

Supplementary material:

Mass Balance of C, Nutrients, and Mineralization of Nitrogen during Anaerobic Co-digestion of Rice Straw with Cow Manure

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S1 – Mass balance calculation

The mass balance of carbon and nutrients has been calculated as presented in the equations and figure below.

The general mass balance as referred to in section 2.5 Mass Balance calculations of the paper, with the equation number of the paper.

$$\dot{m}_{i_{in}} = \dot{m}_{i_{out}} + \Delta MB \quad (2)$$

$$\dot{m}_{i_{in}} = \sum_j \dot{m}_{i_j} = \dot{m}_{RS} \times x_{i_{RS}} + \dot{m}_{CoM} \times x_{i_{CoM}} \quad (3)$$

$$\dot{m}_{i_{out}} = \sum_j \dot{m}_{i_j} = \dot{m}_{SD,dis} \times x_{i_{SD,dis}} + \dot{m}_{LD,dis} \times x_{i_{LD,dis}} + \dot{m}_{BG} \times x_{i_{BG}} \quad (4)$$

$$\dot{m}_{C_{BG}} = \dot{V}_{CH_4} \times \rho_{CH_4} \times x_{C_{CH_4}} + \dot{V}_{CO_2} \times \rho_{CO_2} \times x_{C_{CO_2}} \quad (5)$$

The daily input of Rice straw (RS), cow manure (CoM), water (H₂O) as well as the recycling of liquid digestate was available for the calculation. Furthermore, the gas flow volume and gas composition was measured constantly for CH₄, CO₂, and O₂. The known mass flows are to be seen in figure S1.

The concentration of C and nutrients in the digestate and in the solid and liquid substrate was measured regularly. Measurements of elements in various digestate are further shown in Supplementary material S2.

The mass balance input flow and output flows can be extended by the added water (H₂O) on the input, and oxygen (O₂) mass flow on the output and recirculated liquid digestate (LD rec) on the input and output side.

$$\dot{m}_{i_{in}} = \sum_j \dot{m}_{i_j} = \dot{m}_{i_{RS}} + \dot{m}_{i_{CoM}} + \dot{m}_{i_{H_2O}} + \dot{m}_{i_{LD,rec}} \quad (S1.1)$$

$$\dot{m}_{i_{out}} = \sum_j \dot{m}_{i_j} = \dot{m}_{i_{SD+LD}} + \dot{m}_{i_{BG}} \quad (S1.2)$$

$$\dot{m}_{i_{SD+LD}} = \dot{m}_{i_{SD,dis}} + \dot{m}_{i_{LD,dis}} + \dot{m}_{i_{LD,rec}} \quad (S1.2a)$$

$$\dot{m}_{i_{BG}} = \dot{m}_{i_{CH_4}} + \dot{m}_{i_{CO_2}} + \dot{m}_{i_{O_2}} = \dot{m}_{i_{CH_4}} \times x_{i_{CH_4}} + \dot{m}_{i_{CO_2}} \times x_{i_{CO_2}} + \dot{m}_{i_{O_2}} \times x_{i_{O_2}} \quad (S1.2b)$$

As the flow of the digestate (SD+ LD) was not recorded the mass flow and subsequently the mass flow of the discharged digestate, liquid and solid is calculated by subtracting the biogas flows \dot{m}_{BG}

$$\dot{m}_{i_{(SD+LD)}} = (\dot{m}_{in} - \dot{m}_{BG}) \times x_{i_{SD+LD}} \quad (S1.3)$$

$$\dot{m}_{i_{(SD+LD)}} = ((\dot{m}_{RS} + \dot{m}_{CoM} + \dot{m}_{H_2O} + \dot{m}_{LD,rec}) - \dot{m}_{CH_4} - \dot{m}_{CO_2} - \dot{m}_{O_2}) \times x_{i_{SD+LD}} \quad (S1.3a)$$

The mass flow of discharged solid and liquid digestate (SD, dis & LD, dis) is calculated by subtracting the recirculated LD and a factor for the separation of LD and SD ($x_{SD,dis}$ & $x_{LD,dis}$).

$$\dot{m}_{i_{SD,dis}} = (\dot{m}_{i_{(SD+LD)}} - \dot{m}_{i_{LD,rec}}) \times x_{SD,dis} \times x_{i_{SD,dis}} \quad (S1.4a)$$

$$\dot{m}_{i_{LD,dis}} = (\dot{m}_{i_{(SD+LD)}} - \dot{m}_{i_{LD,rec}}) \times x_{LD,dis} \times x_{i_{LD,dis}} \quad (S1.4a)$$

