

Integrated pest management options to improve maize forage yield and quality for small-scale dairy farmers in central Kenya

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Summary

Many small-scale farmers in Central Kenya stall-feed cattle and a rapid rural appraisal (RRA) in the Kiambu district showed that 25% of the forage comes from the maize crop. Crop protection advice to farmers generally focuses on maize for grain and ignores the importance of the dairy animal in the livelihoods of these resource-poor livestock keepers. The RRA showed that the three principal biotic constraints on the maize crop were maize streak virus disease (MSVD), maize stalk borer and weeds. Experiments showed that early MSVD infections reduced forage offtake from the maize but had little effect on crop quality for livestock production. Tolerant cultivars such as Muguga-1 alleviate yield losses and the taste and cooking quality of this cultivar was acceptable to the farmers.

Weeds likewise seriously reduced forage production. However, for smallscale farmers in Kenya, weeds infesting maize crops provide a measurable source of animal forage, weed digestibility being 65% and crude protein 19.9%. Nevertheless, weeds greatly and directly reduced maize forage digestible dry matter and total crude protein.

The studies also showed that the management of the maize crop is modified by high density planting followed by thinning and delayed second weeding to allow greater forage production from the growing crop. Maize forage digestibility was highest in the thinnings while the stover was lower. Digestibility of stover was similar to the weeds. The impacts of these practices on weeds and MSVD has been studied showing that while high density planting suppresses weeds, a delayed second weeding may allow some shedding of weed seeds.

Integrated pest management options designed to address all three biotic constraints using non-chemical socio-economically appropriate methods will be discussed.

Key words: Forage, maize, maize streak virus disease, weeds, integrated pest management, rural appraisal

Introduction

Dairying is important for smallholders in Kiambu District of Central Kenya (Staal *et al.*, 1998) where 48% of 189709 households stall feed dairy cattle. The smallholder dairy sector in central Kenya produces about 80% of the total marketed milk (Omoro *et al.*, 1999). Due to reduced farm sizes, farmers are seeking to maximise food and feed by growing maize (*Zea mays* L.) in place of planted forage. Hence while Napier grass (*Pennisetum purpureum* Schumacher) has been reducing over the years (Staal *et al.*, 1998), farmers may dense plant maize and thin the extra plants for forage. In this farming system, therefore, crop protection may not only increase maize yields but it may also maintain milk production by ensuring a greater supply of quality forage throughout the dry season. Njuguna (1986) showed that MSVD is the most important disease of maize in Kiambu district. Weeds likewise compete for plant resources and cause 15 - 90% loss in maize yields in Kenya (Maina, 1997). Some weeds of maize are used for forage (Onim *et al.*, 1992) and farmers may delay their second weeding of the maize crop in order to use the weeds as forage. Agronomic maize research in Kenya has however generally ignored the use of maize thinnings, leaves and stover and edible weeds as sources of forage for livestock production. Integrated pest management (IPM) options are therefore desirable for maize which consider both human and livestock uses of the maize crop. This paper first of all quantifies farmers' perceptions of the importance of maize as forage and the impact of pest problems on maize forage. Experimental results showing some IPM options are then described.

Rapid Rural Appraisal

A Rapid Rural Appraisal was carried out in Kiambu district during April and May 2001. Rainfall in the district is bimodal and the long rains normally begin at the end of April or beginning of May. The study comprised two interviews with each of ten farmer focus groups. Groups consisted of either existing formal or informal groups within the study communities, or farmers from the community who were interested in attending the meetings. The sample of villages was chosen purposively to represent areas of high and low maize streak incidence, different production systems, and differences in resource endowment. Production systems were coffee-dairy, maize-dairy, vegetable-dairy and tea-dairy. Maize was grown in all systems.

Napier grass contributed 40% of the total available forage with maize thinnings, maize green stover and maize dry stover contributing 6, 10 and 8 % respectively to feed supply on farms in Kiambu District (Figure 1, McLeod *et al.*, 2001).

