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No-Tillage Seeders and their Adoption in North America with Relevance to Western Australia

A Study Tour Report to The Winston Churchill Memorial Trust of Australia and Wesfarmers Limited

Kevin J. Bligh,
1991 Wesfarmers Churchill Fellow

Resource Management Technical Report No.127

Disclaimer

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Introduction

Tillage “involves disturbance of the entire topsoil structure” (Houghton and Chapman, 1986). Disadvantages of tillage include erosion by water and wind, structural deterioration of most soils, later sowing of crops and burial of pasture seeds too deep for re-establishment in the year following cropping. Tillage for weed control has largely become unnecessary with the development and application of chemical herbicides. Questions therefore arise as to whether tillage is desirable on many soils.

Removing tillage from a cropping system changes the state of the physical and biological components of the soil. For example, soil organic carbon levels and aggregate stability usually increase, and temperatures and evaporation rates may be altered by the presence of stubble residue on the surface. Unwanted insects can also thrive in the trash. And no-tillage seeders must be capable of sowing through plant residues without blockage.

An eight week study tour was undertaken to investigate the development and adoption of no-tillage seeders in New Zealand and North America from May to July, 1991. Travelling funds were provided by the Winston Churchill Memorial Trust and the Western Australian company, Wesfarmers Limited. The Western Australian Department of Agriculture granted paid leave of absence during the period of the study tour.

Numerous farmers, as well as publicly and privately employed specialist personnel mentioned in the Itinerary in Appendix I, contributed generously of their time and expertise. I am also indebted to the many farmers, scientists and engineers in Western Australia who have furthered my education in no-tillage seeding.

Programme

My itinerary was formulated following discussions and correspondence with individuals involved in no-tillage research, development and extension. Many were kindly suggested to me by Dr Keith Saxton, (Agricultural Engineer, United States Department of Agriculture, Washington State University). My hosts then arranged on-farm introductions to further no-tillage farmers, scientists, engineers and machinery company representatives.

Visits were first made to inspect the latest no-tillage seeder developments at Massey University, Palmerston North, and Aitchison Industries, Wanganui, New Zealand. Development and extension personnel were then visited in California, Washington State, Alberta, Saskatchewan and Manitoba, Canada. After further extensive visits in North Dakota, Nebraska, Kansas and Colorado, a paper comparing results using tined and disced no-tillage seeders in Western Australia was presented at the American Society of Agricultural Engineers Summer Meeting at Albuquerque, New Mexico. A visit to the University of Guelph, Ontario, Canada discussing the extensive Tillage 2000 Project then completed the fellowship.

Preamble

"Now, and for time to be, wherever green is worn, Are changed, changed utterly; A terrible beauty is born". W.B. Yeats.

Removing tillage from the traditional cropping system is scarcely less revolutionary than the political independence at the Irish Free State, which Yeats was referring to in the above verse. Tillage had previously been required mainly for weed control in Western Australia (Halpin and Bligh, 1974). The current availability of both economical herbicides and skills for their effective and safe application, has changed all that!

Executive Summary

1991 Wesfarmers

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Project description:

The aim of the project was to further the development and extension of no-tillage sowing to minimise soil erosion and land degradation in Western Australia, by studying no-tillage seeders and their adoption in New Zealand and North America.

The itinerary was largely centred around the Agrisystems Cross Slot® seeder developed by Dr John Baker and co-workers at the then Agricultural Machinery Research Centre at Massey University, New Zealand. Efforts by the Fellow to evaluate the Cross Slot® openers in Western Australia in 1989 were unsuccessful, because Agrisystems Inc. had just bought the patents, and the openers were therefore temporarily unavailable. Subsequent interest has culminated in the purchase of the first commercially-produced Cross Slot® seeders in the world by three Western Australian farmers in 1992. The Fellow intends to continue close liaison with these and other no-tillage farmers and with personnel involved in comprehensive agronomic trials carried out within the Department of Agriculture.

The principal American Cross Slot® investigator, Dr Keith Saxton (Agricultural Engineer, USDA-ARS, Washington State University) hosted my visit for a week, and proposed further no-tillage contacts in California, North Dakota, Nebraska, Kansas,and Colorado Further visits were arranged in Alberta, Saskatchewan, Manitoba and Ontario, Canada. The Fellow then presented a paper on Western Australian experiences at the American Society of Agricultural Engineers International Summer Meeting at Albuquerque, New Mexico.

