

24/11/2022 • autorka: dr Danijela Kirovski • 0


BBC NEWS NA SRPSKOM
Početna strana Ukrajina Srbija Balkan Svet Video Najpopularnije

BBC
Prvo mere količinu metana laserskim detektorom

Nauka, životinje i klimatske promene: Tim iz Srbije otkriva kako


NATIONAL GEOGRAPHIC SRBIJA
NASLOVNA ISTORIJA I KULTURA NAUKA PRIRODA PUTOVANJA EKOLOGIJA ŽUTI OKVIR 2022 UGROŽENE VRSTE ZANIMLJIVOSTI JOŠ

Kako promenama u ishrani krava možemo pomoći ovim životinjama u varenju i smanjiti emisije metana?

Stočarska industrija odgovorna je za nemali udeo globalne emisije metana. Rešenje je u optimalnoj ishrani i preciznom merenju, piše dr Danijela Kirovski, redovni profesor Fakulteta veterinarske medicine Univerziteta u Beogradu

NAJNOVIJE
Između istorije i mita: Navodno je ova sprava za mučenje sa oštrim šiljI...

Environment

air, water and soil where people, animals and plants live

Environmental Pollution

any substances in water, soil, or air that degrades the natural quality of the environment; offends the senses; causes a health hazard; or impairs the usefulness of natural resources.

by natural processes or human activity (ANTHROPOGENIC)

Green house gases (GHG) → *GLOBAL WARMING*

CARBONE DIOXIDE

METHANE

NITROGEN OXIDE

HALOCARBONES

...

Sources of Greenhouse Gases

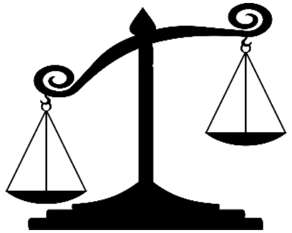
Natural - NOT POLLUTANTS

Production

Elimination

Anthropogenic - ARE POLLUTANTS

Production



Elimination

Greenhouse Effect – Natural Phenomenon

essential for the life on our planet

The average temperature on the Earth is comfortable average 15°C

For the distance of the Earth from the Sun, the average temperature should be - 18°C.

Additional warming

„Greenhouse effect"

Natural phenomenon

Preindustrial period

GHG conc. was 200-280 parts per mil

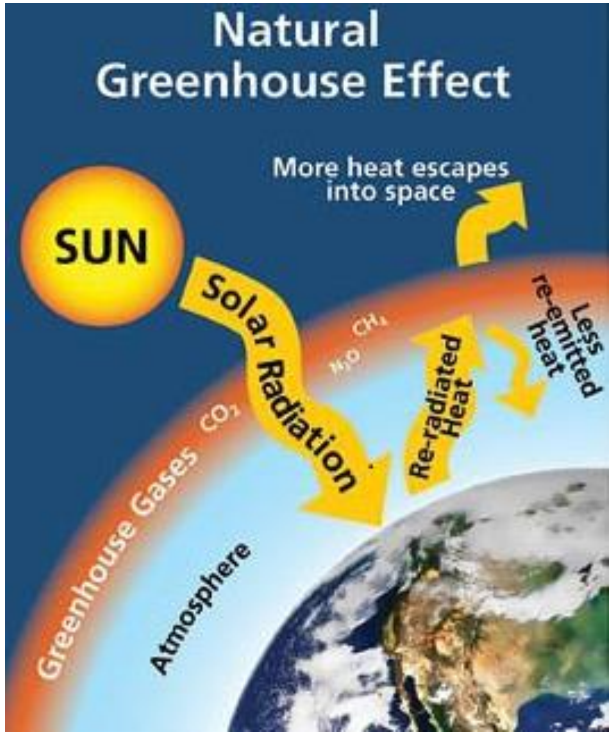
„Grenhouse effect"

Anthropogenic reasons

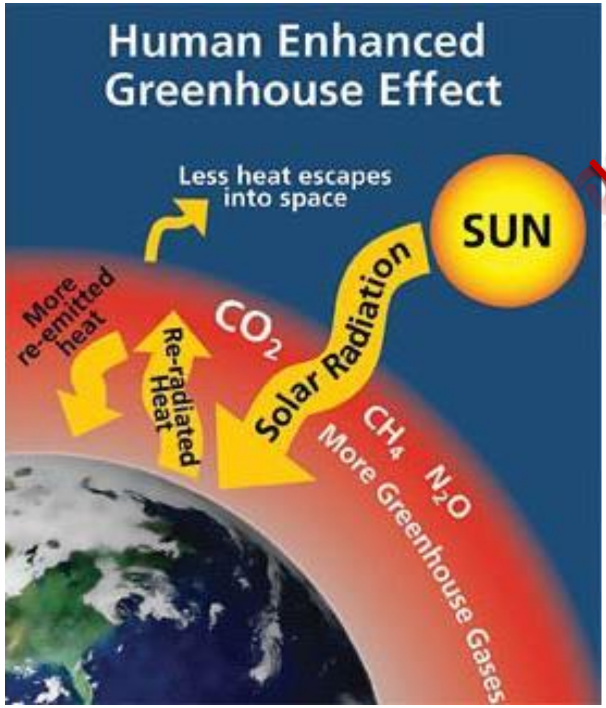
Past 100 years

In 2022 GHG conc. reached more than 420 parts per million

(50% higher than preindustrial level)



„Greenhouse"



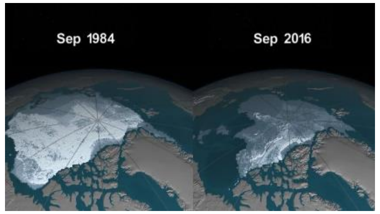
Causing

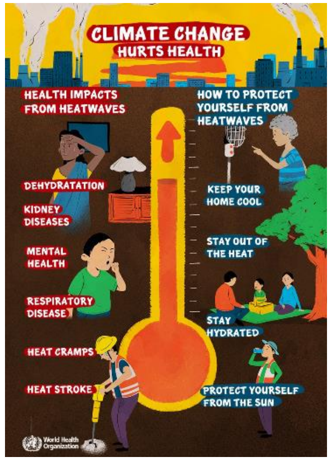
Extra heat to be trapped

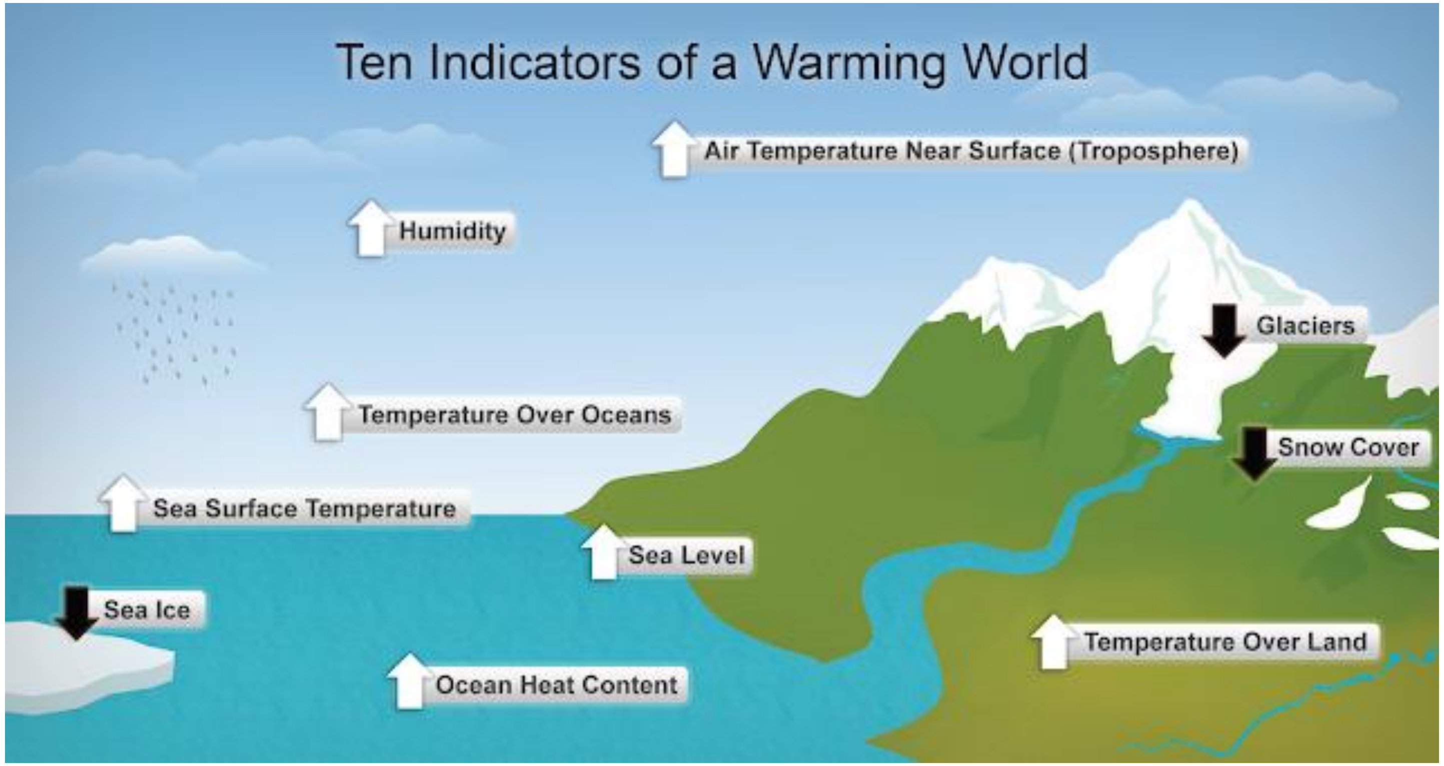
Global temperature to rise

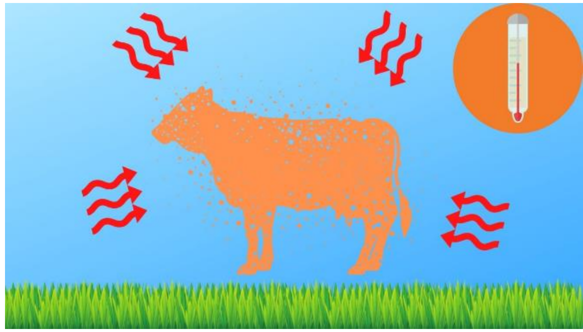
GLOBAL WARMING

INDICATORS OF GLOBAL WARMING









Air temperature increased by 0.8°C in the past 100 years

CLIMATE CHANGE CONFERENCES

Kyoto protokol (1997) : industrialized countries and economies in transition committed that they will limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets (up to an average 5 per cent emission reduction compared to 1990 levels over the five year period 2008–2012).

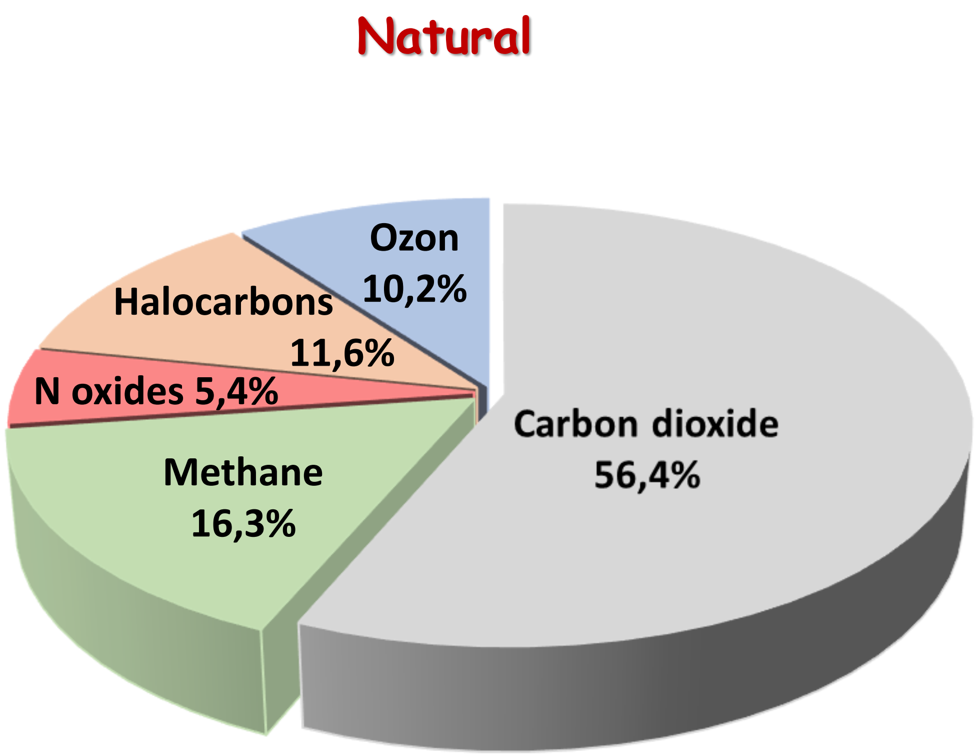
Doha Amendment (2012): agreed to take on commitments in a second commitment period (2013 to 2020)

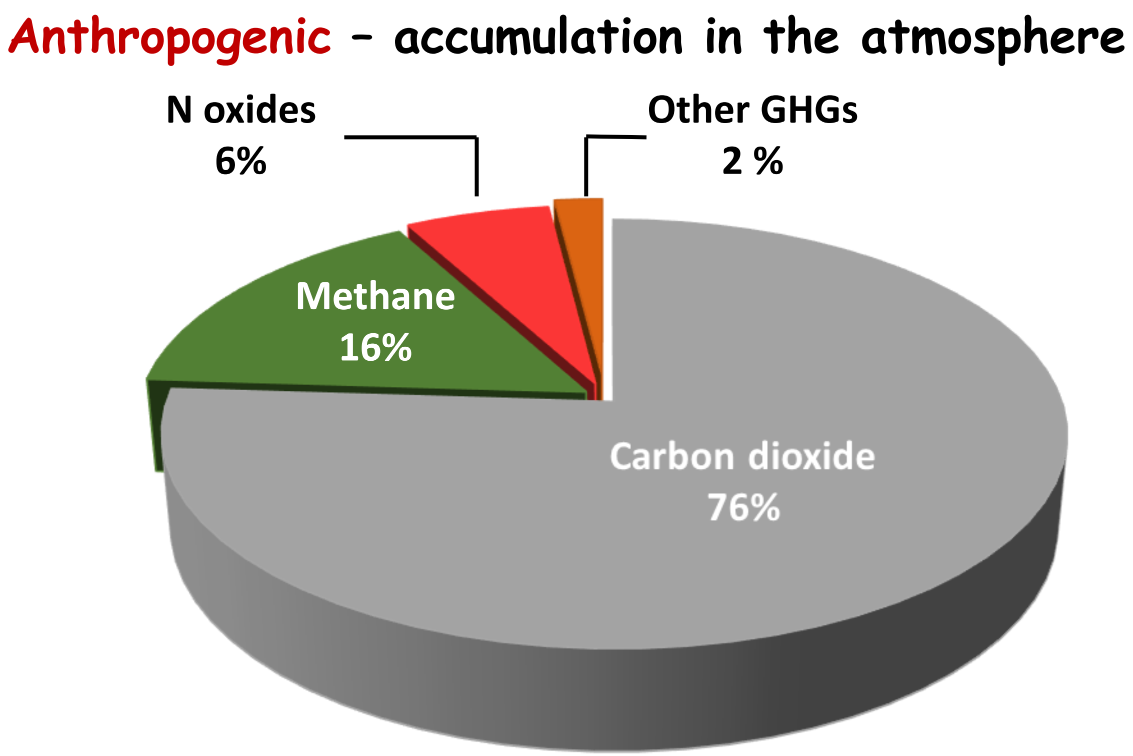
Paris climate conference-COP 21 (2015): Governments agreed a long-term goal of keeping the increase in global temperature well below 2°C above pre-industrial levels and to aim to limit the increase to 1.5°C

26th UN Climate Change Conerence –COP 26 (2020): te reach „net zero“ of GHG emission until 2050.

COP 26 – limit methane emissions by 30% by 2030, compared to 2020 levels.

Presence of GHG in atmosphere

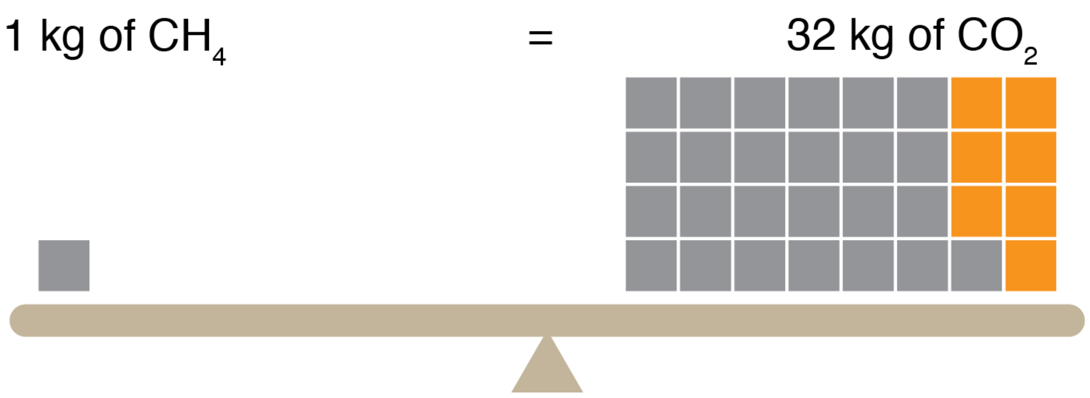


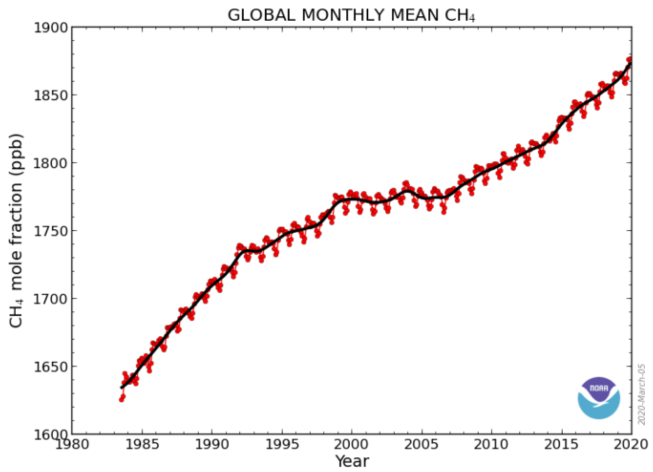


Global warming potential – GWP

A measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO2eq). So, a CO2 eq is a unit used to standardize the climate effects of various GHG.

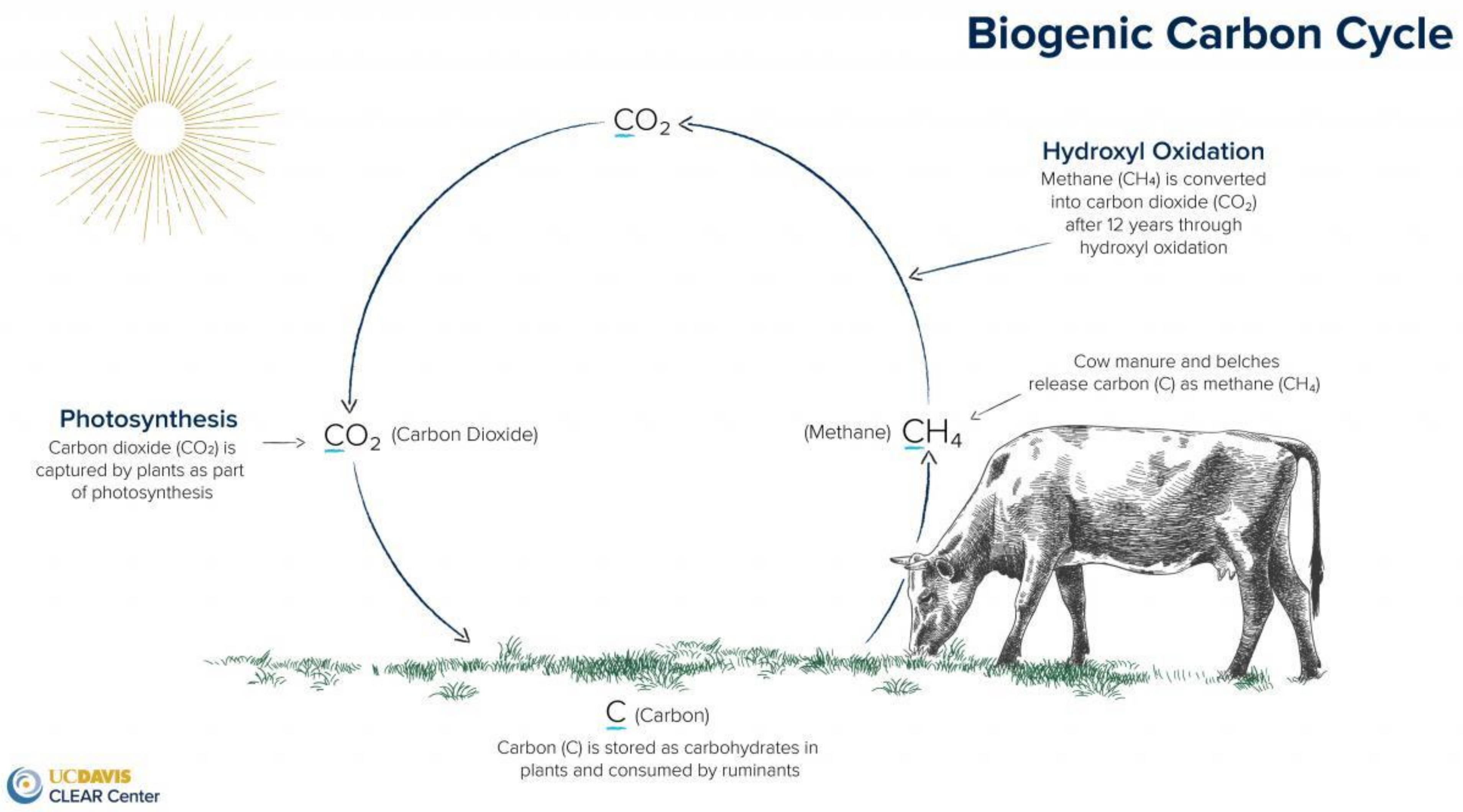
Gas	Half-life (years)	GLOBAL WARMING POTENTIAL		
		GWP_{20}	GWP_{100}	GWP_{500}
CO_2	1000	1	1	1
CH_4	10-12	56	21	6,5
N_2O	120-150	280	310	170



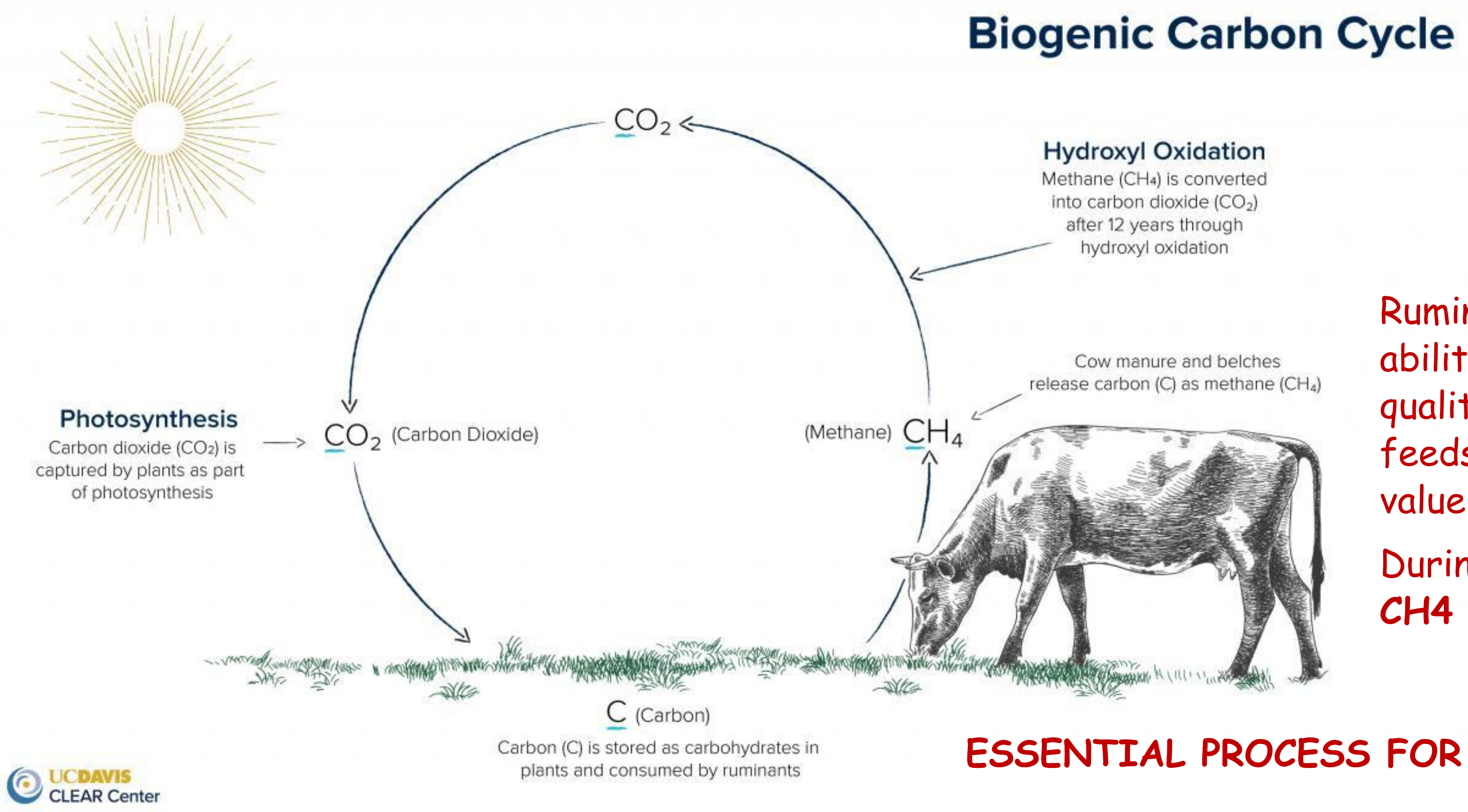


Short-term warming of the earth's surface

COP 26 – reducing methane emissions by 30% by 2030.