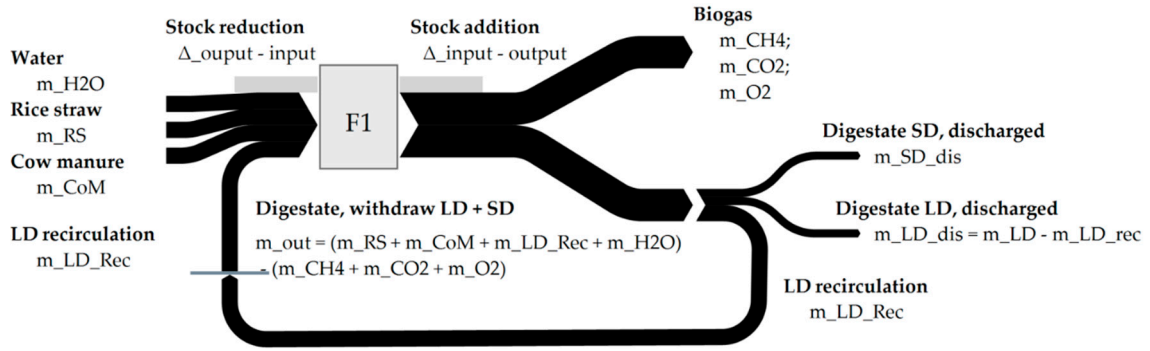


Figure S1. Mass balance of the digester F1 and F2.

S2 – Measurements, digester composition, and elements composition.

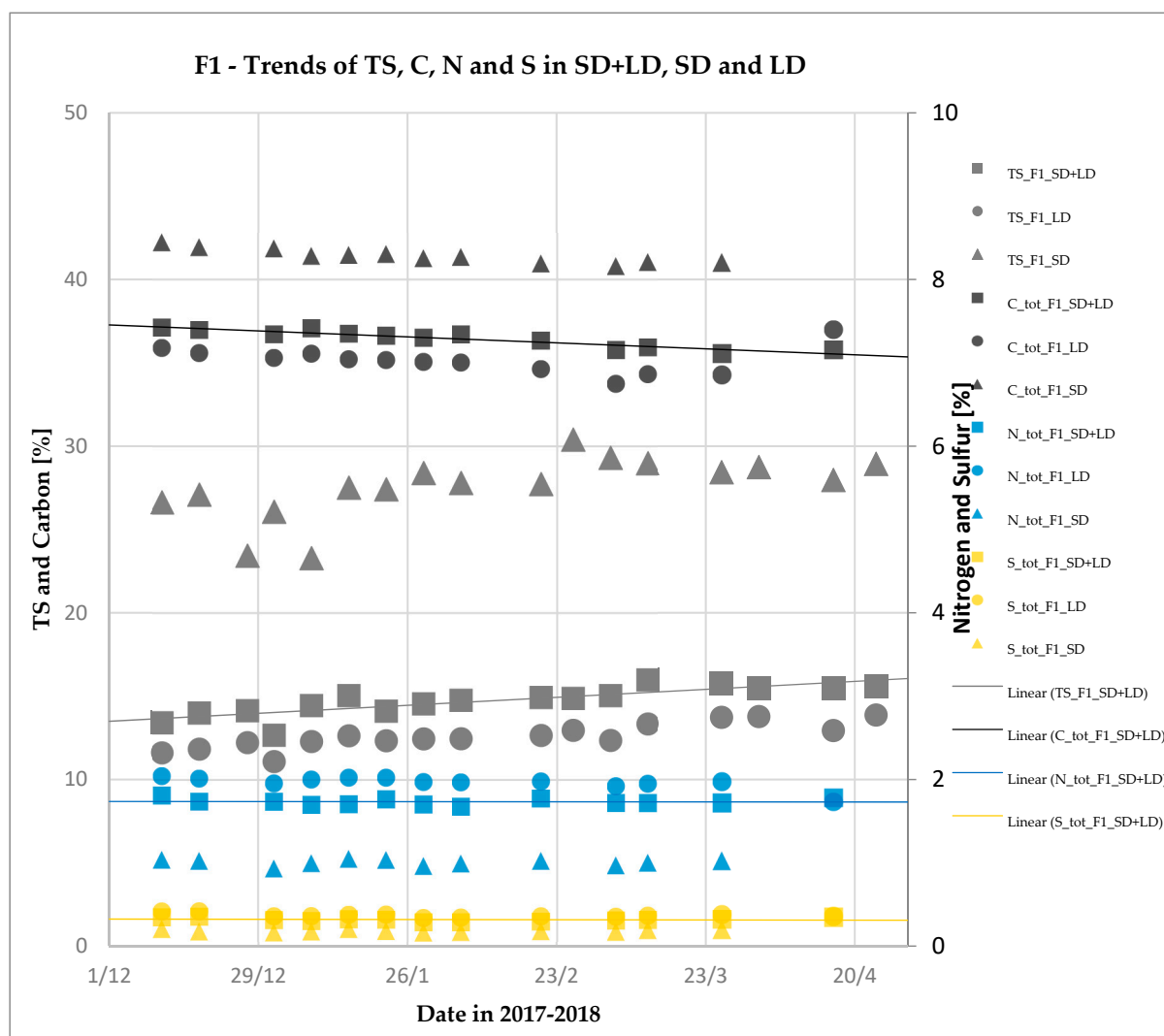


Figure S2. F1-Trends of TS, C, N, and S in SD+LD, SD, and LD.

