Identified soyabean, common bean, cowpea and groundnut varieties with high Biological Nitrogen Fixation potential identified in N2Africa impact zones

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N2Africa

Putting nitrogen fixation to work for smallholder farmers in Africa

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Introduction

This report addresses Milestone 2.1.2 (at least 3 new soyabean varieties with high Biological Nitrogen Fixation (BNF) potential identified) and milestones 2.1.3, 2.2.2 and 2.3.2 (soyabean, common bean, groundnuts and cowpea breeding materials with high BNF traits forwarded to TLII and other breeding initiatives for inclusion in their respective breeding programs). The report also covers Milestones 2.2.3 and 2.3.3 (at least 5 farmer-accepted lines of soyabean, bush, climbing and 5 varieties of groundnut and cowpea with high BNF potential and tolerant to biotic and abiotic stresses identified through farmer participatory variety selection across the impact zones.

In Part 1 of this report we give an overview of the methodology used to estimate BNF by evaluated legume varieties, the criteria used by farmers to select legume varieties and their preferred varieties in different impact Zones. It also present results from literature to estimate the values of parameters necessary to assess BNF in legumes. In Part 2 we present lists of legume varieties found to be high in BNF potential across different impact zones and discuss their potential acceptability by farmers in the project Impact Zones.

1 Methodology

1.1 Selection of varieties for BNF and farmer preferences

Common bean (*Phaseolus vulgaris* L.), cowpea (*Vignaunguiculata* L. Walp.), groundnut (*Arachishypogaea* L.) and soyabean (*Glycine max* L. Merrill) with high BNF potential were selected from variety trials that were conducted across the action sites in the project Impact Zones. The trials were established right after the inception of the project (in 2010) and continued through year four (2013).

In total, 266 varietal tests were conducted across the Impact Zones (Table 1.1). Nearly half of these evaluations were conducted using soyabean. Ghana and Rwanda were particularly adept at varietal evaluation, conducting 37% of these studies. The numbers of varieties evaluated were focused on the assigned target grain legumes, as no country worked with all four crops.

Table 1.1: Grain legume varieties and fodder legume species evaluated for BNF potential in different countries.

Country	bean	cowpea	groundnut	soyabean	Total
DR Congo	8	0	0	12	20
Ghana	0	21	21	11	53
Kenya	23	0	0	16	39
Malawi	10	0	0	25	35
Mozambique	0	0	8	15	23
Nigeria	0	12	10	12	34
Rwanda	14	0	0	32	46
Zimbabwe	8	0	0	8	16
Total	63	33	39	131	266

Many of the evaluated materials have been released or pre-released in the respective countries, except for a few elite soyabean breeding materials (TGx1987-6F. TGx1987-10F, TGx1987-11F, TGx1987-62F) that were obtained from the IITA breeding program in Malawi. The varieties were identified in consultation with breeders from research and development networks e.g. The Pan-African Bean Research Alliance – PABRA), the National breeding programs, CGIAR institutes (namely CIAT for beans, IITA for cowpea and soyabean, ICRISAT for groundnut and from the Tropical Legumes II (TLII) project. Local checks were included, which in most cases, constituted of old but most prominent varieties. The source of each of the test genotype was reported under Milestone report 2.1.1, 2.2.1 and 2.3.1 (Baijukya et al., 2011).

The trials were researcher designed and researcher managed with 90% of them established in farmers' fields. However, there was an exception for Mozambique where the trials were conducted on research stations to ease their management. Attempts were made to avoid very fertile andhighly degraded fields for trials. Before planting, all plots received basal application of P and K at a moderate rate of 20 kg/ha to avoid possible P and K deficiencies. Soyabean and common beans were inoculated with appropriate inoculants in order to enhance their BNF. Weed fallow, maize or sorghum plots were included in the trials for use as reference crops for the determination N_2-fixation. Data on the above ground biomass accumulation, nodulation, grain and stover yields were collected for use in the determination of BNF. Disease severity and incidence on plants were only recorded at two sites on soyabean in Kenya (data not reported).

Participatory variety selection (PVS) was used as a tool to identify farmers' choices of varieties that fit their diversity of socioeconomic and agro-ecological conditionsand preferences. In most cases this concerned new varieties or varieties which were released but remained onshelves. PVS were conducted for common bean in Kenya and DR Congo and for soyabean in Kenya, Rwanda and DR

Congo. For Nigeria, Ghana, Mozambique and Malawi, information on PVS was available from previous work by including TL II (e.g. Abate 2012; Ajeigbe et al., 2010; Tefera, 2009).

1.2 Estimation of BNF

There are different methods for estimation of BNF by legumes (Giller, 2001). In its plan, N2Africa chose the natural abundance method (Högberg 1997; Unkovich et al. 2008), which is relatively easy to apply and it provides estimates with reasonable accuracy. In this method the percentage of N derived from the atmosphere is calculated as follows

$$\%N \text{ from } N_2 \text{ fixation} = \frac{\delta^{15}N\text{ref} - \delta^{15}N \text{ legume}}{\delta^{15}N\text{ref} - B} \times 100$$

where δ^{15}Nref and δ^{15}N legume are the ^{15}N natural abundances (in parts per thousand deviations, ‰, from the ^{15}N:^{14}N ratio in atmospheric N_2, which is 0.0036765 and corresponds to 0.3663 atom% N) in the non-fixing reference species (here, a sample of weedy species, maize or sorghum which was included in the trials) and the fixing species (here, soyabean, common bean, groundnut or cowpea) respectively, and B the ^{15}N natural abundance in the shoot of the fixing species totally relying on N_2 fixation (to adjust for isotopic fractionation between root and shoot within the legume).

