



Horizon 2020



**SYSTEMIC**

*Circular solutions for biowaste*

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**Nutrient mass flow analyses in digestate treatment processes at the SYSTEMIC demonstration plants**

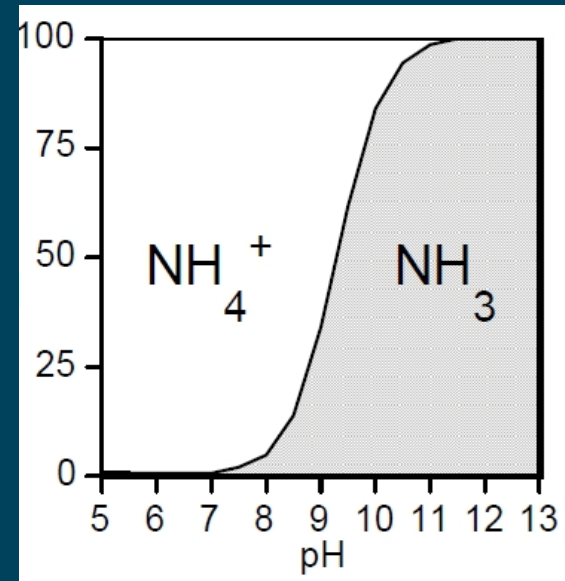
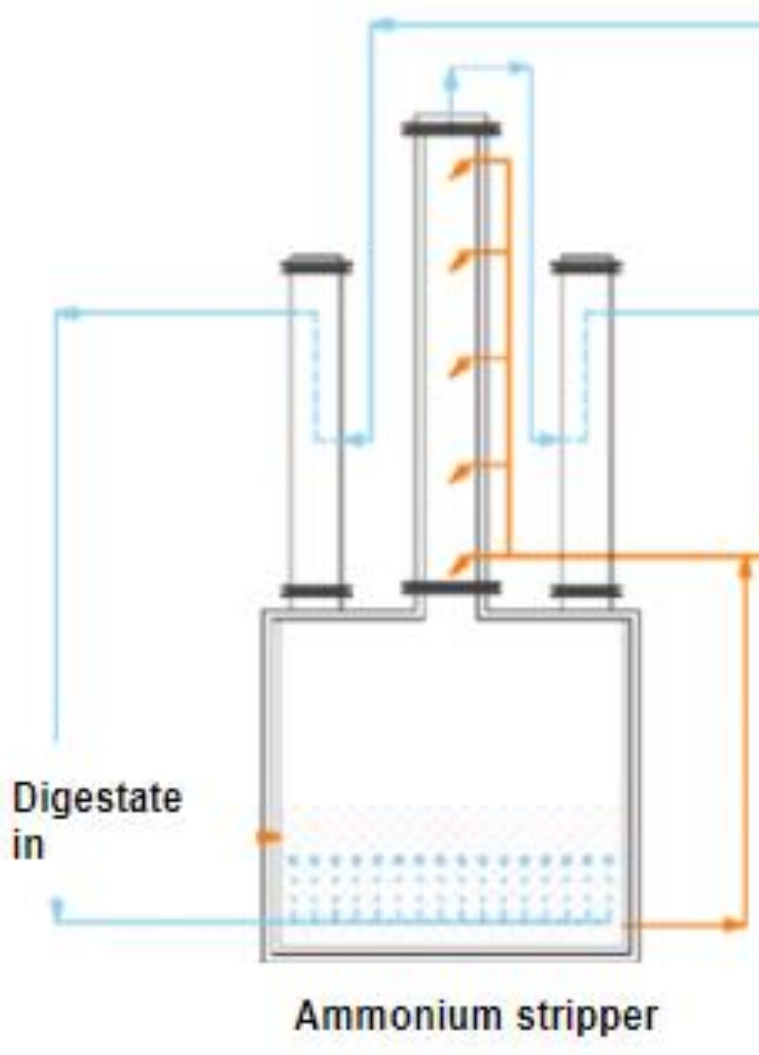
- N-Stripping & Scrubbing → Biobased Ammonium Sulphate fertilizer
- Mass Flow Analyses (MFA) of Ammonium Sulphate production at Benas
- AS generated at Benas has a better mineral-N:total-N compared to digestate

## Part 1: N-Stripping & Scrubbing → Biobased Ammonium Sulphate

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- What is N-stripping & scrubbing?
- Parameters affecting stripping efficiency
- Alternatives to  $\text{H}_2\text{SO}_4$  as scrubbing agent

