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Biogas-based systems to foster circular economy strategies

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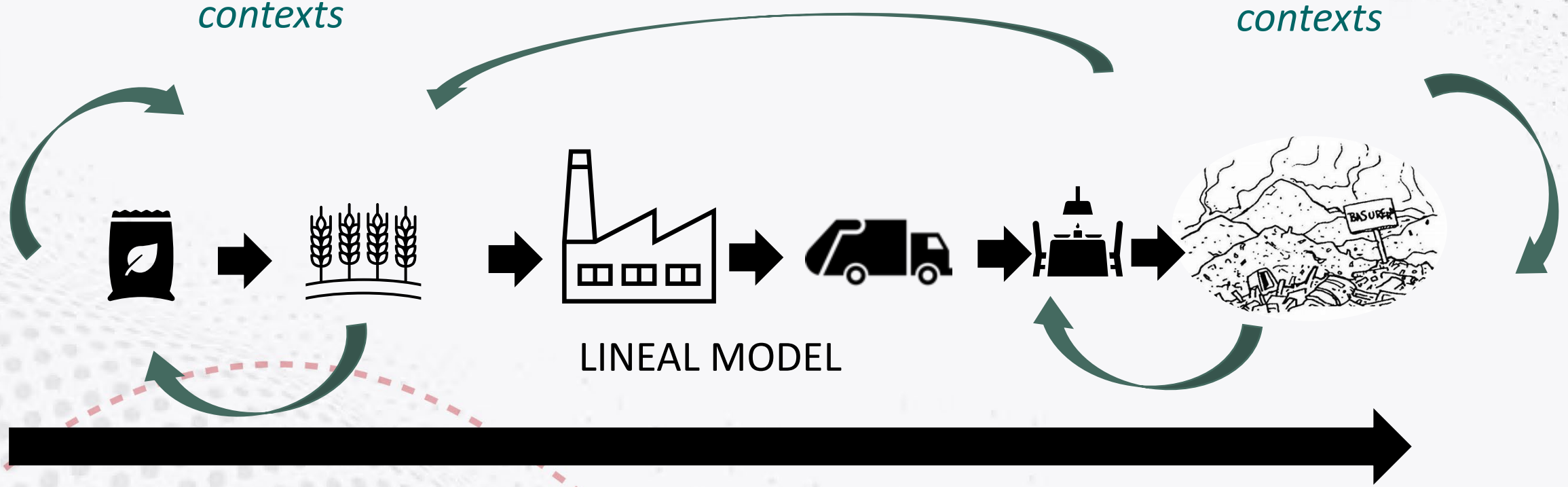
CE STRATEGIES: PROGRESS AND FINDINGS

Opportunities in rural contexts

Opportunities in urban contexts



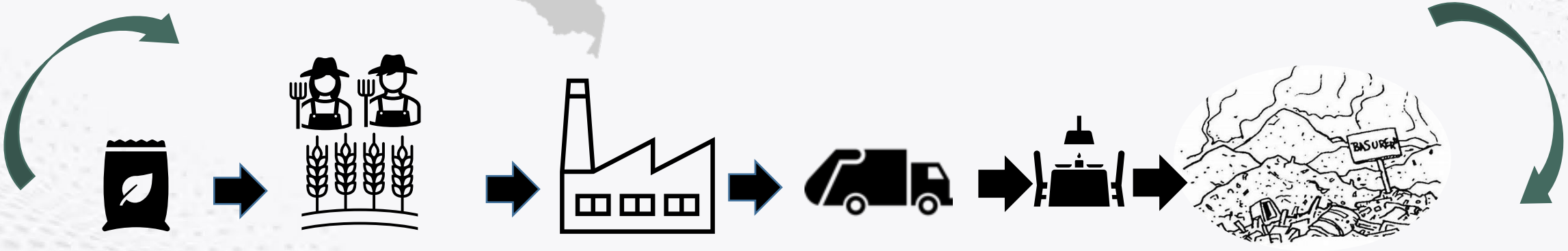
LINEAL MODEL

CE STRATEGIES: PROGRESS AND FINDINGS

Opportunities in rural contexts

- In Colombia **34%** of food produced for human consumption is trhown away[1]
- Around **61%** --> Organic Fraction of Municipal Solid Waste

