PN-AAY-934
ISN 53785
633Ø221

AGRICULTURAL TECHNOLOGY IMPROVEMENT PROJECT

INTSORMIL

MISC. PAPER

EFFECTS OF TILLAGE SYSTEMS ON WEED GROWTH AND WEEDING LABOUR REQUIREMENTS

NUMBER: ATIP MP 87.7

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SEPTEMBER 1987

PRINTED: 30/9/87

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EFFECT OF TILLAGE SYSTEMS ON WEED GROWTH AND WEEDING LABOUR REQUIREMENTS

INTRODUCTION

The following is a discussion of observations on tillage treatment effects on weeds and weeding labour requirements, taken from four sets of trials, between 1985 and 1987. The first two trials concerned a range of tillage options, and were performed at Sebele and in Tutume Agricultural District. The second two were specifically focused on double versus single ploughing options. Again one of these was performed at Sebele, and the other in Tutume Agricultural District.

I. TILLAGE SYSTEM TRIAL

OBJECTIVES

The purpose of this study was to compare a number of tillage systems considered to be of potential benefit to medium and small scale farmers in Tutume Agricultural District. The systems were compared on the basis of relative productivity in the district. However, all labour requirements were monitored, and input costs recorded so that the relative profitability and labour requirements could also be compared across systems. The objective of this study was to identify potentially useful technology, without regard to the level of technology involved.

JUSTIFICATION

Numerous tillage/planting options are being tested at the main research station at Sebele, with promising results. Some technologies transfer easily from the station to the farm. While others require considerable modification before farmers can use them efficiently. This study was necessary to determine which of the more promising systems had greatest potential for immediate use within Tutume Agricultural District, which ones might be useful after further modification, and what types of modifications might be required.

APPROACH

Tillage systems compared are listed below:

1. Traditional check: Seed broadcast and ploughed down.
2. Double ploughing: Spring plough, broadcast seed and re-plough after one rain.
3. Spring plough, row plant after one rain.
4. Spring plough, replough after one rain, and row plant.
5. Band ploughing: Plough strips 2 metres wide, 2 metres between strips. Broadcast seed and replough strips after one rain.

6. Deep rip on 1 metre rows in winter. Cultivate riplines and row plant in spring.

7. Deep rip on 1.5 metre rows in winter. Bed shaping between rows. Cultivate and row plant on riplines in spring.

Preliminary ploughings (or deep ripping) were done by tractor. Cultivations, ploughing operations done for broadcast planting, and row planting operations were all done using donkeys for draught power. The experiments were done in the Researcher Managed/Researcher Implemented (RMRI) mode, owing to the number of treatments involved. Treatments were implemented in such a way that all plots in a location were planted on the same day. The number of people working on a given operation, on a given plot, was recorded, as was the draught power source, number of animals - if any - depth of any tillage operation, and amount and type of any inputs used. Labour time per plot was measured with a stop watch. Part of the data recorded included weeding labour. Plots were weeded three to four weeks after emergence. Plots with ripping treatments were weeded a week ahead of other plots because of their heavy weed burden. Weeding was done by three to four people using hand hoes.

The experiment was conducted in a randomized complete block design at two locations in Mathangwane village. There were two replications per location.

RESULTS

Mean yields and weeding labour requirements are given in Table 1.

TABLE 1: MEAN YIELDS AND WEEDING LABOUR REQUIREMENTS, AVERAGED OVER TWO LOCATIONS, TILLAGE SYSTEMS TRIALS, ATIP, FRANCISTOWN 1986-87

TILLAGE SYSTEM	WEEDING LABOUR* (PERSON HRS/HA)	YIELD (KG/HA)*
1. Traditional check	45 d	108 cd
2. Double ploughing	18 d	289 ab
3. Single plough/row plant	85 dc	12 d
4. Double plough/row plant	12 d	343 a
5. Band ploughing	135 bc	163 bc
6. Deep rip	258 a	15 d
7. Deep rip/bed shape	221 ba	3 d

*Within a column treatments followed by the same letter are not significantly different at the 5% level.

Tillage treatments had a significant effect on both weeding labour requirements and grain yields. The most striking differences were between double ploughed treatments (2 and 4) and deep ripping treatments (6 and 7). Double ploughed treatments had an overall average weeding labour requirement of 15 person hours/hectare and grain yields of around 300 kg/ha. Ripping treatments had an average weeding labour requirement of over 200 person hours/hectare and grain yields of less than 20kg/ha.

Even single ploughed treatments had significantly lower weeding requirements than the ripping treatments, though yield levels were not significantly different. Such differences in weeding labour requirements might not always

be so dramatic. None the less, a similar effect was observed at Sebele in 1985-86 and this past year in Mahalapye, on similar trials.