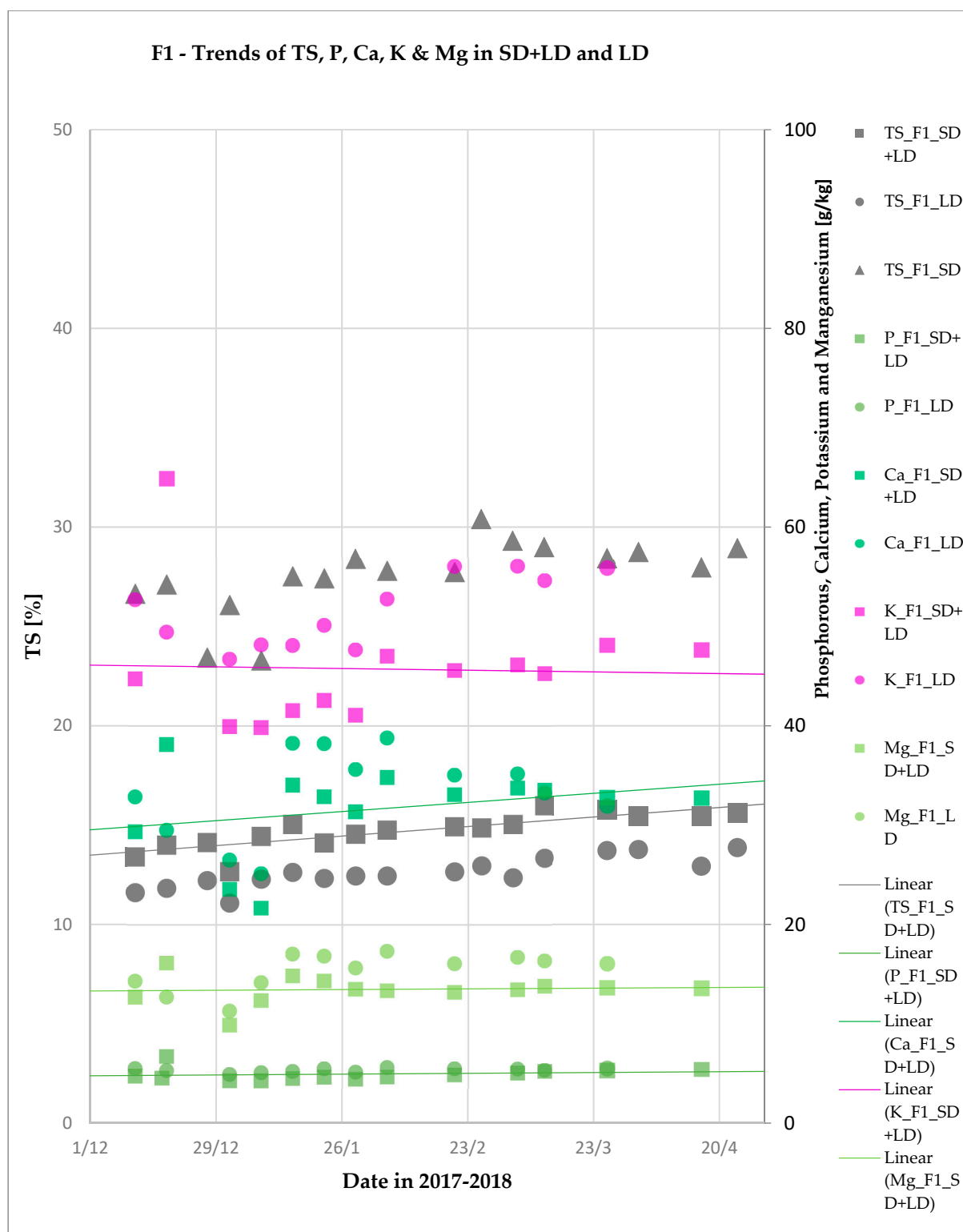


Figure S3. F1 - Trends of TS, P, Ca, K & Mg in SD+LD and LD.

