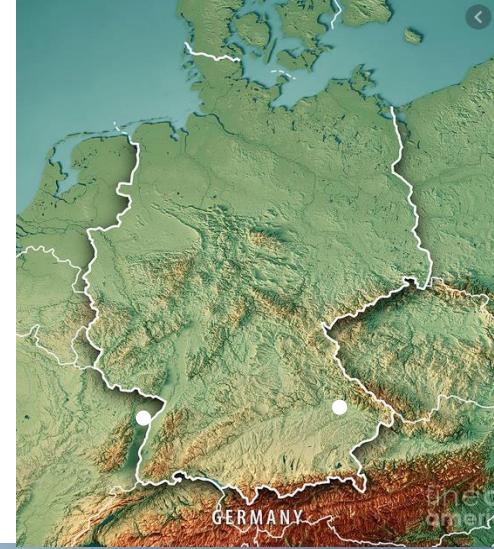


Sensoren für die Landwirtschaft – Nitrat

Prof. Dr. Nicolas Plumeré

Professur für Elektrobiotechnologie
Campus Straubing für Biotechnologie und Nachhaltigkeit
Technische Universität München

Nicolas.plumere@tum.de



Echem lab

Synthesis lab

Protein lab

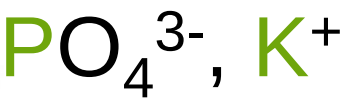


C, O, H, N, S, P, K

51% 42% 6% 0.3% 0.03%

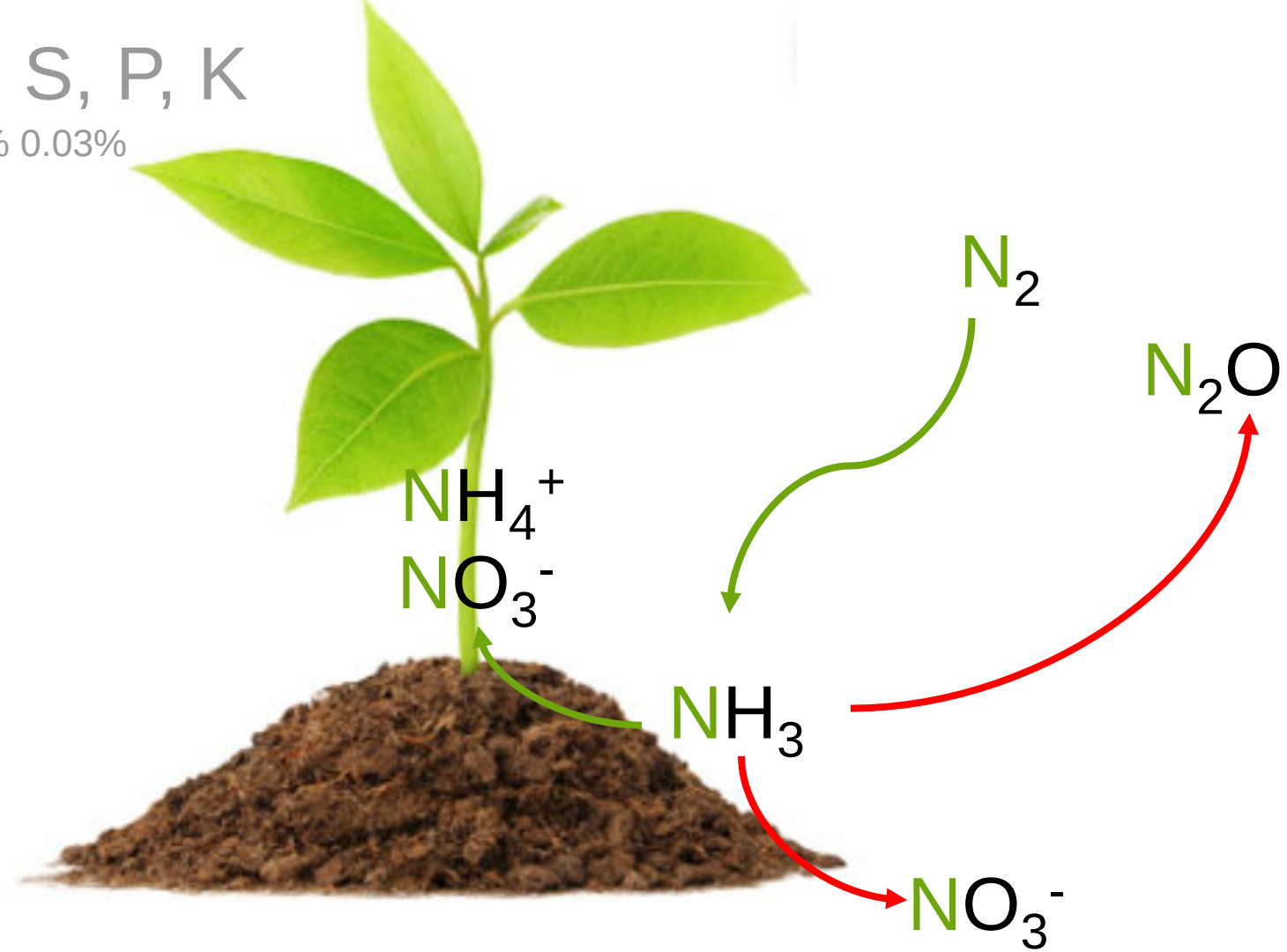


Jan Baptist van Helmont
The Willow tree experiment
Ortus Medicinae (1648)

