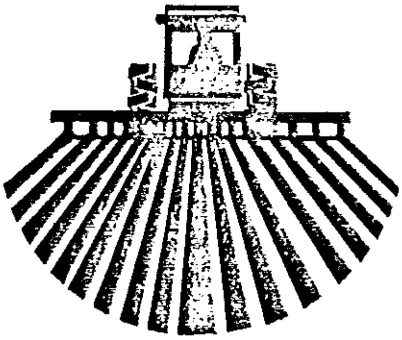

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OVERVIEW OF PRESENT AND POTENTIAL TILLAGE SYSTEMS: NORTHERN AUSTRALIA

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All roads lead to Rome. In this case, Rome consists of zero tillage and the roads are as varied as energy conservation, disease control, pasture improvement, soil conservation, and improved farm economics. Within CSIRO, research directed at tillage problems is modest but even so this variety is still evident.

Investigations by the Division of Soils into soil-borne root diseases in southern cereal areas has led, almost inevitably, to some consideration of the effects of different tillage systems on such diseases (Rovira 1981). The Division of Plant Industry's interest in zero tillage (e.g. Anon. 1978) began over a decade ago, when direct drilling into old pasture was seen as possibly providing a cheap way either of improving thepasture or of taking advantage of the fertility build-up beneath it via a cereal crop. In northern Australia the Division of Tropical Crops and Pastures is investigating reduced tillage because almost certainly it would need to be an integral part of any ley/cropping system that might be introduced in the future.

There is virtually no cropping in the north. Nevertheless, the Northern Territory and Western Australian governments are keen to encourage rural development. In particular, the introduction of cropping is seen as desirable because it introduces both physical and economic diversity into what is essentially a monoculture, viz. extensive cattle grazing.

The problems the researcher into ley farming faces in the north are different from those faced by his colleague in southern Australia. In very broad terms, in the south pasture was introduced into a cropping system, while in the north the intent is to introduce cropping into a pastoral system. For once the scientists may be ahead of the farmers in that they are grasping the opportunity to provide a sound scientific and technological base for a rural management system before it is introduced on an industry basis.

Attempts in the past to introduce cropping into northern Australia have been few and mostly on a large scale. None have been successful in the sense that none exist as commercial cropping enterprises at the present time. The causes of failure are many and varied (Fisher et al. 1977) but certainly in the case of the dryland schemes inadequacies in land preparation were important contributing factors.

It is ironic that in the Queensland-British Food Corporation sorghum cropping scheme in central Queensland (as opposed to the others in the far north) failure can be attributed in part to not using a "traditional" bare fallow to ensure adequate water for the crop. Because of the highly unreliable climate, water stored in the soil profile plays a major role in carrying a sorghum crop through to a satisfactory harvest in many seasons.

The far north, on the other hand, enjoys reliable rainfall. Nevertheless, it does provide a harsh environment for crops, particularly with regard to high temperatures, very high rainfall intensities and surface soil sealing. Further problems are the difficulty of getting cultivation and sowing machinery onto the land not long after the onset of the rainy season and the possibility of late rains interfering with harvesting. The relevance of tillage techniques to these types of problems are fairly obvious.

The current research programme of the Division of Tropical Crops and Pastures on a ley-farming system for the semi-arid tropics is centred on its Katherine Research Station. The average annual rainfall is 900 mm, falling between November and March, mean monthly temperature maxima range from 38°C in October to 30°C in June, and mean length of growing season is 21 weeks.

In brief, the proposed ley-farming system consists of a short rotation of a legume ley (1-2 yr) and one crop of maize or sorghum (McCown et al. 1980a). This involves strip-cropping on the contour, N input either from N fertilizer on crop or P fertilizer on legume (depending on fertilizer costs and efficiency of legume), crops planted directly into pasture using zero tillage, allowing volunteer legume to establish in the cropping phase, and grazing cattle on the legume/crop residue between May and November (dry season).

It became evident in early experiments in this research programme, that soil temperature is a key factor in the effect of direct drilling on both maize and sorghum crops. In one experiment none (control) or 5 t/ha of grass/legume hay was spread over the inter-row zone of a rotary-hoed sandy red earth (Blain sand). For the mulched plots temperatures were 8°C (10 cm) to 16°C (1 cm) lower beneath the inter-row area and 4-5°C lower below the row area. Without mulch, a large proportion of maize seedlings died just as the coleoptile broke the soil surface. Many of those that did emerge were chlorotic and had a slow growth rate. Sorghum emergence was 3-4 days earlier where mulch was applied and total emergence was twice that of unmulched plots. Growth of both crops was more rapid on mulched plots. Soil moisture conditions around and below the seed were favourable indicating that high temperatures were probably causing the adverse effects observed. Similar effects were also observed on a heavier soil (Tippera clay loam).