# Part 1: N-Stripping & Scrubbing → Biobased Ammonium Sulphate



- pH
- Temperature
- Air/liquid ratio
- Air supply rate
- Hydraulic loading rate

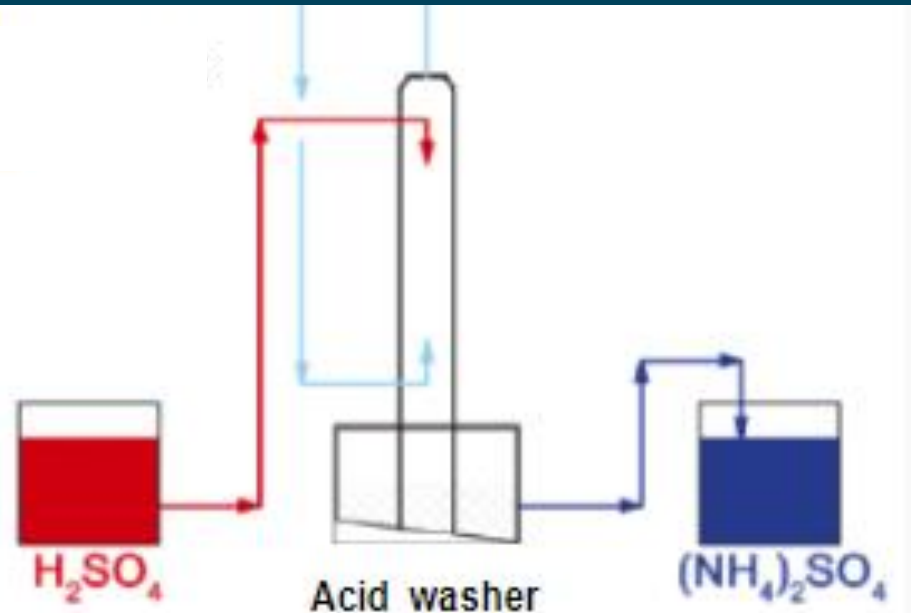
# Part 1: N-Stripping & Scrubbing → Biobased Ammonium Sulphate

Alternative scrubbing agents:

**NH<sub>3</sub>-rich gas + H<sub>2</sub>SO<sub>4</sub> → Ammonium sulphate (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>**

