Animal waste as a source of by-products and bioenergy

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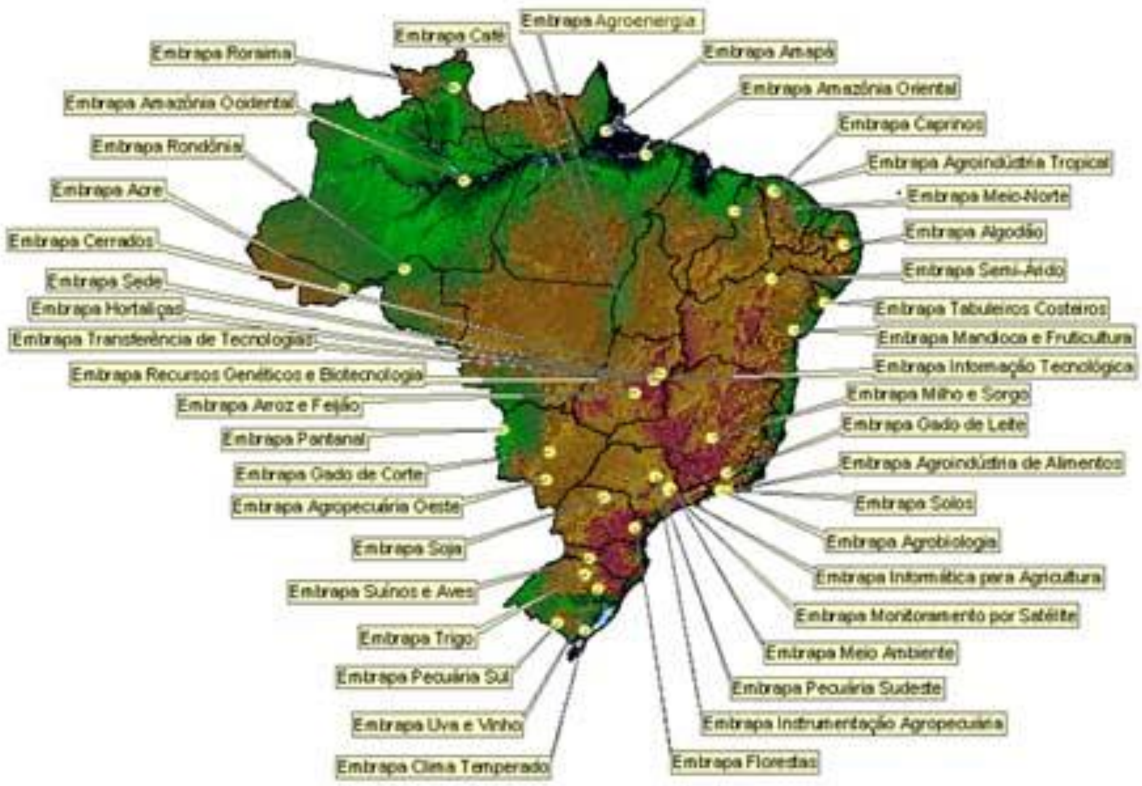
BRAZILIAN GOVERNMENT BRASIL

