Forages for the Future

RESEARCH PROGRAM FOR Managing and Sustaining Crop Collections

Towards a better future for tropical and subtropical forages?

by Bruce Pengelly

A status report from a global survey

A survey of 12 genebanks and forage agronomists conducted in 2015 revealed that there are at least 6 large genebanks and a number of smaller centres focusing on tropical and subtropical forages. The main centres were the international centres of CIAT, ILRI, and the national centres of Australia, Brazil, USA, and South Africa. All of these had collections of between 7,000 and 21,000 accessions and most reported that they had good storage conditions. That was the positive news.

The species numbers in these collections are huge. CIAT for instance has >800 grass and legume species and other centres would undoubtedly add to that count. Collections tend to be dominated by a few genera (*Stylosanthes*, *Desmodium*, *Centrosema* in the legumes, and *Brachiaria* and *Panicum* in the grasses in the case of CIAT). However, there are also large collections of what we might call second-tier genera and very long lists of poorly represented genera in terms of stored accessions, many of which may have little forage potential.

Worrying revelations

Some of the revelations from the survey were more worrying. Almost every center reported that their capacity was being constrained by limited resources, they had fewer staff than they needed, and many collections being held by national centres especially were not being systematically backed-up. Most centres reported that they had much more data available than was in their databases, but that resources were too stretched to enter it into databases. Data exchange was restricted by some, either by institutional policy, or because data were not in a state that enabled sharing. Seed was not able to be exchanged, again because of policy, or because insufficient seeds were available. Most centres acknowledged that they had limited knowledge of the diversity, adaptation or possible use of much of the germplasm that was being held.

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Guinea grass breeding in Brazil

New *Panicum maximum* cultivars for grazing better soils: Since the 1990s commercial cultivars originated from germplasm collections. First products from the breeding program are now entering the market.

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Forages that make a difference

Gliricidia sepium to enhance Bali cattle production in Eastern Indonesia: farmers have multiplied their production and greatly improved their livelihoods.

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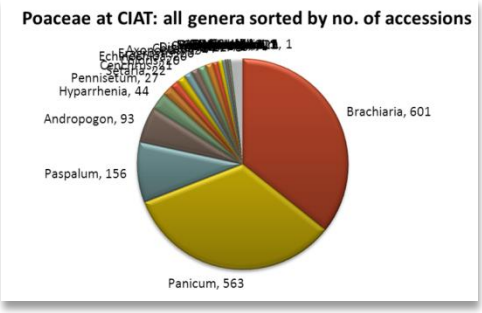
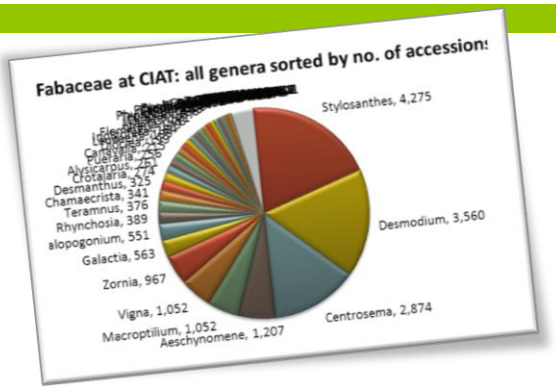
ACCESSIONS IN COLLECTIONS





Forage collections tend to be dominated by a few genera: an example from CIAT's tropical forages collection; number of accession behind each genus

What is ...?

What is an accession?

A germplasm accession stored in a genebank and distributed to users stands for one (seed) sample from a specific collection point. Genebanks assign codes to each individual collection sample upon arrival to facilitate their management. These codes are unique identifiers and usually consist of combinations of letters (or prefixes) and sequential numbers. For example, the USDA genebank assigns the prefix 'PI' for 'Plant Introduction'; while the Australian CSIRO uses 'CPI' for 'Commonwealth Plant Introduction' number.

All genebanks usually assign a new accession code, even if an accession has already been registered in another genebank. Sometimes, there are parallel regional and national accession coding systems, e.g. in Brazil. In some frequently exchanged accessions, this has led to an inflation of accession codes. An accession code of a particular institution is unique and will never be reused, even if there are no viable seeds or living plants left for any reason. An accession should not be confused with an ecotype or a cultivar. Though, a genebank can also register and store a cultivar as an accession.

A "genebank specimen or accession is the unit for storing germplasm material in an ex situ genebank collection" – from: Biodiversity Information Standards

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LINKS: for terminology – Glossary of terms by USDA and the Indian NBPGR; Coconut genetic resources ask: What is variety, cultivar, population and accession?

