# Physical Constraints in Grassland Ecosystems

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# Improved livelihoods from grasslands; the case of Napier grass in smallholder dairy farms in Kenya

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## Key points

1. Many in Kenya consider smallholder dairying as the path out of poverty.
2. The geographic distribution of the smallholder dairy industry is influenced by a combination of socio-economic market access and biophysical constraints on forage production.
3. Napier grass has established itself as the forage crop of choice in intensive smallholder dairy farms.
4. Combining bio-physical constraints to the adoption of planted fodder with farmer's socio-economic situation can help to better target forage technologies.
5. Over dependency on one crop, especially where the genetic diversity is low, can be dangerous.

**Keywords:** market access, forage adoption, socio-economic factors, forage technology

## Introduction

In Kenya, smallholder farmers produce about 80% of the marketed milk. The farming systems vary from mixed farms with up to 10 ha of land and <10 dairy cows (Gitau *et al.,* 1994; Anon., 1985), to intensive smallholder dairy producers in the high human population central Kenya region with 0.9 to 2 ha of land and 3-4 dairy cows (Staal *et al.,* 2001a). Milk production depends heavily on the cultivation of forages, with *Pennisetum purpureum* (Napier grass) by far the most important. An estimated 350,000 of the 600,000 smallholder farms in Kenya grow and utilize *P. purpureum* on their farms.

There are various published data indicating the level of dependence on sown forages. In a survey of 21 smallholder dairy farmers in the highlands of Kenya, Romney *et al.* (2004) found that *P. purpureum* supplied approximately 40 and 60% of the feed offered to dairy cows in the dry and wet months respectively, with the remaining feed provided by concentrates, crop residues (mainly *Zea mays* (maize) stover) and other cut and carry fodder such as roadside grass. In the more intensive cut and carry systems of production practiced in central Kenya, McLeod *et al.* (2003) found that *P. purpureum* was grown by over 70% of the smallholder farmers in their study area. In farm level characterisation surveys of over 3300 households conducted between 1996 and 2000 in central Kenya, 62% kept livestock and more than 50% were growing *P. purpureum*. Farmers were also growing fodder legumes such as *Sesbania grandiflora* (Sesbania), *Leucaena leucocephala* (Leucaena), *Calliandra calothyrsus* (Callindra), *Desmodium intortum/uncinatum* (Desmodium) and *Medicago sativa* (Lucerne), but the frequency did not exceed 7.5% (Staal *et al.,* 2001b).

**What factors lead to the adoption of *Pennisetum purpureum*?**

It is argued that the adoption of a forage crop is not influenced by fodder characteristics alone, but by a complex set of factors including farmer and farm resource base, agro-climatic factors and market access. Staal *et al.* (2002) showed the likelihood of adopting *P. purpureum* increased as i) the number of years of farming experience and education of the household head increased, ii) distance from urban centres decreased, and iii) rainfall increased. Thus, while the adoption of *P. purpureum* as the feed of choice in Kenya is principally due to its forage characteristics in comparison with alternatives, the adoption of a cultivated forage *per se* is likely due to the other socio-economic factors outlined above.

*Forage characteristics*

In order to establish a basis for further discussion, the forage characteristics of *P. purpureum* are briefly outlined prior to addressing the more important factors that led to its adoption.

- The ease of establishment from stem cuttings or root splits overcomes a major constraint to the adoption of a forage crop (Thomas & Sumberg, 1995; Mwangi & Wambugu, 2003).
- High biomass yield is an essential characteristic for smallholder dairy systems where land is a major limiting factor. Dry matter production of 10-20 t/ha per annum have been reported with minimal fertilizer application (Aninda & Potter, 1986), with increases to about 30 t/ha per annum with manure application or intercropping with forage legumes (Mwangi & Wambugu, 2003; Mwangi *et al.,* 2004). These yields compare with 6-8 t/ha per annum from *Chloris gayana* (Rhodes grass) under similar conditions, making *P. purpureum* attractive to smallholder farmers facing land shortages.
- *Pennisetum purpureum* will grow in areas receiving over 600 mm of rainfall per annum, making it suited to most of the east African highlands. Figure 1 maps the potential natural distribution of *P. purpureum*, taking bio-physical factors into account.

The widespread use of *P. purpureum* in Kenya is being threatened by the spread of Napier headsmut, caused by *Ustilago kamerunesis,* which can reduce annual yield by 50-90%. Fortunately there is some variation for resistance to the disease among *P. purpureum* genotypes, and a conventional plant breeding program is under way to produce smut resistant cultivars.

