Paper 15: Integration of forage legumes into the cropping systems of Nigeria's subhumid zone

M.A. Mohamed-Saleem
Forage Agronomist
ILCA Subhumid Zone Programme

Abstract

The subhumid zone of Nigeria is increasingly being occupied by arable farmers and pastoralists. As a result, the traditional grazing land is declining, but the total potential fodder from crop residues could compensate for this loss, at least in terms of bulk. The nutritive value of crop residues can further be enhanced by inclusion of a forage legume in the mixed cropping system. However, in order to optimize the returns of both grain and fodder, the spatial and temporal requirements of the various components in the mixture need to be manipulated. Undersowing sorghum with stylo 6 weeks after planting the grain crop or sowing the two in alternate rows (inter-row sowing) seems to achieve both the desired benefits, from grain for human consumption and from fodder for livestock consumption. But because land tenure is controlled by the arable farmers, who do not generally own livestock, there is no incentive to improve crop residues just for the benefit of pastoralists. It may be easier to persuade farmers to lease land to pastoralists if forage improvement using legumes is equally beneficial to subsequent crop production.

Grain yields of 2 tonnes more on a soil after 2 or 3 years under stylo than on continuously cropped soil suggest that the soil benefits from the planted legume are higher than benefits from natural fallow during a similar period. Hence, legume-based cropping has important implications for soil management, especially in areas where prolonged fallows are not practical due to population growth. Various crop combinations and cropping techniques are discussed.

Introduction

In the subhumid zone of Nigeria, the majority of the cattle owners are pastoralists, who are now settling and will continue to settle in the midst of arable farming communities. To a settled pastoralist, raising crops becomes as important as cattle keeping. There are also many mixed farmers in the subhumid zone, both within and outside Nigeria. Subhumid conditions are favourable for both cropping and livestock enterprises. However, arable farming is spreading at the expense of traditional grazing land. But increase of arable farming does not seem to discourage movement of livestock or their permanent residence within the zone. This imposes a strain on the dwindling grazing resources. Under present farming systems, cropped land deteriorates rapidly. Under these circumstances, development of integrated pasture-livestock-crop systems offers a method of accommodating and improving both crop and livestock production.

Undersowing of cereals with forage legumes

Under the smallholder subsistence farming practised in the subhumid zone, a single household does not cultivate more than 2 to 3 ha at a time even if land is readily available. The small size of farms is primarily due to the labour required for various cultural operations.

Undersowing cereal crops with a forage legume appears to offer a simple method of enhancing the quality of grazing after grain harvest. It imposes minimum inconvenience to or change in the traditional cultural practices.

Experiments were carried out for 2 years (1980 and 1981) to determine the optimum time of undersowing various stylo cultivars into sorghum. Stylosanthes guianensis cv Cook and S. hamata cv Verano were chosen because they grow well under subhumid conditions. The experiments involved the following treatments:

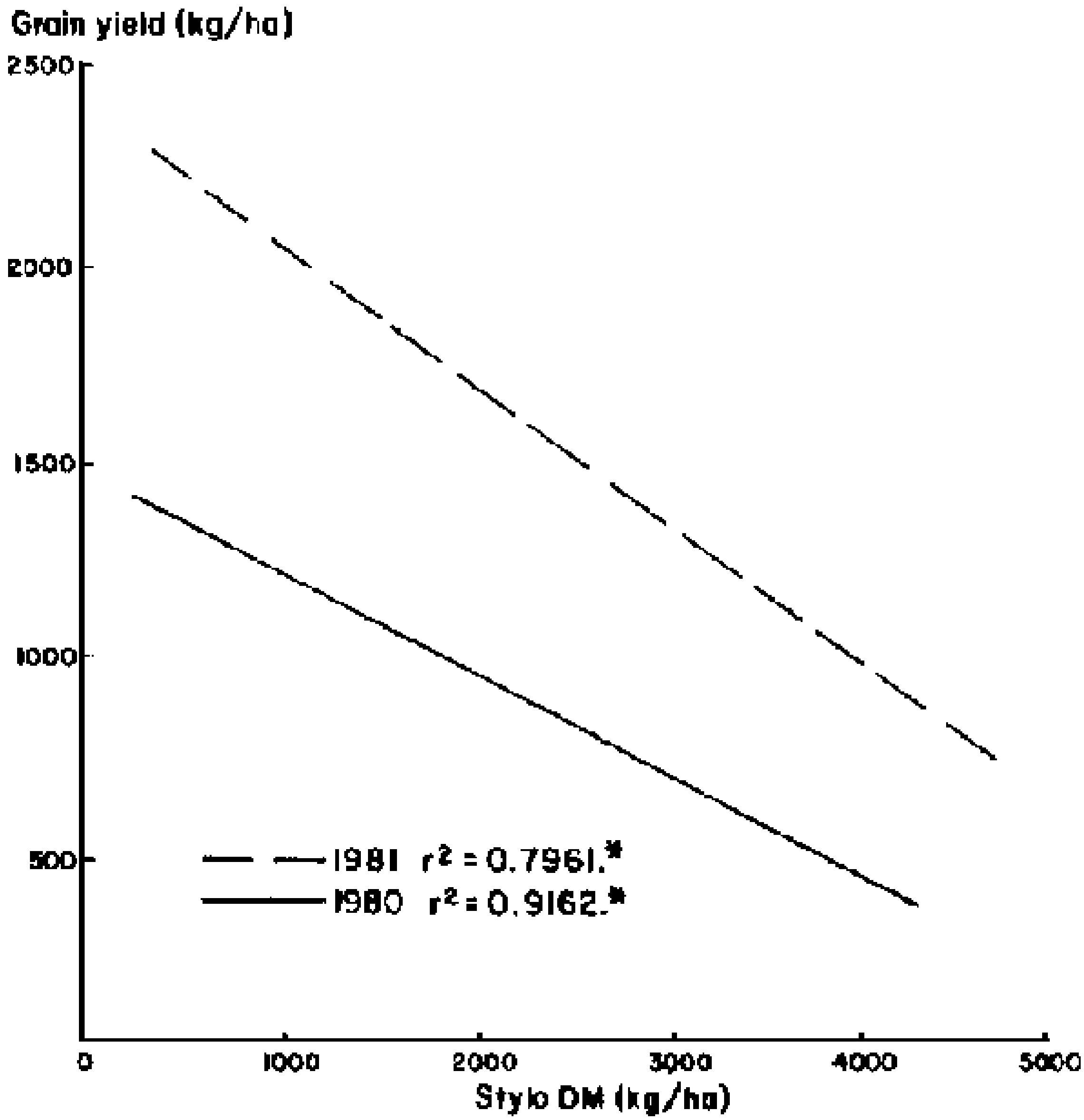
1. Control, i.e. sole crop of sorghum (C_0).
2. Sorghum plus stylo planted on the same day (C_1).
3. Sorghum plus stylo planted after 3 weeks (C_2).
4. Sorghum plus stylo planted after 6 weeks (C_3).
5. Sorghum plus stylo planted after 9 weeks (C_4).

