

BACKSTOPPING KENYA'S EMERGING SOYBEAN INDUSTRY

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A soybean industry is emerging in Kenya and small-scale farmers have an important role to play. Kenya continues to import massive quantities of soybean grain and press cake for use in food processing and feed blending, estimated to be between 60,000 and 100,000 tons per year. This importation is ironic as soybean grows well in Kenya and foreign reserves spent on it could be redirected toward longer-term development. Starting in 2010, the N2Africa Program initiated work among small-scale farmers to better understand and practice biological nitrogen fixation technologies and soybean enterprise. Activities were initiated in west Kenya, an area that enjoys two growing seasons per year and is open to new cash crops due to severe decline in its tobacco and cotton industries. The approach was to conduct a comprehensive outreach campaign backstopped by practical research in legume agronomy and rhizobiology. Efforts were forwarded by the timely commercialization of BIOFIX legume inoculant in Kenya that contains the industry standard *Bradyrhizobium japonicum* strain USDA 110. During the first season, the 2010 long-rains, 50 roadside demonstrations of soybean inoculation and intercropping with maize were planted, 25 farmer field days were conducted and 1500 farmers were provided with improved seed (920 kg total), BIOFIX inoculant (12 kg total), fertilizer (2 kg SSP each) and instructions needed to plant a 120 m² plot of soybean variety SB 19. Two years later, field activities involved 12,500 households planting 73 tons of their own seed inoculated with 15,500 packets of BIOFIX and fertilized with 126 tons of a specially designed fertilizer blend. In addition, the program had bulked seed at 87 sites, trained 180 "Master Farmers" to lead grassroot actions, distributed 16,150 extension manuals and conducted 112 field days and 13 media events. Soybean yields in 2011 averaged 1680 and 1024 kg per ha for farmers following production guidelines in the long- and short-rains, respectively, resulting in net returns up to \$699 per ha. Research played an important role in this success. Promiscuous soybeans SB 19 and SB 24 counter-intuitively benefit from seed inoculation. Biological nitrogen fixation increased yield by 47 kg N per ha with improved management. Seed Co varieties Saga and Squire proved more resistant to soybean rust. Inoculants were shown to contain excess contamination and carrier sterilization was adjusted. A system of inoculant quality control was initiated with 0.2% packets inspected using drop plate counts with three replications, leading to improvement of production practices in the BIOFIX factory. A fertilizer blend, Sympal 0-23-16 plus Ca, Mg and S, was developed in response to soil conditions and plant deficiency symptoms, and later commercialized alongside other specialty blends by MEA Fertilizer Ltd. The greatest signal of programme success is the attraction of private sector interests to the soybean enterprise. Following the 2011-2012 short-rains, cooperators sold over 285 tons of soybeans worth \$179,000 and saved 81 tons for replanting the following season. Furthermore, a network of agricultural stockists are marketing BIOFIX inoculants for the first time and about 166 tons of Sympal fertilizer was ordered by others. Clearly, it is in Kenya's interest to become self-sufficient in soybean production and small-scale farmers stand to benefit from, and greatly contribute, to this achievement. Finally, efforts to develop soybean elsewhere in Africa can learn from the combined outreach and practical research example by N2Africa in Kenya.



Backstopping Kenya's Emerging Soybean Industry

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Background

- ❖ A soybean industry is emerging in Kenya and small-scale farmers have an important role to play.
- ❖ Kenya continues to import massive amounts of soybean grain and press cake for use in food processing and feed blending, estimated between 60,000 and 100,000 tons per year.
- ❖ This importation is ironic as soybean grows well in Kenya and foreign reserves spent on it could be redirected toward longer-term development.
- ❖ Soybean has potential in nutritional security but rural households are unfamiliar with its preparation.
- ❖ The N2Africa Program works with small-scale farmers in west Kenya to better understand and practice biological nitrogen fixation technologies and soybean enterprise.



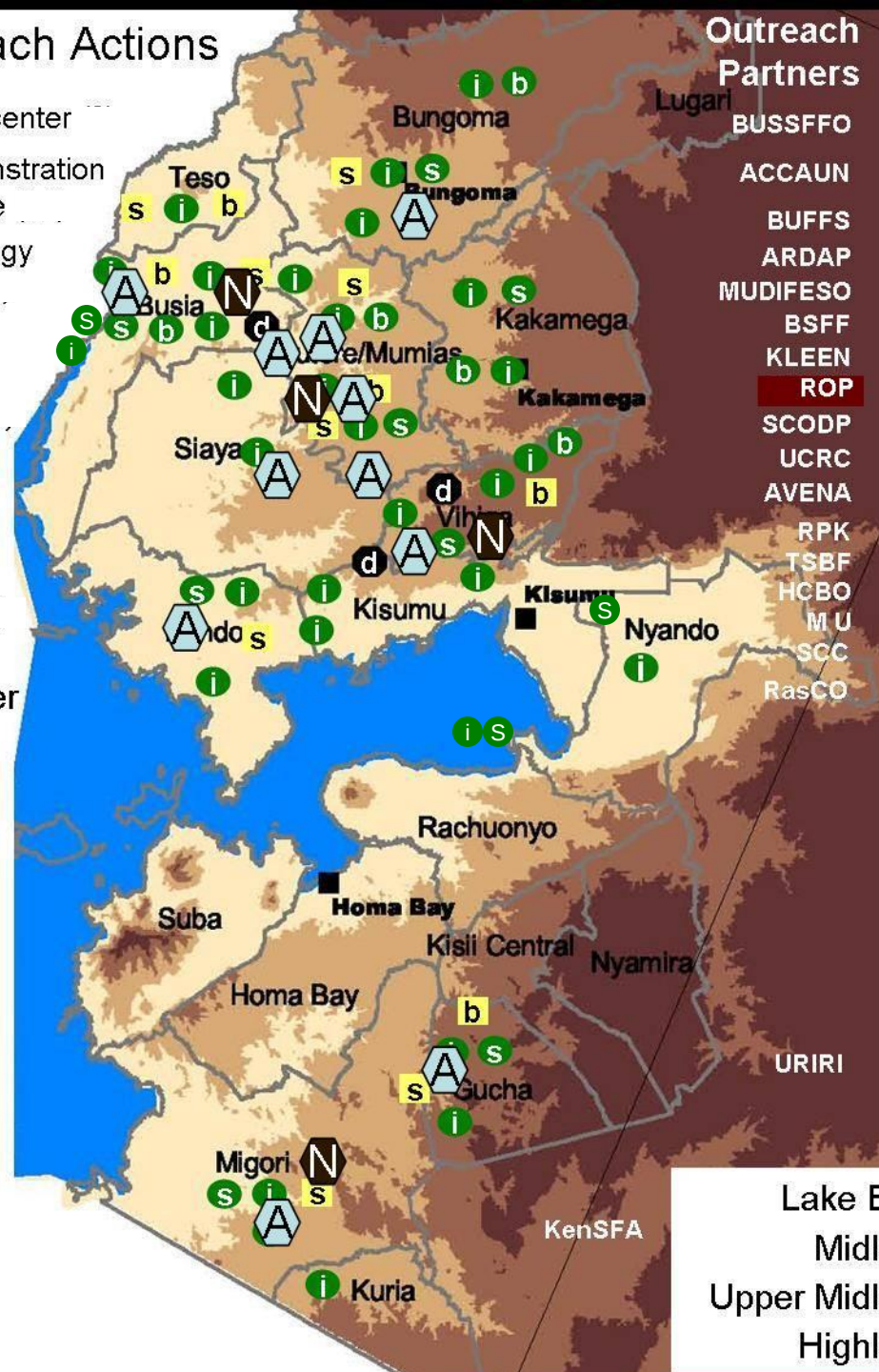
Soybean enterprise among small-scale farmers is promoted through an outreach program involving 26 Kenyan partners

