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AN INVESTIGATION INTO WEAR CHARACTERISTICS

OF A DIRECT DRILLING COULTER (OPENER).

A thesis presented in partial
fulfilment of the requirements for the degree
of Master of Agricultural Science
in Agricultural Mechanisation at
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ABSTRACT.

Wear on a promising chisel coulter, developed at Massey University, was considered to be marginally unacceptable. A functional lifespan of approximately 20 hectares for non-rolling blade components necessitated relatively frequent coulter replacement, and thereby incurred increased costs for components and machine downtime.

Three experiments were carried out with an improved version of the Massey University chisel coulter concept. The respective objectives were as follows:

1. To determine whether soil particles were passing between the rotating disc and stationary coulter blade components during normal field machine operation.
2. To determine the patterns of coulter blade wear.
3. To compare several selected blade treatments in their abilities to prolong functional coulter blade life.

In the first (laboratory) experiment, a stationary test rig was constructed. This closely simulated coulter assembly operation in the field. Measurements of changes in soil particle size with time for "soil" and "no soil" introduction to the disc/blade interface did not detect any soil breakdown which might have indicated a soil "lubrication" effect at that interface. However, observations of the patterns of abrasion and of photographs did indicate that some form of soil "lubrication" had occurred.

(ii)

In the second experiment, a hard-facing welded (Hardcraft 700 over mild steel) and a control treatment (mild steel) were evaluated to establish patterns of wear on a three row field-operating test rig. The former treatment displayed potential for resisting dimensional changes at various stages throughout blade life. The rotating action of the disc against the inner shank of the blade was responsible, in the prevailing conditions, for wear at the inside lower leading edge/wing intersection of the blade. This action eventually accelerated wing wear.

The weld bead pattern was modified for use in Run A of Experiment 3 (top pattern); and another pattern (bottom pattern) was designed to prevent possible increased penetration forces associated with the original weld pattern.

The third experiment involved evaluation of selected treatments during routine field drilling operations, using a pre-production prototype direct drill. Carbonitrided mild steel blades offered an almost three-fold increase in relative wear resistance (in terms of metal weightloss per hectare) compared to the standard mild steel blades. The carbonitrided treatment also resisted dimensional changes more effectively, and was more cost effective than all other treatments.

The influence on wing and shank dimensions exerted by left and right side blade positioning on each coulter assembly, appeared to reflect continual anti-clockwise machine cornering during operation and seed/fertiliser dispersal differences. Coulter wings on the outside of field turns were subjected to

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1 INTRODUCTION.

Research into direct drilling (zero tillage) of seeds into undisturbed seedbeds has demonstrated considerable potential for this technique of plant establishment, compared with conventional methods. Documented advantages include conservation of fuel (Hughes and Baker 35), time (Cannell and Ellis 18, Bakerman 13, Phillips and Young 55, Phillips et al. 54), soil structure (Baeumer 5, Unger et al. 73, Phillips et al. loc cit.), soil moisture (Moschler et al. 49, Barnes et al. 14, Phillips and Young loc cit., Phillips et al. loc cit.) and earthworm populations (Mai 44, Moschler et al. 50, Cannell and Ellis loc cit.) as well as probable reductions in soil temperature fluctuations (Mathews 45, Moody et al. 46), operational costs (Baker 12, Allen 4, Frengley 29) and risk to the farmer (Cannell and Ellis loc cit., Bakerman loc cit., Phillips and Young loc cit., Phillips loc cit.).

Several disadvantages of direct drilling have precluded the universal acceptance of the techniques involved by the farming community. Such disadvantages have included uncertainty of yields (Cannell and Ellis 17), the need for new machinery (Baker 7), insect infestations (Pottinger 56, Carpenter et al. 19), the necessity for new skills to be mastered (Kahnt 39, Baker 12) and the restricted availability of technical advice (Baker loc cit., Kahnt loc cit.).

Wear on existing coulter designs in direct drilling is a major mechanical problem. This wear is primarily due to the fact that soil bulk densities are considerably higher than those for

cultivated seedbeds, requiring larger penetration and draught forces from the drill.

It is generally accepted that disc coulters have offered reduced wear rates in both tilled and untilled soils, but there is doubt about their biological function in direct drilling (Baker 7, Choudhary and Baker 20, 21). Non-rolling coulters, or even components of coulters, sometimes may offer biological advantages but they apparently do so at the expense of wear. The cost benefits of non-rolling and rolling components in relation to wear may be argued for years to come, but there appears to be sufficient evidence to justify examining ways and means of reducing wear of at least one promising non-rolling coulters.

Wear on the redeveloped Massey University experimental chisel coulters was thought to be marginally unacceptable, with the functional life of the non-rolling blades being approximately 20 hectares. This necessitated relatively frequent coulters replacement with inherently increased costs for components and downtime.

The research reported below, therefore, had the following aims:

1. To determine the patterns of wear on the soil engaging components of the Massey University redeveloped chisel coulters.
2. To determine relative wear between individual components of the coulters.
3. To compare various methods of prolonging the working life of the coulters.

2 LITERATURE REVIEW.

2.1 INTRODUCTION.

This review attempts to present both biological and mechanical factors that influence direct drilling machine design. These factors impose constraints on the extent to which any existing coulter may be altered when considering treatments that may prolong functional life of that component.

Interactions between coulter design and wear are also reviewed, together with factors influencing wear of soil engaging tools. The latter section includes soil flow dynamics and effects of tool shape, speed and metallurgical properties.