EMBRAPA in Brazil



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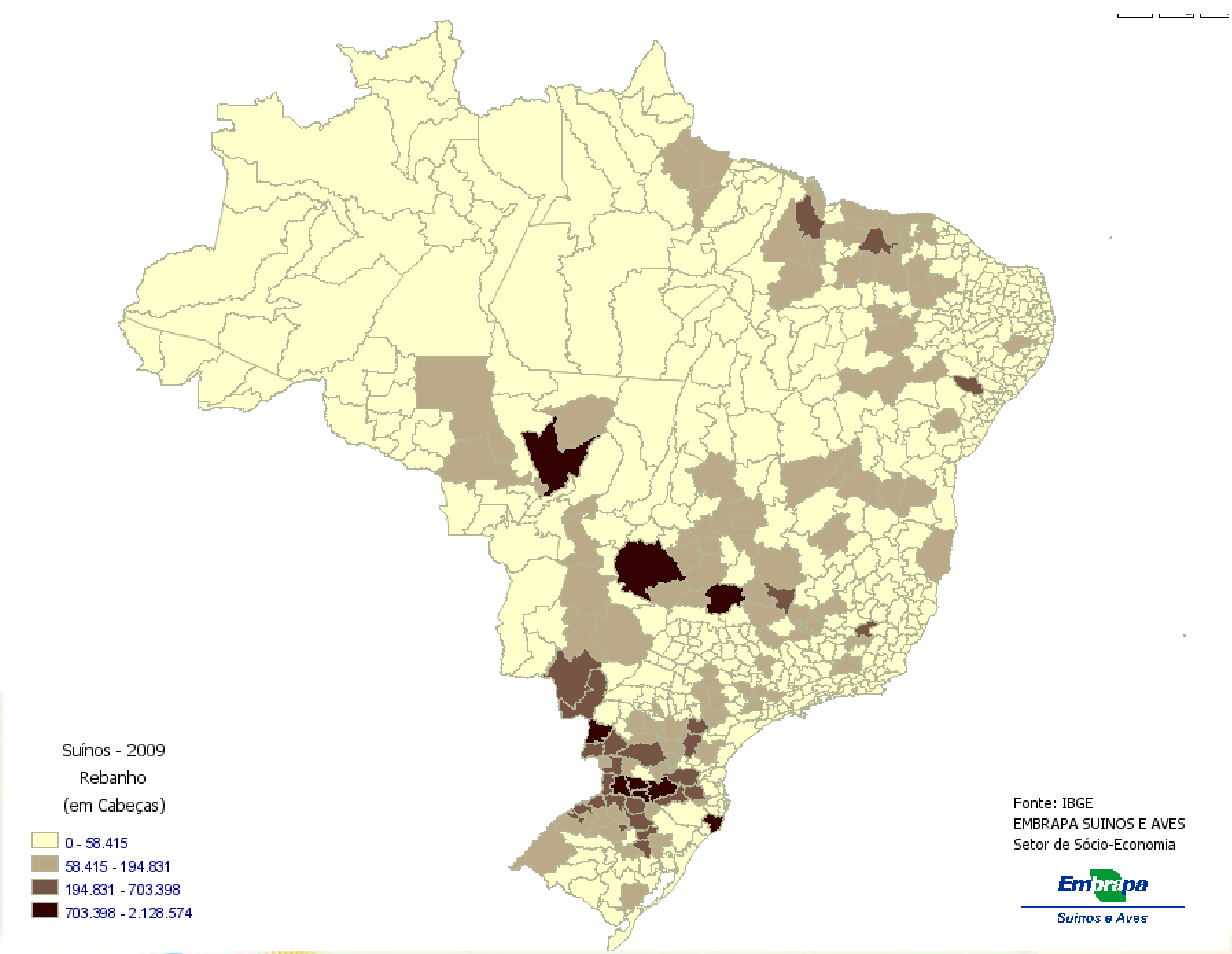
Swine productivity



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Environmental Constrains

Parameters	Domestic wastewater	Swine effluent
Nitrogen	**150**	**2.374 (15×)**
Phosphorus	**25**	**578 (23×)**
BOD	770	14.333
COD	1,830	25.542

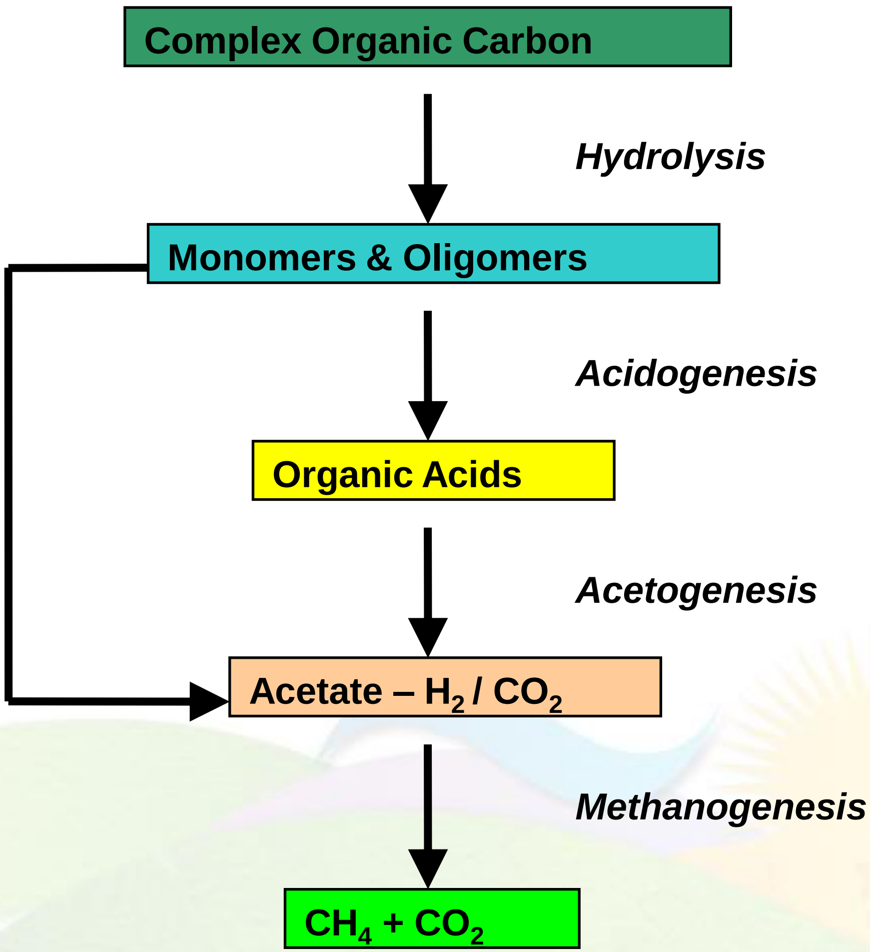
Eutrophication

Uruguay river reservoir, 2001.

