The benefits of ICRAF tree fodder germplasm in smallholder agriculture

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Buffering climate change by conserving agroforestry diversity

Tree diversity plays an important role in maintaining floral and faunal diversity by regulating underlying interactions. Tree diversity is also crucial in sustaining ecosystem services against a backdrop of increasing pressures from drivers of change. Nonetheless, aggressive advances from drivers of change, such as population pressure and related agricultural expansion, threaten tree diversity in Africa. On the other hand, climate change pressures will necessitate an increased reliance on tree diversity as buffers. The multifunctional role of trees as well as their projected importance in the context of climate change renders the conservation of tree diversity a serious priority in Africa.

Hence, tree-based production systems, on the basis of their resilience and multi-purpose benefits, are one of the solution pathways to the myriads of ecosystem challenges facing the African drylands. World Agroforestry (ICRAF) plays a key role in the conservation of tree genetic diversity. The genebank currently holds 5,300 accessions (representing over 190 tree species) of which 3,706 are stored at the Nairobi seed genebank. The accessions held in Nairobi represent over 10 species with *Calliandra calothyrsus (Calliandra)* and *Gliricidia sepium (Gliricidia)* the two most requested species.

HIGHLIGHTS

- ICRAF plays a key role in conserving and making available high quality agroforestry germplasm. We surveyed 51 users of ICRAF genebank who had requested *Calliandra* and *Gliricidia*.
- The ICRAF genebank is the preferred source of *Calliandra* and *Gliricidia* germplasm for the majority respondents. Nearly 500 requests for *Calliandra* and *Gliricidia* were made by farmers.
- 80% of respondents were satisfied with the germplasm they received from the ICRAF genebank. 60% of respondents reported that they shared the germplasm with other farmers.
- Improved food security and incomes, increased milk production, reduced vulnerability to drought, and use as firewood were identified as the main perceived benefits derived from the use of *Calliandra*.
- Improved food security and incomes and soil fertility improvement were cited as the main perceived benefits associated with planting *Gliricidia*.

BOX 1 The ICRAF Genebank

The ICRAF Genetic Resources Unit (GRU) was established in 1993 with the mandate to "collect, conserve, document, characterize and distribute a diverse collection of agroforestry trees, mainly focusing on indigenous species in all ICRAF working regions". The genebank is situated within World Agroforestry, whose headquarters is located in Nairobi, Kenya. The genebank, a medium-term storage facility, currently holds approximately 3,706 accessions representing 190 tree species, with *Calliandra calothyrsus* and *Gliricidia sepium* being the two most requested species. The conservation of these accessions is possible in the case of orthodox seeded trees, whose seeds can survive drying and/or freezing in *ex situ* conservation.

ICRAF GRU has field genebanks in six regions, namely, Latin America, East Africa, Southern Africa, West and Central Africa, South East Asia and South Asia. These field genebanks collectively hold a total of 139 species and are managed by ICRAF projects, national partners, farmers and communities. Field genebanks are especially important in the case of species that have recalcitrant seeds and as such they are maintained as live plants.

