Research Area 1 | Landscape Functioning
Working Group | Silicon Biogeochemistry

Anthropogenic Desilication of Agricultural Soils – Results from a Long-Term Field Experiment in NE Germany

Daniel Puppe, Danuta Kaczorek, Michael Sommer

Introduction

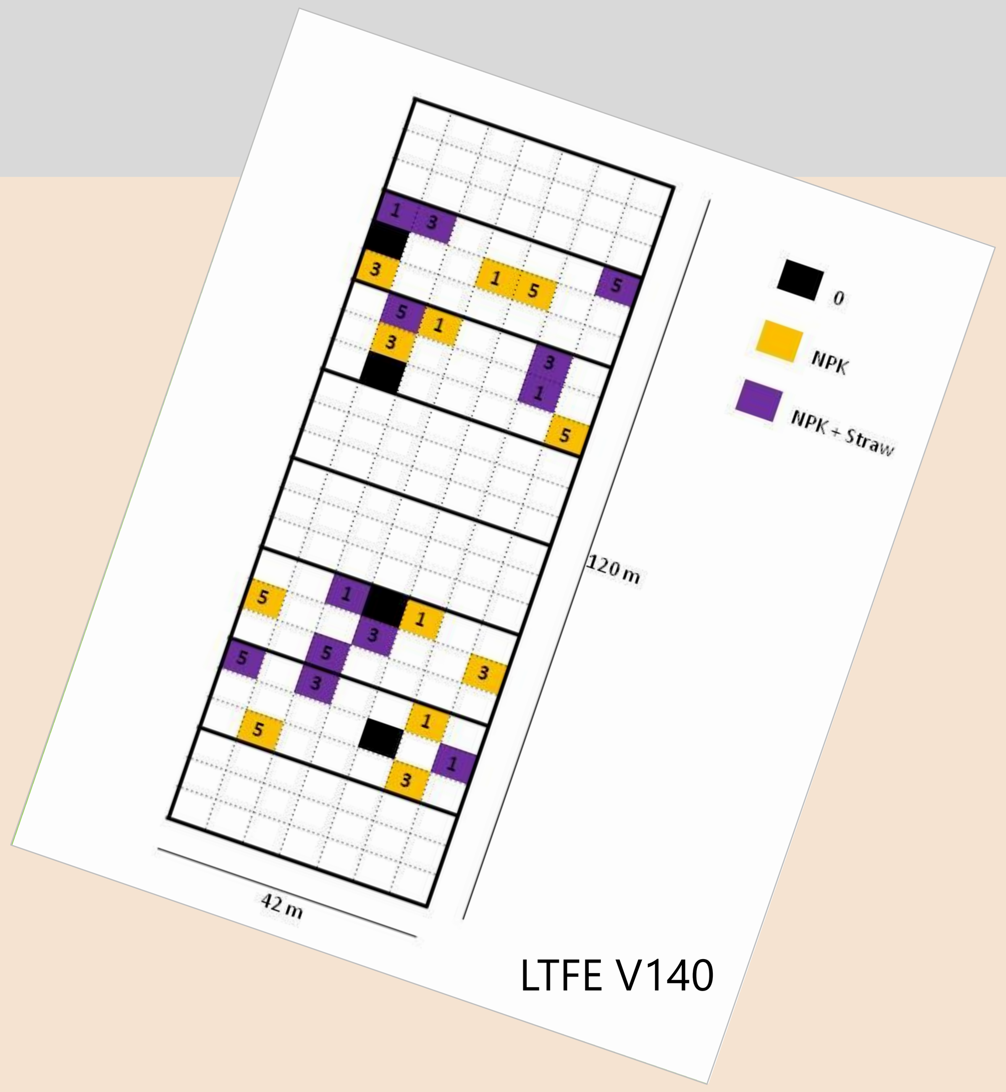
- Intensified land use → Humans directly influence silicon (Si) cycling on a global scale
- Si exports by harvested crops generally lead to a Si loss in agricultural soils → Anthropogenic desilication
- On a global scale about 35% of total phytogenic Si is synthesized by field crops due to their relatively high Si contents and biomasses → Increased agricultural production within the next decades
- Need for long-term field experiments → Detailed understanding of anthropogenic desilication of agricultural systems