However, at the time of preparing this report, analysis results of total N and % of the fraction of plants N derived from air ($\delta^{15}N_{ref}$ and $\delta^{15}N_{fix}$) were available for limited sites in Kenyan, DR Congo and Rwanda. Two major reasons are attributed to the delay in getting analysis results; firstly, the lack of proper equipment in-country, which forced us to send samples from all countries to the CIAT laboratory in Nairobi for initial preparation (fine milling and micro-balancing) before they were shipped to Leuven in Belgium for ^{15}N analysis. In this process several obstacles were encountered e.g. frequent breakdown of the ball milling machine at Nairobi and bureaucracy in obtaining Kenyan import and export permits. Secondly, it took longer than anticipated to have samples analysed at Leuven and the first batch of results were incomplete and did not allow calculations of BNF. Because of a lack of analysis results for many trials, the BNF presented in this report (except for groundnut in Ghana) are estimated based on the grain and stover yields of focus legumes. The stover yields (*Styi*) were usually not measured from the trials but calculated from the grain yield and an assumed dry matter harvest index (*Hi*) which represent the fraction of total aboveground dry matter in the grains as:

$$Styi = \frac{Gryi}{Hi} - Gryi$$

Subsequently, BNF was calculated based on grain yield (*Gryi*) and stover yields (*Styi*), the N concentration in the grain (Ngr) and in the stover (*Nst*) and an assumed % of nitrogen in the aboveground parts derived from N fixation (*%Ndf*):

$$BNF = (Gryi * Ngr + Styi * Nst) * \%Ndf$$

In our calculations, we assumed a harvest index of 0.35 for soyabean and cowpea and a harvest index of 0.37 for groundnut. Table 1.2 gives an overview of the N concentration of stover and grain, as well as the %NDFA for different grain legumes used in our calculations. The BNF by groundnut in Ghana was estimated based on the simple assumption that legumes such as groundnut fix 20 kg of N for every 1 tonne of biomass accumulated (Unkovich et al., 2008). This because of low grain yields from the trials, which were attributed to lack of rain during the grain filling stage.

Table 1.2: N concentrations in grain and stover and percentage nitrogen derived from air (%Ndfa) used in the calculations of BNF.

	N concentration grain (%)	N concentration stover (%)	%NDFA
Common bean	4.3	2.5	50
Cowpea	3.2	3.1	70
Groundnut	3.5	2.2	70
Soyabean	6.0	2.5	70

Source: Giller, 2001;Wortmann, et al., 1998; Ghanbari et al., 2013.

In this report, data collected from Zimbabwe for all legumes and for common bean in Malawi are not considered. This is because of very low yields obtained as a result of either drought or floods during the growing seasons. Average BNF values for countries were then estimated based on selection of the best yielding trials with the numbers presented for each legume and county.

1.3 Target BNF values

The nitrogen fixed by legume can be removed from the field through grain or stover when legumes are harvested. It is therefore desirable that grain legumes fix a proportion of its N at least as large as what is removed in the harvested parts, to avoid anet drain of soil N (Giller et al., 2001). It is on this basis that N2Africa established the threshold values of N to be fixed by the focus legumes based on projected grain yields in the different impact zones (Table 1.3), assuming that all stover will be retained in the field. Thus, the varieties which are considered high in BNF are those that attained the target in the respective Impact Zones.

Table 1.3: Target BNF (kg N / ha) and grain yield (kg grain / ha) of soyabean, common bean, cowpea and groundnut in N2Africa impact Zones set by N2Africa.

Legume	**Characteristic**	**Impact Zone**		
		West Africa	**East &Central Africa**	**Southern Africa**
Soyabean	Target BNF	110	110	110
	Target yield	2088	1274	3534
Common bean	Target BNF	NA	51-60	34
	Target yield		1940	1314
Cowpea	Target BNF	55	NA	NA
	Target yield	1283		
Groundnut	Target BNF	45	NA	60
	Target yield	1815	NA	2115

Source: N2Africa project document; www.N2Africa.org

2 Selected legume varieties

2.1 Soyabean varieties high in BNF potential

Table 2.1gives a summary of soyabean varieties considered to be high in BNF and the amount of nitrogen they fixed in the countries where they were tested. These concern the varieties that fixed 110 kg/ha and above as targeted by the project. The details of yield performance and the amount of N-fixed by the evaluated varieties by country is summarised in Appendix 1. The mean values are comparable to what is found in the literature (e.g. Giller et al., 1997, Thuita et al., 2012) although upper ranges are extremely high e.g. in Mozambique. The differences in N-fixed among varieties and between countries are huge (wide ranges), partly related to yield differences, number of sites where the varieties were tested and the conditions of sites (soil fertility, available moisture, diseases) during the trial period. For example, in DR Congo, Ghana and Mozambique where yields were high, the N-fixed was also high with many of the test varieties achieving high BNF. This is attributed to good soil fertility, good moisture availability and few incidences of diseases during the trial periods. Some of

Table 2.1: N-fixation (kg/ha) of soyabean varieties screened by N2Africa countries.

Country	Variety	n	N-fixed in grain		N-fixed in stover		Total N in fixed	
			Mean	Range	Mean	Range	Mean	Range
DR Congo	449/16	4	92	30-134	71	23-104	163	54-238
	IMPERIAL	5	90	25-139	70	19-108	160	44-247
	Peka 6	4	79	21-162	61	17-125	140	38-287
	TGx1740-2F	5	90	37-194	70	28-150	160	65-345
	Maksoy 2N	5	92	14-207	71	11-160	163	24-368
	SC 823-6-10	2	99	65-146	77	50-113	176	115-259
	SC Saga	2	100	71-128	78	55-99	178	126-228
	SC Squire	2	100	60-147	77	46-114	177	106-261
	TGx1987-11F	2	97	69-147	75	53-114	172	122-262
	TGx1987-20F	2	100	72-131	78	56-101	178	127-233
	TGx1987-28F	2	92	64-131	72	49-101	164	113-232
	TGx1987-64F	2	93	68-133	72	53-103	165	121-237
Rwanda	Maksoy 2N	6	62	11-183	48	8-141	110	19-324
	TGx1835-33F	6	66	9-166	51	7-129	117	17-295
	SC Squire	6	67	8-179	52	6-138	119	14-317
Malawi	Makwacha	14	67	5-157	52	4-122	119	8-279
	Solitera	15	62	3-154	48	2-119	110	5-274
	Soprano	14	65	3-175	50	2-135	115	5-310
Mozambique	Storm	7	123	38-254	95	30-197	218	68-451
	TGx1485-1D	7	122	49-184	94	38-143	216	87-327
	TGx1740-2F	7	117	41-268	91	32-207	208	73-475
	TGx1904-6F	7	112	37-207	87	28-160	199	65-366
	TGx1908-8F	7	109	17-177	84	13-137	193	30-314
	TGx1937-1F	7	97	21-187	75	16-145	172	37-332
Nigeria	SC SAGA	2	78	46-108	60	36-84	138	82-192
Ghana	Anidaso	7	73	11-145	57	8-112	130	19-257
	Jenguma	7	88	13-167	68	10-129	156	24-297
	Quarshie	7	93	26-189	72	20-146	165	46-335
	Salintuya	7	88	11-154	68	8-119	156	19-273
	TGx1448-2E	7	87	11-143	67	8-110	154	19-253
	TGx1834 -5E	7	95	20-142	74	16-110	169	36-252

the varieties tested in DR Congo were also tested in Rwanda and Kenya but yielded low grains and fixed less N because of poor soil fertility, moisture stress and high incidences of soyabean rust diseases at the trial sites (data not reported). Likewise, a prominent soyabean variety TGx1448-2E achieved high BNF and in Ghana but not in Nigeria and this attributed to better site conditions in Ghana than Nigeria. Surprisingly, many of the varieties high in BNF are already prominent with farmers (e.g. TGx1740-2F, TGx1448-2E, TGx1485-1D, Imperial, Storm, Anidaso, Salintuya and Makwacha), and are adapted across the Impact zones e.g. TGx1740-2F and Saga and TGx1448-2E, TGx1485-1D. This finding strongly supports the N2Africa philosophy that BNF can be increased significantly by enhancing the productivity of already existing legume varieties. Moreover, all varieties exhibited a wide range in yield and BNF within and between countries indicating that the yield gap can be closed by improving crop management and addressing specific site constraints.