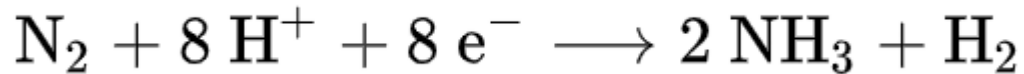
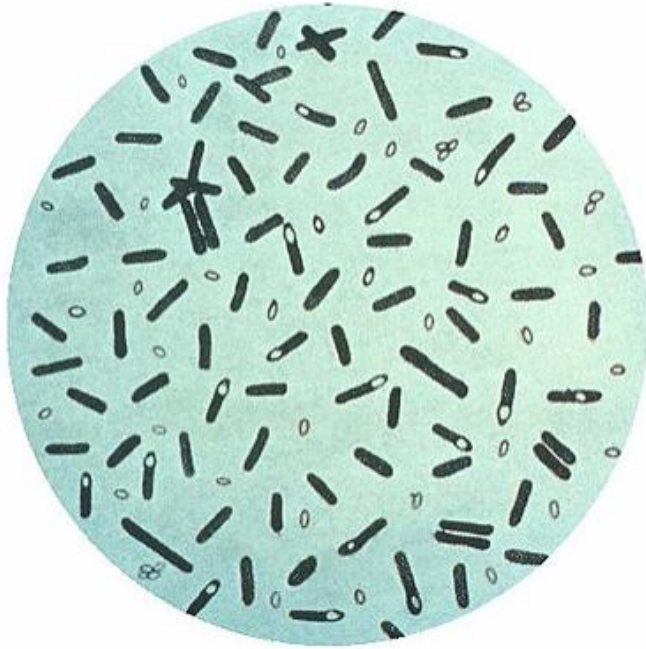