Cellulose is the most abundant organic compound in the world (in all grasses, shrubs, crops, and trees). Its content is particularly high in grasses and shrubs found on **marginal lands, which are places where grains and other human edible crops cannot grow**.

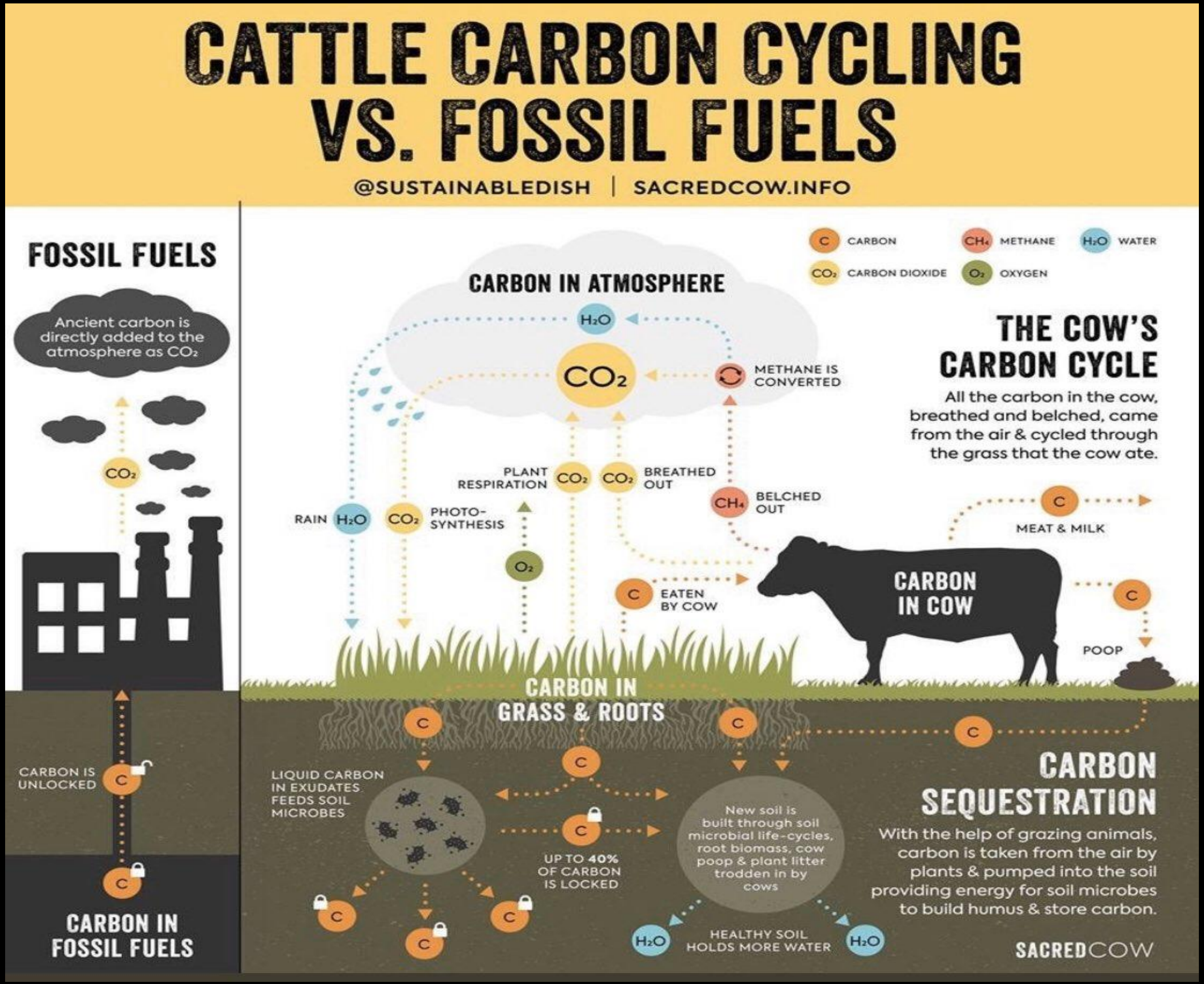


Ruminant livestock have the ability to produce high-quality human food from feedstuffs of little or no value for humans.

During **enteric fermentation CH4** is **produced**.

ESSENTIAL PROCESS FOR HUMAN POPULATION!

Two-thirds of all agricultural land is marginal, full of cellulose dense grasses that are indigestible to humans. Ruminants can digest cellulose.

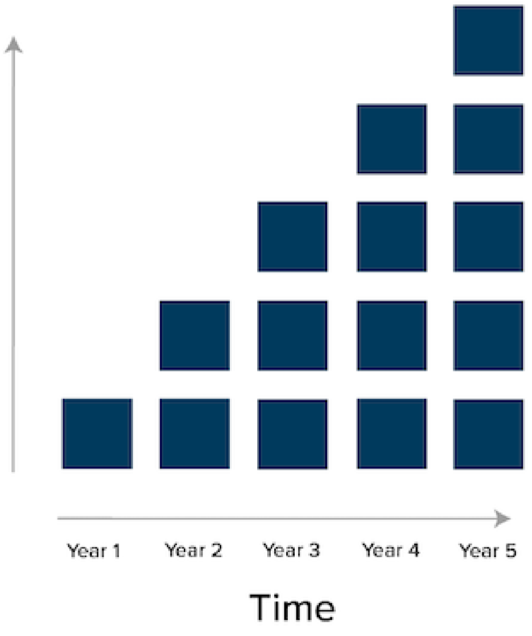


Biogenic carbon (which is present in methane from cows) is going through the cycle and it is very different from **fossil carbon** (which is present mainly in the CO2 burend from fossil fules) which goes through one way street from the bottom up into the air

= Pulse of CO_2

Stock
Gas
Carbon dioxide
(CO_2)

Atmospheric Concentration

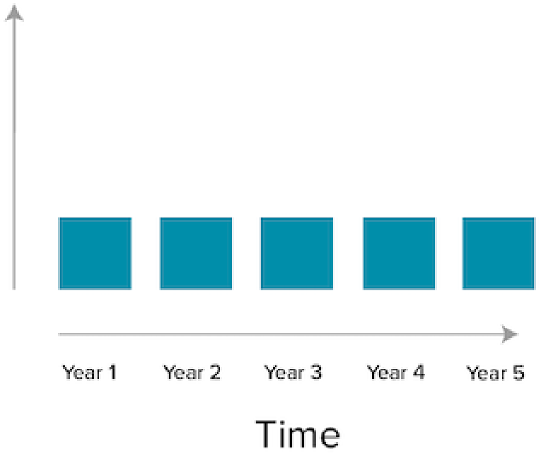


Stock gases will accumulate over time, because they stay in the environment.

= Pulse of CH_4

Flow
Gas
Methane (CH_4)

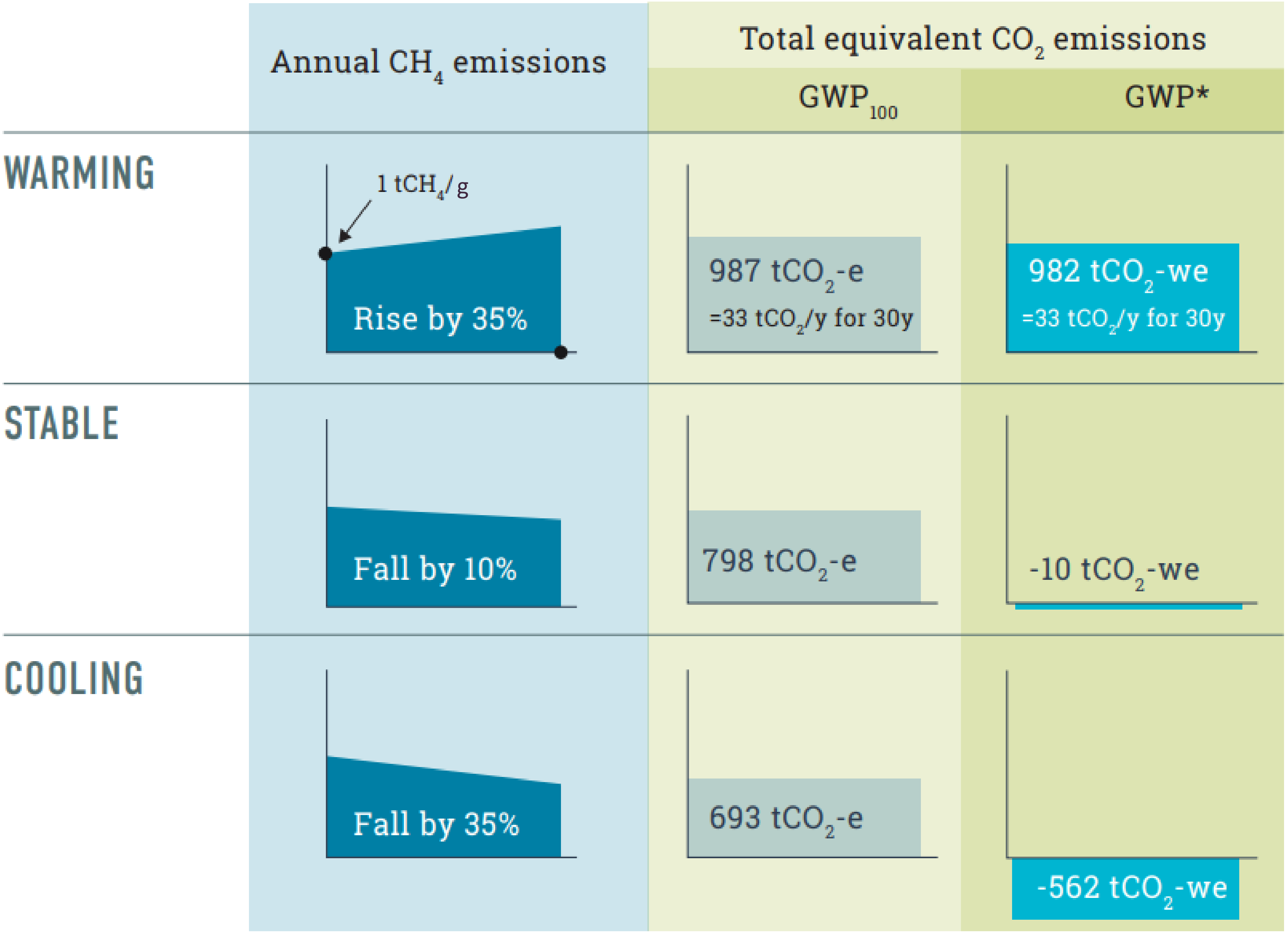
Atmospheric Concentration



Flow gases will stay stagnant, as they are destroyed at the same rate of emission.

UCDAVIS
CLEAR Center

Based on research by Myles R. Allen, Keith P. Shine, Jan S. Fuglestvedt, Richard J. Millar, Michelle Cain, David J. Frame & Adrian H. Macey.
Read more here: https://rdcu.be/b1t7S



If we manage to reduce methane emission from cattle such as with feed supplements we can actually generate short term cooling because we pull carbon out from atmosphere and that induce cooling

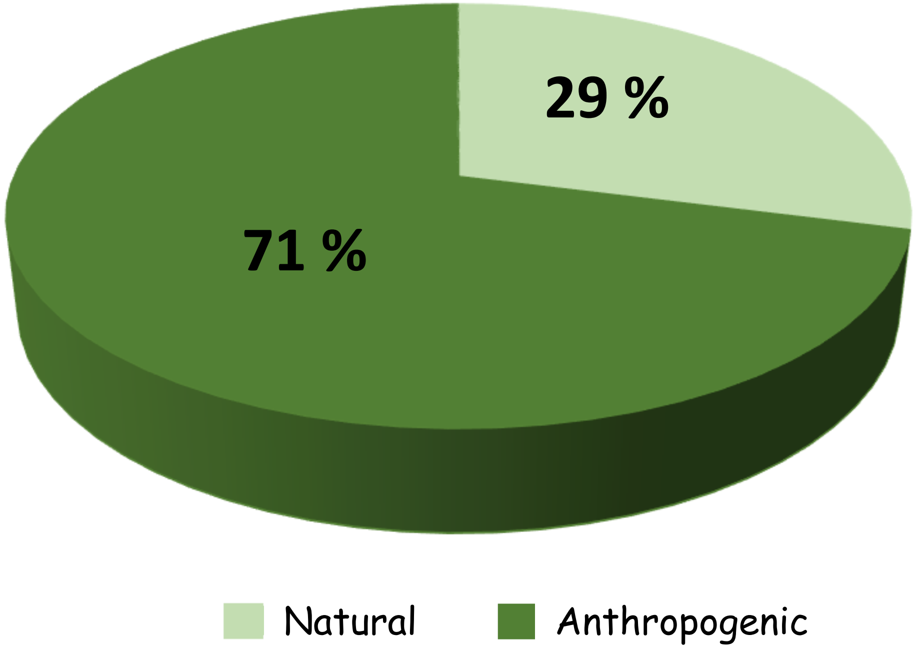
Sources of methane

Oil/gas(12,7%)

Waste (12,4%)

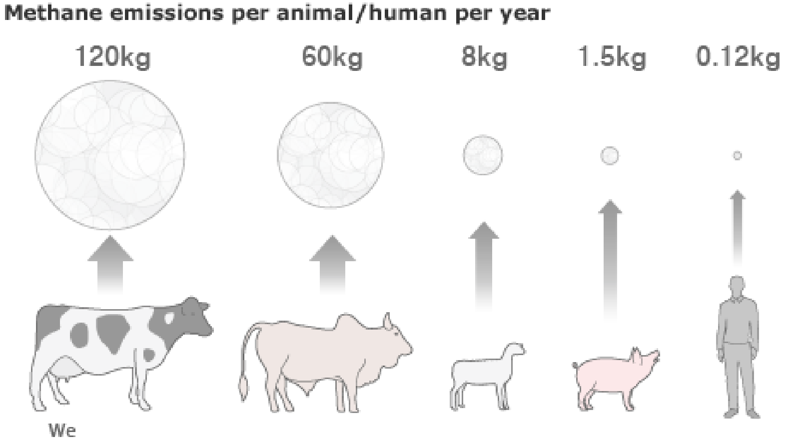
Coal mines (6,9%)

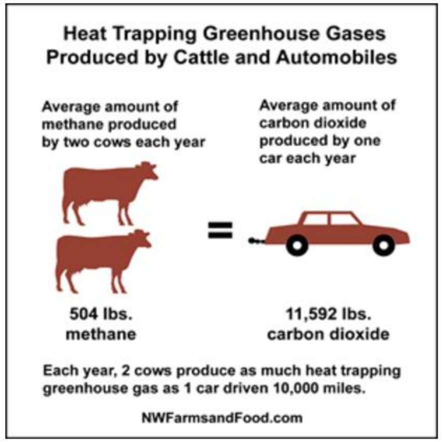
Rice (6,9%)



Livestock (21,3%)

Swamps (29%)





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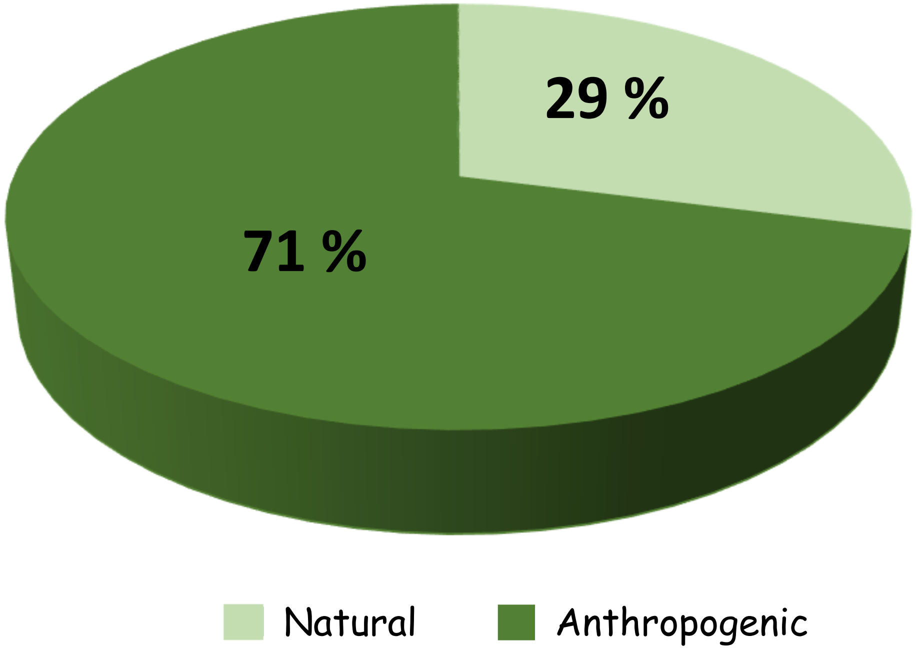
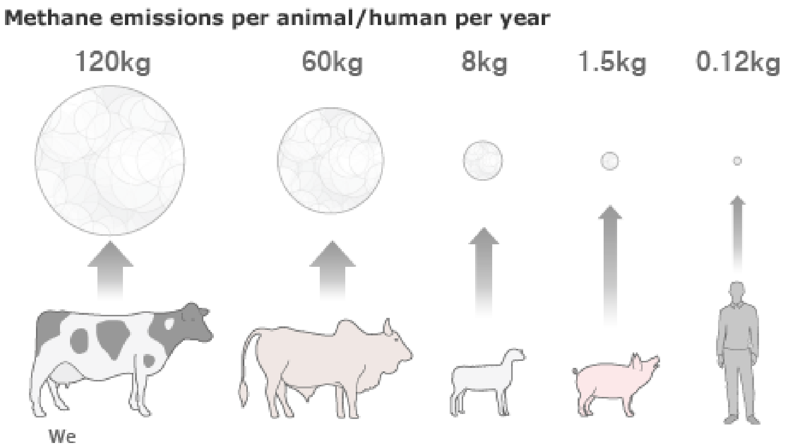


Swamps (29%)



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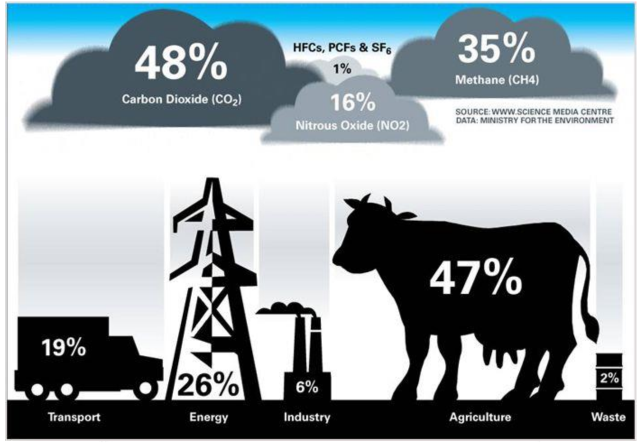
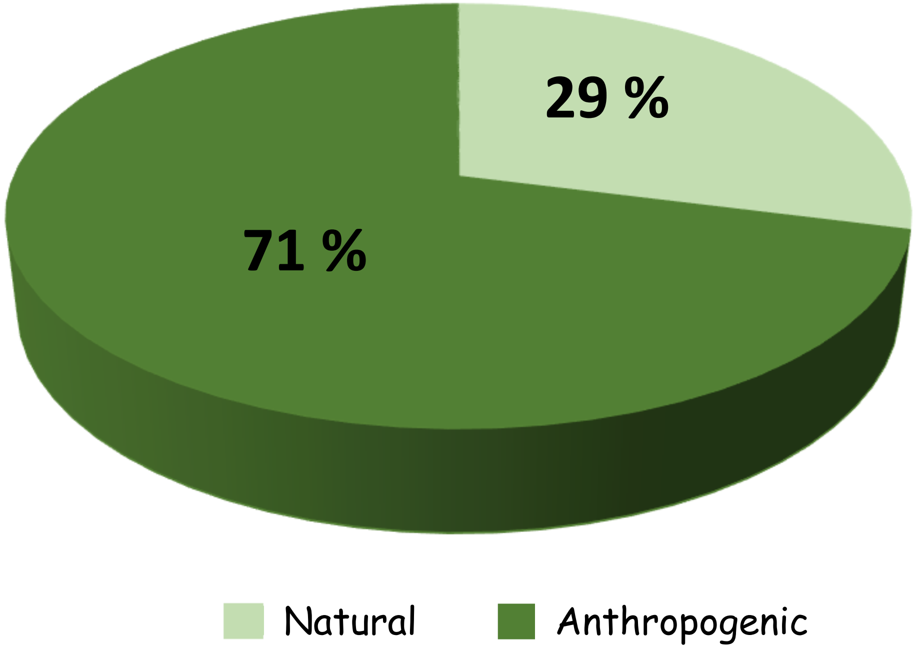


Sources of methane



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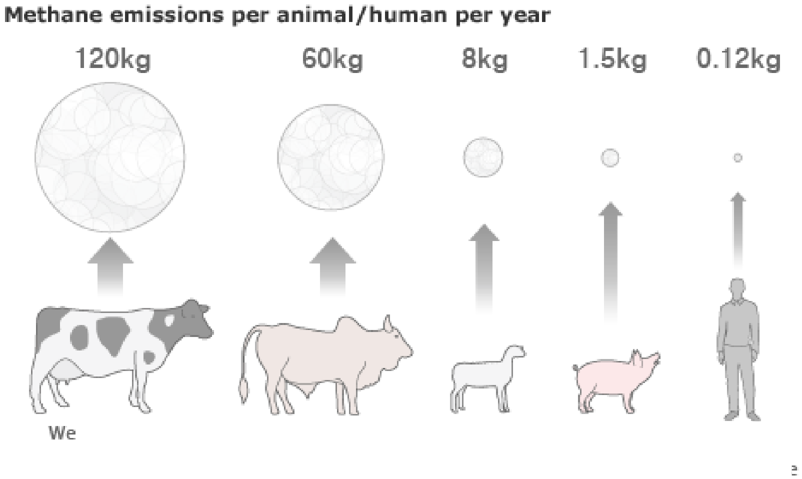
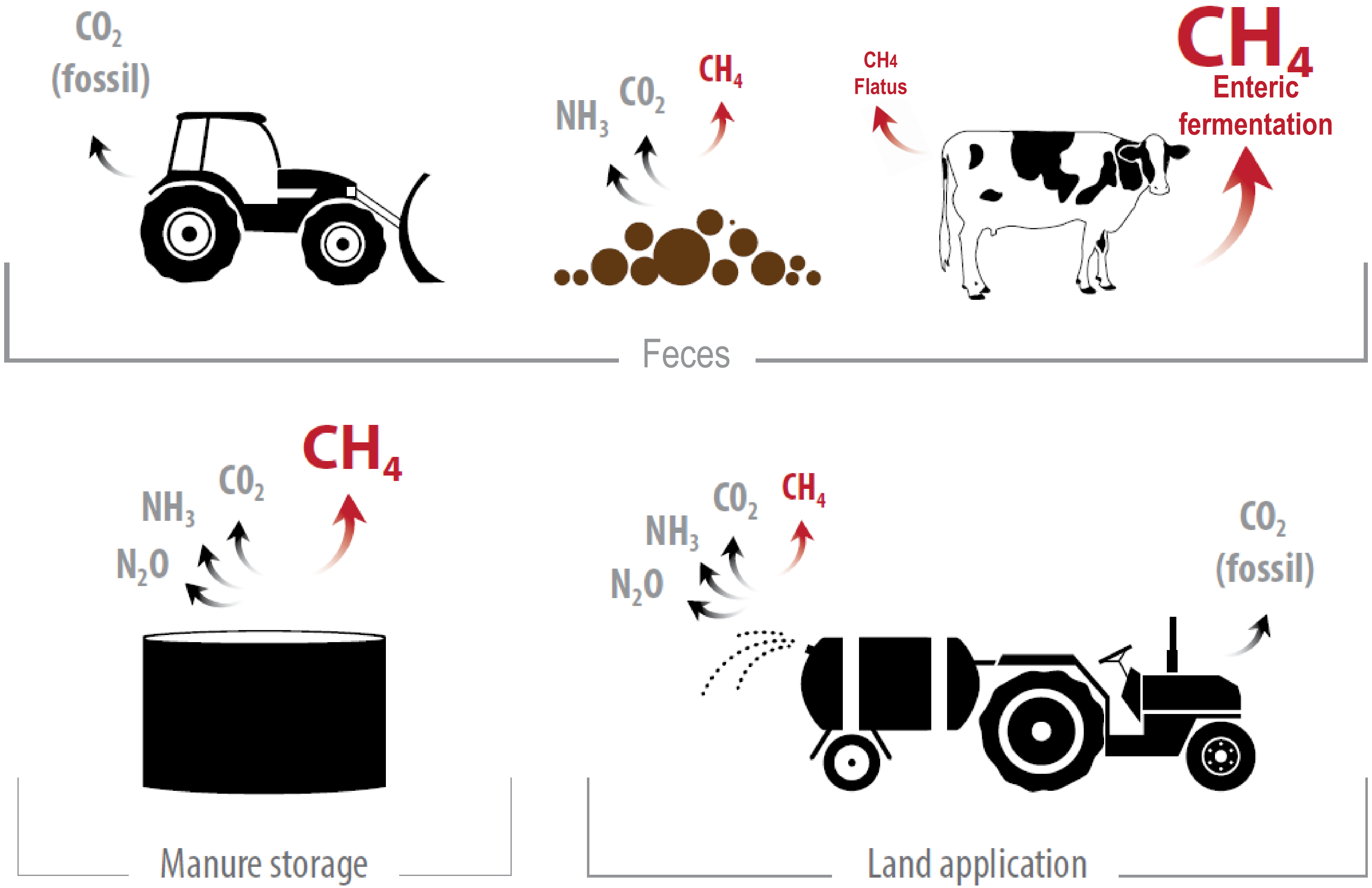
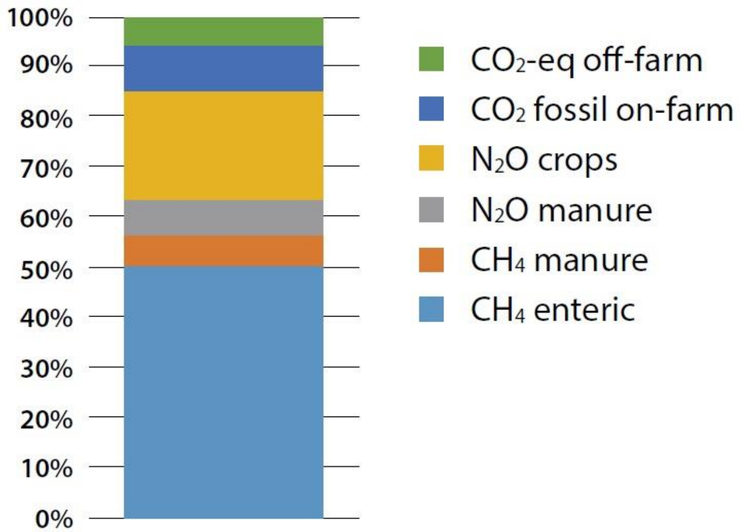
Swamps (29%)