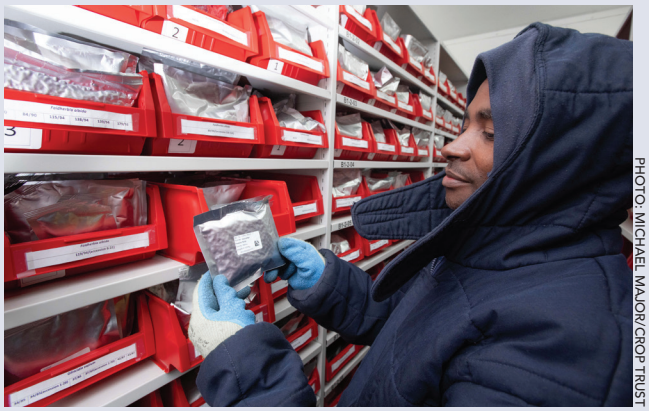

PHOTO: MICHAEL MAJOR/CROP TRUST

The demand for *Calliandra* is fueled by its multipurpose attributes that confer numerous production and ecosystem benefits for smallholder farmers. The appeal of *Calliandra* among smallholder dairy farmers, for example, lies in the fact that it is an affordable protein rich fodder. *Gliricidia*, also a multipurpose leguminous tree, is appreciated for its role as a soil fertility enhancer. The fodder tree – known for its nitrogen fixation and carbon sequestration abilities – has been integrated in what is known as "*Gliricidia* maize mixed intercropping" as a "nutrient fixing" alternative for resource poor farmers.

Germplasm from these species is difficult to come by from sources other than the genebank, highlighting the priority role of conservation by genebanks. The contribution of this study is twofold. First, to the best of our knowledge, no study has yet attempted to investigate the benefits arising from the direct utilization of ICRAF germplasm by smallholder farmers. Secondly, striving to understand the determinants of agroforestry adoption and its perceived benefits remains an active research area given that agroforestry interventions is not widespread despite recognized benefits. Understanding the adoption factors is important in order to identify germplasm-related constraints and provide valuable feedback to the genebank to inform future interventions.

Synopsis of methods

The data for this study was based on Key Informant Discussions and User Surveys. A purposive sampling design frame was employed to select the nine key informants based on their diverse and recognized experience in the promotion of fodder trees. A stratified random sampling was employed to select the sample of requestors for the user survey, based on the distribution data provided by ICRAF genebank for the two species (Calliandra and Gliricidia). The study targeted a minimum sample of 119 users and we were able to interview 51 respondents (a 43% response rate) between 12-29 September 2018.

Qualitative thematic analysis was used to analyze the data from the Key Informant Discussions, whereas both thematic and content analysis was employed to analyze the user surveys. Qualitative thematic analysis is a methodological tool employed for the purposes of identifying, analyzing, and reporting themes within the data set. Content analysis is an analytical technique that involves systematically coding and categorizing large amounts of textual data for the purposes of identifying word trends and patterns, their recurrences, their relationships and related structure.

Table 1. Total germplasm distribution of Calliandra and Gliricidia, 2008 to 2017

Accession Number	Number of requests	Number of samples distributed	Quantity (kg) shipped
Calliandra calothyrsus			
ICRAF 05527	168	168	50.6
ICRAF 07305	72	77	8.4
ICRAF 04622	64	64	13.0
ICRAF 04897	55	55	8.3
ICRAF 04873	23	23	4.6
ICRAF 06612	12	21	10.0
ICRAF 05420	20	20	8.1
ICRAF 05726	10	10	2.0
ICRAF 05537	6	6	0.5
ICRAF 05673	2	2	1.1
ICRAF 8/99	1	1	0.1
ICRAF 07296	1	1	0.1
Calliandra calothyrsus Total	434	448	106.8
Gliricidia sepium			
ICRAF 04891	162	162	117.2
ICRAF 07306	61	66	7.1
ICRAF 04693	6	6	1.0
ICRAF 03375	5	5	0.5
ICRAF 03299	3	3	5.6
Gliricidia sepium Total	237	242	131.4

Source of data: ICRAF GRU

Main findings

Unlike orthodox seed for crops such as most cereals, the planting material of trees is often conserved in live stands. *Calliandra* and *Gliricidia* are conserved as seed, although the ICRAF GRU also maintains tree stands as sources. Patterns of distribution are shown in Table 1. The number of requests for *Calliandra* requests (434) significantly exceeds those for *Gliricidia* (237). Accession Number ICRAF 05527 is the most frequently requested and distributed germplasm of *Calliandra*; whereas in the case of *Gliricidia*, it is ICRAF 04891. The genebank distributed a total of 690 seed samples, with 448 samples of *Calliandra* and 252 samples of *Gliricidia*. A further analysis by quantity (kg) shows that the genebank distributed a total of 238 kg of seed, with *Gliricidia* accounting for 131 kg while *Calliandra* accounted for 106 kg.