Covering lagoons

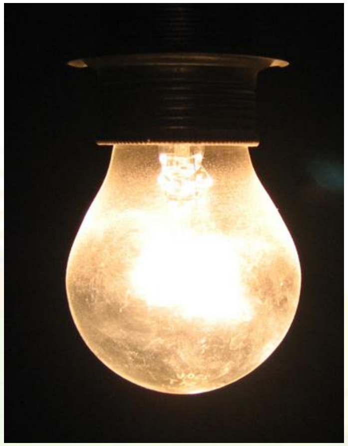
Anaerobic lagoon, Brazil

Biomethane

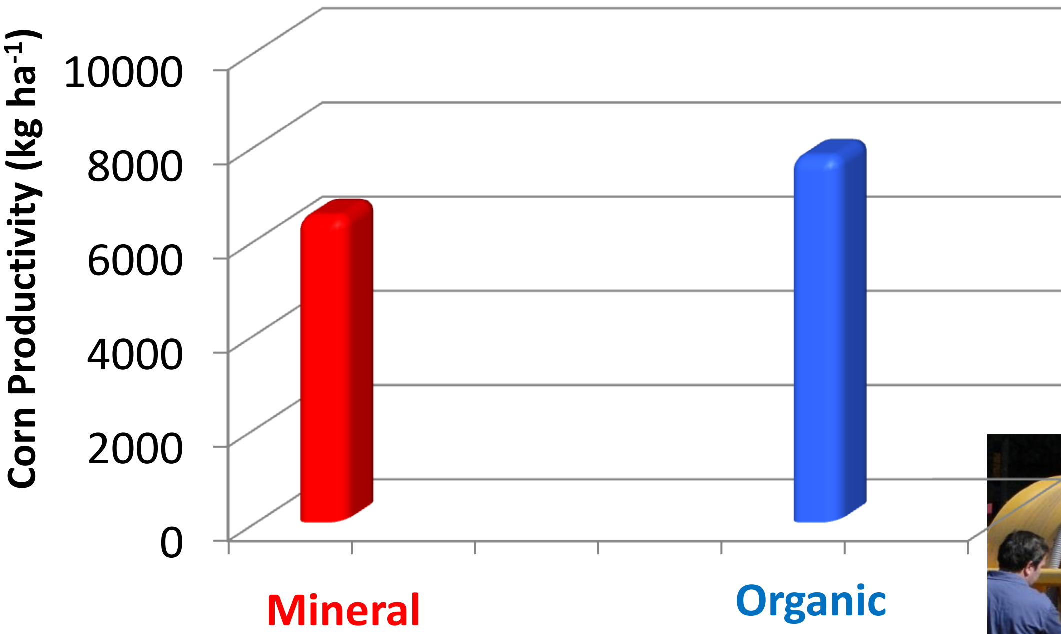


Complex Organic Carbon
Hydrolysis
Monomers & Oligomers
Acidogenesis
Organic Acids
Acetogenesis
Acetate – H_2 / CO_2
Methanogenesis
CH_4 + CO_2

Electricity generation



Biofertilizer



Biofertilizer

Pro	Cons
Low cost	Land availability
Micronutrients	Topography
Formulations versatility	Transportation costs
Easier handling and applicability	Groundwater contamination
High absorption efficiency	Greenhousing emissions
	Odors
	NH_4 losses

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Composting

- Volume reduction → facilitates transportation
- Nutrient-rich organic fertilizer
- Mitigation of greenhouse gases emissions (compared to lagoons)
- Flies and odor control
- Pathogens reduction