**NH<sub>3</sub>-rich gas + HNO<sub>3</sub> → Ammonium nitrate NH<sub>4</sub>NO<sub>3</sub>**

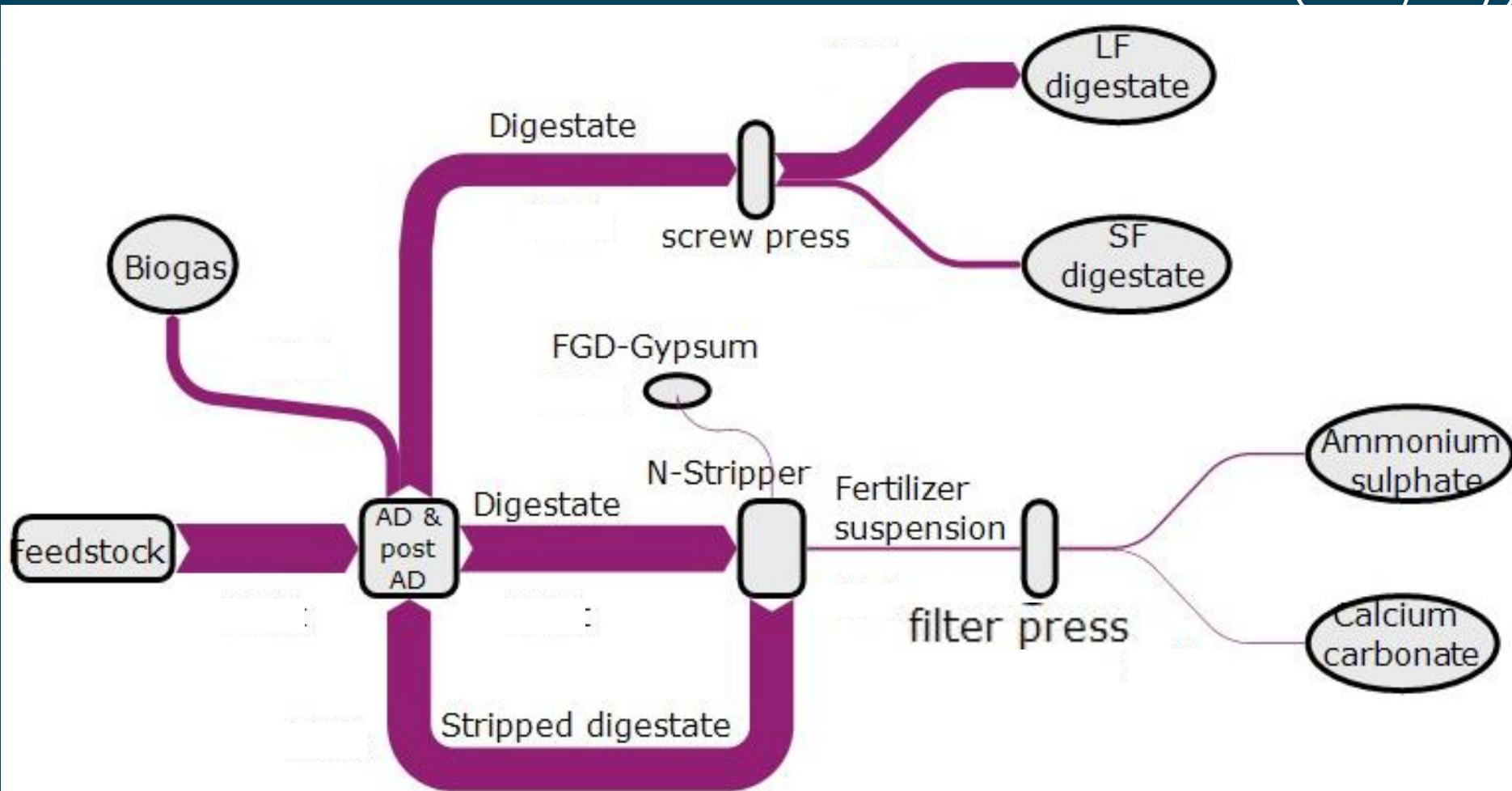
**NH<sub>3</sub>-rich gas + CaSO<sub>4</sub> → (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> + calcium carbonate CaCO<sub>3</sub>**



- Primary macronutrients (N-P-K)
- Secondary macronutrients (Ca-S)
- Nutrient Recovery and Nutrient Separation Efficiencies

