Rebuilding a Tropical Forages for the Future Network – A Call for Resuscitating Enthusiasm for a Commodity with Great Prospects and Innovation Potential

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Rebuilding a Tropical Forages for the Future Network – A Call for Resuscitating Enthusiasm for a Commodity with Great Prospects and Innovation Potential

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Abstract
A series of *Forages for the Future* newsletters, outlining some of the latest tropical and subtropical forage (TSTF) research and development impacts and expertise, has been published since 2016. Amongst the research highlights were Brazilian scientists' focus on grasses such as *Urochloa*, *Megathyrsus maximus*, *Paspalum* and *Cenchrus purpureus*, and on legumes, especially *Arachis* and *Stylosanthes*. Argentinian researchers are similarly targeting *Acroceras macrum* and *Setaria sphacelata*; while Indian and *ILRI* (East Africa) researchers are using plant breeding to overcome disease constraints in Napier grass (*Cenchrus purpureus* and associated hybrids). Also demonstrated were successfully using genetic resources of *Desmanthus*, *Leucaena leucocephala* and *Macroptilium bracteatum* to improve Australian livestock production in varying farming systems on heavy-textured soils.

Amongst the most innovative forage-based development outcomes featured in the newsletters were the increasing role of *Mucuna pruriens* in crop-livestock systems of semi-arid Zimbabwe, and the enabling role that forage grasses and legumes play in the *icipe*-developed "push-pull"-system to control a range of pests in African maize farming-systems.

Some common threads stand out in these impact-delivering programs: longevity and ongoing institutional support, clear end-user focus, deep understanding of species adaptation and their phenotypic diversity and, how various species and ecotypes might be used.

These are just some of the successful research-for-development programs taking place across the tropics and subtropics; they provide an opportunity for strengthening TSTF research and development into the future. One missing ingredient is opportunity for teams from national, international centres and from the private sector to meet regularly to exchange results, ideas and challenges. International conferences and similar forums are expensive and too infrequent; but online options offer new communication approaches. The IGC in Nairobi is the perfect opportunity to discuss possible new collaboration forums and, if required, how they might operate to make for a better, well-informed and innovative international TSTF network.

Introduction
Research into tropical and subtropical forages species diversity, plant geography, adaptation, management and utilisation reached a peak between 1960 and 1990. Since then, there has been a steady decline in all disciplines associated with forages and pastures in the tropics and subtropics (Maass and Pengelly 2001, 2019; Pengelly and Maass 2019). Tropical forage research in the international institutes of the International Center for Tropical Agriculture (CIAT) and the International Livestock Research Institute (ILRI) is now a minor part of their portfolio. Similarly, national programs, which were at the forefront of tropical forage research such as those in Australia, Brazil, United States of America, India, Kenya, Zimbabwe, Argentina and Thailand, have all been significantly reduced.

In recognition of the need of a global approach for germplasm conservation, the Global Crop Diversity Trust commissioned development of global crop strategies for efficient and effective *ex situ* conservation and utilization of crop diversity (Khoury et al. 2010). The "Global Strategy for the Conservation and Utilisation of Tropical and Sub-Tropical Forage Genetic Resources" was developed in 2015 (Pengelly 2015) and subsequently implemented (Pengelly and Maass 2019). According to Pengelly and Maass (2019), "the strategy attempts to address the almost unanimous view from national and international genebanks that they were struggling to implement anything like best practice in genebank management, and that skills and resources had declined significantly".

Towards a More Secure Genetic Resource Base
Improving Communication
The initial phase of implementation of the *Global Strategy* from 2016 to 2019 focused on better communication in the TSTF community and rationalization especially of the international genebanks (CIAT and ILRI). More

than 600 recipients worldwide received a series of *Forages for the Future* newsletters with enthusiastic feedback. The newsletters connected diverse groups and outlined the latest TSTF research and development work and its impacts. However, with no means of continued funding the newsletter, after 3 years, is no longer being produced.

These *Forages for the Future* newsletters, which were published through the Global Crop Diversity Trust between 2016 and 2019 (Maass and Pengelly 2016-2019) highlighted some of the latest tropical and subtropical forage (TSTF) research and development, the impacts that research is delivering, and the teams that are undertaking the research. The highlights included Brazilian scientists' focus on the grass genera/species *Urochloa*, *Megathyrsus maximus*, *Paspalum* and *Cenchrus*, and on a small number of legume genera, especially *Arachis* and *Stylosanthes*. The newsletter reported Argentine work on *Acroceras macrum*, *Setaria sphacelata* and several other grasses and Indian and ILRI (East Africa) researchers using plant breeding to overcome disease constraints in Napier grass (*Cenchrus purpureus* and associated hybrids). Also reported were the success from using selections from genetic resources of *Desmanthus and Macroptilium bracteatum* to improve Australian livestock production in varying farming systems on heavy-textured soils.

