



**Suitable multi-purpose forage and tree legumes for intensive smallholder meat and dairy industries in East and Central Africa  
N2Africa mandate areas**

Milestone reference 2.4.1 and 2.4.2

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**Putting nitrogen fixation to work  
for smallholder farmers in Africa**



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## 1 Introduction

The recurrent scarcity of grazing materials especially during the dry season and decreasing land size per farming family due to the high population pressure, has led to the recommendation of forage and tree legumes as the ideal forages in African smallholder farming systems. This is largely because of their high productivity and quality per unit area, providing small-scale farmers with (a) immediate feeding material for the livestock especially in a zero-grazing system and (b) surplus material which can be conserved in the form of hay or silage for dry season feeding. The role played by forage and tree legumes as a feed is also emphasized because of their high protein content (making animals to produce more meat and milk) and the fact that they fix atmospheric nitrogen into the systems when growing, improve soils fertility through litter fall and provide other environmental services including soil erosion control, soil moisture conservation and carbon sequestration (Wambugu *et al.*, 2006; Niang *et al.*, 1996).

Despite research that has continued with varied intensity for about 4 decades now, forage legumes are making little contribution to agriculture (Apollo, 2006), the reason being that most work was done on research stations with little resemblance to farmer conditions. However, there are presently many productive forage and tree legumes with strong biological nitrogen fixation (BNF) efficiency available from local and international research institutes within and outside Africa that are ready for deployment to smallholder farmers. N2Africa is seeking to provide farmers with the best available forage and tree legume germplasm with proven BNF and environmental adaptation with special focus to areas with intensive milk or meat production. This report fulfills milestones 2.4.1 “at least 6 tree legumes and forage legume species with proven high BNF potential identified across the impact zones” and 2.4.2 “sufficient planting materials are available for at least 2 multipurpose tree legumes and 4 forage legumes with high BNF capacity. However, the information provided in this report is limited to East and Central Africa zone where the work has started. The information from west and Southern Africa will be provided in a separate report as soon as the work is completed in these hubs.



## 2 Intensive smallholder dairy and meat production in East and Central Africa mandate areas of N2Africa

In East and Central Africa, smallholder dairy and meat production systems are found in the highly populated areas, including the N2Africa mandate areas (Figure 1). The area has a large range of agro-climatic zones varying from warm and wet medium-altitude areas (1,150 -1,600 m) in Nyanza and Western provinces in Kenya to cool and wet medium-altitude areas (1600 - 2400 m) in highlands of Rwanda and South Kivu, DR Congo (Table 1). Rainfall regimes also vary from the semi-arid (> 800 mm /year) in areas around Lake Victoria to humid (< 2000 mm/ year) in the highlands of Rwanda and



**Figure 1: Location of N2Africa mandate areas in East and Central Africa**

**Table 1. Smallholder dairy and meat production systems and major climatic zones in N2Africa mandate area in East and Central Africa**

Production system Major product or purpose	Agro-Climatic zone	Altitude (masl)	Rainfall (mm)	Major production mandate areas
<b>Kenya</b>				
1. Smallholder intensive rural dairy-meat-draught, manure	Humid to Semi-humid	1350-1600	1500-2000	Kakamega, Mumias, Bungoma, Migori, Teso North
2. Smallholder semi-intensive rural dairy-meat-draught-manure	Humid to Transitional	1150-1350	750-1200	Kisumu West, Bondo, Siaya, Bumala, Mumula, Busia
<b>Rwanda</b>				
1. Smallholder intensive rural dairy-meat, manure	Humid	1600-2400	1800- <2000	Gakenke, Burera
2. Smallholder semi-intensive dairy, meat, manure	Humid to Semi-humid	1500-1700	1200-1800	Kamonyi, Bugesera, Kayonza
<b>DR Congo</b>				
1. Smallholder semi-intensive rural dairy-meat, manure	Humid	1500-1800	1800- <2000	Bugorhe, Karehe, Birava, Murhesa
2. Smallholder semi-intensive rural dairy-meat, manure	Humid	1400-2000	1500- <2000	Ikoma, Muramba, Mumosho



