THE CONSERVATION FARMING SYSTEM

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Introduction

Some 15-20 years ago, farming, mainly in the form of wheat production, comprised:

- several passes with cultivation implements prior to sowing;

- pre-emergent weed control involving herbicide incorporation;

- fertiliser inputs at suboptimal levels;

- acceptance of whatever yields were obtained.

Surveys at the time (e.g. A Basis for Soil Conservation Policy in Australia, AGPS 1978) showed that soils were in a state of structural decline. Table 1 shows the extent of degradation in NSW in that study.

Table 1. Extent of soil degradation in the cropping zone of NSW in 1976

	% of area
Management changes needed	49
Treatment with works	44
Total needing treatment	93

Further, farmers were experiencing problems with soil crusting, erosion was rife and waterlogging was common. Acidification was apparent and dryland salting was about to impact.

The capacity of our soils to absorb this abuse had been reached and change was inevitable if future productivity was to be preserved. Out of these circumstances emerged the system of conservation farming.

Development Of A New Farming System

The development of this new system was facilitated by the availability of the 'knockdown' herbicides Spray.Seed and Roundup and the post-emergent herbicide, Hoegrass, for annual ryegrass and wild oats control. The success of adoption of conservation farming has been variable but, in general, farmers have adapted the philosophy to develop a system that suits their soils, machinery and management.

It is worth reflecting that in the 1970s, some farmers cultivated their soils 10-12 times per crop, most farmers cultivating at least four times. This represented a considerable waste of manhours, fuel, machinery wearout and unnecessary soil destruction. In 1992 we can acknowledge the considerable progress made. Farmers cultivate 1-3 times, if at all, the outcome being much improved soil structure particularly on the surface.

As a consequence soil structure has improved and there is a greater number and diversity of soil organisms. There is now greater harvesting of water through infiltration, thus less runoff and less surface soil erosion - a very positive result, at least in theory. Life, however, can never be that simple.

The improvement in water infiltration provides a reservoir for use by crops and pastures. It is now well recognised that yield is directly related to crop water use. However, in circumstances where the water is not used, it contributes eventually to a rise in the watertable, subsequently to be expressed by dryland salting downslope in the catchment. Fortunately, technology allows us to monitor groundwater levels relatively easily through electro-magnetic survey techniques so that early warning signals can be given (Figure 1).

Figure 1. Electro-magnetic survey of Charles Sturt University farm.

The percolation through the soil provides the opportunity for leaching, creating a more acid soil and adding nutrients to the groundwater. Thus the problems of soil acidification and of eutrophication causing algal bloom result significantly from poor soil water use.

The lesson from this experience, therefore, is that simple **low output** agriculture is not environmentally sustainable, particularly from a catchment perspective. Because of the inherently low fertility status of most Australian soils, it follows that simple **low input** systems also cannot be sustainable. Such systems, in any case, even on the most fertile soils, are mining operations. For example, crop production on the very fertile black earth soils of the Liverpool Plains occurred for decades without fertiliser inputs but now rely heavily on fertiliser contributions. Even rice production in the MIA now requires phosphate inputs, having previously done without. Low input systems can be financially rewarding provided product prices are high enough but the resource base deteriorates over time.

It follows from the previous arguments therefore, that high productivity is sustainable and highly desirable. Clearly however, it requires high inputs under Australian conditions.

Potential Yield - A Performance Indicator

How, then, does a farmer know what system he operates? What benchmarks can be used to measure the performance of a farmer or a paddock? The 1990s is the era of performance indicators and farming should be no different.

Given that water is the factor over which we have least control, we can expect that water availability will be the ultimate limiting factor to yield attainment. Through the efforts of French (1987) in South Australia and Cornish and Murray (1989) in Wagga Wagga, we now have a benchmark - water limited potential yield. Experience has since shown the concept to be reasonable and attainable by farmers. Thus in a year of 5 t/ha potential yield, a farmer attaining 4.5 t/ha can be well satisfied, whereas another achieving only 3.5 t/ha (considered by many to be a good yield) should undertake a critical analysis of performance. In a less favourable year with a potential yield of 2.5 t/ha, a 2.3 t/ha crop is a top performer.

It has long been known that farmers are likely to attain near potential yields in seasons of poor rainfall, whereas in good seasons actual yields vary markedly from the potential (Figure 2).

Figure 2. A survey of farm yields under different potential yield conditions (Cornish and Murray, 1989)

experimental yields

district yields for Wagga Wagga

Thus the opportunity to make profits from good seasons is not taken, or at least not maximised. Further, the unused water resource in these seasons contributes to the watertable problem previously discussed. Raising productivity uses this water and therefore improves the prospect of sustainability.

Agricultural Chemicals Dependance

(a) Fertilisers In order that productivity be maximised, inputs of agricultural chemicals are necessary. In particular fertiliser phosphate additions are essential to balance the removal of phosphorus in farm product. The phosphorus cycle is of great ecological significance due to the scarcity of the element and due to it being exported from the site of use to the site of consumption and subsequently disposed of through sewers into river systems and oceans. The cycle is thus broken and the process is unidirectional creating long-term concerns.

