ORGANIC AND CONSERVATION FARMING - BRIDGING THE GAP - TO THE FUTURE

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I well remember my first, and last, attempt at snow skiing. It was late in the day. The tow had dragged people upwards all day along two distinct and diverging routes. Nobody told me to choose between them. And so I started out, one ski following each of those well trodden and diverging routes. I was in deep trouble and soon knew it! There was no bridging the gap between those wretched skis. My future was clear and it certainly was not bright.

So it is with the topic today. Whether the gap between conservation farming and organic farming is narrowing or diverging will determine whether or not we bridge the gap. My guess is that, despite a narrowing of the gap, it will not be bridged because of important differences in philosophy.

• At the heart of organic farming is a philosophy which aims to enhance and work with natural biological cycles. It aims at co-existence with "nature", rather than dominance over nature. The National Association for Sustainable Agriculture, Australia (NASAA) notes that an organic system is not merely "free of artificial chemicals". Even "approved" natural inputs should be minimised or excluded. As far as practical, systems are "closed". That is, ideally, no inputs are sourced off-farm despite the export of material from the farm. Dr Scott has highlighted the unsustainability of any system that exports nutrients such as phosphorus without replacing them. Of course, many organic growers do use rock phosphate, but this is not seen as being ideal.

• At the heart of conventional farming, even conservation farming, is a philosophy of managing or controlling nature. "Control" ...... versus "co-existence" in the case of organic farming.

Hence, when the chips are down and the pests or weeds appear to be on top, the conservation farmer will reach for a pesticide ensuring a prompt, effective fix. The committed organic farmer, given the same problem, will live with it in the belief that his system will, in the long run, be better for it.

Success with organic farming, which means persistence when the going gets tough, depends very much on adherence to the underlying values and philosophy of the system.

Having highlighted this difference in philosophy, which I believe cannot be easily reconciled, it remains true that conventional farming has changed as old principles are rediscovered, such as the benefits of crop rotation and the power of weed *management* in lieu of weed *control*. In many respects the practices of conservation farming *are* moving closer to organic farming, as we have seen today. Both involve *systems of farming*, whilst neither can be achieved successfully by changing just a few practices. But the philosophies remain very different.

However, the *difference* between organic and conservation farming is not the key issue for us today. Farmers have come to this conference, with its particular theme, because they care about their land, the environment, and their future. the key issue then, is the capacity of conservation farming, or the alternative of organic farming, to ensure sustainable production and long-term financial security.

Some farmers will have asked if organic farming is a shortcut to financial security. It should be clear by now (ref. Dr Wynen) that organic farming is no solution to rural financial woes, although organic farming may be a useful marketing strategy in oversupplied markets or whilst ever a premium is paid for organic produce.

So let us turn to the real issue, that of sustainability. Which of these approaches to farming is most likely to be sustainable? You will see that the answer to this question is not a simple one. I define here sustainability as the capacity to continue farming indefinitely. It includes goals of:

• maintaining or improving the chemical and physical fertility of soil;

• biological sustainability, including changes in weeds, pests and diseases as well as beneficial organisms; and

• good economic performance.

I add two other factors which are often overlooked. These are:

• the "adoptability" of new practices which are supposed to enhance the sustainability of farming, and

• minimum adverse off-farm impact including the actual or *perceived* safety and healthfulness of foods and food production technology.

Adoptability means that the practice must be wanted by farmers. It must also be within reach of the farmer, given his skills and resources. If it is not, it will not be taken up and therefore cannot contribute to sustainability.

In asking which approach to farming will meet these five goals of sustainability, it is best to start by looking back. Past changes give us a clue to likely future changes. In several papers during the mid-1980s, Pratley and Cornish identified the issues that seemed then to most likely threaten the sustainability of farming. Let us look at how well these issues have been addressed over the past 6-7 years and then identify any new issues which have arisen. With this list of current issues we can consider which approach to farming will best address these issues.