2.2 Common bean, cowpea and groundnut varieties with high BNF trait

2.2.1 Common bean

Table 2.2 gives a summary of common bean varieties (bush and climbers) considered to be high in BNF and the amount of nitrogen they fixed in the countries where they were tested. The average performances of test varieties in different countries are presented in Appendix 2. As for the soyabean, the BNF values are quite variable and they differ from variety and countries. The BNF values for common beans reported in Kenya and Rwanda are comparable to what is reported in the literature (Giller, et al., 1997), but high for Rwanda and very high for DR Congo. Only few observations were made in DR Congo and the trials were installed on very fertile soils (except for one site), and this could explain the observed high BNF values. Nevertheless, the bush bean varieties used in

Table 2.2: Selected bush bean and common bean varieties for BNF and their corresponding N-fixation (kg/ha) in N2Africa countries.

Country	Bush bean				Climbing bean			
	Variety	n	Total N-fixed	Range	Variety	n	Total N-fixed	Range
Kenya	Ayaki	7	56	4-122	Gasirida	6	120	45-340
	KAT B9	4	54	22-116	Kenya Mavuno	6	129	28-280
	KK071	4	64	8-187	Kenya Tamu	8	166	5-475
	KK072	4	69	11-152	Mac 44	6	143	57-335
	KK15	4	54	42-64	MAC 49	6	118	52-257
	KK8	3	87	13-267	MAC 9	6	141	81-265
	Tsimbindi	7	71	49-118	MAMESA	6	129	21-211
					RWV 1129	6	114	44-359
					RWV 2070	6	95	25-144
					RWV 1348	6	194	87-264
					UMUBANO	8	140	31-318
Rwanda	RWR1180	6	78	25-180	GASIRIDA	4	165	16-385
	RWR1668	6	83	12-176	RWV1348	4	172	8-491
	RWR2076	6	83	10-323	RWV2070	4	132	12-359
	RWR2245	6	91	18-302	CAB2	4	103	16-428
					MAMESA	4	142	10-395
DR Congo	AFR 708	3	105	52-215	AND10	3	167	67-310
	CODMLB001	3	112	47-225	KIANGARA	3	169	38-362
	MARUNGI	3	118	48-297	MUSALE	3	122	15-344
	MORE 8802	3	97	18-165				
	RWR 10	3	109	36-214				

Rwanda are high yielding and adapted to low fertility soils, thus with a potential for high NBF. The average BNF values for climbing beans are also within the range of what is found in the literature (e.g. Lazali et al., 2013), although the upper ranges are high for Rwanda.

2.2.2 Cowpea and groundnut:

Table 2.3 gives a summary of cowpea and groundnut varieties considered to be high in BNF and the amount of nitrogen they fixed in the countries where they were tested. The average performances of test varieties in different countries are presented in appendix 3 and 4. As for soyabean and common bean, the BNF values of cowpea and groundnut were related to yields and varied between varieties and country, varieties performing well in Ghana and Malawi and groundnut performing well in Mozambique. The range of N-fixed for cowpea and groundnut lies within the range found in other studies (e.g. Naab, et al., 2009; Belane and Dakola, 2009; Giller et al., 1997).

Table 2.3: Selected cowpea and groundnut varieties for BNF and their corresponding N-fixation (kg/ha) in N2Africa countries.

Country	Cowpea				Groundnut			
	Variety	n	Total N-fixed	Range	Variety	n	Total N-fixed	Range
Nigeria	IT99K-573-1-1	6	56	12-124	AMP12	8	35	24-78
					EVDT		50	14-80
Ghana	Apagbaala	4	156	115-179	Chinese	6	52	18-149
	IT90K -277-2	4	61	44-74	JL 24	6	90	34-157
	IT99K-573-1-1	6	63	25-140	Manipinta	6	65	23-160
	Omondao	6	50	15-96	Nkatie- Sari	6	42	19-64
	Padi-tuya	6	79	15-176	Samnut 21	4	71	27-124
	Songotera	6	61	18-170	Bogla	4	50	14-80
					Samnut 23	4	60	23-135
Malawi	IT82E-16	4	146	25-300	ND			
	IT97k-1069-6	4	103	11-211				
	Mkanakaufiti	4	161	29-391				
	Sudan 1	4	113	15-295				
Mozambique	NA				CG7 (ICGV SM 83)	6	33	4-83
					CHITALA (ICGV-SM-99508)	6	49	11-130
					MAMANE (ICGV-SM 70704)	6	59	10-94
					NAMETIL (ICGV-12991)	6	75	22-165

Majority of selected cowpea and groundnut varieties are well adapted and prominent with farmers. The cowpea varieties Apagbaala, Omondao, Padi-tuya and Songotera are part of famer germplasm in Ghana and are available with the national breeding program. Likewise, the cowpea varieties Mkanakaufit and Sudan 1 are prominent with farmers in Malawi and they constitute the cowpea varieties of the national cowpea breeding program. The cowpea varieties IT99K-573-1-1, IT82E-16, IT90K -277-2 and IT97k-1069-6 are widely promoted by the TL II project with their seeds commercialized by the West Africa Seed Agency (WASA).

The groundnut variety Chinese, Manipinta, Nkatie-SARI is among the old varieties in Ghana but well adapted to local conditions. Varieties Samnut 21, Samnut 23, EMP 12, JL 24 and AVDT were widely tested by TL II in West Africa and are also commercialised by WASA. The groundnut varieties CG7 (ICGV SM 83), CHITALA (ICGV-SM-99508), MAMANE (ICGV-SM 70704) and NAMETIL (ICGV-

12991) are well adapted to Southern African growing conditions and already commercialise by IKULU in Mozambique and some small seed companies in Malawi.