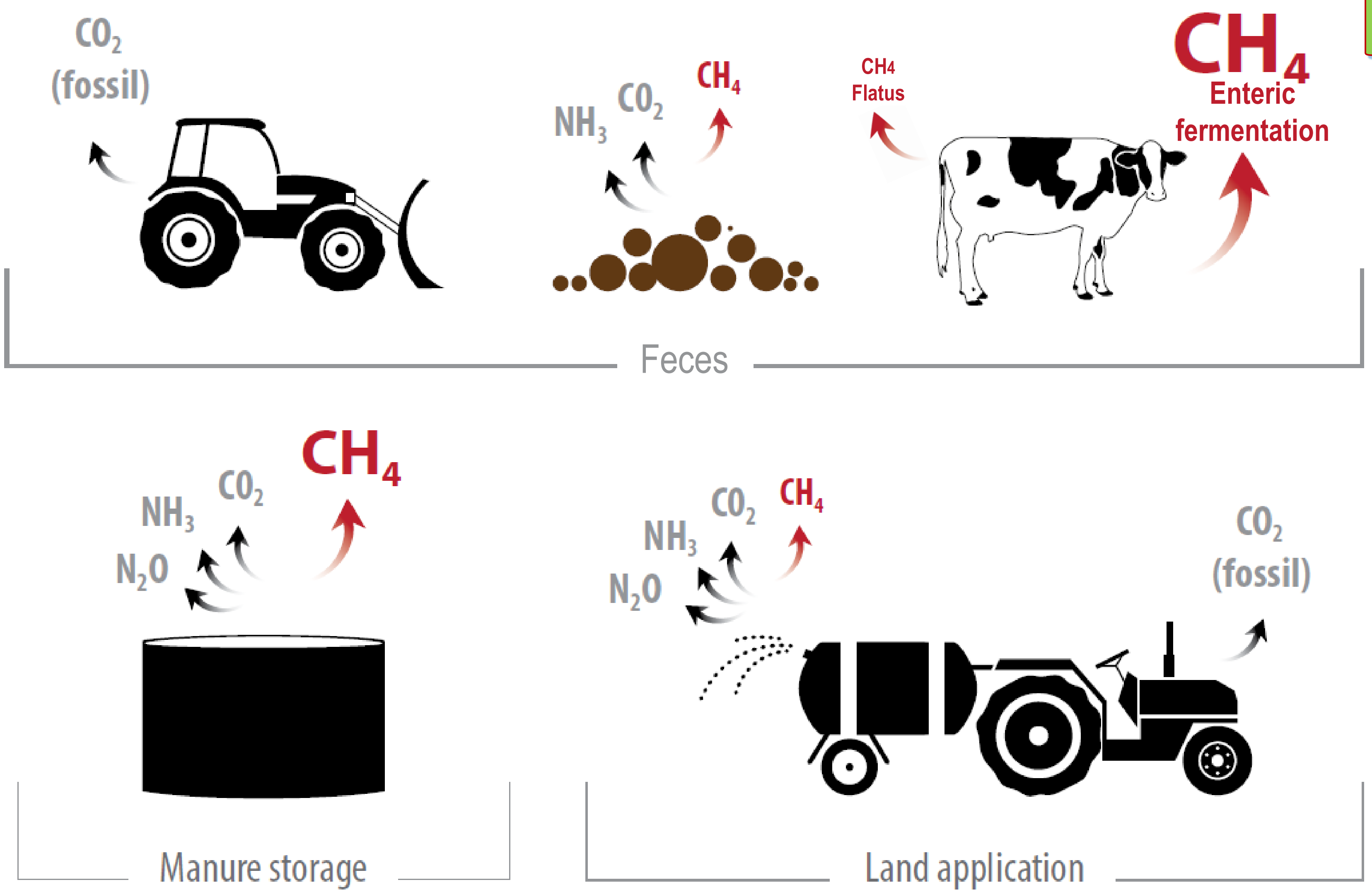
Sources of Methane on Dairy Cow Farms



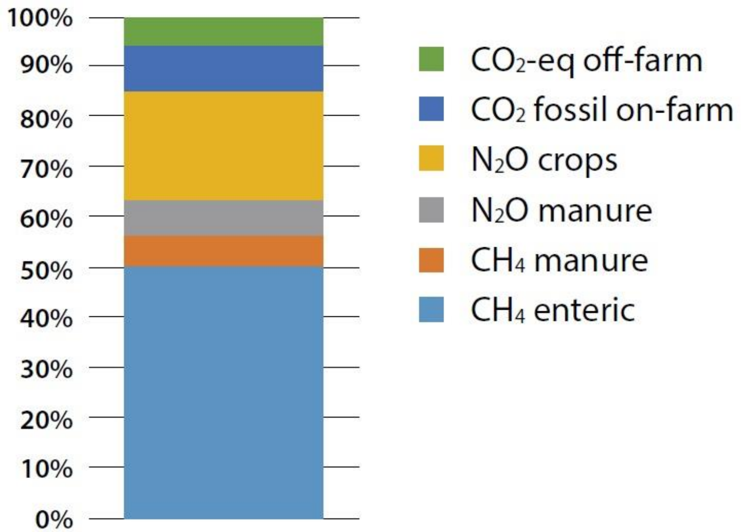


GHG emissions (farms)

Sources of Methane on Dairy Cow Farms



PHYSIOLOGY



GHG emissions (farms)

Management

GHG Emission Measurement Methods in Ruminants

It is necessary to include the **emission factors** for individual GHGs depending on the **production category** of cattle and **part of the world**, the **size** of a given **population**, but also **combustion** of **oil (diesel)** on the farm (1 kg diesel = 3.13 kg CO2eq/kg), **electricity consumption** for milking, milk cooling, barn lighting and ventilation (0.47 kg CO2eq/kWh), **pesticide production** (22 kg CO2eq/kg pesticide), total **mass** of **farm machinery** (3.54 kg CO2eq/kg machine mass), etc.

$$\text{Total CH}_{4\text{Enteric}} = \sum_i E_i$$

$$Emissions = EF_{(T)} \bullet \left(\frac{N_{(T)}}{10^6} \right)$$

$$N_2O_{L(mm)} = \left(N_{leaching-MMS} \bullet EF_5 \right) \bullet \frac{44}{28}$$

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)} \right) \right] \bullet EF_{3(S)} \right] \bullet \frac{44}{28}$$

$$CH_{4\,Manure} = \sum_{(T)} \frac{\left(EF_{(T)} \bullet N_{(T)} \right)}{10^6}$$

$$Nex_{(T)} = N_{rate(T)} \bullet \frac{TAM}{1000} \bullet 365$$

NUMBERS ARE APPRIXIMATE NOT EXACT

Enteric Methane Emission Measurement Methods in Ruminants

Inside the barn - in the facility (group production)

- The origin cannot be precisely determined
- It is not suitable for scientific research related to methane emissions
- Environmental conditions in the barn/methane emission from the facility

Individually by animal

- Precise determination of origin
- Suitable for scientific research

Enteric Methane Emission Measurement Methods in Ruminants

Inside the barn - in the facility (group production)

- The origin cannot be precisely determined
- It is not suitable for scientific research related to methane emissions
- Environmental conditions in the barn/methane emission from the facility

MULTI GAS ANALYSER

Determines up to 7 different gases (CH_4, CO_2, CO, O_2, H_2, NH_3 and H_2S).

The tubes draw the gas and the device measures the concentration.

It has an internal memory for storing 500 readings.

Results are transferred using USB, WiFi or Bluetooth.

It has data collection software

Enteric Methane Emission Measurement Methods in Ruminants

Individually by animal

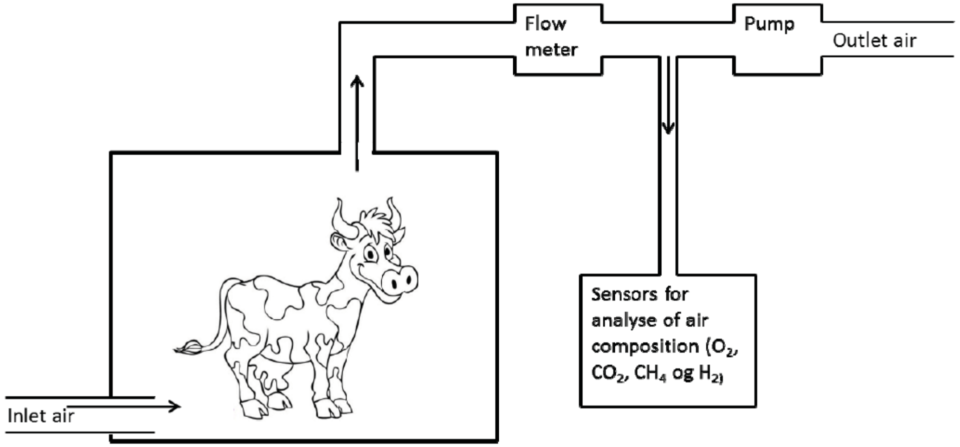
RESPIRATION CHAMBERS

GOLD STANDARD

Initially developed to measure energy metabolism - methane emission.

Collection of exhaled air and measurement of methane concentration

Period of adaptation!



The potential issue:

unnatural environment – question of stress and welfare

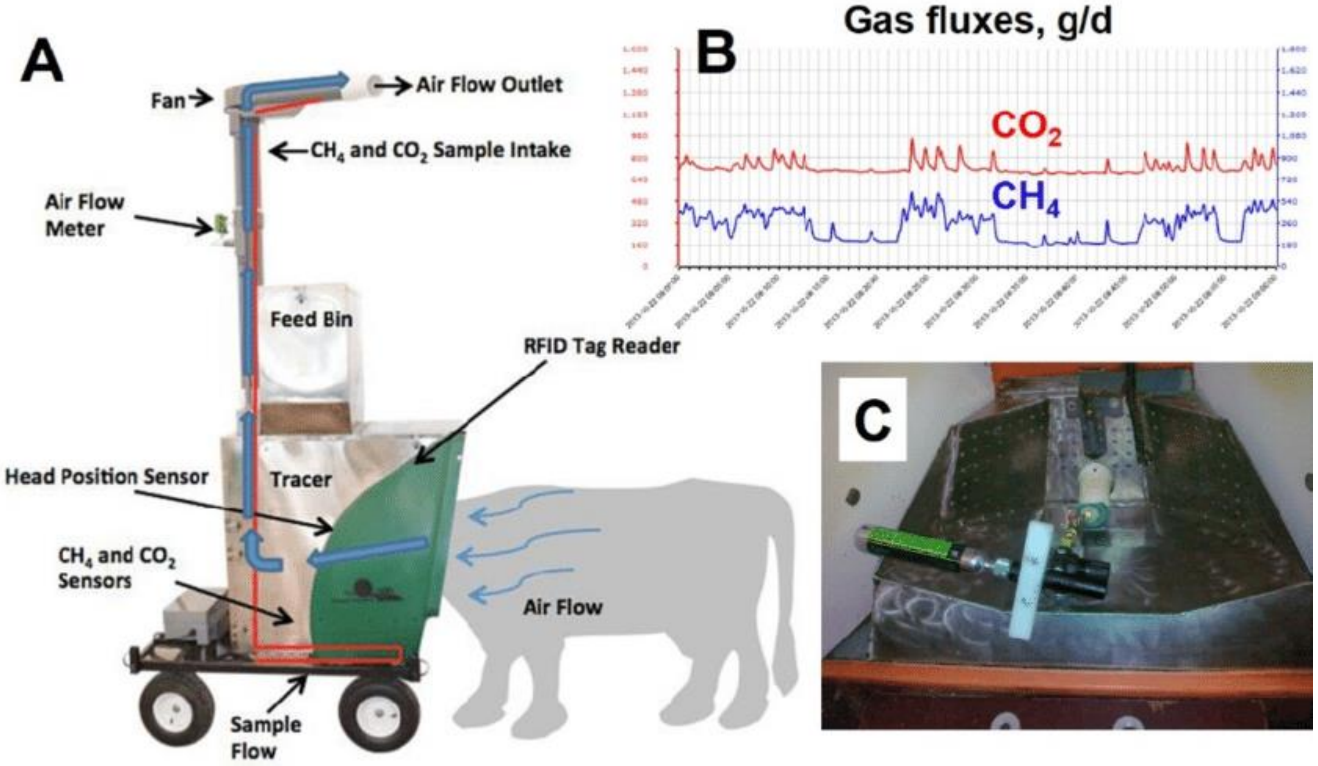
Enteric Methane Emission Measurement Methods in Ruminants

Individually by animal

ALTERNATIVE METHOD

GreenFeed TM method

The GF system estimates daily methane production (DMP, g/day) by measuring gas concentrations and airflow over 3–7 min in exhaled air from cattle when they visit a concentrate feeders



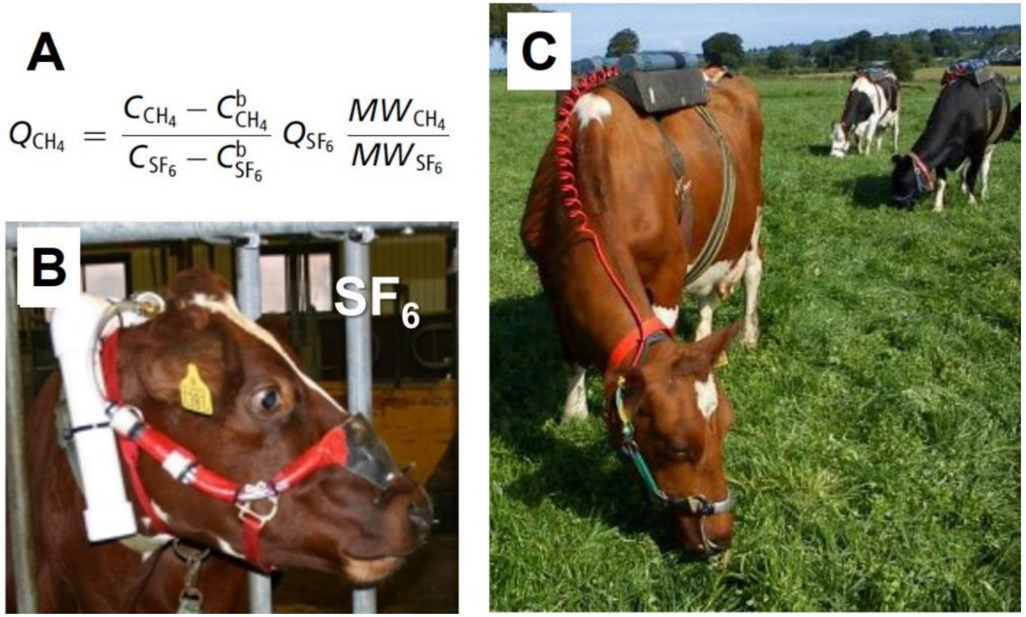
An adaptation period is not required.

Welfare of animal is not interputed

Enteric Methane Emission Measurement Methods in Ruminants

Individually by animal

In situ SF_6 (sulfur hexafluoride) tracer method – diffusion rate



$$Q_{CH_4} = \frac{C_{CH_4} - C^b_{CH_4}}{C_{SF_6} - C^b_{SF_6}} Q_{SF_6} \frac{MW_{CH_4}}{MW_{SF_6}}$$

FOR GRAZING ANIMALS - the device is on the animal

A known tracer gas emission from the rumen

SF_6-non-toxic and physiologically inert gas

SF_6-cheap, low detection level, easy to analyze

Determination of SF_6 and CH_4 from canisters by gas chromatography

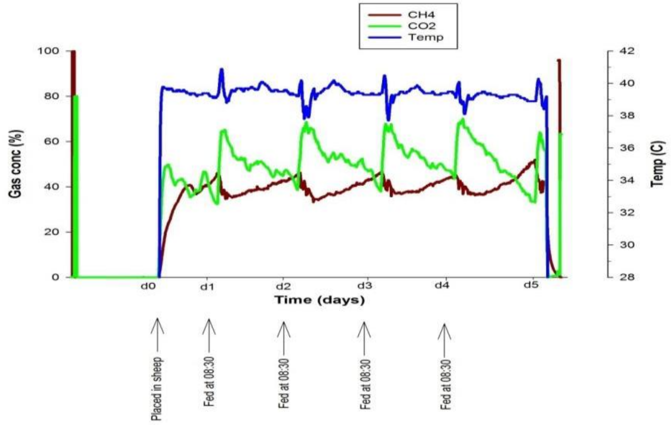
Adaptation to the device, question of welfare

Enteric Methane Emission Measurement Methods in Ruminants

Individually by animal

In situ method for measuring CH_4 production

CSIRO - gas sensors for measuring CH4 production in the rumen



Continuous monitoring of production in real time in the rumen

Measures both CO_2 and H_2 and enteric gases

They measure temperature and pH in the rumen

It does not need to be removed from the rumen

Initially made for human population

OUR CHOICE

Laser Methane Detector
(infrared absorption spectroscopy)

Sensitivity: 1 ppm.
Measurable level: 1 – 50 000 ppm.
Measuring Speed: 0,1 s.

At short intervals, a very low CH_4 concentration released by exhalation or a high CH_4 concentration eliminated by eructation may be detected.

Measurable distance: 0,5 – 50 m.

→ Non-contact measurement of CH_4 emission (animal welfare and operator safety). Minimal interference with the comfort of the animals and their natural behavior..

Detection of CH_4 in a mixture of gases with high specificity (Chagunda, 2013).

→ Suitable for measuring in barns where other gases are present (high specificity)


(a)

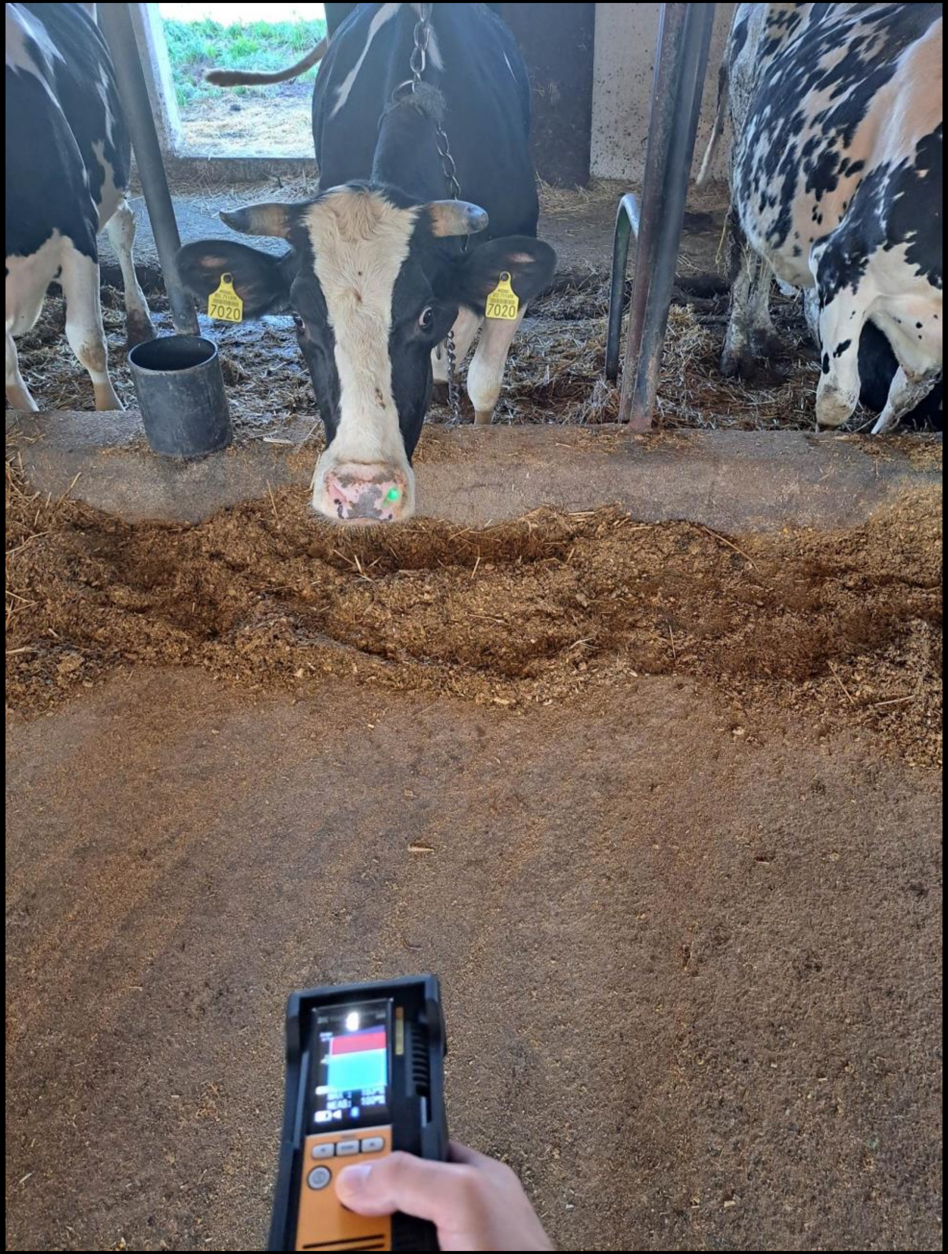

(b)


(c)


(d)

Sorg (2021)

It is easy to handle, and emits laser beam (green - excellent visibility).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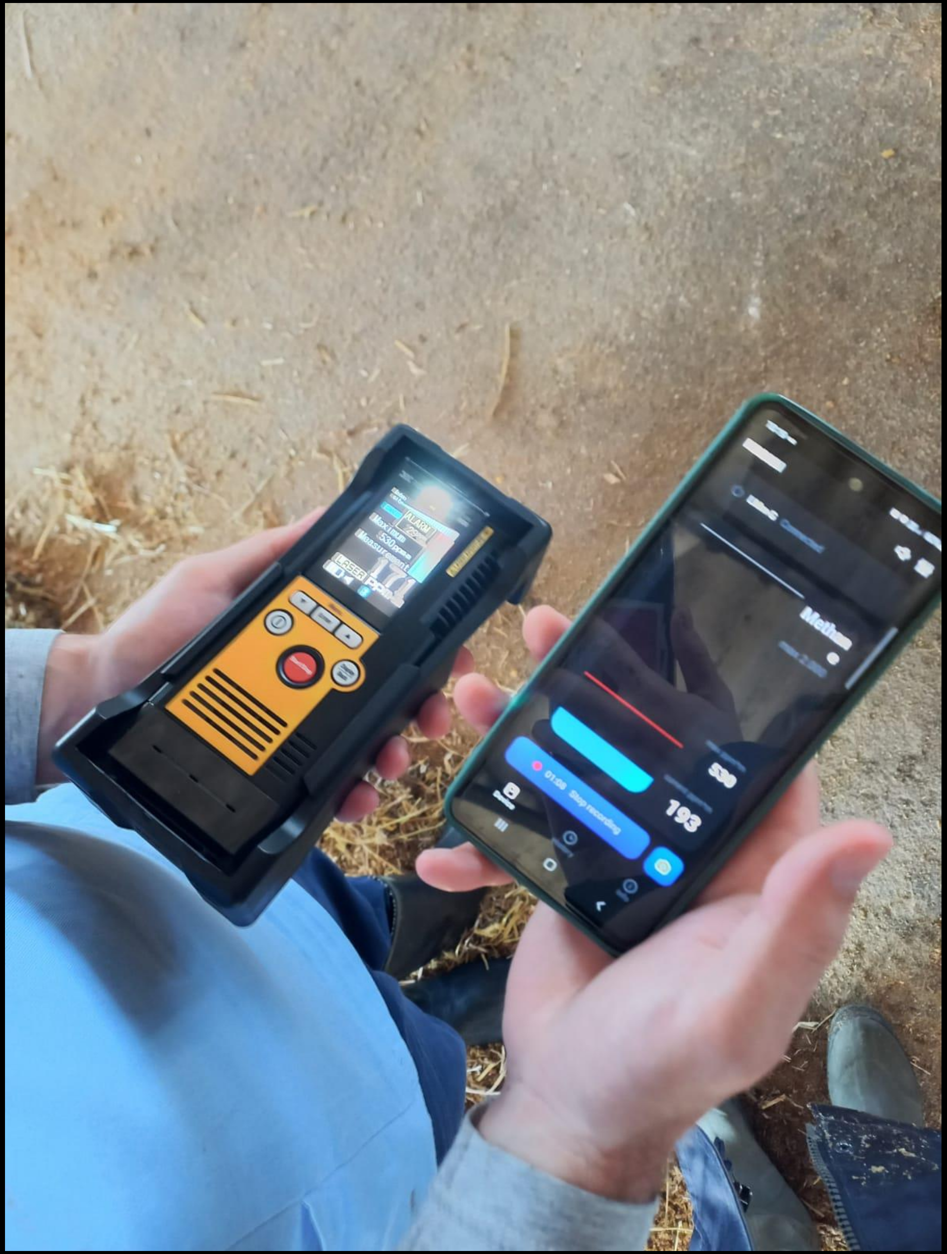
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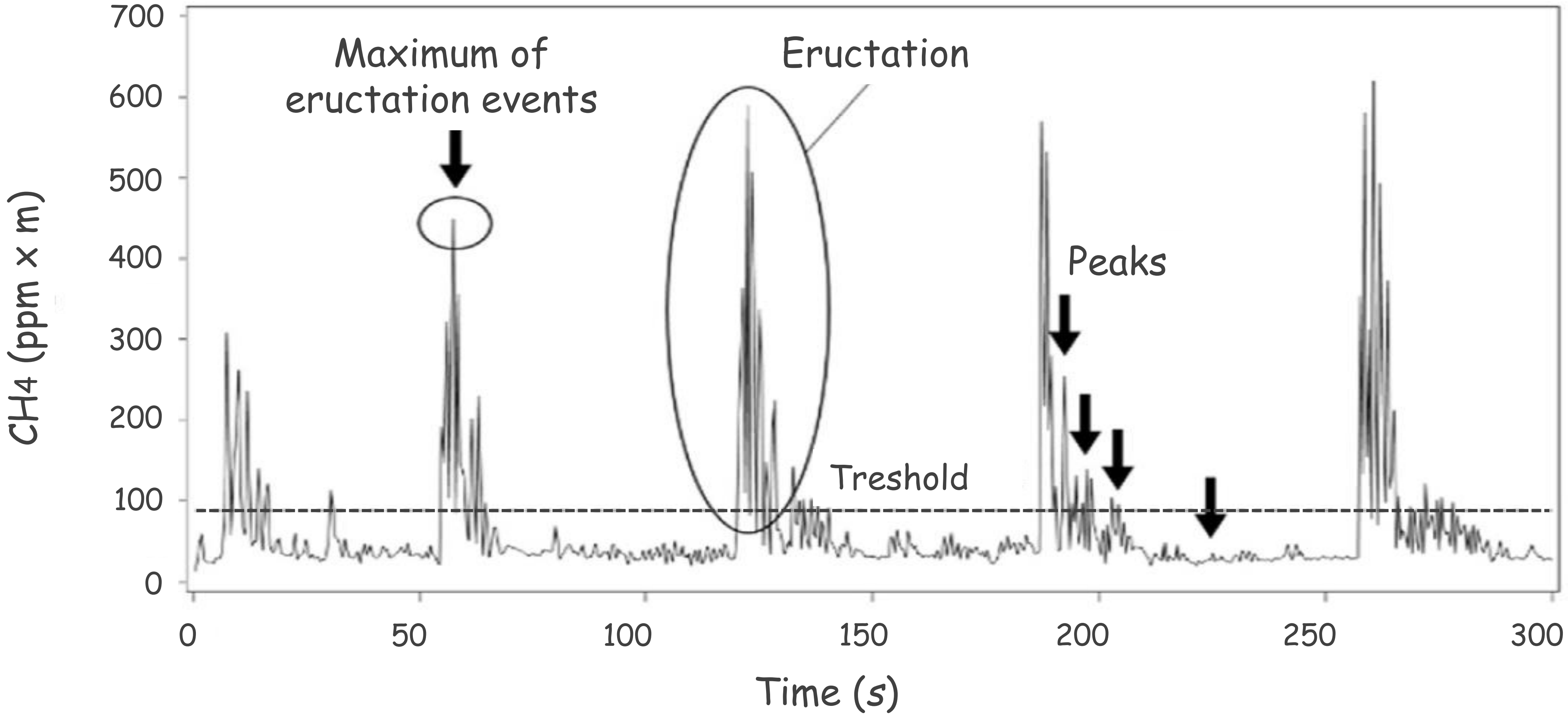
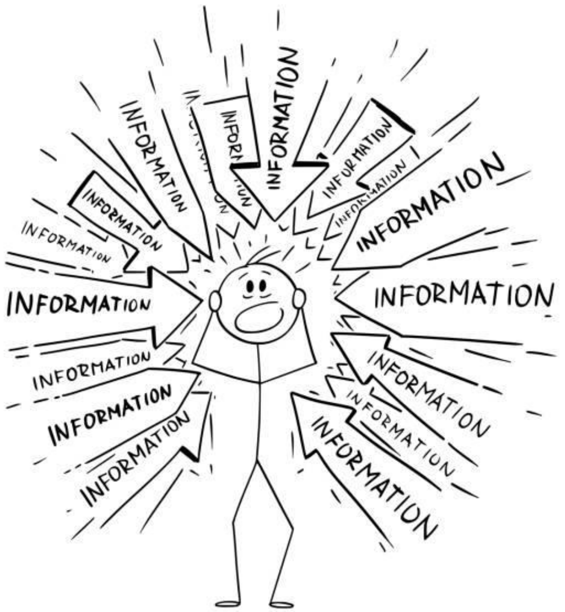