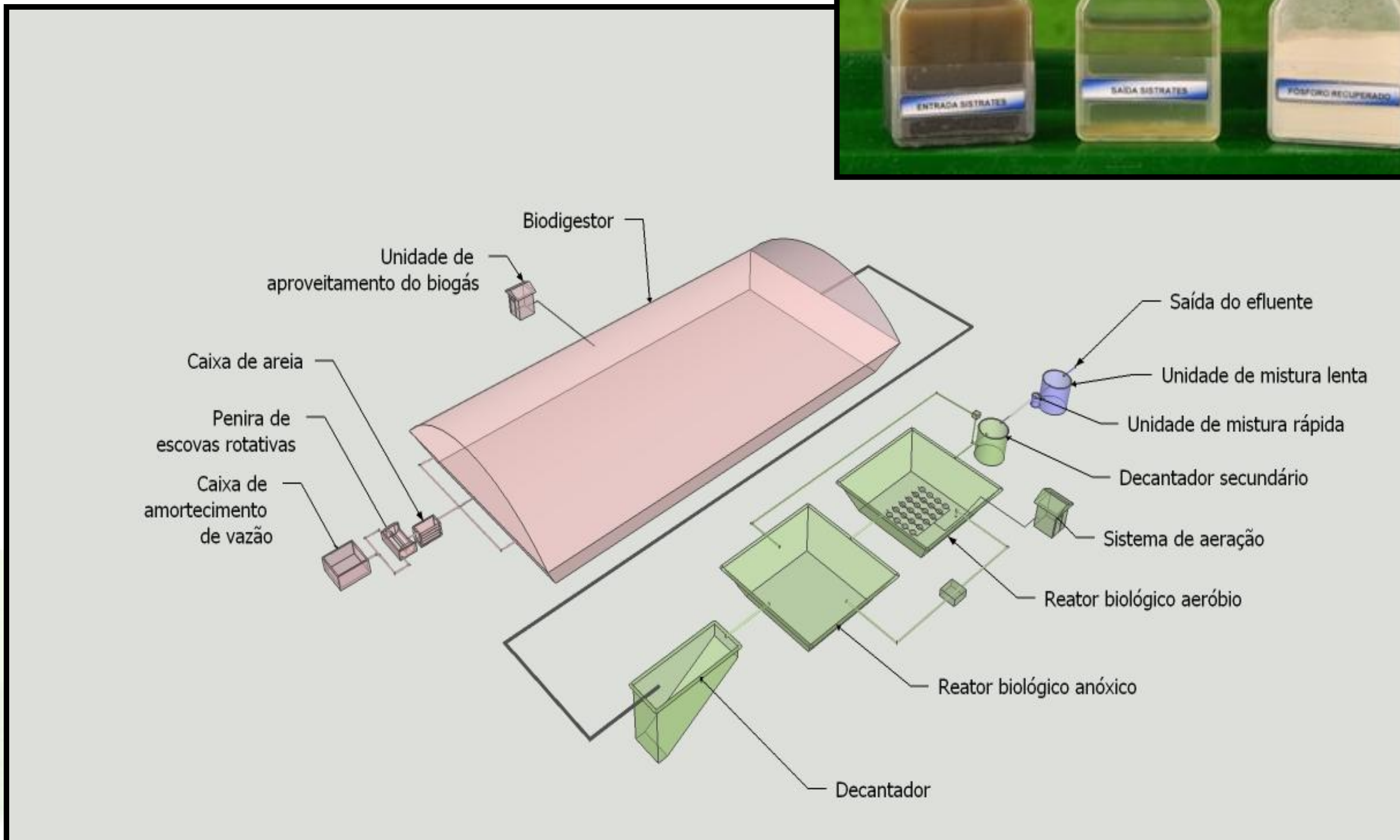
Accelerated Composting

- Enhancement of thermophile activities
- Lower retention times
- Higher compost quality
- Requires less moisture and a wide source of combined wastes: poultry, manure, eggs, dead chickens, etc.

