Potassium deficiency constraints in common bean (*Phaseolus vulgaris* L.) production in West Usambara, Northern Tanzania

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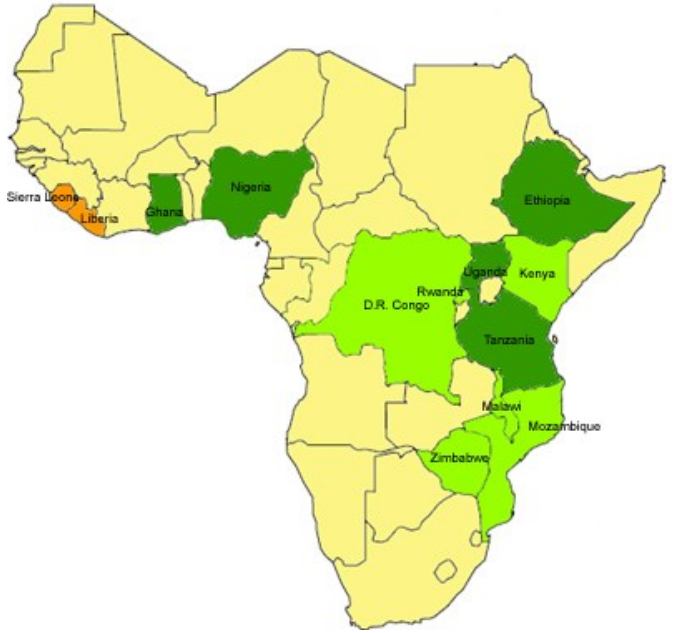
Introduction:

N2Africa

- Science based research in development project
- Focus: "*putting Nitrogen fixation to work for smallholder farmers growing legume crops in Africa*"
- $(G_L \times G_R) \times E \times M$
- Focus crops (Common bean, Groundnuts, soybean, cowpea)



– Yields of above legumes far below potential

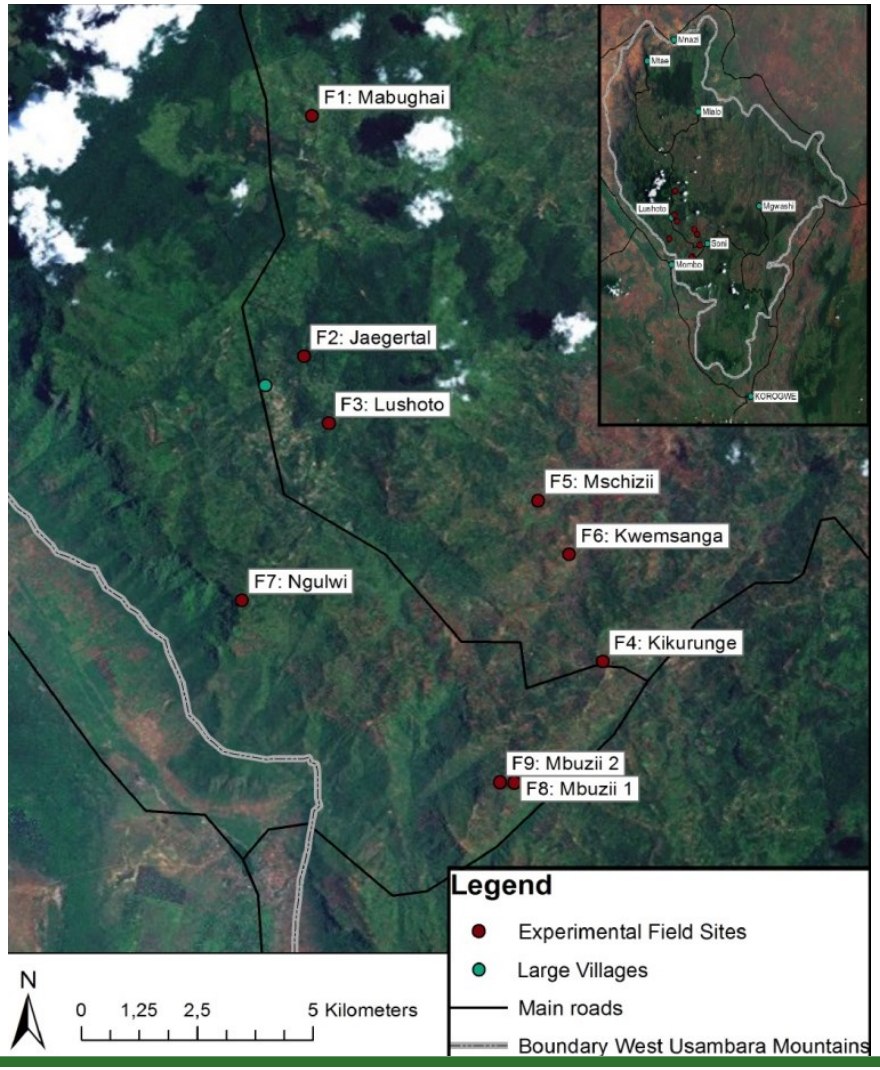
– Major constraints: poor soil fertility, drought, pest and diseases, low quality inputs

Assessing nutrient deficiencies and soil fertility constraints for production of common bean (*Phaseolus* vulgaris L.)