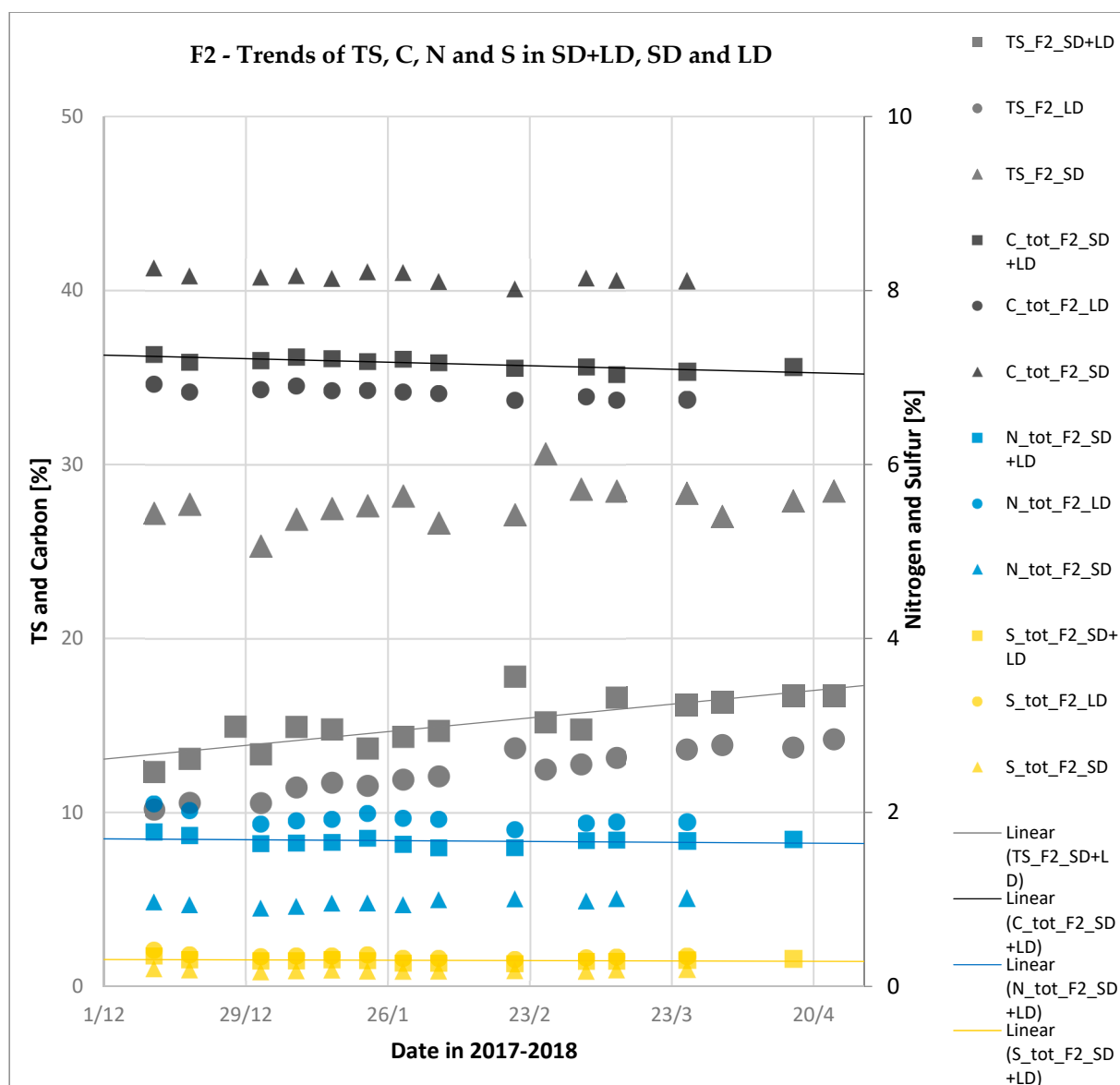


Figure S4. F2 - Trends of TS, C, N, and S in SD+LD, SD, and LD.