In 1980, a local sorghum variety and S. hamata were used. Since phenotypic and genotypic variations were found in the local variety, the experiment was repeated in 1981 with sorghum (variety 5912) recommended by the Institute of Agricultural Research, Samaru, and S. guianensis cv Cook.

The time of undersowing was found to be critical and specific to the legume type. Planting S. hamata cv Verano after 3 weeks and S. guianensis cv Cook after 6 weeks caused minimum grain yield reductions and increased the quality of available fodder (Table 1). The crude protein (CP) cement of the total fodder from undersown plots was greater than that of the crop residue alone. Grain yield reductions were a function of the productivity of the introduced stylo (Figure 1).

Despite its simplicity and low cost, this technique will apply only to farmers with small numbers of stock because of the small areas that are cultivated. Thus farmers with a few small ruminants or two draught oxen should find it useful. Pastoralists with large herds will not appreciate its value for feeding purposes, but they may use it as a source of seed and for spreading the legume in fallow land following the last crop.

Figure 1. Relationship between grain and stylo yields.



* Significant at P<0.01

Where farmers cultivate larger areas with the aid of animal power, undersowing cereals could substantially raise the output of good quality fodder. For example, in the subhumid zone of southern Mali, where an average farmer claims he is able to cultivate between 7 and 10 ha/year, it may be possible, given yields similar to those obtained in Kaduna (Table 1), to raise the total protein output of fodder from 1785 - 2550 to 2905-4150 kg/7-10 ha unit/farmer, simply by undersowing sorghum with S. guianensis cv Cook 6 weeks after sowing the grain crop.

In the following year, self-seeded regrowth will have to be controlled for at least 3 to 6 weeks from the time of planting the sorghum, because of the latter's otherwise slow initial establishment. During early growth sorghum does not withstand competition from Stylosanthes and can easily be smothered (Table 1).

Simultaneous sowing

The results of another experiment, carried out in 1983, suggest that sorghum (variety 5912) can compete effectively with Centrosema pascuorum, Alysicarpus vaginalis and Macroptilium lathyroides without staggered planting dates. These legumes caused no significant differences between the yields of sorghum when undersown and when sown as a sole crop (Table 2). In this case sowing the forage legumes on the same day with the grain crop has the advantage of eliminating the need for extra labour for undersowing later on.

Table 1. Effect of undersowing stylo on grain yield of sorghum and total available fodder after harvest, Kurmin Biri, 1980-1981.[a/]

Time of sowing stylo (kg/ha)	Grain yield (kg/ha)	Grain yield deviation from C_0 (%)	Fodder yield			
			Crop residue (kg/ha)	Stylo DM (kg/ha)	% CP in total fodder (%)	Available CP (kg/ha)
1980						
Sole crop (C_0)	1226 a		7503 a (2.4)		-1.09	180
With grain crop (C_1)	357 b	-70	1303 c	4010 a	5.02	490
After 3 weeks (C_2)	1224 a	+ 0	3719 b	1729 b	1.78	281
After 6 weeks (C_3)	1287 a	+ 5	4260 b	702 c	-0.19	178
After 9 weeks (C_4)	1240 a	+ 1	3919 b	408 c	-1.28	142
1981						
Sole crop (C_0)	2192 a		8796 a		-0.64	255
With grain crop (C_1)	480 c	-78	2367 c	4334 a	4.66	592
After 3 weeks (C_2)	1550 ab	-29	3524 c	3215 b	3.34	493
After 6 weeks (C_3)	1918 ab	-13	5385 b	2464 b	1.42	415
After 9 weeks (C_4)	1980 a	-10	7463 a	456 c	0.01	283

[a/] Values in a column in each year followed by common letters do not differ significantly at the 5% level.