South Kivu. Farmers practice intensive farming predominantly mixed crop-livestock systems, where crops like maize, beans, cassava, sweet potatoes and various vegetable and fruits are grown in combinations with fodder for livestock usually Napier grass (*Pennisetum purpureum*) and cash crops including coffee, bananas and tea is found in the highlands at around 1500 m. The relatively high altitude and cool climate of much of the highlands affect forage choice since 1500 meters, under local conditions, is about the upper limit for many tropical forages. In these farming systems, livestock especially cattle, small ruminants (goat and sheep) and mono-gastric animals (pig, rabbit and guinea pig) play a vital role of maintaining farm productivity through provision of manure, a key input for soil fertility management.

Land holdings are usually small (on average 1 ha or less) and livestock production is based on grazing the animals in fallow and crop land after harvest, a few available pastures and on cut and carry in case of zero grazed dairy cows and goats. The major constraint to the development of livestock sector in these areas is poor nutrition, arising from low quality and low productivity of fodder resources as well as lack of diversity of the existing fodder species. One way of improving livestock productivity is to increase the availability of quality forages by providing farmers with high yielding fodder legumes and trees adapted to different agro-ecologies.



### 3 Suitable multipurpose tree and forage legumes in N2Africa mandate areas in East and central Africa

#### 3.1 Selected multipurpose tree and forage legumes from past work

A list of suitable forage and tree legumes adapted to various N2Africa mandate areas in East and Central Africa (Table 2) was compiled from reports of past and ongoing work including the CIAT–Tropical forage legume program, the World Agroforestry Centre (ICRAF), the legume research network in Kenya implemented under leadership of Kenya Agricultural Research Institute (KARI), the Rwanda Animal Resource Development Authority and from consultation with experts in the region. The legume species included in the list are reported to be well adapted to the prevailing local conditions (soils and climate). In addition they are known have high biomass production, high protein content and have high dry matter intake when fed to animals. Other characteristics include provision of fuel and staking (tree/shrub legumes) and good in controlling soil erosion.

**Table 2: Suitable forage and tree legumes for smallholder systems N2Africa mandate areas in East and Central Africa**

Zone Elevation Annual Precipitation	Tree/shrub legumes	Herbaceous legumes	Reference
Cool and wet Medium to high altitude areas 1850-2400 m 1000-2500 mm	<i>Calliandra calothyrsus</i> <i>Leucaena diversifolia</i> <i>Leucaena pallida</i> <i>Acacia koaia</i> <i>Acacia koa</i> <i>Acacia melanoxylon</i> <i>Acacia mearnsii</i> <i>Mimosa scabrella</i> <i>Chamaecytisus palmensis</i> <i>Alnus acuminata</i> <i>Hagenia abyssinica</i>	<i>Macroptilium bracteatum</i> <i>Desmodium</i> spp. <i>Desmanthus virgatus</i> , <i>Lupinus angustifolius</i> , <i>Lupinus alba</i> <i>Lablab purpureus</i> <i>Vicia villosa-dasycarpa</i> <i>Stylosanthes</i> spp. <i>Medicago sativa</i> <i>Neonotonia wightii</i> <i>Glycine javanica</i> <i>Clitoria ternatea</i> <i>Centrosema molle</i> <i>Vigna unguiculata</i>	Katunga Dieudonne', 2011 (person comm.) Mupenzi et al., 2008; Wambugu et al., 2006; Apollo, 2006; Niang, 2006; Mureithi, et al., 2003; Niang, 1996.
Warm and wet medium altitude areas 1200-1850 1000-2500 mm	<i>Calliandra calothyrsus</i> <i>Lucaena diversifolia</i> <i>Lucaena pallida</i> <i>Leucaena leucocephala</i> <i>Leucaena trichandra</i> <i>L. collinsii</i> <i>Desmodium velutinum</i> <i>Cratylia argentea</i> <i>Sesbania sesban</i> <i>Gliricidia sepium</i> <i>Sesbania grandiflora</i>	<i>Macroptilium bracteatum</i> <i>Macroptilium atropurpureum</i> <i>Desmodium</i> spp. <i>Desmanthus virgatus</i> , <i>Lupinus angustifolius</i> , <i>Vicia villosa-dasycarpa</i> <i>Stylosanthes</i> spp. <i>Canavaria ensiformis</i> <i>Canavalia brasiliensis</i> <i>Vigna unguiculata</i> <i>Neonotonia wightii</i> <i>Mucuna pruriens</i> <i>Lablab purpureus</i> <i>Centrosema pubescens</i>	Barongo, 2008; Mupenzi et al., 2008; Wambugu et al., 2006; Apollo, 2006; Niang, 2006; Mureithi, et al., 2003.



