Improving the yield and quality of common beans in Uganda

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Problem being addressed

Average yields of beans in Uganda are less than 30% of the potential yield. Poor soil fertility is a major contributing factor, but developing practical approaches for smallholder farmers to increase bean yields requires a greater understanding of genotype x soil fertility interactions. On-farm trials have shown the benefit of using improved varieties and fertilizing with manure and phosphorous. However, yields remain well below genetic potential in most cases. Research station trials to test whether the limited response to applied fertilizer was due to fixing of applied P to the soil also revealed limited capacity of the bean crop to respond to inorganic P even at levels well in excess of recommended rates. A positive correlation between harvest population and bean yield implicates poor seed quality, early season vigor, and in-season plant loss as management factors that must be addressed to achieve near-potential bean yields.

Objectives:

1. Evaluate yield response of four improved varieties from NaCCRI under farmers conditions under different fertility regimes using manure and phosphorous.
2. Determine the level of fertilizer P needed to overcome soil P limitation for bean yields in well-managed research station trials.

Approaches:

On-Farm Trials: Conducted on numerous cooperating farm sites in Kamuli District, Uganda during two seasons each year 2009 to 2011. Varieties: K131, K132, NABE4, NABE6 from NaCRRI and farmer selected Kanyebwa. Combinations of farm yard manure (FYM), inorganic P, and FYM+P tested. Plot area was 25 m^2 N=2 reps.

Research Station Trials: Conducted at NaCRRI research stations in Mbarara, Nomulonge, and Nakabango, Uganda in 2011. Plot area was 25 m^2. Varieties: K131, Nabe4. N=3 reps.

Client	pH	OM	N	P	Ca	Mg	K	Textural class
		----%----		--------- (ppm)-------				
Ben	6.6	2.3	0.14	4.6	2734	514	392	Sandy clay loam
Tibaleke	6.7	2.7	0.14	trace	2865	685	451	Clay
Nangabi	6.3	2.2	0.14	0.2	2287	456	150	Sandy clay
Dhage	6.6	2.3	0.13	0.6	3340	669	386	Sandy clay
Nangobi	6.2	1.9	0.13	trace	2439	438	204	Sandy clay
Sabbi	6.7	2.8	0.15	2.6	3780	663	360	Clay
Rosisa	6.1	3.1	0.15	0.2	2696	504	264	Sandy clay
Critical values	**5.2**	**3.0**	**0.20**	**5.00**	**350**	**100**	**150**	

Table 1. Soil analyses for seven farmer fields participating in on-farm trials in Kamuli District, Uganda. Most soils have less than optimum organic matter. Nitrogen and Phosphorus are severely limiting in most cases. Ca, Mg, and K are abundant.

Treatment	Total Yield (kg/ha)	Treatment	Clean Yield (kg/ha)	Treatment	100 Seed Wt. (g)
Control	633a	Control	415a	Control	31.0a
Manure	747b	Manure	509b	Manure	33.7b
Phosphorous	787b	Phosphorous	552b	Phosphorus	31.0a
M + P	752b	M + P	516b	M + P	32.3a

Table 2. Response of Bean Yield to Manure, Phosphorous, & Manure + Phosphorous Fertilizer. Average bean yields from two seasons of on-farm trials. Means in columns with the same letters are not different at p = 0.10%.

Phosphorus rate (kg/ha)	Total Yield (kg/ha)			Clean Yield (kg/ha)		
	Mbarara	NaCRRI	Nakabango	Mbarara	NaCRRI	Nakabango
0	497a	542a	1033a	418a	365a	873a
60	503a	580a	887a	343a	393a	729a
120	477a	421a	1050a	399a	297a	803a
180	505a	510a	1170a	437a	350a	973a

Table 3: Response of common bean yield to increasing levels of phosphorous fertilizer conducted at NaCRRI research stations. Data are the average of two varieties, n=3 reps. Values in columns followed by the same letter are not significantly different at p = 0.05.

Results:

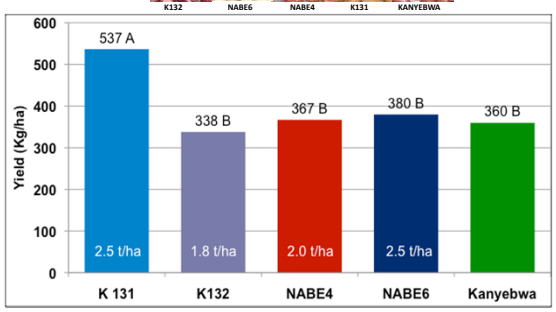

Figure 1. Average bean yields from two seasons of on-farm trials. Means with the same letters are not different at p = 0.10%. Values in the columns are potential yields obtained in research station trials.

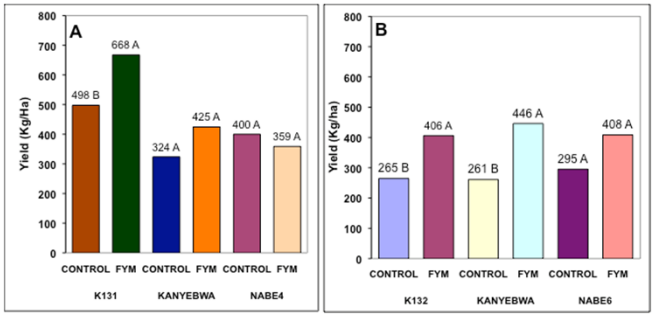

Figure 2. Response of common bean yields to 10 Ton/ha manure application. Average bean yields from two seasons of on-farm trials. Means with the same letters are not different at p = 0.10%.

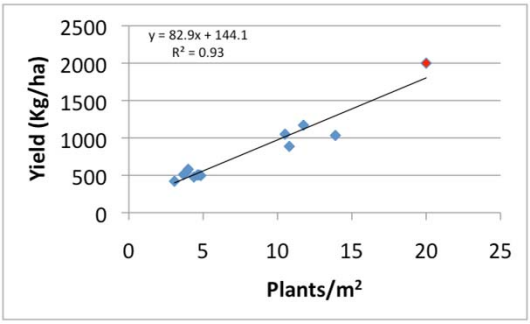

Figure 3. Correlation between bean yield and plant population at harvest. Data are pooled for Kanyebwa and NABE4. The red square represents potential yield of 2000 kg/ha at optimum spacing of 20 plants/m^2.

Conclusions/opportunities:

- Improved variety K131 generally yielded more than the local variety Kanyebwa, **but on-farm yields were far below potential.**
- Manure and phosphorous increased yield in most cases, but there was little/no response to P fertility up to 180 kg/ha. **Repeated annual applications might be needed to ensure P is available.**
- Yields between 495 to 1035 kg/ha were associated with very low plant densities (3-14 pl/m^2) at harvest**. Seed quality – germination, early season vigor, seed borne pathogens – needs to be assessed for farmer saved and certified seed.**
- Maize/Bean Intercropping did not provide a yield advantage over monoculture. **Profitability and market access may determine best management approach on farm.**

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