Outreach action	Total thru Dec '12
Number of on-farm demonstrations	276
Number of on-farm technology tests	39,352
Proportion of women farmers	59%
Inoculant packets distributed (BIOFIX)	42,161
Improved soybean seed multiplied (t)	165 tons
Sympal (0-23-16+) fertilizer mobilized (t)	258 tons
Branded seed & grain sacks distributed	16000
Master farmers trained	130
Agro-dealers trained	80
Extension manuals distributed	34,150

This approach involves many areas of research backstopping

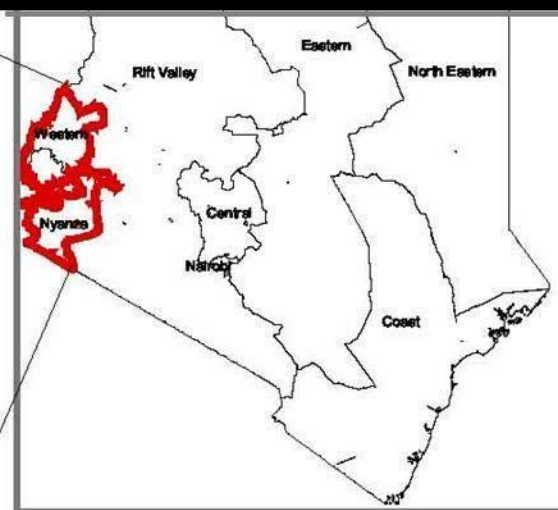
N2Africa Outreach Actions

- d** Input distribution center
- i** Inoculation demonstration & on-farm test site
- s** Soybean technology demonstration
- b** Climbing bean technology demonstration
- s** Soybean seed increase
- b** Climbing bean seed increase
- A** Pilot agro-dealer
- N** Node Leader

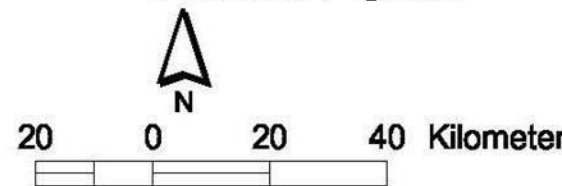


Outreach Partners

BUSFFO
 ACCAUN
 BUFFS
 ARDAP
 MUDIFESO
 BSFF
 KLEEN
ROP
 SCODP
 UCRC
 AVENA
 RPK
 TSBF
 HCBO
 MU
 SCC
 RasCO



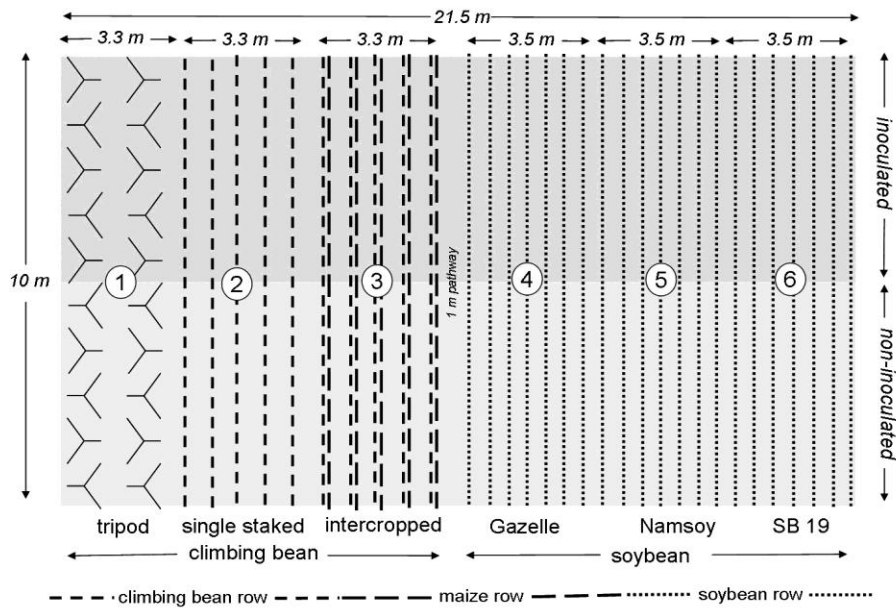
The West Kenya Action Site



- Towns
- District Boundaries
- Lakes

Altitude in meters

- Lake Basin
 - Midlands
 - Upper Midlands
 - Highlands
- < - 1300
 1301 - 1500
 1501 - 1800
 > - 1800



Field demonstration strategy. Field protocols are developed in seasonal planning meetings (upper right) and input kits assembled (upper right). Demonstrations are farmer installed and managed (lower left) and serve as the focus for farmer field days and training in legume technologies (lower right).