# Part 2: Mass Flow Analyses (MFA) of Ammonium Sulphate production at Benas

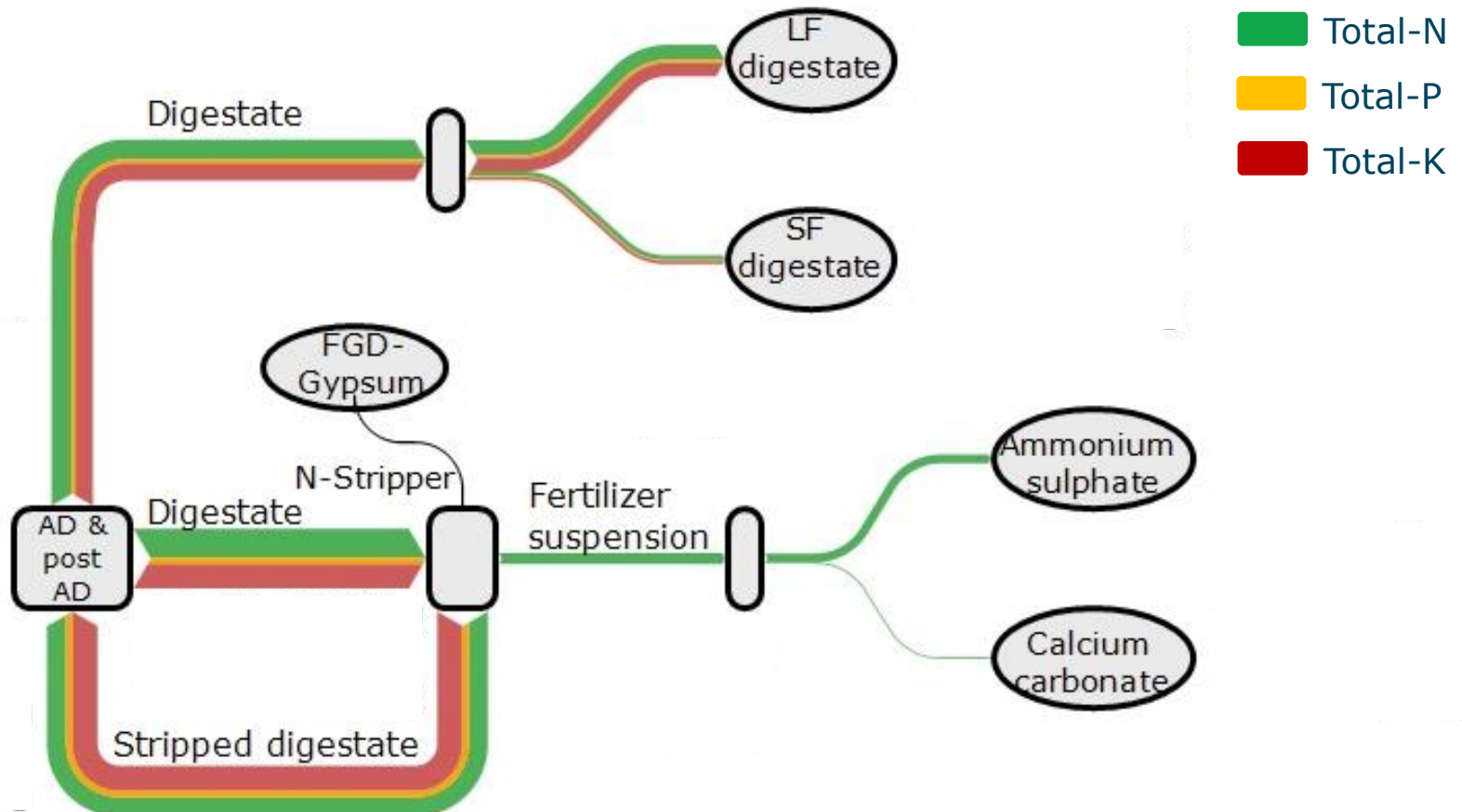
Mass balance (tons/day)