Did you know?

Forage groundnut (*Arachis pintoi*) cv. Amarillo is also being distributed as accession CPI 58113, CIAT 17434, ILRI 10920 and by USDA as PI 338314 or 553013 among many other accession codes registered worldwide.

Towards a better future for tropical and subtropical forages – continued

Tropical and subtropical forage collections probably have more species diversity than most other 'crop' collections and, perhaps, that diversity is itself a major risk for conservation and utilization of germplasm of true forage potential. Over the past 60 years many species collected from the wild have proved to be of no forage or pasture value, but we have them! If they are held by the CGIAR centres, their conservation is a legal responsibility under the International Treaty on Plant Genetic Resources for Food and Agriculture. Other centres without such legal responsibilities also maintain those 'non-forage' accessions. In a world of unlimited resources that is probably a good thing. But with such limited resources the obligations under the Treaty are diluting the effort required to conserve the very germplasm that can make a difference to livestock and environmental systems. Trying to work out some pragmatic solutions to this challenge is one of the issues to be addressed in the strategy.

The Newsletter is a first step

Things will not greatly improve in the next year or so. But there is recognition that some actions can be done to support and build on the achievements of the teams of researchers already doing their best to conserve and make these collections available to others. This newsletter is one of those actions and we hope that it provides you with some new insights into tropical and subtropical forage conservation and utilization from across the globe.

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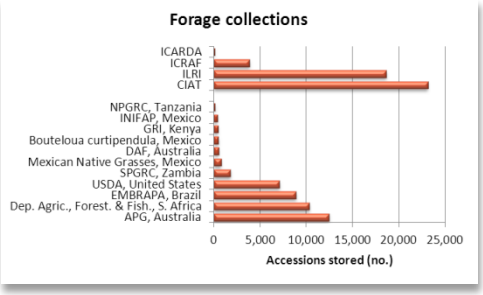
LINKS: A Global Strategy for the Conservation and Utilisation of Tropical and Sub-tropical Forage Genetic Resources

Harvesting seed of tropical forage germplasm at CIAT HQ, Colombia; photo: BL Maass



Abbreviations & Acronyms

ACIAR	Australian Centre for International Agricultural Research
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro International de Agricultura Tropical
CSIRO	Commonwealth Scientific and Industrial Research Organisation
embrapa	Brazilian Agricultural Research Organization
IBERS	Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, UK
ILRI	International Livestock Research Institute
NaLIRRI	National Livestock Resources Research Institute, Uganda
NARS	National Agricultural Research Systems
NBPGR	National Bureau of Plant Genetic Resources, India
USDA	US Department of Agriculture

Native Brachiaria germplasm of Uganda

Brachiaria is globally important

Several *Brachiaria* species are native to Uganda and, thus, well adapted to the environmental conditions of the country.

Brachiaria is an important forage grass worldwide. In order to address shortcomings in South America, CIAT and ILRI (formerly, ILCA) in collaboration with NARS undertook comprehensive collecting in six sub-Sahara African countries in the mid-1980s: Ethiopia, Kenya, Tanzania, Rwanda, Burundi and Zimbabwe. The germplasm then collected is today still maintained at CIAT in Colombia and at ILRI in Ethiopia. A large part of the collection has also been provided to the Brazilian embrapa. When the collecting took place between 1984 and 1985, it was not safe to travel in Uganda due to political unrest. Therefore, the native *Brachiaria* resources from Uganda have not yet been investigated and represent a geographical gap.

Brachiaria is native to Uganda

NaLIRRI is now exploring the native *Brachiaria* genetic resources due to the many virtues of the genus discovered in the past decades of intensive research, particularly in South America. The proven ability of some *Brachiaria* species to suppress nitrification and, hence, conserve soil nitrogen through biological nitrification inhibition processes make the forage a suitable candidate for soil productivity enhancement and may reduce the requirements for soil nitrogen amendment through fertilizer application. In addition, *Brachiaria* has been reported to support symbiotic occurrence of endophytes that provide plants a certain tolerance to various biotic and abiotic stresses. Despite its amazing attributes, few efforts have been undertaken to conserve, characterize and evaluate the performance of different *Brachiaria* species and ecotypes in Uganda.

Current study objectives

Current study objectives are to:

1. Conserve, and genetically and morphologically characterize native *Brachiaria* germplasm in Uganda; and
2. Evaluate the performance of different *Brachiaria* ecotypes in Uganda and select elite candidates for the newly established breeding program in collaboration with IBERS, UK.