- Identify major limiting nutrients and rank them according to the degree of limitation
- Assess the effect of fertiliser and inoculation on nodulation and yield

  - Plant leaf nutrient concentrations

Methodology: Field selection



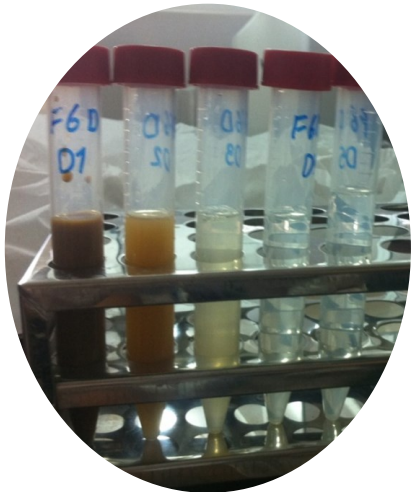
- Experimental field trials at nine locations

Field characteristics of nine selected experimental sites in Lushoto region, West-Usambara Mountains, Tanzania.			
Location	Altitude (m)	Slope (%)	Position on the hill
Mabughai	1667	0-5	Foot slope
Jaegerstal	1415	0	Foot slope - valley bottom
Lushoto	1444	0	Uphill slope
Kikurunge	1340	25-30	Uphill slope
Mshizii	1256	10-15	Foot slope - valley bottom
Kwemsanga	1253	20-25	Slope
Ngulwi	1423	10-15	Slope
Mbuzii I	1218	5-10	Foot slope
Mbuzii II	1286	10-15	Uphill slope

Methodology: Soil analysis

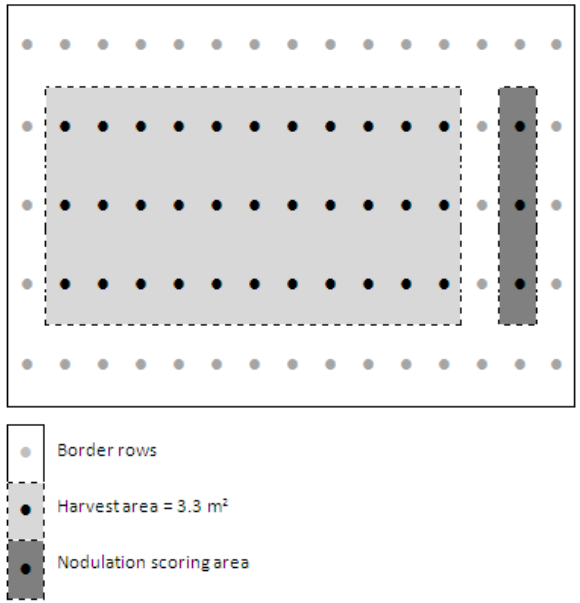
- Soil sampling
- Chemical and physical soil analysis
- MPN counts: Most Probable Number of rhizobia cells

  Indication of indigenous rhizobia population size



Methodology: Experimental trial design

- **Treatment factors and Levels:**
  P Phosphorus fertilizer (26 kg P ha^{-1})
  K Potassium fertilizer (25 kg K ha^{-1})
  Inoc Rhizobia inoculation (Rhizobia inoculan, strain CIAT 899 from Legumefix UK)
  N Nitrogen fertilizer (25 kg N ha^{-1})
- **Treatments**
  1: control
  2: control
  3: K
  4: P
  5: Inoc
  6: K + P
  7: K + Inoc
  8: P + Inoc
  9: K + P + Inoc
  10: K + P + N
-



Methodology: Trial measurements

- Precipitation (rain gauges at each site)
- Crop vigour observation
- Nodulation assessment
- Harvest measurements