Table 2. Benefits of *Calliandra calothrysus* according to farmers

Type of benefits	Frequency
Biodiversity attraction	1
Enhanced environmental resilience	1
Fencing	2
Firewood	5
Improved food security and incomes	15
Increased milk production	9
Reduced vulnerability to drought	5
Soil erosion control	2
Soil fertility improvement	3
Total	**43**

Source of data: 2018 ICRAF GRU user survey. Note: Number of respondents =23, multiple responses allowed.

Table 3. Benefits of *Gliricidia sepium* according to farmers

Type of benefits	Frequency
Improved food security and incomes	4
Increased milk production	1
Reduced vulnerability to drought	1
Soil erosion control	1
Soil fertility improvement	2
Total	**9**

Source of data: 2018 ICRAF GRU user survey. Note: Number of respondents = 5, multiple responses allowed.

BOX 2 The Genebank Impacts Fellowship

The Genebank Impacts Fellowship experience has been a truly fulfilling experience from a cultural, networking and technical perspective. The commencement of the fellowship, which was marked by the Genebank Impacts Bootcamp in Bonn, was a wonderful opportunity for me to forge friendships with my fellow genebank impacts fellows who represent diverse cultures. The bootcamp also afforded a wonderful opportunity to interact and receive important instruction from leading researchers involved with genebank impact evaluation.

The ICRAF genebank manager, Alice Muchugi, went to great lengths to ensure I settled into the fellowship. She put me in touch with key genebank personnel who not only furnished me with the necessary data but also practical experience in genebank operations. I am grateful to Zakayo, Agnes, Ludy, Geoffrey and Eliza who involved me in the genebank operations such as seed characterization, purity analysis and germination testing. The practical experience played an instrumental role in helping me understand the overall context surrounding genebank operations and related literature. I am also grateful to Simon, the database officer, for his help with the datasets used in this analysis.

Finally, I am grateful for the technical experience gained during this fellowship. The fellowship afforded me significant independence which in turn enhanced my managerial skills. I conducted user surveys and Key Informant Discussions, which necessitated various steps including the development of the survey on Ordinary Tool Kit (ODK), sampling requestors, seeking consent prior to interviews and the administration of the survey through webforms. This experience also improved my qualitative analytical skills given the nature of the data collected. While it is not possible to exhaust the compliments of my fellowship experience in this section, all in all I am grateful for this wonderful experience.

Concerning adoption, key informants identified a number of diverse factors limiting the adoption of fodder trees. Key among them is the exclusion of agroforestry in food security policy interventions, germplasm constraints relating to quality and quantity, limited technical expertise and limited infrastructure at the farmer level. Moreover, we also find that fodder attributes pertaining to palatability and realization of benefits influenced the differential uptake among the two species.

Regarding impacts of direct use by smallholder farmers, survey respondents reported that improved food security and incomes, increased milk production, reduced vulnerability to drought, and use as firewood were the main benefits linked to the use of *Calliandra* (Table 2). Improved food security and incomes and soil fertility improvement were cited as the main benefits associated with *Gliricidia* (Table 3). In addition to primary benefits from direct use, the study also found considerable secondary value through recipients sharing acquired germplasm with their communities.

Finally, we find considerable appreciation for the genebank conservation of these accessions from survey respondents. Respondents highlighted the scarcity of these species beyond the ICRAF genebank, noting that it is very difficult to access these species from other sources that include private commercial operators as well as public forestry institutions. They also highlighted that germplasm from the ICRAF genebank is accessed at no cost, a matter that is highly appreciated, given that if these species were accessed through private commercial operators, costs would be exorbitant (Table 4). Lastly, respondents highlighted that the genebank distributes high-quality germplasm, a crucial factor in guaranteeing successful germination. The assurance of high-quality germplasm from ICRAF was a key factor in requests, with respondents noting that they cannot be guaranteed of the same germplasm quality from private commercial providers.