In a second experiment on Blain sand, where mulch was simulated with a layer of hessian cloth and moisture conditions controlled by irrigation (McCown and Peake 1980) similar results were obtained (Fig. 1).

In a third experiment, in Tippera clay loam (McCown et al. 1979), the effects of direct drilling on production of maize and sorghum was compared with conventional tillage under conditions similar to those of practical crop production. However, with the equipment available, the "zero-till" oper-

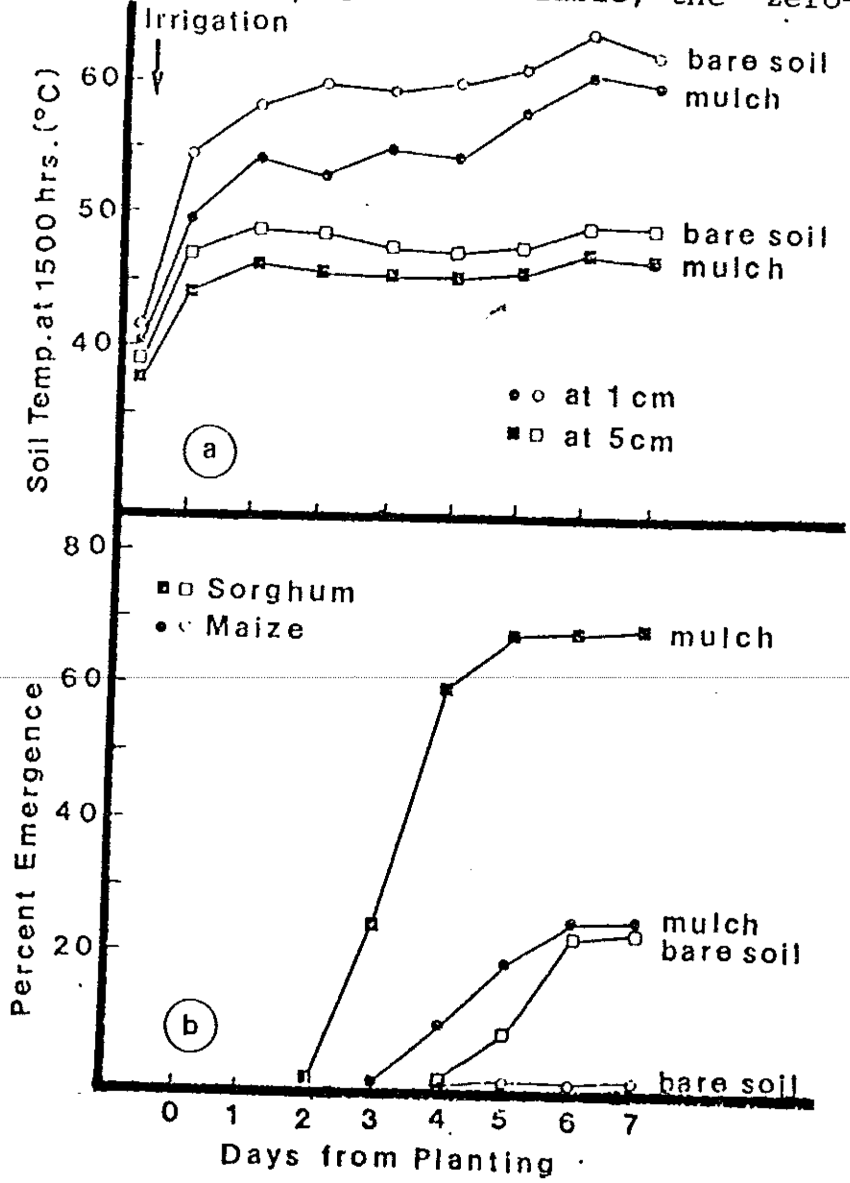

Figure 1. The effect of mulch on (a) soil temperature at two depths, and (b) emergence of seedlings of sorghum and maize.

tion had to be accomplished in two steps. The crops were grown on an area that had been under annual grass-legume pasture for several years. At the time of land preparation there was a living mulch of 1-1.5 t/ha. On the "zero-till" treatment the vegetation was killed with glyphosate and tilled to 10 cm on the rows only with a chisel tyne followed by a fluted coulter. The "conventional" tillage consisted of overall chisel ploughing followed by rotary hoeing and then propachlor was applied at planting. Both treatments received 115 kg N/ha broadcast; crops were planted in 75 cm rows.

Maize grain yields (15% moisture) were 5.6 t/ha with conventional tillage and 7.1 t/ha with direct drilling. Although bird damage on the sorghum precluded yield estimates, stover yields were 20 percent higher with direct drilling. With both crops, direct drilling resulted in greater stand density which probably accounts for much of the yield differences.

Because environmental conditions are so different in the tropics and different crops are involved, it is obvious that it is not possible to extrapolate to the tropics research results obtained in temperate regions. As indicated above a start has been made but with the very limited resources available there is a long way to go yet.

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