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A case study of evaluation, demonstration and adoption of improved forages for a cut-and-carry system in Eritrea

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Introduction

Eritrea, a largely arid or semi-arid country in north-east Africa, lies on the western side of the Red Sea between about 12 and 18° N, and has an elevation ranging from -75 m to 3,018 m asl. Soils span from shallow, often infertile stony soils in steeper areas to fertile clays and clay loams on the flats. Soil pH ranges from slightly acid to moderately alkaline. About 80% of the population is engaged in subsistence mixed farming, with livestock being used for meat, milk, draft and fiber, as well as serving as a financial reserve. Average farm size in the most intensively populated area (central highlands) is about 0.2 ha, and about 2 ha in the less populated western lowlands.

In extensive farming systems, the rangelands that account for more than 90% of livestock feed, have a carrying capacity ranging from about 20 ha/Tropical Livestock Unit (TLU ≡ one bovine with a body weight of 250 kg) in the 100 mm rainfall zone to about 4 ha/TLU in the 600 mm rainfall zone (Kayouli et al. 2002). Crop residue is the second largest source of feed for livestock, with sorghum residue being the most important by a large margin. In the more intensive dairy systems, perennial forages such as *Medicago sativa* cvv. Hunter River (uplands) and Hairy Peruvian (lowlands) and *Pennisetum purpureum* are used by some farmers. Columbus grass (*Sorghum* x *almum*) has been introduced in limited areas in recent years. The combination of an extensive and diverse livestock population, and unreliable and strongly seasonal rainfall, has contributed to widespread overgrazing, which in turn has led to significant loss of ground cover and soil erosion. Much of the native grassland is now severely degraded, and more productive endemic species largely lost.

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The aim of this project was to enhance the sustainability of keeping livestock in Eritrea through improvement of the forage base. As in many countries, it was considered that this improvement might be best achieved through the incorporation of high quality, productive species that are adapted to the wide range of environments and applications found in Eritrea (Wolfe et al. 2008). This paper presents an account of progress in one of these situations, irrigated dairying in the central highlands.

Methods

A collaborative program of plant introduction and evaluation between NARI and New South Wales DPI was commenced in 2006 to select a range of forage grasses and legumes adapted to the various Eritrean environments, and appropriate to current farming systems in the country. Potential introductions were identified through a combination of collection site details (passport data) and the expert knowledge selection tool SoFT developed by Cook et al. (2005). A total of 262 accessions of cool season species (predominantly legumes) were sown in 50 cm square micro-plots in 2006, and 53 accessions of warm season grasses and 242 warm season legumes were introduced during 2006 and 2007, and sown in single or double 5 m rows on NARI research facilities in the central highland region and western lowlands. Twenty-seven cultivars of *M. sativa* were sown in 2008 to compare with locally used varieties. All plots were flood-irrigated when water was available to ensure establishment and rapid development for vegetative propagation and seed set. Phenology of all genotypes was recorded and each rated for yield and leafiness. Seed was harvested, threshed and winnowed by hand.

In the unreliable rainfall environment of Eritrea, it is usually more reliable to use the limited irrigation resource for vegetative propagation of grasses, since plants become less moisture-dependent more quickly than with sowing. Accordingly, larger plots of elite lines were established to provide a source of seed or vegetative propagating material for dissemination of varieties beyond the NARI facility.

Since all species included in the trials had been found beneficial in research in other countries, interested farmers visiting the plots during the evaluation phase were not discouraged from taking propagating material from these plots to establish on their own farms.

On completion of the on-station evaluation, 2 technical guides, one on establishment and management of sown forages generally, and the other relating specifically to the shrub legume, *Leucaena leucocephala*, were prepared and widely distributed to extension staff and education institutions in Eritrea. More promising lines were established on a private farm at Shiketi in the central highlands in 2011. The farm is owned by an influential farmer, who is identified as an innovator by other farmers in the area. This farm is now being used to influence other farmers and senior officials to include the improved species in farm and policy plans.

Results

From the plot work, some of the most productive and best adapted species overall include the grasses, *Panicum maximum* (syn. *Megathyrsus maximus*), *Setaria sphacelata*, *Brachiaria* (syn. *Urochloa*) spp. and several forage *Sorghum* varieties, plus the legumes, *Desmanthus* spp. (particularly *D. leptophyllus* and *D. virgatus*), *Stylosanthes seabrana*, *Macroptilium atropupureum* and *L. leucocephala*. Farmers have shown an interest in using *Lablab purpureus* and *Vigna unguiculata* intercropped with forage sorghum for dairy cows.

Elite lines of the above species, *P. maximum* (syn. *M. maximus*) cvv. Gatton and Tanzania, *S. sphacelata* var. *splendida*, *S. sphacelata* hybrid cv. Splenda, *Brachiaria decumbens* (syn. *U. decumbens*) cv. Basilisk and *Brachiaria* (syn. *Urochloa*) hybrid cv. Mulato, have been established on the model/demonstration farm in plots ranging in size from 80 to 175 m^2. Larger plots of *M. sativa*, *P. purpureum*, *Sorghum* x *almum* and *Ipomoea batatas* have been established to provide for visitors a comparison of the new varieties with existing varieties. The forages currently provide cut-and-carry feed for dairy goats and rabbits on the farm. Legumes (*M. atropurpureum*, *Desmanthus* spp., *S. seabrana*, *L. leucocephala*) will be established in the 2013 wet season. The farm owner can see the economic potential of the forages and is planning to enlarge the area of the cultivated forages. Limited funding and availability of transport have restricted researchers and extension staff, but the enthusiasm of the farmer has offset this difficulty to some extent.

Conclusion

The project has not only led to the introduction and adoption of a wider range of well-adapted, productive forages into Eritrea, but also has had the additional benefit of broadening the professional networks of R & D personnel in the country. Future work will follow a similar format to address the needs of other farming systems in Eritrea, particularly in relation to development of dairying on the extensive fertile clay soil areas of the western lowlands, where irrigation from large dams is available.

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