Climate change adaptation in livestock systems

Brief 3: Feeds and Forages

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Developing, disseminating and ensuring the adoption of improved forages to support increased productivity and resilience for livestock keepers

ILRI's objectives

ILRI will support sustainable intensification of the smallholder livestock sector in low- and middle-income countries of the tropical and sub-tropical regions of the world by identifying, selecting and improving forage genotypes with improved overall productivity in the face of climate change, supporting the development of climate resilient forage supply chains, and providing tools and technical support for farmer adoption. Outcomes include:

- Highly adapted varieties of perennial forages and other forage and feed species selected, developed and disseminated.
- Proven and ready to scale models of forage and forage seed supply systems that deliver high quality seeds and forages to livestock farmers, including women and youth.
- Tools and knowledge available to match forages to suitable production systems and environments and to increase the capacity of livestock keepers to produce and utilize improved forages for maximum productivity and minimum environmental impact.

Situation analysis

Radical shifts towards improved forages in feeding systems are needed to increase the resilience of livestock systems in the global tropics in the face of climate change. The inability to adequately feed livestock throughout the year is the most widespread technical constraint to increased livestock productivity, better livelihoods and more sustainable use of natural resources. Livestock producers in mixed crop-livestock systems, most of whom are small scale and facing shrinking land sizes, rely on poor quality crop residues and degraded natural grazing areas. Pastoralists in the rangelands face increased mobility challenges and degraded rangelands. Livestock keepers already experience regular feed shortages and high feed prices, limiting their overall productivity and potential for growth.

Cultivated forages are 'best bets' for better feeding in the face of climate change, improving productivity with low inputs, providing benefits to the fragile natural resource base, preserving grain for human consumption and increasing resilience to climate variability. High quality, drought-resistant forage grass can deliver up to 40%

more milk for dairy farmers in sub-Saharan Africa (Njarui et al. 2016) and achieve even larger gains if combined with improved genetics[1] (Mayberry et al. 2017). Perennial forages, once established, only need fertilization and irrigation to perform optimally and can easily be tended to produce high yields for many years. Cultivated tropical grasses have high potential to produce abundant biomass of reasonable quality. Forage legumes are high-quality feed that also provide protein for humans. Tree and shrub forages have potential to close seasonal gaps in feed availability.

Photo: ILRI/Apollo Habtamu

Alterations in rainfall patterns, elevated CO2 levels and rising temperature are already affecting the growth, distribution and nutritive value of major forage species. The quantity and quality of feed available for livestock production is changing with the climate; specific effects are dependent on the production system and geography. Extreme and more erratic weather events including heat waves and floods and increased incidence and spread of pests and disease can decimate both food and feed crops. Temperatures higher than a species optimum have negative impact on all stages of plant growth and development. Elevated CO2 is expected to stimulate plant production but is also likely to decrease forage quality through an increase in lignin content and a decrease in nutritive value (Kekae 2017; Thornton et al. 2009). This is occurring at the same time that livestock will require improved nutrition to maintain a neutral body temperature.

Modern molecular genetics can be quickly integrated into current conservation, use and improvement strategies to address yield, nutritional quality and digestibility, and biotic and abiotic stresses in forage species. Recent advances in precise phenotyping, genotyping and related molecular technologies have huge potential to improve yield and nutritional quality, enhance disease resistance and improve drought tolerance of forage species, but have been minimally applied to date.

Disease resistant cultivars of important forage crops are urgently needed. Napier grass, the most important livestock fodder crop in East Africa, is being decimated by the Napier grass stunt and head smut diseases, which are projected to spread further with the effects of climate change. Screening of Napier grass accessions has identified material with resistance to both diseases. The selection and further development of this material to combine disease resistance with improved nutritional quality and agronomic performance is the next step (Negawo et al. 2017).

Plant symbionts—naturally occurring microbes—can be utilized to enhance the overall fitness of cultivated feeds and forages and provide resilience to both biotic and abiotic stresses. This strategy has already been used to successfully enhance biomass production and resilience of forage species and is now being applied to forages important to livestock keepers in low-income countries (Mutai et al. 2017).

Forages that perform well under drought conditions need to be further selected, developed and released for use by farmers. Some cultivars of Buffel grass can produce four times as much biomass while maintaining good levels of crude protein and organic matter digestibility (Sánchez Gutiérrez et al. 2018). Cultivars of Napier grass with enhanced performance under drought could be utilized to expand production into areas with low annual rainfall. Different cultivars of Rhodes grass experience a reduction in biomass production between 5–72% under water stress, indicating an opportunity to select more drought tolerant varieties (Ponsens et al. 2010). ILRI's Biosciences East and Central Africa Hub (BecA) has selected varieties of climate-resilient Brachiaria for roll out across East Africa. Efforts are underway to increase awareness of these varieties among farmers, extension officials and policy makers; and to promote their use through development programs, farmers' groups and seed companies (Njarui et al. 2016). ILRI's Herbage Seed Unit in Ethiopia regionally disseminates selected best bet species for establishing national forage seed production, providing a ready platform to scale up dissemination of improved forages globally.

Increasing the availability and use of improved forage and forage seed and integrating forages into localized feeding strategies will enable livestock farmers to better adapt to climate change. Previous efforts to support livestock keepers in the adoption of forages have focused on technology promotion without building sustainable seed systems or building livestock keeper capacity on forage production and use (Rudel et al. 2015; Rao et al. 2015). Participatory approaches that incorporate the objectives of livestock keepers into forage improvement programs and support them to determine the role of cultivated forages in their production system have been successful in increasing uptake; but these efforts need to be expanded (Rudel et al. 2015). In mixed crop-livestock systems, feed shortages and high costs can be mitigated by supporting livestock keepers to make better use of the resources that are already available and integrating forages into a feeding approach that includes crop residues and agricultural byproducts.

