N2Africa Podcaster no. 58

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Introduction

Although the funding for N2Africa ended in June 2019 we are still busy with reports, impact studies and scientific papers. In November, the IITA N2Africa team received an award from the Board of Trustees of IITA, the Award for Excellence for Outstanding Team in 2019, recognising the excellent work done over the past ten years to promote nitrogen fixing grain legumes in Africa. Congratulations to our colleagues for this important recognition.

IITA DG Dr Sanginga presenting the Board of Trustees Excellence for Outstanding Team Award to Freddy Baijukya, Bernard Vanlauwe and Nkeki Kamai, with Hilde Koper, Master of Ceremonies

December saw the publication of two important publications. First, the study conducted by Giel Ton and Dominic Glover of the Institute of Development Studies on N2Africa activities in Ghana and Ethiopia. Giel and Dominic use a method known as Contribution Analysis through which they could assess the role that N2Africa had played in promoting technologies through two case studies. Their results are summarised in this Podcaster. Second we published *"The Story of N2Africa"* in three ways; as an online magazine with many videos, as a hard copy book and as an ebook that can be read online. We have been delighted by the responses we have received to the book and magazine which allow us to provide a much more complete picture of everything the N2Africa partnerships achieved.

Professor Arthur Mol, Rector Magnificus of Wageningen University inspecting a copy of "The Story of N2Africa" presented to him by Ken Giller

We also provide a summary and links to two policy reports which were led by Ferko Bodnar along with the N2Africa country teams in Ethiopia and Tanzania. We are following up on these policy processes that seem to be gaining some traction in each country. In addition we have two PhD reports – one from Jenneh Bebeley of Bayero Univeristy in Kano, Nigeria and one from Margarida Simbine who recently completed her PhD with Felix Dakora of Tshwane University of Technology, Pretoria, South Africa. Margarida is well known to some of us as she conducted her MSc studies in the first phase of N2Africa in Kenya with Freddy Baijukya. We have one short early report of some results on farm size estimation from the N2Africa Impact Study – we'll provide a detailed discussion of the findings later in the year.

Ken Giller

Verifying contribution claims

N2Africa has gathered and monitored a lot of information about the impact of its work. However, the diversity of N2Africa's interventions, their dynamism, and the widely different contexts where these have been implemented, make it tricky to derive strong inferences about the project's impacts from suvey-based impact evaluations. Therefore, N2Africa also uses institutional information and community-level data collected using qualitative methods. Together, this quantitative and qualitative information is expected to provide evidence for N2Africa's claim of contribution, that is, that the programme's activities have contributed to the impacts indicated in the project's theory of change.

N2Africa's objective is to use these pieces of information to create a coherent contribution narrative, so that those involved in the project can develop more refined theories that may be used to scale and replicate activities in the future.

To assist N2Africa with this effort, a team of external evaluators from the Institute of Development Studies (IDS, Brighton, UK) gathered and critically analysed evidence underlying N2Africa's claims about its impact. The IDS researchers used an approach known as contribution analysis. This evaluation approach is informed by the methodology of process tracing, which is a structured way of critically reviewing a process and sequence of change.

The IDS team reviewed available project documentation and other literature, and gathered data through stakeholder interviews that focused on four generic questions, which help to assess the strength and importance of the contribution made by N2Africa.

Giel Ton at Contribution Analysis brainstorm session at Wageningen University in February 2019

The evaluators applied this approach in two case studies, on Ghana and Ethiopia respectively. The two chosen cases relate to technologies or support interventions that were considered by N2Africa stakeholders to be the most promising for replication or upscaling. The expected impact pathways in each of these cases embody a set of critical assumptions about the immediate and intermediate outcomes of N2Africa's work, which would need to exist in order to have a fair chance of generating the desired impact at scale.

In Ghana, Giel Ton reviewed the evidence-base behind the contribution claim: "N2Africa has been a relevant contributory factor in the expansion of soyabean production in Northern Ghana." He differentiated four assumptions that underpin the contribution claim, verified whether the assumed changes had indeed taken place, and assessed what had been the importance of N2Africa's contribution has been on each of these outcomes.

1. Did the soyabean expansion take place? Yes. Though data is unreliable, most interviewees believe that an expansion of soyabean production in Northern Ghana has indeed taken place. This is considered as a positive development.