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Penned cattle fed on improved Brachiaria grass in eastern Cambodia. Photo by Anna Seidel

People also matter

Cattle production in eastern Cambodia

Smallholder farms in Ratanakiri Province, eastern Cambodia, face the challenge that grazing land is gradually becoming scarcer, and their current cattle productivity is too low for effective commercialization. Planting nutritious forages on small parcels of land and cut-and-carry these to feed their penned cattle can considerably increase animal production and associated income, as known from similar situations in Vietnam. Particularly as beef demand is increasing, this presents cattle-keeping smallholders in Cambodia with an opportunity to enhance their livelihoods.

Feeding improved forages to penned cattle

Over a 4-month period at the onset of the rainy season, penned cattle on five smallholder farms in Pruok Village, Lumphat District were fed a mix of farm-grown forages (*Brachiaria* hybrid Mulato II, *B. ruziziensis*, *Panicum maximum* cv. Mombasa, *Paspalum atratum* cv. Ubon, *Stylosanthes guianensis* var. *vulgaris* var. *pauciflora*). Weights of 37 local cattle were recorded biweekly: 17 were fed the forage mixture, 20 were kept in the traditional manner, i.e. grazing on naturally occurring grasses.

The forages investigated are known to be adapted in the region, although both water surplus and shortages are challenges depending on the season. Yet, when comparing average daily live weight gains of penned 2-year-old cattle with those grazed in the traditional manner, the former were only about one third of the latter. Explanations for the unexpected result can rather be found in people-related matters. (i) As farmers managed the forage stands in a suboptimal way, this resulted in decreases over time in both palatability and nutritional quality; and (ii) farmers were feeding their penned cattle insufficient crude protein that didn't match the animals' requirements, while the grazed cattle could select more palatable and larger biomass amounts. To enhance cattle productivity through improved forages, consequently, farmers must either have sufficient knowledge, skills and resources to grow and feed adequate quality and quantity of cultivated forages to their animals, or they should use such forages to complement normal grazing. Before shifting to a cut-and-carry system, farmers apparently need to consider the market pull vs. their investment into labour.

Research results at Tropentag

Anna Seidel, a student from the German University of Hohenheim, has conducted this research with CIAT for her BSc thesis. Anna will present the results at the International 'Tropentag' Conference to take place in Vienna, Austria, 16-21 September 2016.

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Guineagrass breeding in Brazil

Forage grasses in Brazil

Brazil is essentially an agricultural country with 170 Mha of pastures, of which 50 Mha are native and 100 Mha are cultivated. Brazil's cattle herd is 208 million head, the largest commercial cattle herd in the world and the largest beef exporter. Most cattle are raised on pastures, observing animal welfare conditions, and only 11% of the slaughter is of animals finished in feedlots.

The main forages in Brazil are *Brachiaria* cultivars, responsible for 85% of the seed commercialized in the country, followed by Guineagrass (*Panicum maximum*) cultivars. Typically, *Brachiaria* is used on medium to low fertility soils that are not very demanding on fertilization or management. *P. maximum* is usually employed on medium to high fertility soils that are demanding on fertilization and management. It is ideal to have both genera and different cultivars on a farm, using smaller areas of *P. maximum* for cattle finishing due to both its higher productivity and quality resulting in greater cattle weight gain, while larger areas of *Brachiaria* are taken for raising and maintenance of cattle, especially during the dry season when *Panicum* production is low.

Embrapa Beef Cattle leads *P. maximum* and *Brachiaria* breeding in Brazil. The breeding programs began in the decade of the 1980s and are based on large germplasm collections. To date, five *P. maximum* and four *Brachiaria* cultivars have been released from these programs.

Guineagrass germplasm

A *Panicum maximum* germplasm collection was received from a cooperation-agreement between Embrapa and Orstom (Office de la Recherche pour le Developpement en Cooperation), France, in 1982. The comprehensive collection comprised 426 accessions and 417 sexual plants. The collection is representative of the natural variability found in its region of origin in East Africa, specifically Kenya and Tanzania, thus variability was found for every agronomic and morphologic characteristic evaluated.

Breeding involves crosses between sexual x apomictic plants and evaluation of the progenies. Selected sexual hybrids are used as female genitors in subsequent crosses and selected apomictic hybrids may be released as cultivars after many phases of evaluation, beginning in small plots under cutting until evaluation under grazing in large areas.