C, O, H, N, S, P, K

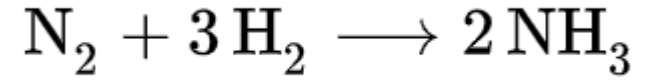
51% 42% 6% 0.3% 0.03%

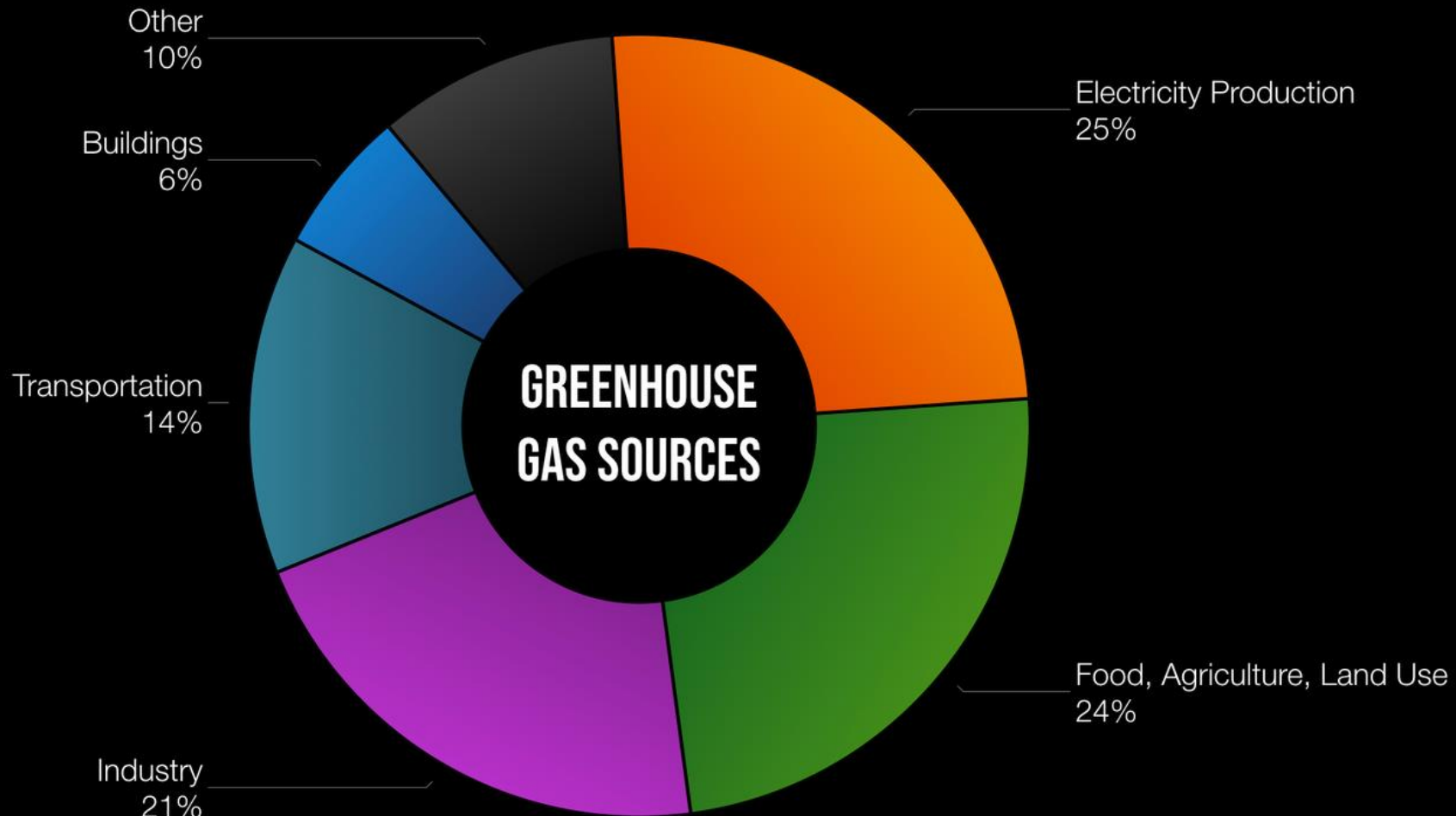


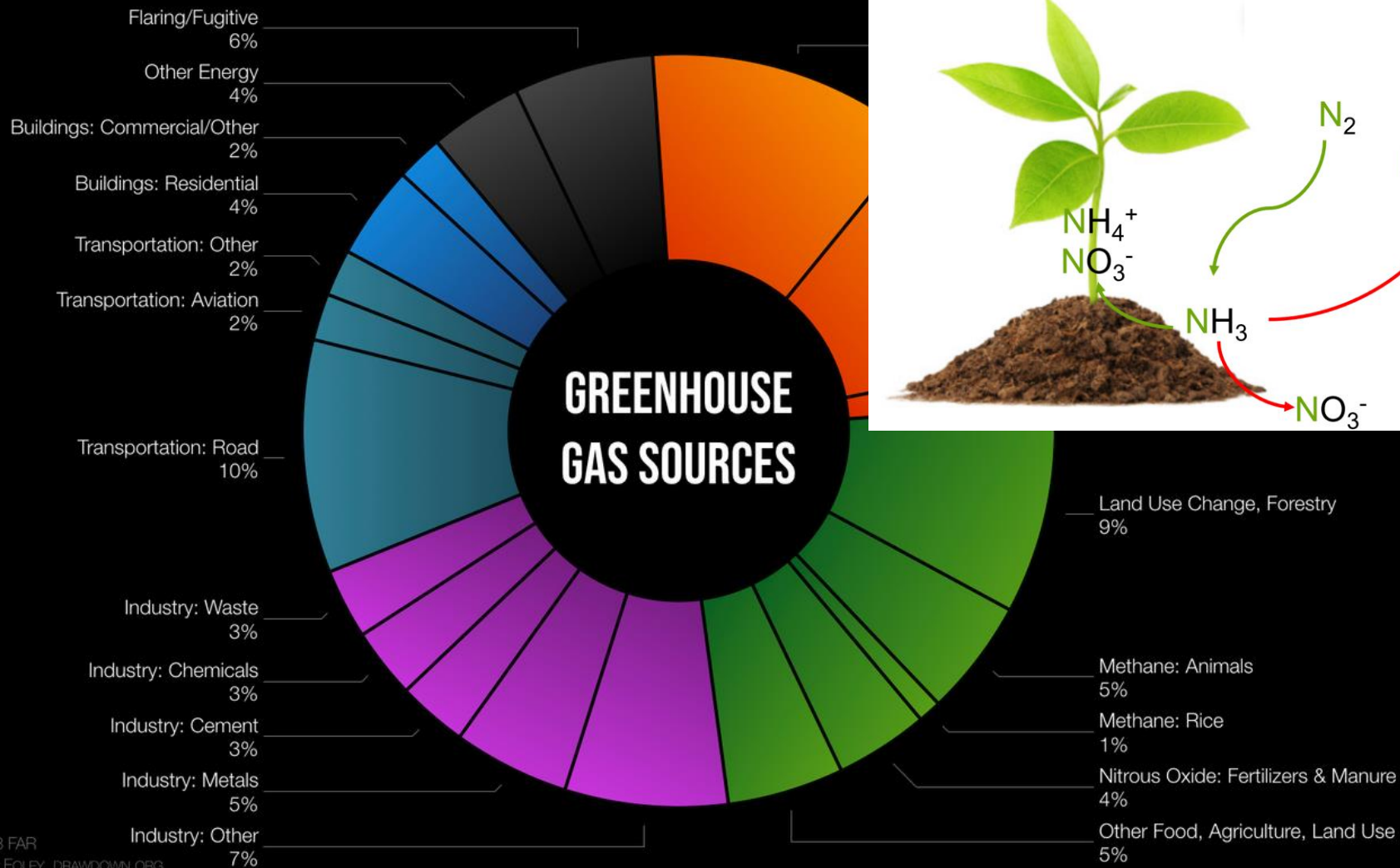
Biologische N₂ Fixierung
120 Millionen Tonnen