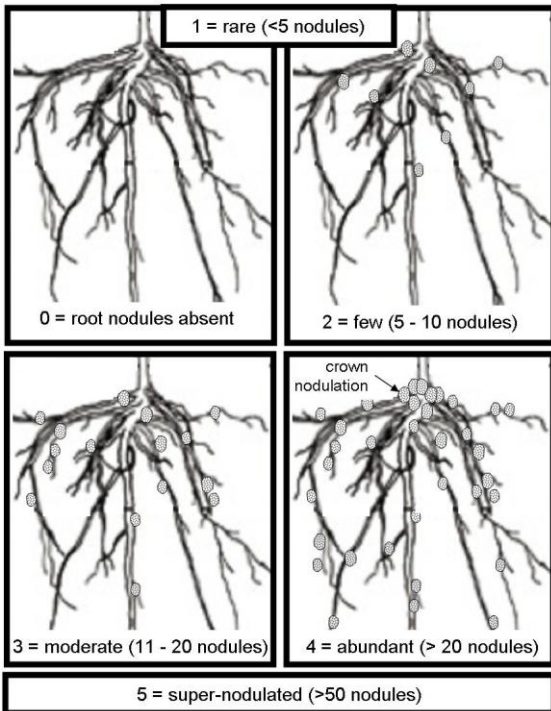


Farmers assess the need-to-inoculate

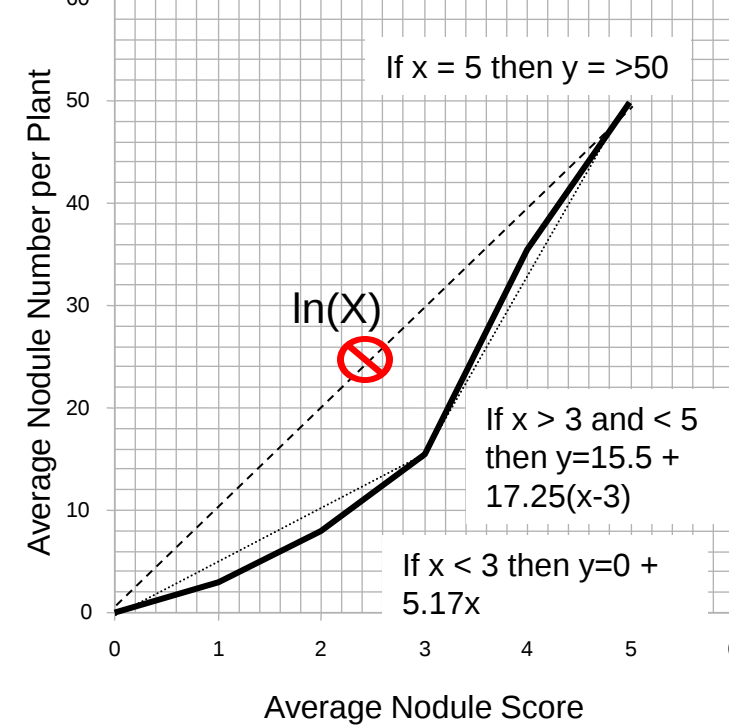
Kenya, on-farm, farmer installed and managed

Season	Long rains 2011	Short rains 2011-2012	Long rains 2012
Soybean variety	SB19	Samba	Saga
	----- soybean yield (kg ha ⁻¹) -----		
Not inoculated	970	634	845
Inoculated	1310	1059	1117
Response (%)	35%	67%	32%

season	Soybean variety	nodule number	crown nodulation	red interior
		no plant ⁻¹	----- % -----	
2011 long rains	SB 19	+5	+26%	+14%
2011-2012 short rains	SC Samba	+10	+31%	+43%
2012 long rains	SC Saga	+13	+35%	+32%
mean		+9.3	+31%	+30%