Opportunities in urban contexts



BIOGAS-BASED SYSTEMS TO FOSTER CIRCULAR ECONOMY STRATEGIES

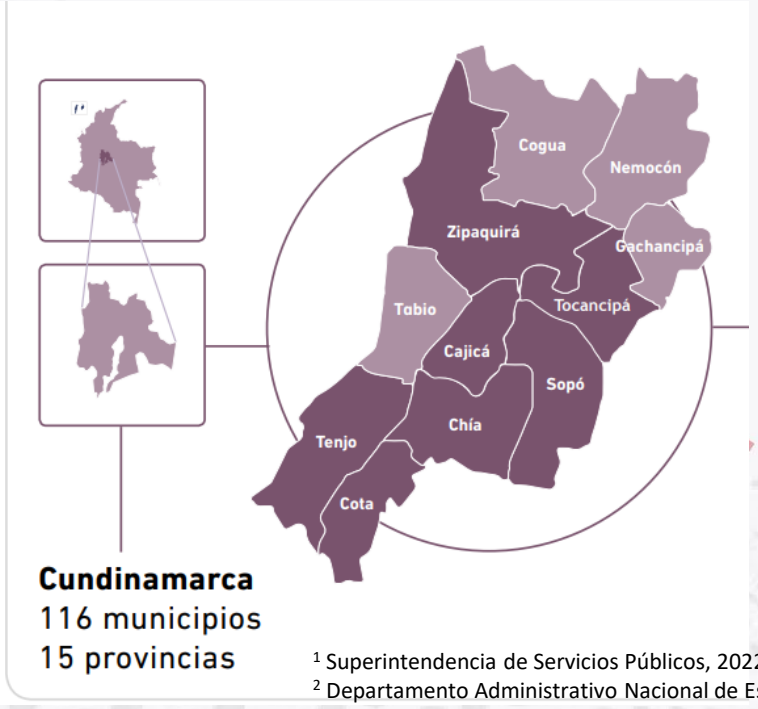
[1] Departamento Nacional de Planeación [internet]. Colombia: Grupo de comunicaciones y relaciones públicas.
[2] Cetrulo, T.B., Marques, R.C., Cetrulo, N.M., Pinto, F.S., Moreira, R.M., Mendizábal-Cortés, A.D., Malheiros, T.F., 2018.

CE STRATEGIES: PROGRESS AND FINDINGS

631.467 inhab. (2021)[2]

124,893 tons per year (2020)[1]

Recycled residues in SC: 10%



CAJICÁ

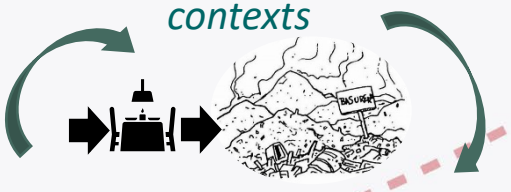
"Caneca verde"

1 IBICOL ← *7 routes* ← Mon and Tue

2 Mon to sun → *37 routes* → Mondoñedo

3 Arca → Comercialización

Opportunities in urban contexts



[1] Superintendencia de Servicios Públicos, 2022
[2] Departamento Administrativo Nacional de Estadística, 2022

CE STRATEGIES: PROGRESS AND FINDINGS

Organic Fraction of Municipal Solid Waste (OFMSW)

Cow Manure (CM)

Municipal Grass Waste (MGW)