The adoption of no-tillage seeders appears generally to be at a similar stage in North America as in Western Australia. One notable difference is the communication provided by several no-tillage farmers organisations, such as the Manitoba-North Dakota Zero Tillage Farmers Association. Since almost all development of no-tillage systems has been carried out by farmers, such associations have proven invaluable in directly providing communication with their peers. The Fellow plans to foster the propagation of similar associations among Western Australian no-tillage farmers, by recounting his experiences in talking with North American farmers, scientists and engineers, and by providing technical back-up support to Department of Agriculture extension personnel and private consultants.

While there is currently a high level of interest in no-tillage sowing with stubble retention in South Coastal areas of Western Australia for economic reasons (e.g. minimal sandblasting of young seedlings; reduced herbicide-resistant grass weeds), peer support in further developing profitable no-tillage systems is required in other areas where expected crop yields are lower. If a conservation-conscious farmer goes “broke”, the new owner of the farm will probably not be conservation-conscious. No-tillage farmers associations are seen as aiding the development of both improved no-tillage seeders, and profitable no-tillage farming systems.

No-Tillage Seeders In New Zealand And North America

No-tillage sowing may be successfully achieved in most soils using either narrow points (shares) on tines, or discs, or a combination of the two.

1. Tined no-tillage seeders

Narrow, "inverted T"-shaped shares for cultivating in the sown rows only, leaving the soil structure intact in the inter-row areas, have been marketed by Aitchison Industries, Wanganui, New Zealand since 1970 (Peter Aitchison, Managing Director, pers. comm. 1989). Baker (1976) reported that crop establishment using narrow "inverted T"-shaped shares in untilled soils was superior to that using conventional hoe shares, or triple-disc drill openers (after Karonka, 1973). Spear-point (Figure 1) or slightly wider shares (Figure 2) are also commonly used for direct seeding in North America. Crop yields using *55* mm wide "inverted T"-shaped shares on seeders equipped with sowing tines only had been found to be comparable or superior to those using conventional shares in Western Australia (Bligh, 1991a). Pressure applied to soil covering the seed, though only marginally beneficial for crop establishment in Western Australia, is clearly beneficial in silty soils in North America (Figure 3), typically loaded at 10-20 kg per cm width. Either small presswheels, (Figure 4) or large rubber tires in each row typically carry the entire weight of the rear of the seeder in Canada (Figure *5).* The seed is also placed shallower and about 15 mm to one side of the fertilizer in the Valcon Conserva-Pak® air seeder, manufactured at Indian Head, Saskatchewan (Figure 6).

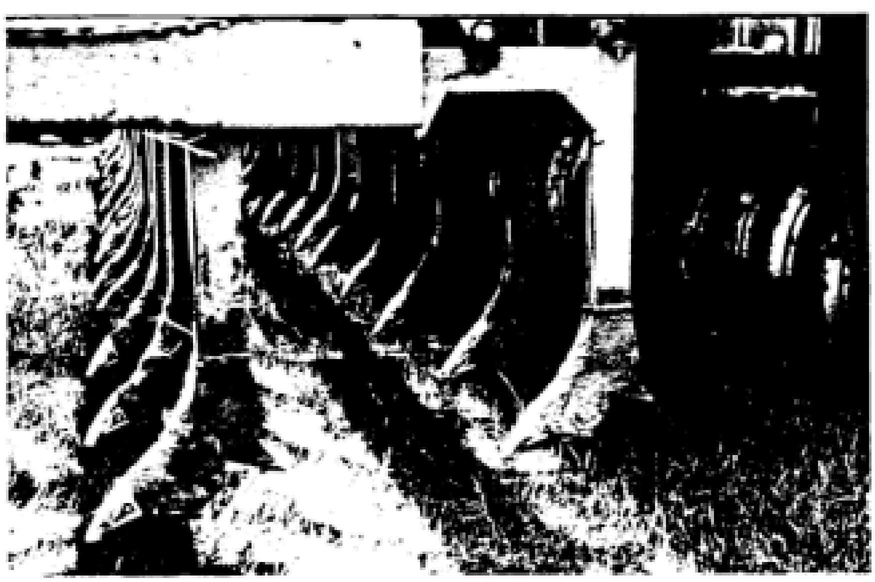

Figure 1. A spear-point hoe-press wheel drill manufactured by Haybuster Manufacturing Inc. (P0 Box 1950, Jamestown, North Dakota 58401, USA).

