FODDER PRODUCTION OF MULTIPURPOSE TREES IN A MAIZE FARMING SYSTEM OF SUBHUMID SOUTHERN AFRICA

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ABSTRACT

Ways to integrate fodder production into maize production systems under Southern Africa's subhumid conditions have been studied. One way involves the planting of tree and grass fodder hedges along soil conservation contour-bunds in maize fields. Management factors that influence the productivity of maize and fodder components in the system are fodder spp., side-pruning and deferment of wet season cutting. The other option involves interplanting tree fodders with maize through the use of a coppicing tree such as *Acacia angustissima*. Practical applications of these methods in mixed crop-livestock production systems are discussed.

KEYWORDS

Fodder hedges, contour-bunds, smallholder farming system, deferred cutting management, poor quality feeds, protein supplements

INTRODUCTION

Ruminant livestock in subhumid Southern Africa derive their nutrients from communal grazing in smallholder production systems. A majority of farmers are small-scale and resource-poor. However, there are regional variations with a tendency towards larger holdings in drier areas. Those farmers that have access to communal grazing may not invest in direct planting of feed resources for socio-economic reasons. Some farmers set aside land specifically for block planting of fodders for deferred usage during dry seasons. In Zimbabwe, some farm families set aside between 0.5 ha to 1.5 ha for the planting of fodders to support up to 5 head of dairy cows. Dairy cows are usually kept in semi-zero grazing systems on a basal diet of Bana grass (*Pennisetum purpureum* or hybrid of *P. purpureum* with *P. americanum*) and, depending on season, crop residues and weed grasses (Abate et al., 1992). Extension services state that good quality Napier grass should be nutritionally capable of supporting milk yields of between 3 to 7 kg/day. Higher milk yields can only be assured through use of supplements/concentrates. The concentrates\supplements are usually given twice daily at milking times and the rates vary from 2 to 4 kg/hd/day (Paterson et al., 1996). However, the relationship between milk price and cost of concentrates/supplements is generally unfavourable (Mupeta, 1995). Methods of integrating fodder production in a maize farming system are feasible on niches within the farmland that do not compete with the maize crop. Planting arrangements vary considerably from region to region, but principally constitute line plantings or multi-row plantings. Productivity of these fodder banks is reviewed in the context of some of the work undertaken by the SADC-ICRAF Agroforestry Project in Zimbabwe's subhumid ecozone.

CONTOUR-BUND PLANTING OF FODDERS

A common feature of the maize farming system in Zimbabwe is soil conservation contour-bunds in the cropland. This area offers opportunities for integrating agroforestry interventions in which leguminous trees can be grown for primarily fodder and secondarily soil conservation. Prunings and cuttings can be used for fodder. The fodder trees reinforce the bunds to arrest soil erosion, conserve water and reduce down slope siltation of water courses and dams. There is not much published information available on fodder production from contour-bund (Akyeampong and Dzowela, 1996). The little literature available from the subhumid ecozone of East Africa point to the fact that fodder plantings on the contour-bunds do not jeopardise food crop production (Burinkiko, 1993; Bihirabake, 1994). To investigate this fodder production possibility the present study was carried out.

INTERCROPPING WITH MAIZE

One of the sequential agroforestry systems advanced by Sanchez (1995) involves improved fallows. When coppicing trees are used, the trees persist beyond the 1- to 3-year fallow period normally recommended with short-duration species such as *Sesbania sesban* (Kwesiga and Coe, 1994). When not used for soil fertility improvement, mulching or organic manuring, the tree in maize/tree intercrop could provide high quality feed to supplement poor-quality maize stover grazed *in situ* or cut and carried off-farm for pen-feeding during the dry season. To investigate this option, the fodder production potential of intercropping a leguminous tree with a maize crop was investigated.

