Theories + engineerings of non-leguminous biological nitrogen fixation

Prof. Dr. Zubin Xie

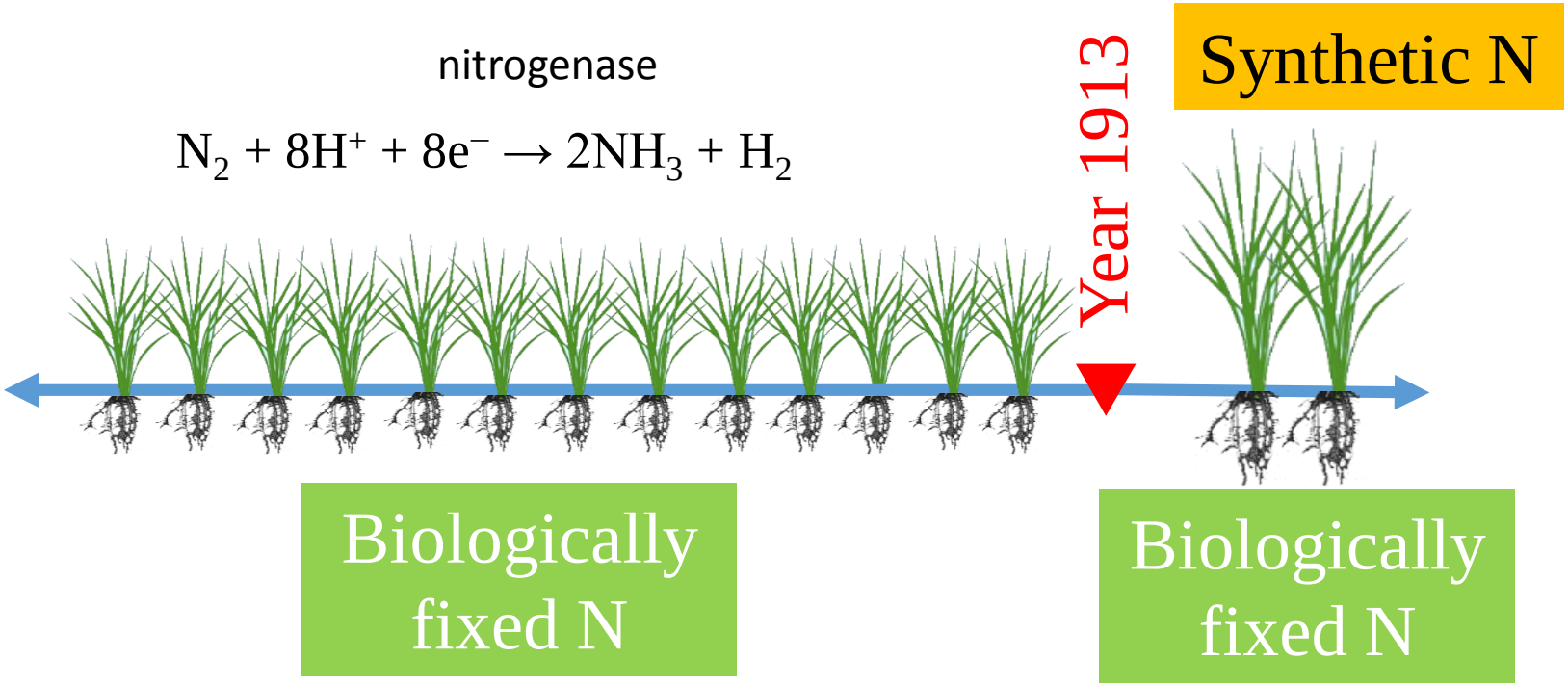
State Key Laboratory of Soil & Sustainable Agriculture
Institute of Soil Science, Chinese Academy of Sciences
zbxie@issas.ac.cn

Background

No N, no life.