A long list of weeds was reported by the groups to be found in maize crops, including some with local names that could not be identified. Weeds that were reported by at least three groups are shown in order of their perceived impact on stover yield (Figure 2). *Commelina* species and *Bidens pilosa* L. were reported by all ten groups to be found in the long rains maize crop. Other very common weeds were *Galinsoga parviflora* Cav., *Digitaria abyssinica* (Hochst. Ex A. Rich) Stapf, *Tagetes minuta* L., *Cyperus* spp (nut grass) and *Oxalis* spp. Most weeds could be fed to livestock, though some such as *Datura* (not in the figure) are poisonous.

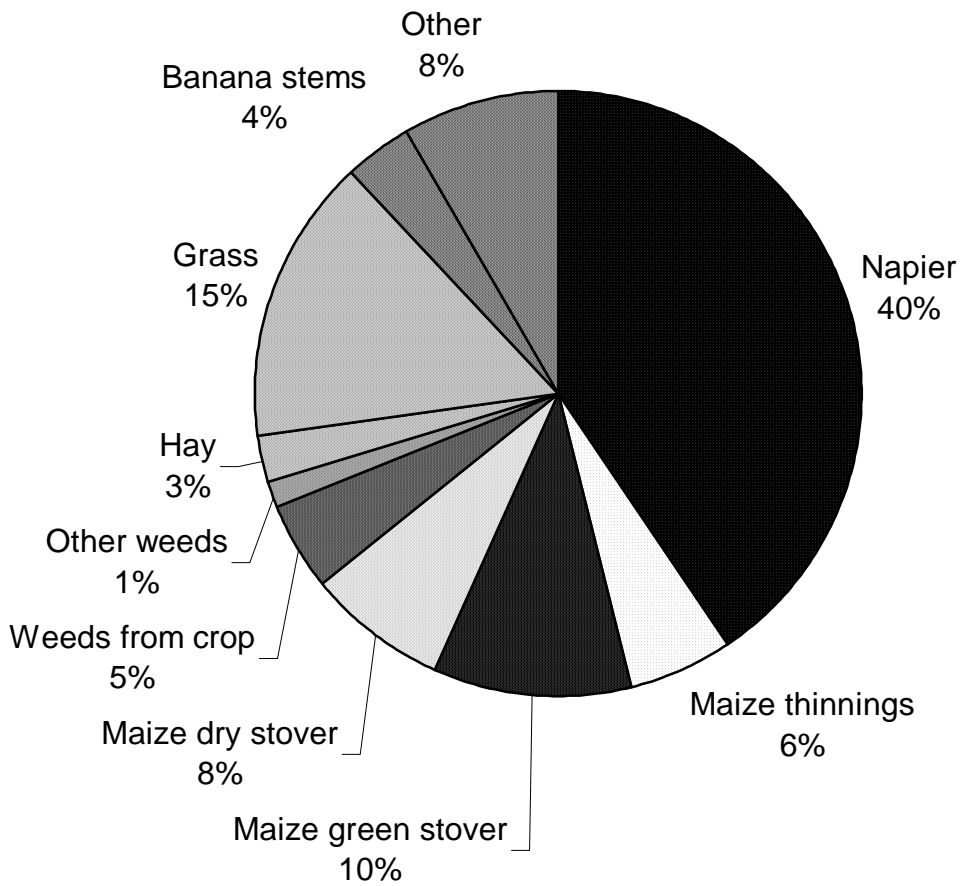


Figure 1. Total annual usage score for different forages in Kiambu, Kenya. (From McLeod *et al.*, 2001)

