Practical and economic considerations of sustainable agriculture in summer rainfall areas of Australia

P.B. Wylie and A.L. Clarke

56 Drayton Street, Dalby QLD 44053 Case Street, Toowoomba QLD 4350

Summary. Farming practices which include reduced tillage, crop rotation, opportunity cropping, legumes and fertilisers can be better utilised by farmers to improve sustainability. Most changes in farming techniques required to overcome constraints to sustainable farming are practical and can improve profitability. Aspects of sustainable farming which reduce profit include the costs of conservation structures, converting to reduced tillage, tree planting, nature reserves and tolerating crop damage from wildlife. On balance, the change to more sustainable farming is likely to be affordable because it is also likely to be more profitable.

Introduction

Sustainable farming implies the long-term maintenance of agricultural productivity, without adverse effects on the environment or consumers of agricultural products.

Soil erosion is the most significant constraint to sustainability in summer rainfall areas. Losses caused by erosion are essentially irreversible. Despite the presence of contour banks, erosion has been measured at 30-60 t/ha/yr on the Darling Downs (1). Erosion causes a serious decline in productivity and can limit the productive life of many sloping soils to less than 100 years (2).

Soil salinity and acidification may be acute in small areas but are not significant problems in the summer rainfall cropping areas. Soil structural decline can reduce productivity on medium textured soils, mainly due to reduced infiltration causing increased runoff.

Although the problems of weed infestation and fertility decline are important to production and farm profitability, they can be overcome by good management and are therefore less serious with respect to long-term productivity.

Potential problems with the use of agricultural chemicals are a significant concern of many farmers and the general community and require attention. To be sustainable, agriculture has to be accepted by the general community as well as being practical and economically viable.

Constraints to sustainability

Soil erosion

When tillage is reduced almost to zero (reduced tillage) residue cover is maximised and soil erosion reduced by 90% of that occurring from cleanly tilled land (3). A growing crop also protects the soil by providing cover and maintaining a soil water deficit. Opportunity cropping, which entails sowing a crop whenever soil water reserves are adequate, maximises soil water use and living cover protection. Surface roughness may assist erosion control when cover is inadequate, and contour banks reduce gullying by controlling runoff .

Soil structural decline

Soil structural decline results mostly in increased runoff and hence reduced moisture storage and crop yields. The important factors affecting structure are erosion, cultivation and associated organic matter depletion (11). Erosion adversely affects soil structure by exposing subsoil with unfavourable structural characteristics. The effects of cultivation and organic matter decline will vary greatly with soil type. Selfmulching clays are least affected, whereas soils with high fine sand and silt components show more serious effects.

Reduced tillage eliminates most of the cultivation damage to soil structure. Zero tillage improves water entry into clay soils by increasing the number and continuity of large pores (B. Bridge, pers. comm. 1991), but effects on aggregate stability may be small. Frequent cropping can benefit soil structure by maintaining surface cover and maximising organic input into the soil. Grass pastures are well known for their ability to restore structure.

Soil nutrient decline

Sustainable farming implies the need to replace nutrients removed in grain or lost in other ways. The most important nutrient in this respect is N, which is removed in cereal grains at a rate of 16-22 kg/t. Phosphorus is also important, being removed at a rate of 3-4 kg/t of grain. The use of P fertiliser is a practical and economic solution, while feedlot or other animal manures can be an alternative and economical source of P and other nutrients where available.

Soils in the northern cereal belt usually have more than adequate N for crop production when first farmed, but levels decline rapidly, with losses more than double N removal from grain (12). After 5 to 30 years, depending upon soil type, mineralisation from organic matter slows and N commonly becomes limiting to crop yield (13).

Grain legume contributions of N to the soil are relatively small, normally 5-25 kg N/ha (14,15). Pasture legumes can contribute much larger amounts of N because production is greater and removal is less. Lucerne in a pure sward can add 80-100 kg N/ha/yr in the higher rainfall areas around Tamworth and on the Darling Downs (16,17,18). Medics contribute 40-70 kg N/ha/yr in favourable locations and seasons (19). For sustainability of N supply, approximately one year of good legume pasture production is needed for each year of crop production. Any deficit may need to be met by the use of N fertilizer.