Cajicá: fruit and vegetables, cooked and uncooked meat, egg shells

Chía: fruit and vegetables, egg shells

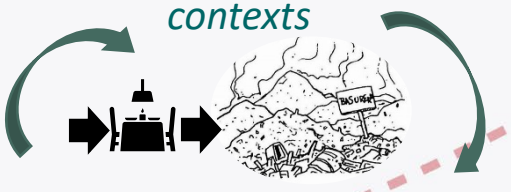
- Mono-digestion of the sample containing meat residues was not recommended
- Improved process stability and successful methane generation through co-digestion processes
- Frequency of organics collection in Cajicá should be increased to minimize aerobic decomposition at the source

Energy for Sustainable Development
Volume 74, June 2023, Pages 372-380

Improving dry anaerobic methane production from OFMSW by co-digestion with grass waste and pretreatment with white rot fungi

Fabiana F. Franceschi [a, b], Alejandro Acosta-González [c], Lili T. Vega [d], Maria Fernanda Gomez [e]

Opportunities in urban contexts



CE STRATEGIES: potential collaboration

Organic Fraction of Municipal Solid Waste (OFMSW) — Cow Manure (CM) — Municipal Grass Waste (MGW)

- Cajicá: fruit and vegetables, cooked and uncooked meat, egg shells
- Chía: fruit and vegetables, egg shells

- ¿How to improve the quality of obtained soil amendment to use it as a competitive fertilizer?
- ¿How to up-scale the process to provide energy and fertilizers to Sabana Centro while considering Circular Economy principles?

ELSEVIER

Energy for Sustainable Development

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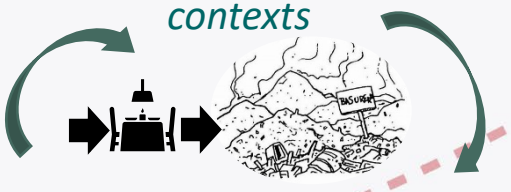

CE STRATEGIES: PROGRESS AND FINDINGS

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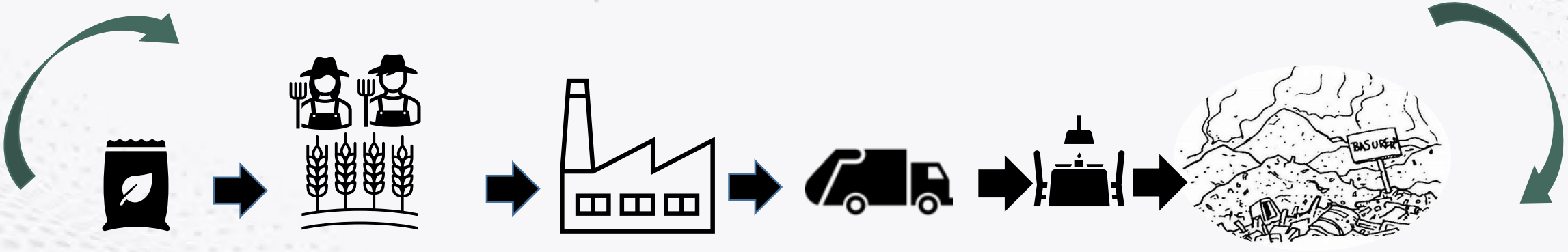
CE STRATEGIES: PROGRESS AND FINDINGS

Opportunities in rural contexts

- In Colombia, about 540,000 families depend on the coffee activity. Most of the farms have an extension < 2ha.[1]

Opportunities in urban contexts



BIOGAS-BASED SYSTEMS TO FOSTER CIRCULAR ECONOMY STRATEGIES

[1] Federación Nacional de Cafeteros, 2023.