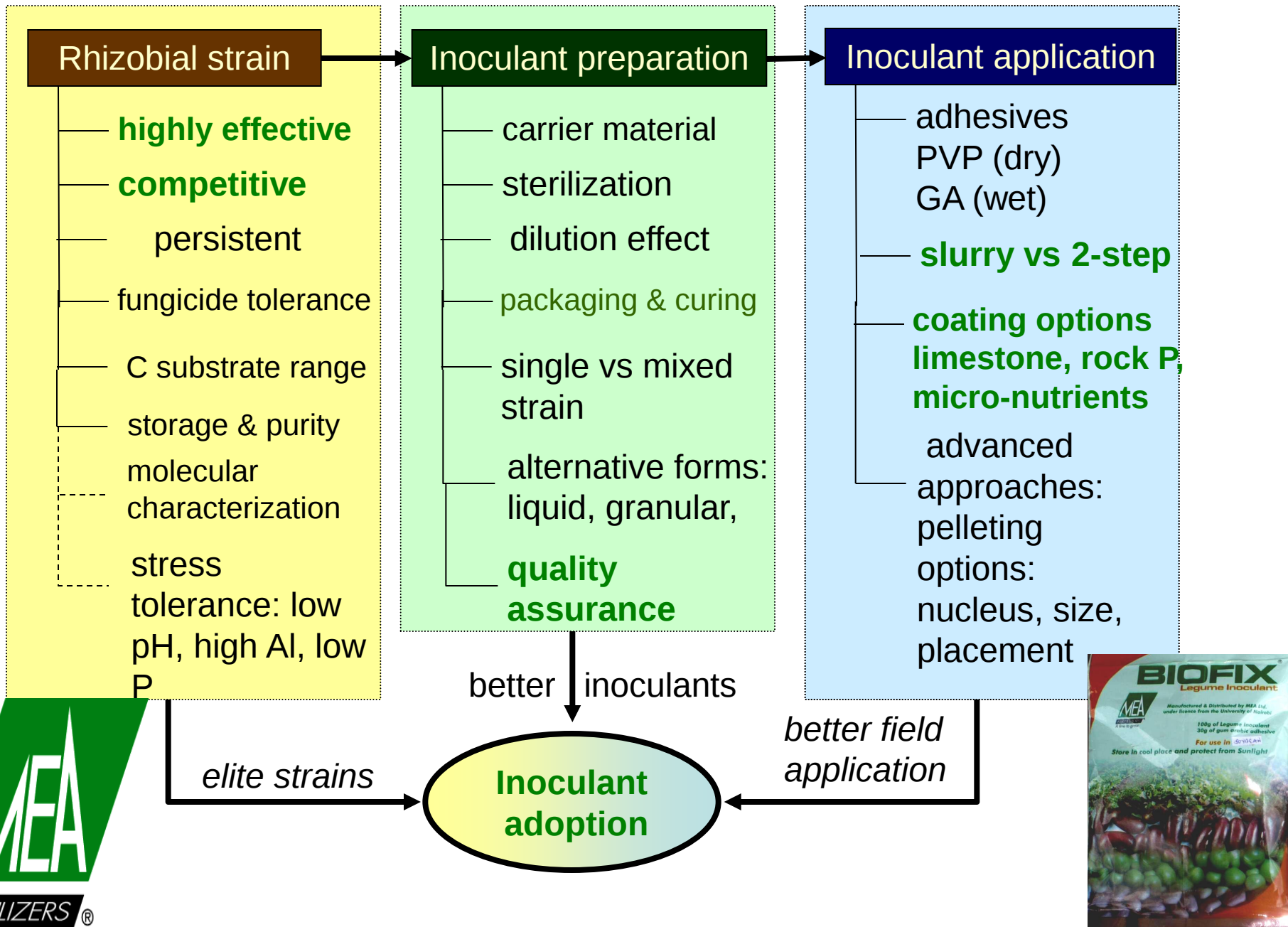
Nodule Assessment



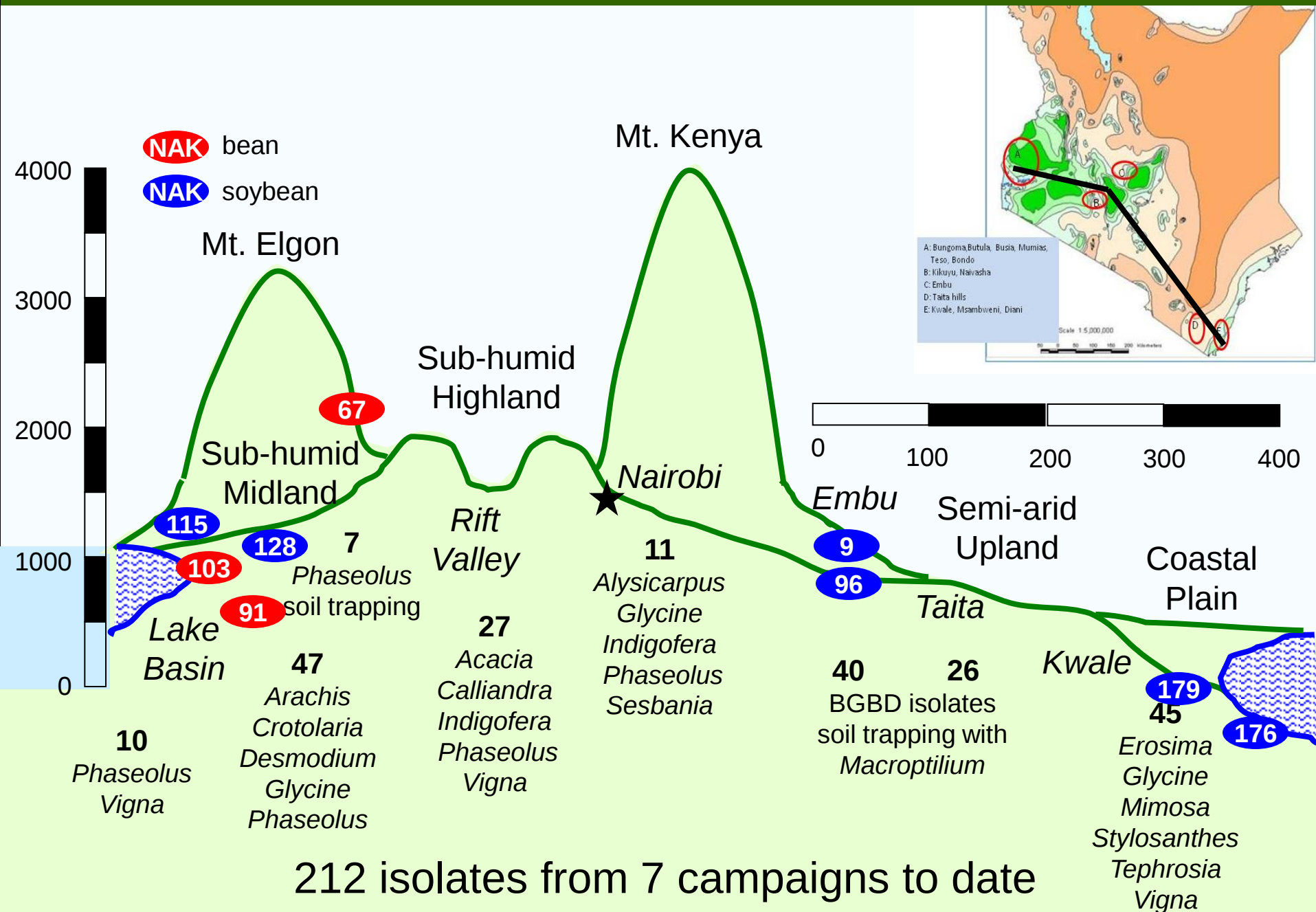
Master Farmers assessed soybean nodulation characteristics in west Kenya in response to applied rhizobial inoculant and blended fertilizer during the 2011 long-rains (SD).