In looking back, we first need to recognise that many past farming practices have appeared to be sustainable but we now know better. Soil erosion resulting from long cultivated fallows, salinity resulting from clearing and a change in vegetation, and rising soil acidity in association with pasture improvement are all good examples of this. These sound a warning. What now seems sustainable to us, whether organic or conservation farming, may well turn out to be non-sustainable. Indeed, this is likely to be so. We need to be vigilant and willing to change.

In Table 1, I have listed the issues and rated them for their apparent importance in 1985 and today. My judgement on the prospects for satisfactorily addressing the issues is also given. This judgement is based partly on trends since 1985 and partly on the papers presented today. You will immediately see that there is cause for concern where an issue is important in 1992 (rated 4,5) but prospects for a solution are low (1 or 2), especially where the issue has been important since 1985. The last column is my judgement on whether the prospects for a solution to the issue are best with organic or conservation farming. Because this is a personal judgement it will be open to debate.

The following discussion highlights the main issues we must address.

Soil Fertility

Sustainability depends in part on our ability to manage the nitrogen cycle. This is to contain fertiliser costs, improve productivity, and minimise environmental damage due to nitrate leaching.

There has been recent dramatic progress in understanding the nitrogen cycle of cropping systems. There has also been progress in fertiliser-N management. I am optimistic that nitrogen management on farms will be much improved over the next decade, regardless of farming methods. This assumes the wise use of rotations (including leguminous crops and legume-based pastures). The main uncertainty is over the stability of legumes in legume-based pasture.

Declining soil phosphorus will not be an issue if organic farmers continue to use rock phosphate from an appropriate source.

Soil acidification will continue to be a major blight on the system and liming is inevitable on many soils. What system will minimise the rate of acidification is not clear, but I suspect conservation farming will have the edge because a wider range of inputs can be used in management. The exception to this would be low input organic systems in which the soil N level remains low - this will have a lower rate of acidification. However, acidification will still occur, and financial returns may not cover the eventual need to lime.

Soil structure has declined in importance as an issue generally, because of a dramatic reduction in cultivation. However, the dependence on cultivation for weed control is a major issue with organic farming, as Jim Derrick has mentioned. Reducing tillage is the key to improving soil structure and reducing erosion of cropped land on most soil types in southern NSW. The judicious use of herbicide to reduce dependence on tillage is still a major tool in the war against erosion.

Organic farms often have lower cropping ratios than other farms. The increased time in pasture could offset any effects of greater cultivation.

Biological Sustainability

Whilst ever herbicides are a key element in reducing dependence on tillage their use will be a major issue in both economic and environmental terms. In this respect organic farming must have an advantage. Costs of herbicide have mitigated against adoption of conservation farming, but any increased weed incidence in organic farming may also be a cost (in terms of yield).

I believe a wider range of management options for weeds will be developed for both conservation farming and organic farming, with the advantage again going increasingly to conservation farming because of the wider range of inputs allowed. Crop rotations and, at least in the medium-term, strategic herbicide use will be at the heart of future weed management.

Herbicide resistance has emerged as a major issue for conservation farming which, of course, is not an issue with organic farming. I suspect this will be an ongoing problem for which the only long-term solution will be a radical reduction in herbicide usage through the development and adoption of alternative weed management strategies. This trend towards weed management is emerging.

I have noted a reduction in the importance of diseases since 1985. This is partly because of progress towards yellow spot resistance, but largely because of widespread awareness amongst growers of the importance of crop rotations in managing diseases.

Both organic farming and conservation farming will enhance the biological activity of soil. This can only be good. It is not clear which system will be most beneficial. Whilst some agricultural chemicals and excessive fertilisers do reduce biological activity, so does tillage which appears to be practised more on many organic farms.

Economic sustainability

Here I am less concerned about the overall profitability of farming than I am about *prospects for improvement* by adopting either conservation farming or organic farming. Improvements in profitability depend very much on the adoption of whole-farm systems, along the lines discussed by Pratley and others at this conference. This applies to both organic farming and conservation farming. New techniques for analysing the economic performance of whole-farm systems are urgently required. They are being developed and will assist management of complex new farming systems.