# Part 2: Mass Flow Analyses (MFA) of Ammonium Sulphate production at Benas

## Nitrogen – Phosphorus - Potassium balances (tons/day)

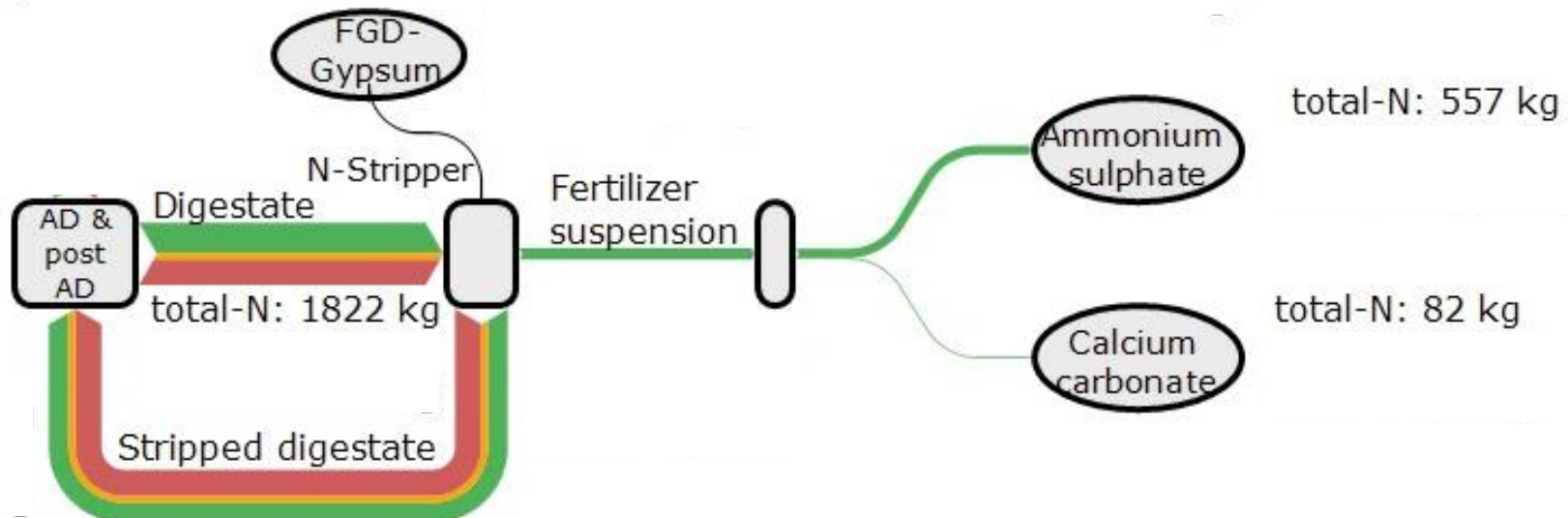


## Part 2: Mass Flow Analyses (MFA) of Ammonium Sulphate production at Benas

Nitrogen – Phosphorus – Potassium balances

Nitrogen Recovery Efficiency =  $(IN-OUT)/IN$

- **31% of total-N** in digestate recovered as **Ammonium Sulphate**
- **4.2% of total-N** in digestate recovered as **Calcium Carbonate**

