Conservation Farming for the Semi-arid Tropics

Editors J. D. Sturtz and A. L Chapman

Proceedings of a Workshop at the NT Rural College, Katherine, 18-20 July, 1995

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THE LATE DOUG PEAKE

CONTENTS

No-Tillage Planters and Crop Performance

Constraints - Soils, Weeds, Pests

Evaluation of Ley Farming Systems in Northern Australia

Preface

The establishment of successful dryland farming industries in the Australian semi-arid tropics (SAT) has been an elusive goal of various governments, research institutions and entrepreneurial producers for over 100 years. Research and commercial experience over the past 20 years has fundamentally altered the prospects for dryland agriculture offering, for the first time, conservation tillage and ley farming technologies that provide a sound basis for sustainable agricultural development.

While some information about this research and commercial experience is available to current producers, prospective investors, researchers and the public, much is not readily accessible. This is a serious deficiency when the outlook for agricultural development (with rapid expansion of the live-cattle export trade to South-East Asia and favourable markets for other commodities) is so positive. Given the rapid turnover of people in both the private and public sectors across the north, loss of valuable knowledge is an ever-present problem.

The prospect of overcoming this deficiency by facilitating the review, collation, publication and dissemination of knowledge about conservation farming in the SAT appealed to the executive of the NT Zone of the Australian Institute of Agricultural Science (AIAS) when it was reviewing the activities of the Doug Peake Memorial Trust several years ago. Doug Peake was a leading researcher into conservation farming in both the CSIRO Division of Tropical Crops and Pastures and the NT Department of Primary Industry and Fisheries until his untimely, accidental death in 1982. Very much the practical agronomist, Doug was strongly committed to extending the conservation "message" by the free flow of information and ideas between producers, agribusiness and R&D agencies. It was appropriate, therefore, that under the aegis of the Trust, the AIAS NT Zone brought together some 60 delegates from across northern Australia for a workshop on "Conservation Farming for the Semi-arid Tropics" at the NT Rural College, Katherine during 18-20 July, 1995.

The Proceedings of this workshop comprise 36 papers covering a broad range of specific commercial, developmental and research activities related to conservation farming. It forms a companion volume to a special edition of the Australian Journal of Experimental Agriculture (December 1996), titled "Conservation Tillage and Ley Farming for the Semi-arid Tropics". This publication contains the 15 reviews of major topics relating to conservation farming, as it is evolving in the semi-arid tropics of northern Australia, around which the workshop was structured.

A.L. Chapman J.D. Sturtz

EVALUATION OF NO-TILLAGE PLANTERS FOR THE SEMI-ARID TROPICS

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Abstract: Nine commercial, no-tillage planters and associated ground tools developed for sowing crops in temperate and subtropical latitudes were tested for their suitability for crop establishment in the semi-arid tropics. The experiments were conducted on a Tippera clay loam soil (a Kandosol) of low water holding capacity at Katherine Research Station during the early 1980s.

MATERIALS AND METHODS

The no-tillage planters ranged from simple to complex and included double disc, tine opener, rotary jab and winged tine types.

The commonly used ground tools included:

trash cutting coulters (plain, fluted and powered);

soil openers (tines with various hoes, double discs, rotary injectors);

in-furrow (seed firming) and over-furrow presswheels (flat, ribbed, twin-inclined);

soil-return devices (discs, rakes and harrows).

The machines and ground tools were evaluated using a range of variables including soil moisture, surface trash (mulch), sowing depth and travelling speed. Maize was used as the test crop. Most of the experiments were conducted using supplementary irrigation during March, April and May or in August, September and November in order to gain better control over the imposition of treatments and to sample a range of thermal environments. The sites were generally sprayed with a knockdown herbicide (glyphosate and/or paraquat/diquat mixture) and slashed with a flail mower. The amount of mulch left on the soil surface ranged from zero (bare soil) to about 3 t/ha.

Soil moisture (0-5, 5-10, 10-15 cm depths) was monitored routinely by hand sampling. The soil strength adjacent to the same sites was measured using a hand-held penetrometer. Thermocouples were used to record soil temperature in the seedbed at various depths.