At Sebele, a related set of trials included a "traditional check" treatment which was ploughed once and then row planted (traditional); a double ploughed treatment (double plough) which was ploughed twice and row planted; a deep ripping treatment (deep rip) which was chisel ploughed (50-70cm depth) on 1.6m rows; and a deep ripping treatment with surface moulding to promote the movement of runoff into the riplines (DR/SM). These treatments were implemented at two sites within Sebele, with four replications per site. Data from these trials are presented in Tables 2 and 3.

TABLE 2: TOTAL WEED NUMBER (GRASS PLUS BROADLEAF) AND BROADLEAF WEED COUNTS (23 DAYS AFTER PLANTING) AS AFFECTED BY TILLAGE, INTSORMIL, SEBELE, 1985-86. (Statistical Analysis was done on Square Root Transformed values).

TILLAGE	TRANSFORMED (ACTUAL) TOTAL WEEDS	BROADLEAF
	(WEEDS/5 M SQ)	
Traditional	7.2403 (52)	6.1397 (37)
DR/SM	16.3187 (266)	15.0538 (227)
Double Plough	8.4424 (71)	8.9981 (49)
Deep Rip	15.5940 (243)	15.005 (225)

TABLE 3: WEED COUNTS BY SPECIES AS AFFECTED UNDER VARIOUS TILLAGE PRACTICES (23 DAYS POST PLOUGHING), INTSORMIL, SEBELE, 1985-86

	TRIBULUS	IPOME	CHENOPODIUM	OTHER BROADLEAF	GRASSES
	(WEEDS/ 4 M SQ.)				
SITE 834 (Loc 1)					
Traditional	19	6	6	10	6
DR/SM	78	104	33	55	58
Double Plough	16	17	9	38	24
Deep Rip	59	99	28	82	28
SITE MEAN = 87					
BLOCK 9 (Loc 2)					
Traditional	23	1	13	4	25
DR/SM	34	28	132	18	27
Double Plough	8	8	11	3	22
Deep Rip	119	54	51	5	13
SITE MEAN = 150					

It can be seen from these data that deep-ripping treatments had much higher

levels of weeds, particularly of broadleaf weeds, three weeks after planting. Also in these trials, double ploughing did not reduce the number of weeds vis-a-vis single ploughing, three weeks after planting. These data, combined over locations, clearly indicate that tillage systems involving deep ripping cannot be recommended for medium to small scale farmers until they include some practical and cost effective weed control measures.

Comparing double ploughed and single ploughed systems, (in the Francistown area) the double ploughed plots out yielded the single ploughed plots, with or without row planting. Double ploughing showed a tendency to reduce weeding requirements vis-a-vis single ploughing, but the differences were not significant. This is not surprising in view of the results from a large number of double ploughing vs. single ploughing comparisons conducted in the Francistown region over the last two years, which are discussed below.

II. DOUBLE PLOUGHING TRIALS 1985-87

OBJECTIVES

The objectives of these on-farm and on-station trials were numerous. The primary objective of the on-farm trials pertinent to this paper was to compare the profitability of double ploughing and single ploughing when labour and inputs were taken into account. The objective of the trials conducted at the Research Station was to characterize the weed burden and species composition.

JUSTIFICATION

Double ploughing has consistently increased per hectare crop production. However, it has also required increased ploughing time per hectare and might in some cases reduce the total hectarage a farmer could plant in a season. Thus careful analysis of the whole system was required before it could be generally recommended.

APPROACH

A system was designed such that a farmer would plant five plots in a comparison. Plots (10m x 40m) were ploughed and planted in the following order:

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Rain 1	Ploughed/ Planted	Ploughed Only		Ploughed Only	
Rain 2		Ploughed/ Planted	Ploughed/ Planted		
Rain 3				Ploughed/ Planted	Ploughed/ Planted

Plot 1 represented what a farmer lost through ploughing without planting on rain 1. Plots 2 and 3 and plots 4 and 5 were simple comparisons of double ploughing versus single ploughing plots, planted on the same days respectively. All labour data was measured by stop watch, and all inputs

were monitored. Trials were researcher managed and farmer implemented. That is to say that researchers designed the trials and suggested weeding when the need arose.

There were two primary comparisons made across trials:

a) The simple comparison of one double ploughed plot versus its companion single ploughed plot, planted on the same day, and;

b) The comparison of a double ploughed plot versus its companion single ploughed plot plus data from plot one. Data from plot one represented the opportunity cost of the first ploughing in a double ploughing system.

There were 10 paired plot comparisons in each of 1985-6 and 1986-7. Statistical comparisons were made using paired t-tests.

RESULTS

Average weeding labour requirements and grain yields across locations, for both years, are summarized in Table 4.

TABLE 4: AVERAGE WEEDING LABOUR REQUIREMENTS FOR DOUBLE PLOUGHING TRIALS (RMFI). ATIP, FRANCISTOWN, 1985-87.