Nitrogen fertiliser is commonly used for crop production in higher rainfall areas, such as the Darling Downs. In drier areas, response is less assured, with no profit from N fertiliser when cereal yields fall below about 1.5 t/ha. Pasture legumes are favoured in these areas as sources of N. To improve production and economics, N fertiliser applications in low rainfall areas can be varied according to crop yield potential estimates of potential crop yield, influenced by soil moisture and planting date at time of sowing.

Weeds, pests and diseases

Measures to control weeds, insects and diseases, need to be economic and environmentally benign. Genetic resistance, an ideal method of controlling diseases and some pests, is being actively sought in breeding programs. Crop rotation can reduce the need to use weedicides and pesticides, with both economic and environmental advantages. The winter weed, wild oats, for example, can be effectively controlled by rotating to summer crop for two to three years. Likewise, yellow spot and crown rot of wheat and root rot of chickpea can be controlled by rotation.

Contamination by agricultural chemicals

Herbicides play an essential role in reduced tillage systems, but without posing environmental hazards if properly used. Advent of the weed-sensing sprayer will further reduce herbicide applications. The environmental benefits of controlling soil erosion are likely to far outweigh potential hazards of herbicide use. Nitrogen fertilizers, especially under zero-tillage, can result in leaching of N, if soil water is under-used. More frequent cropping can reduce this problem.

Sustainability and farm profitability

Reduced tillage

In addition to controlling erosion, reduced tillage can improve crop yields. This results mainly from improved water storage, but it may also allow more timely planting and more frequent cropping. Many trials have shown yield improvements due to enhanced water storage of 5-15% under reduced tillage (3,4,5). The benefits are greatest in dry years, when extra yield is most valuable to assist farm profitability.

With reduced tillage and modified planting machinery, sowing may be continued for several weeks longer after rain than would otherwise be possible (6). On occasions, crops can be successfully established on an early rain when the soil is too dry for conventional planting. This may mean avoiding a loss in yield potential of 5-7% per week's delay beyond the optimum planting date (7), or in extreme situations, the production of a crop when planting would otherwise be impossible. Although opportunities to improve sowing timeliness may only occur three years in 10 (5), if a month's delay (causing 24% yield loss) is avoided in those years, the average annual yield advantage would be 8%. Reduced tillage has also been shown in practice to increase the chance of double-cropping and the yield of these crops.

At times, there is no extra yield from extra moisture stored by reduced tillage, and on occasions yield reductions have occurred. Adverse results can occur from diseases such as crown rot and yellow spot in wheat and from nitrogen deficiency (5). Crop rotation is important to maximise the potential of reduced tillage to improve crop yields.

With less tillage, N mineralisation is reduced (9) and more N is needed. This extra N may have a short-term cost, but a long term benefit by increasing organic matter levels and gradually the need for extra nitrogen may lessen. The practical problem of planting through stubble into unprepared seedbeds can be overcome by improvements to planting machinery, which farmers can achieve by cheaply modifying existing machines (10).

Opportunity cropping

Growing one crop a year may not effectively use all of the rainfall. The optimum crop frequency, in terms of water use, increases with rainfall and with reduced capacity of the soil to store water. The potential to grow more crops is evident in data from the Hermitage fallow management trial in which a winter crop, usually wheat, is grown annually. In three years out of 10, spring rains resulted in the soil being almost at field capacity after winter crop harvest in November (5). In most years, in the environment of the eastern Darling Downs, enough rainfall is stored by early January, to allow the planting of a summer crop following winter cereal.

In northern cereal areas it makes sense to utilise rain in above average years by double cropping. In dry areas, there is also a risk of not receiving planting rain, which leads to opportunity cropping when a planting is missed. For both production and protection, opportunity cropping should be a component of all cropping systems.

Cumulative benefits

Cumulative increases in gross returns can be substantial (Table 1). Increased returns will result from higher yields from reduced tillage programs, with benefits from improved fallow moisture storage (5-15%), improved planting timeliness (5-10%), increased crop frequency (5-25%) and the use of crop rotation and legumes (15-30%).