Research Questions

- (i) Can we observe a significant desilication (indicated by a decrease in plant available Si in soils) of agricultural systems in the temperate zone in the long term?
- (ii) Is this potential desilication affected by NPK fertilization rates?
- (iii) Is this potential decrease of plant available Si in soils reflected in Si concentrations of the grown plants (e.g., wheat)?
- (iv) Can we prevent potential anthropogenic desilication by straw fertilization?

Study Site

- ZALF's long-term field experiment (LTFE) V140, Albic Luvisol, 561 mm, 9.4°C → Effects of management on Si pools since 1963
- Randomized block design → Plots with low, medium, and high mineral NPK fertilization rates, plots with straw fertilization in addition to NPK fertilization, and control plots

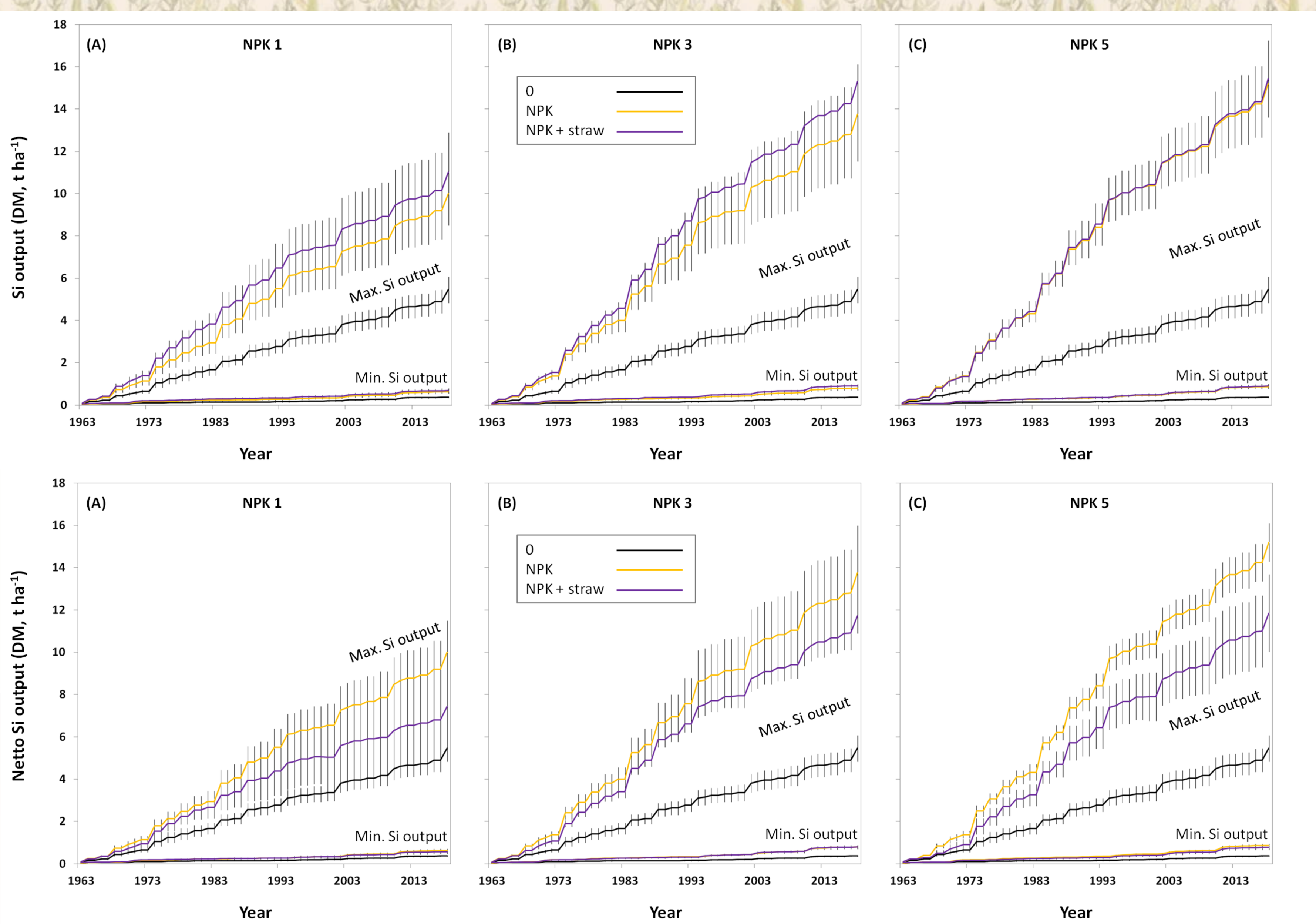


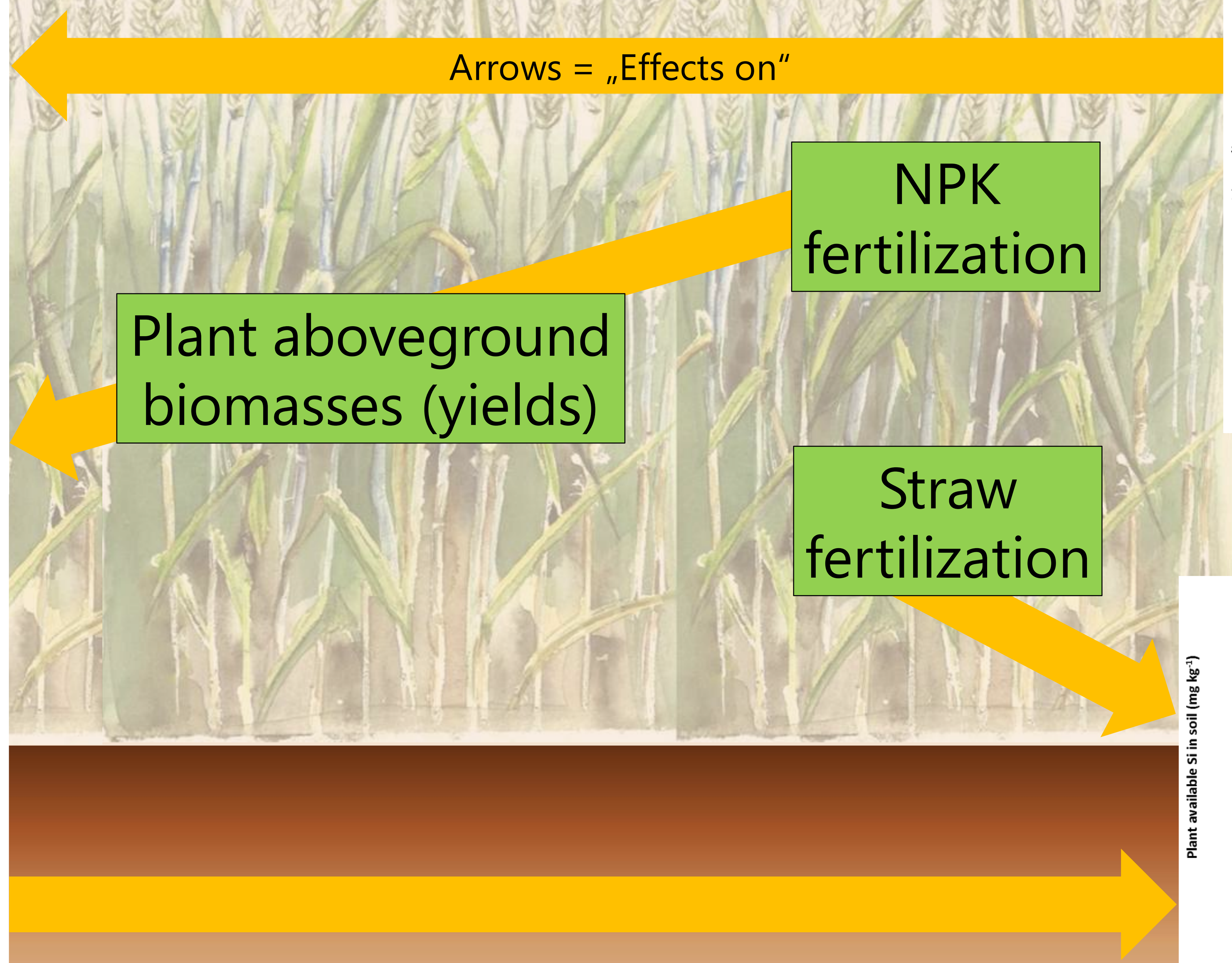
Methods

- Si inputs → Straw fertilization (2.0 t DM ha^{-1} y^{-1})
- Si outputs → Aboveground biomass (t ha^{-1} DM) x (min. and max.) Si concentration in plants (%)
- Netto Si output → Si output – Si input
- Si in plants → HF digestion and subsequent ICP-OES
- Si in soils → $CaCl_2$ extraction and subsequent ICP-OES