Assessment of greenhousing emissions

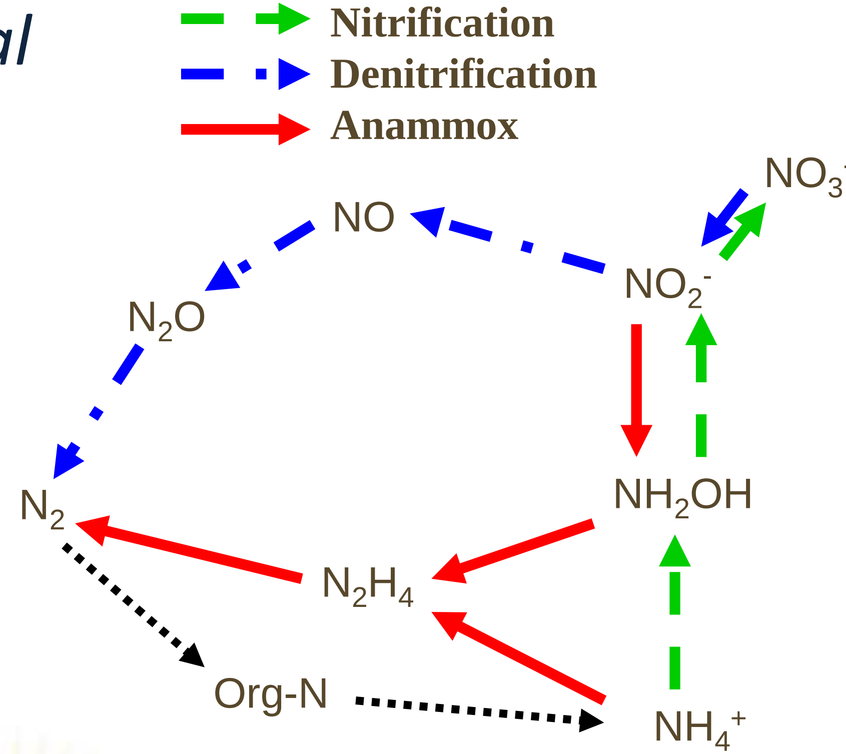
SISTRATES

Swine effluent wastewater treatment plant



- ANAMMOX -

High rate nitrogen removal



- Nitrogen rich effluent with low carbon
- 60× more efficient than nitrification and denitrification - 18 Kg N/m·d

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Phycoremediation

Phycoremediation of nutrients

Phosphorus - 0,02 mg-P/L
Total nitrogen < 1,27 mg/L

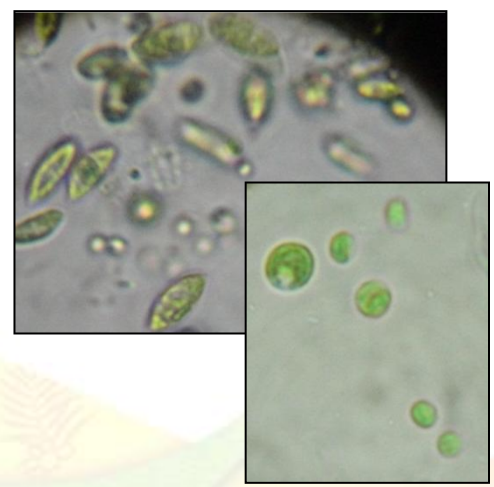
Macronutrients	Influent concentration (mg/m^2 - L)	Efluente concentration (mg/m^2 - L)
NH_4-N	220 ± 3	3,7 ± 0,6
N-organic	50 ± 10	0,27 ± 0,07
Total-N	270 ± 30	0,85 ± 0,1
Total-P	80 ± 10	0,06 ± 0,01