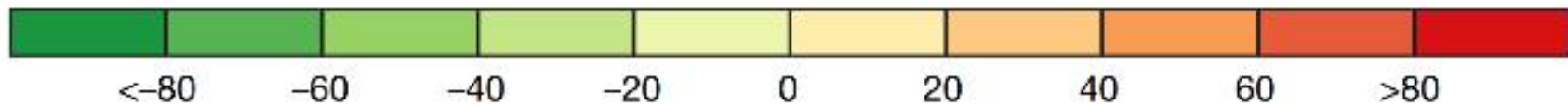
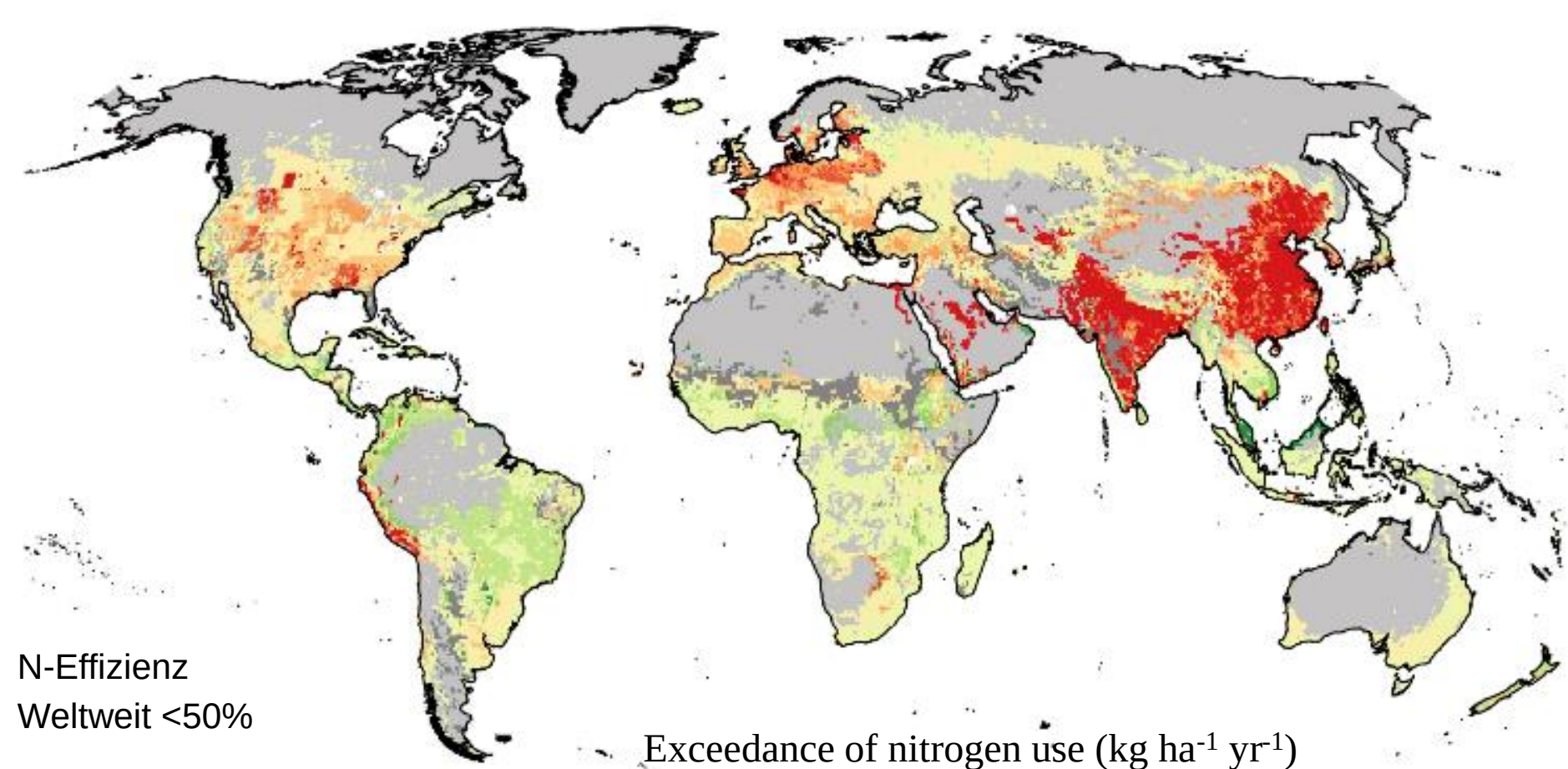