Table 2. Grain yield (kg/ha) of sorghum when planted together with forage legumes on land prepared by two different methods at Kachia Grazing Reserve, 1981.[a/]

Type of crop/ legume mixture	Grain yield (kg/ha) Land preparation		Difference in grain yields between ridged and flat land (%)
	Ridge	Flat	
Sole sorghum	1296 a	870 b	-33
Sorghum plus <u>S. hamata</u> cv Verano	313 def	141 f	-55
Sorghum plus <u>S. guianensis</u> cv Cook	388 def	246 ef	-37
Sorghum plus <u>M. atropurpureum</u>	356 def	444 cdef	+25
Sorghum plus <u>C. pascuorum</u>	1019 ab	595 cde	-42
Sorghum plus <u>A. vaginalis</u>	1092 ab	722 bcd	-34
Sorghum plus <u>M. lathyroides</u>	1297 a	833 bc	-36

[a/] Figures between and among the columns followed by one or more common letters do not differ at the 5% level of significance.

Although the total amount of fodder per unit area from each of the crop-legume mixtures did not vary significantly from that obtained from sorghum as a sole crop, the increase in legume content raised the quality of the fodder (Table 3).

Table 3. Fodder yield (kg/ha) of sorghum when planted together with forage legumes on land prepared by two different methods at Kachia Grazing Reserve, 1983.[a/]

Type of crop-legume mixture	Yield (kg/ha)[b/]						Difference in fodder yields between ridged and flat land (%)
	Land preparation						
	Ridge			Flat			
	Crop residue	Legume DM	Total fodder	Crop residue	Legume DM	Total fodder	
Sole sorghum	4667 a		4667 a	2722 bc		2722 bc	-42
Sorghum plus S. hamata cv Verano	1685 c	2778 a	4463 a	1944 bc	1796 bc	3740 ab	-17
Sorghum plus S. guianensis cv Cook	1555 c	2063 b	3618 ab	2037 bc	1167 de	3204 ab	-11
Sorghum plus M. atropurpureum	2111 bc	1296 de	3407 ab	2430 bc	1019 e	3449 ab	+1
Sorghum plus C. pascuorum	2981 b	1204 de	4185 a	2426 bc	1315 de	3741 ab	-11
Sorghum plus A. vaginalis	2519 bc	926 e	3445 ab	2074 bc	481 f	2555 b	-26
Sorghum plus M. lathyroides	2741 bc	1481 cd	4222 a	2667 bc	1000 e	3667 ab	-13

[a/] Figures between and among corresponding columns followed by one or more common letters do not differ at the 5% level of significance.

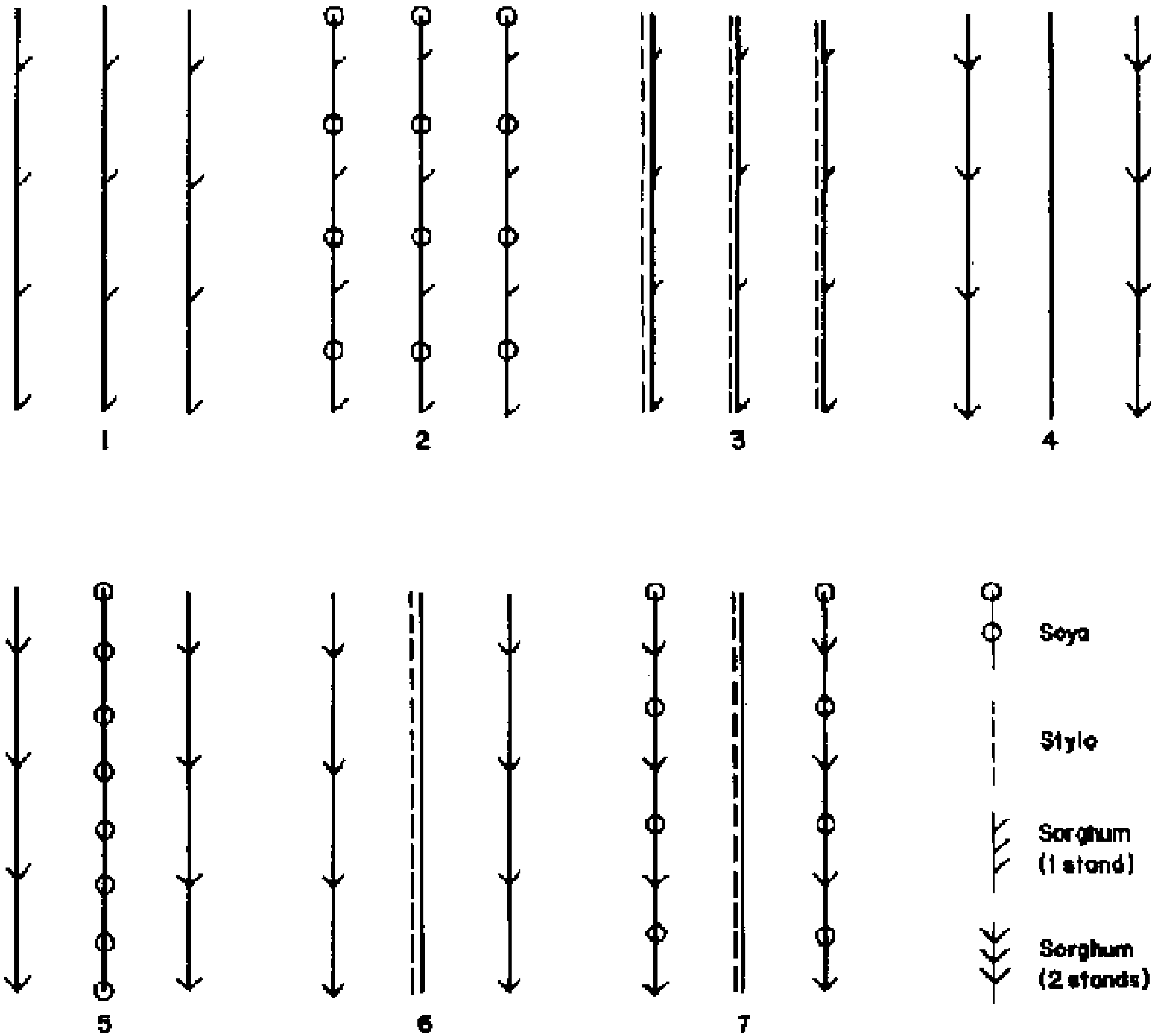
[b/] Due to the early start of the dry season the yields of grain and fodder were generally below expectation for the sorghum cultivar used.