nitrogenase

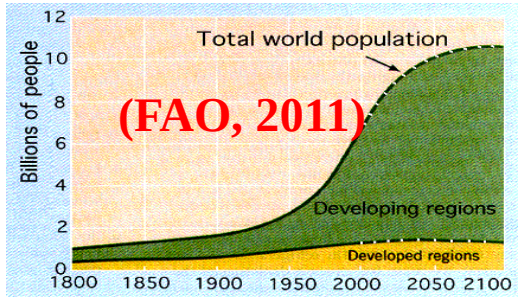
$$N_2 + 8H^+ + 8e^- \rightarrow 2NH_3 + H_2$$

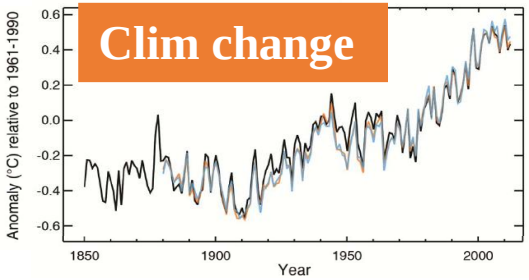


Main N sources

Cleveland et al., 1999; Herridge et a., 2008; Fowler et al., 2013

Challenges



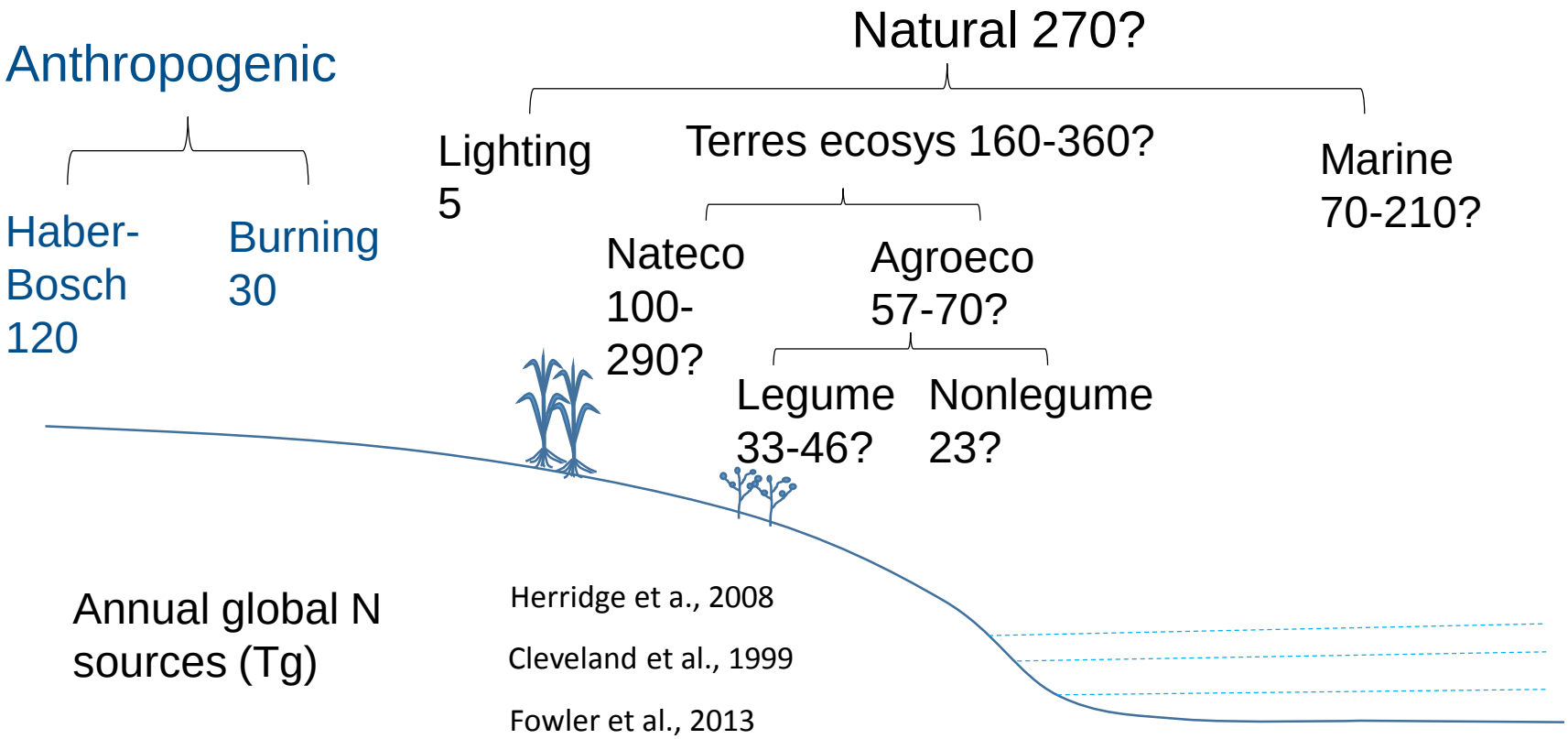


More pop. → More N

Less N ← Envir Poll