Adapted from Kebede-Westhead et al. 2006

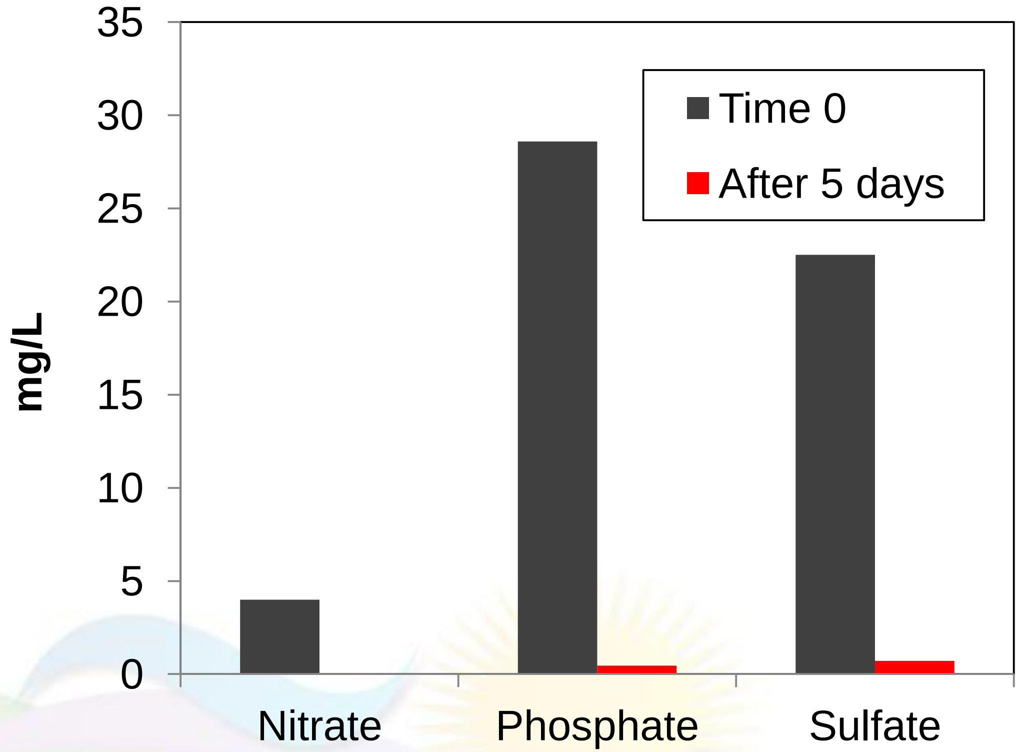
Phycoremediation

Biomass productivity

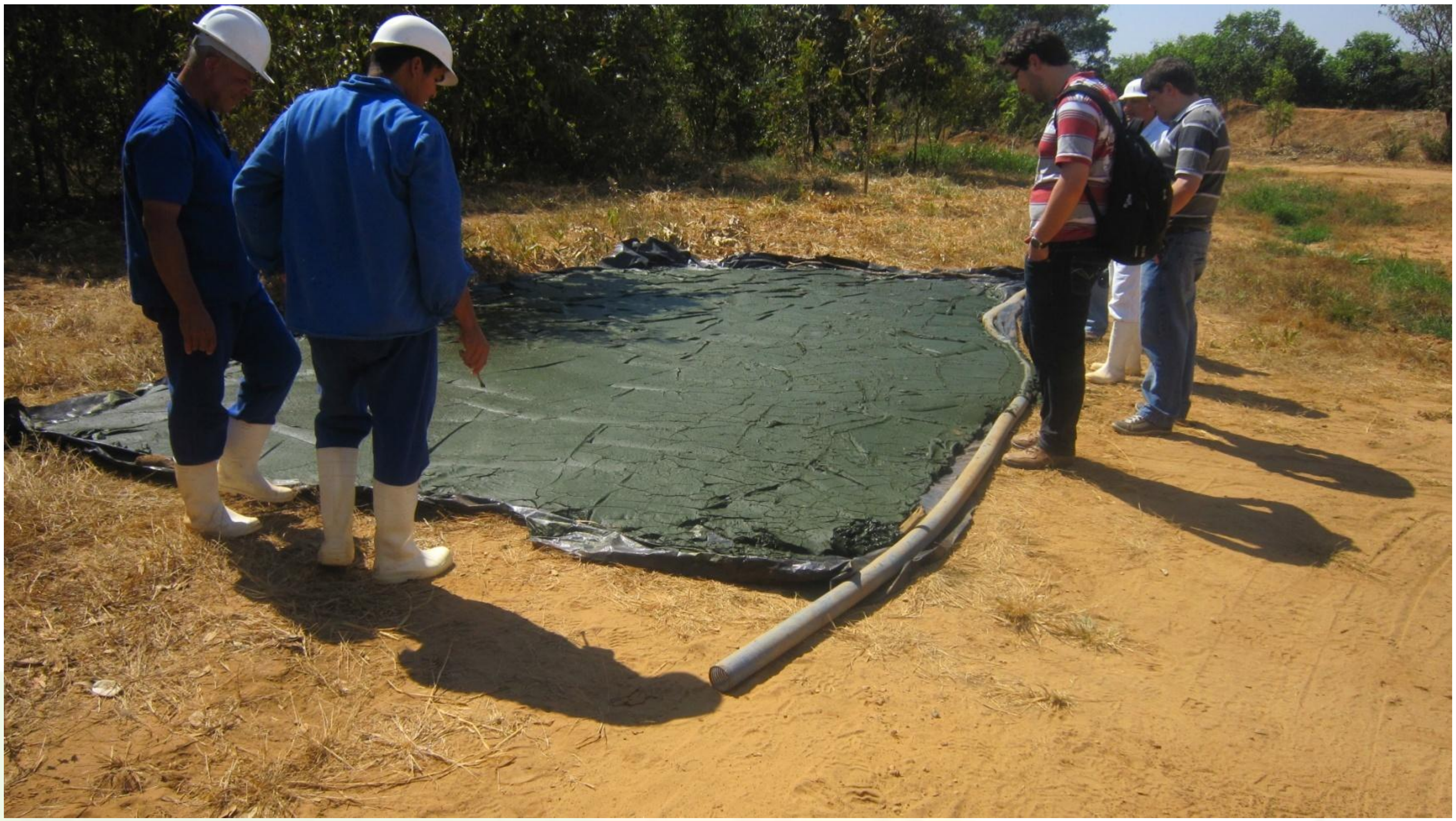
0.3 g-DW $L^{-1} \cdot d^{-1}$



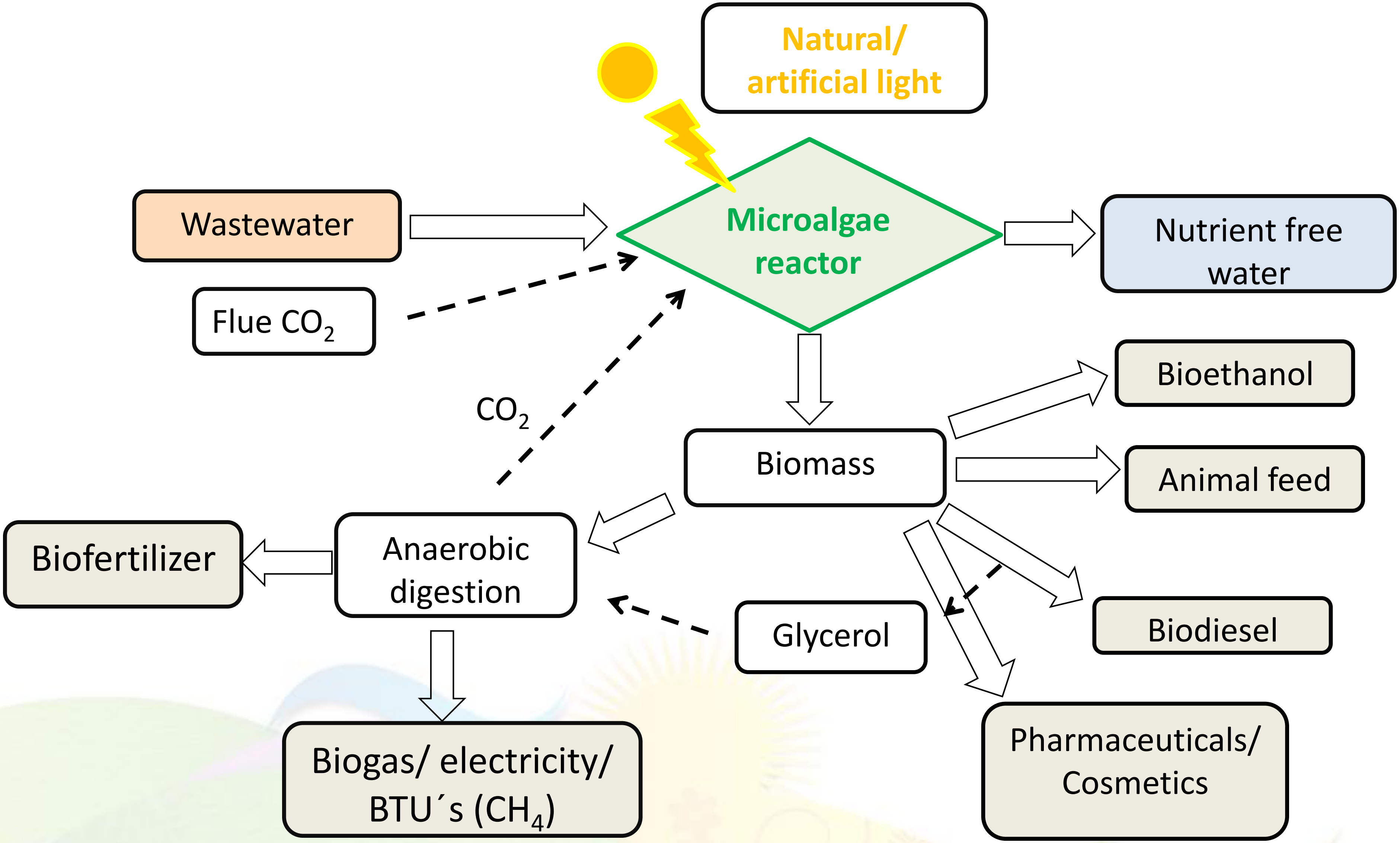
Phycoremediation



Microalgae as feedstock



Nova Mutum, Mato Grosso
Cortesy of Dr. Airton Kunz

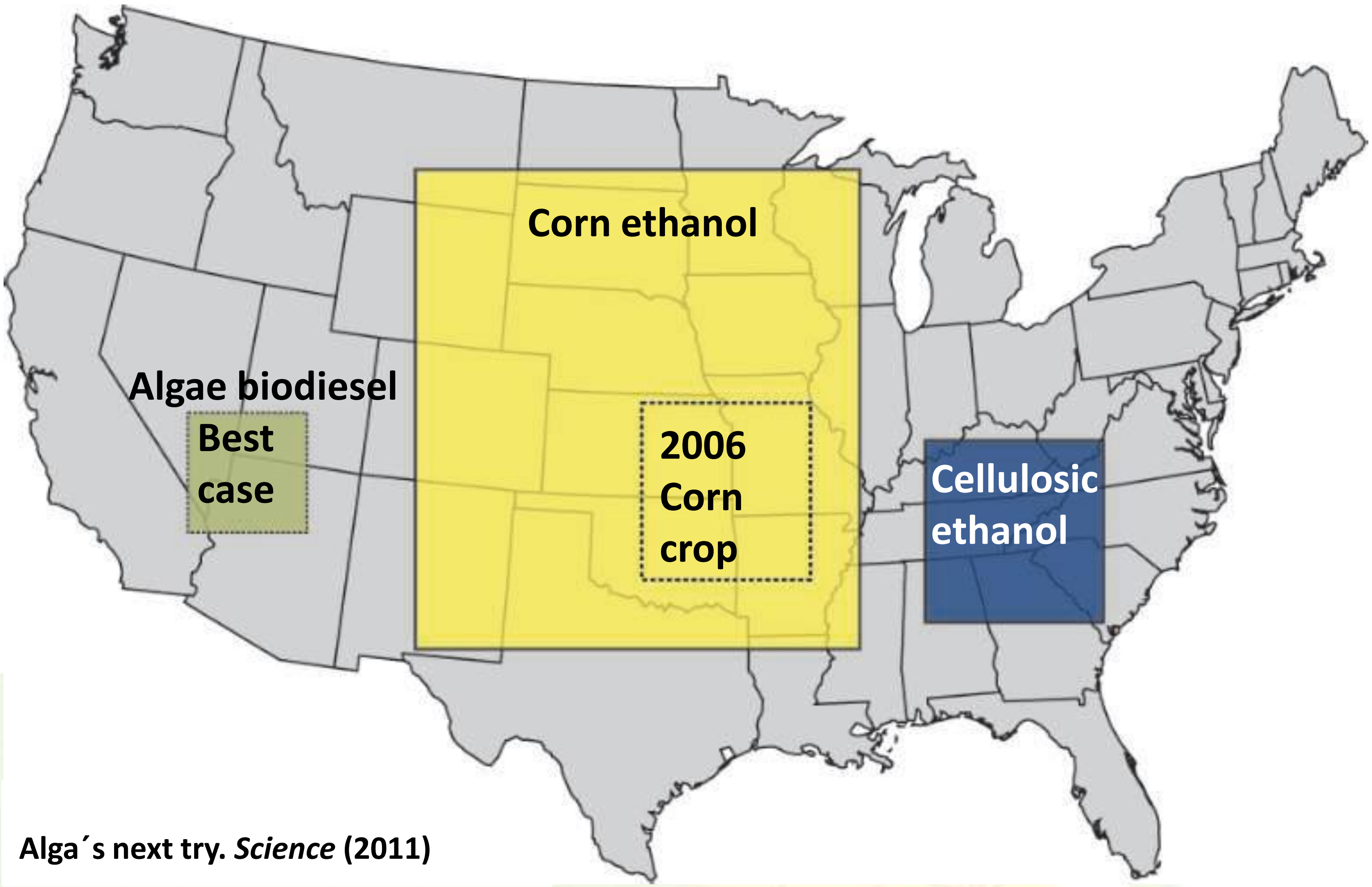

Natural/ artificial light
Wastewater
Microalgae reactor
Nutrient free water
Flue CO_2
CO_2
Bioethanol
Biomass
Animal feed
Biofertilizer
Anaerobic digestion
Glycerol
Biodiesel
Biogas/ electricity/ BTU´s (CH_4)
Pharmaceuticals/ Cosmetics

Feedstock

Feedstock	Oil productivity (Liters/ ha)
Corn	169
Soy	449
Canola	1.189
Jatropha	1.891
Coconut	2.687
Palm	5.955
Microalgae	**33.300** **(17% oil weight)**