Figure 1. *Profile of the CH_4 concentration in the breath of a dairy cow as measured with the laser methane detector. The threshold (T) separates eructation and respiration values and is calculated as T=Q3 + (1.5 x (Q3-Q1)), with Q1 and Q3 being the first and third quartile of the distribution of all CH_4 values in a profile (Sorg i sar. 2018)*

How to reduce methane emissions from dairy farms?

Because of media/social media there is a huge amount of data – some are scientifically true some not



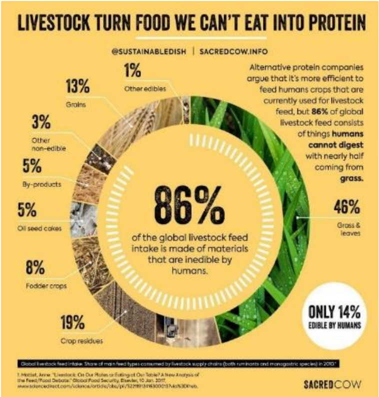
Data analysis is important.

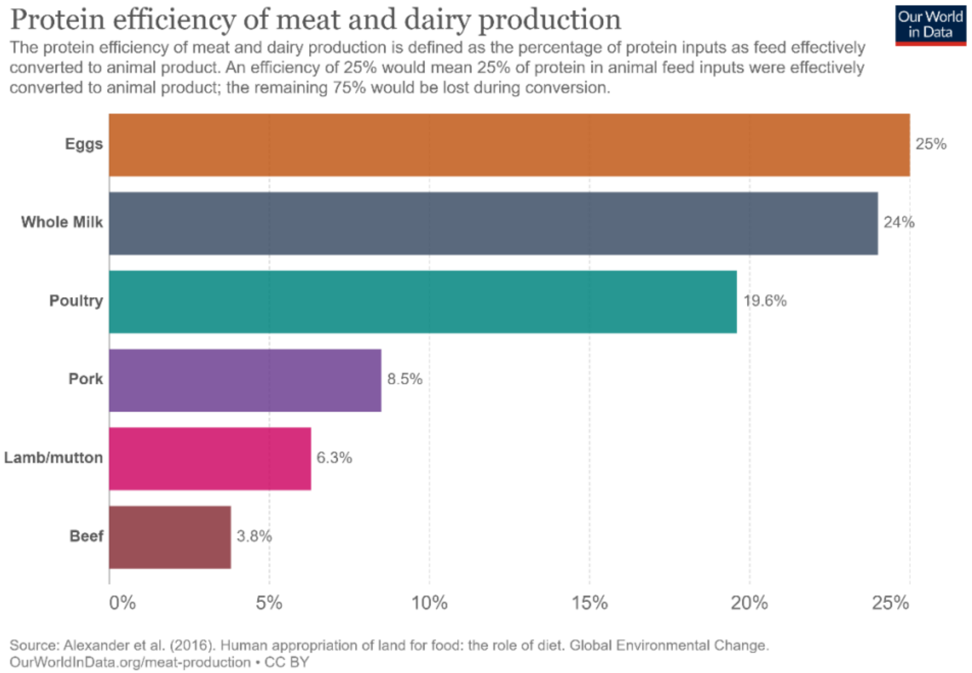
Due to huge amount of data there is the possibility for manipulation by intentionally or unintentionally selecting only certain information

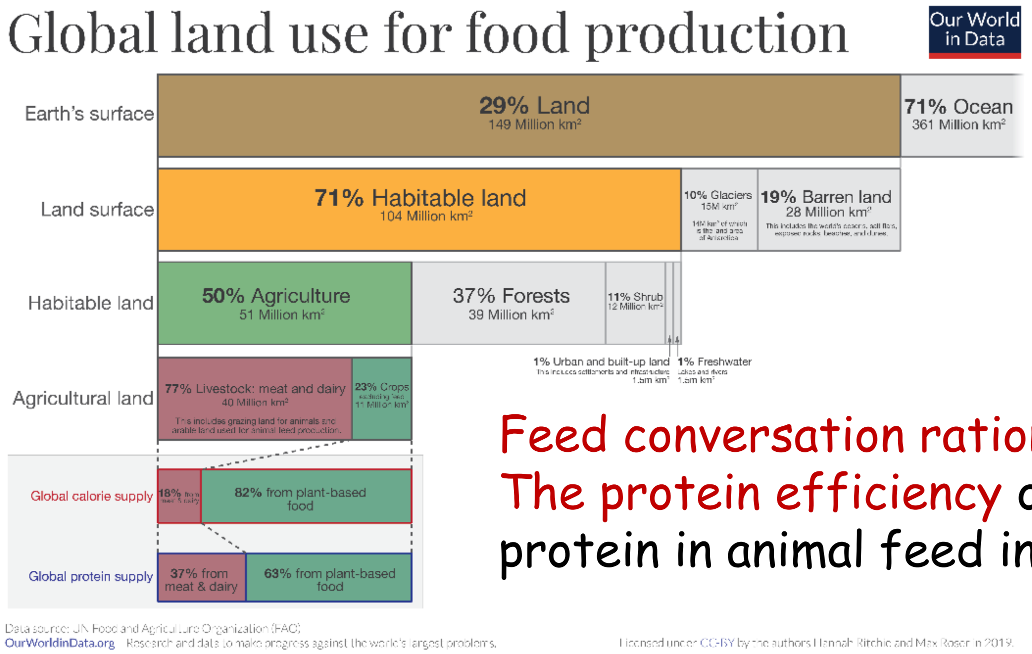
Veganism

The importance of cows farms as a source of high-quality food for human population

Cows consume food not edible for humans from land that is unusable to humans and convert it in high-quality food



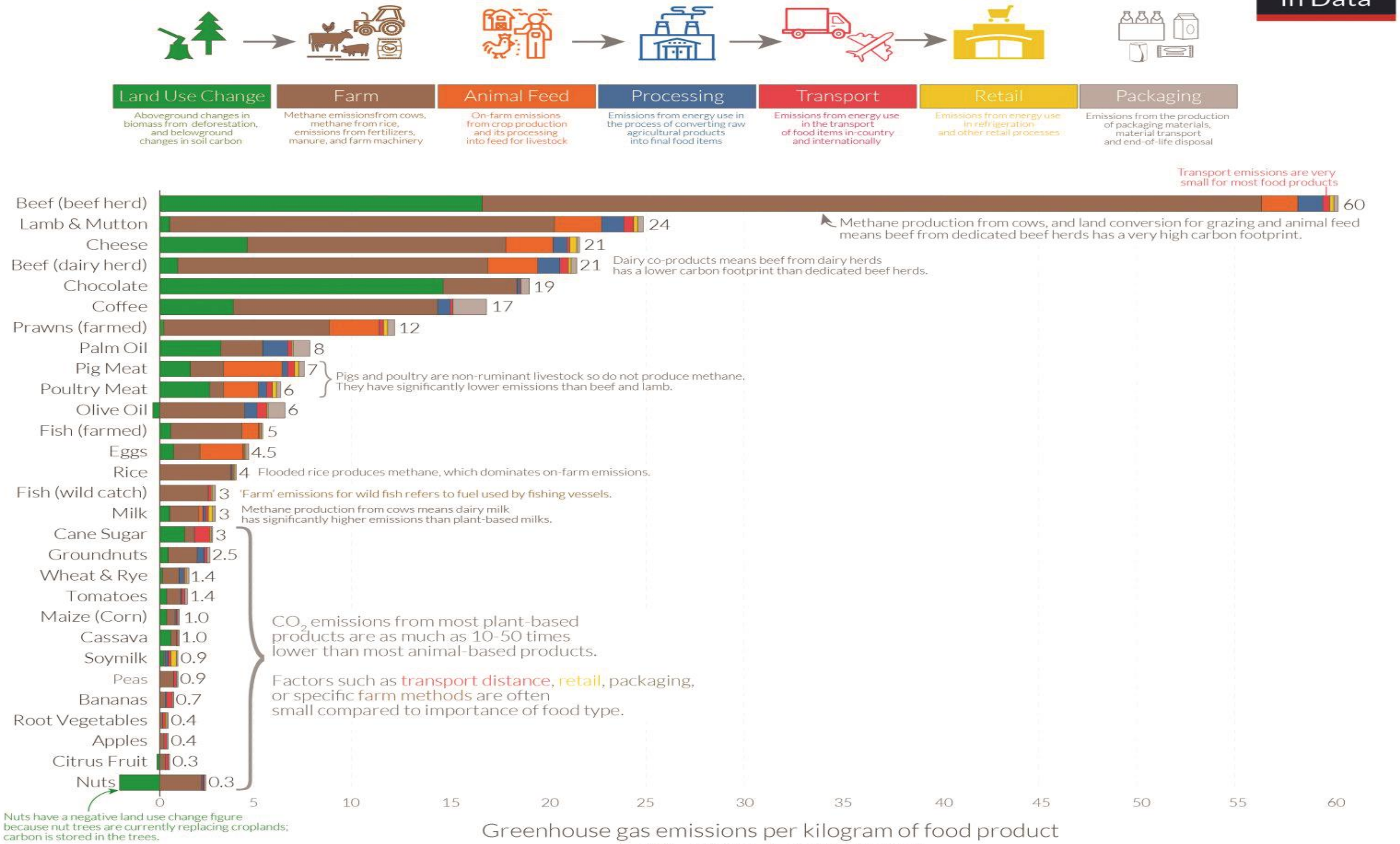




Feed conversation ration is a measure of amount of feed needed to produce milk/meat.
The protein efficiency of meat/dairy production is defined as the percentage of protein in animal feed inputs as feed efficiently converted to animal products.

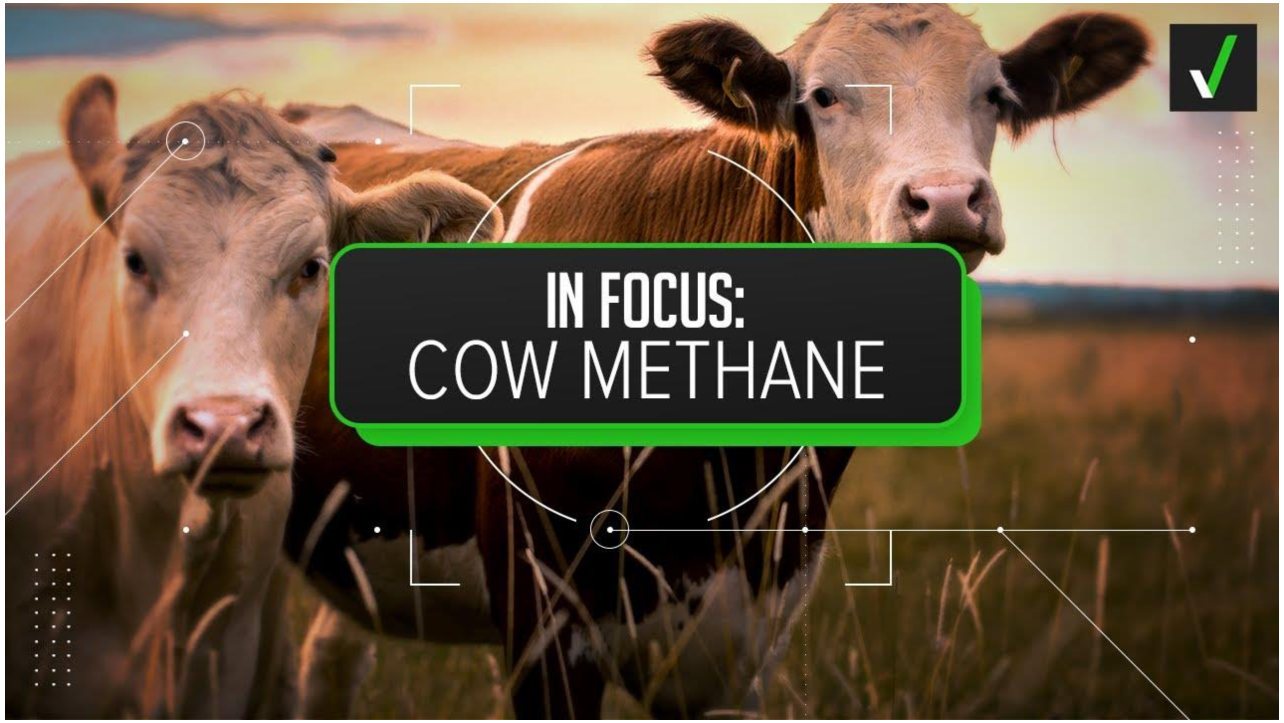
ANIMAL FEED UNEDIABLE FOR HUMANS

Food: greenhouse gas emissions across the supply chain



Note: Greenhouse gas emissions are given as global average values based on data across 38,700 commercially viable farms in 119 countries.
Data source: Poore and Nemecek (2018). Reducing food's environmental impacts through producers and consumers. *Science*. Images sourced from the Noun Project.

Veganism



Livestock (21,3%) **SOURCE OF METHANE** Rice (6.9%)

Veganism

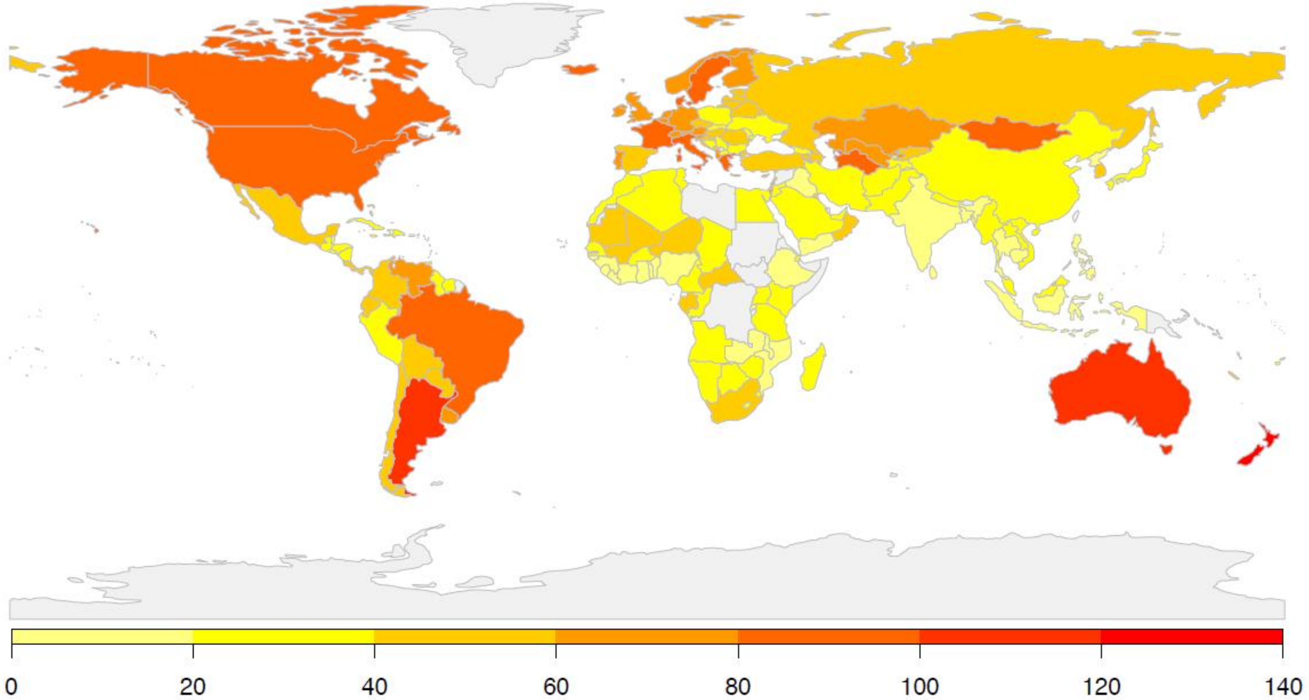
Livestock (21,3%) **SOURCE OF METHANE** Rice (6.9%)

If everyone would be vegan there would not be enough food to feed all of humanity
Cows as plant feed convertors are necessary

Changing the type of nutrients used by human

consumption of new nutrients and reduced food elimination

FAOSTAT - the world's largest database of food and agriculture statistics



Source: FAOSTAT, 2015d. Commodity Balances/Crops Primary Equivalent (2015-12-16). Food and Agriculture Organization of the United Nations, Rome, Italy.

HALF (Human Appropriation of Land for Food) index – How much land has been appropriated for feeding humanity.
average: 35.1 (0.65 ha of land per person)
USA: 97.7/India: 15.8
If all humanity adapt to nutrition obtain by USA citizens: 178% more of agriculture land will be needed
If all humanity adapt to nutrition obtain by Indian citizens: 55% less of agriculture land will be needed

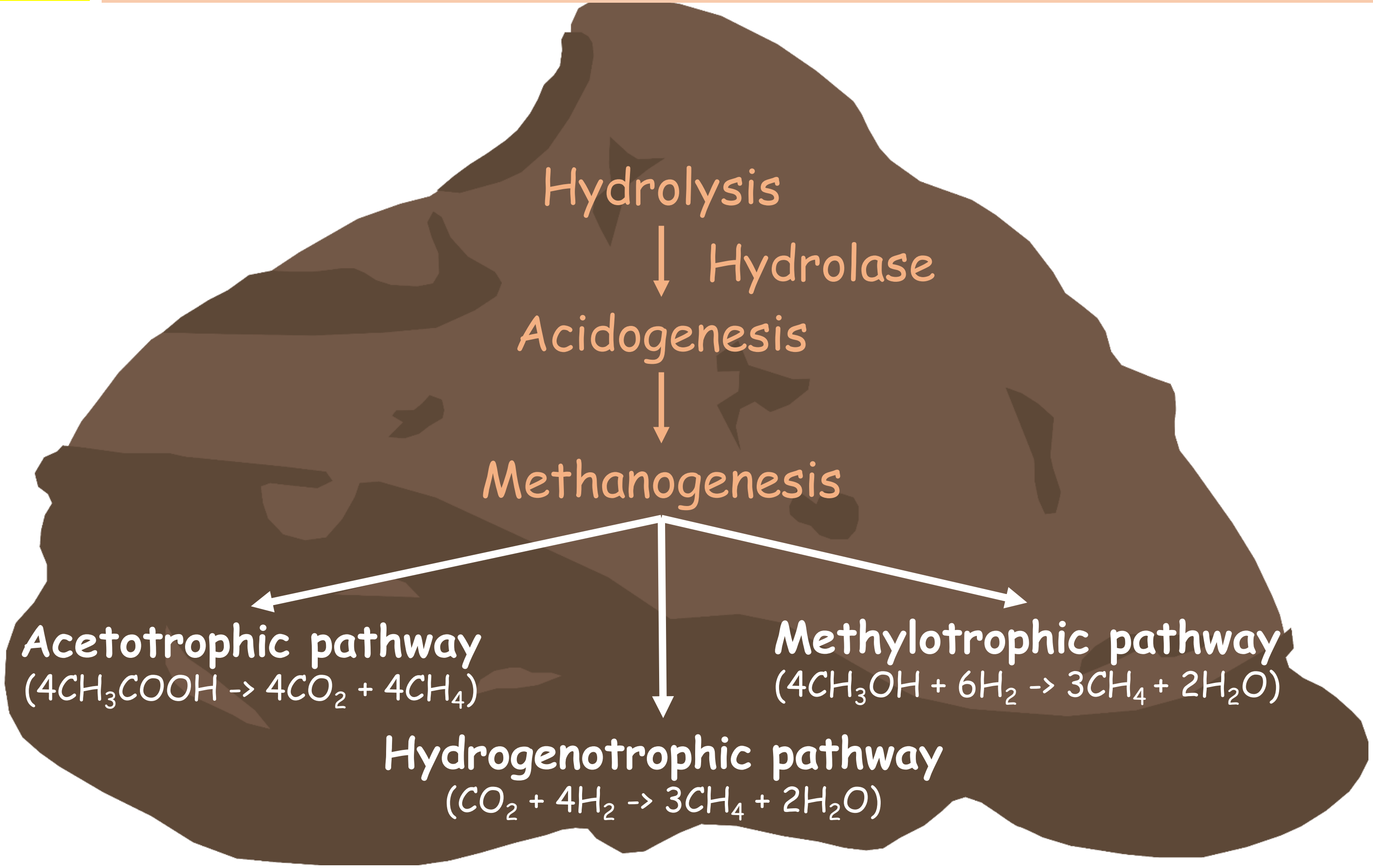
Manure Management

Storage of faeces in anaerobic conditions allows the growth of methanogens.

HYDROLISIS- breakdown fat, protein, CH to long-chain FA and simple sugars

ACIDOGENESIS- conversion of simple compounds into short-chain FA (lactic, propionic, butiric) used by homoacetogenic mo that produce acetic acid and release CO2 and H+ - starting compounds for methanogenesis

Methanogens

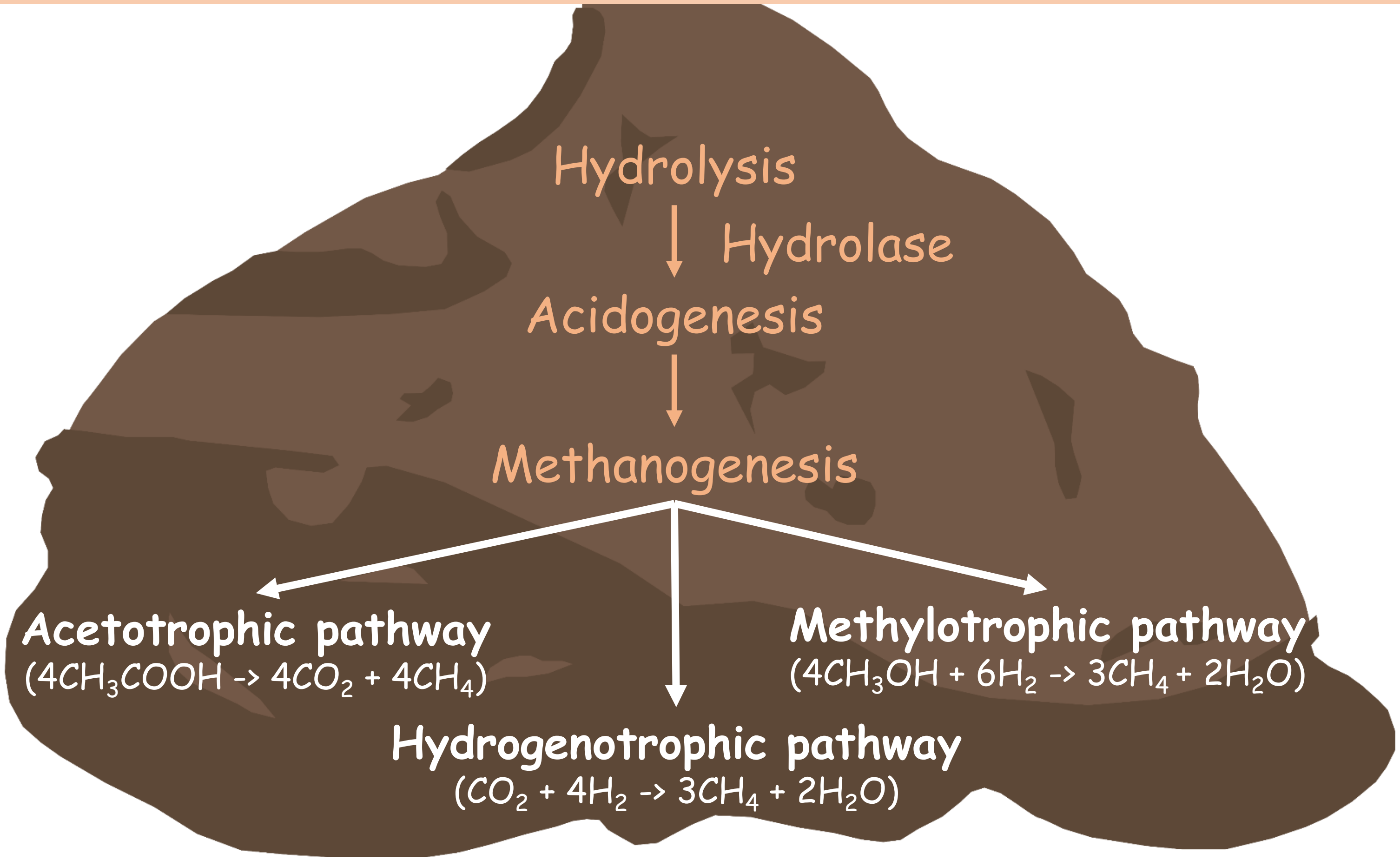


Manure Management

Storage of faeces in anaerobic conditions allows the growth of methanogens.