Biological N_2 fixation offers a way to meet the challenges

Why is the non-leguminous BNF: Large quantity, ubiquity, vast uncertainty and technology breakthrough.



Progresses（BNF quantification）

C_2H_2 reduction [Rao, 1976; Kondo and Yasuda, 2003]

⬇

$^{15}N_2$ indoor incubation[Buckley et al., 2007]

⬇

$^{15}N_2$ near-nature incubation[Bei et al., 2013]

Progresses (diazotrophs)

Non-N media to isolate diazaotrophs [Qiu et al，1981]

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Active diazotrophs [Woebken et al., 2012, 2014]

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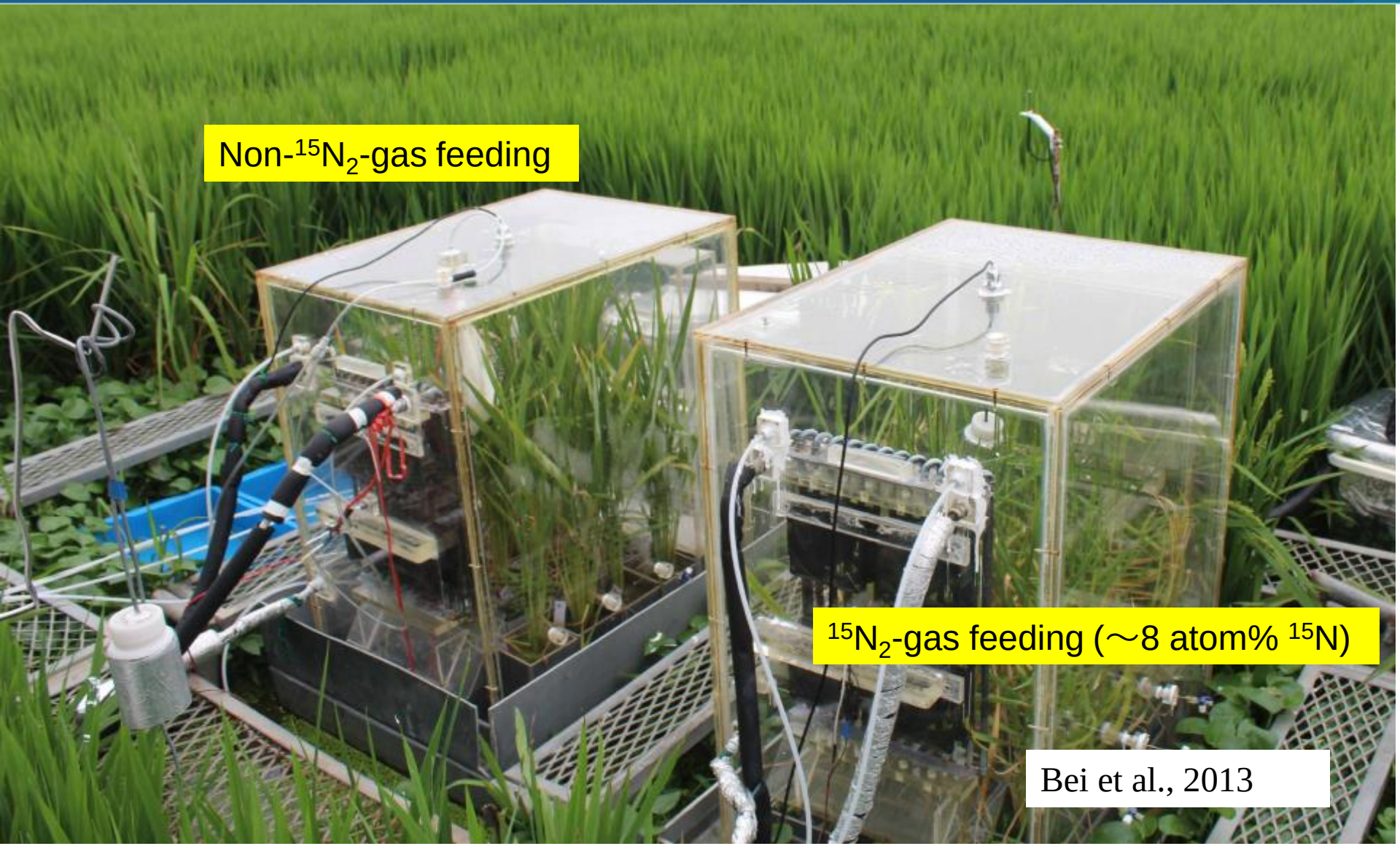
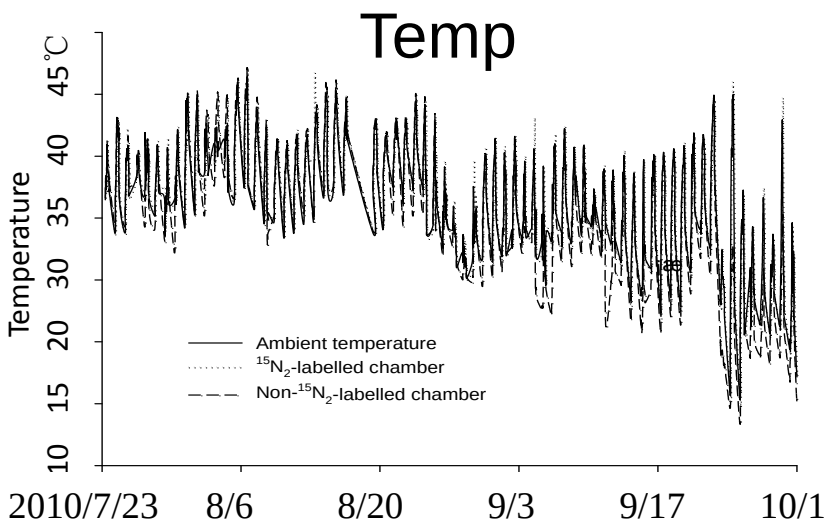
Complete genome sequences [Noar & Bruno-Barcena, 2013]