MATERIALS AND METHODS

Experiment 1: The experiment was conducted in a sub-humid environment on the unimodal rainfall plateau of Zimbabwe, long term mean annual rainfall of 895 mm, falling from November to April; altitude 1475 masl; on a sandy loam soil classified as an Alfisol. In experiment 1, *Acacia angustissima* (Mill.) Kuntze (referred to as *acacia*), *Calliandra calothyrsus* Meissn. (referred to as *calliandra*), *Leucaena leucocephala* (Lam.) de Wit, cv. Cunningham (referred to as *leucaena*) and Bana Napier grass (*Pennisetum purpureum* schumach. x *P. typhoides* hybrid) fodders were planted in seedlings for multipurpose trees and rooted stem splits for Bana Napier grass. Planting was on 2 m wide contour-bunds spaced 20 m - 25 m apart on land of 3% to 4% slope. Plants were spaced 0.5 m x 0.5 m to form a 4-row hedge 8 m long. The fodder plots (main plots) were replicated along a contour-bund 4 times to accommodate cutting deferment treatments (end of January, end of February, end of March and end of April) imposed during the rainy season to maiximize dry season coppice fodders. All treatments were replicated 3 times on adjacent contour-bunds. Maize was planted in 1994/95 and 1995/96 cropping seasons, 0.45 m away from the fodder hedges on either side. There were 10 rows of maize on either side of the fodder hedges spaced 0.9 m and 0.3 m apart, between and within the row respectively. The maize received a full fertilizer dressing of 76 kg N, 42 kg P and 28 kg K/ha as D-compound fertilizer (8 N; 14 P and 7 K) applied at maize planting. This application was followed 6 weeks later by a top-dress fertilizer application of ammonium nitrate (34.5% N) at the rate of 150 kg/ha. The fodders received fertilizer at the rate of 300 kg/ha D-compound at the beginning of the rainy season. During maize crop growth, the fodders were side-pruned twice (January and March). Subsequent coppices to the January to April deferment cutting treatments were left for dry season cutting and use.

Experiment 2: To investigate the intercropping option of fodder integration into maize farming systems, fallow systems based on *Acacia* of 1-, 2- and 3-year durations were compared with traditional grass fallows of 3-years duration. The trees were planted at 1 m x 1 m spacing. At the end of each fallow period, all trees were cut down to ground level. The soil was ploughed and maize planted for two seasons. The maize was fertilized at the rates of (1) 0 N,P,K; (2) 38 N, 21 P, 14 K; (3) 76 N, 42 P, 28 K and (4) 114 N, 63 P, 42 K primarily to determine the efficacy of soil fertility improvement by improved fallows. Plots measured 15m x 12m, and maize was planted at the spacing of 0.9 m x

0.3 m. The plots were then split into 4 quarters to accommodate the 4 fertilizer application rates for maize. There were 3 replicates. Since *Acacia* coppices after cutting back, the coppice growth, was cut back twice at the 1st and 2nd maize weeding operations during the growth of maize (January and March). These two coppices were used as soil mulches. The 3rd coppice which came up at maize tasselling time was left uncut to estimate fodder yield at maize harvest time in May. Dry season regrowth fodder yield was estimated at the end of the dry season in October (1995 and 1996). Maize yields (stovers and grain) and fodder dry matter yields standing at maize harvest time and at the end of the dry season were estimated following standard procedures (AOAC, 1990). Combined statistical analysis was done covering the 3-growing seasons to come up with mean performance in Experiment 1 and 2 years' data were pooled for Experiment 2. All statistical analyses were performed following the procedures of Steel and Torrie (1980).

RESULTS

Experiment 1: The growing of fodders did not significantly ($P>0.05$) affect overall maize yields, especially in response to fodder species and the fodder cutting deferment schedule (Table 1). However, when maize yield was looked at on row basis in relation to the fodder hedges, there were differences between cutting deferment treatments ($P<0.001$) as shown in Figure 1. *Acacia* resulted in a mean yield increase of the order of 12% in the nearest six maize rows compared to the farthest 4-rows away from the hedge. This is contrasted with mean yield reductions of 14%, 14% and 11% associated with *calliandra*, *leucaena* and Bana Napier grass hedges respectively. Wet season forage yields were high, range 139 kg DM/100 m length of hedge realized from Bana Napier grass to 571 kg DM/100 m length of contour hedge realized from *leucaena*. The other fodder species *acacia* and *calliandra* yielded 563 kg and 537 kg DM/100 m length respectively. Similarly, fodder yields increased across all species with increase in cutting deferment treatments ($P<0.001$) as shown in Table 2 and resulted in increases in dry season coppice fodder yields (Figure 2) with January and to some extent February wet season cutting treatments producing significantly higher yields than later cutting treatments ($P<0.001$). There was a significant fodder species x cutting deferment interaction ($P<0.003$). In the first two cuts (January and February) the highest fodder yields were produced by *calliandra*. In subsequent cuts (March and April) highest fodder yields were obtained from *acacia* and *leucaena*.