Management	nodule number	crown nodulation	red interior
	(no. per plant)	----- frequency -----	
No inoculant w/SSP	9 4	0.08 0.20	0.70 0.33
Inoculated w/SSP	14 6	0.34 0.38	0.86 0.28
Inoculated w/PKS+	23 14	0.51 0.42	0.84 0.31

Priority: Upgrade inoculant production capacity



Rhizobium Bio-prospecting in Kenya





Bio-prospecting in action (clockwise): coastal Kenya (top left), bio-prospecting team, *Erythrina* sampling strategies, sampling mixed farming systems, sampling field experiments, carefully sampling drainage ditch during dry season, helpful farmer (left).



Steps in establishing rhizobia as elite strains



Bio-prospecting and isolation

212 isolates



Authentication and preliminary screening

186 isolates



**Effectiveness testing
under greenhouse
conditions**

100 isolates



**Competitive abilities
in potted soil**

24 isolates

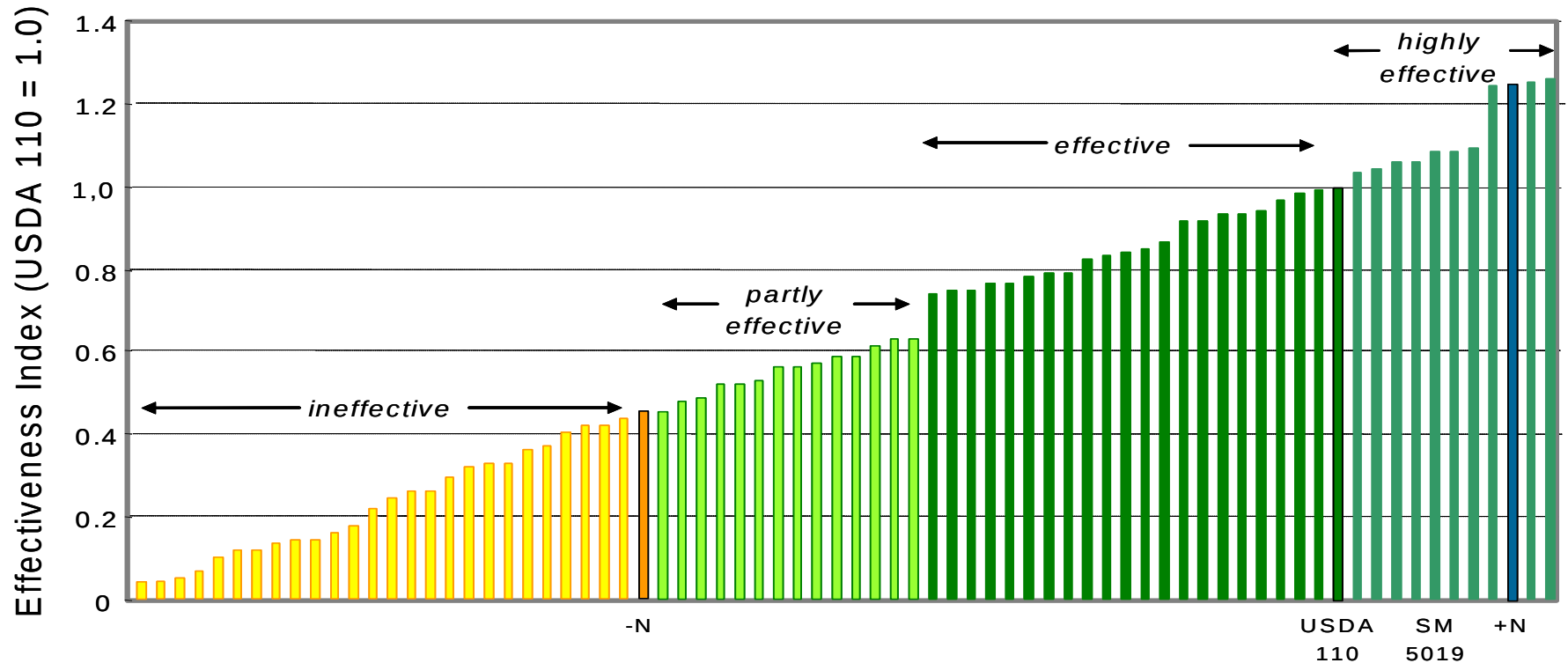


Field testing

6 isolates



Effectiveness testing under greenhouse conditions



N2Africa rhizobia isolates and controls

Strains were compared by Effective Index and then assigned to four categories ($< -N$ control, < 0.75 USDA 110, $< \text{USDA 110}$ and $> \text{USDA 110}$)

Field testing candidate elite strains

Include industry standard strains and local isolates, control and +N

Locate N-deficient soils and add additional high C:N materials (e.g. bagasse)

Different strains must be well separated by non-inoculated boundary rows

Successful field screening displays a “rolling effect” (below)



Our two best performing Kenya strains



isolate	GH step 1	GH step 2 with soil			Field testing
Effectiveness Index	sterile media SB24	Promiscuous SB19	Specific Safari		Western Kenya SB19
NAK96	1.24	0.96	1.18		0.93
NAK115	1.09	1.03	0.97		1.16
NAK128	1.06	1.01	1.34		1.20
NAK9	1.06	0.88	1.32		1.07
USDA110	1.00	1.00	1.00		1.00

Assist in inoculant quality assessment issues

- Industry standards considered ($>10^9$ rhizobia $<10^6$ contaminants per gram) within Biofertilizer Act
- Procedures in place based on drop plating of 10^{-5} to 10^{-7} on CR YMA, target sample of 0.2 to 0.4 %, QA utility available for reporting in MS Excel.
- More rapid assessment required to intercept inferior inoculants from shelves (rather than improvement through hindsight)

BIOFIX for ...	Batch number	rhizobia (SEM)	contaminants (SEM)
		$\times 10^9$ g	$\times 10^6$ g
bean	030812-28	1.3 0.1	1.0 0.4
soybean	130812-23	4.3 0.9	2.0 0.5