Amongst the most innovative forage-based development outcomes featured in the newsletters were the increasing role of *Mucuna pruriens* in crop-livestock systems of semi-arid Zimbabwe (Homann-Kee Tui et al. 2015), and the enabling role that forage grasses and legumes play in the "push-pull"-system developed by icipe (International Centre of Insect Physiology and Ecology) to control a range of pests in African maize farming-systems (Kassie et al. 2018). In short, the contributions to the newsletters demonstrated that there are a whole range of benefits being delivered in farming systems around the tropics and subtropics from the development and better management of both grasses and legumes.

Conservation and Knowledge of Collections

During that same period (2016-2019) the authors travelled to research institutes in India, South America (Brazil and Argentina), Africa (Kenya and South Africa) and Australia, and to the relevant international institutes (CIAT and ILRI) to observe the status of the tropical and subtropical forage germplasm collections being held in those national and international genebanks. These visits followed on from a survey of national and international genebanks carried out by Pengelly (2015) and the Global Crop Diversity Trust in 2015 in which a large proportion of respondents reported that funding was decreasing and all reported difficulty in carrying out genebank operations (unpublished data).

The visits, survey and discussions with key TSTF researchers since all indicate that the collections being held are, at best, in moderate condition such as having large numbers of accessions with poor viability or having only limited viability data and a low proportion of accessions backed up in another genebank. In some national genebanks a large proportion of all the accessions being held are probably lost. In only a few cases could it be claimed that the collections were being conserved in anything approaching best practice.

Often, the moderate status of the collection's conservation was accompanied by limited knowledge of diversity and potential value of species and accession being held. This is a consequence of both the size and diversity of the collections in both grass and legume families, and the rarity with which genebank managers can have an extended career in relevant tropical forage disciplines. This is not a criticism of those working in genebanks. Rather it is a comment on what happens when scientists are not able to have continued careers in genebanks, which enable them to gain a depth of knowledge across the range of relevant disciplines ranging from taxonomy, diversity, geography and plant adaptation to breeding systems and utilisation.

Building a comprehensive understanding of the collections is made even more challenging because of their size. Often the number of accessions is bloated due to over-enthusiastic, poorly targeted collection (Maass and Pengelly 2019). The result is an overwhelming task of conserving large numbers of accessions of low-priority taxa, often with diminishing resources. This challenge can be overcome to some extent by prioritising the taxa being held in these collections (Cook and Schultze Kraft 2016), the development of the Tropical Forages Database (Cook et al. 2020) which summarises current knowledge about priority species, and greater collaboration between genebanks so that the challenges can be shared (Pengelly and Maass 2019). However, collaboration to enable more efficient conservation and to bring about better utilisation of priority taxa cannot just happen, especially in an environment of fewer resources. It has to be worked on.

Networking

An observation from interactions with TSTF genebanks is that both national and international genebanks are, to a large extent, working in isolation, with genebank managers and researchers having little or no communication with any other centres. In most cases, they have never met other TSTF genebank managers or

researchers. This is in stark contrast to the "golden years" of the 1960-1990 period, when collaboration between centres was the norm and yielded so much. That collaboration led to not only exchange of germplasm but also exchange of ideas in the areas of taxonomy, geography, adaptation and utilisation. The collaboration, e.g. by joint research, long-term visits, joint collecting missions, free exchange of germplasm (Schultze-Kraft and Giacometti, 1979), was especially strong between genebanks in Brazil, the USA and Australia and the international institutes (CIAT and ILRI), but it was not limited to just these larger genebanks.

How is Collaboration Rebuilt?

Newsletters are fine to a degree, but they are not a substitute for personal interactions between researchers with common interests and goals. However, the higher profile of tropical and subtropical forage research of the golden years and the associated more generous research budgets that enabled international travel and extended visits of researchers to other institutes around the world is past. International conferences such as the International Grassland Congress (IGC) are expensive to attend and are too infrequent to alone be the avenue for ongoing collaboration and exchange of ideas. The difficulties in achieving collaboration before 2020 have been made more difficult by the COVID-19 pandemic and doubts about if and when low-cost international travel for research collaboration and conference attendance might resume. However, the benefits from collaboration are many and each aspect of collaboration has the potential to make genebanks more efficient and effective (Figure 1).