Figure 2. Wider low-profile shares are also used on some no-tilage seeders in North America.

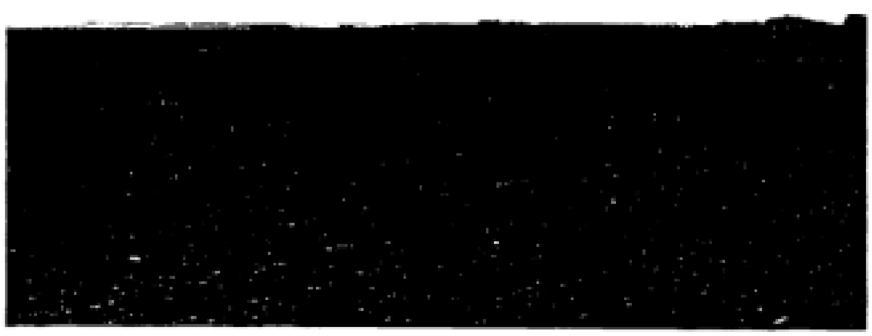

Figure 3. Wheel tracks stretching into the distance from a post-seeding spraying operation, shows increased early vigour, illustrating beneficial effects of pressure over the soil surface on seedling establishment and/or vigour.

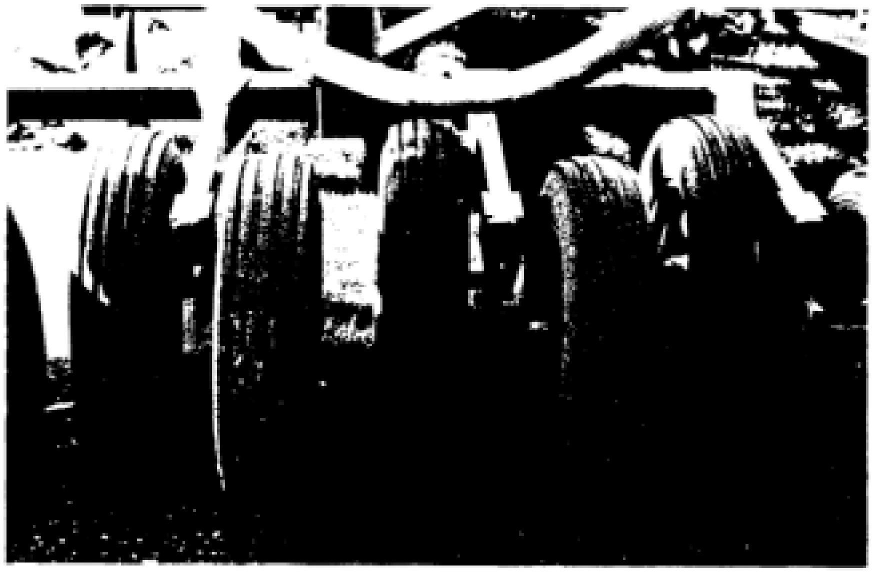

Figure 4. A Valcon Conserva-Pak® air seeder with press wheels sowing through stubble of an approximately 2 t/ha wheat crop in southern Saskatchewan.

Figure 5. Large press wheels carry the weight of the rear of this Concord® Inc. air seeder (2,800, 7th Avenue, Fargo, North Dakota 58102, USA).

