The status of maize stover utilization as feed for livestock in Kiambu and Thika districts of Kenya: Constraints and opportunities

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Abstract
Maize stover is an important feed resource in smallholder crop/livestock production systems. A situation analysis survey was undertaken in four administrative divisions, namely Kiambaa and Githuguri in the Kiambu district and Gatanga and Kamwangi in the Thika district as representatives of this system. The objective of the study was to establish baseline information on maize stover utilization as livestock feed and possible constraints and strategies to deal with these constraints. A structured questionnaire was used to collect data. Simple random sampling was used to select 15 respondents per district, giving a sample size of 30 households. Sampling criteria was based on dairy enterprise priority and a zero-grazing production system. Termite attacks during storage and low quality of stover were the major constraints in utilization of maize stover. Among the major strategies for dealing with the low quality of stover, was supplementation with spent brewers' grains, which was most important in Thika district, while in Kiambu district, supplementation with fodder grasses emerged highest. Treatment of dry maize stover with urea was among the least adopted technologies in the two districts. It was concluded from the study that the efficiency with which the available stover are utilized is compromised by poor handling before feeding. Some of the strategies adopted to overcome the identified constraint of low quality were also inappropriate. This may reflect the lack of technical know-how on how best to use the stover and/or inappropriateness of available technologies. There is a need to address this situation by adapting known and workable technologies under the local conditions.

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Introduction

Livestock production activities among small-scale farmers in the high and medium potential areas of Kenya are integrated with crop production activities (Thairu & Tessema, 1987). The degree of integration varies, but generally intensifies with increasing human population density. Crop production benefits from animals' draught power for tillage, animal manure for fertilization of crops, while crop residues constitute an important feed resource for animals especially in the dry season (Preston & Leng, 1987). With the increasing human population, cropping land is expanding, leading to increased production of crop residues. However, this is associated with decreasing land availability for fodder production, thus forcing crop residues to contribute significantly to the livestock feed resource pool. In Kenya, large quantities of crop residues such as cereal straw and stover, legume crops straw and hulls, sugar cane tops, cassava leaves and sweet potato vines are left in the field and/or harvested for livestock feeding. However, these crop residues are generally poorly utilized as animal feed each year because small-scale farmers lack the technical knowledge on how best to use them (M. Syomiti, 2003, personal observation). Farmers generally utilize these crop residues for livestock feeding without considering the use of any of the existing improvement technologies. This situation may be reversed by adapting known technologies that have been developed for local conditions, such as urea treatment and legume supplementation. In the presence of a dynamic market system, livestock production in a crop/livestock system could thus be intensified and made profitable for small-scale farmers (Preston & Leng, 1987).

Field observations show that maize stover is the most abundant residue in smallholder crop/livestock production systems, but are poorly handled and stored. The most commonly observed methods of handling the maize stover are harvesting and either stacking in the field for gradual collection as required for feeding, storing under trees or in the home compound usually in the open and very rarely in roofed barns. This leads to loss of considerable amounts and nutrients due to weathering and leaf shattering (Methu, 1998). Improper management and storage methods drastically reduce the proportions of cereal stover available as feed as well as the efficiency of utilization (Promma *et al.*, 1994). This study was undertaken to document maize stover handling technologies, constraints to its utilization and strategies for dealing with these constraints. Such information can be used in developing utilization strategies and formulation of improvement packages.

Methodology

The survey was undertaken in four administrative divisions, namely at Kiambaa and Githuguri in the Kiambu district and Gatanga and Kamwangi in the Thika district as representatives of this system. Simple random sampling was used to select 15 respondents per district, giving a sample size of 30 households. The farmers recruited were within an approximately 4 km radius in each district and selection criteria were based on dairy enterprise as a priority and zero grazing with a cut-and-carry feeding system.

A structured questionnaire was used to collect data on maize stover storage methods, mode of processing and feeding, post-harvest constraints to utilization of the stover and strategies to deal with it. All the quantitative data was subjected to SPSS (Version 10.0) for computation of percentages.

Results and Discussion

Most of the maize (83%) was harvested at post hard-grain stage, as shown in Table 1. Most of the maize stover available to respondents was thus of low quality, because the quality of forage crops and digestibility of nutrients reduces with the stage of maturity.