2. Was N2Africa support used in the process? Yes. In particular, seed multiplication is likely to have had positive effects on the soyabean yields of a large number of smallholder farmers. These farmers use certified seeds and improved soyabean varieties.

3. Was N2Africa necessary to speed-up or scale faster? Yes. N2Africa-supported seed multiplication work has had a positive, systemic effect for the availability of quality soyabean seed for smallholder farmers. The impact of N2Africa's work on inoculants and fertilisers is still fairly limited. Uptake seems largely restricted to groups of farmers that are self-organised or who benefit from NGO support, where the demand and supply of inoculants and fertiliser are monitored and communicated to the agro-input shops, and uptake is facilitated by pre-harvest loans.

   However, there are some outstanding challenges. Legume fertilisers are increasingly available but still in a 'pilot distribution mode,' not part of the regular distribution system. The quantities demanded are too small to make legume fertilisers a regular item in the inventory of agro-input shops. An input-subsidy programme is driving demand for legume fertiliser. N2Africa played a facilitating role in opening up this programme to legumes, but this somewhat artificial market may collapse when the subsidies are discontinued. Inoculants are not part of the subsidy programme. Due to their relatively short shelf-life, they are not yet available to farmers in remote areas.

4. Was N2Africa a necessary causal factor for the soyabean expansion to take place? No. N2Africa cannot claim to be the trigger that started the soyabean expansion. The main trigger is the demand generated by processing industries that began to be located in the area. At most, N2Africa played a facilitating role in a wide number of partnerships, alongside the efforts of smallholders themselves to benefit from the increasing demand for soyabeans in Ghana. Without N2Africa, this growth of soyabean acreage would have started anyhow, and will likely continue, but with a (even) lower adoption of fertiliser and inoculants.

In Ethiopia, Dominic Glover verified the claim, "N2Africa has contributed to the increase in production, distribution, uptake and expansion of market demand for legume inoculants." He verified three critical assumptions in the theory of change. The conclusions were as follows:

1. Did the expansion of inoculants production and use take place? Yes. The volumes of production, distribution, sale and use of inoculants increased significantly, albeit from a very low base. Demand for inoculant products has increased, but the inoculant market remains far below its estimated potential.

2. Was N2Africa support used in the process? Yes. N2Africa's support was crucial, especially in two key respects. First, N2Africa played a direct role in securing funds to upgrade and expand inoculant production by a commercial manufacturer. Second, the public—private partnership model brought stakeholders into contact with one another to work in ways that had not existed before the project.

3. Was N2Africa a necessary causal factor for the expansion of inoculant supply and use to take place? Likely yes. While actors in the system already aspired to develop and expand a market for legume inoculants and improve legume production before N2Africa commenced, the project played a catalytic, facilitating role to strengthen and accelerate these processes. The expansion of inoculant production and use might have occurred in the absence of N2Africa, however, these developments might have been delayed indefinitely or prevented entirely without N2Africa's intervention. N2Africa's strategic and targeted approach made a substantial difference.

In summary, there is convincing evidence that N2Africa contributed substantially to a process of technological upgrading of soyabean production in Northern Ghana, which, however, is still only weakly influencing the overall increase in soyabean production in that region. Smallholders cultivate soyabeans in a mixed cropping system, where cash expenses for external inputs are prioritised for other crops (maize, rice), not soyabeans. In Ethiopia, the contribution claims focused on the supply and use of inoculants, where it was clear that N2Africa had made a decisive contribution.

Note: The full report has appeared as an IDS Practice Paper. (Reference: Ton, G. & Glover, D. (2019). Improving Knowledge, Inputs and Markets for Legume Expansion: A Contribution Analysis of N2Africa in Ghana and Ethiopia. In IDS Practice Paper 10 Brighton: Institute of Development Studies. 39 pp.)

Giel Ton, Dominic Glover, Institute of Development Studies, United Kingdom

N2Africa Policy recommendations reports advocacy follow-up in Ethiopia and Tanzania

N2Africa organised two policy advocacy activities in Tanzania and Ethiopia, between October 2018 and May 2019. Following the policy recommendation workshops in Addis Ababa on 3 May and in Iringa on 8 May, the two policy recommendations reports are now finalised, and follow-up activities by the N2Africa country coordinators are ongoing. In Tanzania there is much interest by politicians to support soyabean for livestock production.