Experiment 2: The grain yields from *acacia*-based fallows were 4.6 t, 4.4 t and 4.9 t/ha from 1-, 2- and 3-year fallow durations respectively. The corresponding maize stover yields were 3.7 t, 3.7 t and 4.2 t/ha respectively. Fodder dry matter yields in the wet season from coppice *Acacia* were 0.4 t, 6.6 t and 6.5 t/ha for 1-, 2- and 3-year fallow durations respectively. For both stover and grain production, yields increased with increasing rates of fertilization ($P<0.001$). Fodder yields from *acacia*, on the other hand showed no increase with increasing rate of maize fertilization. This was attributed to the shading effect of healthy maize plants on *acacia* fodder plants arising from increasing fertilization (Table 2).

DISCUSSION AND CONCLUSION

The fact that the planting of fodders on contour-bunds is compatible with crop production is consistent with reports of Burinkiko (1993) and Bihirabake (1994) except for the minor reductions in the yield of rows closest to the fodder hedge. This reduction is attributed to competition for resources especially moisture and nutrients. The fodder yield levels achieved in the study from *acacia*, *calliandra* and *leucaena* (5.63 kg, 5.37 kg and 5.71 kg DM/m - length of the bund) are higher than those achieved for *calliandra* under more humid highland conditions of Burundi (Akyeampong, 1996). With the assumption that a mature livestock unit weighing 300 kg and having a dry matter intake of 3% of its own body weight/day will be supplemented at the rate of 25% to 30% of its diet daily during the dry season, these will require 3 kg to 4 kg DM of protein supplement when it consumes low quality crop residues. Thus, a fodder yield level of *acacia* (563 Kg DM/100m of fodder hedge) is sufficient to supplement some 6 LUS per month. With the 5 contour-bunds in a hectare, there should be enough supplemental high quality fodder to sustain the 6 LUS during the dry season (July to November period). This technology assures availability of both energy (maize stovers and Bana Napier grass) and protein (MPT fodders) to make livestock production self-sustaining at farm level. Contrasted with the pure maize control plots, *acacia*-based fallows complement maize stover production with high quality fodder. The *acacia* fodder dry matter yields (with a 22% crude protein content) translates into 66 kg, 550 kg and 638 kg/ha protein yields respectively from 1-, 2- and 3-year fallows. This is contrasted with protein yields of only 87 kg/ha from the mean maize stover yield of 2.9 t/ha achieved with pure maize control plots (3% crude protein content). The mean stover yield of *acacia*-based fallows (4.6 t/ha) yields 138 kg protein/ha in addition. In many parts of the tropics, fodder trees have been used for block plantings as fodder banks where utilization of feed is reserved for times of pasture scarcity. The trees may be planted alone to form a protein bank or associated with tall grasses in a combination of protein - energy bank (Paterson et al., 1987). This technique is valid where farmers have a need to supplement or complement other grazing or poor-quality feed resources in the dry season. Our studies have shown a possibility of fodder integration in maize farming systems. Contour-bunds conserve soil but produce little direct income for the farmer (Dzowela et al., 1994). If they are made productive, there would be more incentive to maintain them. Planted with Bana Napier grass and fodder trees, the grass and maize stover provide basal diet for energy, while the trees give quality protein supplements from the farming land (Paterson et al., 1996). If the intention is to maximize yield of fodder at the height of the dry season, research in Burundi has shown that the final wet season cut should be made earlier in February (Akyeampong and Muzinga, 1994). In the case of Zimbabwe, long dry seasons coincide with the coldest time of the year. Under this situation, leaf senescence will result from a combination of moisture stress and low temperatures. Thus, it is important that cutting times are carefully chosen to avoid loss of available dry season fodder. In our deferment studies, cutting the wet season fodders in the January - March period appears to maximize tree fodder regrowth for dry season use (Figure 2).