TREATMENT	WEEDING* (PERSON HRS/HA)	YIELD* (KG/HA)
1985-86		
Average for Single Ploughing	32 c	186 b
Average for Double Ploughing	48 b	347 a
Single Ploughing plus Opportunity Cost per 2 hectares	75 a	342 a
1986-87		
Average for Single Ploughing	42 b	49 b
Average for Double Ploughing	37 b	99 a
Single Ploughing plus Opportunity Cost per 2 hectares	108 a	98 a

*Within a column, by year, treatments followed by the same letter are not significantly different at the 1% level.

Double ploughing did not reduce the per hectare weeding time requirement relative to a single ploughing. In fact, in 1985-86, double ploughing actually increased the weeding labour requirement slightly, and it showed a similar tendency in 1986-87. This effect in 1985-86 was attributed to the fact that double ploughing improved the plant growth environment (as seen by per hectare yield results Table 4). It was hypothesized that the improved environment stimulated weed growth as well as crop growth resulting in the need for slightly more weeding.

It should be noted however, that on average single ploughing required twice the amount of weeding labour as double ploughing to produce the same amount of grain. This was because single ploughing required twice the land area.

Weed counts and species composition were assessed under single ploughing and

double ploughing in trials conducted by INTSORMIL at Sebele Research Station during 1985-86. The trial, conducted at two sites [B24 - hardveld, and Block S - sandveld], had two dates of ploughing and 8 planting dates. Weed counts and species composition from the unploughed treatment were compared to land ploughed on 14 December or 31 December before and approximately 6 weeks after planting. A weed count conducted prior to any ploughing [10 Oct.] showed that 'weediness' within the experimental sites was not systematic and therefore not likely to influence the subsequent weed counts[Table 5].

Pre-plant weed counts conducted on 9 January on unploughed and land ploughed 14 December were compared [Table 6]. Statistical analysis of square root transformed weed counts showed a significant [P=.10] difference between the two treatments on the hardveld soil but no different on the sandveld. Species composition was dependent on soil type with the hardveld having relatively greater broadleaf weeds while the sandveld had relatively greater grass weeds [Table 7]. The count numbers of all species were lower for the 14 December ploughing treatment.

Weed counts approximately 6 weeks after planting in the single ploughed, 14 December and 31 December double ploughing were not significantly [P=.10] different.

TABLE 5: ACTUAL WEED COUNTS FOR THE PRE-SEASON/ PRE-PLANT ASSESSMENT IN THE BROADCAST/ PLOUGH PLANT EXPERIMENT, INTSORMIL, SEBELE, 1985-86

TILLAGE AREA	SITE B24 ACTUAL	B24 [STD DEV]	BLOCK 9 ACTUAL	BLOCK 9 [STD DEV]
	[WEEDS/4 M SQ.]			
Single Plough	9.3	[10.2]	3.2	[4.8]
Double Plough-Dec	12.3	[13.2]	8.3	[9.8]
Double Plough-Jan	10.2	[15.1]	4.8	[4.9]

LSD = n.s.

TABLE 6: SQUARE ROOT TRANSFORMED AND ACTUAL WEED COUNTS AS AFFECTED BY SINGLE AND DOUBLE PLOUGHING 27 DAYS AFTER THE FIRST PLOUGHING, INTSORMIL, SEBELE, 1985-86

TREATMENT	SITE B24 TRANSFORM	B24 [ACTUAL]	BLOCK 9 TRANSFORM	BLOCK 9 [ACTUAL]
	[WEED COUNTS/4 M SQ]			
Unploughed	14.43	[208]	4.71	[22]
Ploughed - 14 Dec	10.52	[110]	4.75	[22]

* Significantly different at the 10% level.

TABLE 7: SPECIES COUNTS AS AFFECTED BY SINGLE AND DOUBLE

PLOUGHING 27 DAYS AFTER THE FIRST PLOUGHING, INTSORMIL, SEBELE, 1985-86

SITE	TRIBILUS	IPOMEA	AMARANTHUS	OTHER	GRASSES
	[COMMON WEEDS]				
	[PLANTS/1 SQ]				
B34					
Unploughed	129	44	38	16	14
Ploughed - 14 Dec	40	41	16	18	14
BLOCK 9					
Unploughed	14	2	3	7	89
Ploughed - 14 Dec	9	4	2	19	43

As can be seen from the data the effect of double ploughing on weed growth does vary. Often, a striking difference in weed growth can be observed between single and double ploughed plots planted side by side on the same day. [This is especially true in the case of cynodon dactylon infestations.] However, as seen in the above data, the effect of double ploughing on weed growth is not consistent, and at present, somewhat unpredictable.

CONCLUSIONS

a) Tillage systems involving deep ripping must also include a practical and cost effective weed control component before they can be used as general extension recommendation

b) Double ploughing may effect good weed control in some cases, however, the effect is somewhat unpredictable.

c) Double ploughing generally increased per hectare grain yields much more than it increased weeding labour requirements, per hectare on a percentage basis.