



INITIATIVE ON
Livestock and Climate



Improved forages for increased livestock productivity and climate change adaptation and mitigation

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53 new accessions of Napier grass received at Forage Genebank, ILRI, Addis Ababa from EMBRAPA, Brazil early August 2013 (photo credit: ILRI).

Key Messages



- Climate change negatively impacts livestock production in low- and middle-income countries, affecting feed availability, animal health, and productivity.
- Improved forages enhance climate resilience by increasing productivity, improving feed quality, and reducing greenhouse gas emissions.
- A wide variety of improved forages are available, each with unique characteristics suited to different agro-ecological conditions.
- Engaging and empowering lead farmers—often referred to as pioneer farmers, champion farmers, or positive deviants—to promote improved forage species are key strategies for enhancing livestock productivity and advancing climate change adaptation and mitigation.
- Policy interventions are needed to promote the wider adoption of improved forages, including support for seed systems, and provision of training and financial incentives and investment in research and development.
- Metrics such as forage yield, livestock productivity, greenhouse gas emissions, and soil carbon sequestration can be used to track progress towards sustainable and resilient livestock systems.

This brief is a companion piece to the overall report “**Livestock and Climate Change: Outlook for a more sustainable and equitable future**”. The overall report and its associated briefs are legacy products of the CGIAR Livestock and Climate Initiative drawing from science generated during the 2022-2024 life of the research project.

Climate change poses a significant threat to livestock production in low- and middle-income countries, jeopardizing the livelihoods of millions who depend on livestock for food security and income. Rising temperatures, erratic rainfall, and extreme weather events disrupt feed supplies, reduce animal productivity, and exacerbate poverty (Idupulapati et al. 2014). The livestock sector in these regions is particularly vulnerable due to its reliance on rain-fed pastures and limited access to improved forage technologies (Idupulapati et al. 2014). Further compounding the issue is the predicted increase in demand for animal products by 2050 and the pressure to decrease pollutant output (Hart et al. 2022).

Improved forages—grasses, legumes, and other plants specifically planted to feed animals and selected or bred for desirable traits such as higher yield, improved nutritional value, and greater tolerance to drought and other environmental stresses—offer a critical solution for climate change adaptation and mitigation in livestock production. These forages enhance livestock productivity, ensure a steady feed supply, and reduce greenhouse gas emissions (CIAT 2025).

The Impact of Climate Change on Livestock Production

Climate change affects livestock production in several ways:

- **Reduced Feed Availability:** Changes in temperature and rainfall patterns can lead to decreased forage production and quality, affecting livestock nutrition and productivity (Giridhar and Samireddypalle 2015).
- **Increased Heat Stress:** Rising temperatures can cause heat stress in livestock, leading to reduced feed intake, decreased reproductive function, increased disease pressure, and lower meat and milk production (Idupulapati et al. 2014).
- **Water Scarcity:** Droughts and erratic rainfall can limit water availability for livestock, affecting their health and productivity (Idupulapati et al. 2014).
- **Spread of Diseases:** Climate change can alter the distribution and prevalence of livestock diseases, increasing the risk of outbreaks and economic losses (Cheng et al. 2022)



Farmers being introduced how the feed choppers function by the manufacturer Innovation Lab for Small Scale Irrigation Project (photo credit: ILRI/Apollo Habtamu)

Improved Forages for Climate Change Adaptation and Mitigation

Improved forages offer a crucial solution to the challenges posed by climate change to livestock production by offering a multitude of benefits:

- **Reducing Greenhouse Gas Emissions:** Improved forages can significantly contribute to climate change mitigation due to their high digestibility, which in turn reduces methane emissions from livestock (Idupulapati et al. 2014). Certain legume forages further reduce methane emissions due to presence of antimethanogenic compounds. Certain grasses have also shown the ability to reduce soil nitrification, in turn nitrous oxide emissions from soil. Indirectly, increasing land productivity can reduce land use change related emissions.
- **Enhancing Resilience to Extreme Weather Events:** Improved forages can help livestock systems withstand the impacts of extreme weather events. Drought-tolerant forages, such as *Urochloa* grasses with their deep root systems, can maintain feed supply during periods of water scarcity (CDD 2013). Some forages can even tolerate temporary waterlogging, providing a valuable feed source in flood-prone areas (CDD 2013).
- **Carbon Sequestration:** Certain forages, particularly those with deep root systems, enhance soil carbon sequestration, effectively removing carbon dioxide from the atmosphere (Idupulapati et al. 2014). Research has shown that in areas of high rainfall, well-managed *Urochloa* grasses can sequester as much carbon as native forests, or even more (CDD 2023).
- **Supporting Biodiversity:** Diverse forage systems promote biodiversity, contributing to ecosystem stability and resilience (Idupulapati et al. 2014). Other pathways include optimised grazing management and reduced land use change.

These benefits are further enhanced by advanced grazing management systems, which create positive feedback loops that improve soil organic matter content, water holding capacity, and nutrient cycling, boosting the resilience of forage-based livestock production systems in the face of a changing climate (CIAT 2024). Improvements in grazing land management and forage production are among the most effective options for increasing soil carbon sequestration and mitigation potential of livestock systems (Silveira et al. 2022).

Challenges to Adoption

The four benefits mentioned above are primarily long-term and may not immediately translate into direct financial gains for farmers, such as increased income from higher production, especially in the absence of robust carbon markets. Furthermore, and despite the numerous benefits of improved forages, several challenges hinder their wider adoption:

- **Lack of access to quality seeds:** Farmers often have limited access to high-quality seeds of improved forage varieties. This can be due to limited availability, high costs, or inadequate seed distribution networks (Abazinab et al. 2022).
- **Limited knowledge and technical expertise:** Many farmers lack the knowledge and skills to effectively establish and manage improved forages. This includes selecting appropriate forage varieties, establishing and managing forages, and integrating forages into livestock production systems (Abazinab et al. 2022).
- **Financial constraints:** The initial investment costs for establishing improved forages can be a barrier for some farmers, particularly those with limited financial resources (Abazinab et al. 2022).
- **Land tenure insecurity:** In some regions, land tenure insecurity discourages farmers from investing in long-term improvements like establishing improved forages. Without secure land rights, farmers may be hesitant to make investments that they may not be able to reap the benefits of in the future. (Abazinab et al. 2022)

Policy Recommendations

To promote the wider adoption of improved forages, the following policy interventions are recommended:

- **Identify and empower lead farmers:** lead farmers—recognized for their innovation and community leadership—to establish demonstration plots showcasing improved forage species. These plots serve as practical examples, allowing other farmers to observe benefits such as increased biomass and enhanced livestock nutrition. Facilitate farmer-to-farmer learning through field days and workshops and provide continuous training and resources to ensure the success and sustainability of these initiatives.
- **Support seed production and distribution:** Policies should support the production and distribution of high-quality seeds of improved forages, ensuring that farmers have access to these essential inputs (Sperling et al. 2005). This may involve establishing seed production systems, providing subsidies for seed purchase, and strengthening seed distribution networks.
- **Provide training and extension services:** Farmers need access to training and extension services to gain the knowledge and skills required to effectively establish and manage improved forages (Tesfay et al. 2014). This should include information on selecting appropriate forage varieties, establishing and managing forages, and integrating forages into livestock production systems.
- **Offer financial incentives:** Financial incentives, such as subsidies or grants, can help overcome the initial investment costs and encourage farmers to adopt improved forages. These incentives can be accessed through programs like the Environmental Quality Incentives Program (EQIP), which provides financial and technical assistance to agricultural producers for implementing conservation practices (USDA 2015).
- **Develop markets for sustainable livestock products:** Creating markets for livestock products from improved forage systems can incentivize farmers to adopt these practices (Report Linker 2022). This may involve promoting the nutritional and environmental benefits of these products to consumers and creating market linkages between producers and buyers.
- **Integrate climate change considerations into livestock policies:** Climate change considerations should be integrated into livestock policies to ensure that the sector is resilient to the impacts of climate change (Moreno et al. 2022). This includes incorporating forages into national climate action plans and livestock development strategies. Improving livestock productivity through enhanced feeds, combined with reducing herd sizes, could significantly lower emissions in many cases. As highlighted in the research, policies that focus on emissions from land-use change are likely to be the most effective climate strategies involving livestock (Havlík 2014).
- **Invest in research and development:** Continued investment in research is needed to develop improved forage varieties that are adapted to different farming systems and agro-ecological conditions, that are resilient to climate change and reduce (directly or indirectly) GHG emissions (Notenbaert et al. 2021; Earlham Institute 2025). This should include research on plant stress tolerance, high yield, improved nutritional value, and reduced methane emissions as well as on system agronomy and social science



