Pak. J. Agri. Sci., Vol. 20 (3-4), 1983

THE EFFECT OF INTRODUCING LEADING SHALLOW TINES IN COMBINATION WITH WINGED SUBSOILER

M. Amanat A. Chaudhry*

ABSTRACT

The attachment of wings to the foot of a conventional subsoiler increased the area of soil disturbed for very small amount of increase in draught. A further increase in disturbance was obtained by introducing shallow tines ahead of the subsoiler tine. The ratio between soil disturbance and draught increased by 60 per cent by introducing two leading shallow tines in combination with winged subsoiler. Soil disturbance in sandy soil was more than that in clay and it increased by increasing the depth of leading tines. It was also found that the ratio between draught and soil disturbance decreased significantly by attaching three leading shallow tines with two winged subsoiler.

INTRODUCTION

It is an admitted fact that deep tillage improves the crop yields in many soil types (Trouse and Humbert, 1959). James and Wilkins (1972) suggest that deep ploughing is not recommended for all soils. Most soils which produce high yields show little benefit from deep ploughing; other soils double their yields. It is advantageous to plough soils deeply which would not take up water readily. Deep ploughing modifies the soil structure so that water can move more readily from the surface to the water table or to drains. Another reason for an increased soil disturbance or deep ploughing is to bury surface concentrations of saline and alkali compounds so that they would not stop plant growth. It also helps to control the plant diseases.

The object of this study was to design an equipment which would decrease the draught and increase the soil disturbance.

For a given soil condition, there is a working depth referred to as the

* Department of Basic Engineering, University of Agriculture, Faisalabad.

critical depth, above which the soil is lifted towards the surface and hence loosened. On the other hand, at working depth below critical depth, the soil is compacted around the blade and foot of the subsoiler. These observations lead to two approaches to improve the effectiveness of operation. The first is to fit wings to the subsoiler foot and the second to loosen the top soil by shallow chisel plough tines running ahead of the subsoil tine. It will make easier for the winged subsoiler to lift the deeper layer towards the surface if the surface layer is loosened first, resulting in a decrease in the draught and increase in the soil disturbance.

THE EQUIPMENT

(a) *Soil Disturbance Measuring Apparatus*

This is also called as the Profilemeter. Soil upheaval and profile cross-section of soil disturbance were measured by this apparatus. This consists of fifty movable aluminium rods spaced laterally at 20 mm distance apart and mounted on a rectangular aluminium box. These rods are capable of sliding upwards or downwards in the guide holes of the box and can be held in any position by tightening a screw located on the side of the instrument. While taking the readings, two fixed vertical rods at both ends of the box are placed on a levelled surface and the movable rods are dropped down by loosening the side screw and outlines of profile disturbance are marked using coloured pencils on drawing paper.

(b) *Force Measuring Apparatus*

An extended octagonal ring transducer equipped with strain gauges designed by Godwin (1975) was used to measure the forces. It contains three four-arm bridge circuits and measures the horizontal force (F_x), the vertical force (F_v) and the moment (M_v). The output signals from the strain gauges were transmitted to an amplifying unit and recorded on an ultra-violet (U.V.) oscillograph.

TESTING PROCEDURES, RESULTS AND DISCUSSION

As already described, the soil distrubance was measured by means of a profilemeter. The soil disturbed or loosened was removed by spade. For measuring the disturbance, the two fixed vertical rods at both ends were placed on a levelled surface and the movable rods were dropped down by loosening the side screw. The rods were locked in position by clamping the screw and outlines of profile were marked on the drawing paper. The profile was then drawn to a small scale and the area of the soil disturbed was found by means of a planimeter.

To measure the draught, the amplifying unit and the U. V. recorder were placed on a Land Rover and a long cable was used to connect the transducer to the amplifying unit. The traces obtained from the U. V. recorder were used for the determination of draught.

A study cf soil disturbance and draught for different treatments and depths was made at Flitton Experimental Area in Bedford (U. K.). The soil under study was classified as sandy loam and its dry density was almost constant with depth.

The results showed that soil disturbance was more in sandy soils than that in clays, keeping the depth constant in both cases. This is because sandy soils are subjected to more shattering as they are cohesionless as compared to clays, which have greater value of cohesion. The soil bisturbance was found to increase as the depth of pass increased.

The results of soil disturbance caused by winged subsoiler with two leading shallow tines for different treatments and depths are shown in Table 1. The arrangement of the leading tines and the winged subsoilers on the tool bar is shown in **Plate 1.** The results indicated that the effect of shallow tines caused a significont increase in the area of the soil loosened for no increase in the total draught.

The soil distrubance per unit draught increased by 60 per cent by introducing two leading shallow tines 0.50 meter apart and 0.17 meter deep, when the winged subsoiler was 0.24 meter deep. The corresponding increase reduced to 25 per cent when the leading shallow tines spaced 0.50 meter, were 0.12 meter deep. This showed that soil distrubance per unit draught increased when the leading shallow tines attached with the winged subsoiler were deeper. Figures 1 and 2 show the variations of soil disturbance with draught and depth, respectively. The variations have been expressed by mathematical equations shown on the figures.