METHANOGENES- occurs in one of three pathways. Acetotrophic patway is dominant
Emission of methane from manure participate approximately 2% in antropogenic emission.
The amount released depends on manure management (humidity, pH, temperature), season (ambient temperature), manure composition

~~O_2~~



Methanogens

Manure management- Manure stored anaerobically - higher CH4 production

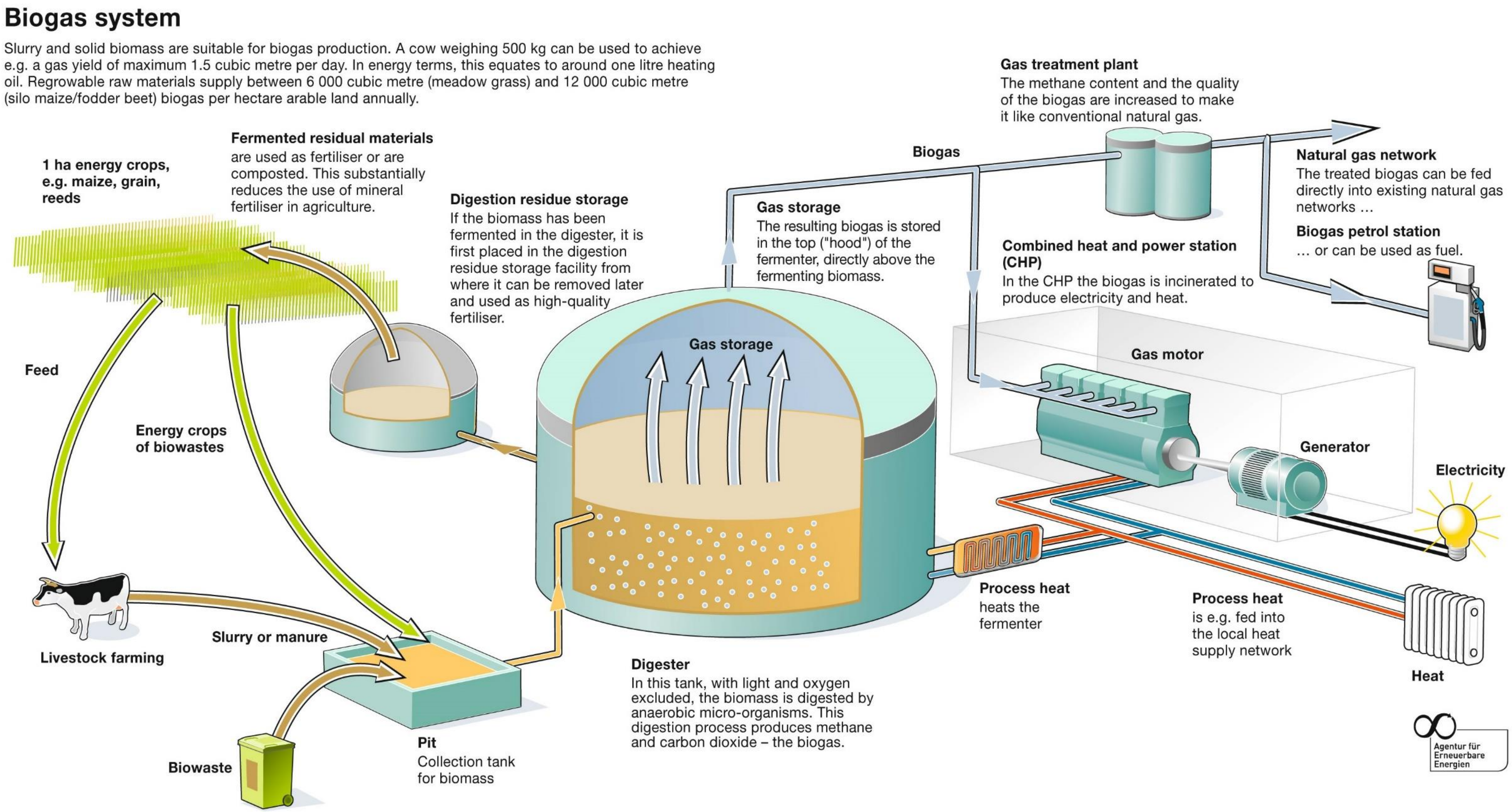
Manure temperature control - 1-2°C ↓ CH_4 5-10% ↓

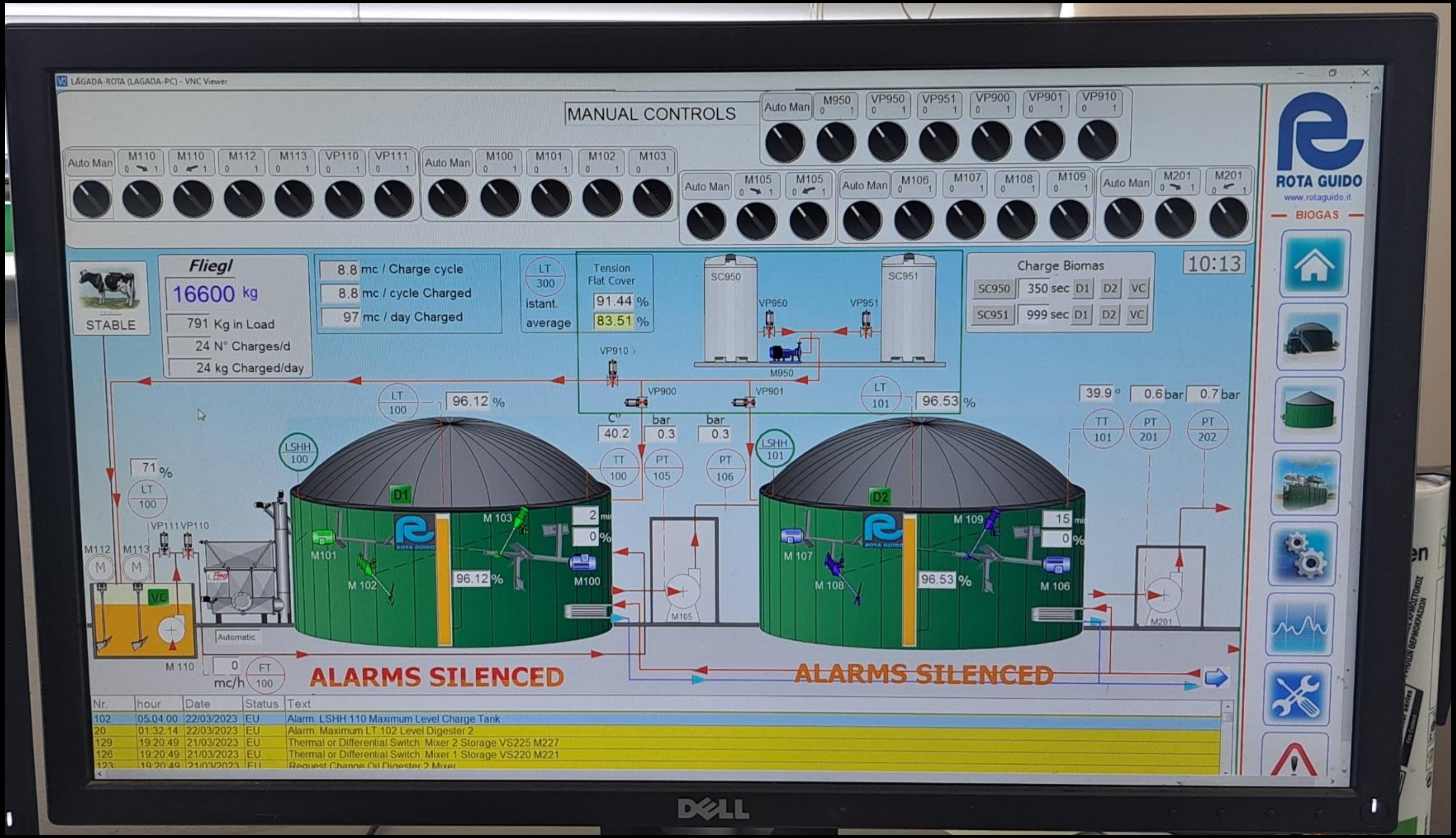
Acidification of manure –

pH 7 optimum

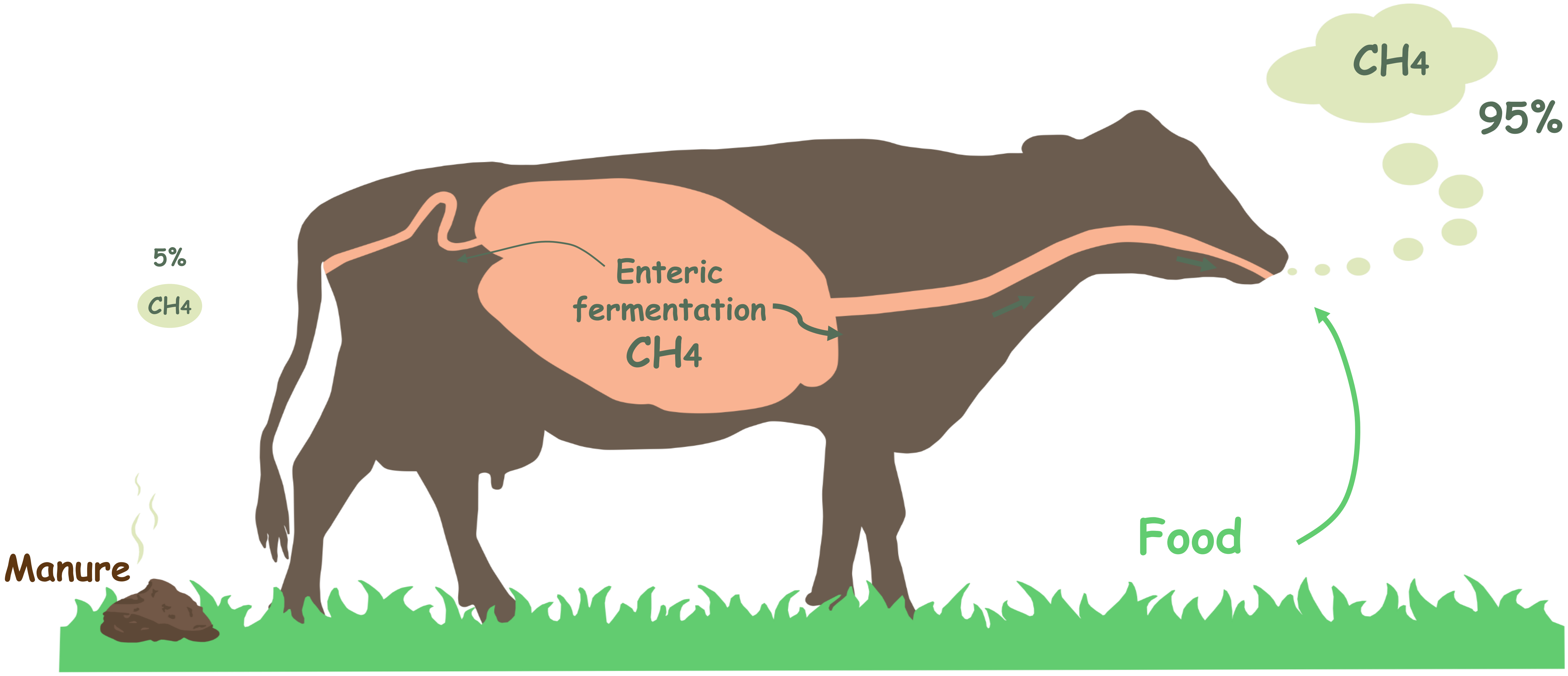
pH 6.5/pH 8.3; ↓ CH_4 50%; pH 4.5 NH_4 i N_2O ↓

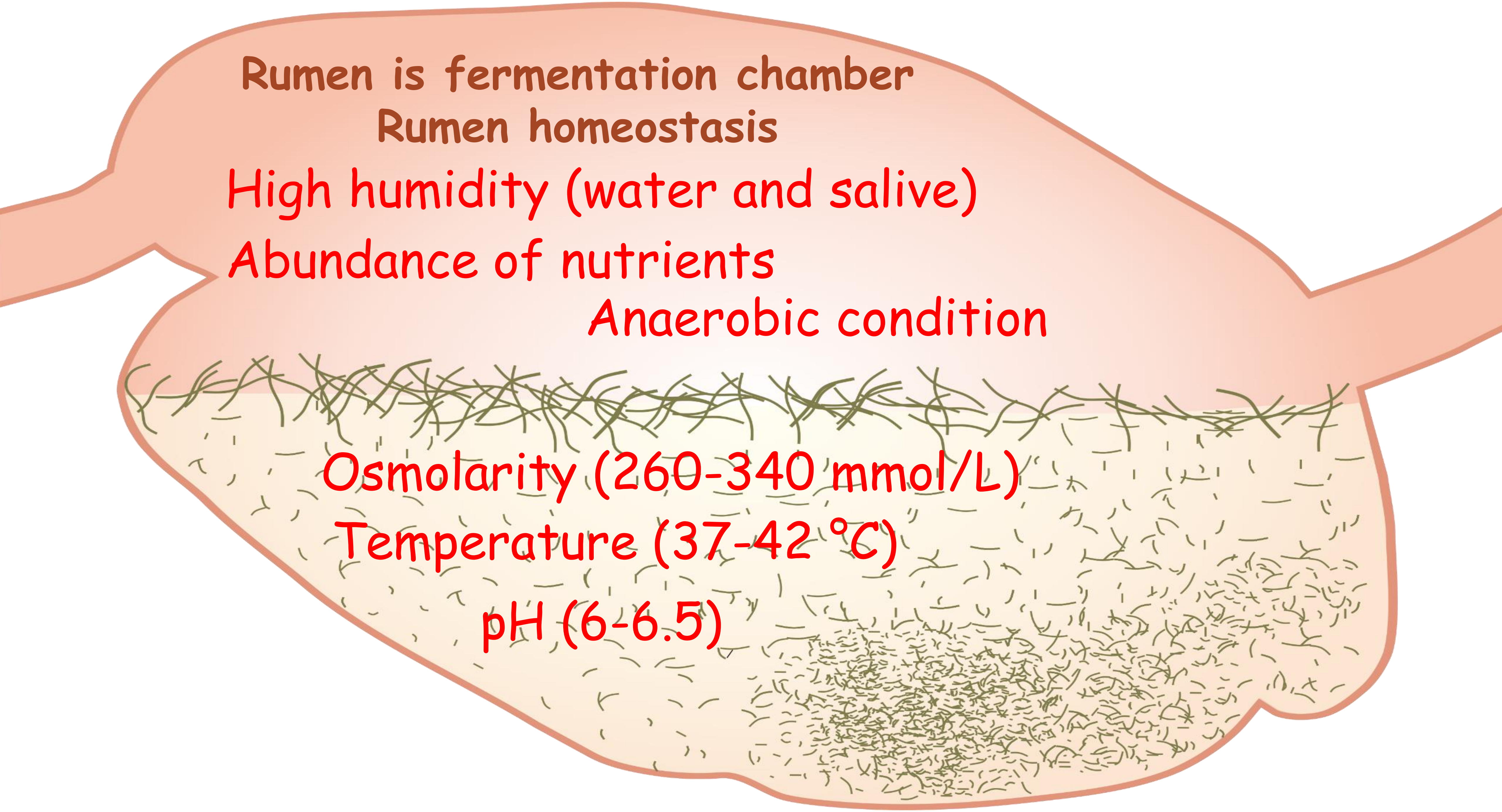
Anaerobic digestion can be used for the production of biogas in special plants




LAGADA-ROTA (LAGADA-PC) - VNC Viewer
MANUAL CONTROLS
ROTA GUIDO
www.rotaguido.it
BIOGAS
Fliegl
16600 kg
STABLE
791 Kg in Load
24 N° Charges/d
24 kg Charged/day
8.8 mc / Charge cycle
8.8 mc / cycle Charged
97 mc / day Charged
Tension Flat Cover
istant. 91.44 %
average 83.51 %
Charge Biomas
SC950 350 sec D1 D2 VC
SC951 999 sec D1 D2 VC
10:13
96.12 %
96.53 %
D1
D2
ALARMS SILENCED
ALARMS SILENCED
Nr. hour Date Status Text
102 05:04:00 22/03/2023 EU Alarm. LSHH 110 Maximum Level Charge Tank
20 01:32:14 22/03/2023 EU Alarm. Maximum LT 102 Level Digester 2
129 19:20:49 21/03/2023 EU Thermal or Differential Switch. Mixer 2 Storage VS225 M227
126 19:20:49 21/03/2023 EU Thermal or Differential Switch. Mixer 1 Storage VS220 M221
DELL

Nutritive Modulation of Cow`s Metabolism




Rumen is fermentation chamber
Rumen homeostasis
High humidity (water and salive)
Abundance of nutrients
Anaerobic condition
Osmolarity (260-340 mmol/L)
Temperature (37-42 °C)
pH (6-6.5)

Types of bacteria in the rumen

Based on their substrate

Celullolytic

Hemicellulolytic

Amylolytic

Pectinolytic

Proteolytic

Urealytic

Based on their products

Methanogenic
(phylum Euryarcheota,
domein of Archaea)
Archaea-differs from eucaryotes and similar to bacteria with their own cofactors
(coenzymes M, F420 and F 430)
and lipids (isoprene-glycerol esters)