Chisti 2007. *Biotechnology advances*.

Biofuels comparison



Alga´s next try. *Science* (2011)

Nutritional potential

Parameter	Corn[a]	Soy bean meal[a]	Microalgae
Total protein (%)	7.9	45.2	49.4
Lipids (%)	6.7	1.7	17 - 22
Total nitrogen (%)	1.3	7.2	7.9
***a.a.* lysine (%)**	**0.2**	**2.6**	**5.1**
Ca (%)	0.03	0.24	0.49
Cu (%)	0.0002	0.002	0.01
Fe (%)	0.0024	0.015	0.06
K (%)	0.29	1.83	0.49
Mg (%)	0.09	0.320	0.20
P (%)	0.25	0.560	0.70
Zn (%)	0.0022	0.005	0.05

[a] *Source: Rostagno et al. 2011.*

Anaerobic digestion

Specie	Methane (m^3/ kg)
Laminaria sp.	0,26 – 0,28
Gracilaria sp.	0,28 – 0,40
Macrocystis	0,39 – 0,41
L. digitata	0,50
Ulva sp.	0,20
Swine waste	**0,35**

Harun et al., 2010

Methanogenesis

Microalgae challenges

- Genetically engineered biomass (GMOs)
- Synthetic biology
- New metabolic pathways (succinate/ hydrogen/ etc)
- Cost-effective culturing strategies
- Overall system optimization/ automation
- Modeling studies
- Environmental risks assessment
- Biodiversity
- Cosmetics/ pharmaceutics
- Food

III Meeting of Korea-Brazil Knowledge Economy

Ministry on Trade/ Industrial Cooperation

Thank you !

Life Cycle Analysis

"… switchgrass, canola, and corn farming have lower environmental impacts than algae in energy use, greenhouse gas emissions, and water.

To reduce these impacts, flue gas and, to a greater extent, wastewater could be used to offset most of the environmental burdens associated with algae…"

***Environ. Sci. Technol*. (2010), 44: 1813–1819**