THE IMPACT OF THE INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

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APPENDIX 1: CIAT and ICARDA Livestock Research

CIAT Livestock Research, 1967–2018

A thorough history of the Centro Internacional de Agricultura Tropical (CIAT) stated that one purpose of ‘...CIAT’s research over the past 50 years has been to establish fundamental knowledge on tropical forages’ (Lynam and Byerlee, 2017, p. 81). The search for this knowledge began with CIAT’s Beef Program in 1969. The programme’s objective was to ‘... increase cattle productivity in the lowland tropics of Latin America...at elevations below 1000 m’ (CIAT, 1973, p. 4). The farm type targeted by CIAT animal research was ranches of varying size, typically with sown pastures, and some small- and medium-scale dairying in Central America. Research themes were ambitious, seeking to: (i) improve the quantity and quality of feed; (ii) control diseases and parasites; and (iii) ‘devise production systems that produce good quality beef efficiently and cheaply’ (CIAT, 1973, p. 5). Feed work involved collecting and evaluating legumes and grass species, initially in Latin America and later in sub-Saharan Africa and in Asia, with related soil analyses. Work on production systems included field surveys, modelling and economic analysis. Animal breeding and health were initially seen as major themes in the Beef Production Systems Programme but were later left to the national programmes and the private sector in Latin America (CGIAR/TAC, 1977, p. 47). The Beef Production Systems Programme ultimately evolved into a Tropical Pastures Programme in 1979, later becoming the Tropical Forages Programme (CIAT/TFP) and shedding along the way the work on animal health, breeding and reproduction.

The CIAT Tropical Forages Programme had three broad themes after 1980: (i) forage germplasm, in response to the identified need to increase the available species and genotype pools of forages, both grasses and legumes, for screening for adaptation to limiting abiotic (mainly soil) and biotic (pests and diseases) constraints; (ii) on-farm forage development using materials that could thrive on acid soils and resist insects and diseases, notably anthracnose on *Stylosanthes* spp.; and (iii) natural resource management, involving plant, animal and soil components.

**Forage germplasm**

Two phases can be distinguished in the development of the CIAT forage gene bank: (i) a first phase with the main focus on assembling and using the forage germplasm collection (1972–1993); and (ii) a second phase that comprised continuing use of germplasm, diversity studies and routine germplasm management and its optimization (1993–2017).

In the early 1970s, CIAT began systematic missions throughout tropical America to collect germplasm of wild species with forage potential. The objective was to create a diverse germplasm pool for cultivar development via selection or, if
natural variability failed to provide the desired traits, via breeding (Lynam and Byerlee, 2017, pp. 81–82). Collecting missions ranged from excursions of short duration, particularly in Colombia, to several weeks-long expeditions. Another germplasm source was opportunistic collections made by CIAT staff and collaborators during field visits. There was a combined target focus on acid-soil regions and plant genera of particular interest. The emphasis was on legumes, in many cases including associated rhizobia, as the Neotropics are the main centre of diversification of the Fabaceae (Leguminosae) family. From 1979 onwards, collection missions expanded to South-east Asia, an important centre of legume diversification (e.g. *Pueraria* and *Desmodium* spp.). Collections extended in the 1980s to Africa, with a focus on grasses, as sub-Saharan Africa is the main centre of Poaceae diversity. Maintenance of the forage collection passed on to the CIAT Genetic Resources Unit (GRU) after its foundation in 1977. The GRU manages seed testing, seed increase, germplasm preservation, safety back-ups of the collection, maintenance of living collections, seed distribution, etc., all of which are routine and costly germplasm conservation measures.

Achievements in forage germplasm (paraphrased from Lynam and Byerlee, 2017, pp. 85–88) were: (i) the collections conserved in the gene bank with provision of germplasm for selection and breeding programmes; and (ii) forage adoption particularly in tropical America.

**The forage gene bank**

With a total of approximately 23,000 accessions (about 21,500 legumes and 1500 grasses) from some 75 origin countries, the CIAT collection is the largest tropical forages germplasm collection worldwide. Its particular value lies in its focus on: (i) plants from, and subsequently adapted to, acid, low-fertility soils; and (ii) legumes. However, as far as countries and regions on which germplasm collecting missions concentrated in the past are concerned, there are still important gaps: the collection is probably far from being representative of the geographic diversity of tropical Poaceae and Leguminosae.

**Forage adoption**

The greatest achievement in tropical forages has been the wide-scale adoption of such materials in Brazil (Schultze-Kraft *et al.*, 2020), for which most of the credit goes to the national program of Brazil, with some more recent input from CIAT. It is estimated that about 120 million ha are planted to forages, of which nearly 100 million are *Urochloa* spp. and approximately 17 million ha are *Megathyrsus maximus* (Jank *et al.*, 2014). Arguably about 50 million ha are planted to one cultivar, *Urochloa brizantha* cv. Marandu, in Brazil alone (Lynam and Byerlee, 2017, p. 87). Particularly impressive is the rapid adoption from an estimated 16 million ha in the mid-1980s to nearly 120 million ha by the early 2010s, indicating the transformative potential of improved forages when respective support structures, including involvement of the seed industry, are in place. Together with parallel improvements in animal breeds and animal health, more productive forages contributed to a fourfold increase in productivity per area and per animal; this is recognized as one of the major successes of global agriculture in the past 30 years (Lynam and Byerlee, 2017, p. 87).