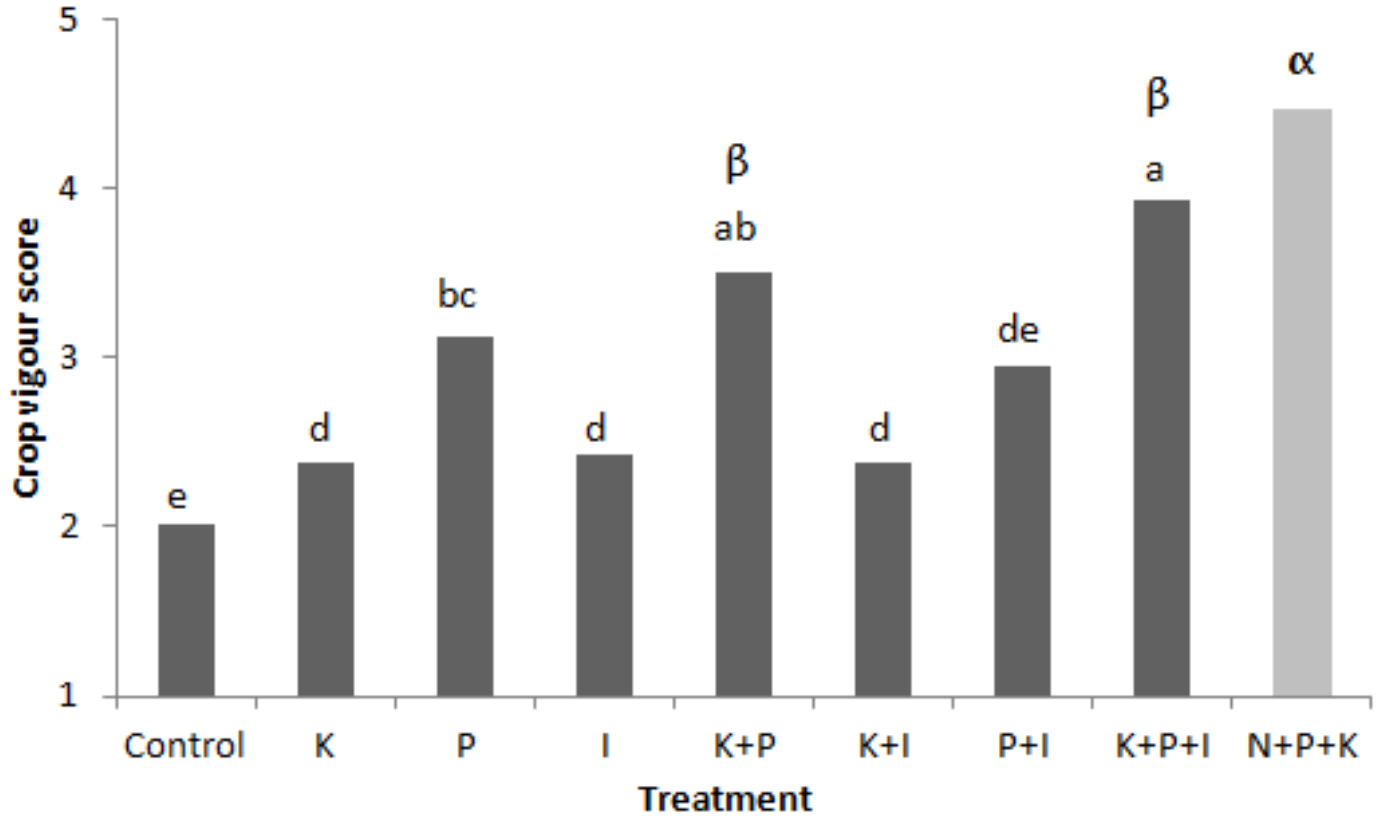
Methodology

Leaf analysis

- Leaf sampling – at 50% flowering from
  - Experimental plots
  - Farmer fields (50 fields)
- Leaves washed, dried and grinded prior to analysis
- ICP-OES and CHN elemental analysis done at KU-Leuven (Belgium)
- Result of leaf nutrient concentrations of; N, P, K, Ca, Mg, Mn, Cu and Zn
- Compared with critical nutrient levels from literature

Results

Crop vigour score



Results – Crop vigour

Field 7 - Ngulwi 25-12-2013


R1T1 - Control


R1T2 - Control


R1T3 - K


R1T4 - P


R1T5 - Inoc.