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CE STRATEGIES: PROGRESS AND FINDINGS

Residual biomass from agricultural and livestock sectors in Colombia [1,2]

Theoretical energy potential of agricultural residues suitable for processing through biological route

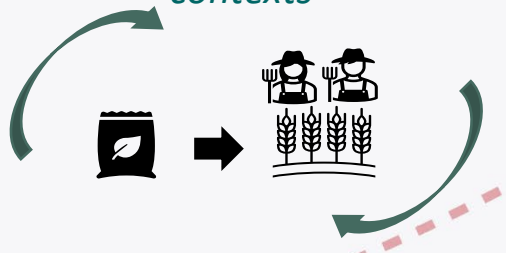
Crop	Residue	Residue factor [t residue/t main product]	Production of dry residue [t/year]	LHV [kcal/kg]	Theoretical energy potential [TJ/year]
Sugar cane	Tops- leaves	3.8	37,692,544.8	4,049.0	599,232.0
Plantain	Rachis	1.0	511,257.3	1,808.0	3,867.5
	Rejected	0.2	139,433.8	2,488.0	1,451.5
Banana	Rachis	1.0	542,172.5	1,809.0	4,103.6
	Rejected	0.2	75,652.0	2,488.0	787.5
Palm oil	Rachis	1.1	834,610.6	4,021.0	14,041.4
Corn	Bract	0.2	58,769.0	3,815.0	938.1
Coffee	Pulp	2.4	363,037.4	3,792.9	5,761.2
	Mucilage	0.8	26,843.0	477.7	53.6
Total agricultural			**40,370,521**		**630,236.4**

Theoretical energy potential from livestock residues [3]

Sector	Population [Head]	Residue [t/year]	Theoretical energy content [TJ/year]
Bovine	29,301,392	129,849,175	70,182.6
Porcine	5,536,331	3,512,884	3,023.5
Poultry	213,246,140	6,447,298	5,517.2
Total livestock	**248,083,863**	**139,809,357**	**78,723.3**

- **The theoretical energy content of the agricultural residues is about of 2 million of TJ/year.**
- **From biological treatment the energy potential is 630,236 TJ/year**

Opportunities in rural contexts



[1] Ministerio de agricultura. (2023, December 1). *Agronet*. Reporte: Comparativo de Área, Producción, Rendimiento y Participación Departamental Por Cultivo. https://www.agronet.gov.co/estadistica/Paginas/home.aspx?cod=3

[2] UPME. (2006). *Atlas del Potencial Energético de la Biomasa Residual en Colombia*. https://doi.org/10.1017/CBO9781107415324.004

[3] Instituto Colombiano Agropecuario (ICA). (2022). *Instituto Colombiano Agropecuario (ICA)*. Censos Pecuarios Nacional. https://www.ica.gov.co/areas/pecuaria/servicios/epidemiologia-veterinaria/censos-2016/censo-2018

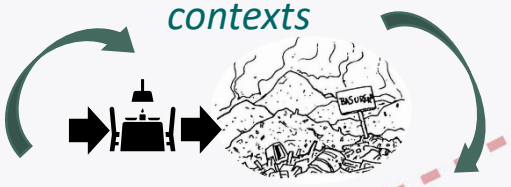
CE STRATEGIES: PROGRESS AND FINDINGS

Case of study: Gualivá Province

Municipalities of the Gualivá province located in Cundinamarca

- La Vega belongs to the Gualivá Province.
- AD system at pilot scale will be located in the experimental station José Celestino Mutis in La Vega, Cundinamarca.

Opportunities in urban contexts



CE STRATEGIES: PROGRESS AND FINDINGS

Residual biomass from agricultural and livestock sectors in Gualivá Province

Theoretical energy potential for agricultural residues[1,2]