In 2002, a *Urochloa* (syn. *Brachiaria deumbens × brizantha × ruziensis* cultivar from CIAT’s breeding programme was released as the first bred *Urochloa* sp. cultivar worldwide. Uptake based on documented seed sales until the end of 2016 is estimated at 750,000 ha mostly sown in the past decade. Adoption includes more than 40 countries in Latin America and the Caribbean, tropical Africa, tropical Asia, Australia and Oceania, tropical/subtropical North America and southern Europe; most adopters appear to be small- and medium-sized livestock producers.

CIAT has released materials from its germplasm base, including 11 grasses and 16 legumes in Mexico and Central America. The CGIAR Standing Panel on Impact Assessment (SPIA) found limited published work that evaluated the adoption and impact of these materials in Mexico and Central America (Jutzi and Rich, 2016, pp. 46–55).

Better documented is the uptake of *Urochloa* grasses in Mexico and Central America where plantings of over 3 million ha were reported up to the early 2000s (Holmann *et al.*, 2004).
Surveys in Colombia’s Eastern Plains carried out in 2017 suggested that about one-third (about 3 million ha) of improved pastures is sown using *Urochloa* cultivars selected by Corporación Colombiana de Investigación Agropecuaria (CORPOICA)\(^7\) and CIAT, or bred by CIAT (Labarta *et al.*, 2017). Empresa Brasileira de Pesquisa Agrícola (EMBRAPA), with CIAT contribution, achieved another success with about 1.5 million ha sown to *Andropogon gayanus* up to 2000 (Rivas Ríos, 2002). The national system of Nicaragua, supported by CIAT, promoted the adoption of improved forages such as *Urochloa* spp. and *Canavalia brasiliensis*, benefiting about 2000 smallholders and giving a 28% increase in daily milk yield (Pinillos *et al.*, 2018).

Notable production gains were achieved in the Eastern plains of Colombia as part of the collaboration between CORPOICA and CIAT. These gains were due to the inclusion of *Urochloa* spp. in crop–pasture rotations leading to a twofold gain in carrying capacity over degraded pasture and a tenfold gain over native savannah (Rincón and Ligaretto, 2008).

**ICARDA Livestock Research, 1977–2018\(^8\)**

Research at the International Centre for Agricultural Research in the Dry Areas (ICARDA), established in 1977, has covered improvement of barley, chickpea, faba bean, grass pea, lentil and wheat, as well as development of water and land management and crop–range–livestock integration. ICARDA livestock research has focused on three areas: (i) introduction of *Medicago sativa* into North African and West Asian farming systems; (ii) conserving and using forage germplasm; and (iii) understanding soil–water–plant–animal livestock interactions in the mixed grazing systems of North Africa and West Asia.

**Conserving and using forage germplasm**

ICARDA plays a crucial role in conservation and use of global forage genetic resources. It holds more than 155,000 accessions in trust, including 38,955 accessions of temperate forage and range species. ICARDA gene banks hold a highly diversified collection of temperate/Mediterranean forages including globally important and unique collections of members of the genera *Lathyrus, Medicago, Pisum, Trifolium* and *Vicia* representing 16.6% of holdings reported in Genesys. The bulk of the collection is still conserved in the gene bank in Syria, although after 2014, gene bank core activities were relocated to Lebanon and Morocco where new facilities were established and efforts to regenerate and characterize the active and base collections were undertaken.

The ICARDA forage collection is unique in its geographical coverage (originating from 112 countries) and its species coverage (631 taxa including many neglected species). The base collection has a total of 30,008 accessions representing 77% of the active collection. Only 62.5% of the collection is safety duplicated in four gene banks representing mostly the accessions collected by ICARDA. ICARDA also conserves an important *Rhizobium* spp. collection totalling 1483 strains belonging to 73 taxa, most of which are related to forage legumes. In 2008, ICARDA started sending the accessions in its active collection to the Svalbard Global Seed Vault in Norway, and approximately 23,360 accessions have been sent there for long-term conservation.

The ICARDA forage gene bank has distributed over 30 years approximately 205,000 samples for use by ICARDA scientists and external partners. Most have been used to select ecotypes for pasture improvement or as sources of traits for plant-breeding programmes.

**Notes**

1. Material on CIAT is derived from Lynam and Byerlee (2017) and from Schultze-Kraft *et al.* (2020, forthcoming).
3. CIAT’s early swine programme closed in 1978 (Lynam and Byerlee, 2017, p. 29).
4. CIAT germplasm collections and its accessions database are described in Schultze-Kraft *et al.* (2020, forthcoming).
See Chapters 12 and 13 (this volume) for forage gene bank results from ILRI, CIAT and ICARDA.

This is probably not equivalent to ‘smallholders’ as used in the African context.

CORPOICA is now known as Agrosavia.

The following section on ICARDA is derived from material found at www.irl.org/dataportal/impact/forage.

References

CIAT (1973) External review team: beef production systems program. CIAT, Cali, Colombia.