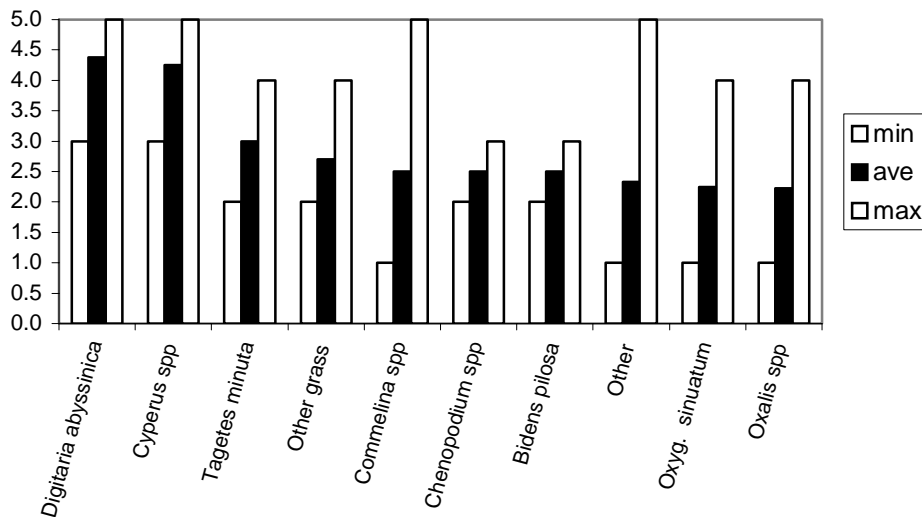


Figure 2. Farmer perceptions (0 = no effect; 5 = high impact) of the effects of weeds on maize stover yield in Kiambu, Kenya (From McLeod *et al.*, 2001).

Table 1. Percentage dry matter digestibility (DMD) and crude protein (CP) of edible weeds assessed 126 days after crop emergence and maize stover and thinnings in the 2001/2 short rains (from Maina *et al.*, 2003)

Weed type	DMD (%)	CP (%)
<i>Amaranthus spp</i>	52	8.5
<i>Emex australis</i> Steinh.	55	27.9
<i>Galinsoga parviflora</i>	64	19.7
<i>Erlangea cordifolia</i> (Benth.) S. Moore	65	16.4
<i>Ageratum conyzoides</i> L.	66	17.7
<i>Erucastrum arabicum</i> Fisch. & C. Mey	66	32.1
<i>Commellina benghalensis</i> L.	68	13.0
<i>Bidens pilosa</i>	68	16.5
<i>Leonotis mollissima</i> Guercke	68	22.7
<i>Sonchus oleraceus</i> L.	73	27.1
<i>Digitaria abyssinica</i>	74	16.9
Weeds mean	65	19.2
Maize stover mean	62.5	4.3
Maize thinnings mean	76.5	7.3

The most dominant and widespread weed species which were of value to farmers as foliage were *Galinsoga parviflora*, *Bidens pilosa*, *Commellina benghalensis* and *Amaranthus spp*. In separate field trials, dry matter digestibility of some edible weeds tested, ranged from 52 to 74% and the crude protein ranged 8.5 to 32% (Table 1). *Amaranthus spp* had the lowest CP (8.5%) and was also the least digestible (52%). On the other hand couch grass (*Digitaria abyssinica*) had the highest digestibility while its crude protein was about average. The mean DMD and CP of the edible weeds were 65% and 19% respectively. Maize forage dry matter digestibility and especially the crude protein were low in the stover compared to the weeds tested. The maize thinnings were better quality forage than the stover, but the crude protein was still low (Table 1). These proportional figures must be evaluated in the light of the total yields obtained.

Several weeding regimes were tested and where the weeds were uncontrolled, CP and DMD yields were reduced in stover, thinnings and total forage from maize, but not surprisingly, the CP and DMD yields increased in edible weeds (Table 2).

Table 2. The effect of weeding regime on the quantity of digestible dry matter and crude protein of maize and edible weeds forage in the 2001/2 short rains (from Maina *et al.*, 2003).