Costs

Cost-wise, reduced tillage is becoming increasingly attractive relative to conventional tillage as herbicide costs decrease and fuel and machinery costs rise. Many conservation farmers now have fallowing costs similar to or less than those of conventional farmers. One way farmers have cut costs is to use sulphonyl-urea herbicides to provide control of broad-leaf weeds in the winter crop and extending into the summer fallow, when sheep are used to control summer grasses. The weed-sensing sprayer mentioned above will further reduced costs. Field testing of this equipment has demonstrated weed control with less than 10% of the normal herbicide rate (8). Herbicide cost could be reduced from around $15 to $2 per hectare, which with spraying costs, would mean a total of around $6 per hectare compared with $12 for a cultivation. Farm overhead, depreciation and labour costs are very significant when compared to total variable costs for fuel, fertiliser and other inputs. Using less tillage enables a farmer to crop a larger area with the same machinery and labour and so spread his overhead costs.

Additional costs incurred by farmers seeking to make their farming more sustainable, include the conservation structures and for machinery changes required for conversion to a reduced tillage farming system. Extra nitrogen fertiliser may be required, but the cost will be offset by increases in crop yield. If ley farming is used to maintain soil structure and/or soil N, the initial profit may be less than from alternative grain crops and additional costs will be incurred with farm infrastructure. However, additional yield from subsequent cereal crops may compensate for these losses. Tree planting, setting aside reserves and tolerating crop damage from wildlife are further costs of farmers wanting to maintain or improve their farm's environment. A combination of tax incentives and good management may help to reduce the burden of these costs.

Table 1. Comparison of profits ($/ha) for conventional and reduced tillage in three grain growing areas of southern Queensland.

	Conventional tillage			Reduced tillage		
	Eastern Downs	Downs Plains	Western Downs	Eastern Downs	Downs Plains	Western Downs
Gross income	280	360	192	320	414	220
Variable costs (fuel, fertiliser, etc.)	125	150	102	130	168	120
Overhead costs, labour	128	124	68	96	93	50
Profit:	27	86	22	94	153	50
Gain from reduced tillage	67	67	28			

Conclusion

The move towards more sustainable farming is practical and can be more profitable than existing farming methods. Improved agronomic practices, which reduce erosion, maintain soil fertility and improve yields provide considerable scope for increasing farm profits and so offset the costs of practices such *as* tree-planting that aim to improve the farm environment.

References

1. Freebaim, D.M. and Wockner, G.H. 1986. Aust. J. Soil Res. 24, 135-158.

2. White, P.J. 1986. J. Aust. Inst. Agric. Sci. 52, 12-22.

3. Freebaim, D.M., Ward, D.L., Clarke, A.L. and Smith, D.G. 1986. Soil Tillage Res. 7, 211-229.

4. Holland, J.F., Doyle, A.D. and Marley J.M. 1987. In: Tillage - New Directions in Australian Agriculture (Eds P.S. Cornish and J. E. Pratley) (Inkata Press: Melbourne). pp. 48-71.

5. Marley, J. M. and Littler, J.W. 1989. Aust. J. Exp. Agric. 29, 807-827.

6. Radford, B.J. and Nielsen, R.G.H. 1983. Aust. J. Exp. Agric. Anim. Husb. 23, 302. Woodruff, D.R., and Tonks, J. 1983. Aust. J. Agric. Res. 34, 1-11. Felton, W. 1991. Aust. Grain 1, 11-14.

7. Dalal, R.C. 1989. Soil Sci. Soc. Am. J. 53, 1511-1515.

8. Marshall, J.P. 1991. In: Farmer Developed Planters for Stubble Farming. (Conservation Farming Information Centre: Dalby). pp. 1-6. Loch, R.J. 1988. QWRI Biennial Report 1986-88 (in press). Dalal, R.C. and Mayer 1986. Aust J. Soil Res. 24, 281-292. Dalal, R.C. and Mayer 1986. Aust J. Soil Res. 37, 493-504. Doughton, J.A. 1987. Proc. Qld Crop Prod. Conf., QDPI, Brisbane, pp. 31-33.

9. Wylie P.B. and Powell, E. 1990. In: The Practicality and Potential of Organic Cereal Production, Report prepared by Peter Wylie and Associates, Dalby. pp. 31-33.

10. Littler, J.W. 1984. Qld J. Agric. Animal Sci. 4, 1-12. Holford, I.C.R. 1980. Aust. J. Agric. Res. 31, 239-250. Holford, I.C.R. 1989. Aust. J. Agric. Res. 40, 255-264. Clarkson, N.M. 1987. Aust J. Exp. Agric. 27, 256-265.