2.3 Farmer preferred legume varieties

The highly preferred varieties by farmers as identified through the variety testing in agronomy trials are summarised Table 2.1. These are the varieties which were selected by more than 90% of the farmers during the PVS exercises in DR Congo, Rwanda, and Kenya. Farmers selected varieties according to preferences and performances. For Kenya, Rwanda and DR Congo, farmers preferred most soyabean varieties that are high yielding with short maturity period, large seeds and high market demand. The preferred common bean varieties were varieties that were fast growing, high yielding, large seeded, and well adapted to low fertility soils and tolerant to pests and diseases. In DR Congo bean varieties should also be tolerant to heavy rains. In Ghana and Nigeria, farmers prefer soyabean varieties that are high yielding with early to medium maturity period, large to medium sized seed and resistance to pod shattering. Preferred cowpea varieties have cream colour seed, and are high in grain and fodder yield, resistant to drought, striga and alectra and tolerant to pests and diseases. Preferred groundnut varieties are those that are high in grain and fodder yield, high in oil content (market preference) and resistant to rosette diseases. In Malawi and Mozambique, highly preferred soyabean varieties are those which are high yielding with short to medium maturity period and tolerant to soyabean rust disease. Preferred groundnut varieties are those that are high in grain yield, tolerant to rosette disease, large in grain size and drought tolerance.

From the PVS results it is clear that different farming communities want varieties that suit their diverse needs and preferences and not all varieties have all the desired characteristics. For example, not all farmer preferred varieties are high in BNF suggesting that more work needs to be done to enhance BNF of farmer valued varieties.

2.4 Legume varieties with combined farmer-preferences and high BNF

Ten soyabean varieties, eight common bean varieties, six cowpea varieties and seven groundnut varieties were found to be high in BNF potential and with attributes that are most preferred by farmers (Table 2.5). Apart from fixing large amount of N, these varieties combine adaption to specific environments and to abiotic and biotic stresses with suitable seed types and grain quality. A good number of these verities have been released in countries and were entered into the dissemination campaigns, and multiplied through the project activities.

Table 2.4: Varieties most preferred by farmers identified from a list of varieties tested for BNF potential in different countries. The varieties were selected by more than 90% of farmers who participated in the PVS exercise and from literature.

Country	Soyabean	Common bean	Cowpea*	Groundnut*
Kenya	SC Squire, SC Saga, TGx1740-2F, Nyala	Bush: KK8, KK15, KAT B 9 Climbers: Kenya Tamu, RWV 1348, Umubano	NA	NA
Rwanda	SC Squire, PKa6, SC Saga; Namsoy 2N	Bush: RWR2076, RWR1668, RWR 2245 Climbers: RWV 1348, Gasirida	NA	NA
DR Congo	SC Squire, IMPERIAL, PKa6, SC Saga	Bush: Marungi Climbers: AND 10, Musale	NA	NA
Nigeria*	TGx1448-2E,TGx1835-1-E, TGx1485-1D	NA	Danilla, EVDT, IT89KD-391, IT89KD-288	EVDT, Samnut 22 RMP12, Samnut 23
Ghana*	Salintuya, TGX 1448-2E	NA	Songotera, IT99K-573-1-1, Apagbaala, IT90K -277-2	Chinese, Samnut 23, Samnut 22, Samnut 21
Malawi*	Makwacha, Solitera, PAN 1867	ND	Mkanakaufiti, IT97k-1069-6, Sudan 1, IT82E-16	
Mozambique*	TGX 1740-2F , TGX 1485-1D, Storm, TGx1904-6F	NA	NA	CG7 (ICGV SM 83), CHITALA (ICGV-SM-99508), MAMANE (ICGV-SM 70704), NAMETIL (ICGV-12991)

*from Ajeigbe et al., 2010; Abate, 2010; Hairu, 2009.

NA = Not applicable
ND = Not determined

Table 2.5: Soyabean, common bean, cowpea and ground varieties selected for high BNF, grain yield and preference by farmers and or market in project Impact Zone. The target values for BNF set by N2Africa are on average 110, 51 and 55 and 45-60 kg/ha for soyabean, common bean, cowpea and groundnut, respectively. Data in the parenthesis indicate % increase from the target BNF values. The BNF values of a variety tested in more than one country within the impact zone are averaged.

	East & Central Africa		West Africa		Southern Africa	
	Variety	N-fixed (kg/ha)	Variety	N-fixed (kg/ha)	Variety	N-fixed (kg/ha)
Soyabean	Saga	124 (13%)	Saga	138 (25%)	Makwacha	118 (7%)
	TGx1987-62F	125 14%)	Salintuya	156 (42%)	TGx1740-2F	128 (16%)
	TGx1740-2F	119 (8%)	TGx 1448-2E	153 (39%)	TGx1485-1D	216 (96%)
					TGx1904- 62F	199 (81%)
Common bean	Kenya Tamu	166 (176%)	NA		Data not included due to poor performance of trials	
	RWV 1348	83 (205%)				
	GASIRIDA	165 (223%)				
	AND10	167 (178%)				
	RWR 2076*	83(63%)				
	RWR 2245*	90 (76%)				
	Marungi*	80 (57%)				
	Tsimbindi	71 (39%)				
Cowpea	NA		Apagbaala	155 (181%)	Sudan 1	112 (103%)
			Songotura	62 (12%)	IT97-1069-6	99 (80%)
			IT99K-573-1-1	61 (11%)	IT82E-16	142(158%)
Groundnut	NA		EVDT	50 (10%)	ICGV - SM 83	61 (26%)
			Samnut 21	52 (15%)	ICGV SM 99568	65 (16%)
			RMP12	47 (2%)	ICGV - SM 90704	61 (16%)
					ICGV -12991	62 (16%)

* Bush bean variety; NA = not applicable.

2.5 Concluding remarks

A major aim of the N2Africa project was to screen varieties for their N_2-fixation ability, so that varieties that are stronger in N_2-fixation are brought into the dissemination activities. Many of the varieties we worked with are old but well adapted to farmers conditions and with good market demand. Surprisingly, a good number of these varieties are high in BNF when the growing conditions are favourable and or optimized. This observation appears to suggest that farmers can achieve high BNF with presently available varieties if their management is optimized. Furthermore the N_2-fixation assessment in this report indicates that BNF of the same variety greatly differs from one site to another and from country to country showing the importance of targeting varieties to specific environment.