### 3.2 Selected multipurpose tree and forage legumes for testing with farmers

From a long list of suitable fodder and tree legumes above, only a few could be selected for further evaluation with farmers in N2Africa sites. The choice has largely depended on the availability of seeds to kick start the activity, ease of establishment, the potential to provide quality fodder to different types of animals and possibilities of “easy” fit into the prevailing farming systems.

#### Selected legumes per country include:

##### Kenya

Three tree legumes, *Calliandra calothyrsus*, *Leucaena trichandra* and *Leucaena collinsii* and 10 herbaceous forage legumes *Macroptilium bracteatum* cv. Burgundy bean, *Desmodium uncinatum* cv. Silverleaf, *Desmodium intortum* cv. Greenleaf, *Desmanthus virgatus*, *Lupinus angustifolius*, *Vicia dasycarpa*, *Canavalia brasiliensis*, *Labiab purpureus*, *Cratylia argentea*, *Clitoria ternatea*, as well as forage grasses of the genus *Brachiaria*)

##### Rwanda

Four tree forage legumes namely *Acacia koa*, *Mimosa scabrella*, *Calliandra calothyrsus* and *Leucaena diversifolia* and 6 herbaceous forage legumes *Macroptilium bracteatum* cv. Burgundy bean, *Desmodium uncinatum* cv. Silverleaf, *Desmodium intortum* cv. Greenleaf, *Desmanthus virgatus*, *Lupinus angustifolius*, *Vicia dasycarpa*.

##### DR Congo

Three shrub/ tree legumes namely; *Calliandra calothyrsus*; *Leucaena diversifolia* and *Flemingia macrophylla* and 4 herbaceous legumes: *Stylosanthes guianensis* (CIAT 11995 and cv. Cook), *Canavalia brasiliensis*, *Desmodium intortum*, *Desmodium uncinatum*



## 4 Ongoing and future work

For all countries, several accessions of these species (except the tree legumes) were obtained in small quantities from Kenya (KARI-Kakamega), Australia, Colombia and Nicaragua and are undergoing seed bulking at KARI-Kakamega (Kenya); ISAR Nyagatare (Rwanda) and at several sites Tubimbi, Kamanyola and Nyangezi (DR Congo). Seed bulking is coordinated by CIAT–Tropical forage legume program in partnership with N2Africa and the local research centres namely KARI-Kakamega, ISAR Nyagatare and INERA- Mulungu for Kenya, Rwanda and RDC respectively.

In Rwanda and DR Congo, the established plots are used for assessing agro-ecological adaptation under regular cutting and the herbage (i.e., forage biomass) used by farmers in the area to test acceptability by livestock and appreciation by farmers. Plots established at Kakamega are left solely for seed bulking.

On-farm activities are expected to start during 2012 long rain season where farmers in selected action sites will be provided with seeds to establish some plots. This will be closely followed by monitoring of performance and BNF of test legumes. In DR Congo however, some farmers have already established some plots of tree/shrubs and monitoring work will start by December this year.



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## 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 soybeans, 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



## Partners involved in the N2Africa project



Caritas Rwanda



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Eglise Presbiterienne Rwanda



Resource Projects-Kenya



Université Catholique de Bukavu



University of Zimbabwe