Dr Wynen and Mr Derrick have both shown that the short- to medium-term economic prospects for organic farming are not especially bright, although they depend very much on prices received. In the longer term, freedom from pesticide residues may be a marketing strategy which facilitates sales on saturated international markets that may otherwise not occur at any price.

I suspect that management skill is the key to profitability in both systems, and a well managed farm of one type (system) will always out perform a poorly managed farm of the alternative type.

Adoptability

There has been great progress in the understanding of sustainability issues and the widespread adoption by farmers of sustainability as a goal. However, we must be realistic. Unless farming techniques are profitable they cannot be adopted. I am confident that better farming practices can be both environmentally better and more economic.

Also being realistic, these new systems are complex and getting more difficult to manage. This is a major issue. Future profitability and sustainability will depend not only upon better management of the components of farm systems, such as better crops and better pastures, it also depends on relationships between these components to give better management of weeds, diseases, pests, soil fertility and the available rainfall. The long-term effects of management on soil structure need to be considered, not to mention juggling the cash flow, meeting market demands for quality, predicting and taking advantage of trends in market prices and so on.

This complexity presents the greatest challenge to conservation and organic farming alike. I should note that dealing with this complexity is very much at the heart of the organic farming philosophy.

Since 1985 there has been great progress in extension methods. Better understanding of farmers and the decisions they must make, together with new ways of presenting information to growers, should help the adoption of conservation farming.

Off-farm considerations

Concern is rising in the wider community about the off-farm effects of agriculture. Siltation of waterways can be readily reduced, because large particles of soil are readily stopped from moving. Reduced tillage gives conservation farming an advantage over organic farming. Smaller particles cause less damage by siltation, but they carry phosphorus which leads to algal growth in streams and dams. Organic farming, with lower nutrient inputs, should have an advantage here, but if erosion is greater the net result may be no better than conservation farming.

A common misunderstanding is that superphosphate contributes more than rock phosphate to nutrient pollution of rivers, because the phosphate in super is soluble in water. Both sources of phosphate can contribute equally to river pollution, and neither leaches readily, except in very sandy soils.

Dryland salinity will be difficult to address in the short-term. The solution will come about by increasing water-use by plants. I find it difficult to see how low input organic farming can use as much water as conservation farming *unless* the mix of crops, pastures and wooded areas is altered.

The public has a perception that food is not always safe. Whilst this perception may be incorrect, there does remain the demand to reduce pesticide usage in food production. This may give farmers a "low-chemical" marketing edge, but for this to succeed the public may need to accept lower levels of cosmetic quality.

Conclusion

Organic farming is a commendable philosophy, especially in that the farm is seen as a whole system. There is an emphasis on cooperation with the natural cycles of nature and there is no doubt that this can reduce or eliminate the need for some off-farm inputs. This emphasis on whole-farm management should be the envy of all farmers. Conservation farmers and organic farmers share a commitment to conservation as a goal, and to whole-farm systems as a means of achieving this goal.

There are concerns with organic farming in the areas of soil structure, and also declining phosphorus if fertiliser is not used. Economic performance is also in question. On the other hand, the cost of herbicides and herbicide resistance are major issues with conservation farming.

In the future I see the two systems continuing to converge, which will be to the advantage of conservation farming, especially in the areas of crop rotations and weed, pest and disease management. But philosophical differences will persist. Also, I believe that conservation farming will benefit from access to a wider range of inputs compared with organic farming. However, in the case of pesticides (and herbicides) and fertilisers there must be greater emphais given to minimising inputs, consistent with maintaining productivity and profitability, and monitoring the results of their use.

Finally, the greatest barrier to the adoption of more sustainable systems, of either philosophy, is their complexity and the need for greatly improved farm management. Top priority for future research and extension should therefore be given to joint programs with farmers to develop better ways of obtaining and using the wealth of information available.

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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.

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