



Growing food and feed with less environmental impact: A dual-crop impact narrative

Did you know?

- Feed represents, on average, around 70% of the cost of milk production. However, through better use of crop residues, this can be reduced to 50%.
- Among crop cultivars of a given species, sufficient genetic variations exist that selection for fodder traits can ultimately result in a 3 to 5 litre increase in daily milk production per animal.
- By doubling average daily milk production in India from about 4 to 8 litres per animal, feed requirements could be almost halved and total methane emissions from dairy reduced by around 1 million tonnes annually.
- Multi-dimensional crop improvement could contribute to reducing water requirements for milk production by a factor of four.
- Crop residues are transported over several hundred kilometres in specialised fodder value chains.

Dual-purpose crops, which produce both high grain yields and nutritionally-rich crop residues for livestock, allow combined production of food and fodder from the same land and using a similar amount of water and labour. Such crops particularly benefit smallholders with mixed livestock-crop farming systems, addressing common problems such as poor availability of quality livestock feed and strong competition for land. Much research to improve the feed value of fodder in recent decades has emphasised post-harvest treatment of crop residues. In contrast, ILRI and its partners have focused on crop breeding, to develop improved crop cultivars that better match farmers' needs for both grain and nutritious residues. In India, for example, research has shown that improved sorghum residue, combined with feed fortification, could more than triple average daily milk yields from 4 to 15 litres per animal.

Context

In developing countries, crop residues are an important source of fodder. In India, for example, dried leaves and stalks of crops such as wheat, maize and sorghum, also known as stover, provide around 70% of the available dry matter for feeding livestock. However, while the demand for animal-based products is increasing at a rapid rate, the natural resource base for feed and fodder production is shrinking, particularly in terms of arable land and water. In many regions, farm plots are becoming too small to sustain both fodder and food crops and areas of public land, often

used for grazing among marginal and landless communities, are also decreasing. As a result, in parts of India, weight for weight, crop residue prices are now approaching, and sometimes even exceeding, half the price of the grain.

Beyond such pressures, residues, especially from cereals, are often of low nutritional quality. This impacts on livestock productivity, farmers' livelihoods and the economics of livestock production, as well as natural resource use efficiencies. Scarcity of fodder during dry seasons is a particular hindrance for farmers wanting to improve their year-round livestock productivity.

In responding to these challenges there is an urgent need to improve feed and fodder resources without jeopardising food security or over-taxing natural resources. In this context, an important strategy is the genetic improvement of fodder quality, i.e. during crop improvement and cultivar release processes. This strategy has the advantage of not requiring farmers to adopt new technological complexities, since essentially only the seeds are changed – a development path already pursued successfully many times.

Africa RISING field day in Sinana, October 2013.



Food and fodder – twin targets for crop breeding

While Indian farmers have traditionally been aware of differences in the fodder quality of crop residues even within the same species, until recently, fodder traits of crop residues were largely ignored in crop improvement. As a

result, new cultivars improved only for their grain yields were sometimes rejected by farmers, since they failed to meet their needs in terms of supplying livestock feed.

ILRI's research approach focussed on establishing strong cooperation between scientists working in animal nutrition and crop improvement, particularly those involved in studying the characteristics of individual plant species. This aimed to support and develop 'phenotyping' platforms that could assess crop residue quality traits in numerous samples, quickly and affordably. Existing cultivars of key cereal and legume crops were investigated to assess their fodder quality, and both conventional and molecular breeding techniques were used for genetic enhancement of desired fodder traits.

From its links with national and international crop breeding institutions, ILRI recognised the critical need to demonstrate that improvement of crop residue quality and quantity should be incorporated within mainstream crop improvement efforts. Through collaborative work, the Institute was able to convince its partners that high demand for good quality crop residues is a reality and will become stronger. ILRI scientists were also able to demonstrate that selecting food crop varieties with desirable residue traits could make a significant improvement to livestock nutrition, without any loss in crop yield, and that such varieties had a much greater chance of being adopted by farmers.

As a result of these efforts, several key national and international institutions started to seriously explore crop residue traits as additional important traits in crop improvement. In particular, ILRI worked with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and partners from the Indian Council of Agricultural Research (ICAR) to initiate several multi-disciplinary research projects creating crop cultivars that better matched farmer's needs for grain and fodder.