As the project was coming to an end mid-2019, N2Africa organised a policy advocacy activity in Ethiopia and Tanzania. Policy recommendations would encourage government and development partners to bring N2Africa results further by paying more attention to the economic, environmental and nutritional potential of the legume sector, while addressing some of the constraints experienced along the value chain, and in the organisation of the sector as a whole. (See N2Africa Podcaster 56)

In May 2019, draft policy recommendations were presented and discussed in two half-day policy workshops. Using the workshop feedback and incorporating more of the N2Africa yield results, the two policy recommendations reports have been finalised. (See N2Africa reports no 122 and 123)

In Tanzania, N2Africa Country Coordinator Freddy Baijukya (IITA), in partnership with Southern Agricultural Growth Corridor of Tanzania (SAGCOT) continued the policy advocacy work, focusing first of all on soyabean, as source of plant based protein for manufacturing livestock feed. Baijukya explained: “We were requested to be more specific on the issues we are addressing and target a specific sub-sector. We then identified the shortage of plant-based protein as a source for animal feed, and this became an entry point to promote soyabean. So we developed a policy brief in that direction, targeting the Ministry of Livestock Development which will be tabled to parliament in December 2019.” Moreover, Baijukya is in the process of developing another policy brief on the fortification of maize flour with soyabean flour for the use in school feeding programs, this time targeting the President’s Office, Regional Administration and Local Government who are in charge of primary education.

N2Africa Country Coordinator Endalkachew Woldemeskel pointed at the new National Pulse Sector Strategy and Plan of Action 2019-2024, for which he was consulted. The strategy was launched on 3 September 2019 by the Ministry of Agriculture. The involvement of private sector and exporters in this strategy clearly strengthened the focus on public private partnerships, the enabling business environment, and the coordination of the pulse sector in Ethiopia – in line with some of the recommendations of the N2Africa workshop. Meanwhile, the Business Development Officer for N2Africa, Edward Baars, together with Paul Ingenbleek of WUR, developed a project proposal for the development of input- and output markets for soyabean in Ethiopia, Tanzania and Uganda. Baars explained: “We want to strengthen the agricultural marketing system, by using ICT-platforms to overcome information asymmetries in markets, developing bundled input markets, and using existing maize input delivery infrastructure for soyabean input market development.”

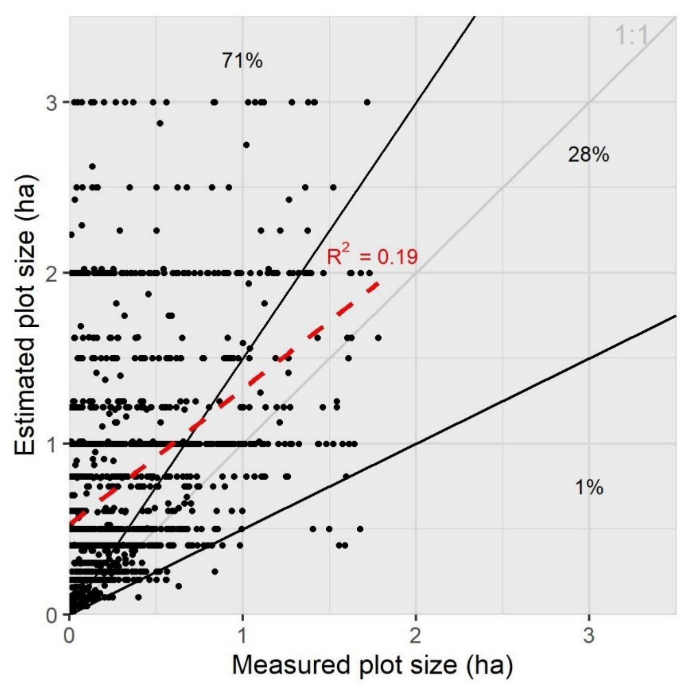
Ferko Bodnar, who coordinated these policy advocacy activities with the N2Africa country coordinators, will try to track to what extent N2Africa’s broader experiences in general, and the policy recommendations in particular, are finding its way in new government and development partner’s policies and strategies in Ethiopia and Tanzania.

Ferko Bodnar, Agrevalue, The Netherlands

Can we trust land area estimates?