In assessing the effectiveness of the various machine and ground tool combinations (see below), particular attention was paid to the reason for failure of emergence as well as the rate and degree of crop emergence. To this end, the soil in contrasting treatments was carefully excavated and seeds which failed to germinate and seedlings which failed to emerge were examined. Samples of soil displaced from the planting rows were collected for measurement of clod size distribution. Soil profiles created by different machines were described using a profile meter, plaster casts and photographs.

Machine and ground tool combinations tested

Experiment 1

Planters		Coulters		In-furrow presswheels		Flat over-furrow presswheels
Janke moisture-seeking tine		plain		on		on
Baker winged tine	X		X		X	
John Deere Max-Emerge		wavy		off		off
Triple disc opener		As supplied				
Aitchison 2000		As supplied				
Power-Till		As supplied				

Experiment 2

Planter		In-furrow presswheel		Over-furrow presswheel
Janke moisture-seeking tine		on		plain
Baker winged tine	X		X	none
Mason SR Integral		off		twin-inclined
John Deere Max-Emerge				
Triple disc opener				As supplied
Power-Till				As supplied
Buffalo (convertible) slot planter plus covering wheels				
IITA Rotary Jab				As supplied
Nodet-Gougis (modified) opener (replaced runner opener with tine opener)				
Aitchison 2000				As supplied

Experiment 3

Planters	Coulters		Depth		Soil moisture at sowing
None	plain		4 cm		very wet
	wavy	X		X	ideal 1
	powered		7 cm		ideal 2
					very dry

Experiment 4

Planters		Coulters		Soil moisture (days after watering)
Buffalo (convertible)				1
Aitchison 2000	X	plain	X	3
John Deere Max-Emerge				8
Mason SR Integral				
Janke moisture-seeking tine		plain		1
Duckfoot	X	wavy	X	3
Baker Winged Tine		powered		8

Experiment 5

Planters		Presswheel		Presswheel pressure		Rake		Soil moisture
Janke moisture-seeking tine		twin		zero		on		moist
Duckfoot	X	ribbed	X	light	X	off	X	dry
John Deere Spearpoint		in-furrow		medium				
Triple disc		heavy						

Buffalo with covering disc and wheels
John Deere Max-Emerge with wavy or plain coulters

Experiment 6

Planters		
Buffalo (convertible)		7 combinations of depth,
John Deere Max-Emerge	X	ground tool arrangement and
Baker Winged Tine		speed (non-factorial)
Aitchison 2000		(soil moisture, dry to very wet; mulch, heavy to very heavy)

Experiment 7

Planters		Ground Tools		Times
Buffalo (convertible)		4 configurations		4 sowing times
Buffalo (compact)	X	of ground tools	X	according to
John Deere Max-Emerge				soil moisture
Mason SR Integral (modified)				

SUMMARY OF RESULTS

(1) For successful, no-tillage planting of maize on the clay loam soil of the experimental sites, an effective trash cutting device was essential. A plain coulter proved adequate for this purpose as it was not required to serve as a tillage tool.

(2) During planting, the seed must be embedded firmly (but not excessively so) into moist soil without smearing of the furrow bottom. Most soil opening tools permitted the seed to be placed at the desired depth, when sufficient ballast was added to the planter, but few of the machines tested provided the necessary seed-soil contact to ensure germination and emergence. Effective seed-soil contact was most readily achieved by a narrow seed firming wheel, with a pressure of less than 4 kg/cm of tyre width, running in the furrow bottom. Pressures higher than 4 kg/cm were often detrimental. Tined openers presenting a blunt edge to the soil (see Fig. 1) were especially prone to cause smearing of the furrow bottom. Seedling roots often failed to penetrate across the smeared layer into the surrounding moist soil.

(3) Compaction of soil, by presswheels above the seed, for example, was usually detrimental to seedling emergence. This was especially so when the presswheels were operated at high pressure on the soil surface in an effort to improve seed-soil contact at depth. Generally, only the single, narrow, in-furrow presswheel gave the required seed-soil contact without undue surface compaction. Twin-inclined presswheels typically closed the furrow slit only near the surface leaving voids around the seed below. Seedlings attempting to emerge through these voids did not have enough mechanical support to enable them to push through the compacted soil above.