R1T6 - K+P

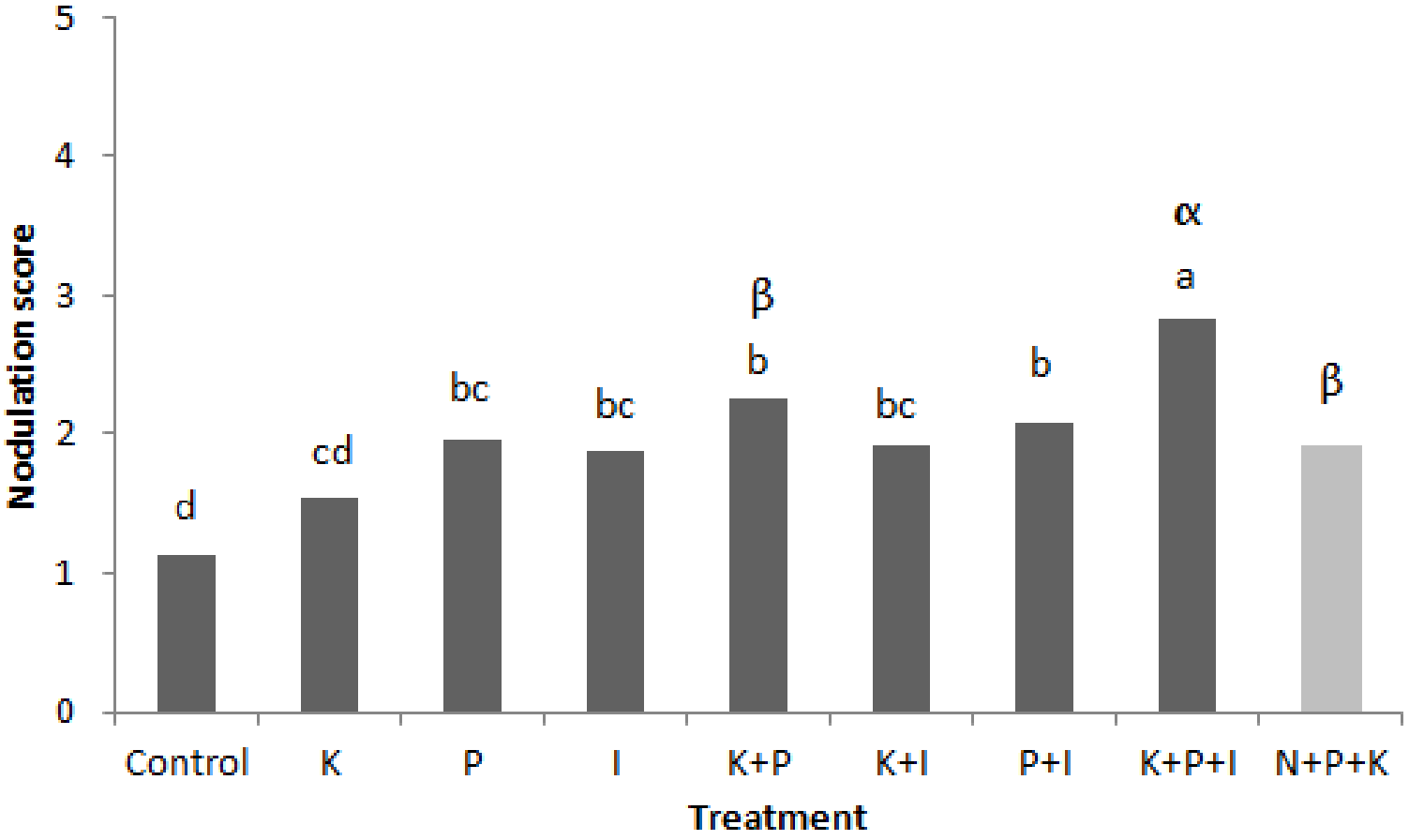

R1T7 - K+Inoc.


R1T8 - P+Inoc.