Table 1. *Results of soil disturbance and draught at various depths by different treatments*

	Draught (KN)			Soil disturbance (cm²)		
Depth of operation (cm) / Treatment	16	24	32	16	24	32
By winged subsoiler	4.85	9.21	18.58	420	830	1700
By winged subsoiler + two leading shallow tines spaced 50 cm, depth 17 cm	—	8.64	—	—	1250	—
By winged subsoiler + two leading shallow tines spaced 50 cm, depth 12 cm	—	9.14	—	—	1110	—

Soil disturbance caused by two winged subsoilers spaced at 0.45 meter and 0.25 meter deep with three leading shallow tines spaced at 0.51 meter and 0.13 meter deep was also measured. The arrangement of the leading shallow tines and the winged subsoilers on the tool bar is shown in Plate 2. The results (Table 2) again showed that leading shallow tines caused a significant increase in the area of the soil loosened with no change in draught. The increase in the area of the soil loosened was 41 per cent.

The results (Table 1) showed that draught decreased by introducing two leading tines with the winged subsoiler, with an appreciable increase in soil disturbance. It was also obvious from the results that draught was less when the leading tines were deeper, because they loosened the soil surface at depth, and it became easier for the subsoiler tine to lift the soil with less draught.

The results (Figures 1 and 3) showed that draught was directly proportional to the soil disturbance and working depth of the subsoiler. The variations have been expressed by mathematical equations shown on the figures.