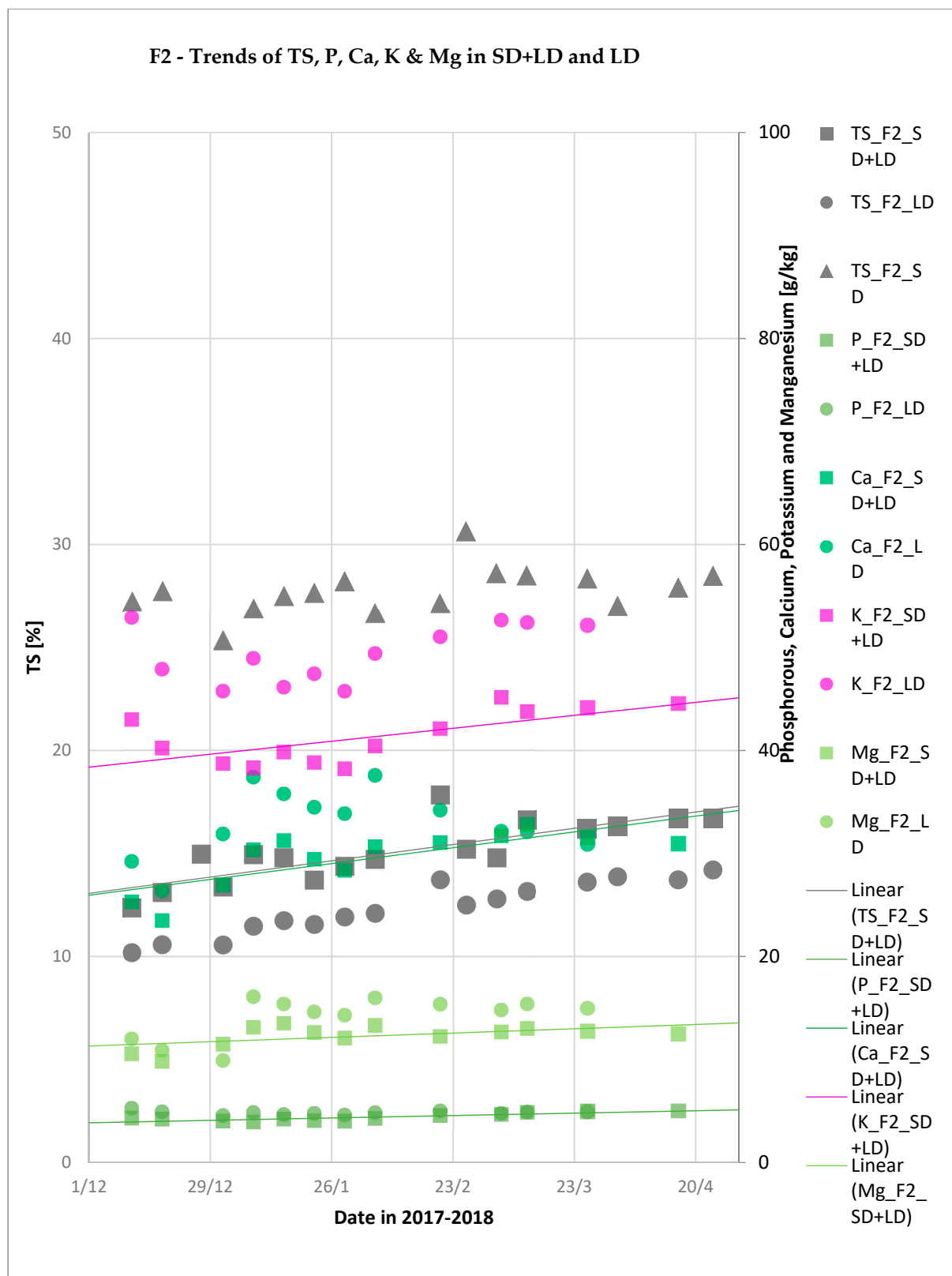


Figure S5. F2 - Trends of TS, P, Ca, K & Mg in SD+LD and LD.

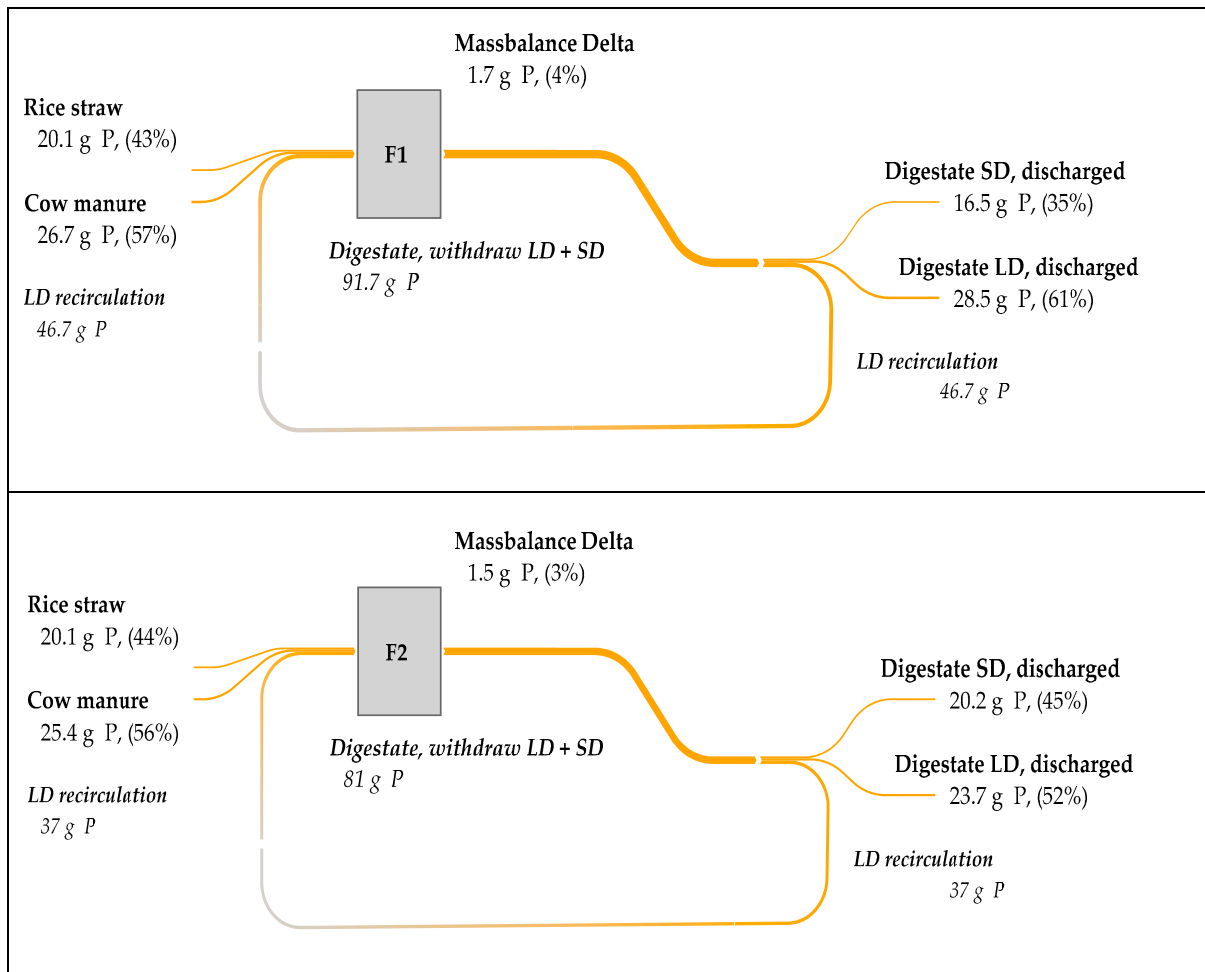
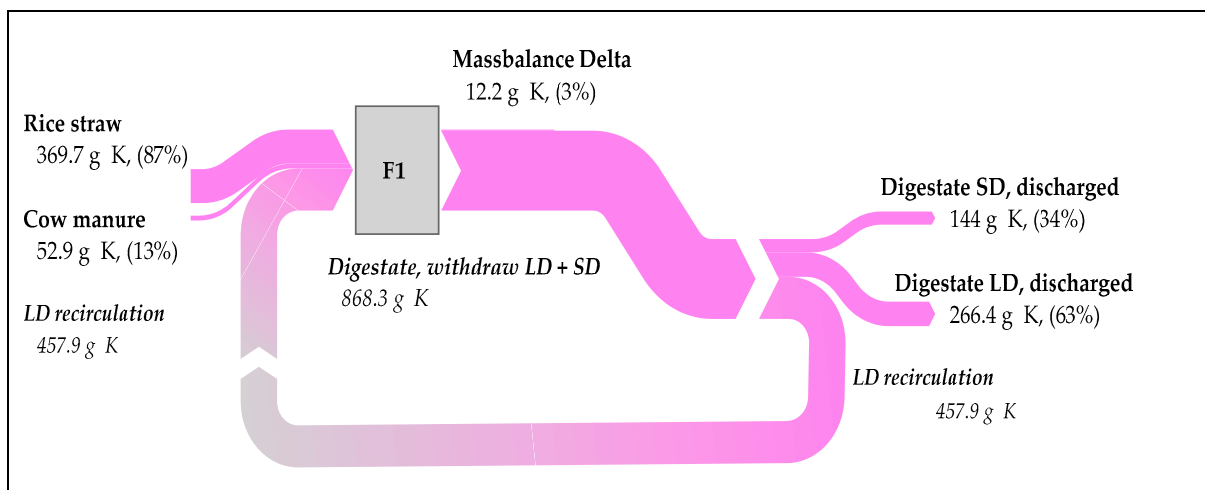