1 See the brief titled *Leveraging improved genetics and breeding to support climate adaptation for livestock keepers in low-income countries* for information on ILRI's approach to livestock genetics.

Tools such as the Feed Assessment Tool (FEAST)[2], which has been used in more than 20 countries with over 1,000 application downloads; and Tropical Forages Tool[3], which had almost 500,000 visits in 2017, can be further rolled out for this purpose. Public-private partnerships can be built to formalize seed supply systems, ensuring a sustainable supply of seed and forage year-round. The ILRI FeedSeed[4] program in Ethiopia recruited, trained and supported the development of 30 forage seed producing enterprises, which then rolled out the ten best bet forage species from ILRI's Genebank to cooperatives and farmers. This model can be replicated in other countries. Growing interest in the tropical forages sector from multinational agricultural companies can also be leveraged.

ILRI's solutions

Solution 1: Utilize modern molecular genetics to select productive and resilient perennial forage varieties to benefit farmers now and breed new varieties for the future, focusing on high yield, good nutritional quality, enhanced disease resistance, reduced GHG emissions and improved stress tolerances in the face of climate change.

1. Identify and select superior genotypes from the core collection at ILRI's forages Genebank.
2. Generate sequence information.
3. Develop genetic maps and identify high throughput marker systems for the localization of genomic region(s) and discovery of genes controlling traits of interest.
4. Utilize marker-assisted selection/breeding to facilitate the selection of new clones and/or varieties with improved agronomic performance.

Solution 2: Utilize novel research in microbiomes to improve the resilience of major forage species.

Analyze the microbial communities associated with major perennial forage species to select any combinations that could increase resilience under climate change.

Solution 3: Rigorously test forage varieties on station and with farmers in target regions.

1. Conduct on station field trials.
2. Conduct participatory field trials.
3. Assess the impact of these technologies on animal productivity, GHG emissions, farm incomes and the distribution of benefits to producing and consuming families, including women and children.

Solution 4: Roll out forage varieties to farmers in the global tropics.

1. Globally disseminate improved varieties to national partners, including both government and private sector. In select countries:
2. Diagnose feed constraints and opportunities and prioritize and target context specific feed and forage interventions utilizing FEAST and other tools.
3. Develop and pilot viable business models for forage and forage seed production, distribution and use, including forage processing opportunities in small-scale production systems.
4. Work through public-private partnerships to build small and medium enterprise opportunities around seed multiplication and sale.
5. Develop policies and guidelines for seed certification and quality control.

Roll out ready tool: The Feed Assessment Tool (FEAST)

ILRI will scale-up the use of the FEAST tool by building the capacity of governments and development actors to utilize the tool when funding and implementing feed related climate adaptation strategies for livestock. Determining localized strategies that optimize feed utilization and animal production is especially important to livestock keepers, governments and development actors in the face of climate change. The Feed Assessment Tool (FEAST) is a systematic method to assess local feed resource availability and use and design appropriate intervention strategies. Downloaded in 20 countries, FEAST is widely used across the livestock research for development community. The use of the FEAST tool in East Africa has not only led to increased use of forages by dairy farmers but also a closer interaction amongst stakeholders in promoting forages. There is scope to scale up use among development agencies and governments looking to identify feeding solutions and take them to scale, matching technologies to target environments and socio-economic contexts. Recently, FEAST has been built out to include an Intervention Ranking Analysis, which is in its beta version. This new module allows users to rank a series of possible feed interventions—including improved forages—based on their suitability to the farming system, commodity and socio-economic conditions of their target community.

ILRI's impact and capacity

Facilities and expertise including feed and forage analyses, animal nutrition, forage improvement, on-station facilities for the development and rigorous testing of feed and forage options, and unparalled access to forage accessions to select and develop for climate adapted traits. The ILRI forages Genebank conserves almost 19,000 accessions of forages from over 1000 species. This is one of the most diverse collections of forage grasses, legumes and fodder tree species held in any Genebank in the world. Key species in this collection (including Napier grass, Buffel grass and Brachiaria spp.) have been extensively characterized, with both drought tolerant and pest and disease resistant genotypes identified. Napier grass germplasm selected from ILRI's Genebank was the basis of

2 https://www.ilri.org/feast
3 http://www.tropicalforages.info/
4 http://sustainable-livestock.ilri.org/2016/08/04/feedseed-ethiopia/

varieties resistant to smut developed In Kenya (Mwendia et al. 2008) and Uganda (Kawube et al. 2014).

Successful models of Public-Private Partnerships for creating and strengthening feed and forage supply chains. The FeedSeed program implemented in Ethiopia successful built the capacity of 30 seed entrepreneurs, 12 of which sold USD616,000 worth of forage seen in one season.

Strong strategic partnerships with national programs and businesses in target countries who can test and roll-out these technologies. Target countries include but are not limited to Ethiopia, Kenya, Tanzania, Uganda, Nigeria, India and Mexico. As of 2018, BecA-ILRI Hub and its partners have leveraged national partnerships to expand the use of Brachiaria to 15 countries in Africa; 35,000 farmers in Kenya are now planting Brachiaria as a result of outreach efforts.

Close partnership with CIAT guided by an MOU (signed in 2017) to leverage each institution's strengths to deliver the best forages for livestock keepers globally. For example, ILRI will apply advanced molecular genetics techniques to support CIAT's breeding program to select new and improved Brachiaria varieties.

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