Table 1 Maize stover harvesting, storage, processing and feeding.

Management method (% Respondents)	Kiambu	Thika	Mean
Harvesting stage			
Green stover	20	14	17
Dry stover	80	86	83
Storage of stover after grain harvesting			
Harvest and store in barns	39	33	36
Harvest and store under/top of trees	46	40	43
Harvest and stack in the field	15	13	14
Stacking along fences	-	13	7
*Processing and feeding**			
Chopped and fed alone	20	67	43
Un-chopped and fed alone	7	7	7
Un-chopped and mixed with other basal feeds	-	-	-
Chopped and mixed with other basal feeds	73	20	47
Chopped and mixed with concentrates	13	14	14

*Figures on processing and feeding are more than 100% in the two districts due to respondents having multiple processing and utilization methods.

The results indicated that a larger proportion of green maize stover (20%) were available as livestock feed in the Kiambu district than in Thika (Table 1). This may be attributed to the close proximity of the Kiambu district to the city of Nairobi where there is good market for green maize, unlike in the Thika district, where the study sites were further inland. The study showed that the stover were harvested by all the respondents to make room for another cropping season and either stored under or on top of trees (43%), in roofed barns (36%), stacked in the field (14%) or stacked along fences in their homesteads (7%). Most of the respondents (64%) stored the stover in ways that could result in loss of dry matter and nutrients. Maize stover, as is true of other high fibre crop residues, are generally deficient in nutrient content and low in digestibility (Doyle *et al.*, 1986).

This deficiency in nutrients is further amplified by the poor handling and storage due to losses from oxidation, proteolysis, leaching and also termite attacks.

The majority of the respondents chopped the stover before feeding it to the cows, some without any supplementation (43%), but more supplemented it with other basal feeds (47%) and a few with concentrates (14%) as indicated in Table 1. A small percentage (7%) was feeding the maize stover to the livestock without chopping it. Supplementation with green fodder is reported to have beneficial effects on rumen function in diets based on crop residues which translates to improved animal performance (Preston & Leng, 1987). However, the green fodder used in the study area is Napier grass, which, even if harvested at the right stage (6-8 weeks), has a crude protein (CP) content of about 10%. This as a supplement would not support milk production in high yielding dairy cows, whose minimum requirement for CP is about 16%. Therefore, supplementation strategies with compounded feeds with a higher N-content would be preferred to upgrade the low quality of maize stover. Chopping of the maize stover before feeding has a positive effect on improving the feed intake and the efficiency with which the stover is utilized by reducing selective feeding by the animal.

Table 2 illustrates the major factors affecting the utilization of dry maize stover as feed for livestock. The storage problem of the stover ranked first in importance with an average of 37%, followed by poor quality (31%) and then by termite attacks during storage (20%). A combination of termite attacks and storage problems were treated by some farmers in the Thika district as a single constraint, and this accounted for 13%. The proportion of respondents citing poor quality and storage problems as constraints to efficient utilization of maize stover was higher in Kiambu than Thika (Table 2). This may be explained by the fact that the constraint of feed inadequacy is more critical due to smaller land holdings averaging about 1-2 acres in the Kiambu district, as compared to an average of approximately 4 acres in the Thika district. (Omore, 2003). Thus, in Kiambu, maize stover as a resource for animal production is more important than any of the other constraints.

Table 2 Constraints to utilization of maize stover and strategies to handle poor quality in the Kiambu and Thika districts (% respondents).

Constraint	District		
	Kiambu	Thika	Mean
Poor quality	33	27	30
Storage problem	40	33	37
Termite attack	27	13	20
Termite attack + Storage problem	-	27	13
*Strategies to handle poor quality**			
Molasses addition	21	9	15
Concentrate supplementation	12	13	13
Spent brewers' grains	25	53	39
Poultry waste	12	13	13
Fodder legumes	11	16	14
Green grasses	11	41	26
Urea treatment	7	8	8
Overnight soaking in water	13	14	14
Overnight soaking in NaCl	6	8	7
Effective micro-organisms (EM) treatment	14	17	15

*Figures on the strategies to handle poor quality are more than 100% in the two districts due to respondents having multiple mechanisms.