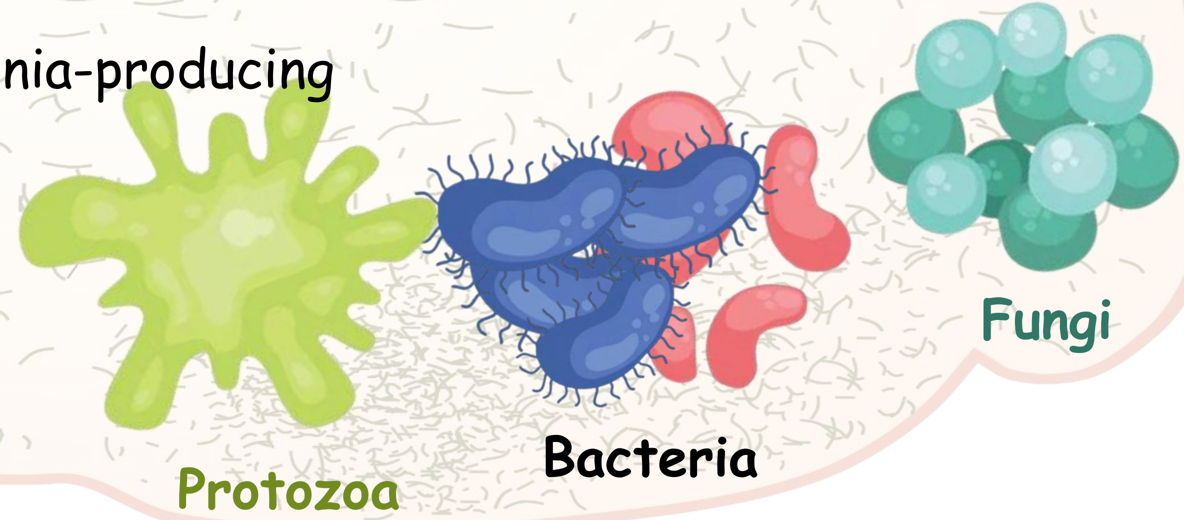
Ammonia-producing

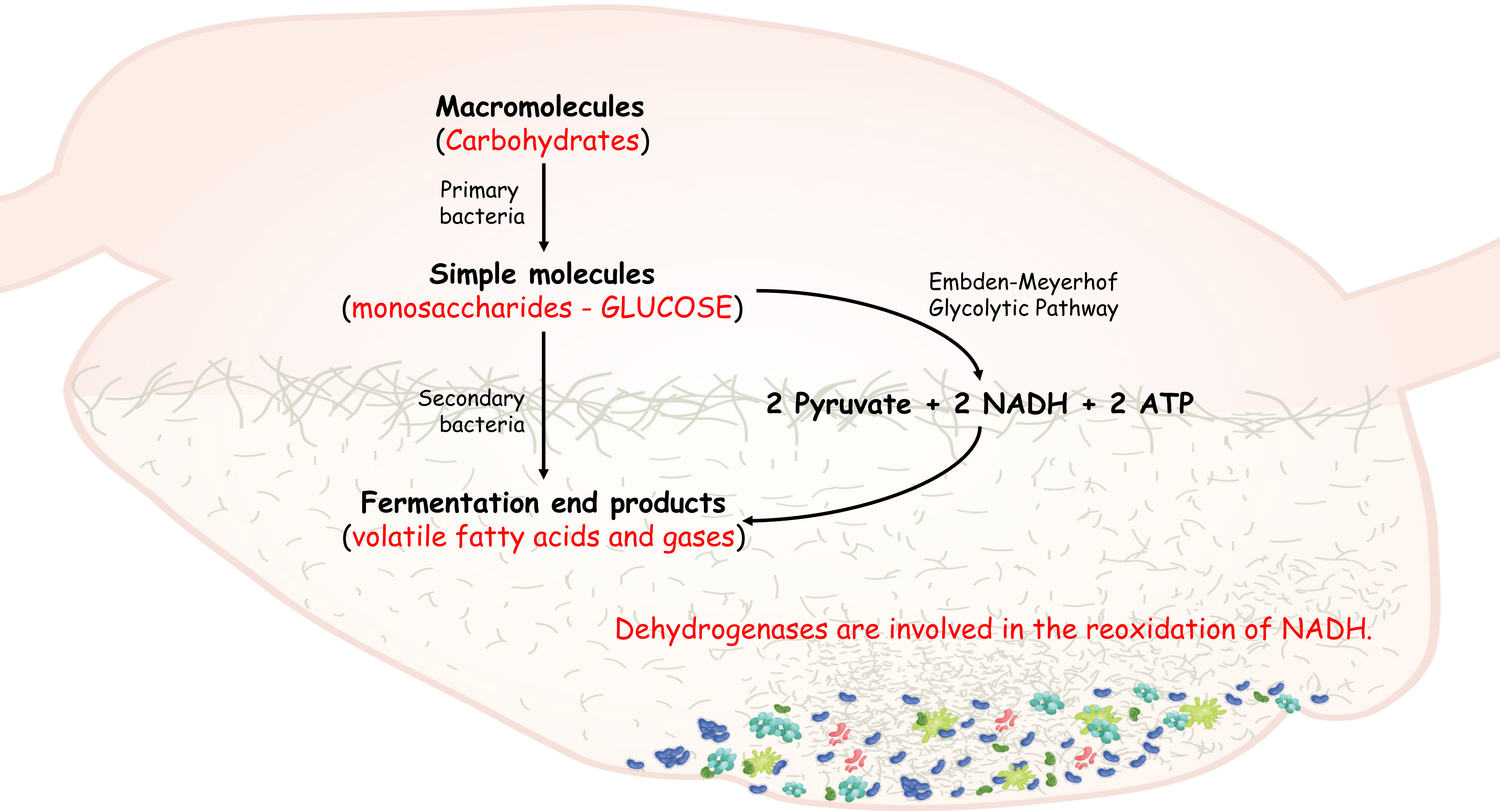
Based on consumption

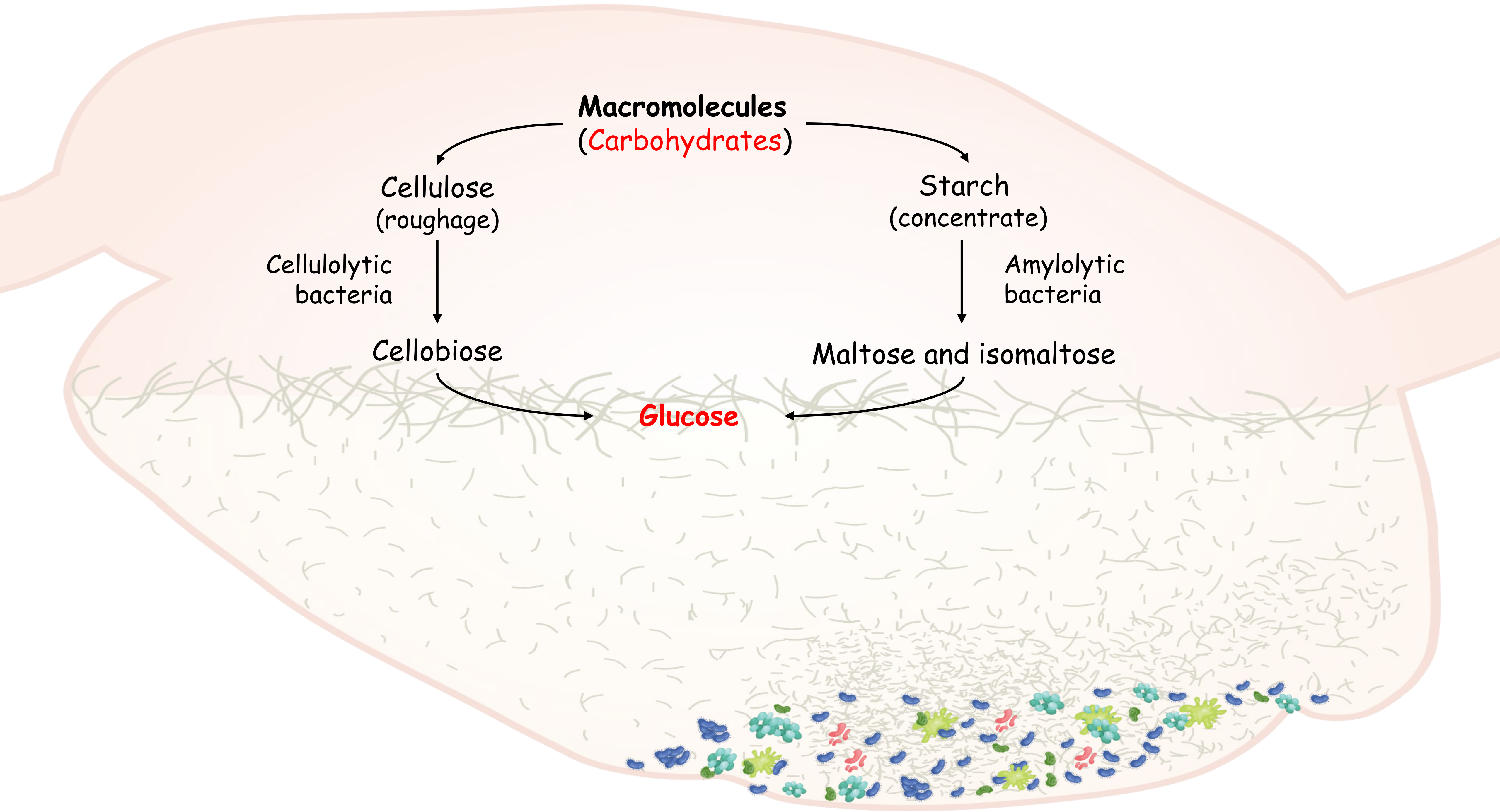
Sugar consuming

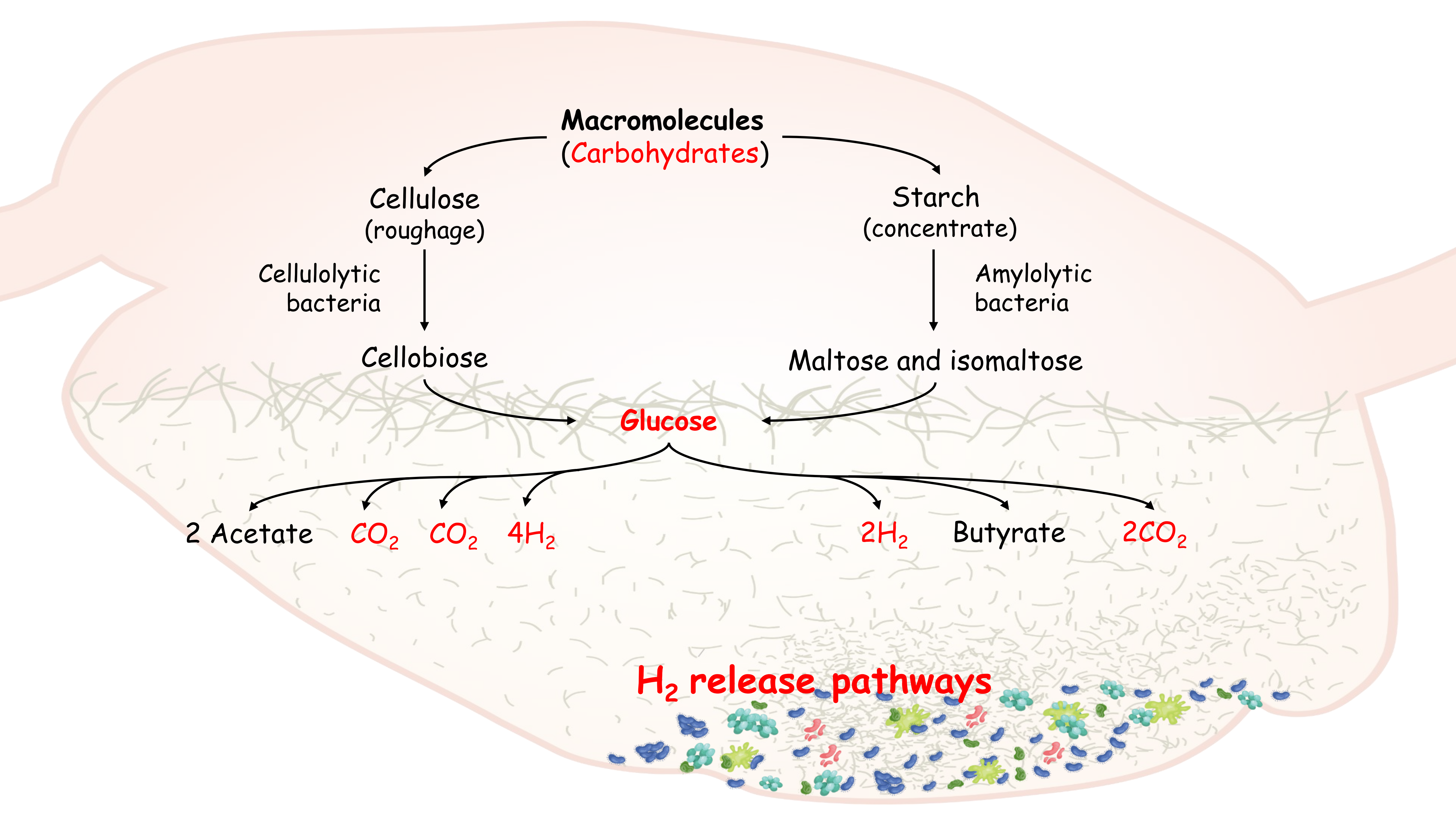
Acids consuming

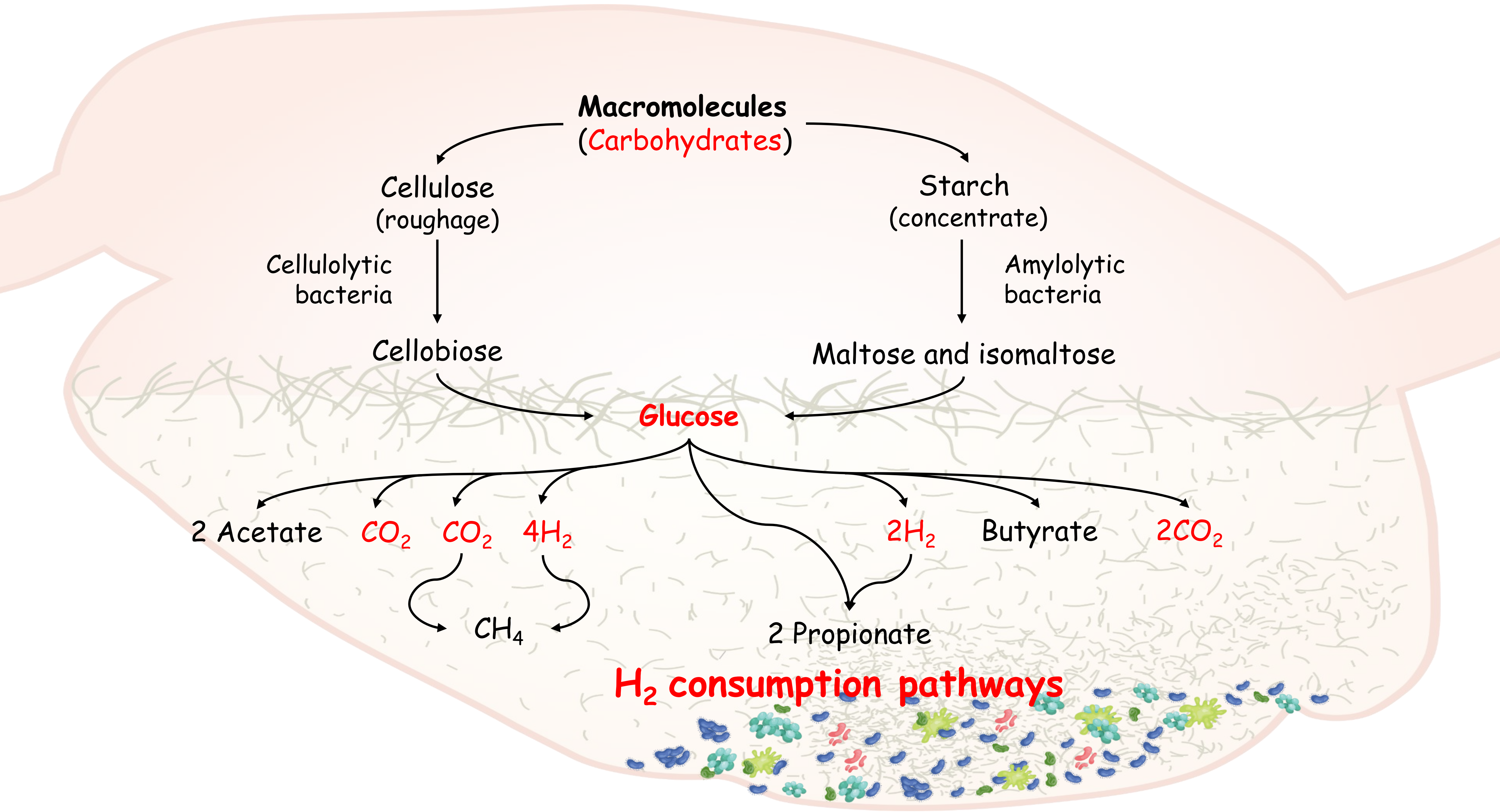
Lipid consuming



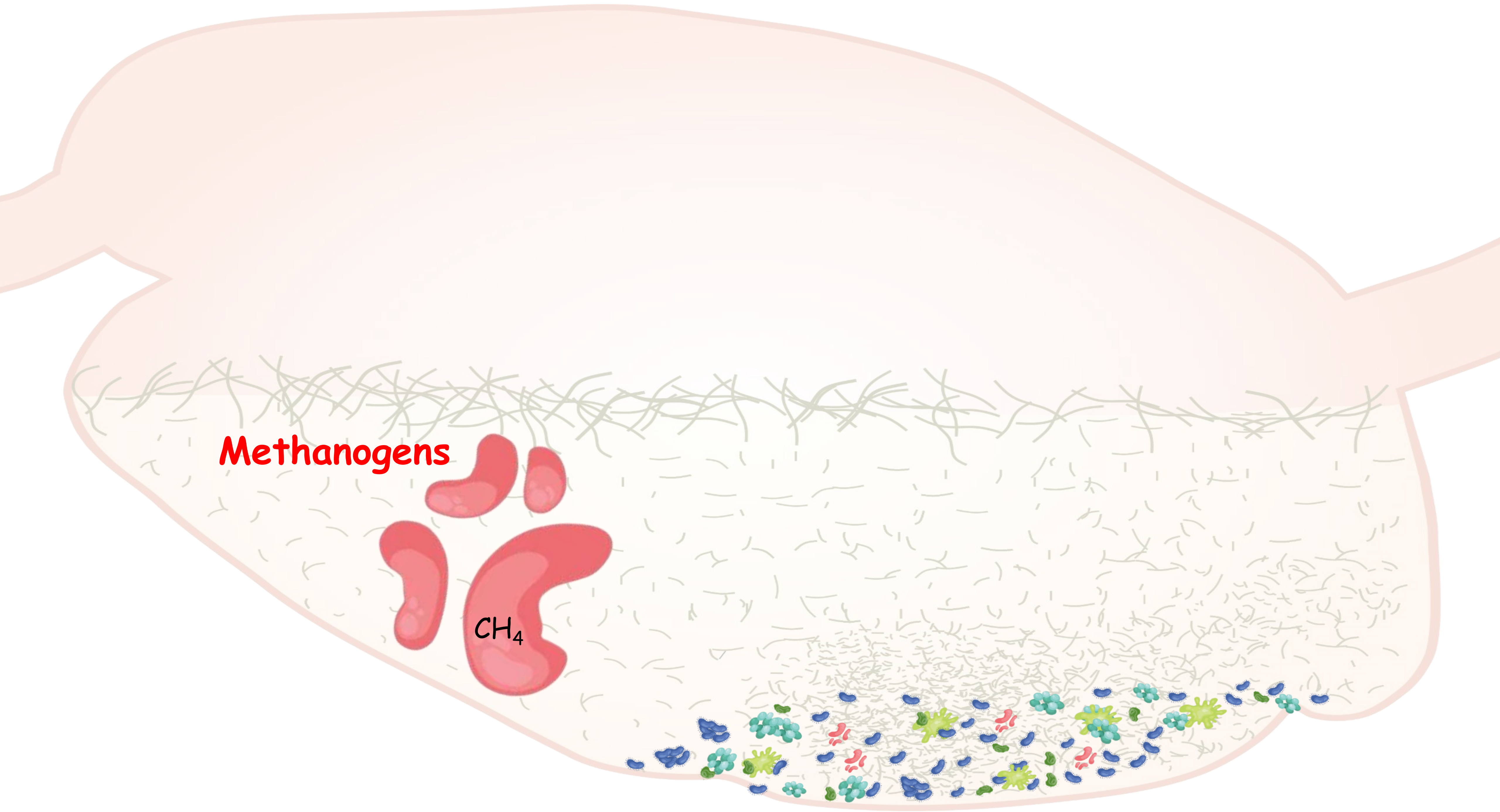

Macromolecules
(Carbohydrates)
Primary bacteria
Simple molecules
(monosaccharides - GLUCOSE)
Embden-Meyerhof Glycolytic Pathway
2 Pyruvate + 2 NADH + 2 ATP
Secondary bacteria
Fermentation end products
(volatile fatty acids and gases)
Dehydrogenases are involved in the reoxidation of NADH.

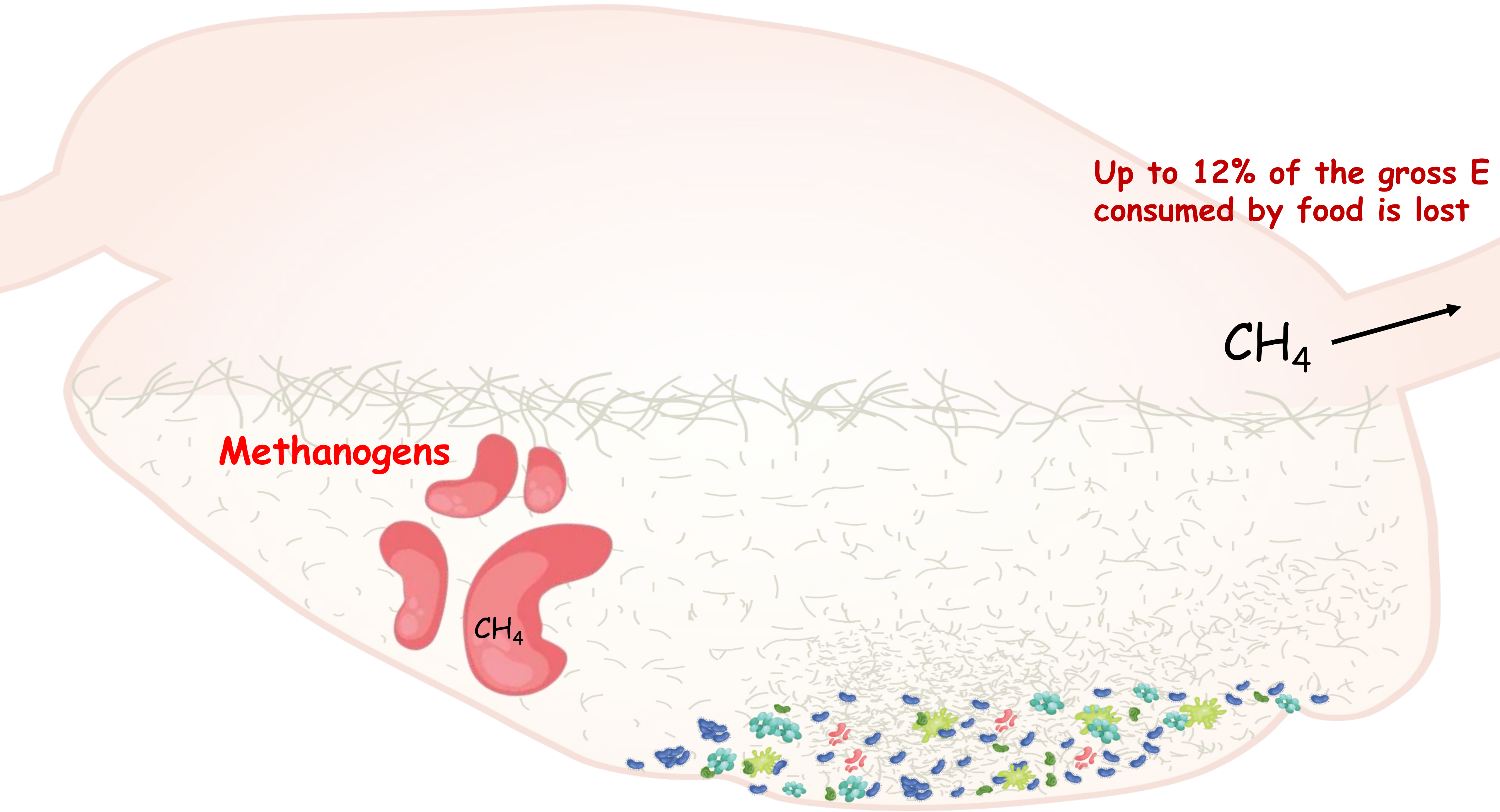

Macromolecules
(Carbohydrates)
Cellulose
(roughage)
Starch
(concentrate)
Cellulolytic
bacteria
Amylolytic
bacteria
Cellobiose
Maltose and isomaltose
Glucose

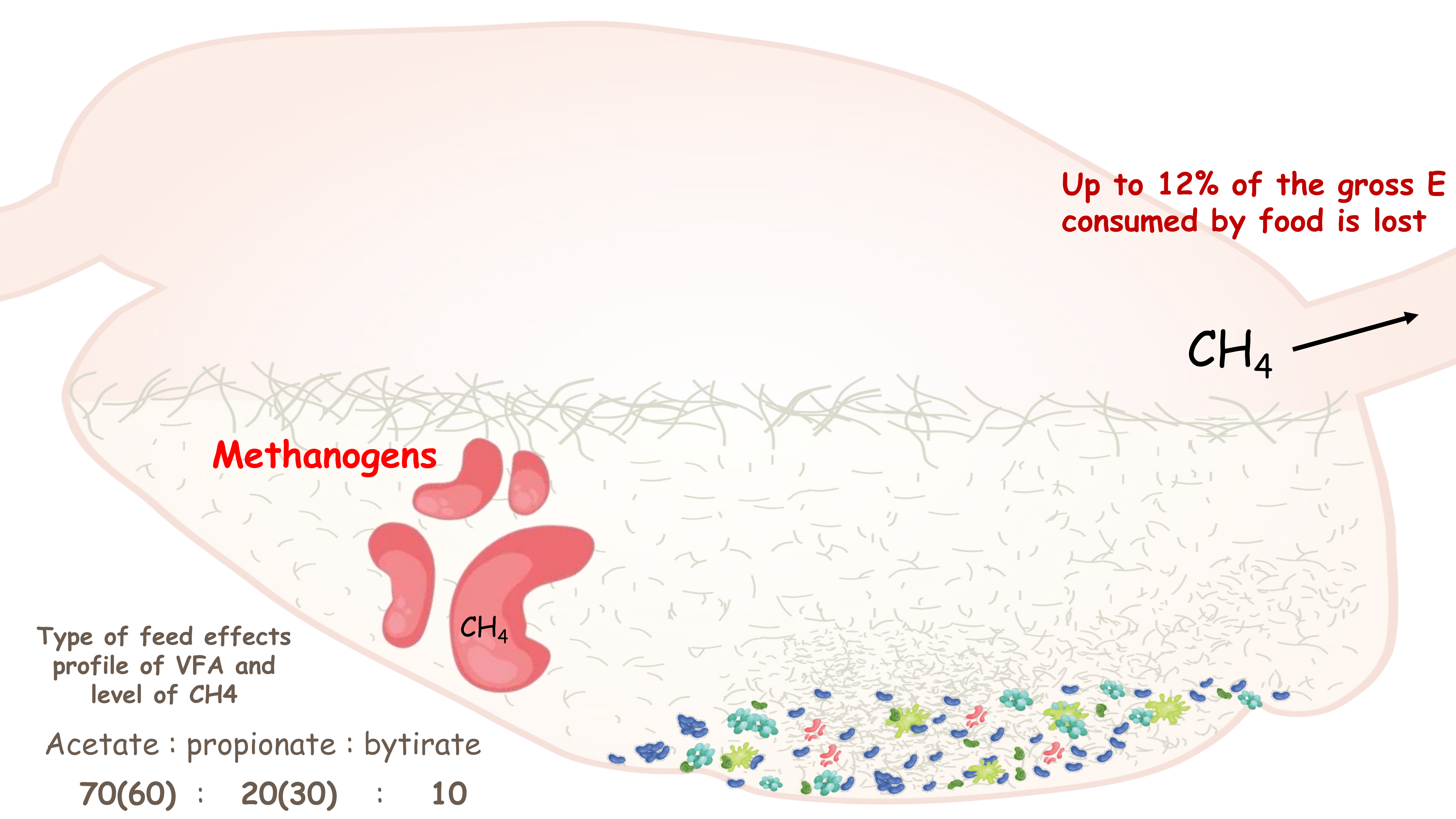

Macromolecules
(Carbohydrates)
Cellulose
(roughage)
Cellulolytic
bacteria
Cellobiose
Starch
(concentrate)
Amylolytic
bacteria
Maltose and isomaltose
Glucose
2 Acetate
CO_2
CO_2
$4H_2$
$2H_2$
Butyrate
$2CO_2$
H_2 release pathways



Macromolecules
(Carbohydrates)
Cellulose
(roughage)
Starch
(concentrate)
Cellulolytic
bacteria
Amylolytic
bacteria
Cellobiose
Maltose and isomaltose
Glucose
2 Acetate
CO_2
CO_2
$4H_2$
$2H_2$
Butyrate
$2CO_2$
CH_4
2 Propionate
H_2 consumption pathways


Methanogens
CH_4


Up to 12% of the gross E
consumed by food is lost
CH4
Methanogens
CH4


Up to 12% of the gross E consumed by food is lost
CH_4
Methanogens
CH_4
Type of feed effects profile of VFA and level of CH4
Acetate : propionate : bytirate
70(60) : 20(30) : 10

CH4 production in rumen is essential for the rumen homeostasis because it avoid excessive accumulation of H2 which could inhibit the activity of dehydrogenases involved in the reoxidation of reduction equivalents (NADH) formed in previous degradable processes

Propionate is end product of rumen fermentation that is probably the principal alternative of the H+ consumption after CH4

Increases in propionate formation is strongly associated with decreases in CH4 production

Two key groups of methanogens

***Methanobrevibacter* SGMT**
(McrI and McrII)

Mbb. smithii, Mbb. gottschalki, Mbb. millerae i Mbb. thaueri

***Methanobrevibacter* RO** (due to coenzymes-not so important)
(McrII)

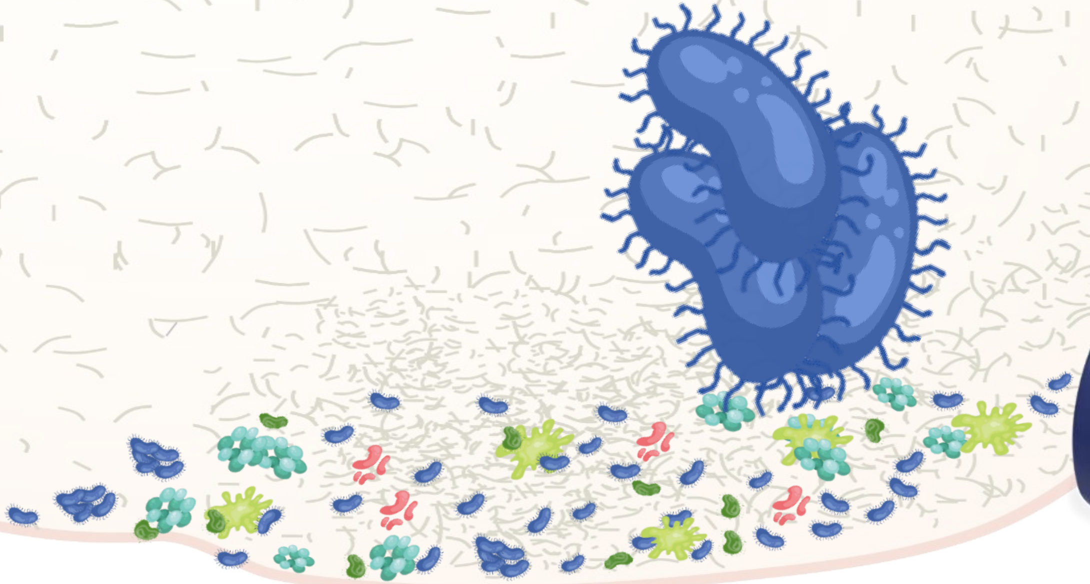
Mbb. ruminantium i Mbb. olleyae

CH_4

Loss of 12% energy

***Propionibacterium* spp.**

Methanogens



<70% E

Acetate : propionate : butyrate
70 : 20 : 10

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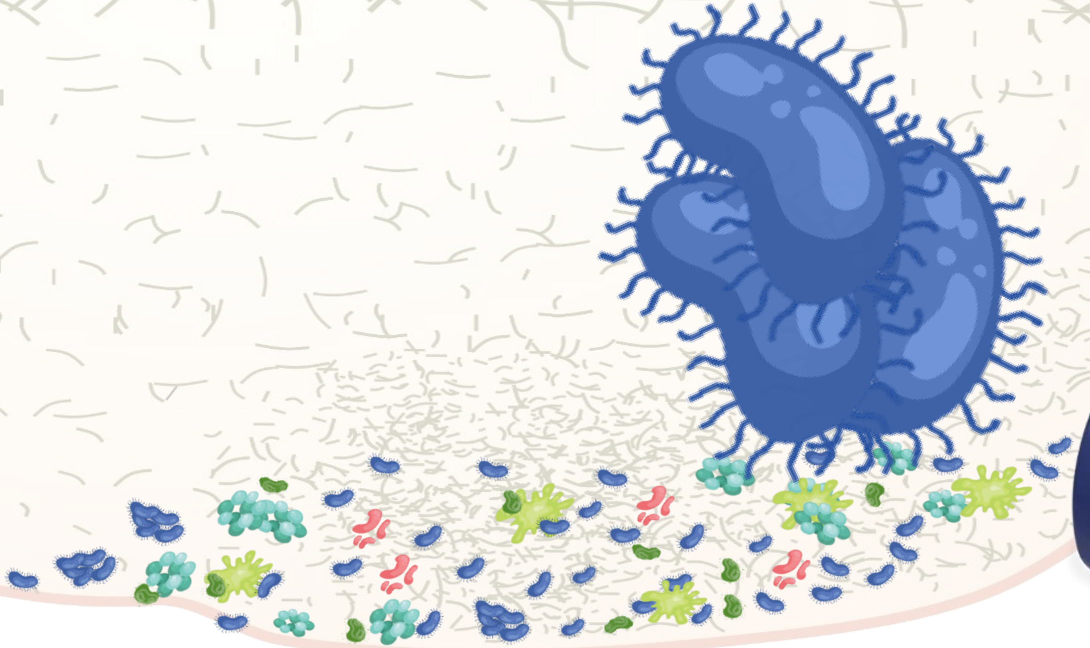
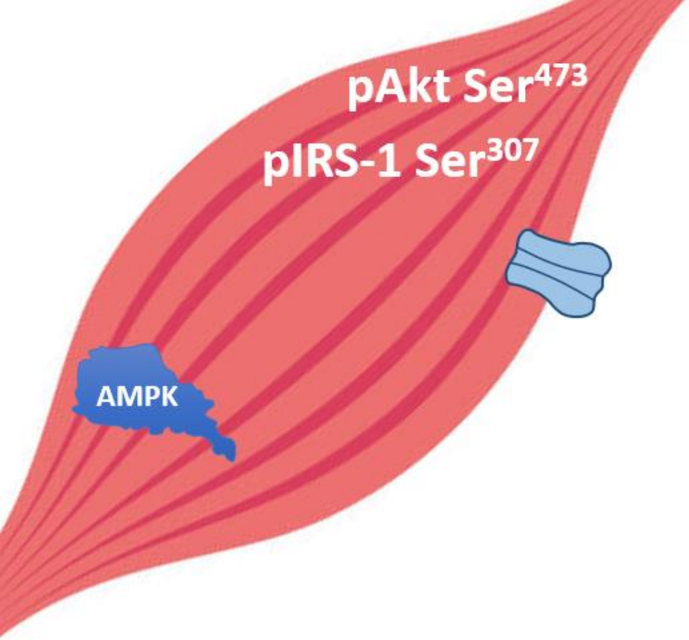
Methanogens