In the present report, N-fixation was assessed based on grain and stover production giving possibilities of underestimating the BNF potential of the dual-purpose legumes with low harvest index. More estimates will be done using a non-biased 15N abundance method once a full set of analysis results is available to check against the present results.

References

Abate T., 2010. Lessons from two year of Tropical Legume II. www.tropicallegumes.org

Ajeigbe, H., Abdulaye, T and Chikoye, D., 2010. Improved crop-livestock systems for enhabced food security and income. International Institute for Tropical Agriculture (IITA). Ibandan, Nigeria.

Baijukya, F.P, Giller K.E and Dashiel K., 2011. Selected soyabeans, common beans, cowpeas and groundnuts varieties with proven high BNF potential and sufficient seed availability in target impact zones of N2Africa Project. www.N2Africa.org.

Belane, A.K and dakola, F. D., 2009. Measurement of N2-fixation in 30 cowpea (*Vignaunguiculata* L. Walp) genotypes under field conditions in Ghana, using the 15n natural abundance technique. Symbiosis, 48, 47-56.

Ghanbari, A.A., Shakibi, M.R, Torch, M and Chomkan, R., 2013. Nitrogen changes in beans and accumulation of some minerals in the seed of red-whiti and Chittii bean (Phaseolus vulgaris) under water deficit. Australian J. of Crop Science 4(5)706-712.

Giller, K. E. (unpublished). Report on Legume varieties for early start in N2Africa N2fixAfrica, 2009: PROJECT DESIGN AND IMPLEMENTATION PLAN. www.N2Africa.org.

Giller,K. E., 2001. Nitrogen fixation in Tropical Cropping Systems. Oxon, CABI Publishing.

Giller, K.E., Amijee, F., Brodrick, S.J. and Edje, O.T. 1998. Environmental constraints to nodulation and nitrogen fixation of Phaseolus vulgaris L. in Tanzania. II. Response to N and P fertilizers and inoculation with Rhizobium. African Crop Science Journal 6(2):171-178.

Giller, K.E., Cadisch, G., Ehaliotis, C., Adams, E., Sakala, W.D. and Mafongoya, P.L. 1997. Building Soil Nitrogen Capital in Africa: In Buresh, R.J., Sanchez, P.A and Calhoun, F. (eds). Replenishing Soil Fertility in Africa. Madison: American Society of Agronomy, Soil Science Society of America.

Naab, J.B., Chimphango, S.M and Dakora, F.D. 2009. N2-fixation in cowpea plants grown in farmers fields in the Upper West Region of Ghana, measured using 15N natural abundance. Symbiosis, 48, 37-46.

Peoples, M.B., Faizah, A.W., Reekasem, B. and Herridge,D .F. 1989. Methods for Evaluating Nitrogen fixation by Nodulated Legumes in the field. ACIAR, Canberra, Australia.

Tefera, H. 2009. Enhancing productivity and production of soyabean in drough prone areas of sub-Saharan Africa. www.tropicallegumes.org

Thuita, M., Pypers, P., Herrmann, L., Okalebo, R.J., Othieno, C., Muema, E and Lesueur, D. 2012. Commercial rhizobial inoculants significantly enhance growth and nitrogen fixation of promiscuous soyabean variety in Kenyan soils. Biology and Fertility of Soils, 48, 87-96.

Unkovich, M., Herridge, D., Peoples, M., Cadisch, G., Boddey, R., Giller, K., Alves., P and Chalk, P. 2008. Measuring Plant-Associated Nitrogen Fixation in Agricultural Systems, Australian centre for International Agricultural Research.

Wortmann, C. S., M. Silver-Rwakaikara and J. Lynch, 1998, Efficiency of nitrogen acquisition and utilization in common bean in Uganda. African Crop Science Journal, Vol. 6. No. 3, pp. 273-282.

Appendices

Appendix 1: Grain and stover yields, N-fixed in grain, N-fixed in stover and total-N fixed (kg/ha) by soyabean, estimated from soyabean variety trials conducted in DR Congo, Rwanda, Kenya, Malawi, Mozambique, Nigeria and Ghana. n = number of sites.

Country	Variety	n	Grain yield		Stover yield		N-fixed in grain		N-fixed in stover		Total N in fixed	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
DR Congo	449/16	4	2198	719-3197	4082	1335-5937	92	30-134	71	23-104	163	54-238
	IMPERIAL	5	2140	588-3313	3975	1091-6153	90	25-139	70	19-108	160	44-247
	Peka 6	4	1889	509-3856	3508	946-7162	79	21-162	61	17-125	140	38-287
	TGx1740-2F	5	2139	875-4625	3973	1625-8589	90	37-194	70	28-150	160	65-345
	Maksoy 2N	5	2194	328-4938	4075	609-9170	92	14-207	71	11-160	163	24-368
	SC 823-6-10	2	2368	1540-3479	4397	2860-6461	99	65-146	77	50-113	176	115-259
	SC Saga	2	2385	1689-3056	4430	3137-5675	100	71-128	78	55-99	178	126-228
	SC Squire	2	2383	1418-3507	4426	2633-6512	100	60-147	77	46-114	177	106-261
	TGx1987-11F	2	2301	1631-3511	4274	3029-6521	97	69-147	75	53-114	172	122-262
	TGx1987-20F	2	2391	1711-3122	4441	3178-5798	100	72-131	78	56-101	178	127-233
	TGx1987-28F	2	2202	1517-3112	4089	2817-5780	92	64-131	72	49-101	164	113-232
	TGx1987-62F	2	2219	1621-3178	4120	3011-5902	93	68-133	72	53-103	165	121-237
Rwanda	Peka 6	6	921	175-1952	1710	325-3625	39	7-82	30	6-63	69	13-145
	Maksoy 2N	6	1477	250-4350	2743	464-8079	62	11-183	48	8-141	110	19-324
	TGx1835-33F	6	1575	225-3961	2924	418-7357	66	9-166	51	7-129	117	17-295
	SC Saga	6	1445	233-4908	2683	433-9114	61	10-206	47	8-160	108	17-366
	SC Sequel	6	1420	375-2774	2637	696-5151	60	16-116	46	12-90	106	28-207
	SC Squire	6	1597	192-4255	2965	356-7902	67	8-179	52	6-138	119	14-317