Senegal dairy genetics project: improved food and nutritional security from better utilisation of dairy cattle breed-types types in Senegal.(photo credit: ILRI/Karen Marshall)

Policy Outcomes and Impact

Implementing these policy recommendations can lead to several positive outcomes:

- **Increased livestock productivity:** Improved forages can lead to higher yields of milk, meat, and other livestock products, contributing to increased income for farmers and improved food security (Alemayehu et al. 2024).
- **Enhanced climate resilience:** Climate-tolerant and high-yielding forages can help maintain a steady feed supply for livestock even during periods of water scarcity or extreme weather events (Havlík et al. 2014).
- **Reduced greenhouse gas emissions:** Improved forages and reduced herd size can contribute to climate change mitigation by reducing methane emissions from livestock, nitrous oxide from soil, while also enhancing soil carbon sequestration (Earlham Institute 2025).
- **Improved livelihoods:** Increased income from livestock production can help reduce poverty and improve the livelihoods of smallholder farmers in tropical regions (Alemayehu et al. 2024).
- **Environmental sustainability:** Improved forages can contribute to environmental sustainability by improving soil health, conserving water resources, and supporting biodiversity (Notenbaert et al. 2021; Alemayehu et al. 2024).

Metrics for Measuring Progress

To track progress towards sustainable and resilient livestock systems, the following metrics can be used:

- **Forage yield and land productivity:** Measure the productivity of improved forages in terms of biomass or protein production per unit area.
- **Livestock productivity:** Monitor changes in milk yield, meat production, and other livestock production parameters.
- **Greenhouse gas emissions:** Measure methane emissions from livestock and nitrous oxide emissions from soils.
- **Soil carbon sequestration:** Assess the amount of carbon stored in soils under improved forage systems.
- **Socioeconomic indicators:** Track changes in farmer income, food security, and poverty levels.

Conclusion

Improved forages offer a multitude of benefits for livestock production in low- and middle-income countries, particularly in the face of climate change. By enhancing productivity, ensuring a steady feed supply, and mitigating greenhouse gas emissions, improved forages contribute to both climate change adaptation and mitigation. Farmers and policymakers have a crucial role to play in promoting the wider adoption of improved forages through supportive policies and interventions. By investing in research and development, strengthening seed systems, providing training and financial incentives, and integrating climate change considerations into livestock policies, policymakers can help unlock the full potential of improved forages for sustainable and resilient livestock production in tropical regions. Addressing the challenges to adoption, such as limited access to quality seeds and lack of knowledge, through targeted policy interventions can lead to increased livestock productivity, enhanced climate resilience, reduced greenhouse gas emissions, improved livelihoods, and environmental sustainability. The metrics outlined provide a framework for monitoring progress towards these goals and ensuring the long-term viability of livestock production in low- and middle-income countries.

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