Haber Prozess N₂ Fixierung
230 Millionen Tonnen







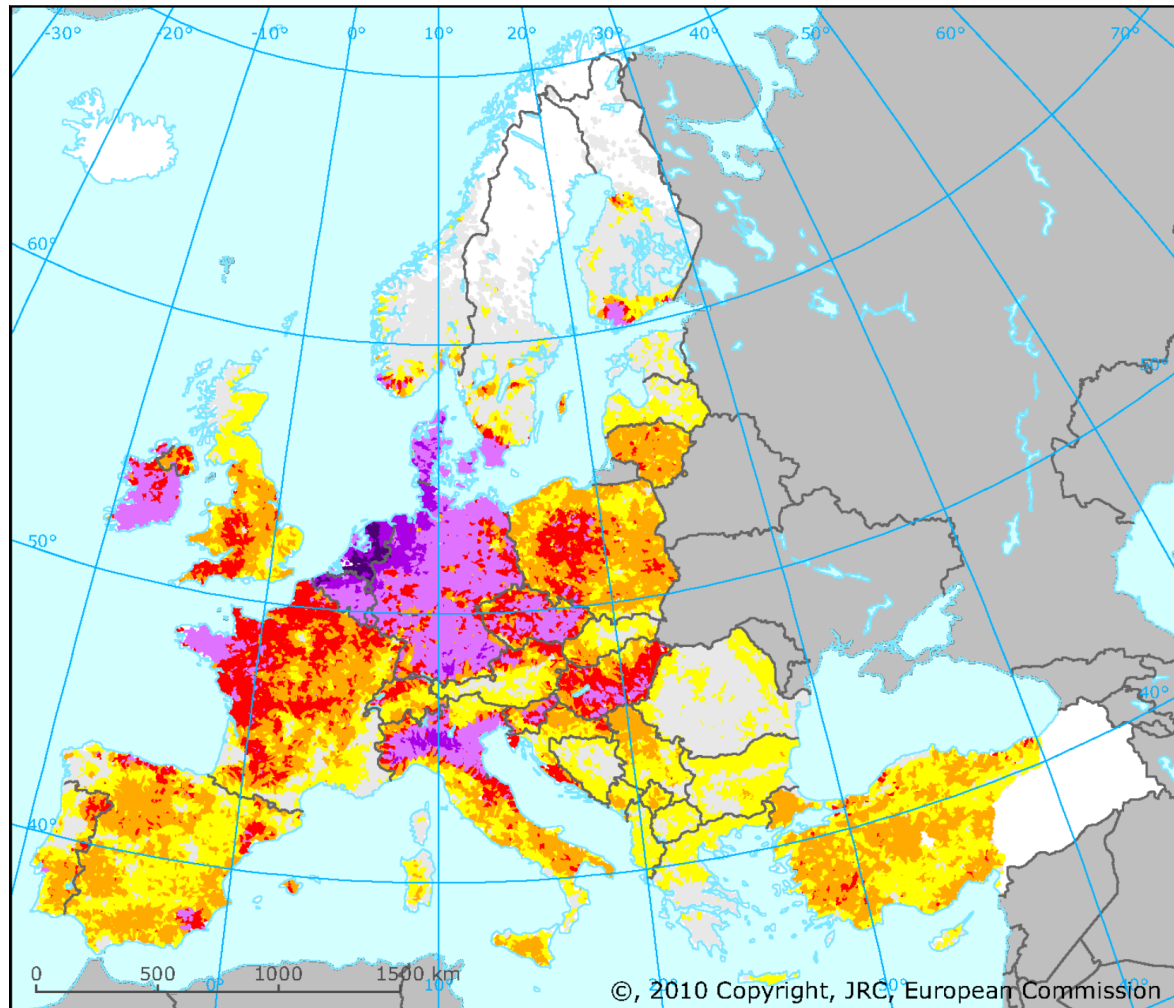


Nitrogen surplus, 2005

(kg/ha)



No data
Outside coverage



N-Effizienz
Weltweit <50%
DE <50%

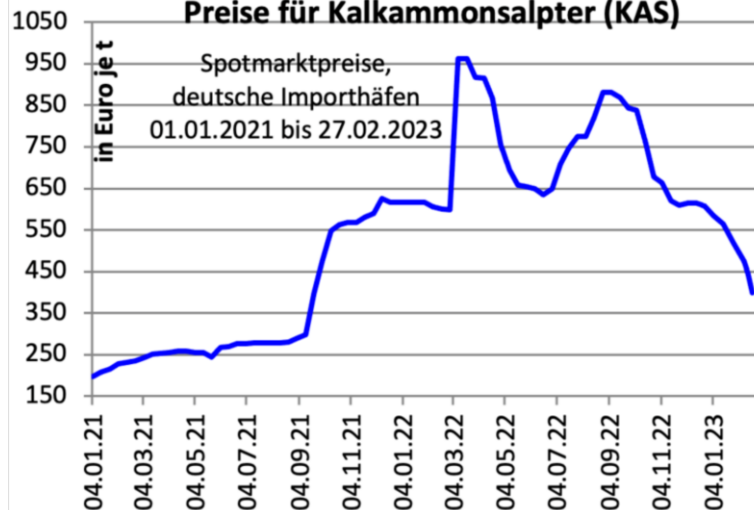
ÜBER SEE UND ÜBER LAND

Weltweite Transportwege von Mineraldüngern, Warenströme über 300.000 Tonnen, 2013



KONZERNATL. S.2017 / ICIS, FAO

Preise für Kalkammonsalpter (KAS)



Absatz nach Regionen in Millionen Tonnen, 2014



Stickstoff-Phosphat-Mischungen aufgeteilt auf Stickstoff- und Phosphatdünger, ohne schwefelhaltige Dünger



20% **reduction** in fertilizers.

Achieve Nitrogen use
efficiency of 75-90%.



European
Green Deal

Reduce nitrate below the
safety threshold of 50 mg/L.

EU Nitrates Directive (91/676/EEC)	Water Framework Directive (2000/60/EC)
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Entwicklungsstadien des Getreides

270 kg N/ha



40 kg N/ha
(50% N Eff.)