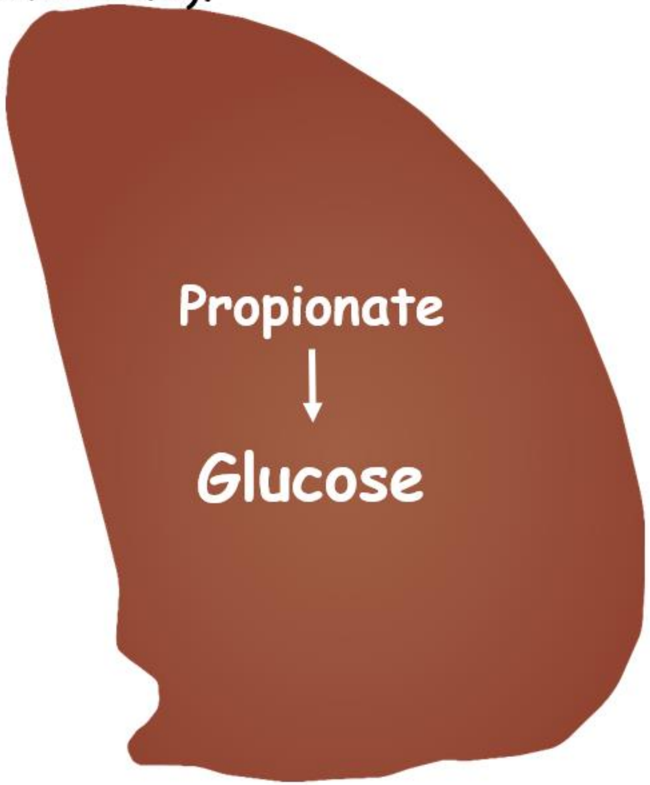
<70% E

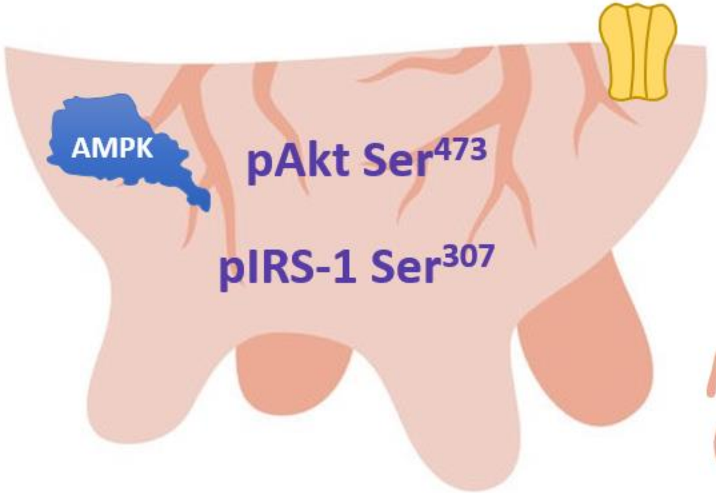
Acetate : propionate : butyrate
40 : 40 : 20



Muscle tissue
(insulin-dependent)

Maximizing the flow of metabolic hydrogen in the rumen away from CH4 and toward propionate would increase the efficiency of ruminant production.
WHY?
Propionate is predominantly used as a glucose precursor in ruminants. From liver, glucose can be redirect to peripheral or mammary tissue (favorable).





Mammary gland
(insulin-independent)

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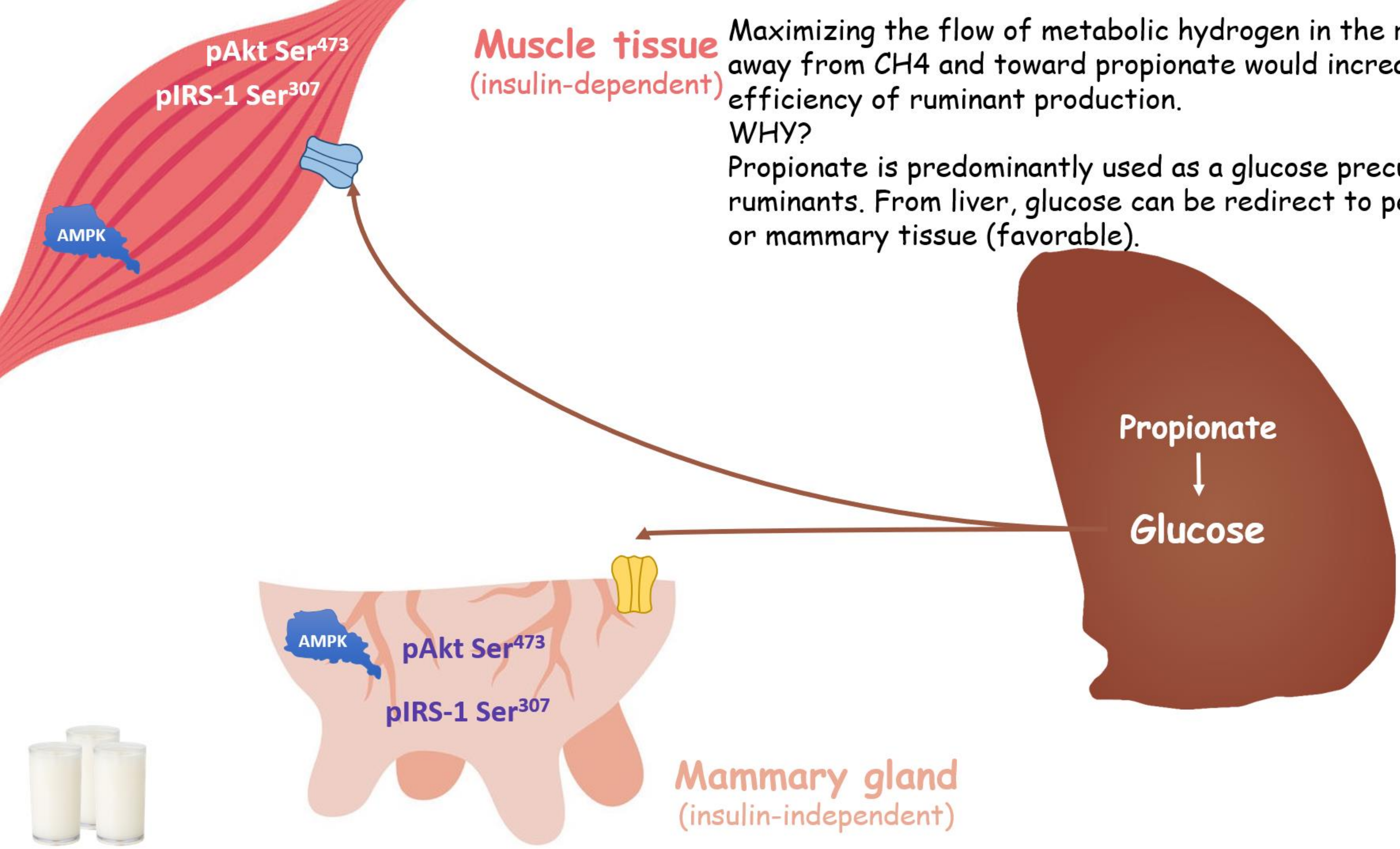

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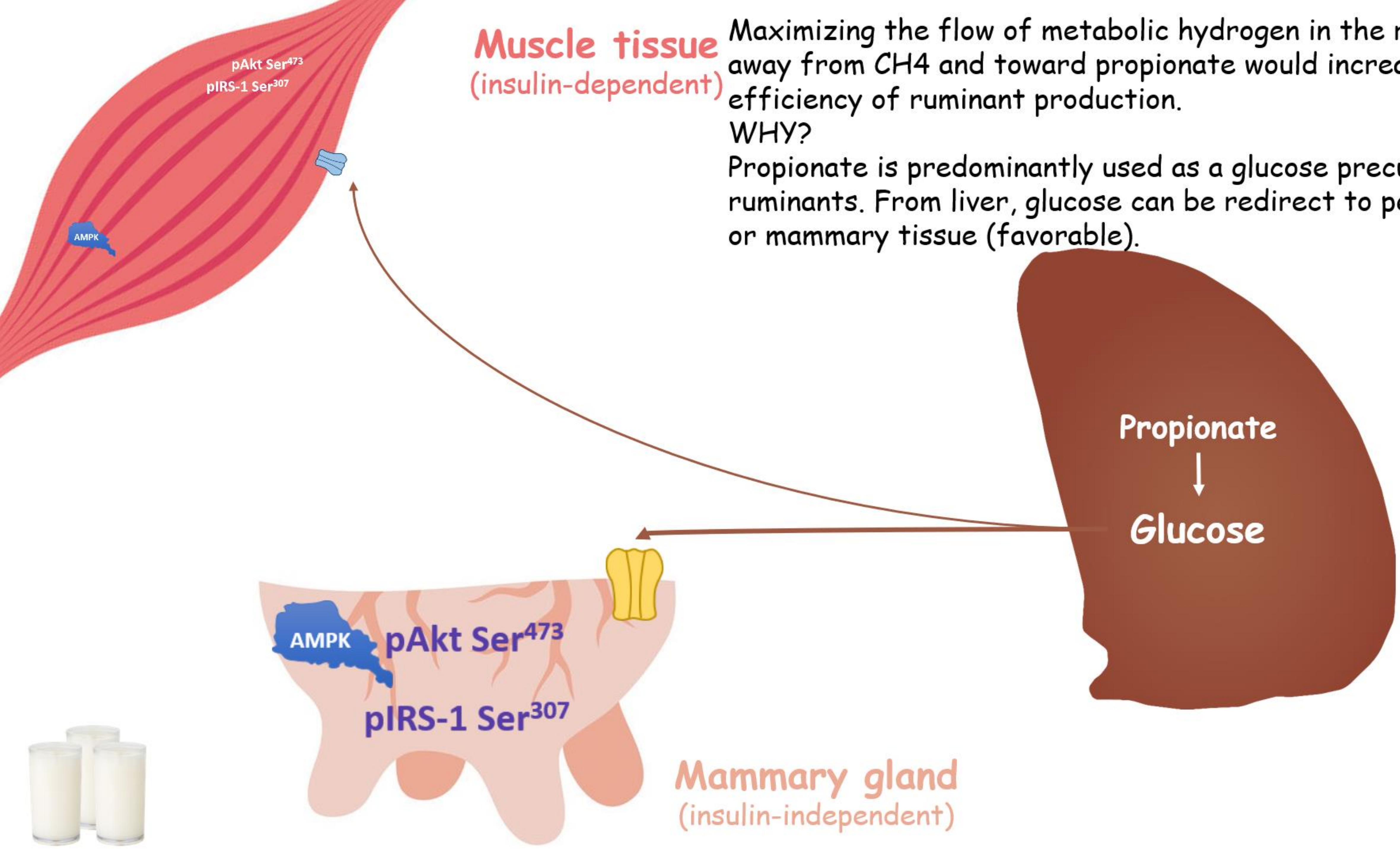

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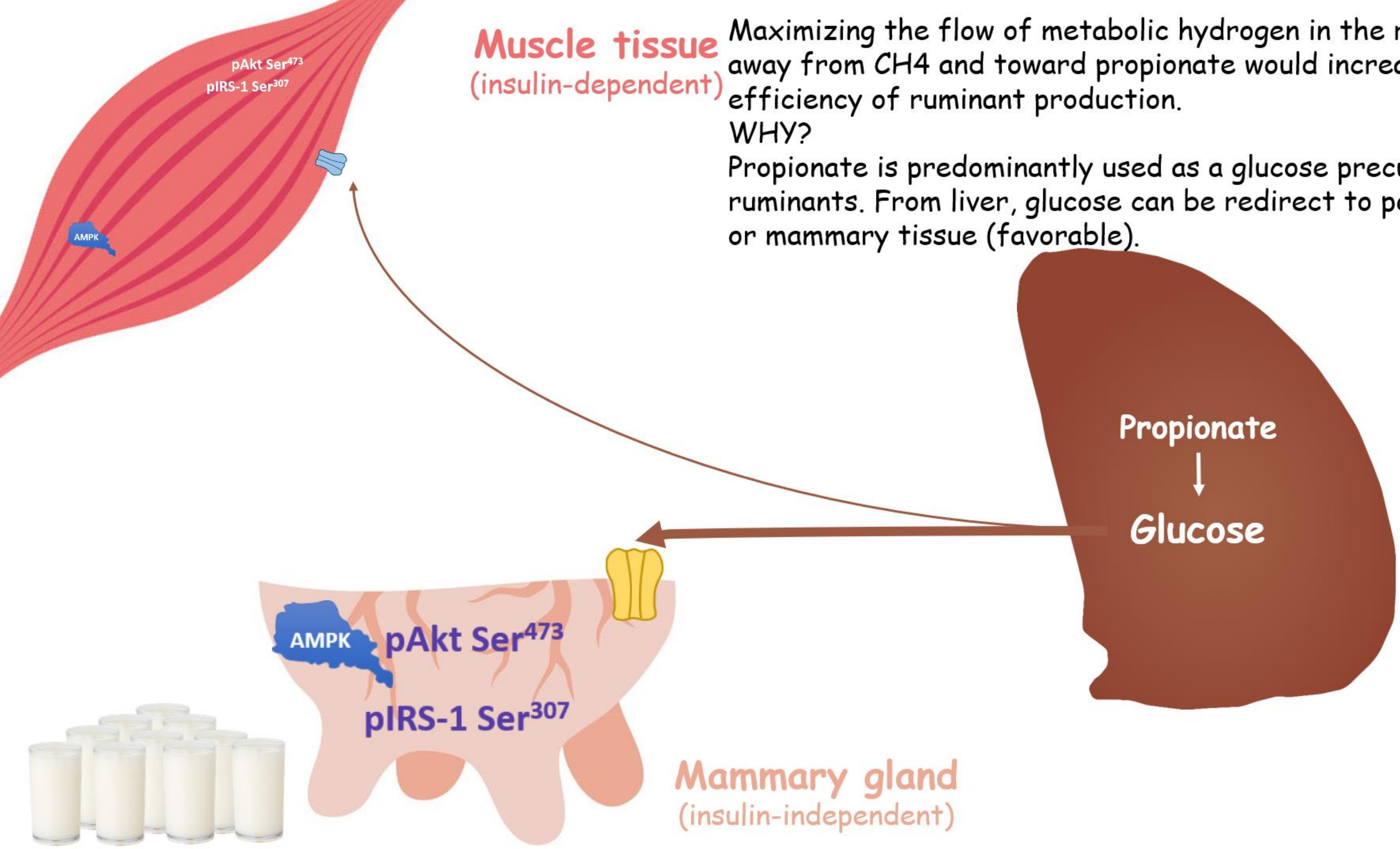


MAIN GOAL of nutritive modulation of metabolism

Modifaing the dietary formulation to shift the H+ flow toward alternative electron acceptors, as propionate

CH_4

Loss of gross energy intake

Milk production

Farm profitability

Ecologically friendly and high-profitable dairy farms

Nutritive modulation of metabolism
Dietary supplements

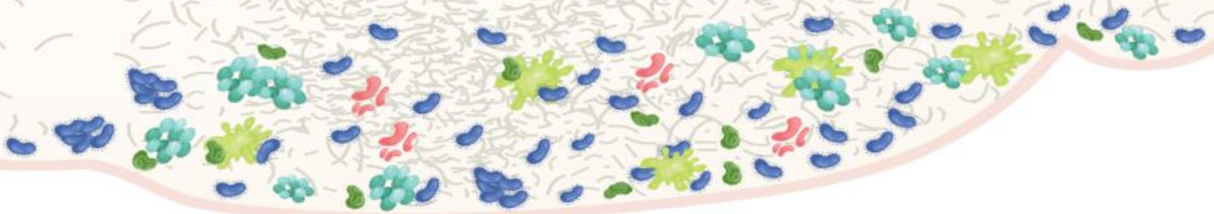
Tannins

Bactericidal effect - reducing the population of methanogens (Honan et al., 2021).

Improve antioxidant defense mechanisms (Prodanović et al., 2023).

CH_4

Reduce emissions



Nutritive modulation of metabolism
Dietary supplements

Tannins

Diallyl disulfide

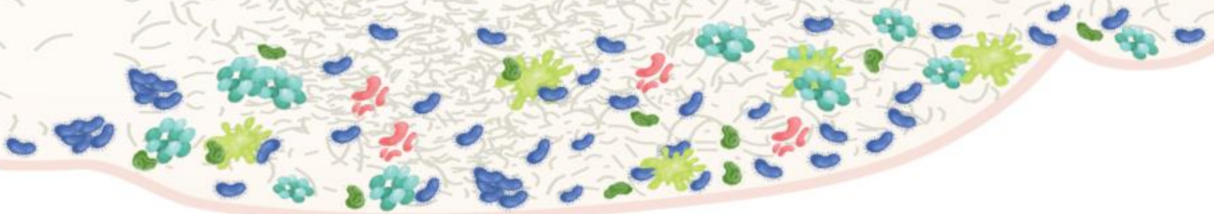
Inhibition of the enzyme system of archaea (Kirovski et al. – unpublished data).

Antimicrobial properties (Nakamoto et al., 2020).

Reppelent effect on insects – natural flies control for cattle (Showler, 2017).

CH_4

Emissions reduced by 60-70%



Nutritive modulation of metabolism

Dietary supplements

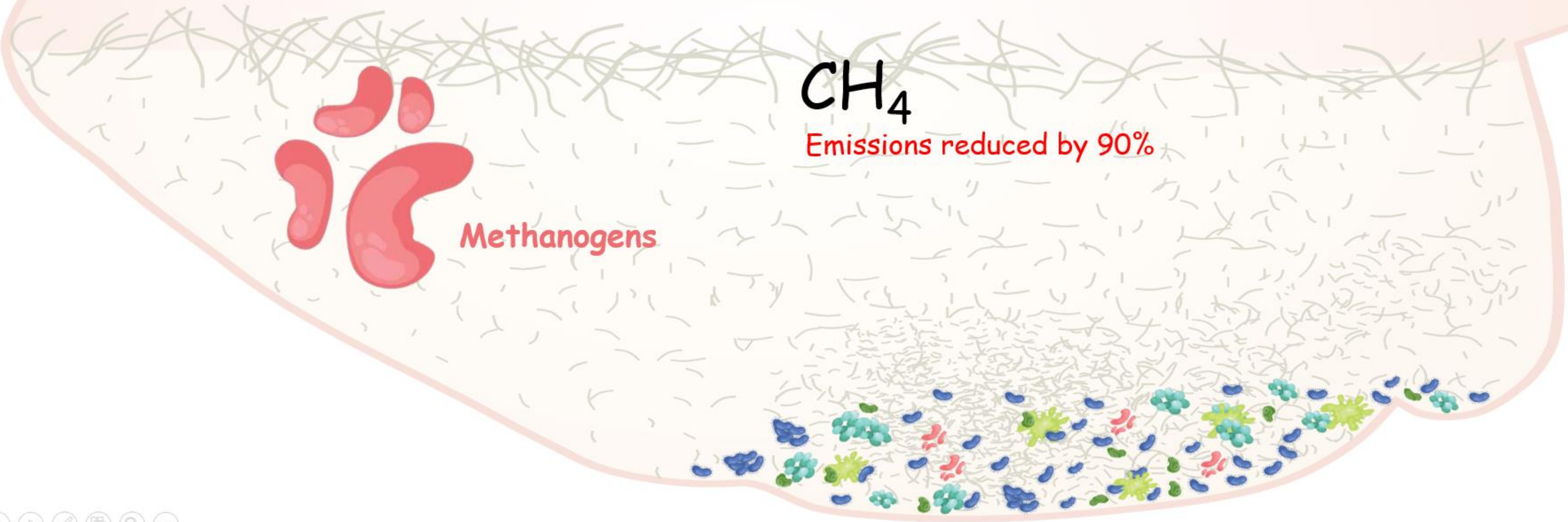
Tannins

Diallyl disulfide

Brown seaweed (Phlorotannins)

Improve milk productivity, milk quality and health of milking cows (Nguyen et al., 2022).

Suppress the population of cellulolytic bacteria (Machado et al., 2014).



Nutritive modulation of metabolism
Dietary supplements

Tannins

Diallyl disulfide

Brown seaweed (Phlorotannins)

Red seaweed (Bromoform)

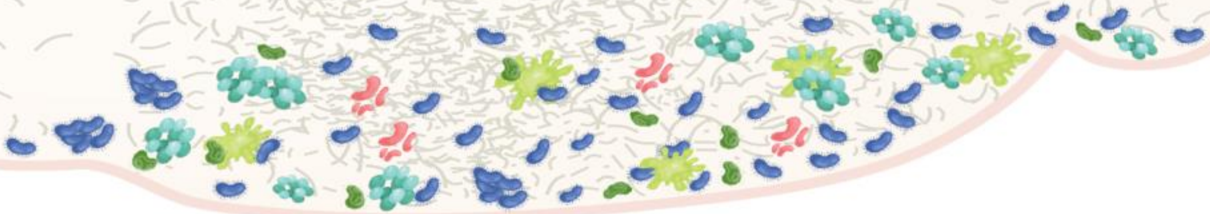
Improve milk productivity, milk quality and health of milking cows (Nguyen et al., 2022).

Block corrinoid enzymes and inhibit cobamide-dependent methyl group transfer in methanogenesis (Abott, 2020).