The seeds of the six legume types were broadcast and slightly worked into the soil of all three replications. Sorghum was planted either on flat seedbeds or on ridges. Ridge making involved more work but resulted in higher grain yields (Table 2). Crop residue yields did not differ significantly between planting on the ridge and on the flat. When sorghum was planted alone on the flat the residue from it was 42% lower than when planted on ridges, but there was no significant difference in legume production between ridges and flatbeds (Table 3).

Alternative crop geometry to accommodate forage legumes

The possibilities for incorporating forage legumes through simple adjustments in plant geometry and fertilizer application were also investigated with S. guianensis cv Cook. A mixture of sorghum and soybean, as traditionally planted on ridges according to local practice, was taken as a reference model (Figure 2, pattern 2) for comparison with different crop-forage combinations (Figure 2, patterns 3-7).

Figure 2. Crop-crop-forage planting patterns.



On one ridge, two sorghum stands were planted 0.3 m apart, with soybean in between, while S. guianensis cv Cook was planted alone on the other ridge (inter-row planting or alternate row planting - Figure 2, pattern 7). This variation offered a good compromise for growing a two-crop and one-forage mixture without having adverse effects on grain yields compared with sole cropping (Table 4). Undersowing sorghum with soybean did not cause as severe a grain reduction as undersowing with stylo.

Table 4. Grain and fodder yield (kg/ha) when soybean and stylo were undersown (US) or sown on alternate ridges (AR) with sorghum, 1982.[a/]

Sorghum spacing (m)	Legume sowing method		Grain yield[b/] (kg/ha) at:			Fodder yield[b/] (kg/ha) at:			Mean grain yield (kg/ha)	Mean crop residue yield (kg/ha)
	Soya	Stylo	0	40	80	0	40	80		
			(kg N/ha)			(kg N/ha)				
1 x 0.30	-	-	952	1481	2040	3921	7092	7571	1491 ab	6159 ab
1 x 0.30	US	-	740	1217	1645	2652	6238	6619	1201 bc	5170 c

			(47)*	(90)	(137)				(91)	
1 x 0.30	-	US	617	1206	1365	1904 (1159)	3381 (1460)	4968 (1381)	1063 c	3418 d (1333)
2 x 0.30	-	-	857	1730	2142	3603	7625	8095	1576 a	6441 a
2 x 0.30	AR	-	834 (162)	1666 (170)	2174 (185)	2998	6619	7031	1558 ab (172)	5549 be
2 x 0.30	-	AR	778	1429	1963	3540 (1556)	5238 (1857)	7008 (2016)	1390 abc	5262 c (1803)
2 x 0.30	US	AR	779 (29)	1335 (69)	1878 (108)	2746 (1127)	5032 (1286)	6662 (1667)	1331 abc (68)	4813 c (1360)

[a/] Mean grain and crop residue values followed by common letters do not differ significantly at the 5% level of significance.

[b/] Values in parenthesis correspond to grain yield of soybean and fodder yield of stylo respectively.