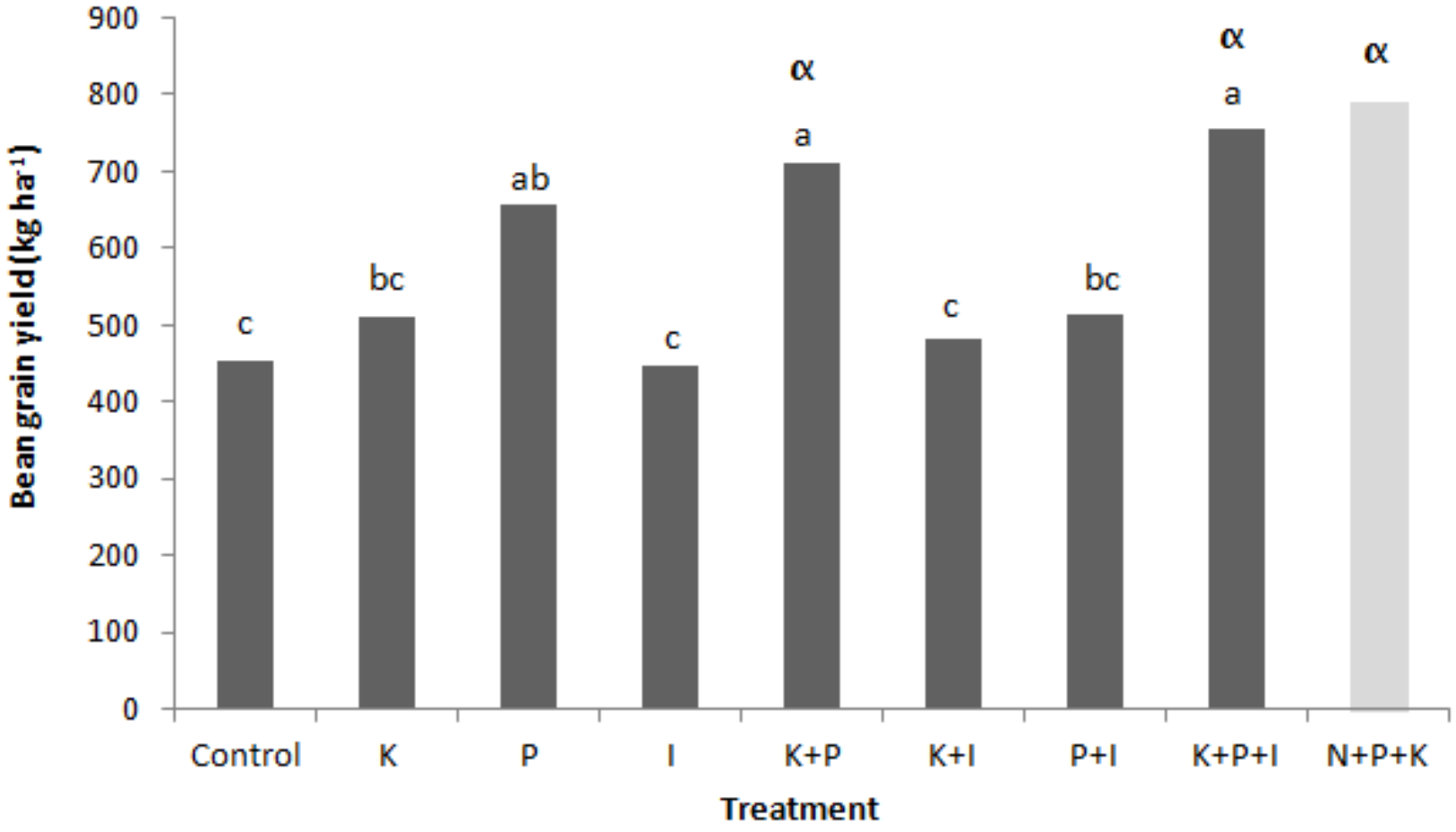

R1T9 - K+P+Inoc.


R1T10 - P+K+N

Results- Nodulation



Results - grain yield



Results: Soil analysis

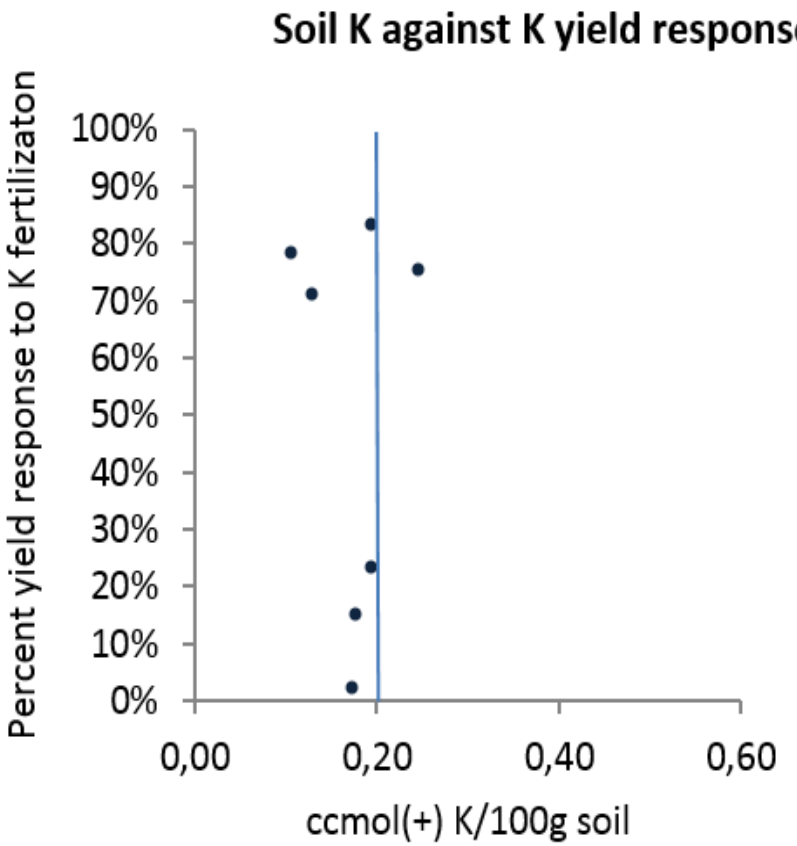
- Rhizobia populations between 1.2 x 10^2 to 2.4 x 10^5 cells/gram soil
- Soil particle size: clay texture

