Getting superior Napier grass to dairy farmers in East Africa

Key fact
To meet demand for high-yielding, disease resistant fodder from smallholder dairy farmers in East Africa, scientists from the Kenya Agricultural Research Institute (KARI) and the International Livestock Research Institute (ILRI) worked together to select and distribute smut-resistant varieties of Napier grass.

Summary
Napier grass has become the most important fodder crop in Kenya, but 20 years ago head smut disease began to have a devastating impact, turning valuable fodder into thin, shrivelled stems. With the cost of disease control using systemic fungicide beyond the means of most smallholder dairy farmers, KARI began work to select smut-resistant varieties.

With access to Napier grass germplasm from ILRI’s genebank, KARI developed two resistant varieties - *Kakamega I* and *Kakamega II*. Favourable laboratory results were confirmed in farmer’s fields and work began to multiply planting material. Within a year, cuttings were distributed to over 10,000 smallholder farmers. The new varieties are not quite as productive as the best of Kenya’s local Napier grass varieties, but have still proven popular in smut-affected areas. By 2007, 13 per cent of farmers were using *Kakamega I* for zero grazing systems in smut prone areas.

The chance of head smut resistance breaking down in the new varieties is high, so KARI is screening more materials from ILRI, which is continuing to build its Napier grass collection to have germplasm available to screen for new resistant varieties. In 2012, ILRI provided the Brazilian Agricultural Research Corporation, Embrapa, with *Kakamega I* and *II* to enable researchers to use them to develop higher yielding and more nutritious resistant varieties.

Facts & figures
- Head smut disease reduces Napier grass yields by 25-46% and many smallholders have lost up to 100% of their Napier grass crop due to stunt disease, another emerging disease.
- Napier grass constitutes between 40-80% of the forage used by more than 0.6 million smallholder dairy farms in Kenya. By 2007, 13% of farmers were using *Kakamega I* for zero grazing systems in smut prone areas of Kenya.
- The ILRI germplasm collection, maintained in ILRI’s genebank, is an important source of germplasm for screening for disease tolerance, productivity and feed quality.
- ILRI provides seeds and planting material to support forage use by smallholders and demand for Napier grass cuttings increased in Ethiopia from around 100,000 cuttings over the 1990s to more than 2 million in the next decade.
- Building upon the planting material and capacity strengthening developed by ILRI, NGOs and the private and public sector in East Africa have been able to grow and distribute forage seed and planting material over recent years.
European funding
ILRI received direct funding from the European Union, Germany, Switzerland and the United Kingdom to support their forage diversity work and forage genebank. In addition, ILRI has also been supported with unrestricted support from Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Sweden, Switzerland and the UK’s Department for International Development (DFID).

Project milestones
- 1992: ILRI provides material of nine promising Napier grass clones to KARI for screening in Kakamega.
- 1994-1995: Kakamega I and II are developed from these ILRI accessions by KARI.
- 1996-97: The two varieties are screened for smut resistance by KARI.
- 2000-01: Kakamega I is screened for biomass production and nutritional value at KARI Kitale.
- 2005: Kakamega I has been distributed to 1,383 farmers in smut affected areas.
- 2007: 13 per cent of farmers are using Kakamega I for zero grazing systems in smut prone areas of Kenya but there are concerns over them having lower yields than susceptible varieties.
- 2007: Collaboration between ILRI and KARI to develop methods for early detection of smut to speed up the search for resistant material and prevent further spread of the disease.
- 2010: A probe based on ß-tubulin, an optimised extraction protocol and ITS primers are identified for laboratory use in detection of smut in Napier grass tissue using polymerase chain reaction (PCR) technology.
- 2010: Smut detection technologies are transferred to two technicians from KARI for diagnostic testing in Kenya.
- 2011-2012: KARI is testing more germplasm from the ILRI genebank to look for more smut tolerant lines.
- 2012: ILRI sends Napier grass varieties to Brazil for breeding to improve yield and quality.

Costs and benefits
Based on figures from Mwendia for production losses due to smut of about 0.2 tonnes per hectare per year for zero grazing systems, the annual loss to a smallholder farmer would be equivalent to 22 days of feed for a dairy animal, a loss in income on 220-330 litres of milk. For farmers growing Napier grass for sale to dairy producers - considering the cost of Napier grass at US$15 per tonne and an estimated yield of 18 tonnes per hectare per growing season - a reduction of 40 per cent of the yield due to smut would cost a farmer US$108 in lost income from Napier grass sales. These losses can be offset by using Kakamega I rather than a susceptible variety.

Multimedia material
Saving Animal Feed Plants to Preserve Livelihoods
Putting ILRI’s Genebank to Work

More information
International Livestock Research Institute - www.ilri.org/foragediversity

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Dairy farming, Kenya’s leading livestock sector activity, is vital for the livelihoods and food security of millions of Kenyans. More than 80 per cent of milk produced and sold in Kenya comes from smallholder farmers, typically raising just one or two dairy cows on small plots of land. Women perform half of all dairy related activities in Kenya, which improves household welfare, primarily through increased household income and milk consumption.