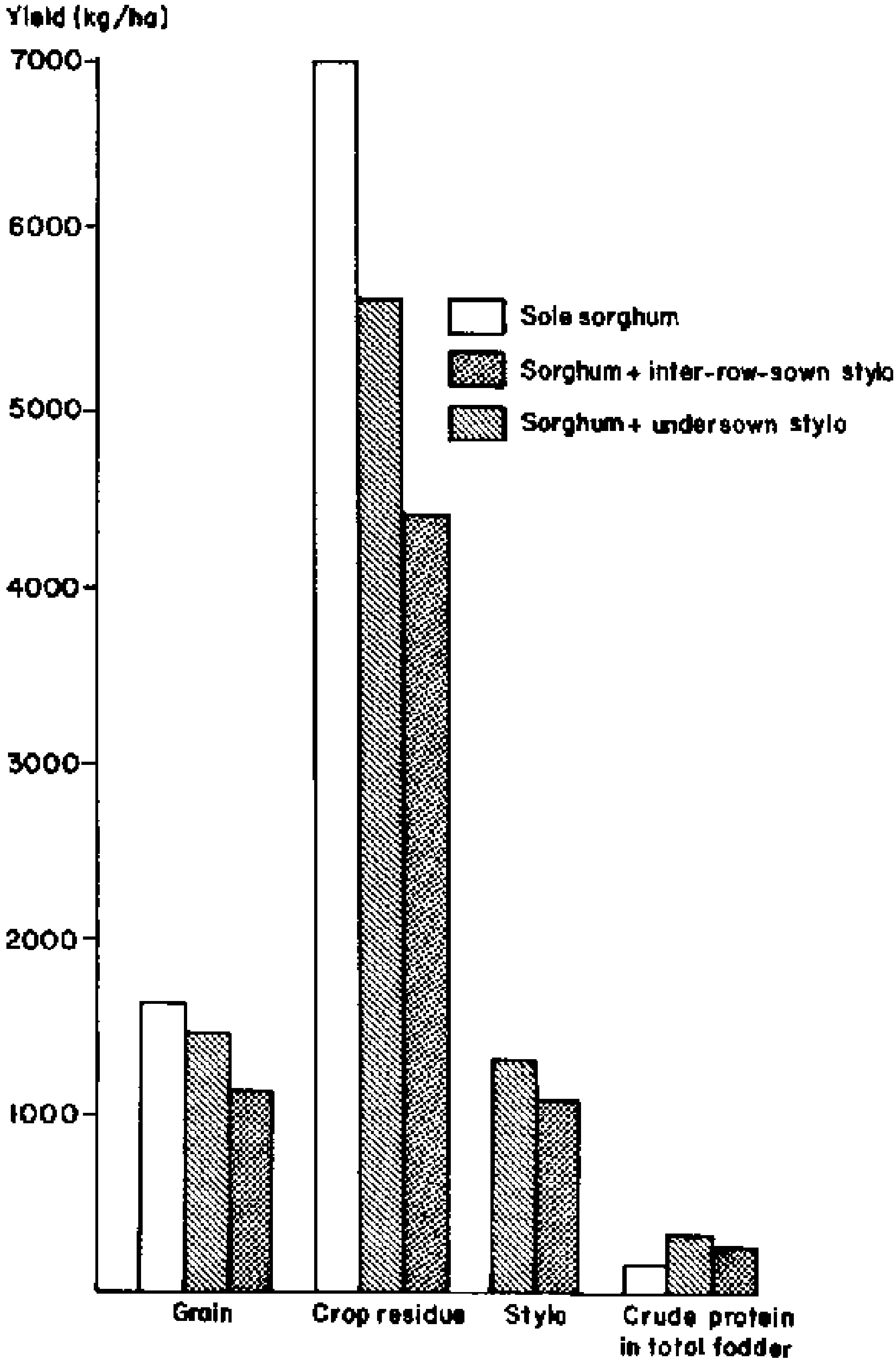
Both sorghum and soya grain yields responded to the application of nitrogen. With N application to the sorghum row, they produced comparable yields when planted either separately on different ridges or together on the same ridge and alternated with stylo rows. When fertilized with 80 kg of N/ha the inter-row sowing of stylo, with sorghum and soya on alternate ridges, produced 8.2 tonnes of fodder per ha. Out of this, 1.6 tonnes were made up of stylo (CP = 13.1%), increasing the CP yield over sole-crop sorghum from 216 kg to 391 kg/ha.

Undersowing and inter-row sowing were also tested in researcher-managed, farmer-implemented trials. Thirteen farmers who had previously planted sole-crop sorghum were recruited at Abet in 1981 and persuaded to undersow or inter-row sow their crop with Stylosanthes. When inter-row sown the total sorghum plant population was maintained by planting two stands per position instead of one. Inter-row sowing resulted in a reduction of about 10% in grain yields compared with the sole-crop control. Undersowing resulted in a grain in loss of about 30% (Figure 3).

The value of the grain loss from inter-raw sowing was less than that of the extra fodder gain, based on the comparative cost of obtaining the same amount of protein from cottonseed cake.

Stylosanthes was also more productive on ridges (Table 4) but farmers will not expend labour on ridge making and then plant only half their ridges with cereal unless they either own livestock or have access to a market for the fodder.

Figure 3. Average grain and fodder yields of sorghum with under-or inter-row-sown stylo in researcher-managed farmer-executed trials, Abet, 1981.



Contribution of forage legumes to food crop production

Land under S. hamata cv Verano and S. guianensis cv Cook for various lengths of time supported higher maize yields compared with those from uncropped or previously cropped areas. This became evident from trials using maize rows (four replications) to assess the effect of different rates of N (0, 20, 40, 60, 80, 100, 133, 166, 199 kg/ha) on grain and fodder productivity of land that had had the following histories:

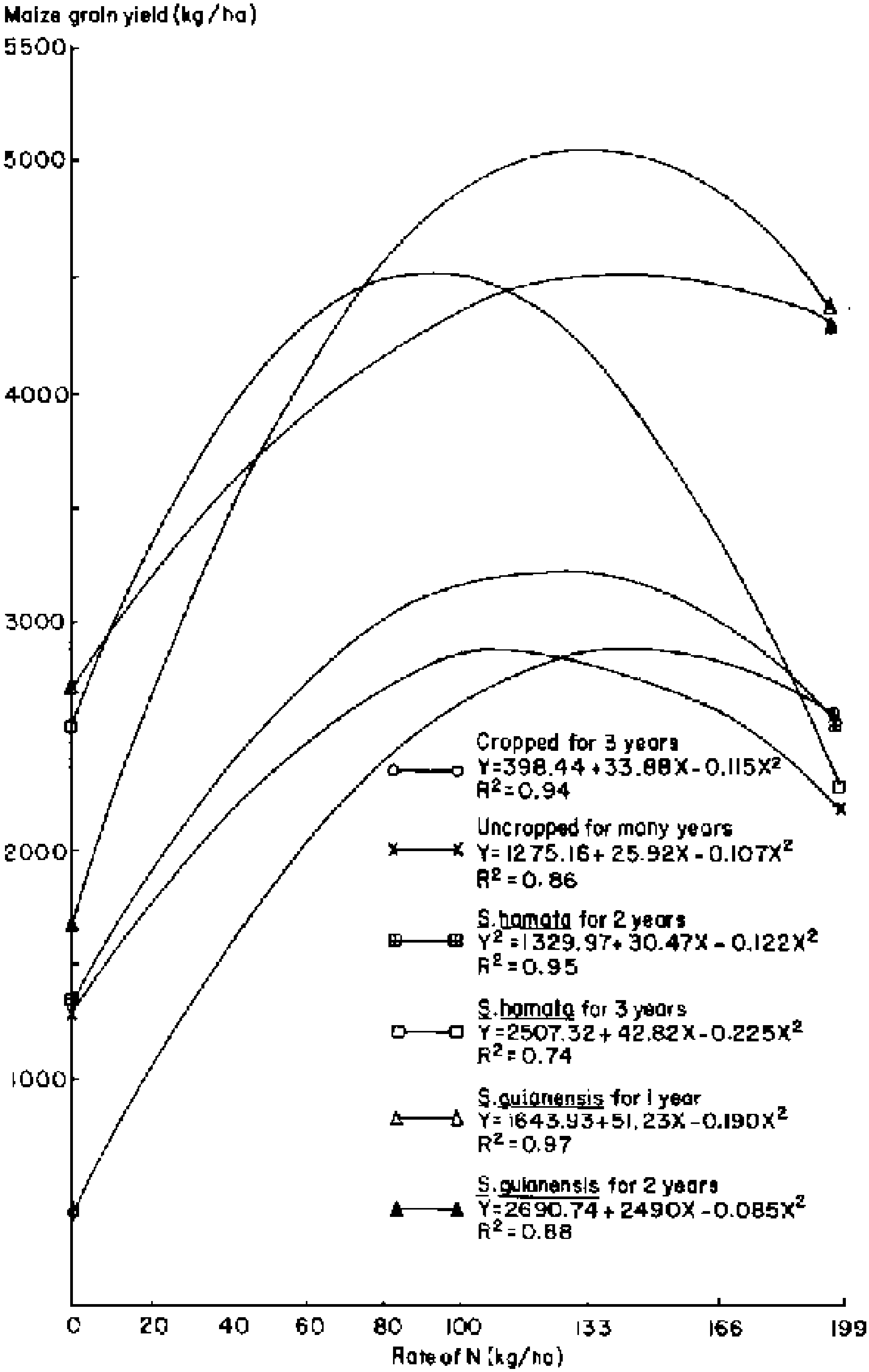
1. Uncropped for a number of years.
2. Cropped for 3 years.
3. Under S. hamata cv Verano for 2 years.
4. Under S. hamata cv Verano for 3 years.
5. Under S. guianensis cv Cook for 1 year.
6. Under S. guianensis cv Cook for 2 years.

The results of this experiment are summarized in Figure 4, from which the amounts of N required to be applied to a soil cropped for 3 years to achieve crop yields equivalent to the various legume fallow treatments can be derived. The amounts are given in Table 5.

Table 5. Estimated level of N utilization (kg/ha) from soil with different histories at Kurmin Biri, 1983.

Soil type	Grain yield at 0 kg/ha of N	Amount of applied N (kg/ha) required by cropped soil for equivalent yields of other soil types at zero N
Cropped for 3 years	461	
Uncropped for many years	1275	30
S. hamata for 2 years	1329	32
S. hamata for 3 years	2507	90
S. guianensis for 1 year	1643	44
S. guianensis for 2 years	2696	110

Figure 4. Effect of N application on grain yield of maize grown on land with different cropping histories, Kurmin Biri, 1983.



The main crop benefitted from N amounts equivalent to 90 and 110 kg/ha from soil that had been under S. hamata cv Verano and S. guianensis cv Cook for 3 and 2 years respectively. It produced much higher yields, approximately 1.2 to 2.2 tonnes/ha over and above those from previously cropped or uncropped soils.

The more rapid improvement of soil under stylo than under natural fallow has favourable implications for forage cropping in the subhumid zone. However, for how long such an improved soil could support cereal production has not yet been determined. Studies in Kenya (Maher, 1951; Webster, 1954) showed that the beneficial effects of a grass pasture were lost after 1 or 2 years of grain cropping.

There may be other legumes resistant to anthracnose that could impart greater benefits to soil than S. guianensis cv Cook and S. hamata cv Verano in the subhumid zone. In a screenhouse study where maize was grown for 6 weeks in pots using soil collected from legume introduction plots after two growing seasons, several lines showed higher beneficial effects (Table 6). The different lines were acquired from CIAT (Columbia) and were not inoculated at the time of planting.