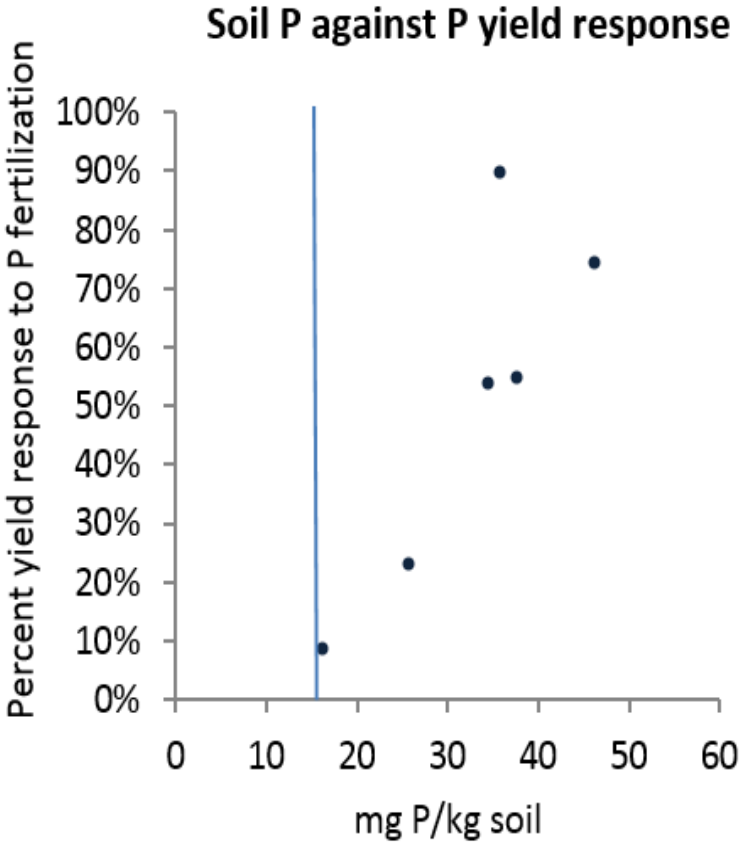
Soil chemical properties of the experimental fields.

						Exchangeable bases				
	pH	Org C	Total N	Av. P	CEC	Ca	Mg	K	Na	EC
Fields		%C	%N	mg/kg		cmol/kg				mS/cm
#1 Mabughai	5.3	2.6	0.3	16.3	17.6	3.9	0.8	0.1	0.2	1.1
#2 Jeagertal	5.6	2.4	0.3	34.6	21.7	5.6	1.4	0.3	0.2	2.7
#3 Lushoto	5.2	2.5	0.3	37.8	12.5	2.4	0.7	0.2	0.2	1.2
#4 Kikurunge	6.9	2.3	0.2	25.7	24.2	8.0	3.1	0.1	0.3	0.3
#5 Mshizii	6.6	2.0	0.1	47.9	15.7	5.0	1.8	0.3	0.3	0.7
#6 Kwemsanga	6.4	1.4	0.1	55.2	16.8	5.4	1.6	0.2	0.2	0.2
#7 Ngulwi	6.0	2.5	0.2	46.2	16.7	5.2	1.3	0.2	0.2	0.7
#8 Mbuzii 1	6.1	2.0	0.2	45.3	21.5	6.3	2.2	0.2	0.3	0.8
#9 Mbuzii 2	6.1	2.4	0.2	35.9	18.7	5.4	2.0	0.3	0.3	1.2