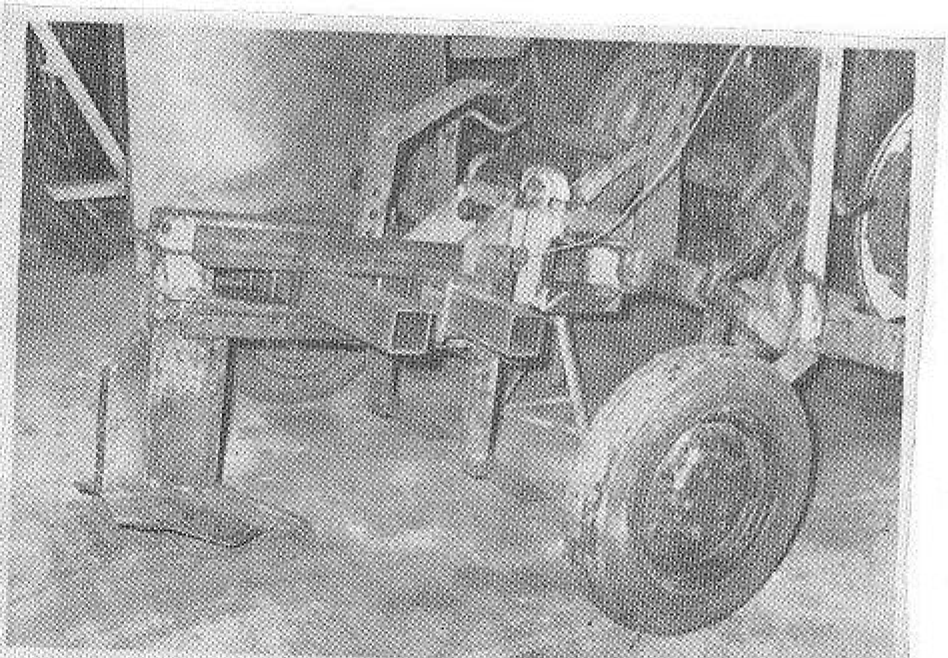

PLATE 1. POSITION OF LEADING AND SUBSOILER TINES, SHOWN RAISED

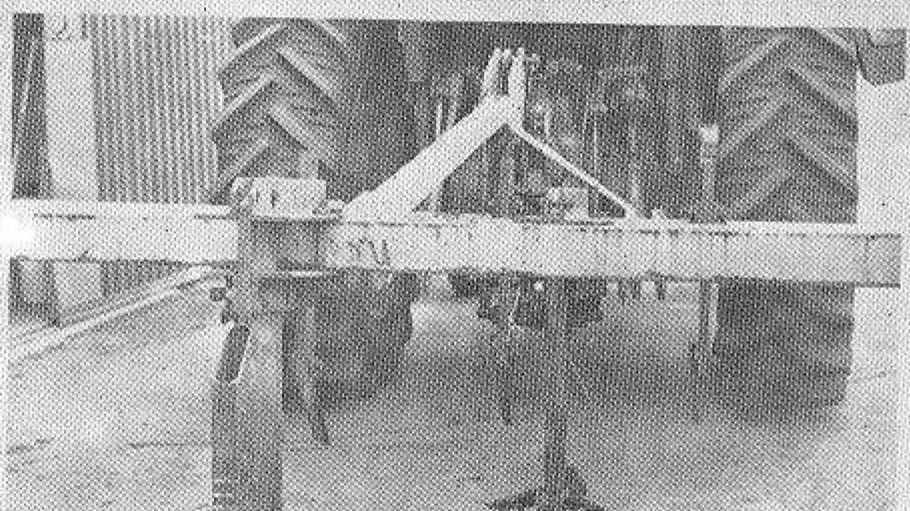

PLATE 2. POSITION OF TWO WINGED SUBSOILERS AND THREE LEADING SHALLOW TINES, FIXED ON TOOL BAR

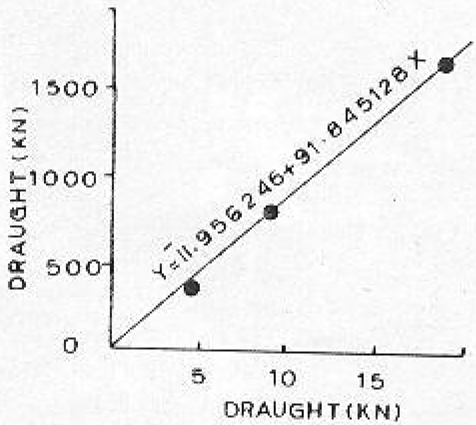

FIG. I. GRAPH BETWEEN DRAUGHT AND SOIL DISTURBANCE.

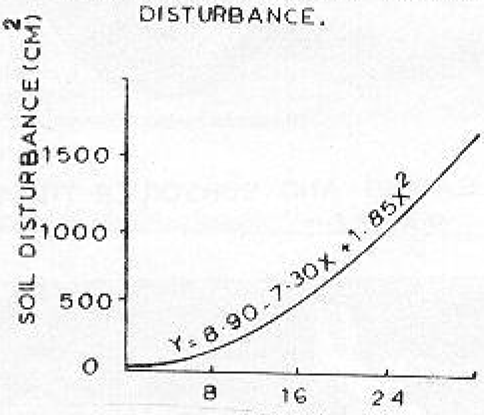

FIG. 2. GRAPH BETWEEN DEPTH AND SOIL DISTURBANCE.

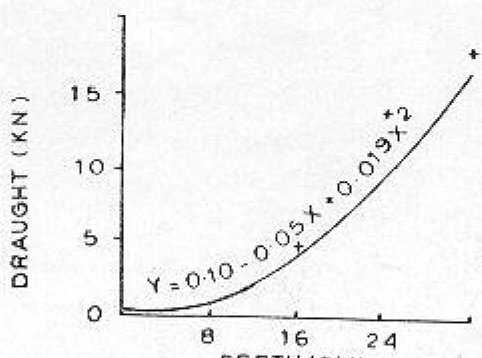

FIG. 3. GRAPH BETWEEN DEPTH AND DRAUGHT

Table 2. *Results of soil disturbance and draught at 25 cm depth by different treatments*

Treatment	Block No.	Draught (KN)	Soil disturbance (cm^2)
By two winged subsoilers 45 cm apart	1	20.20	2450
	2	21.08	2500
	3	18.89	2250
	Mean	20.05	2400
By two winged subsoilers 45 sm apart + three leading shallow tines 51 cm apart, 13 cm deep	1	17.92	1600
	2	21.59	1730
	3	20.64	1770
	Mean	20.05	1700

The results (Table 2) also revealed that there was a significant increase in the soil disturbance by introducing three leading shallow tines with the two winged subsoilers, with no change in draught.

Statistical analysis depicted that the decrease in draught-soil disturbance ratio, caused by introducing three leading shallow tines with the two winged subsoilers was significant at 5 per cent level.

CONCLUSIONS

1. For the same depth, soil disturbance in sandy soil is more than that in clay.
2. Soil disturbance is directly proportional to the depth of subsoiler tine and and leading tines.
3. The ratio between soil disturbance and draught is increased by 60 per cent by introducing two leading shallow tines in combination with winged subsoiler.
4. Draught is directly proportional to the depth of subsoiler tine.
5. Draught decreases by introducing two leading shallow tines in combination with winged subsoiler, with a suficient increase in soil disturbance,

6. The ratio between draught and soil disturbance decreases significantly by introducing three leading shallow tines in combination with two winged subsoilers.

ACKNOWLEDGEMENTS

The author would like to acknowledge with thanks the most valuable guidance and suggestions of Dr. R. J. Godwin and Mr. Gordon Spoor during the experimental work at the National College of Agricultural Engineering, Silsoe, Bedford, England.

The author is also grateful to the technical staff of the College.

REFERENCES

Godwin, R. J. 1975. Ph. D. Thesis, Cranefield Institute of Technology, U.K.

James, E. P. and E. D. Wilkins. 1972. Deep ploughing-an engineering appraisal. Transactions A.S. A.E. 15:27-31.

Trouse, A.C. and R.P. Humbert. 1959. Deep tillage in Hawaii - subsoilling. Soil Science, 88 : 67-73.