Table 6. Total dry matter (DM) yield of maize in pots using soil collected from plots of respective legumes after two growing seasons, 1984.

Accession	Species	Yield[a/] (g/plot of 10 seedlings)
350	D. ovalifolium	7.16 a
1019	S. capitata	6.97 ab
3001	D. gyroides	6.80 abc
5233	C. aurinarium	6.78 abcd
2039	S. macrocephala	6.74 abcd
1582	S. macrocephala	6.68 abcd
5062	C. macrocarpum	6.66 abcd
728	Z. latifolia	6.64 abcd
5234	C. brazilianum	6.56 abed
7485	Z. brazihanum	6.53 abcd
1342	S. capitata	6.38 abcd
1523	S. guianensis-tardio	6.36 abcde
1045	S. capitata	6.30 bcde
1693	S. capitata	6.30 bcde
5274	C. macrocarpum	6.24 bcde
2133	S. macrocephala	6.14 bcdef
1318	S. capitata	6.14 bcdef
2044	S. capitata	6.12 bcdef
1280	S. guianensis-tardio	6.08 cdef
1097	S. capitata	6.02 cdefg
1728	S. capitata	5.94 cdefg
1315	S. capitata	5.92 defg
1441	S. capitata	5.50 efgh
5234 x 5224	C. brazilianum	5.36 fgh
1643	S. macrocephala	5.20 gh
1283	S. guianensis-tardio	4.66 hi
Control	No legume	3.50 i

[a/] Means of four replications. Values in the column followed by one or more common letters do not differ at the 5% level of significance.

Legume-based cropping techniques

Rate of soil regeneration under a legume is a function of the legume's concentration and productivity. A concentrated legume stand cannot be maintained indefinitely. After 2 or 3 years fodder banks tend to be invaded by nitrophilous grasses in response to the build-up of N in the soil. A cereal crop can be planted to use the surplus nitrogen instead, thus benefitting not only itself but also the legume, the subsequent concentration of which will be improved.

Land preparation after-a natural fallow is geared towards producing a clean seedbed. Methods may include burning, stumping large trees and shrubs ridging, etc. But when clearing an area that has been under a legume, farmers should not aim at its total removal. The crop and legume phases should each be short because, as noted above, gains in soil fertility are not long lasting. Hence, there is a need to maintain adequate legume seed reserves for re-emergence.

Again, the presence of legumes amongst the grain crop residue is of value to livestock, but as noted above the regrowth of the legume must be controlled for the first 3 to 6 weeks in order to avoid competition after sowing of the grain crop at the start of the following growing season.

In the light of these considerations, research has been carried out on two techniques: superimposed cropping and intersod transplanting.

Superimposed cropping

Superimposed cropping means growing a cereal every year in areas also sown with forage legumes. The essential feature is that the cereal grows while the legume is kept under control by manual weeding or by herbicide application. Once the grain crop is fully established and able to withstand competition the legume is allowed to regenerate from seed and contribute to the total poet-harvest fodder. This system requires large legume seed reserves in the soil, and thus a good seed return after each growing season. The presence of adequate seeds with different sensitivities will ensure regeneration of the legume after land preparation and weed control have eliminated early legume flush.

In an experiment at Kurmin Biri where sorghum was planted in an area under Stylosanthes hamata cv Verano, application of a herbicide Round-up (glyphosphate) at 3 litres/ha before planting the grain crop - did not reduce early re-emergence of the legume, although the initial flush was totally killed. The growth rate of sorghum planted on the flat was low compared to that planted on ridges (Table 7). Sorghum planted on the flat was smothered completely by the legume in spite of herbicide application.

Table 7. Growth of sorghum at 7 weeks when planted in an area under S. hamata after different land preparations, Kurmin Biri, 1983.

Land preparation		Plant height (cm)	Root length (cm)	Number of leaves	Leaf area index
No-legume area					
	Ridge	124	42	9	0.32
	Flat	50	25	6	0.18
S. hamata area					
	Ridge	119	44	9	0.32
	Flat	43	23	5	0.09

When the soil was ridged and the grain crop sown early in the season, legume emergence was low and was confined to the valleys, while grain crop growth was faster (Table 8). This low emergence was probably due to burial of most of the legume seeds under the ridges. Application of herbicide after making the ridges but before planting the grain crop did improve grain yields from both legume and non-legume areas but, in the former, legume content of the final fodder was reduced as compared with that from unsprayed ridges. Although grain and fodder yields of sorghum were low (probably due to moisture stress imposed by the early start of the dry season in 1983), there appears to be a clear yield advantage from ridging, especially when grain crops are superimposed on a legume area (Table 8). This result suggests that a planted legume fallow or a fodder bank should be cultivated using ridges in the traditional manner.

Table 8. Effect of land preparation and herbicide application on the grain and fodder yields when sorghum was superimposed on an area under S. hamata, 1983.

		Herbicide			No herbicide		
		Grain (kg/ha)	**Crop residue (kg/ha)**	**Stylo (kg/ha)**	**Grain (kg/ha)**	**Crop residue (kg/ha)**	**Stylo (kg/ha)**
No-legume area							
	Ridge	749	4124	-	542	2562	-
	Flat	457	1662	-	329	1500	-
S. hamata area							
	Ridge	1213	4687	1088	750	3581	1882
	Flat	340	1725	3980	125	1440	5850

The presence of a forage legume may provide better protection against soil erosion than a sole crop. However, an important consideration for a farmer is the relative labour requirements for ridging a soil that has been under a legume compared with that which has not. This still needs to be tested.