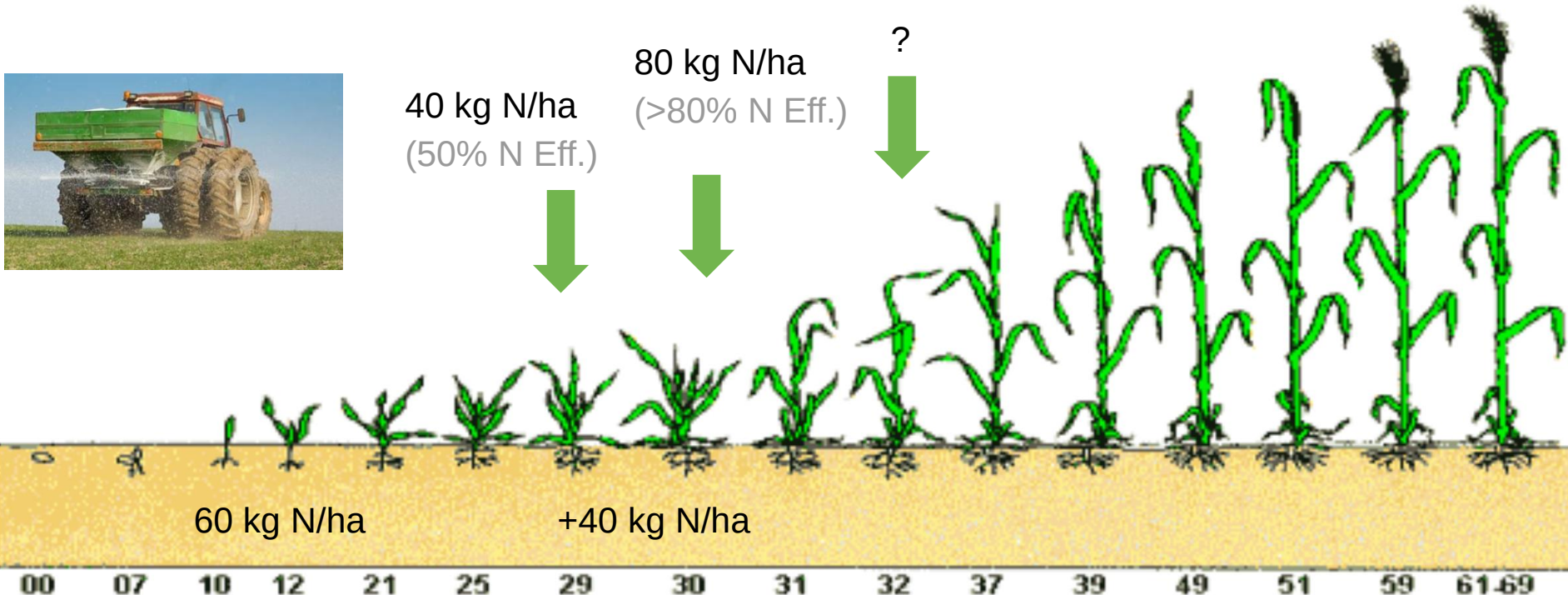
80 kg N/ha
(>80% N Eff.)

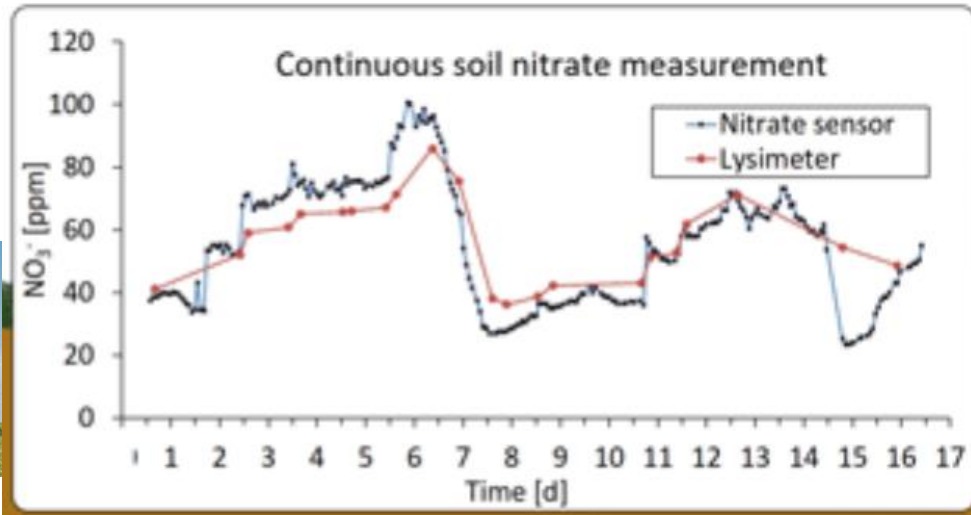
?