The adverse effects of compacted layers, especially in wet soil, can be reduced by a 'mulch' of loose soil to delay drying and slow down the development of strong soil crusts. In moist soil, tined implements often produce clods when the seed is sown at depths greater than 60 mm to access moist soil. If clods greater than 40 mm in diameter are returned to the furrow they often prevent the emergence of maize seedlings. Under such conditions, soil-returning devices are detrimental.

(4) The standard double-disc opener cut through the trash effectively and minimised soil disturbance but did not perform well under dry conditions. When the standard double-disc opener was preceded by an hydraulically driven coulter, the soil was broken up into small clods which made it difficult to cover the seed adequately.

While double-disc openers cleared obstacles readily, few of the tined openers did so. However, tined openers penetrated dry soil more easily and were less prone to fouling under wet conditions. A narrow profile tine preceded by a wavy coulter produced large clods which can be detrimental to seedling emergence.

(5) The important practical considerations in machine choice are mechanical reliability, versatility and scope for adjustment to suit the prevailing conditions. The Buffalo machines, both convertible and compact, fitted with the slot opener, the V-shaped forming bar and in-furrow presswheel with options on discs or rakes as covering devices in wet conditions, proved to be the most reliable in this regard over the range of conditions tested within the experiments.

These machines are, however, not commercially available in Australia (the models tested were imported direct from the USA) but in recent times there has been further development of Australian planters which may offer the same degree of versatility and reliability required by farmers in the semi-arid tropics of Australia.

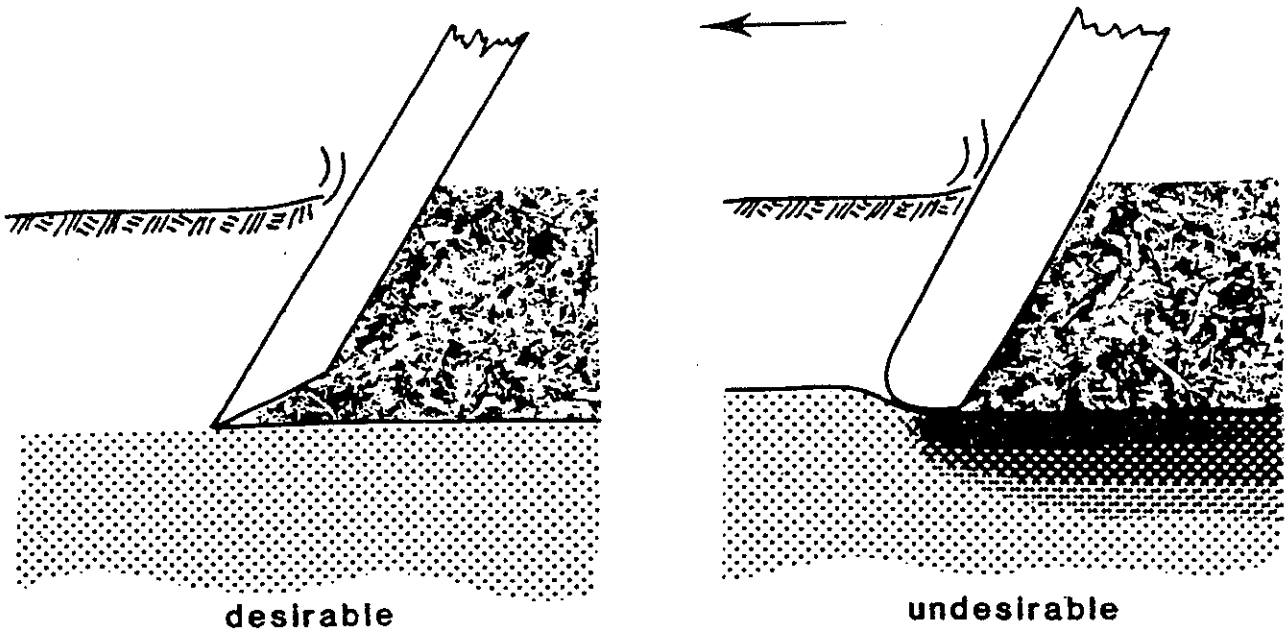

Figure 1. Tine-type openers can affect seedling survival, as those with an undesirable 'blunt approach to the soil can smear the furrow bottom, preventing seedling roots from penetrating the furrow bottom and reaching nearby moist soil.