THE ESTABLISHMENT OF A LONG TERM DIRECT DRILLING CONVENTIONAL CULTIVATION COMPARISON FOR INTENSIVE ARABLE CROPPING

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For many centuries Man has been preparing seedbeds and controlling weeds by cultivation of the soil. Virgil, writing in the last century before the Christian era, described the crude Roman mouldboard ploughs, the heavy harrows and mallets Julius Ceasar brought to Britain as part of the cultivation armoury. In Fitzherbert's Boke of Husbandry (1523) his account of cultivation methods shows clearly that apart from the reinforcement of the wooden mouldboard plough by an iron ploughshare, there had been no effective advance in cultivation methods in 15 centuries. Two hundred years later in his 'Essay on the Principles of Tillage and Vegetation' in 1731, Jethro Tull in speculating on how plant roots gather nutrients from the surface of soil particles, deduced that pulverisation of the soil would vastly increase the surface area and would therefore increase the 'pasture' upon which roots could feed. Tull's influence was such that for two centuries, farmers in Britain and elswhere 'stirred their soils like Christmas puddings' in the belief that they were benefiting their crops. The labours undertaken to prepare seedbeds were extreme; ploughings and cross-ploughings, spiked harrows and chain harrows amounting to a dozen or more cultivations for a seedbed are on record.

However, the reaction to this abuse of soil structure set in with the development of soil erosion problems, especially in the North American Continent. Many tillage experiments were conducted in different parts of the world during the first 40 years of the 20th Century. The general conclusion of most of these studies could be summarised by the statement of E. W. Russell and Sir Bernard Keen at the end of a long series of tillage studies at Rothamsted. In their report in 1941, they concluded that the 'primary function of ploughing is weed control'. The situation was therefore ripe for the development of the first selective herbicides in the early nineteen fifties. These chemicals stimulated interest in direct drilling, the ultimate in reduced cultivation, in which seed is introduced directly into a chemically (rather than mechanically) prepared seedbed. In New Zealand, Blackmore (1957) pioneered this field. Initial interest waned however, due to inadequate chemicals and drilling machinery. Interest was stimulated again in the early nineteen sixties with the advent of paraquat, but since 1975, much greater research and farmer attention than ever before has been focused on this concept.

There are three reasons for this -

Firstly, the costs of conventional cultivation and seedbed preparation have increased enormously. In the two years from 1974 to 1976, the cost of running a tractor in the U.K. trebled (Bullen, 1977). Secondly, most of the machinery now being manufactured for direct drilling is far superior to the equipment of 20 years ago and thirdly, the development of chemicals such as glyphosate permits a level of weed control, without soil residues, not possible beforehand.

The point to remember is that while seedbed preparation by cultivation has been practised for centuries, direct drilling has been under study for only about 25 years. There is a strong subconscious urge in most of us to cultivate a seedbed well if we wish it to produce a good crop. As Bond (1975) noted, 'I was brought up in the tradition of enjoying good ploughing, with a nice straight furrow and complete burial of trash, as being one of the things in which I could take a pride'.

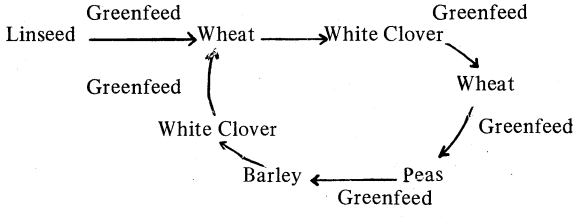
It is this background which has influenced our study of direct drilling. We are tending to regard it as some adjunct of or addition to, conventional cultivation rather than as a completely new and radically different method of plant establishment with its own attendant features which can be exploited and disadvantages which can be minimised. At the end of a review of U.K. experiments on reduced cultivation and direct drilling, Davies, and Cannell (1975) stated; 'In most of these experiments, cultivation treatment was the only variable, with other agronomic procedures, (e.g., sowing date) being at the established optimum for the ploughed treatment. There has been little or no emphasis on regarding minimum cultivation and direct drilling as systems, where to gain full advantage of the new techniques, it may be necessary to vary other agronomic practices'.

It is also this rather restricted view of direct drilling which has generated a lot of short term comparisons with conventional cultivation. Very often, these comparisons are made for one year only or, at the most, two to three years and then conclusions drawn on the relative merits of the two systems. In discussing the research needs associated with direct drilling, Professor E. W. Russell stated, 'The major benefits of direct drilling can only be achieved if this technique is used for a number of years consecutively, for the benefits take time to build up. In particular, it takes time for the top layer of the soil to become mechanically strong, well-structured and porous, and this will be the first benefit to be lost when direct drilled land is cultivated' (Russell 1975).

It was against this background that the Research

Division of MAF for the Northern South Island Region commenced a project in 1978 to compare as two independent systems, direct drilling with conventional cultivation and seeding on a long term basis in an intensive cropping system. The project has commenced at Winchmore on an irrigated Lismore soil and it is planned to extend it onto two of the heavier soil types in Canterbury. Two treatments only are involved in this project – direct drilling (d. d.) and conventional cultivation (c.c.). Under d.d. crop seeds are introduced straight into the uncultivated ground. No cultivation equipment is used – weed control is by herbicides and crop competition. Under the second treatment, a conventional cultivation programme is followed to prepare the seedbed for each crop in the rotation. (Conventional cultivation is that in current use by the majority of farmers in Canterbury employing a similar rotation on comparable soils). The two treatments operate under the same crop rotation, but are considered as independent systems to the extent that opportunities or problems on one can be exploited or rectified as appropriate without the necessity to do the same thing on the other treatment if some objective measurement indicates it to be either impractical or unnecessary. For example, if in a wet spring the spring wheat crop can be sown three weeks earlier on the d.d. than the c.c. treatment, this opportunity can be taken and appropriate measurements recorded at the time to justify the decision. On the other hand, if slugs threaten an emerging crop on the d.d. treatment and counts indicate no threat to the crop on the c.c. treatment, control measures will only be used on the d.d. treatment and thus the cultivation treatment will be free of the cost of this problem specific to direct drilling. In this approach, careful measurements to justify decisions such as these are extremely important, but with systems as diverse as these two, only by allowing this independence will their features be expressed.

The crop rotation adopted for this project is –



All wheat, barley and pea crops are spring sown and the white clover is established with the wheat and barley crops. The rotation commences in the spring of 1978, 1979, 1980 and 1981 to give four time replicates of this study, thus permitting a 'strong' comparison of the two systems for each of the different crops with seasonal variability well accounted for. Plot size of 90 x 36 meters permits the type of cultivation on the c.c. treatment that is relevant to field scale operations.

Prior to the start of the project at each site, the following soil measurements are taken -

- Full mineral analysis
- pH
- Organic carbon
- Total nitrogen
- Bulk density
- Porosity
- Field capacity

Wilting point

In addition, the earthworm population is sampled, the species identified counted and weighed.

During the project, we record the number and type of all cultivation operations, herbicide rates and types, crop and greenfeed sowing times, harvest times and yields, crop plant numbers and size, weed types, numbers and yield. At approximately two–yearly intervals during the project, all the soil physical and chemical measurements are repeated and the earthworm population resampled. On surface irrigated land, the rate of watering and the frequency of re-bordering are both recorded.

This project has and will continue to arouse debate. Objective measurements are important to justify the decisions which have to be made in a flexible comparison such as this. However, as Davies and Cannell (1975) have already suggested, only with a suitably flexible approach can we fairly study an aspect of agriculture as radically different as direct drilling.

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