Weeding regime	Crude Protein, $t\ ha^{-1}$				Digestible Dry Matter, $t\ ha^{-1}$			
	Stover	Thinnings	Weeds	Forage	Stover	Thinnings	Weeds	Forage
Weed free	0.7	0.9	0.0	1.6	10.3	9.9	0.1	20.2
Unweeded	0.4	0.6	0.8	1.0	6.5	6.2	3.3	12.7
Herbicide	0.6	1.0	0.0	1.6	9.8	10.6	0.1	20.5
Hand weeded twice	0.8	0.9	0.3	1.7	12.2	10.1	0.9	22.3
SED ($P = 0.05$, $df = 21$)	0.12	0.1	0.06	0.15	1.9	1.1	0.2	2.1

Maize streak virus disease

Of pests and diseases occurring in the area, farmers perceived maize streak virus disease to have the greatest effect on forage yields (Figure 3). Farmers also reported MSVD as difficult to

control in 9/10 farmer groups. Apart from a dressing called "Marshal", available from extension staff and used by a few farmers, no chemical control method for MSVD was known and farmers may remove young diseased plants and re-seed but the disease tended to spread over a large area.

Field trials in which plants were artificially infected with the disease likewise showed that there was a very devastating effect of early infection with MSVD (14 days after crop emergence) on the thinning yields at 100% level of infection. However little effect of early infection occurred if only 25% of plants were infected (Figure 4). On the other hand there appeared to be little effect on yields with later infection 35 days after emergence at either 25 or 100% infection levels. Further there was also little difference between the effect of infection at 35 and 56 days as compared to the control (no infection). The same trends were recorded for dry stover (Figure 5).

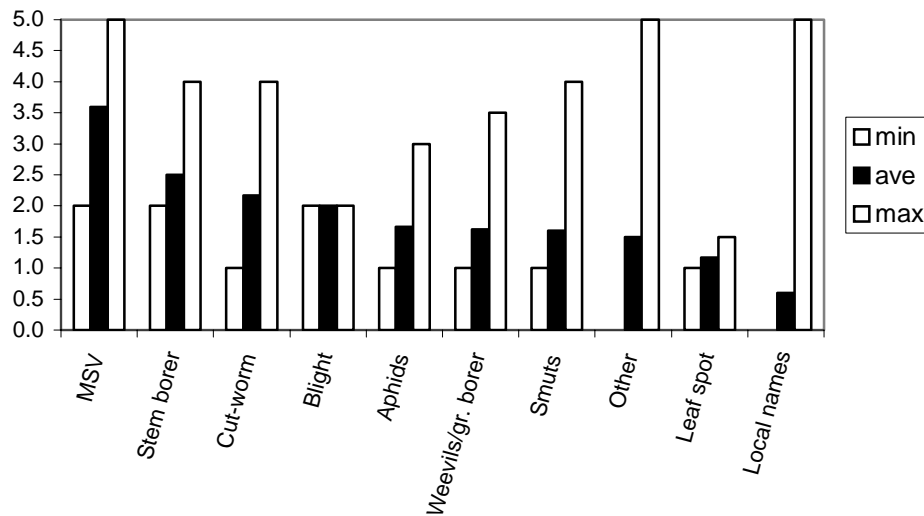


Figure 3. Farmer perceptions (0 = no effect; 5 = high impact) of the impact of pests and diseases on stover yield (From McLeod *et al.*, 2001)