Cultivars from germplasm

Highlights have been the release of selected accessions in the past decades and, recently, hybrids with improved quality, which may be easily managed in the production system. Thus, cultivars Tanzania, Mombaça and Massai, released in 1990, 1993 and 2001, respectively, have been a great contribution to Brazil. The new cultivars concentrate increased leaf yield in the same or smaller plant stature than the commercial cultivar Colonião at the time. Thus, they help to increase animal gains by facilitating the cattle to apprehend the leaves and by improving cattle management at farm level. Other attributes of the released cultivars were improved growth during the dry season and less fertilizer demand.

New releases

Recently, cv. BRS Zuri was released in 2014, a higher-yielding higher-quality accession from the germplasm bank. Its advantage is the very intense growth and also a high degree of resistance to a leaf spot disease caused by *Bipolaris maydis*, a major problem for some cultivars, such as cv. Tanzania. The first products of the breeding program are now appearing in the market. Thus, we now have cv. BRS Tamani released in 2015 and cv. BRS Quênia to be released shortly. Both have excellent plant structure with abundance of leaves, and very high quality resulting not only in increased animal gains per area, but also in increased gain per animal and improving ease of management.

BY: Liana Jank, Cacilda Borges do Valle, Sanzio Carvalho Barrios, Mateus Figueiredo Santos and Rosangela Maria Simeão

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LINKS: *Panicum maximum* cvs. BRS Zuri, BRS Tamani and BRS Quenia

***Panicum maximum* or *Megathyrsus maximus* – what is right?** Read Cook and Schultze-Kraft's (2015) article on "Botanical name changes–nuisance or a quest for precision?" in Tropical Grasslands—Forrajes Tropicales!

WHAT DO YOU THINK? WRITE TO US!

A group of forage and genebank experts came together in Bonn, Germany, last year to start a new forage movement. This **newsletter is a first step** in implementing the strategy on tropical and subtropical forage conservation and utilization.

Tell us your forage stories from across the globe!

Panicum maximum cv. Tanzania

In grazing trials at Southeast EMBRAPA Cattle, Brazil
Photo by S. Reynolds; source: FAO

Panicum maximum cv. Zuri

Photo: RAMOS, Allan Kardec Braga; source: embrapa

Using *Gliricidia sepium* in Indonesia

The SPA story to improve Bali cattle production in eastern Indonesia

Lack of a reliable, high-quality dry season forage supply is a major constraint to increasing cattle production in Eastern Indonesia. Tree and shrub legumes, well adapted to this monsoonal environment, can provide high quality feed for cattle and goats well into the dry season, due to their ability to access sub-surface water, not available to tropical forage grasses. Tree legumes such as *Leucaena leucocephala* and *Gliricidia sepium* are widely grown as living fences throughout this region. However, their fodder value was poorly recognised by smallholder farmers until recently, when their utility was successfully demonstrated during several ACIAR-funded projects conducted between 2001 and 2010.

One such project, based at SPA village on Sumbawa Island, Nusa Tenggara Barat (NTB) province focussed on the use of *Gliricidia* to improve dry season nutrition of Bali cows. SPA is a typical transmigrant village of mixed crop-livestock smallholders, located in the drier eastern region of Sumbawa, with a short wet season of around 1000 mm, and long dry season. Cattle typically lose weight through the dry season, when farmers spend up to 6 hours each day scavenging far and wide for scarce cattle feed resources.

Advantages of *Gliricidia*

Gliricidia, a robust perennial tree legume well suited to this environment, is easily grown from cuttings, making establishment relatively simple compared to *Leucaena*, which is usually established from seed. With a crude protein content of 18-30% and *in vitro* digestibility of 60-65% it has the potential to provide high quality fodder year round. However, difficulties with palatability (due to presence of volatile aromatic compounds in some ecotypes) have often limited its use as cattle feed by smallholders.

Gliricidia, known as 'gamal' in Bahasa Sasak language, was already present in SPA living fences. Once farmers were shown how to train their cattle to eat 'gamal', it's planting and use took off rapidly throughout SPA and neighbouring villages – so much so that the percentage of 'gamal' in dry season cattle diets went from almost zero to over 80% in just 4 years amongst monitored farmers.

As a result, Bali cow dry season body condition improved significantly over the study period, turning an average 30 kg/head late dry season annual live weight loss into a 20 kg/head gain for SPA farmers. Near infrared reflectance spectroscopy (NIRS) faecal sampling of monitored cows also revealed a significant increase in dietary crude protein from 4.7% to 9.4% over the same period, coinciding with an increase in the non-grass dietary component from 28% to 78%, due to *Gliricidia* use.