All values are in kg/ha

Appendix 1 continued

Country	Variety	n	Grain yield		Stover yield		N-fixed in grain		N-fixed in stover		Total N in fixed	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Kenya	EAI3600	4	336	114-686	624	211-1275	14	5-29	11	4-22	25	8-51
	Saga	3	1178	193-3495	2188	358-6491	49	8-147	38	6-114	88	14-260
	TGx1740-2F	5	805	168-2011	1496	312-3734	34	7-84	26	5-65	60	13-150
	Sequel	2	1063	606-2262	1975	1126-4201	45	25-95	35	20-74	79	45-169
	Squire	3	1206	265-3114	2240	493-5783	51	11-131	39	9-101	90	20-232
	TGx1987-10F	3	1005	734-1344	1867	1363-2496	42	31-56	33	24-44	75	55-100
	TGx1987-18F	3	1197	770-2055	2223	1430-3816	50	32-86	39	25-67	89	57-153
	TGx1987-62F	3	1140	213-2459	2118	395-4568	48	9-103	37	7-80	85	16-183
	TGx1987-6F	3	1403	784-2536	2605	1456-4709	59	33-106	46	25-82	105	58-189
	TGx1835-33F	3	465	254-829	863	472-1540	20	11-35	15	8-27	35	19-62
	Namsoy 4 M	5	866	127-2271	1609	236-4217	36	5-95	28	4-74	64	9-169
	Maksoy 2N	5	1024	536-1822	1901	995-3384	43	22-77	33	17-59	76	40-136
	TGx1835-10E	3	1033	369-2084	1919	686-3871	43	16-88	34	12-68	77	28-155
Malawi	Makwacha	14	1588	109-3743	2950	202-6952	67	5-157	52	4-122	118	8-279
	Nasoko	15	1456	37-3433	2704	69-6376	61	2-144	47	1-112	108	3-256
	PAN 1867	15	1401	63-3849	2602	117-7149	59	3-162	46	2-125	105	5-287
	SC Saga	3	859	71-1798	1595	131-3339	36	3-76	28	2-58	64	5-134
	Solitera	15	1480	63-3672	2749	117-6819	62	3-154	48	2-119	110	5-274
	Soprano	14	1546	66-4161	2872	123-7728	65	3-175	50	2-135	115	5-310
	TGx1740-2F	3	635	69-1279	1179	128-2375	27	3-54	21	2-42	48	5-95
	TGx1835-10E	3	565	71-1551	1049	131-2881	24	3-65	18	2-50	42	5-116
	TGx1987-10F	3	683	71-1867	1269	132-3468	29	3-78	22	2-61	51	5-139
	TGx1987-11F	3	643	78-2549	1194	145-4733	27	3-107	21	3-83	48	6-190
	TGx1987-62F	3	623	82-1336	1157	153-2482	26	3-56	20	3-43	46	6-100
	Tikolore	15	1457	97-3702	2705	180-6874	61	4-155	47	3-120	108	7-276

All values are in kg/ha

Appendix 1 continued

Country	Variety	n	Grain yield		Stover yield		N-fixed in grain		N-fixed in stover		Total N in fixed	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Mozambique	Storm	7	2934	911-6056	5448	1692-11247	123	38-254	95	30-197	218	68-451
	TGx1485-1D	7	2894	1164-4385	5374	2162-8144	122	49-184	94	38-143	216	87-327
	TGx1740-2F	7	2785	973-6374	5173	1808-11837	117	41-268	91	32-207	208	73-475
	TGx1904-62F	7	2668	876-4918	4955	1626-9133	112	37-207	87	28-160	199	65-366
	TGx1908-8F	7	2584	400-4213	4799	743-7825	109	17-177	84	13-137	193	30-314
	TGx1937-1F	7	2301	502-4450	4273	933-8264	97	21-187	75	16-145	172	37-332
Nigeria	SC SAGA	2	1858	1100-2577	3451	2044-4786	78	46-108	60	36-84	138	82-192
	TGx1485-1D	5	1312	837-2600	2437	1555-4829	55	35-109	43	27-85	98	62-194
	TGx1835-10E	5	945	178-1941	1755	331-3605	40	7-82	31	6-63	71	13-145
	TGx1904-6F	5	853	231-2807	1585	428-5212	36	10-118	28	7-91	64	17-209
	TGx1935-3F	5	770	234-2389	1430	435-4438	32	10-100	25	8-78	57	17-178
	TGx1945	5	1100	374-1380	2043	695-2562	46	16-58	36	12-45	82	28-103
	TGx1951-3F	5	983	224-2803	1826	416-5206	41	9-118	32	7-91	73	17-209
	TGx195-554F	5	1414	391-2704	2626	727-5022	59	16-114	46	13-88	105	29-201
	TGx19-62F	5	1320	861-2512	2452	1599-4665	55	36-106	43	28-82	98	64-187
	TGx1448-2E	5	1091	293-3172	2026	545-5890	46	12-133	35	10-103	81	22-236
Ghana	Anidaso	7	1748	255-3446	3247	473-6399	73	11-145	57	8-112	130	19-257
	Jenguma	7	2091	319-3984	3883	593-7399	88	13-167	68	10-129	156	24-297
	Quarshie	7	2210	617-4495	4105	1145-8349	93	26-189	72	20-146	165	46-335
	Salintuya	7	2089	258-3664	3880	480-6804	88	11-154	68	8-119	156	19-273
	TGx1448-2E	7	2071	260-3394	3845	483-6304	87	11-143	67	8-110	154	19-253
	TGx1834 -5E	7	2267	482-3383	4209	895-6283	95	20-142	74	16-110	169	36-252
	TGx1835-10E	7	606	130-1626	1126	242-3021	25	5-68	20	4-53	45	10-121

All values are in kg/ha

Appendix 2.1: Grain and stover yields, N-fixed in grain, N-fixed in stover and total-N fixed (kg/ha) by bush bean, estimated from bush bean variety trials conducted in Kenya, Rwanda and DR Congo. n = number of sites.