Figure S6. Mass balance of phosphorus (P) for 134 days and its output distribution into LD and SD in F1 and F2. The input flows of RS and CoM sum as 100 % and are basis for the output flows (discharged SD and LD). LD rec is process internal flow. Mass balance delta (ΔMB) represent the losses during AD.



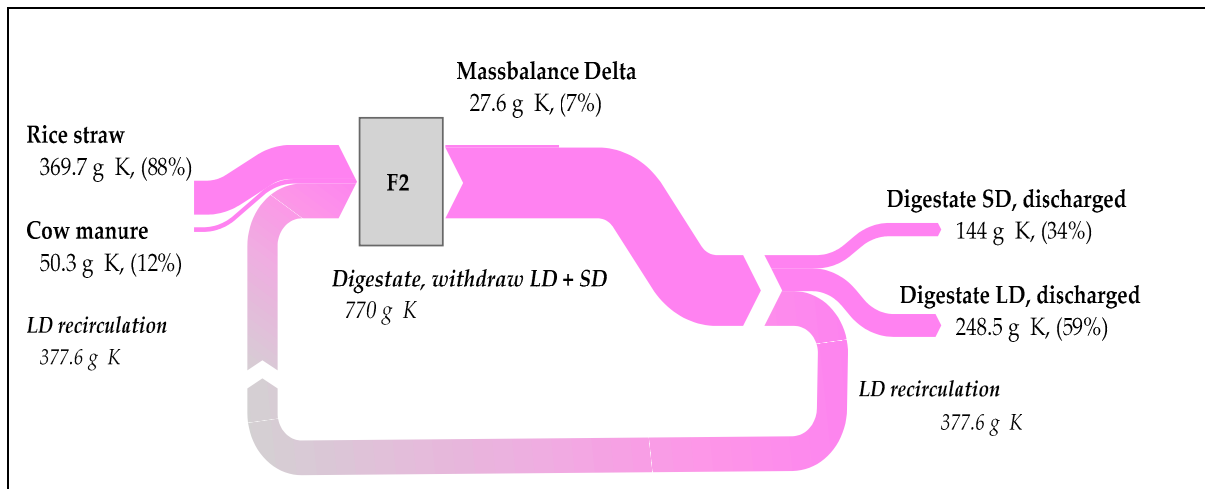


Figure S7. Mass balance of potassium (K) for 134 days and its output distribution into LD and SD in F1 and F2. The input flows of RS and CoM sum as 100 % and are basis for the output flows (discharged SD and LD). LD rec is process internal flow. Mass balance delta (ΔMB) represent the losses during AD.