*Socio-economic factors*

A study by Staal *et al.,* (2002, 2001a) has shown that the adoption of a cultivated forage (in this case mainly *P. purpureum*) was heavily influenced by farmer characteristics and access to milk markets. Data was collected from a household survey involving 3,311 households between 1996 and 2000, and GIS maps were produced using population density, the distance to the nearest urban centre and the condition of the road as a proxy for market access. Potential adoption of *P. purpureum* was predicted using these market access data and then combined with the bio-physical limits to determine areas where adoption of the grass was expected to be high (Figure 2). The findings of the survey were compared with the prediction made using GIS layers on market access and bio-physical limits (rainfall, temperature and soils) and the fit was more that 80% (Figure 3).

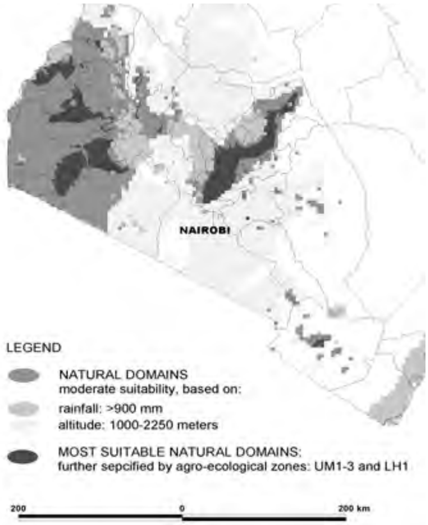


**Figure 1** Natural recommendation domains for Napier grass based on bio-physical limits. (Source, Staal *et al.,* ILRI, 2001a)

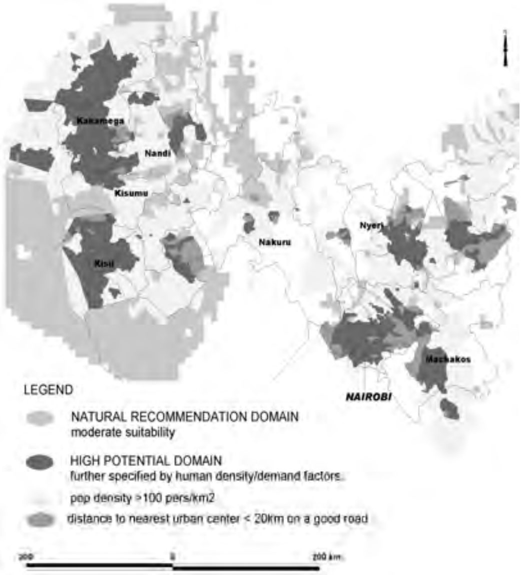


**Figure 2** Recommendation domain after combining the bio-physical limits and socio-economic factors. (Source, Staal *et al.,* ILRI, 2001a)

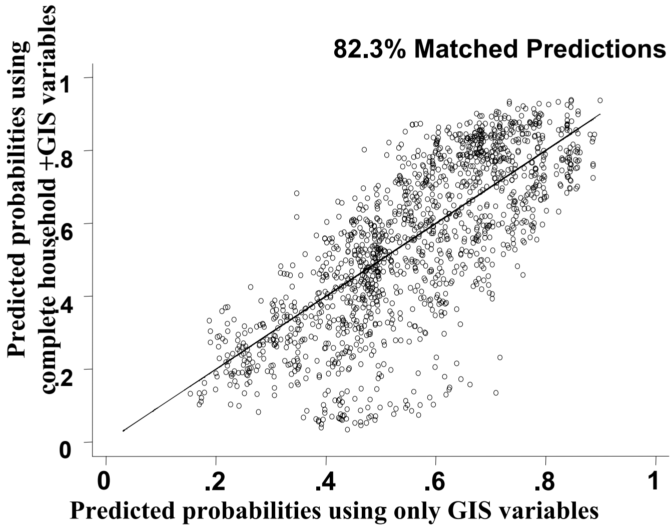


**Figure 3** Comparison of planted forage predicted using GIS tools and household survey

This milk industry case study indicates that where data are available, it is possible to use GIS and socio-economic statistics to define recommendation domains for planted forages. This would enhance adoption as dissemination efforts could be better targeted.

## Lessons learnt

1 The adoption of planted forages is not only determined by forage characteristics but also by the socio-economic situation of the farmer. Market access for livestock products and land availability are important factors in the adoption of *P. purpureum*. It is contended that policies that improve market access by the poor will result in uptake of planted forages.
2 GIS predictions can be used to fine-tune recommendation domains for forage technology so that extension activities can be targeted at areas where adoption is most likely.
3 The smallholder dairy sector in central Kenya has become reliant on *P. purpureum,* which provides 40-80% of the feed in the system. This high dependency on one fodder crop has a potential downside with the incidence of plant disease. This is particularly the case with *P. purpureum*, which is propagated vegetatively, meaning that the population will have a narrow genetic base. For this reason it is important to maintain the biodiversity of the forage plant and/or to develop alternative forages.

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