The storage problems arise due to the bulkiness of the stover; thus the requisite space is a constraint on small holdings. Losses through termite attacks during storage were critical to many respondents who isolated it as a constraint on its own. The three constraints accounted for 100% of responses in both districts. Poor quality was a nutritionally important constraint, and further information was sought from the respondents on how they handled this.

The summary of various strategies to counteract the low quality status of the maize stover and their adoption levels is given in Table 2. Supplementation with spent brewers' grain (SBG) was the most common technology adopted by respondents (53% in the Thika district and 25% in the Kiambu district). The proximity of respondents in Thika to the source of SBG in the East African Breweries Malt plant at Ruaraka may explain the higher adoption of this technology.

Spent brewers' grains, a high protein feed with a CP level above 20%, would enhance microbial activity and thus improve digestibility of the stover. Other strategies with similar effects but with lower levels of adoption are supplementation with fodder legumes and poultry waste. Supplementation with fodder grasses, mainly good quality Napier grass, was the second most important (42%) strategy in Thika and is also expected to improve microbial nutrition and activity. In the case of the respondents in Kiambu, supplementation with molasses was the second most important (23%) strategy. Molasses has been used to enhance the palatability of feeds (Preston & Leng, 1987). However, though a good source of fermentable energy, it is low in crude protein (usually below 5%) and would be an inappropriate accompaniment to maize stover which is also deficient in Nitrogen.

Supplementation with concentrates, mostly dairy meal with a CP level of approximately 14-16 %, would have provided a balanced supply of both energy and protein for microbial activity though adopted by relatively few respondents in both districts. Soaking in water, with and without Sodium Chloride (NaCl), was also cited as a strategy by respondents in the two districts. Soaking dry residues in water is reported to improve digestibility and thus the intake of such feeds. This results from the swelling of the cells weakening the bonds between lignin and structural carbohydrates thus increasing access of cell contents to microbial enzymes.

Treatment with urea was adopted by 8% of the respondents in both districts. This is a treatment with well documented benefits of improved digestibility and thus intake of high fibre residues (Preston & Leng, 1987), but with very low rates of adoption in Kenya. With this treatment, the urea is used as a source of ammonia (NH_3) which is then hydrated to Ammonium hydroxide (NH_4OH), a weak alkali. For effective urea treatment, the material must be ensiled for 6 to 8 weeks. One of the reasons cited for not adopting this technology is fear by farmers of poisoning their animals. Additionally, ensilage as a technology has been poorly adopted by smallholder dairy producers (Land O' Lakes Inc., 2003).

Effective micro-organisms (EM) treatment was adopted by 14% and 17% of respondents in the Kiambu and Thika districts respectively (Table 2). Effective micro-organisms (EM) are being marketed in Kenya as a probiotic. In the treatment of high fibre residues, it is reported to break the lignin-cellulose/hemi-cellulose bonds thus increasing their digestibility and intake. However, no scientific evaluation of EM in Kenya has been done and the information provided by the marketers is vague on the specific micro-organisms found in EM. Thus its mode of operation is unclear.

The results of the study showed that various measures to improve the quality of the stover were taken in the two districts. It was also noted that a higher proportion of respondents in Kiambu, (86%) took action to counter this constraint compared to only 34% in Thika (Table 1). This is consistent with the higher level of awareness that low quality of maize stover is a constraint to effective utilization in Kiambu, 33% *vs*. 27% respectively. The higher rate of adoption of technologies to improve stover quality in Kiambu can be explained by the smaller land holdings and the need to optimize utilization of available resources.

The results of this study confirm that maize stover remains an important feed resource in smallholder crop/livestock production systems. This agrees with the report by McLeod *et al.* (2001) that crop residues, mainly from the maize crop, ranked second in importance, after Napier grass, as livestock feed in the high potential areas of Kenya. However, according to Mwendia (2006), many Napier grass varieties grown in Kenya are susceptible to diseases which can be very destructive, citing the case of the Napier stunting and head smut diseases. Some work has been done to screen for resistant varieties, but from the work by Mwendia (2006) adoption of such identified varieties remains very low. Thus the two diseases remain a threat to the smallholder dairy industry which is heavily depended on Napier grass as the main feed. In view of this, it is suggested that the use of crop residues, specifically maize stover, will remain high and probably will increase in future. On the one hand, with the increasing human population, cropping land is expanding leading to increased production of crop residues, and on the other hand, there is reduced land availability for fodder production (Omore, 2003).