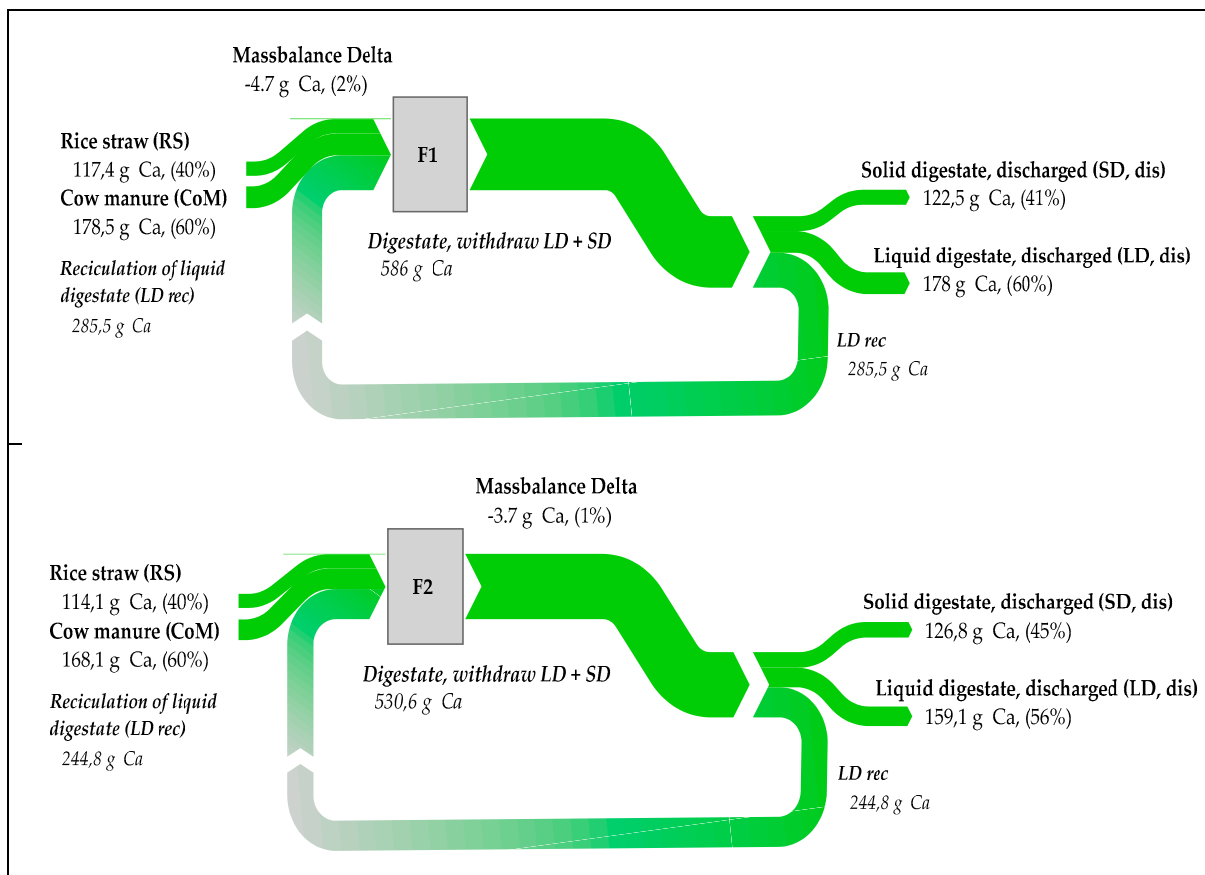


Figure S8. Mass balance of calcium (Ca) for 134 days and its output distribution into LD and SD in F1 and F2. The input flows of RS and CoM sum as 100 % and are basis for the output flows (discharged SD and LD). LD rec is process internal flow. Mass balance delta (ΔMB) represent the losses during AD.