Nitrogen fertilisers are also regularly used, often for raising quality of product through increased protein levels. Much nitrogen availability for plants is achieved through the process of nitrogen fixation of legumes, a natural process, and improved methods of managing this form of nitrogen are needed.

(b) Herbicides The development of conservation farming has also increased the dependance by farmers on herbicides, an area where the philosophies of the conservation farmers and the organics diverge. It must be said in the defence of herbicides that their availability has allowed us to successfully address the issues of soil structure decline and improved productivity. It must also be said that most herbicides are relatively safe if used as directed. New chemicals have shorter residual life and are much safer to use. The group of sulfonyl ureas, for example, target an enzyme in plants which is not present in mammalian metabolic systems. This is not to say that caution is not needed in their use. Training of users also becomes an imperative.

As well as their effectiveness, herbicides have become increasingly important because their cost has remained more than competitive with alternate practices. They are easy to use and farmers have become more familiar and experienced with the technology.

Their ready acceptance has brought its own problems, the development of herbicide resistance being of greatest concern. In any population there will be individuals who react differently to the rest. Thus an effective herbicide will remove the susceptible weeds and allow the resistant subpopulation to dominate. Subsequent applications of the same or related herbicide will be increasingly ineffective. Farmers need to be aware of this issue and implement strategies, particularly herbicide rotation, to reduce its buildup. Regular testing for resistance of weeds that escape control should be done to reduce unnecessary use of chemicals which do not work. Such a process is environmentally and economically sensible.

(c) Reduced Chemical Inputs It is fair to say that most farmers would like to reduce their inputs of farm chemicals, both on cost and environmental grounds. The reality is, however, that farmers will be dependant on their use into the foreseeable future.

Prospects for reducing their use are strong. Technology will soon be available through remote sensing technology such as aerial video to map the weed distribution in paddocks and only spray the infested areas. Already similar technology exists for fallow weed control. Known as the WASP, the machine uses red and infra-red reflectance to discriminate green vegetation from soil or litter such that individual nozzles release herbicide only where green material is detected (Felton *et al*. 1987).

(d) Integrated Pest Management Numerous actions by farmers can reduce the need for chemical inputs. Factors such as disease resistant cultivars, early sowing, weed management in the pasture phase and crop rotations all play a part in the process. These factors are addressed elsewhere in the conference.

(e) Natural chemicals A new term for farmers is allelopathy, the chemical control of one plant on another. Natural allelochemicals exist in both growing plants and in dry residues of the plants and are commonly effectively used by weed species. In silvergrass, for example, such chemicals in the dried residues inhibit the germination and establishment of crop and pasture species (Pratley, 1989; Pratley and Ingrey, 1990).

Some crop and pasture plants and their stubbles also have allelopathic capacity. Canola is noted for its ability to produce a clean seedbed for a succeeding crop. Cereal stubbles, where retained, have interfered with establishment of crops being sown into them. Litter of phalaris is known to inhibit the germination of subterranean clover.

The phenomenon of allelopathy currently acts negatively by inhibiting production. Greater knowledge of how it operates and which compounds are involved may allow farmers of the future to effectively counteract the inhibition of productive plants or to use the process positively to limit dependance on chemical inputs. So-called 'natural' herbicides may be an outcome of the research. However, will these allelochemicals be any safer than those used now?

What Is The Best Farming System?

In ecological systems there are no simple answers. Simple solutions are always unstable solutions. Consequently, there is no one best farming system.

Such systems evolve as our knowledge base increases, and as technology develops. Attitudes also change and farmers are now more environmentally conscious than ever before, in line with community expectations. However, all of us have to operate within the constraints imposed on us at the time - be they economic, regulatory, or knowledge. But, evolving farming systems must be intensively monitored to measure performance and to make adjustments where undesirable trends are identified.

Objective Measures

Decision making on the farm must be made as objective a possible.

Good record keeping of both financial and physical data will enable an analysis of "what went right/wrong". It will also provide the basis for more accurate forward planning.

Many objective tests already are available or will be in the near future. Farmers will test for or have tested:

- root zone soil moisture through the season;

get regular soil tests for fertility and pH. Plant tissue testing may substitute in some cases;

- groundwater over time to monitor watertables;

- herbicide resistance;

- soil structural stability;

and may make regular use of remote sensing technology such as aerial video mapping.

Crop and pasture monitoring will be routine.

It is important to note that the top performers are those who get all the factors of production right. This has been shown regularly in farm monitoring groups and is shown in Figure 3.

Figure 3. The relationship between yield, profitability and the adoption of key factors by farmers in a crop monitoring group at Finley, NSW (J. Lacy, personal communication)

Getting it right becomes easier because priorities become clearer due to the sound platform of information.

Conclusion

Conservation farming has come a long way in a short time. It embraces many of the aspects of the organics and is empathetic with much of the philosophy. It clearly differs in its approach to pesticides and fertilisers which remain an integral part of the system as it endeavours to obtain profitable yields of good quality produce.

References

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