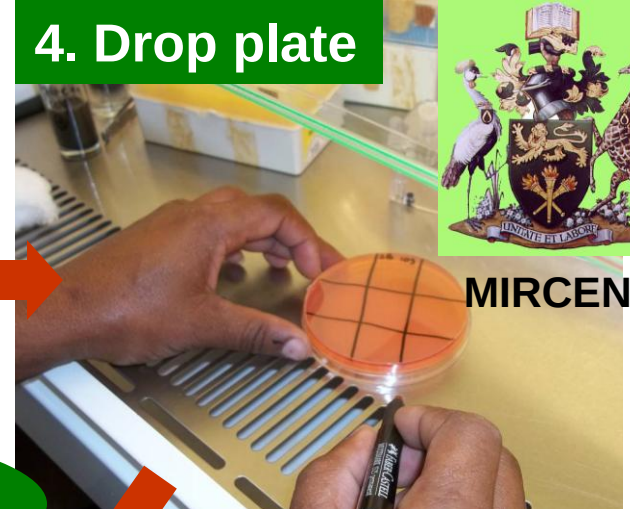
2. Disperse sample



3. Dilute



4. Drop plate

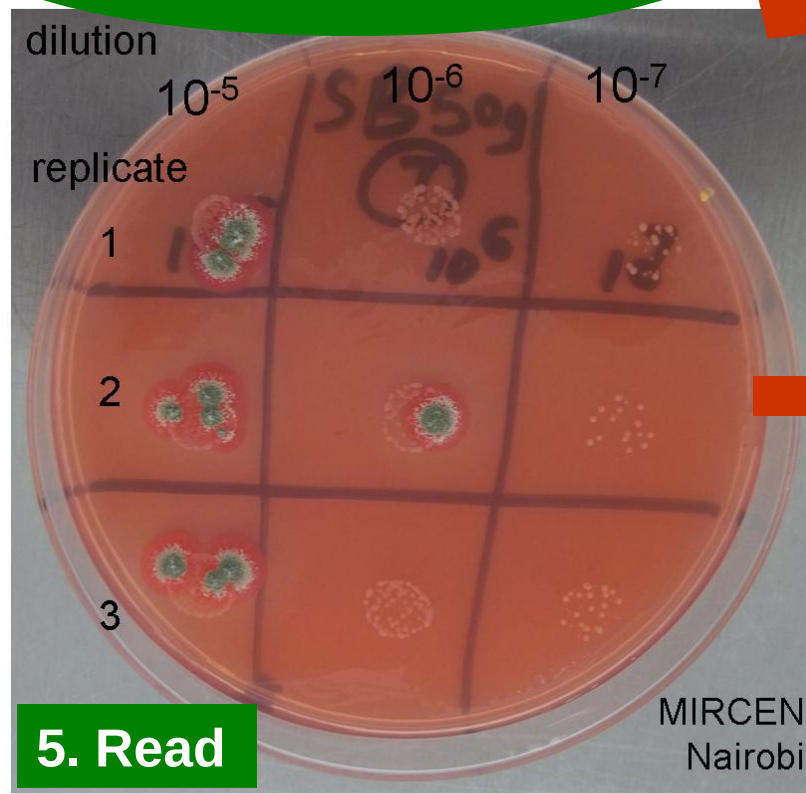


MIRCEN

Quality Control Steps



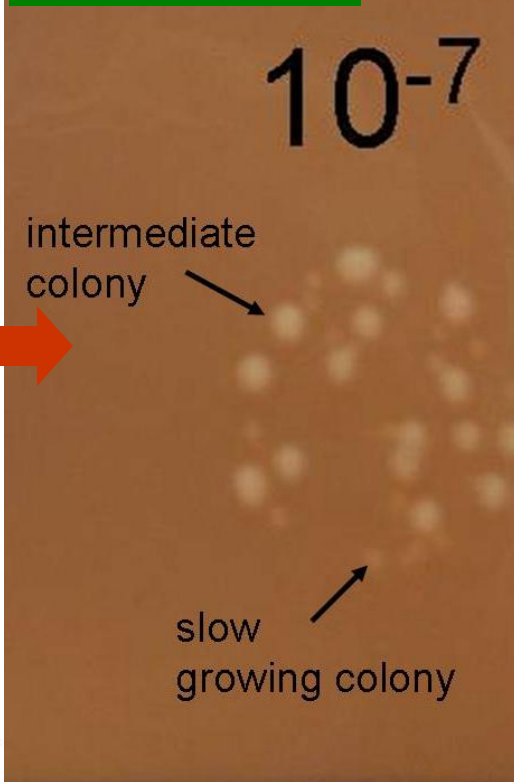
1. Inspect package



5. Read

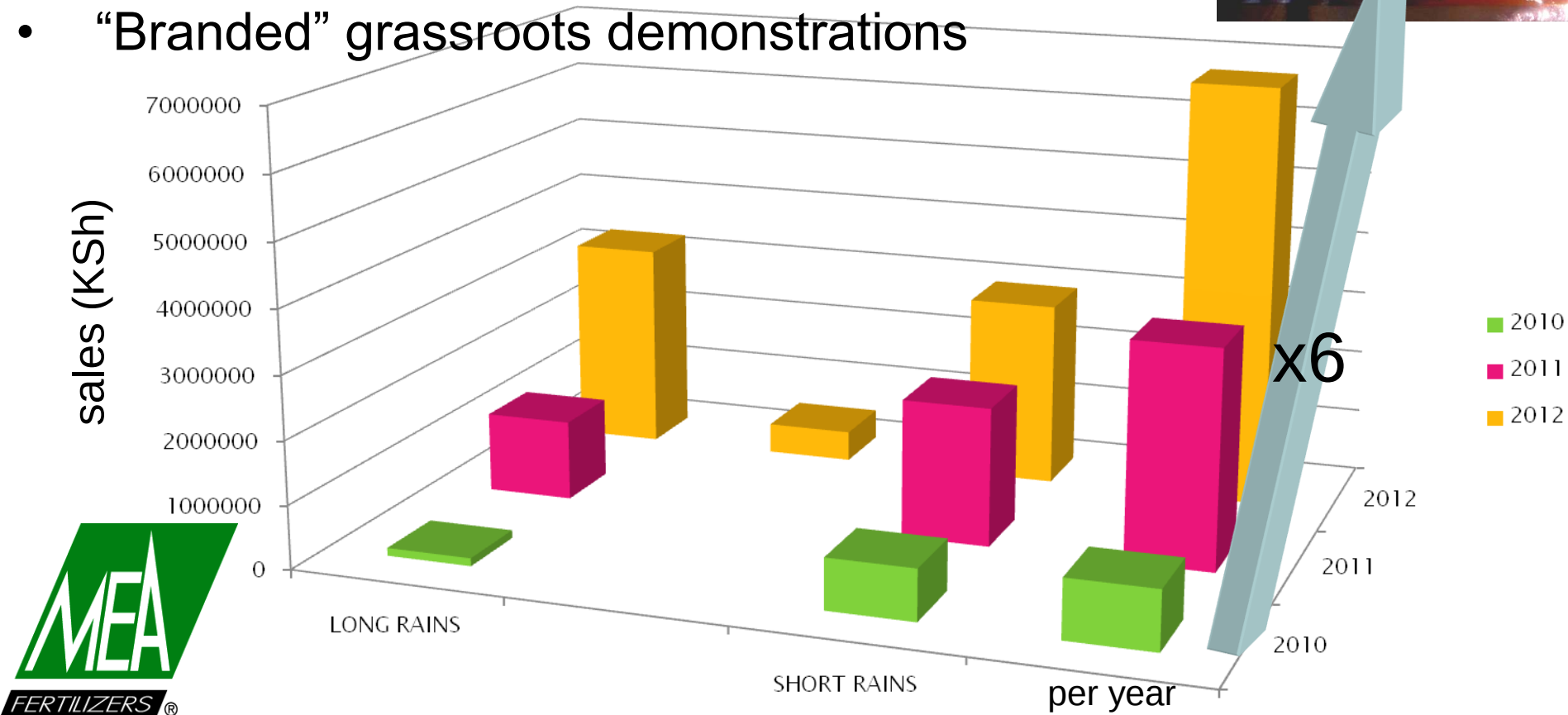
Population = (count/dilution factor) x drop factor

6. Interpret