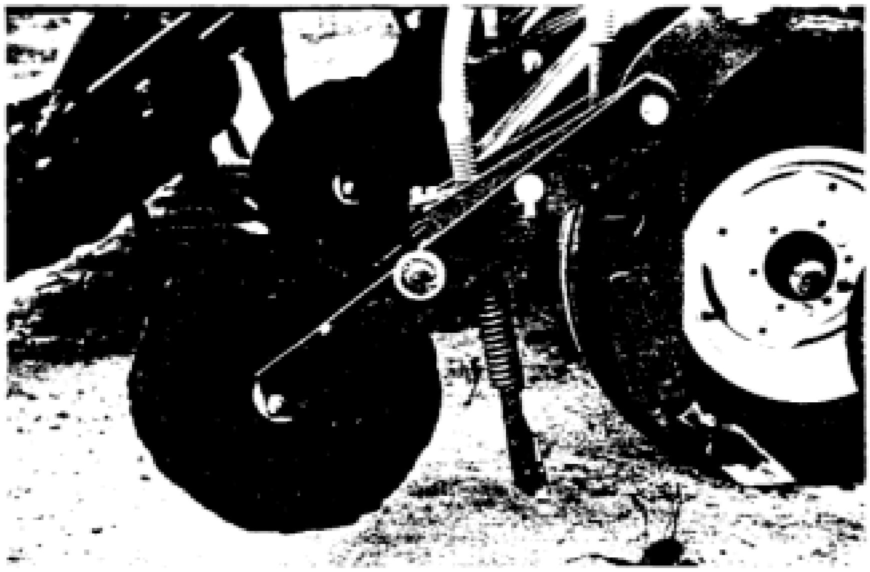

Figure 6. A second tine for shallower sowing about 15 mm to one side on Valcon Equipment Limited's Conserva-Pak® air seeder (P0 Box 417, Indian Head, Sadkatchewan, Canada SDG 2K0). The press wheel also controls the depth of sowing.

2. Disced no-tillage seeders

a. Double-disc drills

Double-disc press drills (Figure 7) have traditionally been used for sowing into tilled seed- beds in North America. Triple-disc drills include a preceding disc coulter in order to slice into hard, untilled sod, for improved penetration.

Most currently-marketed double-disc no-till seeders in North America have one disc approximately 10 to 20 mm in front of the other, to provide a leading edge for penetration. The “Yielder®” drill includes additional openers for deep placement of fertilizer nitrogen between each pair of rows, and has a capacity to provide up to almost a tonne of mass per sown row for penetration (Figures 8 and 9).

A more refined double disc opener developed at the Swift Current Research Station, Saskatchewan has one smaller disc rubbing against the larger disc (Figure 10). However one disc wears against the other, thereby reducing its useful life. Leading-edge double-disc drills which include a leading disc coulter, effectively making them triple-disc drills, are marketed either with a front disc caddy or as integral units (Figure 11) in widths up to about 9m.

b. Single disc drills

Single-disc no-tillage seeders used in North America include the John Deere (BioMax®) 750-Series No-Till Drill (Figure 12), which is also marketed with an additional front opener between every pair of sown rows to band fertilizer (Figure 13). The Unidrill® (Figure 14) was manufactured under licence to Moore Uni-drill Ud of Northern Ireland by

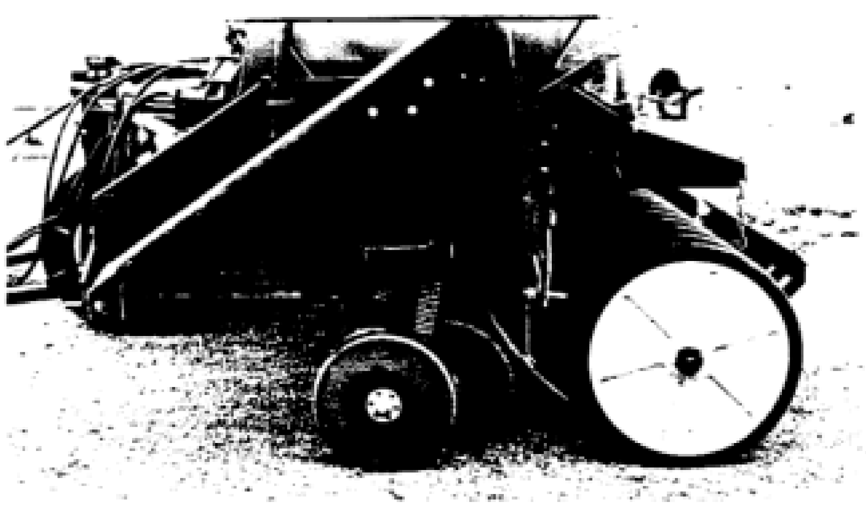

Figure 7. A traditional double-disc press-drill. The castor wheels at the front of the machine (partly obscured) carry some of the seeders weight and the press wheels the remainder.

Manufacturing Corporation (KMC) in Georgia, and GT Versa-Drill of Clay Center, Kansas. All use a single plain disc angled at about 7 to the direction of travel (e.g. Snyder *et al.,* 1988; Bigbee *et al.,* 1988) in order to open a slot. A sowing boot then places the seed in the groove.