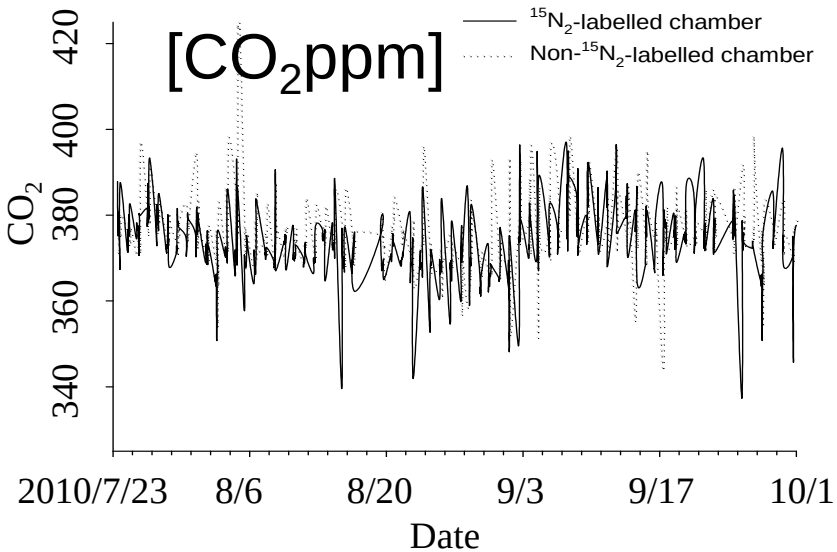
Some of our work

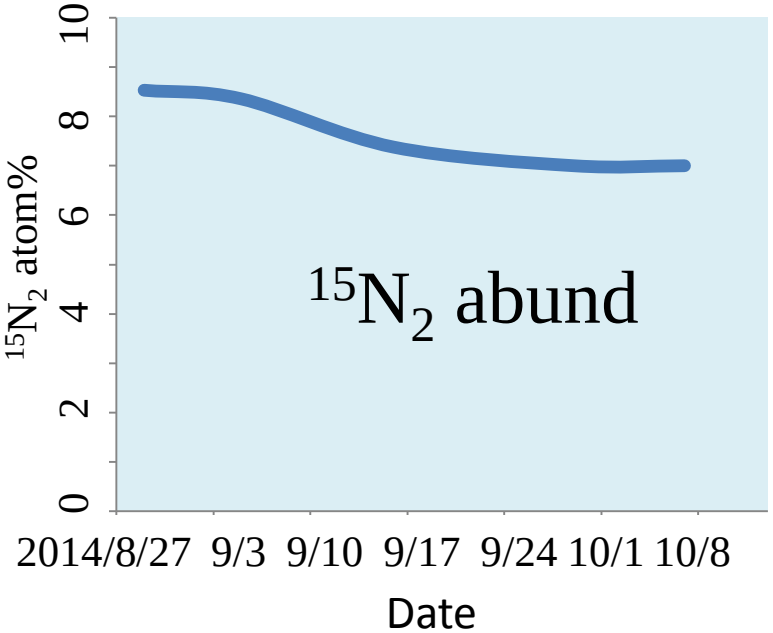


Bei et al., 2013

Performance of the system

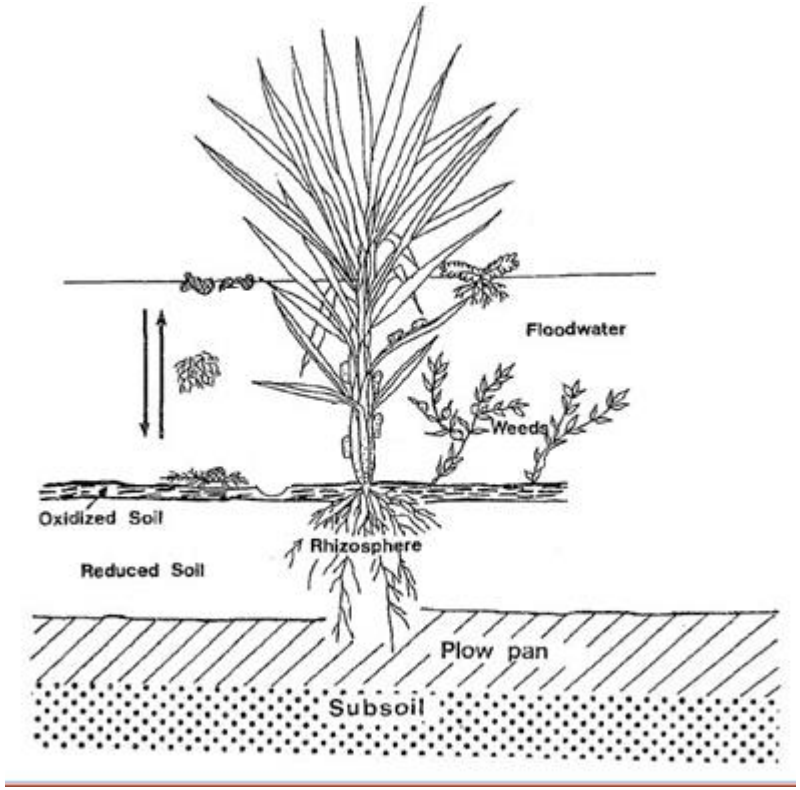