CH_4

Emissions reduced by 90%

Methanogens



Nutritive modulation of metabolism
Dietary supplements


Tannins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Brown seaweed (Phlorotannins)


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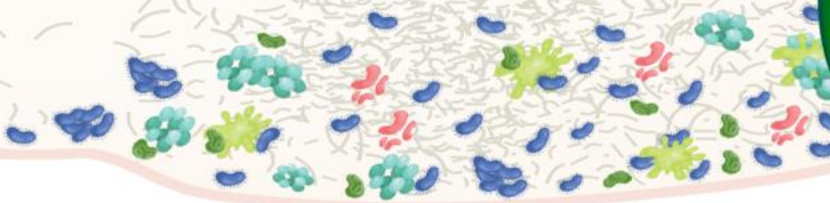
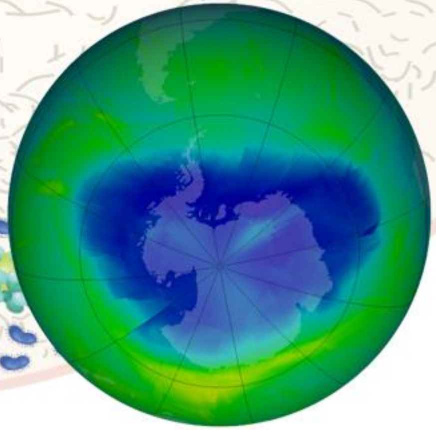
Methanogens

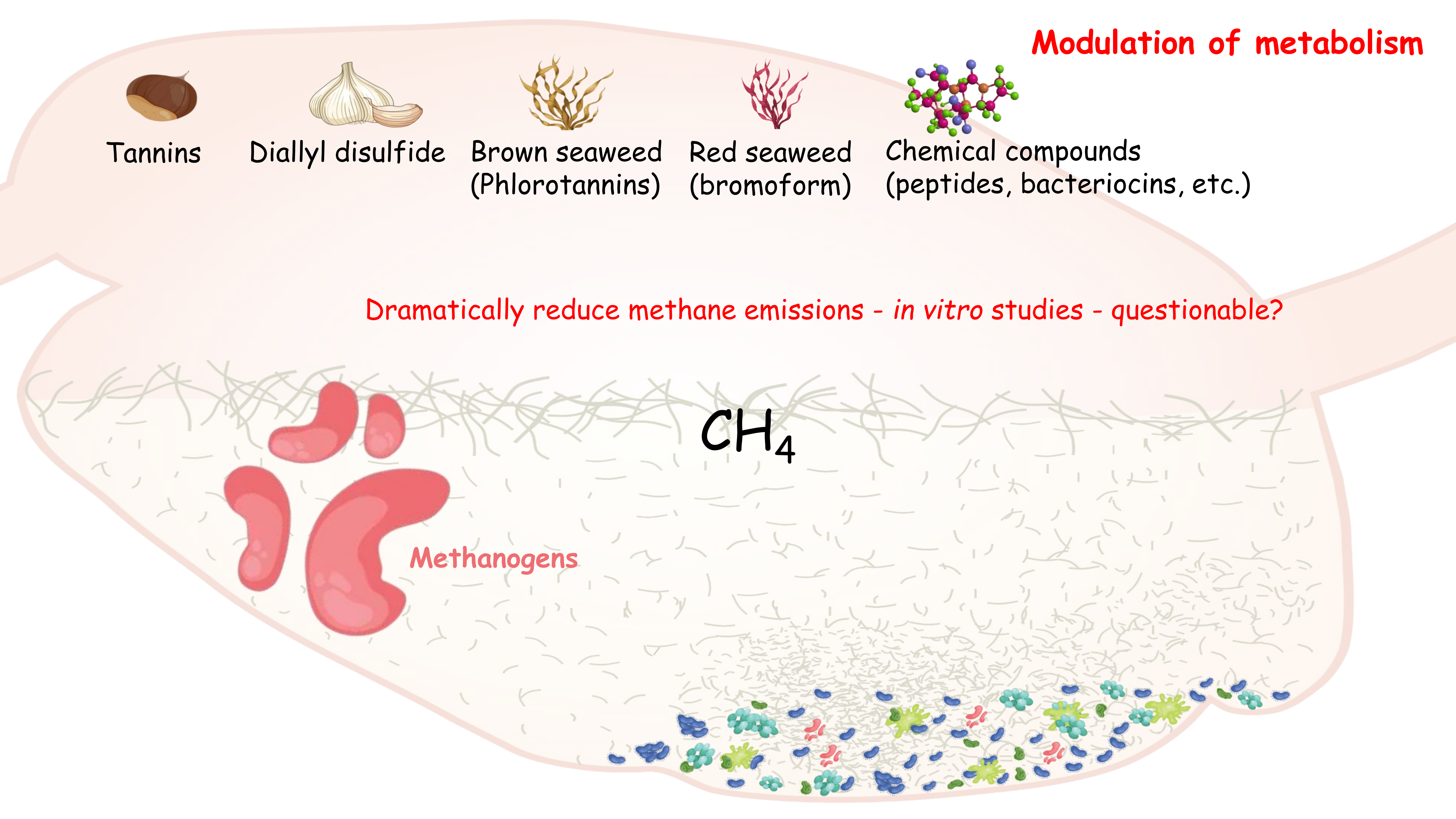
CH_4

Emissions reduced by 90%

However...

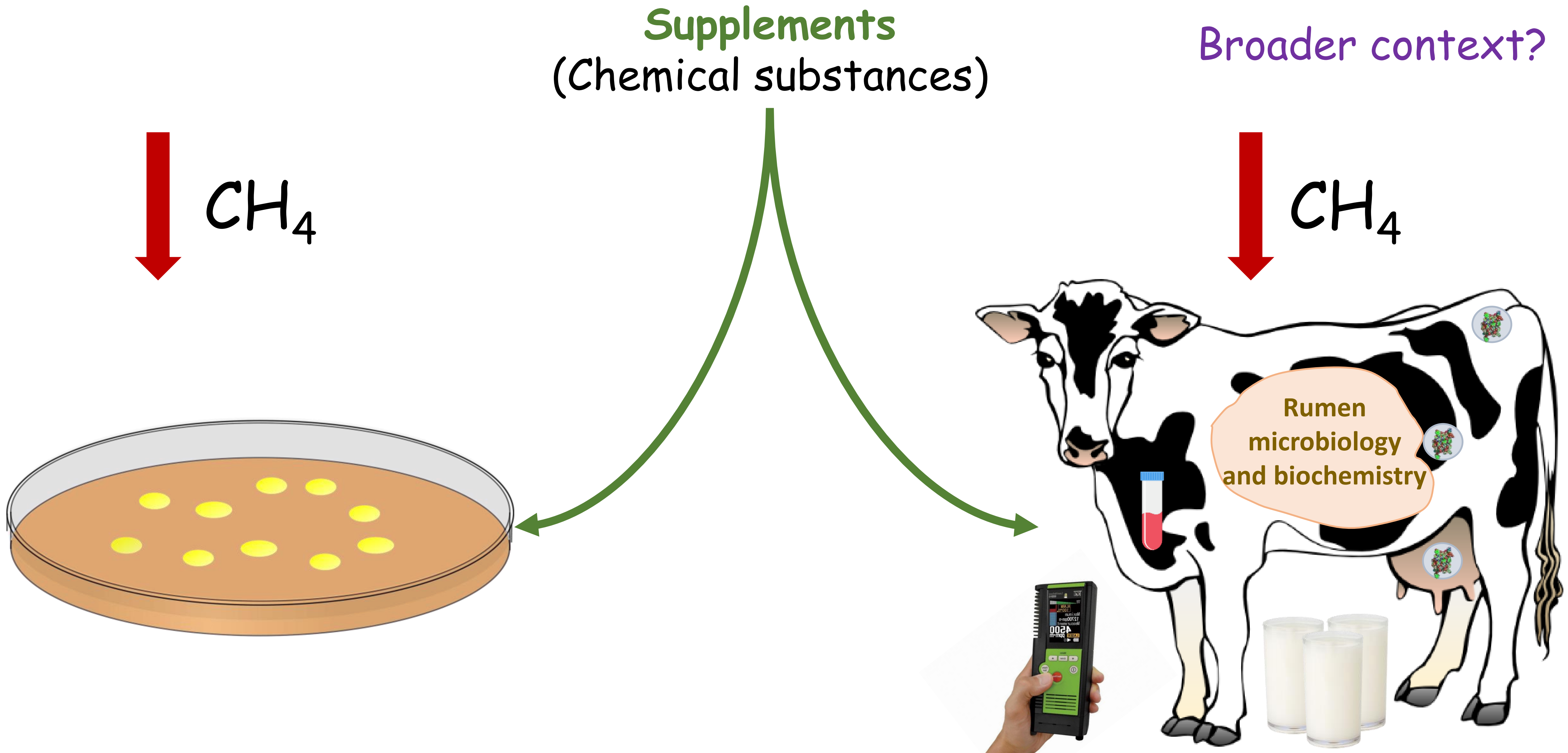




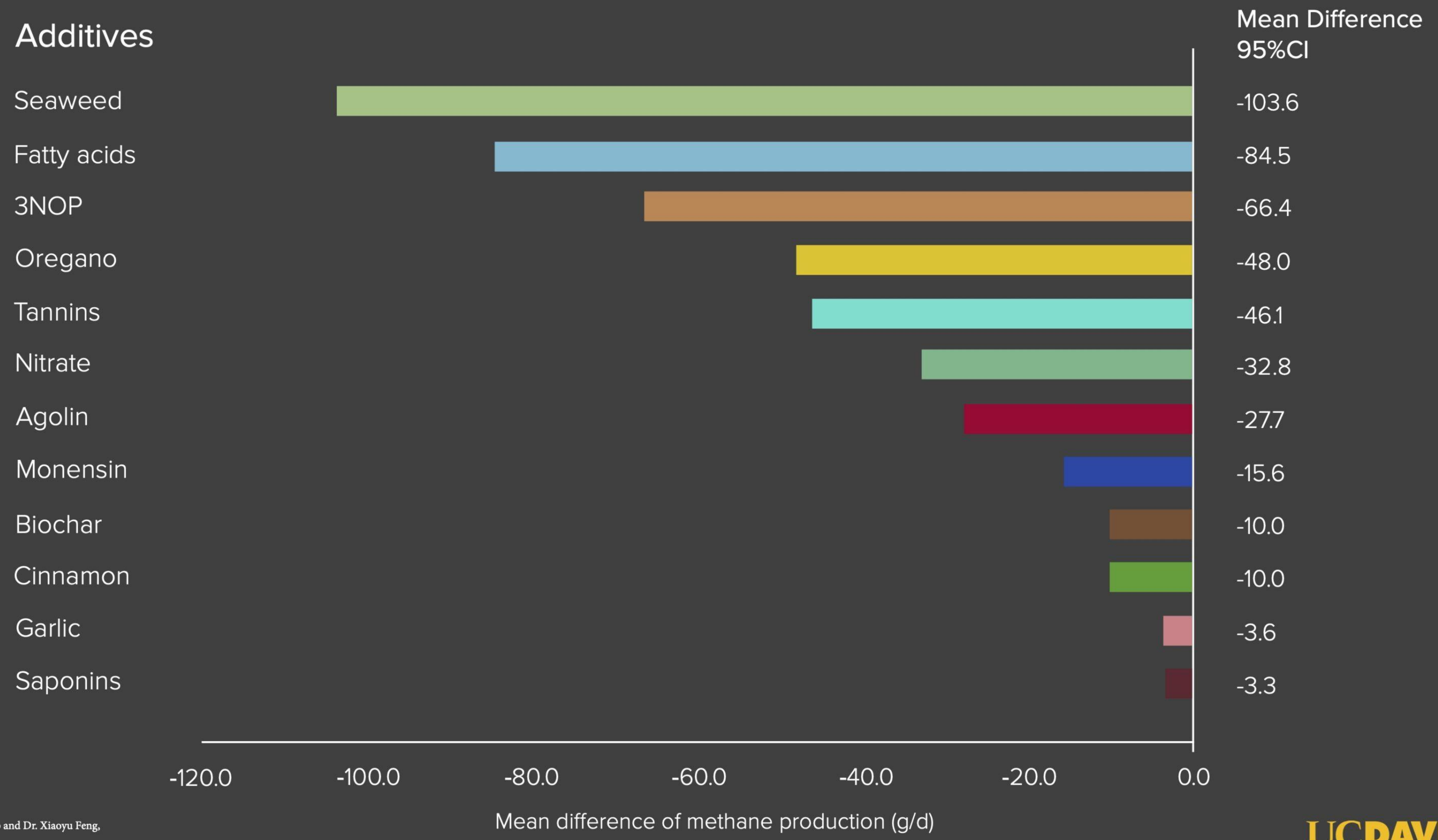


Modulation of metabolism
Tannins
Diallyl disulfide
Brown seaweed (Phlorotannins)
Red seaweed (bromoform)
Chemical compounds (peptides, bacteriocins, etc.)
Dramatically reduce methane emissions - *in vitro* studies - questionable?
CH_4
Methanogens

In Vitro Vs. *In Vivo* Studies



Methane Reductions from Feed Additives



Created based on the work of Dr. Ermias Kebreab and Dr. Xiaoyu Feng, University of California, Davis.
https://ww2.arb.ca.gov/sites/default/files/2020-12/17RD018.pdf

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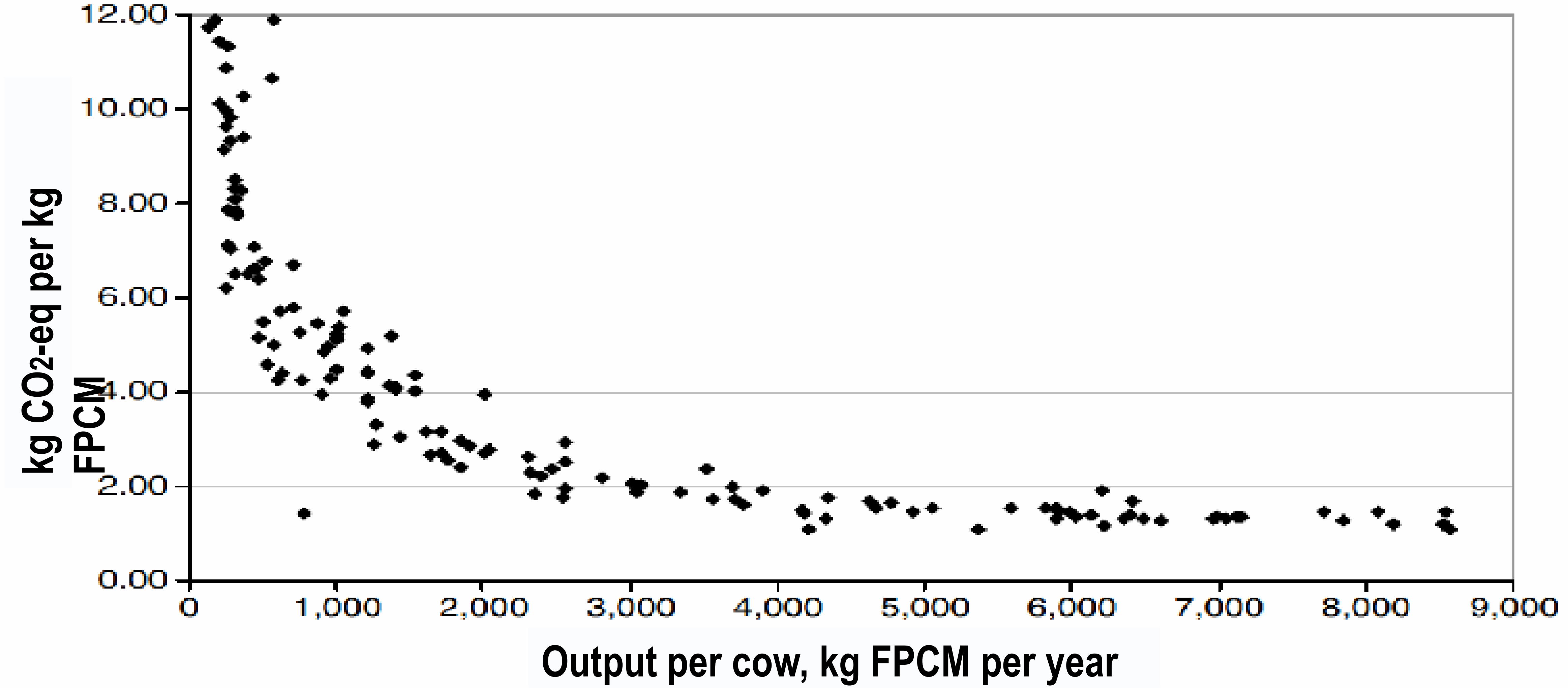
It is important to consider the enteric production of CH_4 per unit of livestock product (kg of milk) because it is necessary to aim for the balance between produced food for a growing human population and GHGs emissions including CH_4



*FPCM – fat-protein corrected milk.

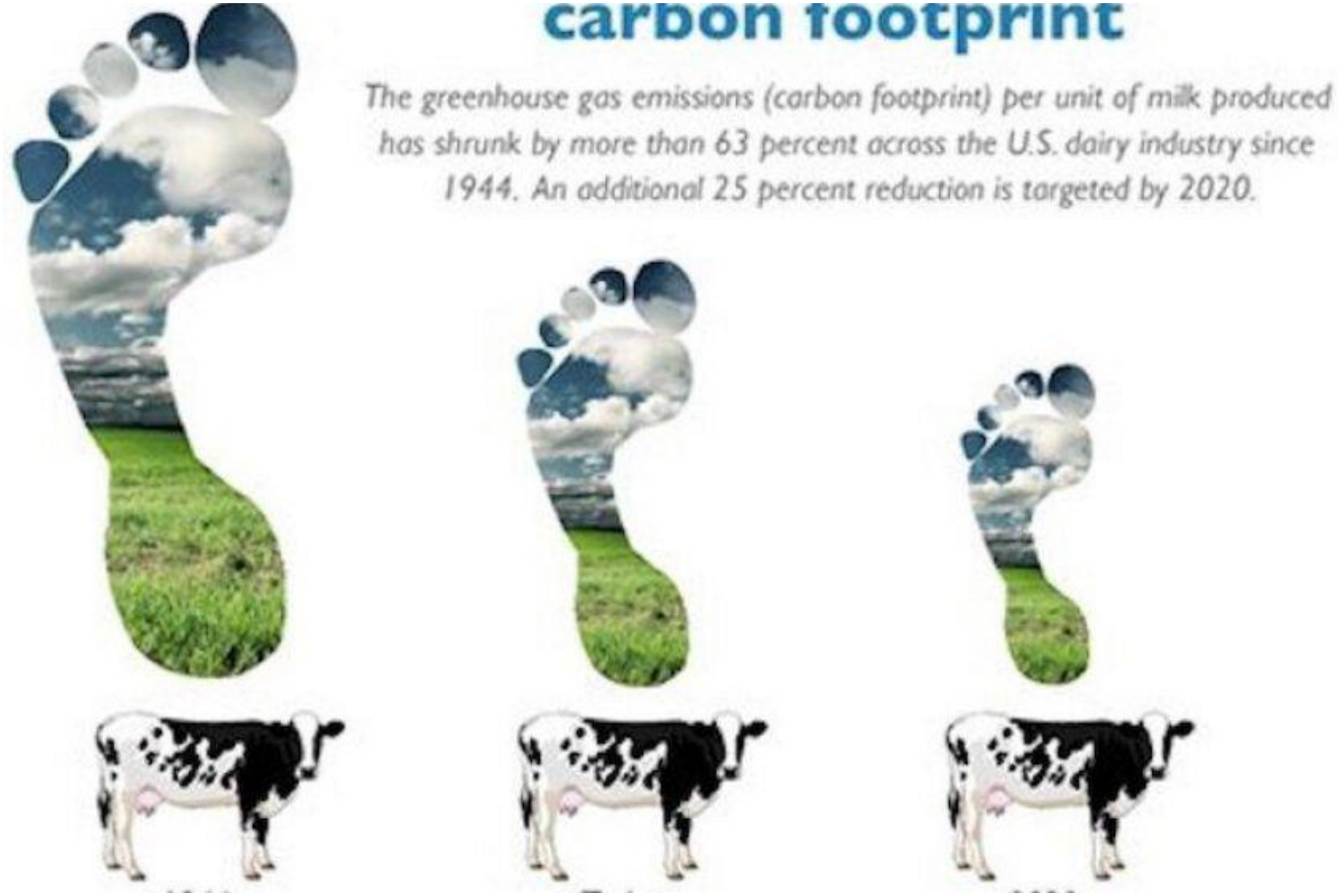
„Carbon footprint“

The total amount of GHG emissions associated with a product, along with its supply-chain. It is usually expressed in kilograms or tones of carbon dioxide equivalent (CO2-eq). Methane emitted from enteric fermentation is the major hotspot contributing up to 75 per cent of the total GHG emissions of the dairy sector.

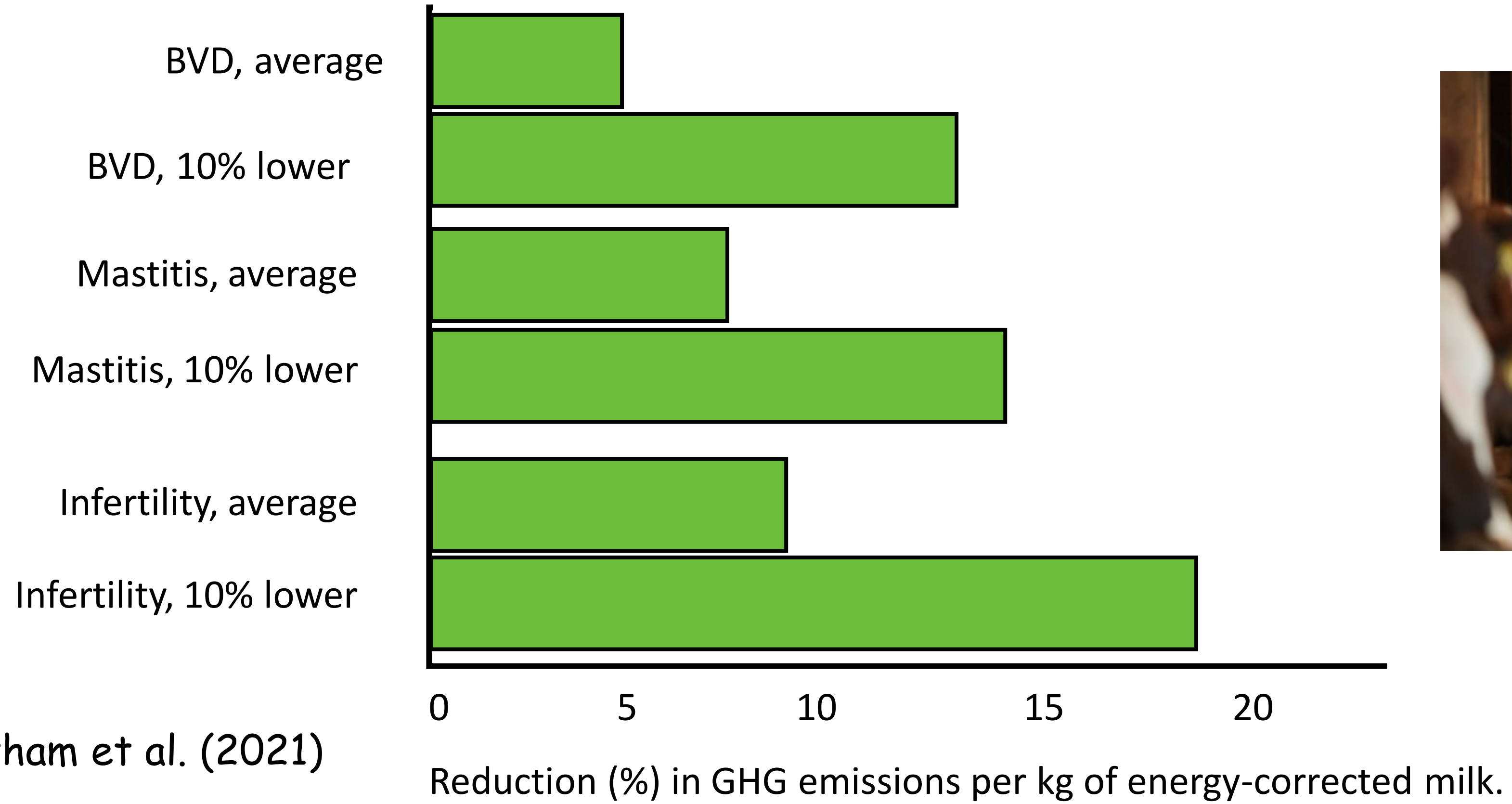
The CF of dairy products from range from: 1.0-6.0 kg CO2e per kg fresh dairy products, 4.5-10.0 kg CO2e per kg cheese

„Carbon footprint"

More efficient cow (higher milk production) – lower CF per kg dairy product

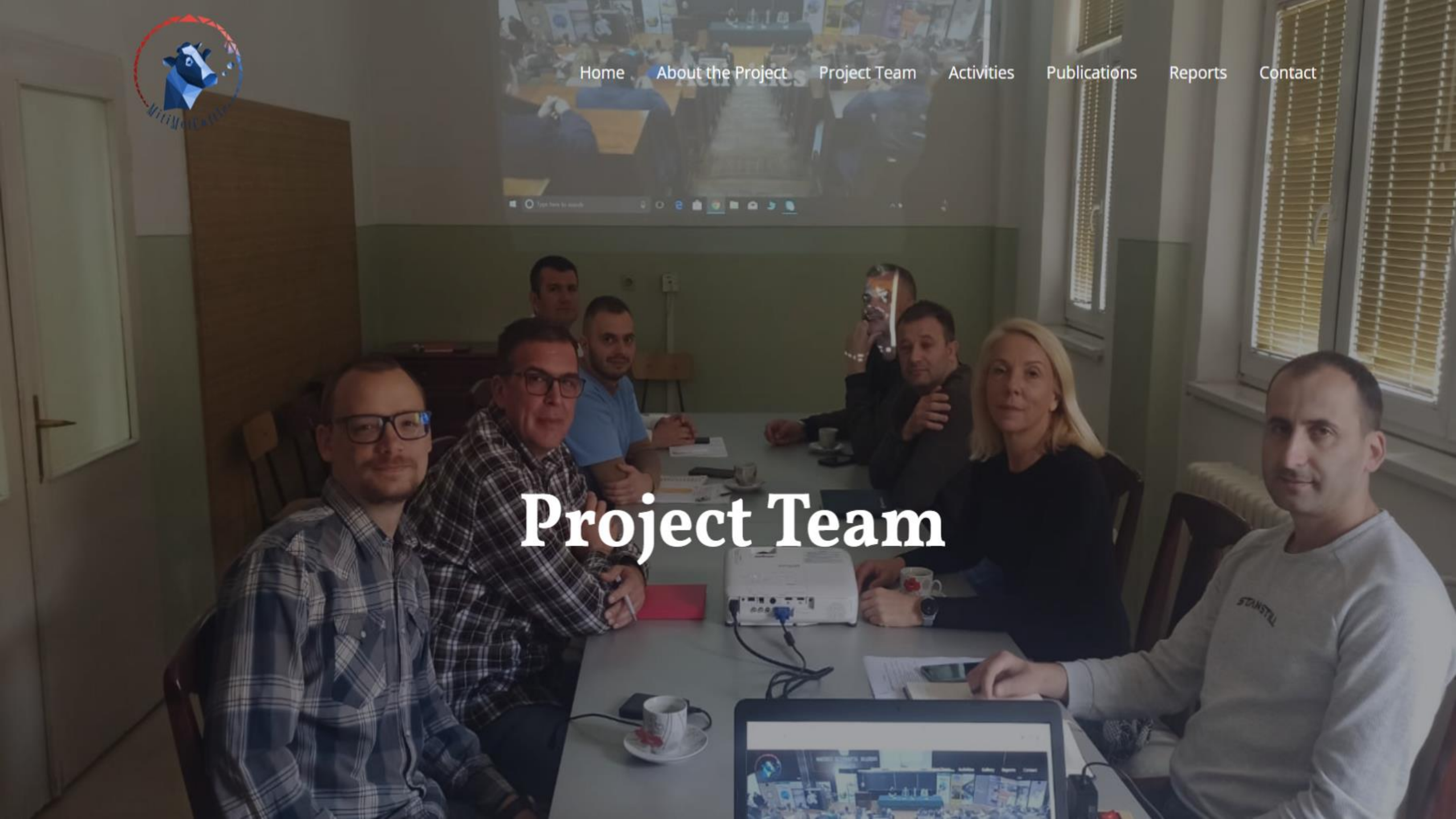


GHGs emissions can be significantly reduced by controlling the occurrence of diseases in the herd



Statham et al. (2021)

By monitoring health status of dairy cows ALL VETERINARAIN CONTRIBUTE TO ENVIROMENTAL PROTECTION by decreasing GHGs EMISSION



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Thank you for your attention
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www
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