The John Deere No-Till BioMax® Drill then presses seed and fertilizer into the soil before covering with soil dislodged by an additional furrow-closing wheel. Stephens and Johnson (1992) report a range of soil strengths achieved in the seed zone of moist soil with a texture of 60% clay and 40% sand, using a BioMax® opener. The Unidrill® includes a larger metal press wheel which forces additional soil to that which has already fallen in, on top of the seed.

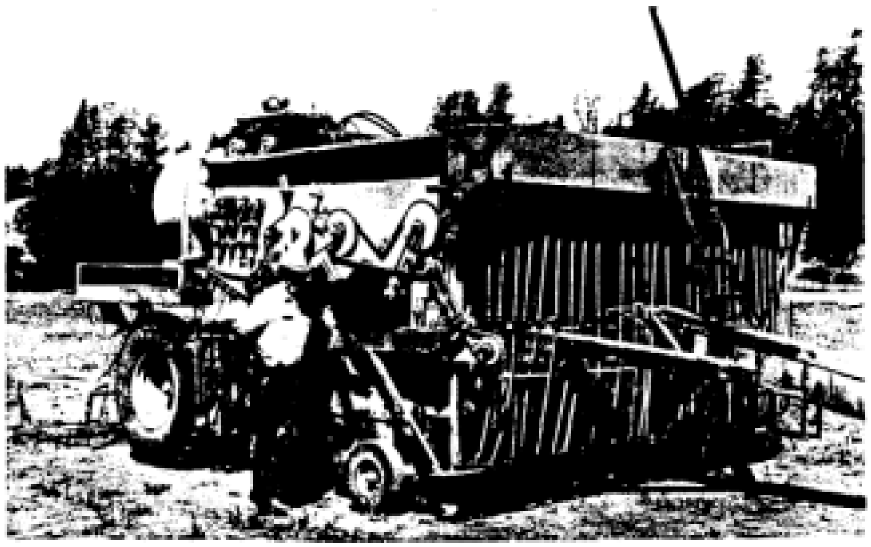

Figure 8. The undercarriage of a "Yielder®" drill used for one-pass sowing, featuring a flared surface applicator for granular insecticide, with deeper placement of nitrogen between each pair of sown rows by the front leading-edge double disc opener (left). Composite rubber depth wheels control the sowing depth of each pair of leading-edge double-disc seeder openers.

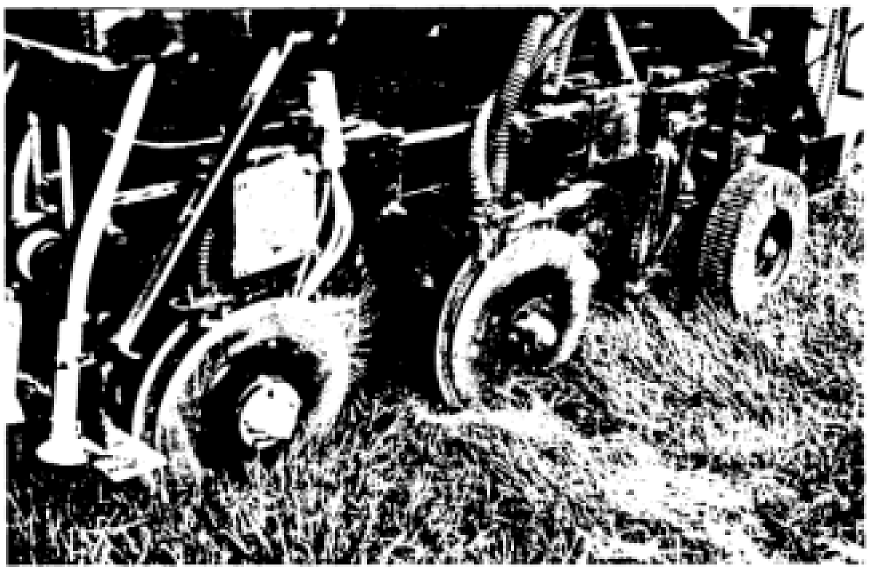

Figure 10. The Swift Current Zero-Till (SCOT) opener comprises a small second disc rubbing against the larger leading-edge disc.

Figure 9. A “Yielder®” drill used in Central California, showing a gear-cover panel removed after it was damaged when the seederjack-knifed and rolled over sowing down a steep hill. The rear fertilizer nitrogen tanks are movable laterally on-the-go, in order to maintain the seeder’s centre of gravity close to the mid-point of the wheel tread on steep side slopes. Exhaust emission (“Jake”) brakes are also commonly fitted to towing tractors on hilly land in California in order to reduce downhill speed, and the probability ofjack-knifing.