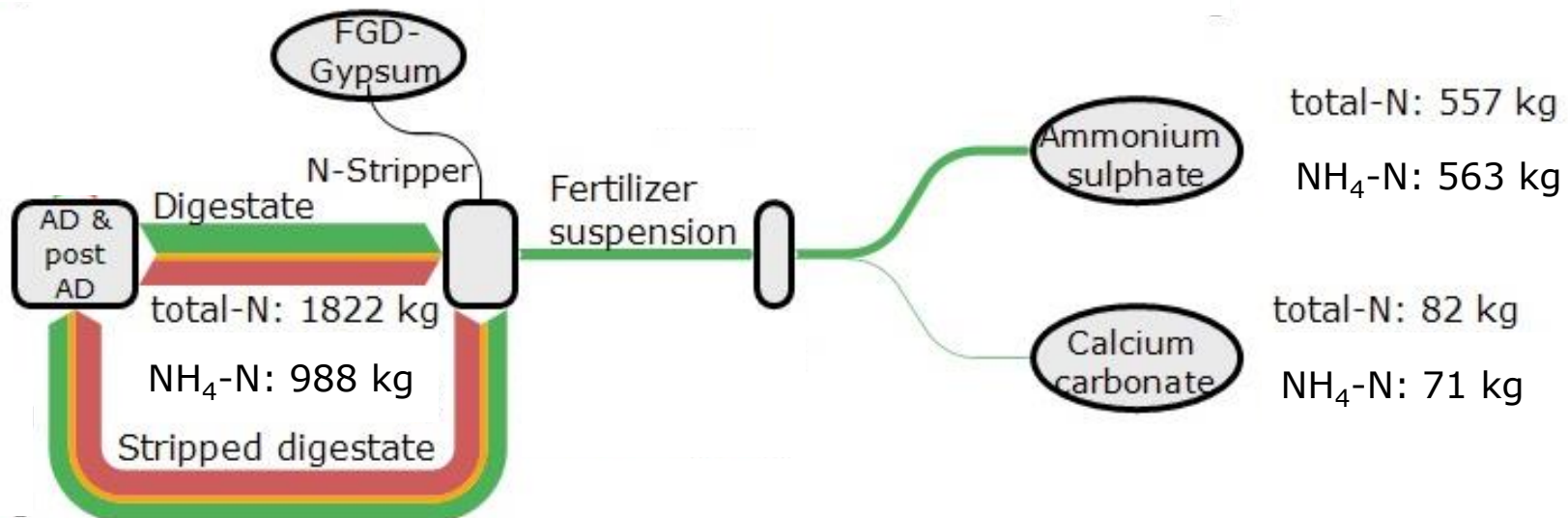


## Part 2: Mass Flow Analyses (MFA) of Ammonium Sulphate production at Benas

Nitrogen – Phosphorus - Potassium balances

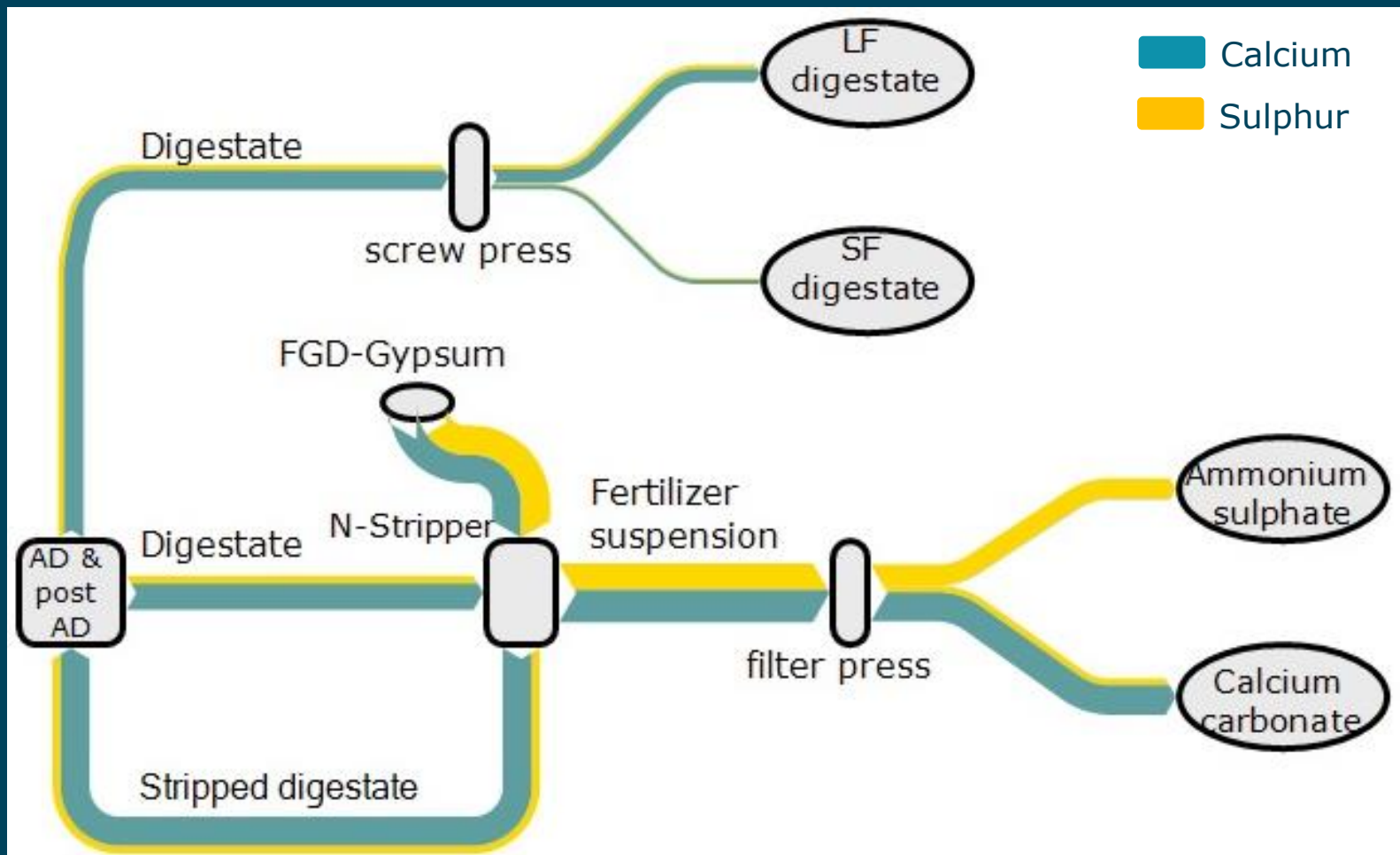
$\text{NH}_4\text{-N}$  Recovery Efficiency =  $(\text{IN}-\text{OUT})/\text{IN}$

- **57% of  $\text{NH}_4\text{-N}$**  in digestate recovered as **Ammonium Sulphate**
- **7.2% of  $\text{NH}_4\text{-N}$**  in digestate recovered as **Calcium Carbonate**