Bei et al., SBB, 2013; Wang et al., under preparation

BNF allocations in rice and soil



Panicle：0.28

Leaf blade：0.77

Leaf sheath：0.42

Stem：0.27

Root：0.18

Weeds：0.18

49%

Soil（0-1cm）：1.21

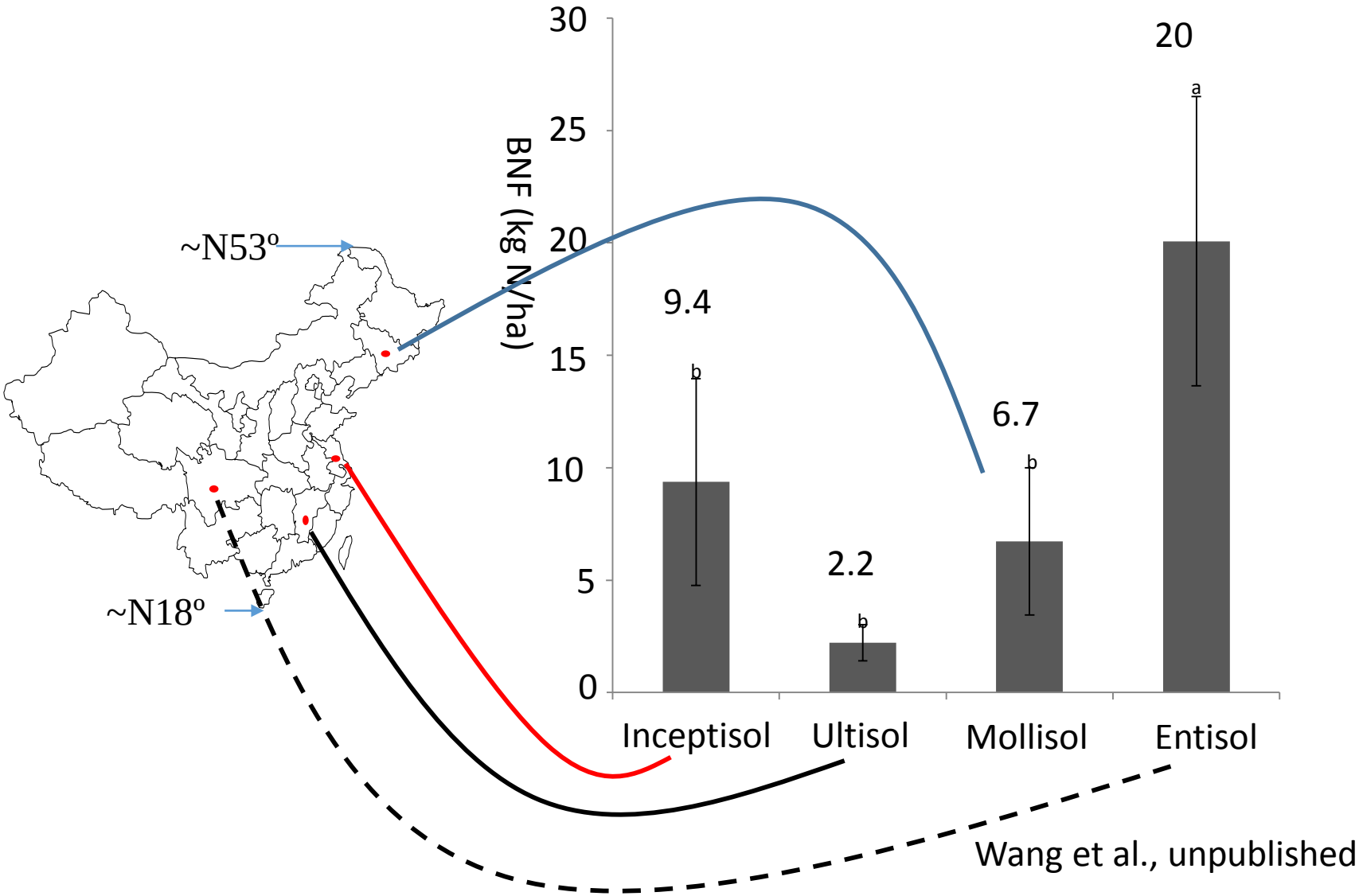
Soil（2-15cm）：0.99

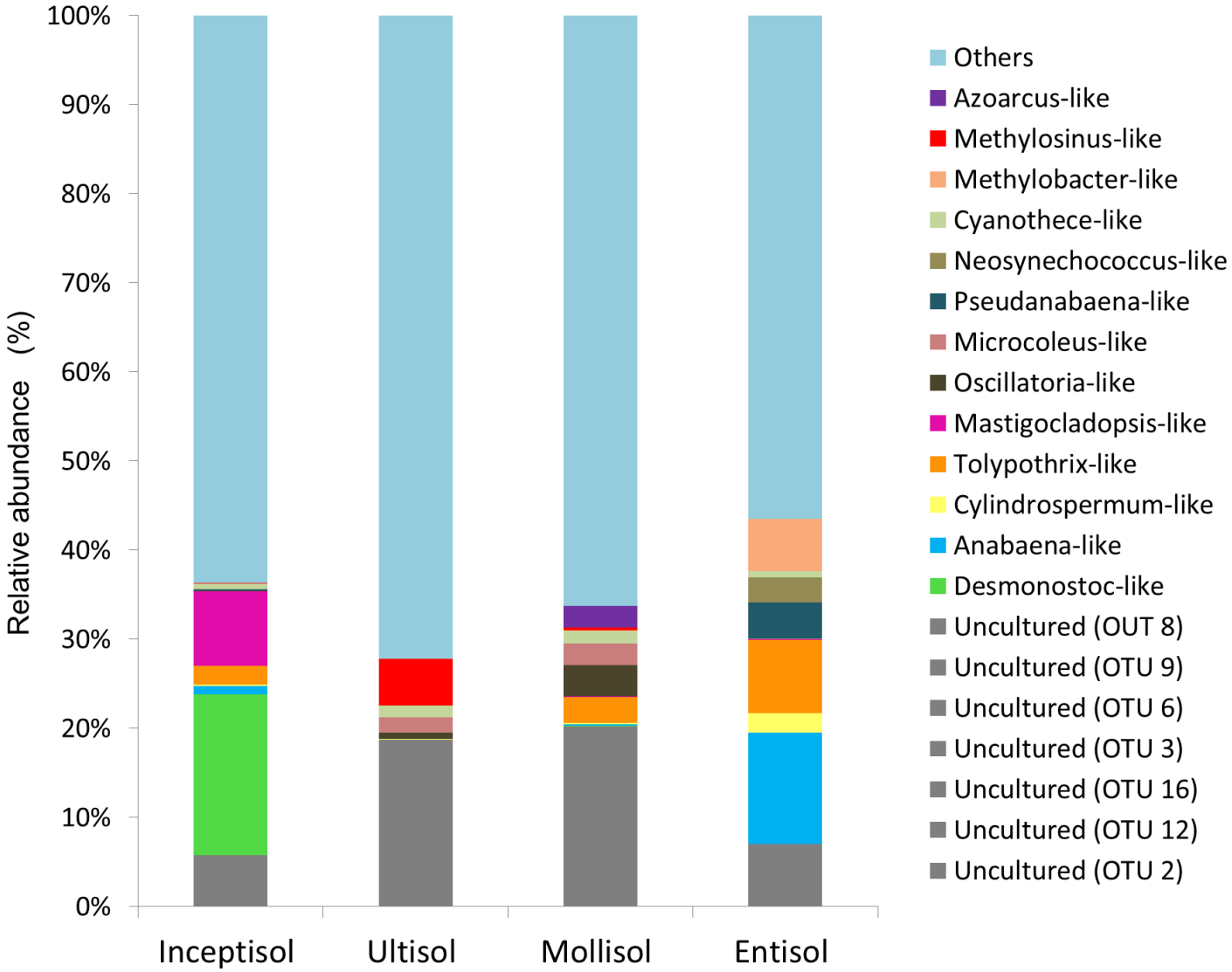
51%

BNFs in 70 days are 45kg/ha with rice planting, and14kg/ha with no plant at 0 nitrogen fertilization in Inceptisol.