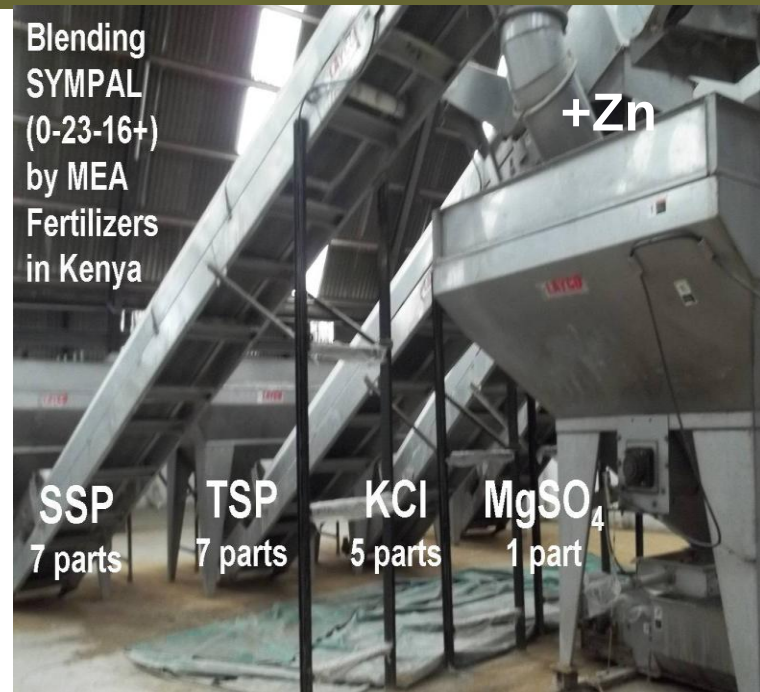
N2Africa services contribute to rapid growth in Kenya's inoculant industry:

- Strain selection and preservation
- Carrier sterilization and curing process
- Quality assurance procedures
- Generate demand for smaller sized packets
- Agro-dealer awareness
- “Branded” grassroots demonstrations