60 kg N/ha

+40 kg N/ha

00 07 10 12 21 25 29 30 31 32 37 39 49 51 59 61-69





270 kg N/ha



60 kg N/ha

+40 kg N/ha

00 07 10 12 21 25 29 30 31 32 37 39 49 51 59 61-69



Laboratory tests



Soil tests



Plant analysis



Remote sensing

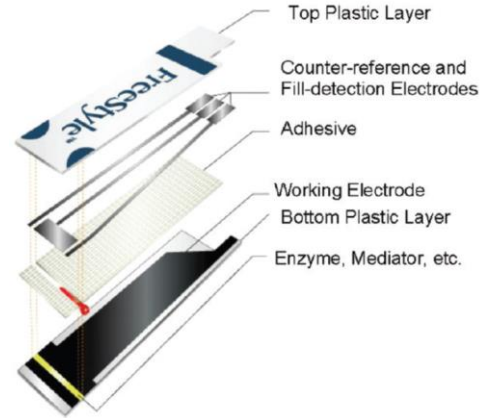




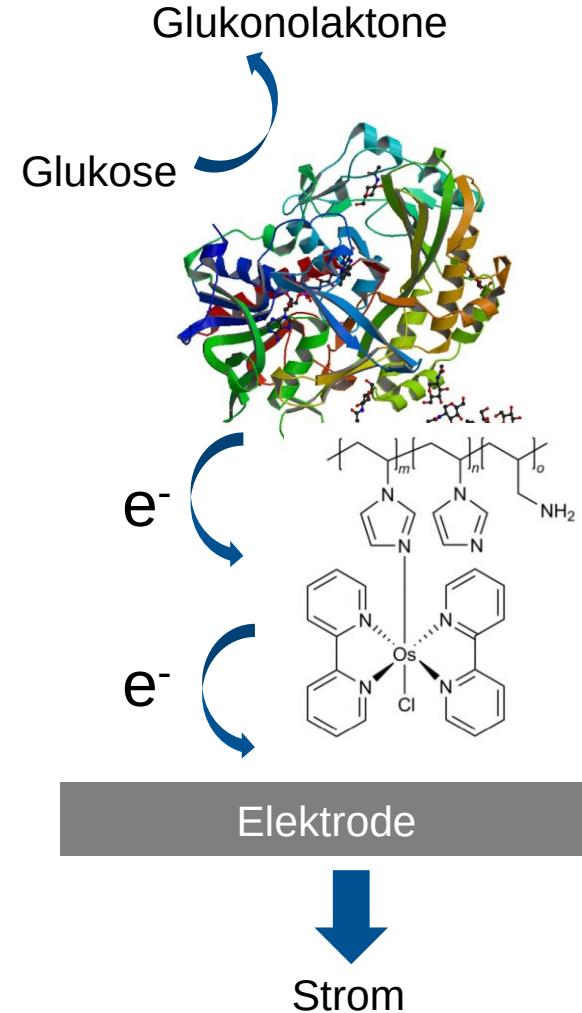
**Blut-Zucker
Sensor für
Diabetiker**



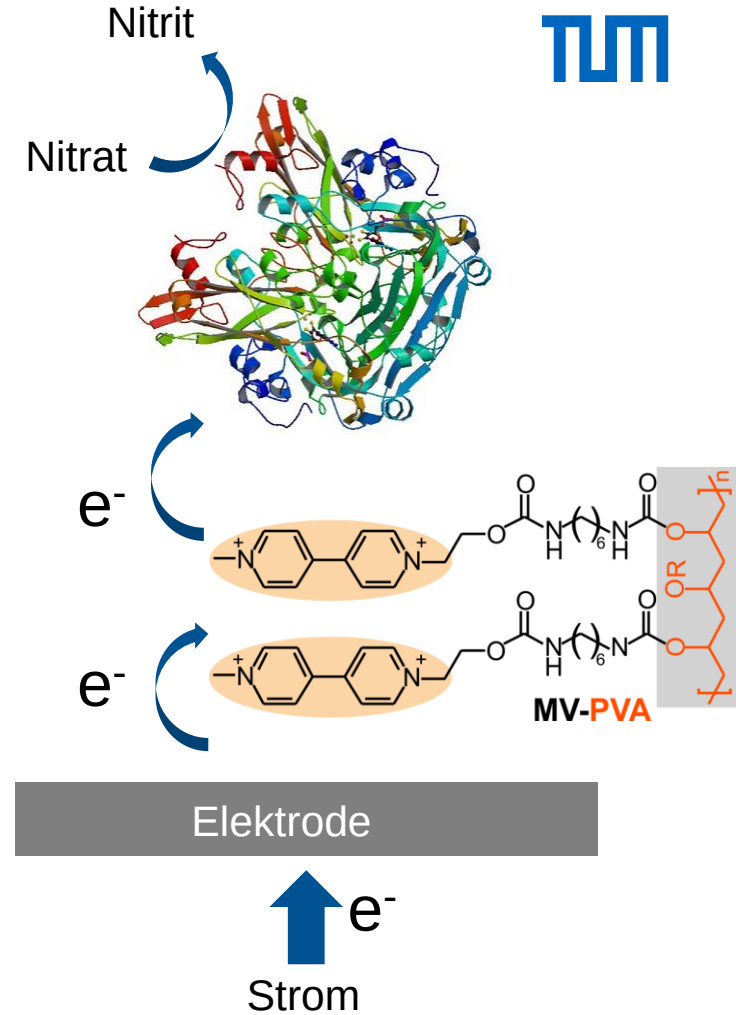
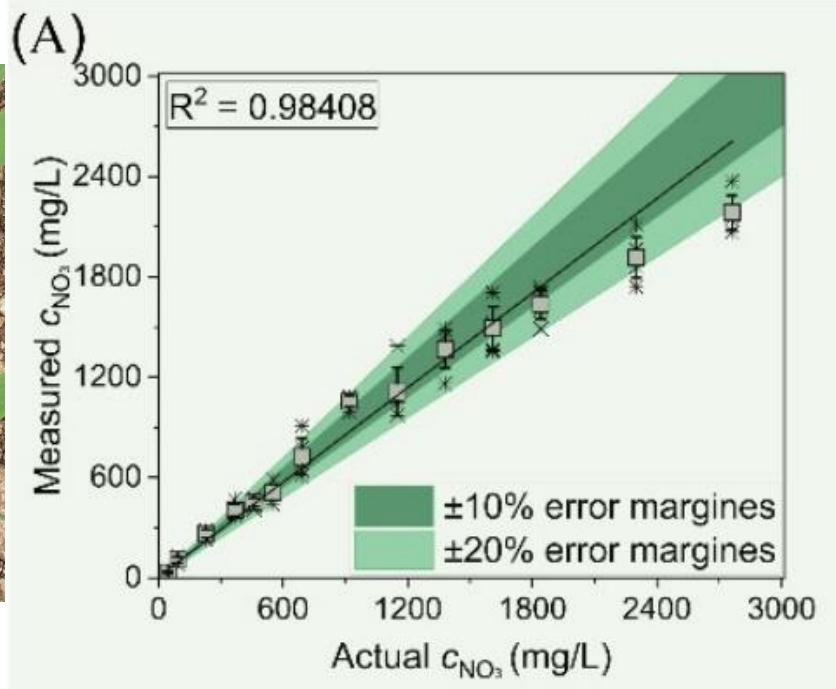
GLUKOSE SENSOR