Figure 11. A 9 m wide no-till leading-edge double-disc drill made by “Great Plains®” Manufacturing Inc. (P0 Box 218, Assaria, Kansas 67416, USA).

Figure 12. A John Deere 750-Series No-Till Drill (BioMax®) opener, featuring a single disc angled at 70 to the direction of travel, and a close coupled depth wheel rubbing against the disc. A 25 mm- wide press wheel then presses the seed and fertilizer into the soil, followed by an angled furrow-closing wheel providing soil cover.

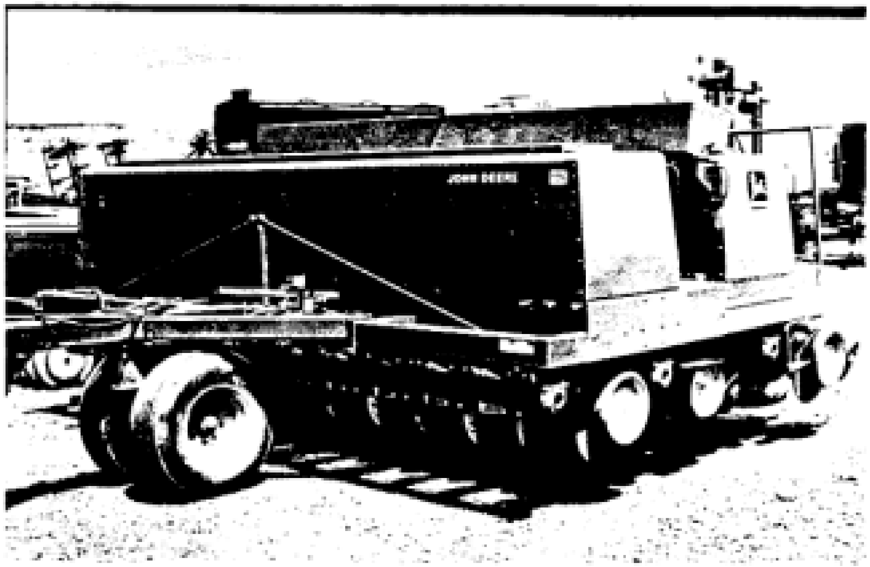

Figure 13. The John Deere 750 Series No-Till Drill is also marketed with front openers for deep placement of fertilizer nitrogen between each pair of sown rows.

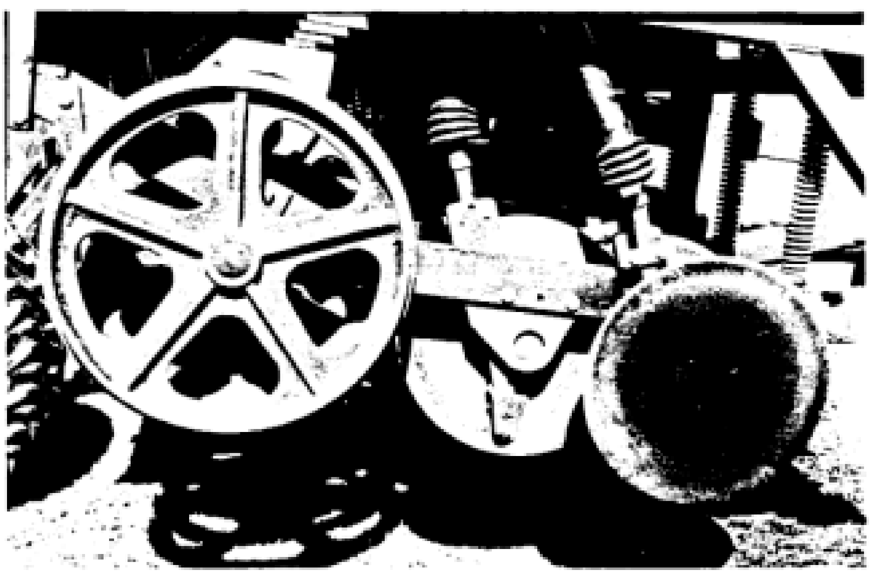

Figure 14. The Urn-drill® features angled 400 mm diameter discs and sowing boots mounted in pairs in front of large metal press wheels.