# Part 2: Mass Flow Analyses (MFA) of Ammonium Sulphate production at Benas

## Calcium - Sulphur balances (tons/day)

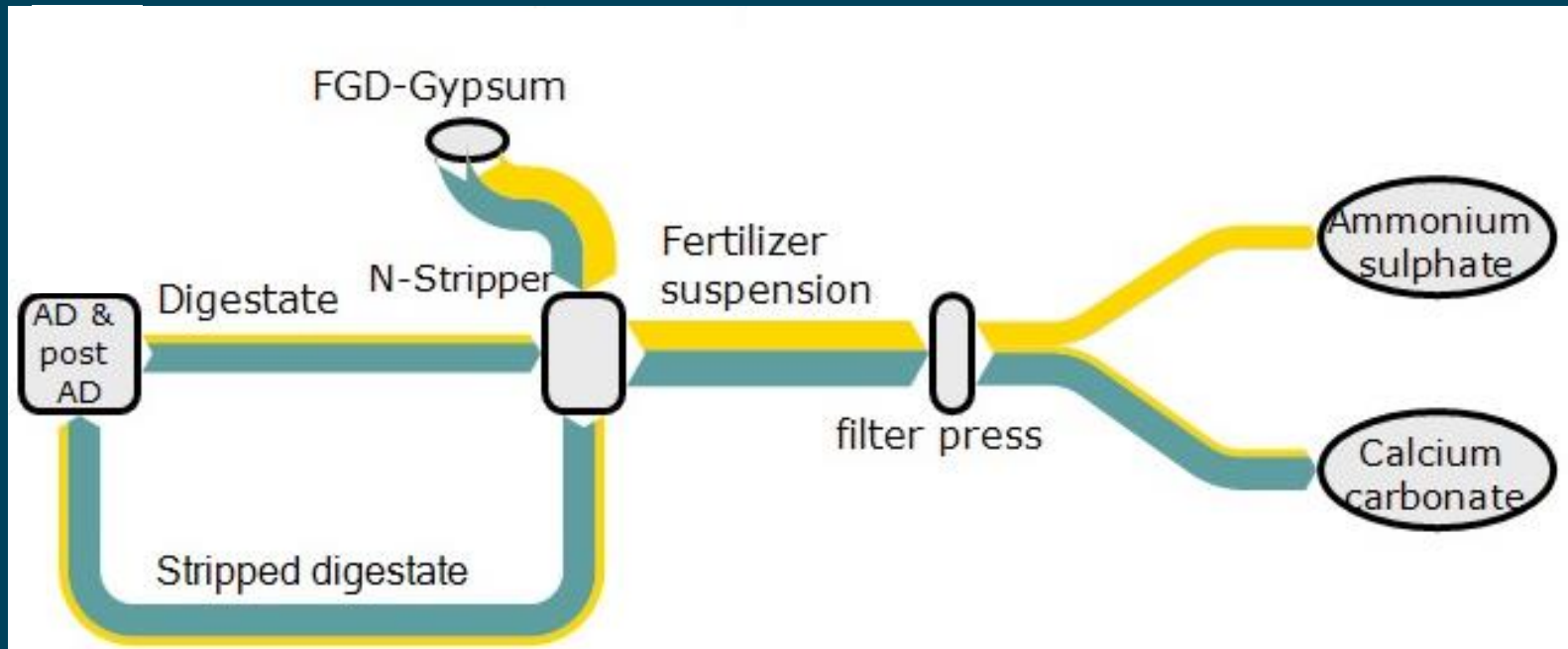


## Part 2: Mass Flow Analyses (MFA) of Ammonium Sulphate production at Benas

Calcium - Sulphur balances (tons/day)

Calcium Separation Efficiency = (IN-OUT)/IN

- **1% of Ca** in fertilizer suspension segregated in **Ammonium Sulphate**
- **86% of Ca** in fertilizer suspension segregated in **Calcium Carbonate**