With a growing population and shrinking areas for pasture, cattle are increasingly being fed on crop residues, cultivated fodder and some concentrates. Ninety per cent of farmers now produce on-farm feeds. Being able to provide enough good quality fodder is by far the most important factor in achieving high milk quality and yield, with a well fed animal producing two or three times more milk than an averagely fed one.

The high yielding fodder, Napier grass - *Pennisetum purpureum* - has become by far the most important due to its wide adaptation to different regions, high yield and ease of propagation and management. Napier grass constitutes between 40-80 per cent of the forage for more than 0.6 million smallholder dairy farms. With fodder in high demand, selling Napier grass as a business has good potential for improving smallholder livelihoods. According to a recent survey, up to 58 per cent of Kenyan smallholder farmers already sell fodder, including crop residues, straw or grass.

However, in the early 1990s, head smut disease, caused by the fungus *Ustilago kamerunensis*, began to have a devastating impact on Napier grass. Spread rapidly by wind and infected plant material, smut turned valuable Napier grass into thin, shrivelled stems and reduced yields by 25-46 per cent. For smallholder farmers, the threat was very serious.

Disease control using systemic fungicide in fodder crops is very expensive and therefore beyond the means of most smallholders. Using tolerant high yielding varieties is a cost effective solution and avoids the additional costs of moving to a different feeding system. The International Livestock Research Institute (ILRI) maintains an international collection of forage germplasm under the auspices of the International Treaty on Plant Genetic Resources for Food and Agriculture. The state of the art genebank, based in Ethiopia, holds over 19,000 forage accessions, including 60 genotypes of Napier grass.

In 1992, scientists from the Kenya Agricultural Research Institute (KARI) and ILRI began collaborative work to screen new clones of Napier grass for improved productivity. The best lines were released as *Kakamega I* and *II*. In 1996, in response to the threat of head smut, KARI began further screening to find smut-resistant varieties of Napier grass. *Kakamega I* and

Dairy farming is Kenya’s leading agricultural sector
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Head smut disease
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Kakamega II were identified as both high yielding and resistant to head smut. The favourable results obtained in the laboratory were confirmed in farmers’ fields and work began immediately to multiply planting material in government institutions. Within the first year, cuttings were distributed to over 10,000 smallholder farmers.

In 2001, KARI’s Muguga research station received numerous requests for Kakamega root splits to multiply the material, and some schools in the area are, at the request of parents, using school gardens to multiply the material. The most productive clone, Kakamega I, is grown at bulking sites maintained by Farmer Training Centres and Parent-Teacher Associations and disseminated through KARI, the local agricultural offices and by farmer to farmer exchange.

The new varieties - developed using material from Swaziland and Zimbabwe by KARI - are not quite as productive as the best of Kenya’s local Napier grass varieties, but have still proven popular in smut-affected areas. By 2007, 13 per cent of farmers in smut prone areas of Kenya were using Kakamega I for zero grazing systems.

Another serious disease - Napier grass stunt - was identified in Western Kenya in 2002. Affected shoots become pale yellow in colour and seriously dwarfed. Often the whole stool is affected, with yield reductions of 75 per cent and even complete loss in yield and eventual death. In badly affected areas, smallholders have lost up to 100 per cent of their Napier grass crop and are then forced to sell their animals.

Between 2007 and 2010, an Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)-funded project worked to reduce the impact of smut and stunt by raising awareness of the diseases and providing information on how to manage them. ILRI, in partnership with KARI, icipe, Rothamsted Research, Tanzania’s National Biological Control Program and Uganda’s National Livestock Research Institute, developed improved management practices to reduce the incidence and spread in farmers’ fields. For both diseases, digging up infected plants and replacing them with healthy canes is the best strategy. Smut infected plants should be burnt to kill the fungus.

During this period, ILRI provided KARI with a large pool of Napier grass germplasm from the forage genebank, developed an early screening test for smut, and provided training to KARI scientists on the technology - essential when looking for

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Patrick Mogoko, farmer, Kiambu, Kenya

Alexandra Jorge, ILRI’s genebank manager

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“The ILRI genebank is a tremendous resource, not only for now, but also for the future, to provide the genes that allow plants to adapt to climate change or low soil fertility. Additional research will extract these useful genes.”

Jean Hanson, ILRI

Kakamega I was identified as high yielding and smut resistant

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resistant plants - and on field diagnosis of the disease.

Despite the success of Kakamega I and Kakamega II, some major hurdles remain. One is the danger posed by relying on just two varieties which are clonally propagated, meaning that the new plants are genetically identical to the parent. This means the chances of the resistance to smut being broken down are high. KARI scientists have already begun to screen germplasm from over 50 Napier grass accessions to select further resistant varieties. The aim is to increase the number of varieties that can be distributed and identify plants that combine smut-resistance and high yields.

With feedback from farmers that Kakamega I and Kakamega II aren’t quite as productive as other local Napier varieties, in August 2012 ILRI exchanged resistant lines with the Brazilian Agricultural Research Corporation (Embrapa), which has a Napier grass breeding programme with highly productive lines. Through cross-breeding, Brazilian researchers are working to develop lines with better agronomic and nutritional value as well as disease resistance.

References


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