Intersod transplanting

Intersod transplanting means transplanting cereals into established legume swards. Ridge making is a labour-intensive operation. The extent of land that can be prepared for cropping largely depends on the labour availability at the appropriate time. Techniques that reduce labour requirements and/or spread labour demands into slack periods would thus benefit the farmer. Farmers in the ILCA study areas habitually transplant millet and, to a lesser extent, sorghum. Sorghum is transplanted when it has to be re-established during the growing season or when opening rains are late in the year. Seedlings raised in nurseries are easier to irrigate than when they are on larger plots.

Building on this traditional practice, preliminary attempts were made to transplant sorghum and millet into 1-year-old plots of S. hamata cv Verano. Nurseries of sorghum and millet were established in June and July, and seedlings were transplanted in July and August into separate plots of S. hamata at 30- and 25-cm spacings respectively along the rows. The rows, each 30 cm in width and 1 m apart, were cut or strip-hoed within an established plot of S. hamata. In some plots the herbage between the rows was also cut and removed from the plots at the time of transplanting.

Transplanting into stylo reduced grain yield of the two cereals by 20 to 38% compared with the yield anticipated on traditional ridges without stylo (Table 9). Removing stylo from between as well as within rows at the time of planting improved grain yields of transplanted millet.

Table 9. Grain and fodder yields (kg/ha) of sorghum and millet under different land preparations and planting methods, Kurmin Biri, 1981.

Land preparation/planting	**Grain yield**	**Deviation in grain in relation to L_1 (%)**	**Crop residue[a/]**	**Stylo DM[a/]**	**Total fodder CP**
Sorghum Ridge - no stylo (L_1)	1833	-	4916 (24)	-	118
Intersod transplanting within stylo (L_2)	1366	-20	3800 (2.4)	2432 (12.9)	409
Millet Ridge - no stylo (L_1)	860		1748 (3.18)		
Intersod transplanting (stylo between rows uncut at planting) (L_2)	530	-38	648 (2.89)	2820 (12.3)	366
Intersod transplanting (stylo between rows cut at planting) (L_3)	670	-22	894 (3.10)	2238 (12.1)	298

[a] Values in parenthesis indicate % CP.

In another experiment in 1983 intersod transplanting of sorghum was compared with transplanting onto ridges. The grain yield of sorghum transplanted onto ridges made within plots of S. guianensis cv Cook was twice as high as that from ridged areas without stylo (Table 10). Sorghum established in the stylo from seeds suffered greater loss of grain yields, especially when planted late to coincide with transplanting in a year with a short wet season. Application of weed killer reduced the productivity of stylo. The effects of stylo soil and ridging on crop yield were again very evident.

Table 10. Effect of land preparation and method of crop establishment within stylo fields on grain and fodder yields (kg/ha) of sorghum, Kurmin Biri, 1983.

Land preparation method	Planting method	Yields[a/]		
		Grain (kg/ha)	Crop residue (kg/ha)	DM stylo (kg/ha)
Sorghum without stylo[b/]				
Ridge	Seed	292 d	2750 de	
	Transplant	795 bc	4833 ab	
Strip-hoe	Seed	84 d	1646 fg	
	Transplant	583 c	3667 cd	
Sorghum with S. guianensis cv Cook				
Ridge and no herbicide	Seed	342 d	2617 def	1440
	Transplant	1093 b	4315 bc	1512
Strip-hoe and no herbicide	Seed	94 d	1313 g	2205
	Transplant	240 d	2050 efg	2058
Ridge and herbicide	Seed	531 c	3375 d	748
	Transplant	1563 a	5716 a	760
Strip-hoe and herbicide	Seed	250 d	2207 ef	1030
	Transplant	563 c	3750 c	942

[a/] Values of grain and crop residue followed by one or more common letters do not differ at the 5% level of significance.

[b/] Grain and crop residue yields of sorghum on stylo-free area did not differ significantly between herbicide and non-herbicide treatments.

Transplants compete with stylo better than do seedlings. Raising seedlings first in a nursery helps to select strong, healthy plants. Transplanting into stylo without having to make ridges offers another way of growing crops and forages together without increasing labour requirements The amount of labour spent on strip-hoeing is approximately one third of that required for ridge making. It would thus be possible to compensate for the loss of grain by cultivating larger areas with the available labour. This innovation could be very advantageous wherever labour rather than land is the limiting factor, as in many parts of Nigeria's subhumid zone.

Conclusions

Superimposed cropping and incorporating forage legumes into crop mixtures appear to offer the most promising methods of improving fodder supplies and maintaining soil fertility without prejudicing grain crop yields, but more research with farmer participation needs to be done on all the various cropping techniques and combinations to evaluate their relevance in agropastoral production systems.

References

Maher, C. 1951. Soil conservation in Kenya colony, 1: Factors affecting erosion, soil characteristics and methods of conservation. Emp. J. Exp. Agric. 18: 137.

Webster, C.C. 1954. The ley and soil fertility in Britain and Kenya. East Afr. Agric. For. J. 20: 71.