I expect that many readers of the N2Africa podcaster would readily answer ‘no’ to that question. However in spite of knowing that land area estimates can be unreliable, N2Africa and other agricultural development projects often rely on estimates of plot areas, and that on top of estimates of crop yield. We may have no other choice if we want a lot of data, preferably for multiple (past) seasons, for several crops in different countries.

So how inaccurate are these land area estimates exactly? In the recent Impact Study, some legume plots were measured with a GPS tool – tracing the field boundaries. The area estimates by farmers were collected as well, and a comparison generates the figure below.



It is a shocking graph: of all plots (1471 in total), 71% have >50% overestimation; 28% have <50% over/underestimation; and 1% of all plots have >50% underestimation. The difference between estimated and measured areas is not predictable. The figure shows that researchers should take great care with collecting and interpreting area data.

Evidently, the Impact Study data on productivity are analysed on the basis of the GPS-traced area measurements, but unfortunately not all of the legume plots were measured that way because it is a time-consuming effort. Therefore, rather than relying much on impact indicators like legume yield and legume area, other indicators like technology awareness and use receive more focus in the Impact Study analysis.

Eva Thuijsman, Wageningen University & Research, The Netherlands

Evaluation of the Productivity and Profitability of Soyabean (*Glycine max* [L.] Merr.) Production Technologies in the Nigerian Savannas

Introduction: Soyabean is an important crop in Nigeria, that has gradually evolved to be a crucial cash crop for rural households in the Nigerian Savannas due to its rising industrial demand. Nigeria is the second largest producer of soyabean after South Africa producing 700,000 Mt of soyabean per year. Despite its growing importance in the Nigeria savannas, soyabean yields are low due to several production constraints including poor soil fertility with emphasis on phosphorus, intermittent drought and low biological nitrogen fixation by adapted varieties. This study was carried out to assess the effect of integrated input management systems on productivity of soyabean in the Nigeria savannas.

Rainfed soyabean with integrated input bundle (S+P+M+I) that is Supplementary irrigation + Phosphorus fertilizer+ Manure + Inoculant

Methodology: Field experiments were conducted during the 2017 and 2018 cropping seasons at the experimental site of Bayero University Kano (BUK), in the Sudan Savanna and at the IITA experimental site in Lere in the Northern Guinea Savanna of Nigeria to evaluate the use of input bundles in soyabean production systems. The treatments consisted of two soyabean varieties (TGX 1835-10E and TGX 1987-62F) and five input bundles: Supplementary irrigation + Phosphorus + Manure + Inoculant (S+P+M+I) (T1), Phosphorus + Manure + Inoculant (P+M+I) (T2), Phosphorus + Inoculant (P+I) (T3), Phosphorus only (P) (T4) and the control which is Inoculant only (I) (T5). The experimental design was a Randomized Complete Block Design with three replications. Plot size was 3m × 5m long consisting of four ridges with spacing of 75 cm between rows and 10 cm within rows.

Table 1: Effect of input bundle on Number of nodules plant^{-1} Soyabean at BUK and Lere in 2017 and 2018 Rainy season

Treatments	BUK				LERE			
	Number of nodules plant^{-1}				Number of nodules plant^{-1}			
	TGX1835-10E		TGX1987-62F		TGX1835-10E		TGX1987-62F	
	2017	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
I	30.7b	39.7b	38.0cd	33.3c	30.7c	30.3a	37.1b	33.4c
P	28.9b	80.4b	32.5d	74.8bc	51.5b	53.4a	58.6b	43.9c
P+I	38.3b	87.5b	49.3c	109.8bc	57.3b	48.5a	62.8b	41.3c
P+M+I	47.1b	113.8b	67.0b	166.7ab	59.0b	54.4a	75.4ab	71.9b
S+P+M+I	104.3a	193.8a	103.3a	218.8a	73.3a	62.7a	100.9a	92.0a
SE±	7.19	18.04	4.18	23.19	3.15	7.82	8.96	6.01
Probability level	0	0.003	<.0001	0.003	0.0002	0.137	0.011	0.001

* I = Inoculant P = Phosphorus P+I = Phosphorus and Inoculant P+M+I = Phosphorus, Manure and Inoculant S+P+M+I = Supplementary irrigation, Phosphorus, Manure and Inoculant

Means within the same location and treatment group followed by same letter(s) are not significant at 5% probability level using Least Significant Difference (LSD)

Table 2: Effect of input bundle on yield (Kg ha^{-1}) of Soyabean at BUK and Lere in 2017 and 2018 Rainy season