In 2002, ICRISAT introduced an early maturing, high yielding and drought-tolerant groundnut variety (ICGV91114), which produced 15 per cent higher pod yields, 17 per cent more haulm and better quality fodder than the locally grown variety. Farmers who fed their cows and buffalo the improved fodder saw their milk production immediately increase by 11%. A subsequent impact study estimated that adopters of the new variety earned around US\$970 from sales of groundnut and milk – four times more than from growing the local variety. Within 10 years the variety was estimated to be grown on 25,000 ha in one groundnut dominated district (Anantapur) alone and, by 2013, was the third most popular All India breeder seed multiplied by federal and state seed cooperations

In another example, the Indian Directorate of Sorghum Research included stover quantity and quality as desirable criteria for their new cultivars. All new cultivars, identified and released every two to three years, now need to be 10% superior than best local check cultivars in grain and stover yield; stover digestibility needs to at least match that of the local check. The most recent such cultivar, a winter season variety named BJV 44, is currently planted on at least 5,500 acres, with seed availability reportedly the major constraint to greater adoption.

Within the agricultural research centres of the CGIAR, there has also been an acknowledgement of the need to simultaneously improve grain yields, residue yields and fodder quality. As a result, CGIAR research programs focussed on maize, rice, sorghum, pearl millet, barley, cowpea and groundnut have all added the improvement of crop residue quantity and quality to their breeding criteria, with this now becoming the mainstream approach. Mainstreaming development of dual purpose crops in India would benefit more than 200 million people owning about 25% and 35% of India's bovine and small ruminant population, respectively. The benefit-cost ratio of the research was estimated 15 to 69:1 depending on the lag time of new cultivar adoption.

Next steps

The increasing demand for livestock products represents an exciting opportunity for livestock farmers to find new markets and increase their income. However, globally, livestock production faces increasing pressures because of its negative environmental impacts, not least its high demand for water and contribution to greenhouse gas emissions. Finding environmentally sustainable ways for small-scale livestock keepers to meet the demand for milk and meat is therefore imperative, with dual purpose crops showing considerable potential.

The progress made by ILRI and its partners in developing highly productive dual purpose crops serves as an eye-opener to researchers and presents a strong case for further, stronger collaboration between national and international crop and livestock institutions. It also paves the way for more extensive efforts to further develop dual-purpose varieties of key crops for mixed crop-livestock

systems, which will be crucial in meeting food and nutrition security demands in the coming decades.

However, extending such varieties to a significant number of farmers is likely to prove challenging. Many of those already improved, such as BJV 44 and ICGV 91114 are open pollinated, and therefore produce fertile grain, which farmers can save for re-planting the next year. While this can be an advantage to farmers, it is a disincentive to private sector seed companies, since farmers may only need to buy new seed from them every three or four years. As a result, such companies may have little enthusiasm to take up large scale seed production for these new varieties. However, hybrids are gaining more and more ground over open pollinated varieties and the private sector is heavily engaged and invested in hybrid seed production and dissemination. Thus several very promising dual purpose pipeline maize hybrids have been identified by ILRI-CIMMYT collaboration in 2013 and by 2014 were already pilot tested in 3 states in India, made possible by collaboration with the private seed sector.

References:

- Blümmel, M., Haileslassie, A., Samireddypalle, A., Vadez, V. and Notenbaert, A. 2014. Livestock water productivity: feed resourcing, feeding and coupled feed-water resource data bases. *Animal Production Science* 54 (10) 1584-1593.
- Blümmel M., Anandan S. and Wright I. A. 2012. Improvement of Feed resources and Livestock Feeding in Mixed Cropping Systems. IN: Mehra, U. R., Singh, P., and Verma, A. K. *Animal Nutrition Advances and Development*. Satish Serial Publishing House, India: 459-475.
- Kristjansson, P. M. and Zerbin, E., 1999. Genetic enhancement of sorghum and millet residues fed to ruminants ILRI Impact Assessment Series 3. Nairobi: ILRI.

Moses Siambi (ICRISAT) looks at sweet sorghum varieties being tested for biofuel production by Eco-Energia at Ocuva, Mozambique.





Photo credits:

Page 1: (left) CIAT (right) CIAT/Neil Palmer

Page 2: ILRI/Apollo Habtamu

Page 3: ICRISAT/Swathi Sridharan

Page 4: CIAT/Neil Palmer

This is one of a series of briefs documenting the impacts of ILRI's research.

It was prepared by WRENmedia with inputs by Michael Blummel.

Contact

Michael Blummel, ILRI
m.blummel@cgiar.org



ilri.org

Better lives through livestock

ILRI is a member of the CGIAR Consortium

Box 30709, Nairobi 00100, Kenya
Phone: +254 20 422 3000
Fax: +254 20 422 3001
Email: ILRI-Kenya@cgiar.org

Box 5689, Addis Ababa, Ethiopia
Phone: +251 11 617 2000
Fax: +251 11 617 2001
Email: ILRI-Ethiopia@cgiar.org