Multiple benefits of *Gliricidia*

Benefits of *Gliricidia* use did not stop there for SPA farmers. Improved cow condition flowed through to improved cow-calf productivity, via increased weight gain of calves kept for fattening and improved cycling of cows, which helped reduce calving intervals. As a result, SPA smallholder cattle farmers had more than doubled their number of cows and significantly increased income from cattle sales within 5 years of taking up *Gliricidia* use, while the number of SPA households with cattle had risen from 60 to 100%, according to local agency sources. Moreover, *Gliricidia* use had allowed farmers to reduce time spent gathering dry season forage from an average 6 hours per day to less than 2 hours, with labour saved re-allocated to improving crop production.

It was not surprising that *Gliricidia* use has spread rapidly to neighbouring villages and from there throughout the Dompu region of Sumbawa, according to district extension staff interviewed during a 2012 ACIAR project review visit. *Gliricidia* has the potential to provide similar benefits to smallholder livestock producers throughout Eastern Indonesia and beyond to similar environments throughout S.E. Asia, especially with the advent of more palatable cultivars.

CONTACT: Jeff Corfield (Email: jeffcorfield@yahoo.com.au)

SOURCE: Corfield J., Sutaryono, Y., Lisson, S., MacLeod, N., Wirajaswadi, L. and McDonald, C. 2008. The impacts of enhanced tree legume utilisation in the smallholder crop-livestock farming systems of eastern Indonesia. Proceedings of the 13th AAAP Congress, Hanoi, September 2008.

SPA farmer with his cattle and Gliricidia hedge in the background; all three photos by J. Corfield

SPA farmers with well-managed Gliricidia 'living fence' hedgerow

SPA farmer with cut Gliricidia sepium ready to feed his cattle

SPA stands for 'Satuan Pemukiman' transmigration area unit 'A'.

FURTHER READING:

Lisson, S., MacLeod, N., McDonald, C., Corfield, J., Pengelly, B., Wirajaswadi, L., Rahman, R., Bahar, S., Padjung, R., Razak, Puspadi, K., Dahlanuddin, Sutaryono, Y., Saenong, S., Panjaitan, T., Hadiawati, L., Ash, A. and Brennan, L. 2010. A participatory, farming systems approach to improving Bali cattle production in the smallholder crop-livestock systems of Eastern Indonesia. Agric. Systems 103:486–497.

FAST FACTS

<10%

A significant number of respondents to the survey reported that < 10% of collections was backed-up in other institutes, national or international. Others, such as the USDA, CIAT and Australia reported > 75% of accessions backed up for safety.

85%

The majority of the large forage germplasm collections of CIAT and ILRI consist of legumes although grasses are much more widely used as cultivated forages.

FOR MORE INFORMATION

Read the report on "A Global Strategy for the Conservation and Utilisation of Tropical and Sub-Tropical Forage Genetic Resources".

Characterization data needed!

To make the most of the forage germplasm collections already assembled, there must be an understanding of the diversity within the priority species. Researchers have examined diversity in key species over the past 50 years and much of this work has been published in the formal or gray literature. Some researchers have even developed core collections that represent the available diversity. The strategy implementation plan for 2016 includes the assembling as much characterization data as possible and to make that available on a dedicated web site or via links.

If you know of publications (formal or grey) that belong in this task, then please let us know. Unless we make this effort to assemble the results of characterization studies (morphological, agronomic or molecular), then there is a danger that the work will be forgotten or repeated.

We expect your contributions!

FUTURE NEWSLETTER ISSUES

We aim at covering a wide diversity of matters in this newsletter in order to rebuild the global community of tropical and subtropical forage genebanks and its users.

Share your forage stories with us and the global community!

This can be about genebanks or forage research and development.

How come that the majority of genebank accessions belong to legumes, while the most widely used improved forages are grasses? Do we need to correct this imbalance?

Where do forages make a difference to people's livelihoods? How do they fit into production systems?

What about particular species? Which forage have we neglected in the past that deserves more attention in R&D? Does it have an adequate germplasm collection? Where?

How and where do you locate forage seed? Share your experience!

What about people? Who has lately retired and deserves some recognition? Where are the forage researchers of the future? Who has just finished a PhD in forages? What were important results?

LETTERS TO THE EDITORS

If you are not on the recipient list but you want to receive this newsletter, please contact us.

If you are not interested in receiving further issues of this newsletter, please send us an email.

Please share your opinions and write us letters regarding **controversial issues**. We are eager to debate with you your **agreements or disagreements**!

Your opinions matter!

Germplasm evaluation at Quilichao, Colombia; photo: BL Maass

NEXT NEWSLETTER ISSUE

We aim at producing the next newsletter by end of August 2016.

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