Treatments	BUK				LERE			
	Yield (kg ha^{-1})				Yield (kg ha^{-1})			
	TGX1835-10E		TGX1987-62F		TGX1835-10E		TGX1987-62F	
	2017	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
I	1277.8d	1621.9c	1148.3d	1613.8c	789.1d	870.7c	843.9e	974.9c
P	2037.1c	2145.9b	1953.0c	2097.6bc	1483.8c	1757.2b	1550.6d	2099.6b
P+I	2183.4c	2332.5b	2080.4c	2366.0bc	1518.3c	1859.5b	1422.9c	2074.2b
P+M+I	2441.7b	2437.0b	2383.5b	2683.7ab	1900.2b	2288.2a	1713.2b	2347.3ab
S+P+M+I	3132.1a	2996.1a	3363.2a	3267.6a	2115.8a	2199.4a	2507.5a	2653.3a
SE±	73.05	129.51	85.91	212.49	61.94	95.82	35.64	101.96
Probability level	<.0001	0.001	<.0001	0.006	<.0001	<.0001	<.0001	<.0001

* I = Inoculant P = Phosphorus P+I = Phosphorus and Inoculant P+M+I = Phosphorus, Manure and Inoculant S+P+M+I = Supplementary irrigation, Phosphorus, Manure and Inoculant

Means within the same location and treatment group followed by same letter(s) are not significant at 5% probability level using Least Significant Difference (LSD)

Results: The effect of input bundles on nodule number and grain yield of soyabean are shown in Table 1 and 2. The results show that, different input bundles significantly influenced number of nodule plant^{-1} and grain yield. The application of input bundle S+P+M+I consistently produced the highest nodule number plant-1 and grain yield for both varieties in each location (Table 1 and 2). The input bundle S+P+M+I produced 65.9%

higher grain yield at BUK and 66.3% at Lere over input bundle I for the two varieties. This result indicates that the combination of input such as phosphorus, inoculant, manure and supplementary irrigation will increase soyabean grain yield in the savannas. There was generally no response to inoculation with Bradyrhizobium when no phosphorus was applied to the soyabean varieties.

Jenneh Bebeley, Bayero University Kano, Kano State, Nigeria.

Genetically diverse microsymbionts belonging to novel and other defined symbiovars are responsible for cowpea root nodulation in Northern Mozambique

Cowpea is an important food legume that is well-adapted to the semi-arid regions of the tropics. The bacteria nodulating cowpea exhibit a large diversity which has been reported in different regions of the world. Little is known about the rhizobia nodulating cowpea in Mozambican soils. In this study ERIC-PCR was used to characterise cowpea rhizobia. This method allowed us to distinguish 20 groups at a similarity level of 20%, indicating a high genomic diversity for the native rhizobial populations in the two agroecological zones. Many reports have shown that there are more rhizobial types in tropical and subtropical than temperate regions. Therefore, studies of rhizobial diversity in tropical environments such as Mozambique could lead to the discovery of diverse rhizobia with interesting traits for use in agriculture.

Our results are consistent with several studies that found cowpea to be nodulated by genetically diverse rhizobial populations in Mozambique and other African countries (Dabo et al., 2019, Pule-Meulenberg et al., 2010). Furthermore, the fact that some ERIC-PCR clusters were homogenous in terms of the origin of isolates, and others heterogenous suggests that, while the distribution of rhizobial types may be shaped by edaphic and climatic factors, some isolates probably exhibited wider adaptation and could therefore occur in contrasting environments.

Moreover, the results of 16S rRNA and symbiotic gene phylogenetic trees showed that all the test rhizobial isolates belonged to the genus *Bradyrhizobium*. Most isolates grouped with *B. yuanmingense* and *B. elkanii*, though some clustered with *B. icense*, *B. algeriense*, *B. vignae* and *B. japonicum*. It has been shown that rhizobial isolates from Mozambican soils shared 100% sequence identity, and were closely related in the 16S rRNA gene tree to *B. yuanmingense* and *B. elkanii* (Chibeba et al., 2017). The symbiotic genes phylogenies of isolates (TUTVuIM4, TUTVuIM5, TUTVuAG22, TUTVuAG12 and TUTVuMS1) from AEZ 8 which formed a monophyletic group and could represent a novel symbiovar group of *Bradyrhizobium*. Another group of isolates (TUTVuIM14, TUTVuIM23, TUTVuIM6) from AEZ 8 close to *B. yuanmingense* could also be novel symbiovar. Interestingly, all these isolates were obtained from landrace Namuruwa, a highly adaptable landrace in those agroecologies. Results suggested that the native microsymbionts form the best mutual bonding with plants highly adaptable to the environment.