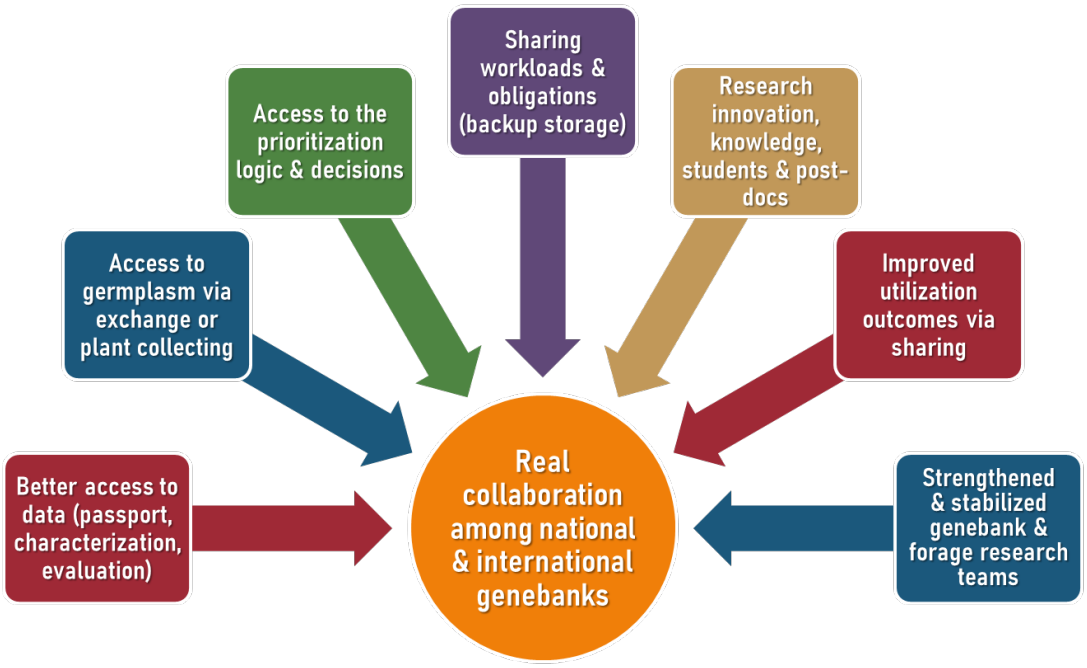

Figure 1. Some of the benefits that could be expected from greater collaboration among genebanks and tropical and subtropical forage researchers (modified from Pengelly and Maass 2019)

The COVID-19 pandemic has achieved a greater acceptance of the value and necessity of virtual meetings, of how they might be better conducted and chaired, and supported by a rapidly improving range of technologies. These changes perhaps offer a way forward for genebank staff to start to strengthen networks, sharpen the priority setting that almost all genebanks will be forced to undertake at some time, develop options to share the global conservation workload and, by working together, improve the understanding of what germplasm is being held for future generations.

Achieving a revitalised network of national and international tropical and subtropical forage genebanks will require leadership from one or national centres or from international agencies such as the Global Crop Diversity Trust (GCDT). Perhaps this is a task for a reformed Consortium of International Agricultural Research Centres (CGIAR). This will not be an easy task. It will require commitment over a long period by all, but especially by the international institutes, recognition of the challenges of different time zones, languages and the status, resources and roles of the various genebanks and careful thought to make engagement interesting and readily beneficial to participating genebanks. It has to avoid being a talkfest and an unwanted obligation.

Conclusion

It is proposed that tropical and subtropical forage genebanks must take drastic action to survive. Thirty years of decline in TSTF tropical forage research commitment by a range of agencies has resulted in genebanks being mostly in survival mode. Doing nothing will almost undoubtedly lead to further decline. The genebank managers who have taken on responsibility to conserve germplasm in perpetuity need to develop a better argument for sustained funding. That argument will need to be built around being more effective (providing the new germplasm for forage and environmental utilisation) and being more efficient. Efficiencies are achievable through active and engaged collaboration and a functional network of genebanks working of priorities.

Perhaps COVID-19 has provided a timely opportunity to have tropical and subtropical forages available in another 30 years from now. Livestock production for meat, milk, skins, fibre and draught will continue and those animals will require feed and sustainable feed production systems. Without a way forward to maintain genebanks and at least the priority germplasm as we know it today means that feed options will be lost forever to future generations.

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