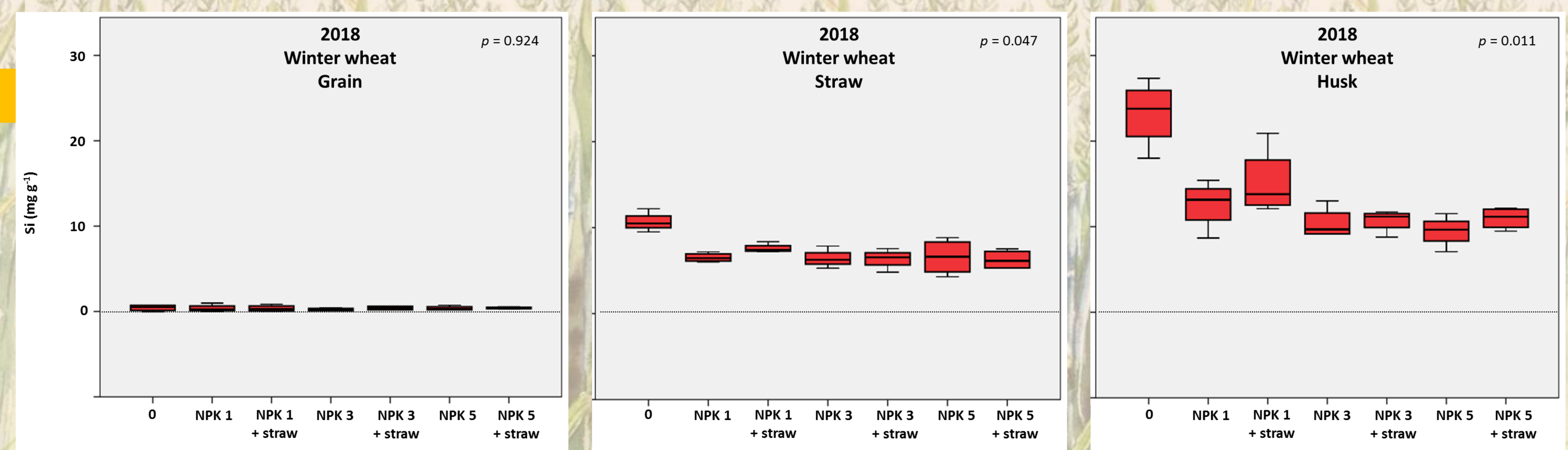
Results

Si inputs and outputs

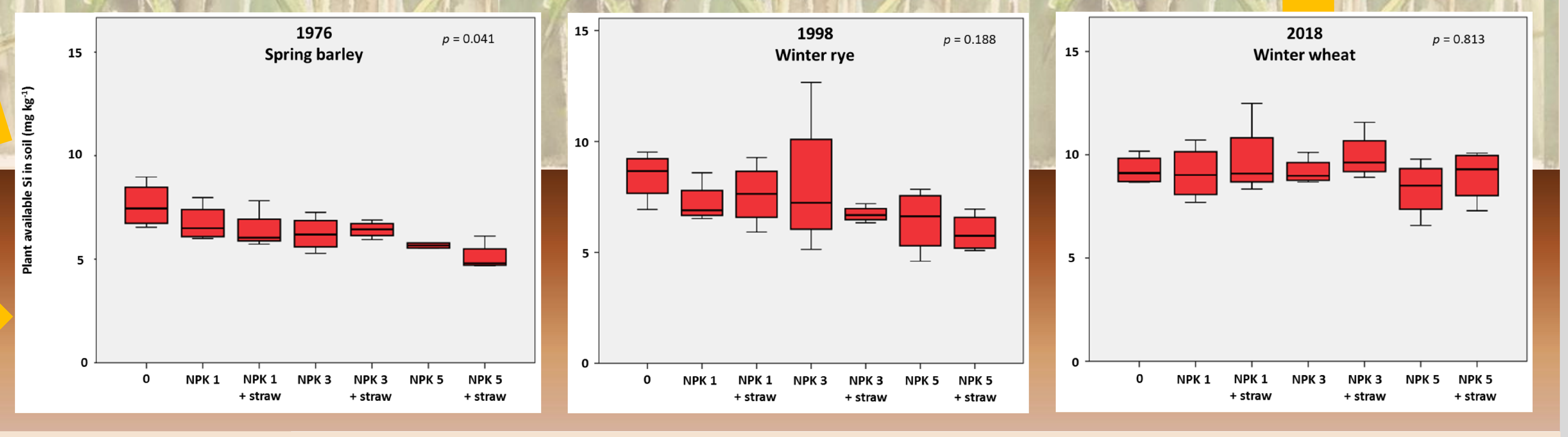




Si in plants



Si in soils



Conclusions

- Anthropogenic desilication is mainly driven by harvested plant biomasses → Plant biomasses in turn are controlled by NPK fertilization rates
- Straw fertilization prevents anthropogenic desilication of agricultural systems → No decrease of plant available Si in soils (indeed plant available Si increases in the long term)
- Si in soils is directly reflected in Si concentrations of plant materials → Especially plant parts with high Si concentrations (husks) seem to be well-suited indicators

Contact: Dr. Daniel Puppe
Leibniz Centre for Agricultural Landscape Research (ZALF) · 15374 Müncheberg · Germany
www.zalf.de · daniel.puppe@zalf.de · +49 33432 82 4077

Deutsche Forschungsgemeinschaft
Grant PU 626/2-1

Interested? Get more information right here:

Puppe, D. & M. Sommer (2018). Experiments, uptake mechanisms and functioning of Si foliar fertilization – A review focusing on maize, rice and wheat. ***Advances in Agronomy*** 152, 1-49.

Puppe, D. & M. Leue (2018). Physicochemical surface properties of different biogenic silicon structures: results from spectroscopic and microscopic analyses of protistic and phytogenic silica. ***Geoderma*** 330, 212-220.

Kaczorek, D., Puppe, D., Busse, J., & M. Sommer (2019). Effects of phytolith distribution and characteristics on extractable silicon fractions in soils under different vegetation – An exploratory study on loess. ***Geoderma*** 356, 113917.