Country	Variety	n	Grain yield		Stover yield		N-fixed in grain		N-fixed in stover		Total N in fixed	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Kenya	Ayaki	7	797	57-1739	1480	106-3230	20	1-43	36	3-79	56	4-122
	KAT 56	7	472	52-825	876	97-1532	12	1-20	22	2-38	33	4-58
	KAT B1	4	608	163-1729	1129	303-3212	15	4-43	28	7-79	43	11-122
	KAT B9	4	765	308-1645	1420	572-3055	19	8-40	35	14-75	54	22-116
	KAT X56	4	711	209-1404	1321	388-2607	17	5-35	32	10-64	50	15-99
	KK071	4	907	112-2664	1684	208-4947	22	3-66	41	5-122	64	8-187
	KK072	4	985	158-2157	1829	293-4006	24	4-53	45	7-99	69	11-152
	KK15	4	774	598-910	1438	1110-1691	19	15-22	35	27-42	54	42-64
	KK8	3	1245	187-3798	2311	348-7053	31	5-93	57	9-173	87	13-267
	New-rosecoco	7	634	47-1850	1178	87-3435	16	1-46	29	2-85	45	3-130
	Tsimbindi	7	1014	692-1680	1883	1285-3120	25	17-41	46	32-77	71	49-118
Rwanda	RWR1180	6	1112	356-2568	2064	662-4768	27	9-63	51	16-117	78	25-180
	RWR1668	6	1179	167-2500	2190	310-4643	29	4-62	54	8-114	83	12-176
	RWR2076	6	1187	146-4599	2205	272-8541	29	4-113	54	7-210	83	10-323
	RWR2145	6	1033	129-2083	1919	239-3869	25	3-51	47	6-95	72	9-146
	RWR2245	6	1287	259-4290	2389	482-7967	32	6-106	59	12-196	91	18-302
DR Congo	AFR 708	2	1492	740-3063	2770	1374-5688	37	18-75	68	34-140	105	52-215
	CODMLB001	2	1597	675-3197	2967	1253-5937	39	17-79	73	31-146	112	47-225
	MARUNGI	2	1676	690-4231	3112	1281-7858	41	17-104	77	32-193	118	48-297
	MORE 8802	2	1389	253-2341	2579	471-4347	34	6-58	63	12-107	97	18-165
	RWR 10	2	1562	514-3045	2900	954-5656	38	13-75	71	23-139	109	36-214

Appendix 2.2: Grain and stover yields, N-fixed in grain, N-fixed in stover and total-N fixed (kg/ha) by climbing bean, estimated from climbing- bean variety trials conducted in Kenya, Rwanda and DR Congo. n = number of sites.

Country	Variety	n	Grain yield		Stover yield		N-fixed in grain		N-fixed in stover		Total N in fixed	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Kenya	Gasirida	6	1718	637-4831	3190	1183-8971	42	16-119	78	29-221	120	45-340
	Kenya Mavuno	6	1829	399-3981	3397	742-7393	45	10-98	84	18-182	129	28-280
	Kenya Tamu	8	2366	69-6751	4393	128-12538	58	2-166	108	3-308	166	5-475
	Mac 44	6	2041	808-4762	3790	1501-8843	50	20-117	93	37-218	143	57-335
	MAC 49	6	1680	741-3658	3121	1376-6793	41	18-90	77	34-167	118	52-257
	MAC 9	6	2012	1159-3767	3736	2153-6995	49	29-93	92	53-172	141	81-265
	MAMESA	6	1839	298-3001	3415	553-5573	45	7-74	84	14-137	129	21-211
	RWV 1129	6	1617	619-5112	3004	1150-9493	40	15-126	74	28-234	114	44-359
	RWV 2070	6	1354	356-2051	2515	662-3809	33	9-50	62	16-94	95	25-144
	RWV 1348	6	2769	1243-3751	5142	2309-6967	68	31-92	126	57-171	194	87-264
	UMUBANO	8	1999	445-4530	3712	826-8412	49	11-111	91	20-207	140	31-318
Rwanda	GASIRIDA	4	2353	222-5483	4370	413-10182	58	5-135	107	10-250	165	16-385
	RWV1348	4	2453	115-6984	4556	213-12971	60	3-172	112	5-319	172	8-491
	RWV2070	4	1877	167-5108	3486	310-9486	46	4-126	86	8-233	132	12-359
	CAB2	4	1466	222-6087	2723	413-11304	36	5-150	67	10-278	103	16-428
	MAMESA	4	2018	144-5621	3748	267-10439	50	4-138	92	7-257	142	10-395
DR Congo	AND10	3	2401	539-5150	4459	1002-9564	59	13-127	110	25-235	167	67-310
	KIANGARA	3	1738	216-4893	3228	401-9087	43	5-120	79	10-224	169	38-362
	MUSALE	3	2022	141-4801	3755	262-8916	50	3-118	92	6-219	122	15-344

Appendix 3: Grain and stover yields, N-fixed in grain, N-fixed in stover and total-N fixed (kg/ha) by cowpea, estimated from cowpea variety trials conducted in Nigeria, Ghana and Malawi. n = number of sites.

Country	Variety	n	Grain yield		Stover yield		N-fixed in grain		N-fixed in stover		Total N in fixed	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Nigeria	Danilla	6	300	124-550	557	230-1021	7	3-13	12	5-22	19	8-36
	EVDT	6	419	196-607	778	364-1127	10	5-15	17	8-24	27	13-39
	IT199K-499-35	2	475	122-956	882	226-1775	12	3-23	19	5-39	31	8-62
	IT89KD-288	6	580	241-979	1076	448-1818	14	6-24	23	10-39	38	16-63
	IT89KD391	6	711	133-1723	1321	246-3199	17	3-42	29	5-69	46	9-112
	IT90K_277-2	5	801	156-2436	1488	290-4523	20	4-60	32	6-98	52	10-158
	IT93K-227-2	6	608	307-1670	1130	571-3102	15	8-41	25	12-67	39	20-108
	IT97K-499-35	5	817	71-5671	1518	132-1753	20	2-139	33	3-229	53	5-367
	IT98K-205-8	6	265	134-432	491	249-803	6	3-11	11	5-17	17	9-28
	IT99K-573-1-1	6	866	189-1907	1608	351-3542	21	5-47	35	8-77	56	12-124
Ghana	Apagbaala	4	2398	1773-2768	4453	3292-5141	59	43-68	97	71-112	156	115-179
	IT90K -277-2	4	942	675-1143	1750	1253-2122	23	17-28	38	27-46	61	44-74
	IT99K-573-1-1	6	961	393-2161	1786	730-4013	24	10-53	39	16-87	63	25-140
	Marfo-tuya	6	828	413-1322	1538	767-2456	20	10-32	33	17-53	53	27-86
	Omondao	6	771	238-1474	1431	441-2737	19	6-36	31	10-59	50	15-96
	Padi-tuya	6	1217	233-2719	2259	433-5049	30	6-67	49	9-110	79	15-176
	Songotera	6	935	273-2629	1737	507-4883	23	7-64	38	11-106	61	18-170
	Zayura	6	744	204-1617	1383	379-3003	18	5-40	30	8-65	48	13-105
Malawi	IT82E-16	4	4184	705-8586	2253	380-4623	55	9-113	91	15-186	146	25-300
	IT97k-1069-6	4	2928	328-6047	1572	176-3256	39	4-80	64	7-131	103	11-211
	Mkanakaufiti	4	4614	832-11208	2484	448-6035	61	11-148	100	18-243	161	29-391
	Sudan 1	4	3223	420-8441	1735	226-4545	43	6-111	70	9-183	113	15-295

Appendix 4.1: Grain and stover yields, N-fixed in grain, N-fixed in stover and total-N fixed (kg/ha) by groundnut, as estimated from groundnut variety trials conducted in Nigeria and Mozambique. n = number of sites.