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Table 1
Fodder contour hedges effect on maize yield (maize stover and grain in t/ha) in response to deferred fodder cutting

Fodder species	Yield Component	Cutting times				Means
		January	February	March	April	
Acacia	stover	3.5	3.3	3.2	3.2	3.3
	grain	3.7	4.0	3.9	3.6	3.8
Calliandra	Stover	3.5	3.3	3.3	3.2	3.3
	Grain	3.7	3.6	3.7	3.9	3.7
Leucaena	Stover	3.5	3.3	3.4	3.4	3.6
	Grain	3.3	3.7	3.7	3.9	3.6
Napier	Stover	3.3	4.0	3.4	3.8	3.6
	Grain	3.8	3.4	3.9	3.9	3.7
Means	Stover	3.4	3.5	3.3	3.4	
	Grain	3.6	3.7	3.8	3.8	
		Stover	**Grain**			
SED	Stover - spp.	± 0.10 ns	0.13 ns			
	Cutting	± 0.10 ns	0.13 ns			
CV(%)		8.4	9.6			

Table 2
Wet season fodder yield in kg dry matter per 100 m length of hedge in response to deferred cutting management in the wet season

Fodder species	Cutting times				Means
	January	February	March	April	
Acacia	444	527	641	643	563
Calliandra	409	505	587	650	537
Leucaena	419	533	601	729	571
Napier	66	143	154	193	139
Means	334	427	495	554	
SED Fodder species means			±144 *		
Cutting times means			± 25 ***		
CV(%)			15.6		

Figure 1
Grain yield (kg) per 5 m of row in relation to distance away from the fodder hedge
AA - Acacia; CC - Calliandra; LL - Leucaena; BG - Bana Grass

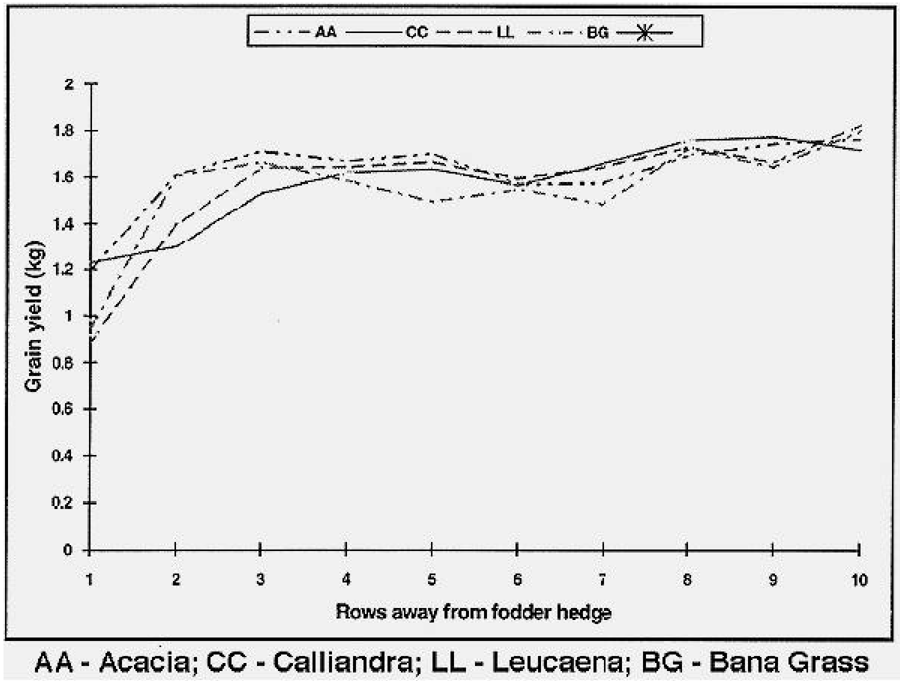

Figure 2
Dry season fodder production (means of 1994/95 and 1995/96 seasons) in response to wet season cutting deferment treatments
AA - Acacia; CC - Callliandra; LL - Leucaena; BG - Bana Grass