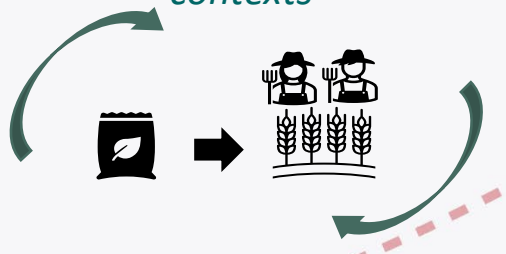
Crop	Residue	Production of dry residue [t/year]	Theoretical energy potential [TJ/year]	WtE route
Cane	**Tops- leaves**	**700,054.0**	**10,790.5**	**Biological**
	Bagasse	1,026,700.1	19,141.7	Thermochemical
Plantain	**Rachis**	**2,149.9**	**16.3**	**Biological**
	Pseudostem	89,612.8	761.9	Thermochemical
	Rejected	586.3	6.1	Biological
Orange	NR	-	-	
Coffee	**Pulp**	**1,991.1**	**31.6**	**Biological**
	Mucilage	147.2	0.3	Biological
	Silverskin	809.4	14.5	Thermochemical
	stem	11,041.8	217.9	Thermochemical
Cassava	NR	-	-	
Total		**1,833,092.8**	**30,980.8**	

Theoretical energy potential from livestock residues [3]

Sector	Population [Head]	Dry residue [t/year]	Theoretical energy content [TJ/year]
Bovine	76,283	42,239	175.6
Porcine	127,200	23,343	67.0
Poultry	5,874,600	40,781	139.6
Total livestock	**6,078,083**	**106,363**	**382.2**

[3] Instituto Colombiano Agropecuario (ICA). (2022). *Instituto Colombiano Agropecuario (ICA)*. Censos Pecuarios Nacional. https://www.ica.gov.co/areas/pecuaria/servicios/epidemiologia-veterinaria/censos-2016/censo-2018

Opportunities in rural contexts



[1] Ministerio de agricultura. (2023, December 1). *Agronet*. Reporte: Comparativo de Área, Producción, Rendimiento y Participación Departamental Por Cultivo. https://www.agronet.gov.co/estadistica/Paginas/home.aspx?cod=3

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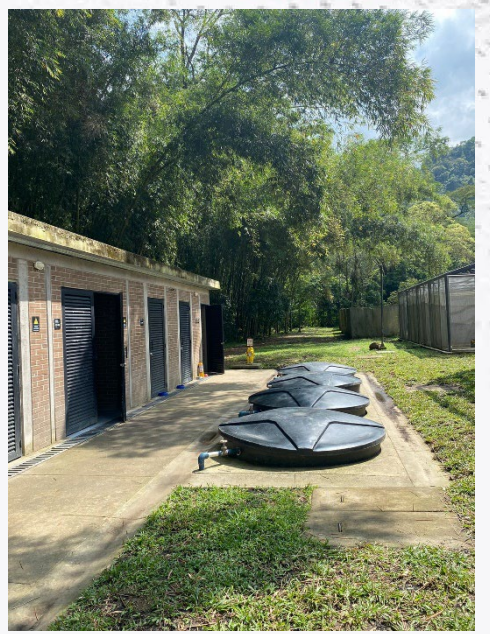
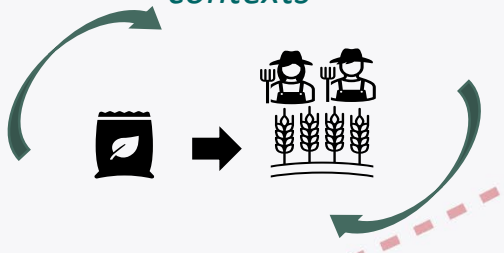


Storage

Pilot system

Vehicle access

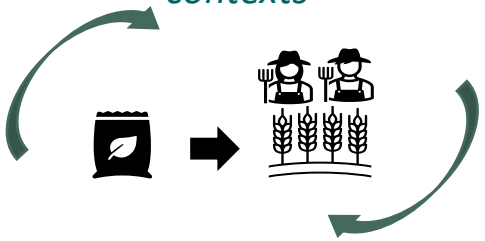
Opportunities in rural contexts



CE STRATEGIES: potential collaboration

¿ How to maximize the value of digestate as fertilizer for coffee crops while considering Circular Economy principles?

Opportunities in rural contexts



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Thanks!

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