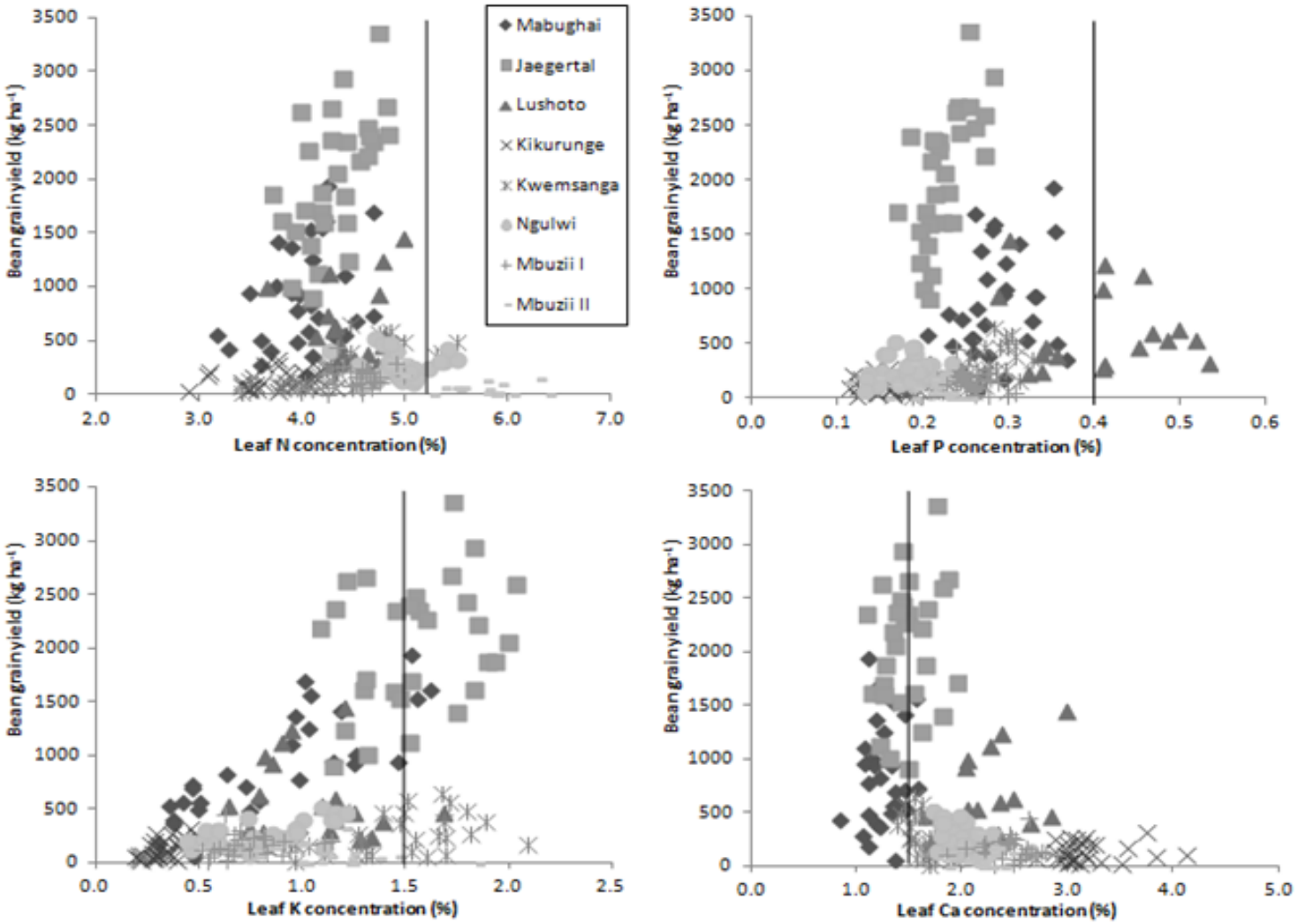
Results - Soil analysis

Relation between P and K concentration and fertilizer effect



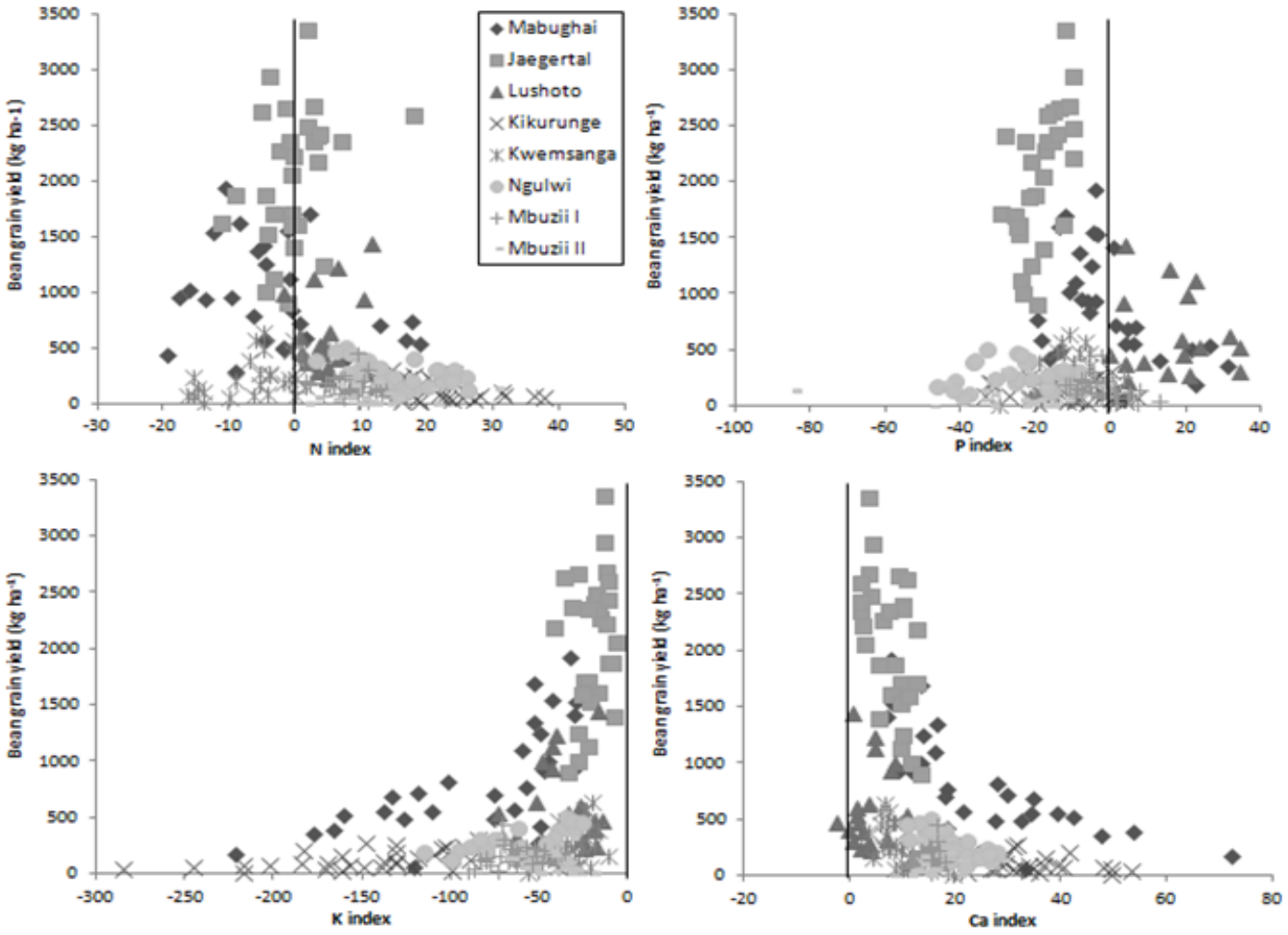


Results – leaf nutrient concentration



Putting nitrogen fixation to work for smallholder farmers in Africa

DRIS



Putting nitrogen fixation to work for smallholder farmers in Africa

Discussion & conclusion

- Leaf nutrient concentrations and DRIS both indicated deficiencies for the nutrients K, P and partially N
- P and K fertiliser application is able to compensate, but…
- … Overriding yield limiting factors played a major role at some experimental sites:
  - Inadequate rainfall > P and K uptake
  - Root rot
- Effect of *Rhizobia* inoculation depended on P and K application
- DRIS can best be seen as a supplement to sufficiency nutrient range diagnosis

Discussion & conclusion

- Soil deficiency in P and K
  - Soil chemical analysis - P not deficient
  - Fertilizer trails - P and K deficient
  - In accordance with previous research
  - At some fields other constraints played a major role
  - Management: farmers do not use inputs on beans
- Biological nitrogen fixation
  - Inoculation slightly increases yield
  - Rhizobia populations present in the soil but inoculation may be needed
  - No N deficiency in the soil
  - Nodulation constrained by P and K deficiency

Acknowledgment

- Farmers in Lushoto for hosting the experiments
- BMGF for funding the research through N2Africa project
- Organisers of the symposium for the invitation

Thanks for your attention!