In earlier reports, only sv. glycinearum and sv. tropici symbiovars were reported in cowpea (Tampakaki et al., 2017, Dabo et al., 2019). This study suggests that more diverse symbiovars are responsible for cowpea nodulation in Mozambican soils. In conclusion, this study has revealed that genetically diverse rhizobia belonging to different symbiovars are responsible for cowpea nodulation in Northern Mozambique, thus confirming the promiscuity of this legume. Despite some exceptions, the *Bradyrhizobium* strains formed many monophyletic groups with the tendency of isolates from a particular agroecological zone to dominate a particular cluster. Another observation is that the cowpea *Bradyrhizobium* species from Northern Mozambique belonged to the symbiovars glycinearum, sojae and tropici and novel symbiovars.

Acknowledgements
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Margarida Simbine, defended her PhD Thesis in October 2019, at Tshwane University of Technology, South Africa

Cowpea plants inoculated with different rhizobia strains isolated from cowpea root nodules sampled from farmers fields in Northern Mozambique

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Tampakaki, A. P., Fotiadis, C. T., Ntatsi, G. & Savvas, D. 2017. A novel symbiovar (aegeanense) of the genus Ensifer nodulates Vigna unguiculata. *Journal of the Science of Food and Agriculture*, 97, 4314-4325.

N2Africa publications

- Intermediate Maturing Soybean Produce Multiple Benefits at 1:2 Maize:Soybean Planting Density by Margarida G. Simbine, Frederick P. Baijukya and Richard N. Onwonga;
- Inoculation and phosphorus fertilizer improve food-feed traits of grain legumes in mixed crop-livestock systems of Ethiopia by Sisay Belete, Melkamu Bezabih, Birhan Abdulkadir, Adugna Tolera, Kindu Mekonnen, Endalkachew Woldemeskel;
- Co-design of improved climbing bean production practices for smallholderfarmers in the highlands of Uganda by Esther Ronner, Katrien Descheemaeker, Conny Almekinders, Peter Ebanyat, Ken E. Giller;
- Which options fit best? Operationalizing the socio-ecological niche concept by Descheemaeker, K., Ronner, E., Ollenburger, M., Franke, A.C., Klapwijk, C.J., Falconnier, G.N., Wichern, J., Giller, K.E.;
- Poor farmers - poor yields: socio-economic, soil fertility and crop management indicators affecting climbing bean productivity in northern Rwanda by Franke, A. C.; Baijukya, F.; Kantengwa, S.; Reckling, M.; Vanlauwe, B.; Giller, K. E.;
- PhD Thesis Participatory approaches to diversification and intensification of crop production on smallholder farms in Malawi by Daniel van Vugt;
- PhD Thesis Enhancing biological nitrogen fixation and yield of soybean and common bean in smallholder farming systems of Rwanda by Edouard Rurangwa.

Reports and other output uploaded on the N2Africa website

- N2Africa in northern Ghana;
- N2Africa annual report 2019;
- MSc thesis Understanding the role of soybean (Glycine max (L.) Merrill) cultivation by smallholder farmers in northern Uganda by Els van der Spek;
- MSc report Assessing the rotational effects of maize (*Zea mays* L.) and soybean (*Glycine max* (L.) Merr.) through two field experiments for smallholder farms in Ethiopia by Bouwiene Zwaan.

N2Africa in the news

FCRN linked to The story of N2Africa in their Fodder entry.

Related newsletters

- Icrisat news: Scientists: ‘Partnering with farmers crucial for saving degraded lands’;
- SeedSystems blogs: The Private Sector’s Role In Getting Improved Seeds To Farmers and Improved Seeds For Farmers To Generate 25 Million Metric Tonnes Of Food;
- Icrisat news items: Using the digital seed catalog and seed roadmap for better access to seed information and Consolidated efforts to modernize crop improvement in Ghana;
- IITA news: Improved soybean varieties increase farmer incomes by 53% – study shows (Malawi).

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