Public-Private partnership in formulation of specialty fertilizers

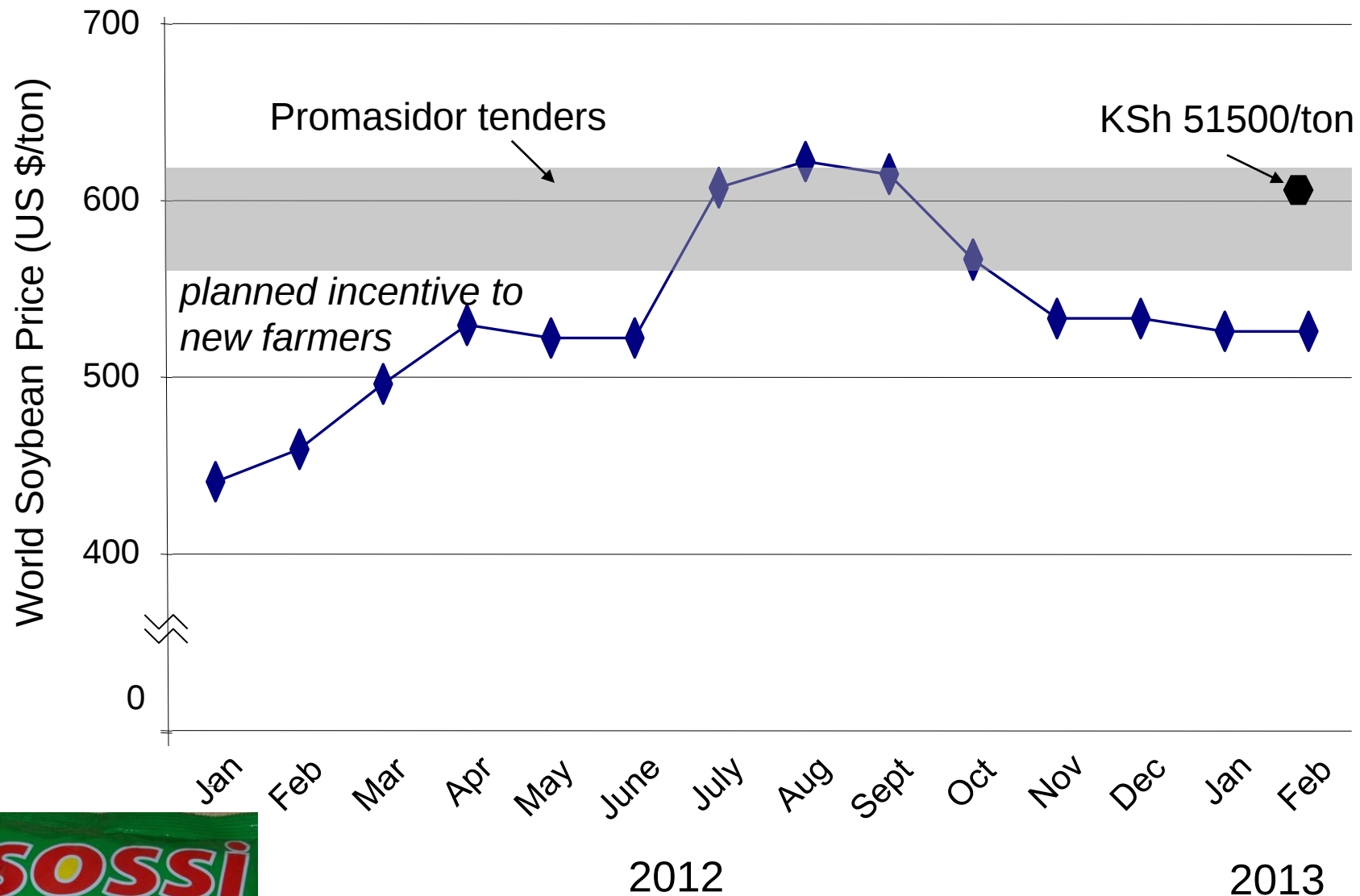
- ❖ No fertilizers were available in Kenya for symbiotic legumes
- ❖ Sympal blend (0-23-16 + Ca, Mg, & S) developed by N2Africa and commercialized by MEA
- ❖ Available in 2, 10 and 50 kg bags for about \$0.79 per kg
- ❖ Product samples distributed through agro-dealer network (KENADA)
- ❖ “Extra ingredient” for success: Addition of 0.1% zinc to Sympal fertilizer blend improves yield and nodulation



Devise grain marketing strategy

1. Soybean importers contacted and notified of local purchasing opportunities
2. Three buyers responded very positively, industry standards established and tenders announced
3. Grain processing kits and branded 50 kg grain sacks were deployed.
4. Local collection points and schedules established
5. During 2012, 537 tons sold to one buyer by 16 farmer groups worth \$333,000 while retaining 81 tons of seed for the following season





Prices offered by **Promasidor Ltd.** for soybeans at N2Africa marketing collection points in west Kenya compares favorably with world prices.

Local processing and improved nutrition also important

- ❖ Many other cooperators prioritize local value-added processing and consumption
- ❖ Cottage industry products include soymilk, yoghurt, fortified flours and snacks
- ❖ Soymilk is being prepared locally by communities using a simple mince-and-press technique
- ❖ Local entrepreneurs make and sell soy products (right)
- ❖ Nutritional benefits readily observed among vulnerable children orphaned by AIDS

MAMA SOYA SHOP One Stop Health Shop

FAIDA ZA SOYA
NI CHAKULA CHENYE
DAWA (A FOOD WITH
MEDICINAL VALUE)

PROTEIN ----- jenga mwili
----- imarisha kinga ya mwili
OMEGA -3 ----- jena ubongo
----- imarisha nerves
----- imarisha kinga ya mwili
ISOFLAVONES ---- zuia cancer, ugonjwa wa oyo,
kisukari, hotflashes, arthritis,
na PMS.



and learn about
growing, marketing
and processing
soybeans from the
N2Africa Program

Soya
unga,
kawa,
njugu,
mala,
yoghurt
& nyama



Backstopping inoculation and seed technologies

Kenya lacks commercial suppliers of soybean seed requiring community-based bulking of improved varieties.



Several innovations followed: germination test kits (above), variety reference boards (upper right), material-efficient two-step inoculation (lower left) and opportunities for seed coating with lime and rock phosphate (lower right)



Soybean seed following two-step inoculation with rhizobia



Soybean seed following addition of 20% finely ground limestone





N2Africa trains agrodealers in west Kenya on the marketing and handling of BNF technologies including improved legume seed, fertilizer blends and legume inoculants.

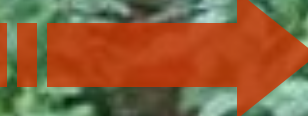


Parameter	KENADA	Agrodealers nominated by cooperators	
Class	Baseline	Apart from N2A	Aware of N2A
Year	2011	2013	2013
Sample (n)	30	18	13
Stocks Sympal blend	n.a.	6%	46%
Stocks soybean seed	30%	22%	54%
Stocks BIOFIX inoculant	17%	24%	69%
Stored in refrigerator	23%	44%	71%

Ingredient for success: Steady improvement of agronomic practice based upon economic analysis

soybean	grain	total	net	benefit:
management	yield	cost	return	cost
	- kg ha ⁻¹ -	--- \$ ha ⁻¹ ---		ratio
SC Saga no BIOFIX	845 21	285	246	1.86
SC Saga + BIOFIX	1117 33	310	391	2.26
SB19 + BIOFIX	1053 33	299	363	2.21
SB19 + BIOFIX + Zn	1162 37	299	430	2.44



1100 kgl/ha  **2800 kgl/ha**

Conclusions

- It is in Kenya's interest to become self-sufficient in soybean production
- Small-scale farmers stand to benefit from and greatly contribute to this achievement
- Promotion of soybean enterprise among African smallholders requires a diverse range of applied and social research activities
- Combinations of improved crop varieties, BNF technologies and soil fertility management can substantially increase soybean yields
- Local processing and consumption opportunities are attractive to grassroots cooperators
- Efforts to develop soybean elsewhere in Africa can learn from the combined outreach and practical research example by N2Africa and its partners in Kenya.