Bei et al., SBB, 2013

Vast differences of BNF in different soils for 40d

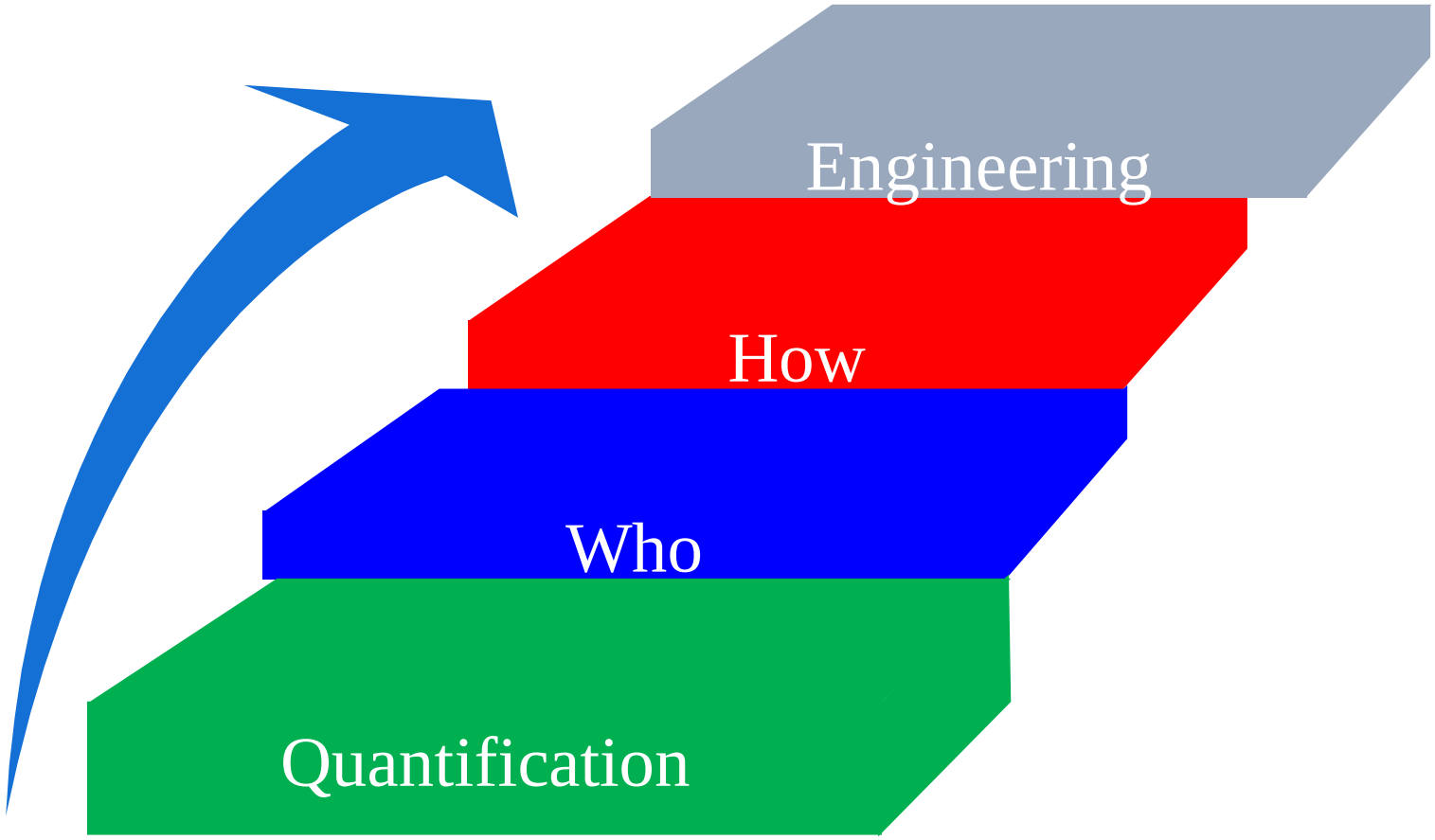




20 dominant OTUs of the putative diazotrophs most frequently detected in 4 different soils

Wang et al., unpublished

Research priorities



Thank you very much for your attention!