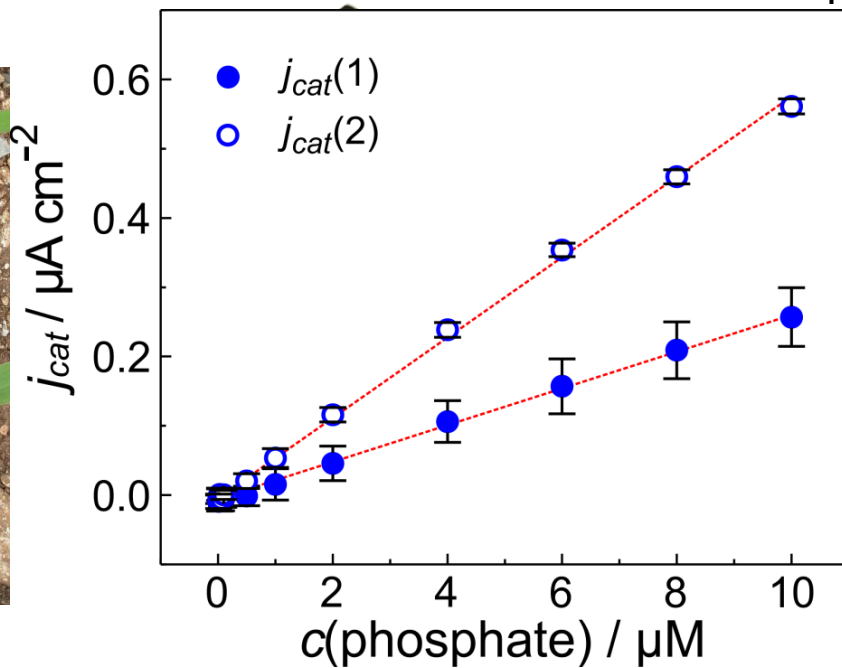
10 Milliarden Glukose Sensoren pro Jahr



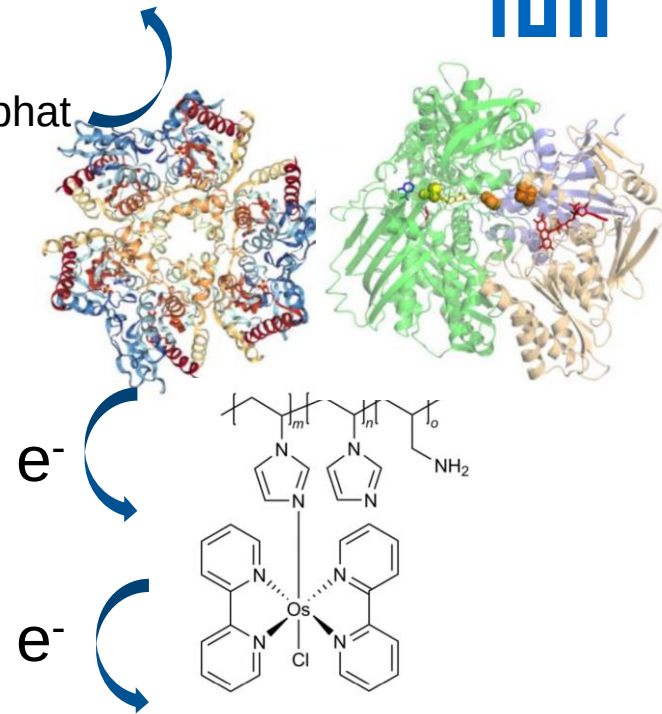
NITRAT SENSOR



PHOSPHAT SENSOR



Phosphat

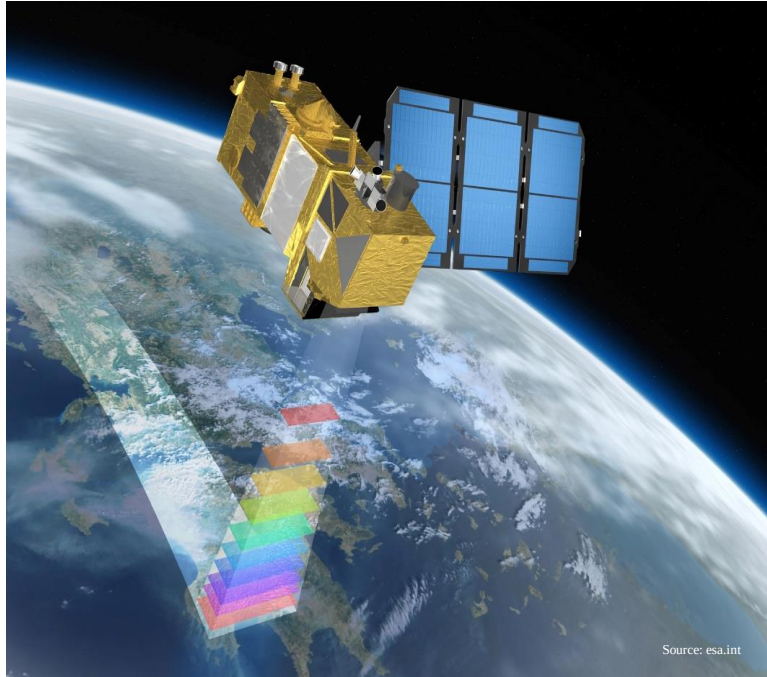


Elektrode

Strom



COPERNICUS: MULTISPECTRAL IMAGERY



REMOTE SENSING → CROP HEALTH STATUS



Dr. Tobias Vöpel
Biochemistry



Dr. Débora Moretti
Innovation Management



Dr. Alaa Oughli
Electrochemistry