Country	Variety	n	Grain yield		Stover yield		N-fixed in grain		N-fixed in stover		Total N in fixed	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Nigeria	EVDT	6	975	247-1424	1420	459-2644	24	7-39	26	7-41	50	14-80
	Ex-Dakar	6	397	92-1284	736	171-2384	11	3-35	11	3-37	22	5-72
	RMP12	8	728	112-1504	1247	207-2793	19	17-17	22	18-18	47	35-35
	RMP91	2	504	182-982	936	339-1824	17	3-41	18	3-43	35	6-84
	Samnut 23	7	518	75-1534	962	139-2849	14	5-27	14	5-28	28	10-55
	Samnut 22	8	611	110-1591	1134	205-2955	14	2-42	15	2-44	29	4-86
	Samnut 21	8	596	80-1482	1108	148-2753	17	3-43	17	3-46	34	6-89
Mozambique	CG7 (ICGV SM 83)	6	985	92-2543	1830	171-4722	16	2-40	17	2-42	33	4-83
	CHITALA (ICGV-SM-99508)	6	881	206-2334	1636	382-4334	24	6-64	25	6-67	49	11-130
	MAMANE (ICGV-SM 70704)	6	1052	170-1685	1953	316-3129	29	5-46	30	5-48	59	10-94
	NAMETIL (ICGV-12991)	6	1344	400-2950	2496	743-5478	37	11-81	38	11-84	75	22-165

Appendix 4.2: Above ground biomass accumulation, grain yield and N fixed (kg/ha) by groundnut, estimated from groundnut variety trials conducted Ghana. n = number of sites.

Variety	n	Above ground biomass		Grain yield		N-fixed	
		Mean	Range	Mean	Range	Mean	Range
Bogla	4	2321	455-4096	253	10-893	46	9-82
Chinese	6	2618	920-7426	168	7-471	52	18-149
JL 24	6	4479	1687-7845	143	5-297	90	34-157
Manipinta	6	3256	1141-7985	223	29-1111	65	23-160
Nkatie Sari	6	2106	950-3176	301	6-528	42	19-64
Samnut 21	4	3537	1354-6185	274	47-812	71	27-124
Samnut 23	4	2984	1165-6743	343	73-677	60	23-135

List of project reports

1. N2Africa Steering Committee Terms of Reference
2. Policy on advanced training grants
3. Rhizobia Strain Isolation and Characterisation Protocol
4. Detailed country-by-country access plan for P and other agro-minerals
5. Workshop Report: Training of Master Trainers on Legume and Inoculant Technologies (Kisumu Hotel, Kisumu, Kenya-24-28 May 2010)
6. Plans for interaction with the Tropical Legumes II project (TLII) and for seed increase on a country-by-country basis
7. Implementation Plan for collaboration between N2Africa and the Soil Health and Market Access Programs of the Alliance for a Green Revolution in Africa (AGRA) plan
8. General approaches and country specific dissemination plans
9. Selected soyabeans, common beans, cowpeas and groundnuts varieties with proven high BNF potential and sufficient seed availability in target impact zones of N2Africa Project
10. Project launch and workshop report
11. Advancing technical skills in rhizobiology: training report
12. Characterisation of the impact zones and mandate areas in the N2Africa project
13. Production and use of Rhizobial inoculants in Africa
18. Adaptive research in N2Africa impact zones: Principles, guidelines and implemented research campaigns
19. Quality assurance (QA) protocols based on African capacities and international existing standards developed
20. Collection and maintenance of elite rhizobial strains
21. MSc and PhD status report
22. Production of seed for local distribution by farming communities engaged in the project
23. A report documenting the involvement of women in at least 50% of all farmer-related activities
24. Participatory development of indicators for monitoring and evaluating progress with project activities and their impact
25. Suitable multi-purpose forage and tree legumes for intensive smallholder meat and dairy industries in East and Central Africa N2Africa mandate areas
26. A revised manual for rhizobium methods and standard protocols available on the project website
27. Update on Inoculant production by cooperating laboratories
28. Legume Seed Acquired for Dissemination in the Project Impact Zones
29. Advanced technical skills in rhizobiology: East and Central African, West African and South African Hub
30. Memoranda of Understanding are formalized with key partners along the legume value chains in the impact zones
31. Existing rhizobiology laboratories upgraded

32. N2Africa Baseline report
33. N2Africa Annual country reports 2011
34. Facilitating large-scale dissemination of Biological Nitrogen Fixation
35. Dissemination tools produced
36. Linking legume farmers to markets
37. The role of AGRA and other partners in the project defined and co-funding/financing options for scale-up of inoculum (banks, AGRA, industry) identified
38. Progress Towards Achieving the Vision of Success of N2Africa
39. Quantifying the impact of the N2Africa project on Biological Nitrogen Fixation
40. Training agro-dealers in accessing, managing and distributing information on inoculant use
41. Opportunities for N2Africa in Ethiopia
42. N2Africa Project Progress Report Month 30
43. Review & Planning meeting Zimbabwe
44. Howard G. Buffett Foundation – N2Africa June 2012 Interim Report
45. Number of Extension Events Organized per Season per Country
46. N2Africa narrative reports Month 30
47. Background information on agronomy, farming systems and ongoing projects on grain legumes in Uganda
48. Opportunities for N2Africa in Tanzania
49. Background information on agronomy, farming systems and ongoing projects on grain legumes in Ethiopia
50. Special Events on the Role of Legumes in Household Nutrition and Value-Added Processing
51. Value chain analyses of grain legumes in N2Africa: Kenya, Rwanda, eastern DRC, Ghana, Nigeria, Mozambique, Malawi and Zimbabwe
52. Background information on agronomy, farming systems and ongoing projects on grain legumes in Tanzania
53. Nutritional benefits of legume consumption at household level in rural sub-Saharan Africa: Literature study
54. N2Africa Project Progress Report Month 42
55. Market Analysis of Inoculant Production and Use
56. Identified soyabean, common bean, cowpea and groundnut varieties with high Biological Nitrogen Fixation potential identified in N2Africa impact zones

Partners involved in the N2Africa project

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