Conclusion

First, the findings of this study reaffirm the important role that agroforestry diversity has in providing cost effective solutions to agricultural challenges faced by smallholder farmers with significant resource constraints. The most common benefit cited by users of either tree species is improved food security and income. This confirms that agroforestry should be recognized as an integral part of national strategies to achieve food security. Second, the findings highlight the essential function that quality tree germplasm from ICRAF serves in the absence of markets or other reliable public providers. Developing tree value chains could contribute to stronger effective demand. Third, user perceptions regarding palatability and germination rates for *Gliricidia* underscore the significance of continued investment in fodder tree research and germplasm constraints.

Table 4. How would you be affected if germplasm from ICRAF were not available?

Reasons	Freq.
Abandon planting	1
Abandon conservation project	1
Expend a lot of time looking for alternatives	2
Have to purchase at high cost	12
Have to purchase from other farmers	1
Increased costs of dairy production	2
Loss of soil fertility	1
Self multiplication which would take time	1
No alternative source	6
No protein fodder	7
Unaffected – Would look for seedlings at alternative places	1
Unaffected – Request was for experimentation	1
Unaffected – Would look for other varieties	2
Not applicable	6
Unaffected – Has other feed sources	1
Plant other varieties at significant cost	1
Reduced milk productivity	1
Risk of intrusion due to no fence	1
Risk of wrong informative from alternative sources	1
Seed quality from private suppliers not guaranteed	1
Total	**50**

Kenyan farmer in maize field intercropped with *Gliricidia*. Photo: ICRAF

We expect that the role of tree genebanks will become increasingly pronounced in the quest to find cost effective, environmental solutions to the numerous agricultural and ecosystem challenges our plant is projected to face.

Further Reading:

Raffaello, Cervigni and Michael Morris. Confronting Drought in Africa's drylands: Opportunities for Enhancing Resilience. Africa Development Forum series. Edited by Cervigni Raffaello and Michael Morris. Washington, DC: World Bank. doi:10.1596/978-1-4648-0817-3. License: Creative Commons Attribution CC BY 3.0 IGO, 2016.

Bromhead, Marjory-Anne. Forest, Trees, and Woodlands in Africa: An Action Plan for World Bank Engagement. Washington,DC: © World Bank. https://openknowledge.worldbank.org/handle/10986/11927 License: CC BY 3.0 IGO, 2012, 112.

Jew, K.E., J.A. Dougill, M.S. Sallu, J. O'Connel and G.T. Benton. "Miombo woodland under threat: consequences for tree diversity and carbon storage." *Forest Ecology and Management* 361 (2016): 144-153.

Franzel, Steven, Sammy Carsan, Ben Lukuyu, Judith Sinja and Charles Wambugu. "Fodder trees for improving livestock productivity and smallholder livelihoods in Africa." *Current Opinion in Environmental Sustainability* 6 (2014): 98-103.

Makumba, Wilkson, Festus K. Akinnifesi, Bert Janssen and Oene Oenema. "Long-term impact of a gliricidia-maize intercropping system on carbon sequestration in southern Malawi." *Agriculture, Ecosystems & Environment* 118 (2007): 237-243.

Mbow, Cheikh, Meine Van Noordwijk, Eike Luedeling, Henry Neufeldt, Peter A. Minang and Godwin Kowero. "Agroforestry solutions to address food security and climate change challenges in Africa." *Current Opinion in Environmental Sustainability* 6 (2014): 61-67.

ICRAF Genetic Resources Unit. "ICRAF Agroforestry Tree Genetic Resources strategy 2013–2017." Available at http://worldagroforestry.org/products/grunew/downloads/ICRAFGeneticResourcesStrategy2013.pdf/ [Accessed 1 July. 2018].

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Additional details can be found in the paper on which this brief is based: Kavengi Kitonga, Alice Muchugi, Nelissa Jamora and Melinda Smale. 2019. The benefits of ICRAF tree fodder germplasm in smallholder agriculture. Genebank Impacts Working Paper No. 7. CGIAR Genebank Platform, ICRAF and the Crop Trust.

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