Additionally, FAO crop production statistics (2008) show that there has been tremendous growth in maize production between 1964 and 1997, fueled by the introduction of hybrid maize and related technologies often dubbed the "Kenya Green Revolution" (Karanja & Oketch, 1998). Currently, the country is reported to produce about 28 million 90 kg bags of dry maize grain (FAO Crop Production Statistics, 2008). It is estimated that for every 1 kg of grain obtained, there are 2 kg DM of stover/straw or residue available as livestock feed (Mifugo News Magazine, 2007). Therefore an estimated 5.04 million metric tonnes DM of maize stover are produced in Kenya, which can make a significant contribution to the feed resource pool in the country, if efficiently utilized.

Conclusions and Recommendations

The study concludes that the efficiency with which the available stover is utilized is compromised by poor handling before feeding. Spent brewers' grains was highly adopted but was site-specific. Urea, a cheap source of ammonia for the chemical treatment of poor quality crop residues, was poorly adopted by farmers. Other strategies adopted by farmers to overcome the identified constraint of low quality, such as supplementation with molasses, were also inappropriate. This may reflect the lack of technical know-how on how best to use the stover and/or inappropriateness of available technologies. There is a need to address this situation by adapting known, cost-effective and workable technologies under the local conditions and thereby expand the feed resource base in Kenya.

References

Doyle, P. T., Devendra, C. & Pearce, G. R., 1986. Rice straw as a feed for ruminants. International Development Program of Australian Universities and Colleges (IDP). Canberra Journal of Livestock Production Science, 55: 117-125.

FAO Crop Production Statistics, 2008. www.faostat.org/statistics/yearbook/vol 1.

Karanja, D. D. & Oketch, O., 1998. The impact of maize research in Kenya. In: Proceedings of a workshop: Review of the National maize research program KARI/ISNAR management Training Linkage Project. 100 pp.

Land O' Lakes Inc., 2003. Testing and promoting silage making technologies in the smallholder dairy farmers in Kenya. In 1st technical report, 2003, p. 6-10.

Mcleod, A., Njuguna, J., Musembi, F. & Miano, D., 2001. Farmers' strategies for maize growing, maize streak virus control and feeding of smallholder dairy cattle in Kiambu district, Kenya. Results of a rapid rural appraisal held in April and May, 2001. First technical report of DFID project. University of Reading. Reading, UK. (Cited by Mwendia, 2006).

Methu, J. N., 2003. Testing and promoting silage making technologies in the smallholder dairy farmers in Kenya. Quarterly report. Land O' Lakes Inc.

Mifugo News Magazine., 2007. Fodder conservation article. Ministry of Livestock and Fisheries Development, 17 pp.

Mwendia, S. W., 2006. Impact of Head Smut on Napier grass yields in smallholder dairy production systems. MSc.-Thesis. College of Agriculture and Veterinary Sciences, Faculty of Agriculture, University of Nairobi. 120 pp.

Omore, A. O., 2003. Livestock production and feed resources in Kenya. Aggrippa-peer reviewed. FAO Electronic journal. http://www.fao.org/aggrippa/155.

Preston, T. R. & Leng, R. A., 1987. Matching ruminant production systems with available resources in the tropics and sub-tropics. Pernambul Books, Australia. 245 pp.

Promma, S., Tasaki, I., Cheva-Isarakul, B. & Indratula, T., 1994. Stabilization with sulfuric acid of the Crude Protein in Urea-treated Rice straw. Australasian Journal of Agricultural Science, 7: 481-486.

SPSS Inc., 2007. Software Version 10.0. Users' guide: Statistics.

Thairu, D. M. & Tessema, S., 1987. Research on animal feed resources: Medium potential areas of Kenya. In: J. A. Katengile, A. N. Said and B. H. Dzowela (eds), Animal feed resources for small scale livestock producers. Proceedings of the 2nd PANESA workshop held in Nairobi, Kenya, 11-15 November 1985, Nairobi, p. 125-148.