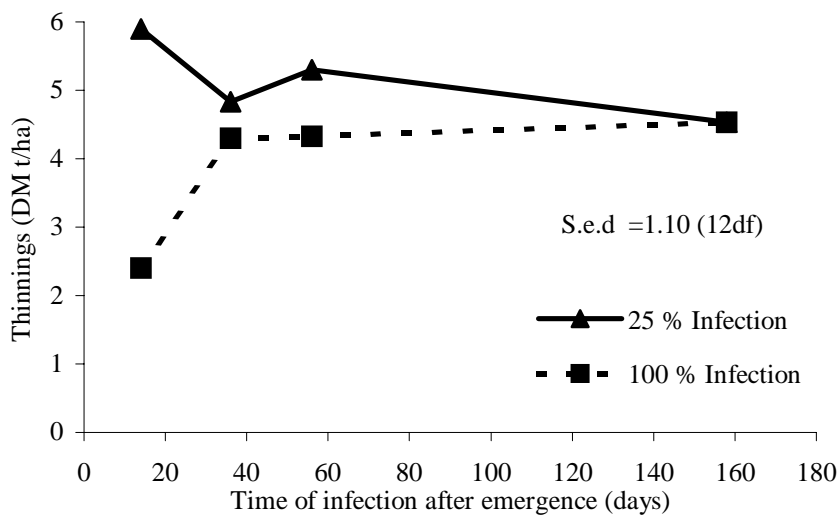


Figure 4: Effect of level of infection on thinnings (DM t/ha) (Redrawn from Lukuyu *et al.*, 2002)

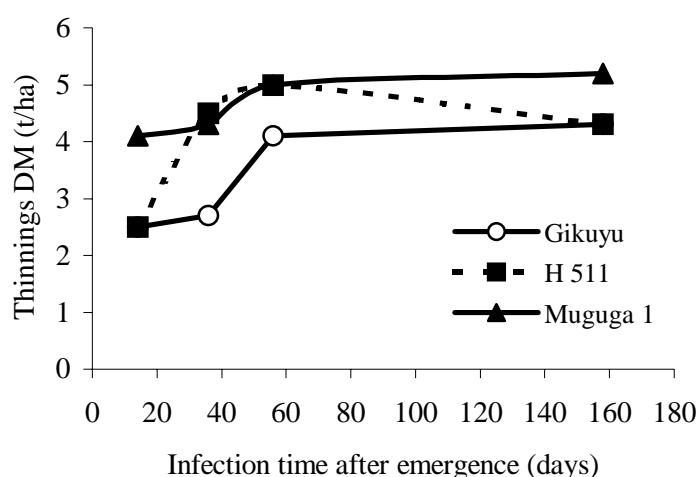


Figure 5 Effect of time of infection and cultivar on maize thinnings (DM t/ha). All plants were infected except for the uninfected control shown as though it were infected on the harvest date - 158 days after emergence (From data in Lukuyu *et al.* 2002)

Farmers were mostly unaware of resistant cultivars and used susceptible maize cultivars. For example, early infection of H511 seriously affects forage (Figure 5). The tolerant variety (Muguga 1) yielded more forage and grain than other varieties although it should be noted that it is a later maturing variety which may have had an unfair advantage since irrigation was carried during most of the trial. The local landrace (Gikuyu) seems tolerant with respect to grain yield (data not shown) but not with respect to forage yield. Forage quality (characterised simply by the leaf:stem ratio) was unaffected by MSV (Lukuyu *et al.*, 2002).

Discussion

Maize forms an important source of forage for the maize-dairy farmers of the Kiambu district. Although this paper has shown that the farmers have considerable awareness of the impact of pests, weeds and diseases on forage production, farmers generally failed to protect their crops. In the case of MSVD, this was due to ignorance of the existence of resistant cultivars, which in turn was due to marketing problems in the country (happily now resolved). Tolerant cultivars such as Muguga-1 alleviated yield losses caused by early infection with the disease, and the taste and cooking quality of this cultivar was acceptable to the farmers (data not shown). While generally favourable to the use of herbicides, it is interesting that farmers had reasonable but unnecessary concerns about the herbicide residues in maize harvested for forage. However, we have shown that the farmers also use the weeds from the crop to supply 5% of their forage for their animals. Partial budgeting procedures are therefore being employed to evaluate the economic consequences of losing weeds as forage, which might result from use of herbicides. Participatory on-farm research is also currently in progress to combine non-chemical control of maize stalk borer using a push-pull biocontrol system with use of resistant cultivars for control of MSVD.

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