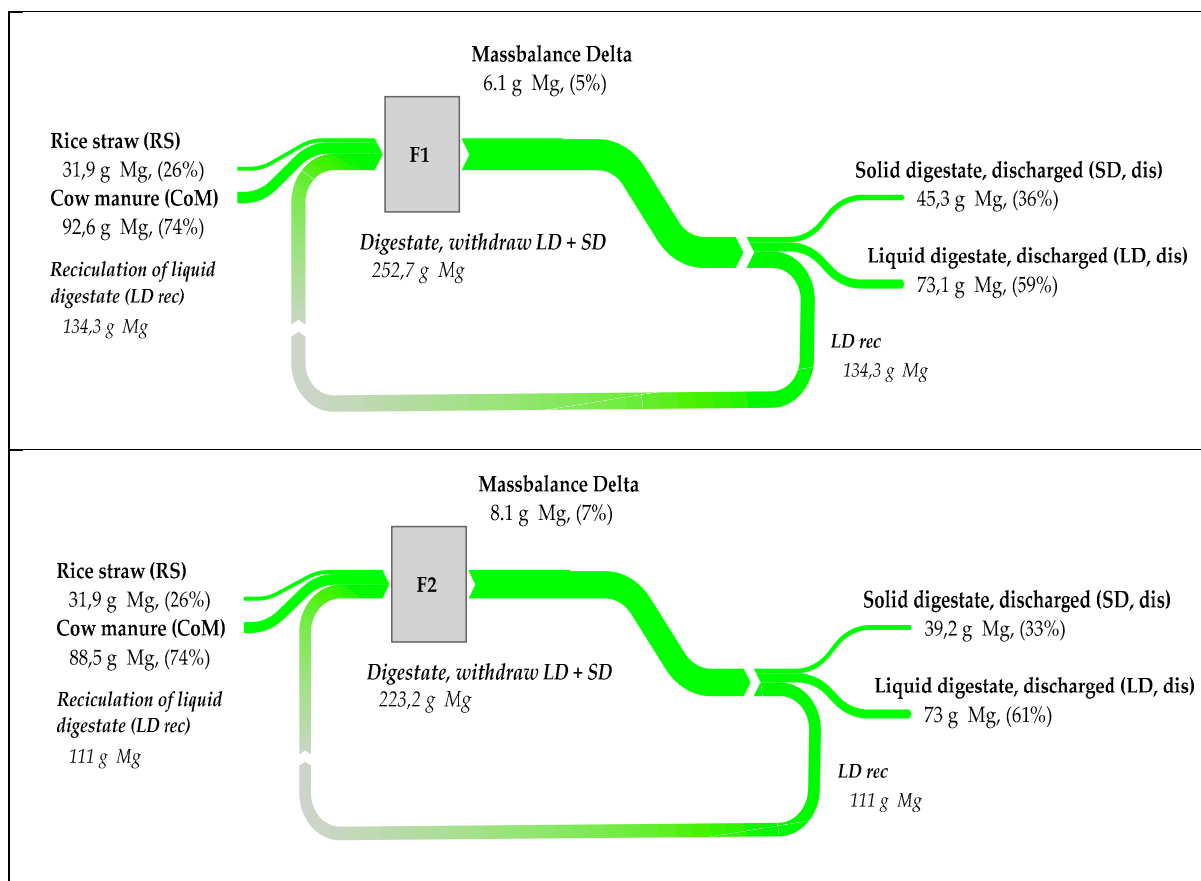
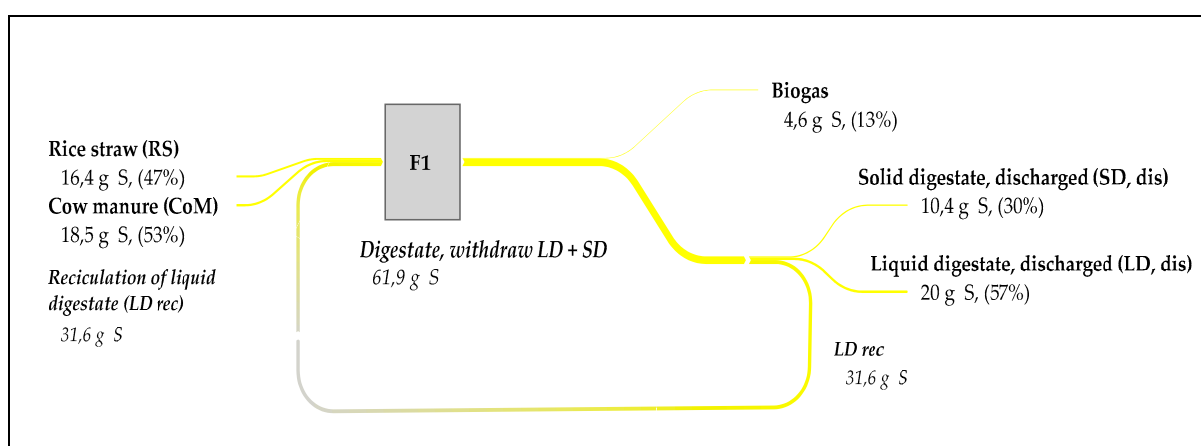


Figure S9. Mass balance of magnesium (Mg) for 134 days and its output distribution into LD and SD in F1 and F2. The input flows of RS and CoM sum as 100 % and are basis for the output flows (discharged SD and LD). LD rec is process internal flow. Mass balance delta (ΔMB) represent the losses during AD.



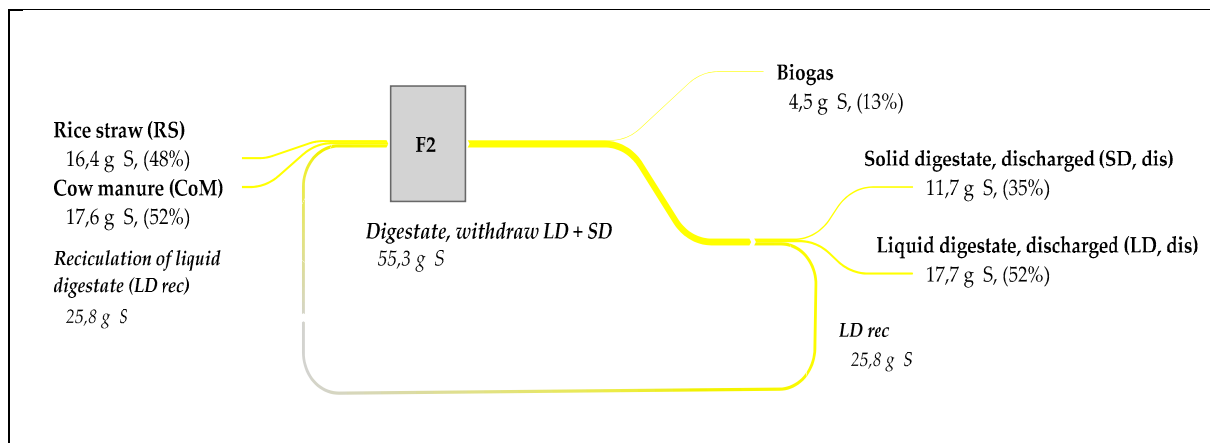


Figure S10. Mass balance of sulfur (S) for 134 days and its output distribution into LD and SD in F1 and F2. The input flows of RS and CoM sum as 100 % and are basis for the output flows (discharged SD and LD). LD rec is process internal flow.