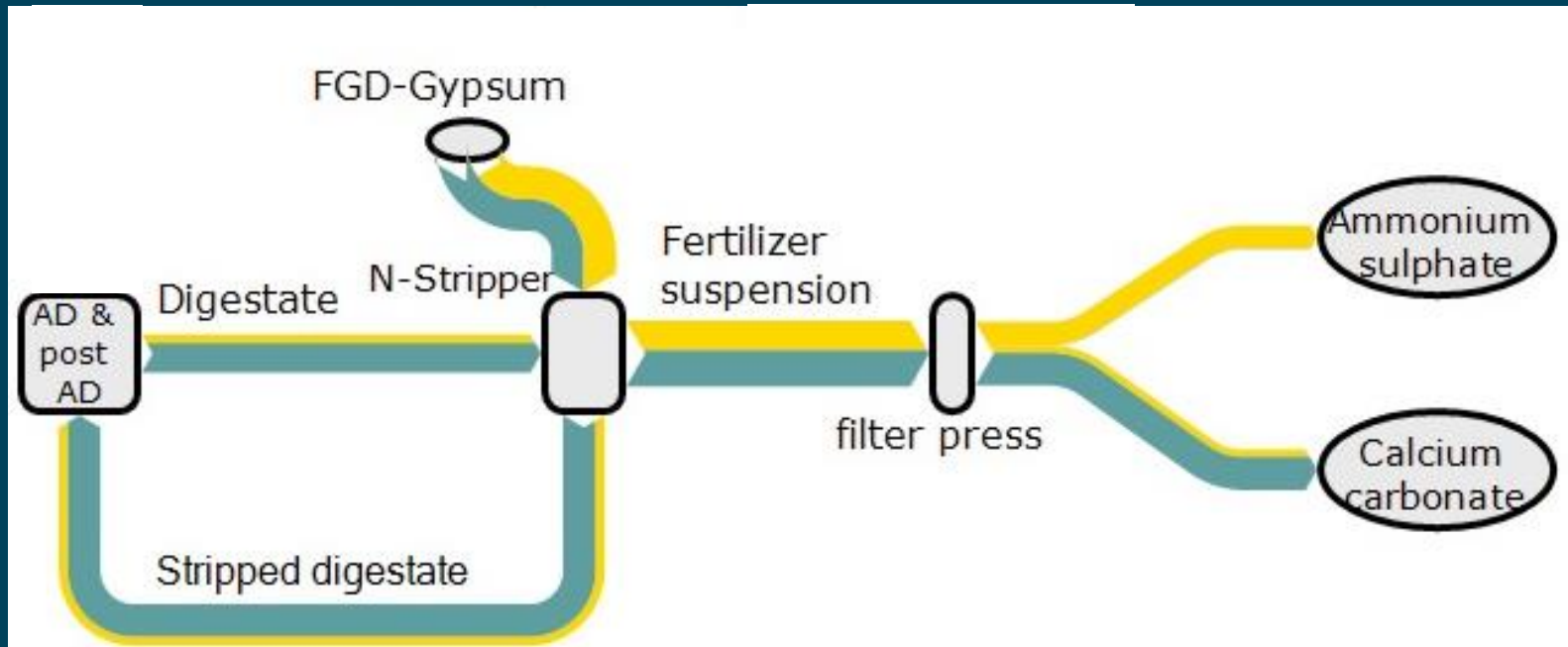


## Part 2: Mass Flow Analyses (MFA) of Ammonium Sulphate production at Benas

Calcium - Sulphur balances (tons/day)

Calcium Separation Efficiency = (IN-OUT)/IN

- **81% of S** in fertilizer suspension segregated in **Ammonium Sulphate**
- **24% of S** in fertilizer suspension segregated in **Calcium Carbonate**

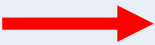


## Part 3: Ammonium Sulphate has a better mineral-N:total-N compared to digestate

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- Product characteristics of Ammonium Sulphate
- Ammonium Sulphate has a better mineral-N:total-N ratio, compared to anaerobic digestate

## Part 3: Ammonium Sulphate has a better mineral-N:total-N compared to digestate

Parameters	Digestate	Ammonium Sulphate
Dry matter (g kg <sup>-1</sup> )	110	224
pH	8.5	7.8
Electrical conductivity (mS cm <sup>-1</sup> )	29	 226
Nitrogen <sub>total</sub> (g kg <sup>-1</sup> )	8.2	46
NH <sub>4</sub> -N (g kg <sup>-1</sup> )	4.5	46
Nitrogen <sub>mineral</sub> / Nitrogen <sub>total</sub> (%)	54	100
Potassium <sub>total</sub> (g kg <sup>-1</sup> )	7	0.0058
Phosphorus <sub>total</sub> (g kg <sup>-1</sup> )	1.7	<0.0037
Sulphur (g kg <sup>-1</sup> )	1.2	58
Calcium (g kg <sup>-1</sup> )	4.1	1.2



- N-Stripping & Scrubbing → Biobased Ammonium Sulphate fertilizer
- Mass Flow Analyses (MFA) for the technical assessment Ammonium Sulphate production at Benas
- AS has a better mineral-N:total-N compared to digestate



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# Nutrient mass flow analyses in digestate treatment processes at the SYSTEMIC demonstration plants

Claudio Brienza  
SYSTEMIC Workshop  
September 2019



Gesellschaft für  
Nachhaltige  
Stoffnutzung mbH



UNIVERSITÀ DEGLI STUDI DI MILANO



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[www.systemicproject.eu](http://www.systemicproject.eu)

