Organic rice cultivation - for sustaining irrigation farming in the Riverina

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Summary. Gross margins of four organic rice farms were calculated to determine returns per hectare. Results indicate that organic rice may be more profitable than conventional practices and the implications of seven environmental issues commonly associated with irrigated agriculture are discussed.

Introduction

The dependence of modern agriculture on non-renewable inputs, its adverse effects on soil and water and other natural resources and its growing dependence on agricultural chemicals have raised serious questions about its sustainability. Concern over these trends has led to a greater interest in alternative agricultural systems of which 'organic' farming is only one of many (9). These farming systems may more appropriately be referred to as biological farming systems which aim to produce high quality food at reasonable cost while conserving fossil fuel and other resources, reducing soil erosion and degradation and minimizing adverse effects on the environment (15).

The processes used in biological farming emphasise naturally occurring mechanisms of controlling weeds, diseases and insect pests and the efficient use of on-farm sources of plant nutrients and organic matter. A major difference between these systems and conventional approaches is founded on the hypothesis that external control is far less energy efficient than internal control. This is one of the fundamental principles of agroecology (11).

Very little research has attempted to record the environmental effects of conventional and organic/biological farming systems (2). No data on an Australian application of these systems to irrigation farming exist although concern about current agricultural resource use is recognised (8,13).

In this study, rice cultivation has been selected as it *is* the dominant crop in the Riverina irrigation districts and at the same time is a major user of water, artificial fertilizers and agricultural chemicals. The rice industry is in an ideal position to benefit from the implications of new approaches to farm management systems and their effect on the environment, provided these systems can be shown to be economically viable.

Methods

This research is part of an interdisciplinary study of four organic rice farms which are certified Level A by the National Association for Sustainable Agriculture in Australia (NASAA). NASAA is one of three national organisations responsible for the certification of farmers producing agricultural goods without the addition of artificial fertilizers and chemicals (12).

Gross margin analysis and management surveys for the 1990/91 rice crop grown on these farms were conducted to establish the viability of organic rice production. Dry weight yields were obtained from the Ricegrowers Cooperative. Comparisons with conventional systems were made using crop budgets prepared by the NSW Department of Agriculture at the Yanco Agricultural Institute (6). These comparisons have been included to give an indication of average returns and costs that may be expected from a sod sown conventional rice crop in the district.

Results and discussion

Economics of organic rice production

Gross margins (Table 1) show that organic farms had higher returns per hectare and per megalitre. This result has come from three factors. Organic farms have lower variable costs per hectare, due largely to the absence of fertilizers and chemicals. Savings from these two inputs amounts to $137/ha or 23% of the total variable costs for conventional crops.

Organic crops performed well on yields. Only one farm recorded yields below the district average for the rice variety, Pelde, of 8.0 t/ha (NSW Agriculture, pers. comm., 1991). Yields for the four organic farms were 6.98, 8.05, 8.68, and 9.55 t/ha. Yields of 9.0 t/ha are usually only achieved with heavy nitrogen fertiliser applications (3).

The price premium of $30/t has added to the income received by organic farms. However, organic growers do not rely on price premiums in order to be viable. These results challenge the common belief that organic produce must receive higher returns in order to compensate for lower yields and/or higher costs.

The ratio of gross margins to variable costs is a measure of dollars returned per dollar invested. On farms where finance is limited and cash advances will have to be repaid with interest, this measure of profitability is important. Organic rice farms have higher gross margin variable cost ratios (-2.5) than conventional systems, which according to Crean (6) range from 0.67-1.03.

Hinchcliffe (10) has reported similar gross margins but has cautioned that the need for long pasture rotations may make organic rice production less viable on farms less than 240 ha. In this study three of the four farms were below 200 ha. Opportunities to increase income from more frequent rice cropping is affected by a range of factors including labour, livestock enterprises, capital to re-invest, family size and industry restrictions on production areas.

Table 1. Annual gross margins (GM) for organic and conventional rice (cv. Pelde) farming.

	Organic	Conventional
Income items		
Yield (t/ha)	6.98-9.55	8.00
Price ($/t)	211	181
Income ($/ha)	1473-2015	1448
Variable costs ($/ha)*		
Tractor hours	14-28	25
Seed	24	22
Fertiliser	Nil	53
Sprays	Nil	84
Irrigation	195-243	182
Harvest	150-205	172
Cartage	46-63	52
Total	429-563	590
GM ($/ha)	1044-1452	858
GM/ML of water use	70-77	61
GM/variable costs	2.45-2.58	1.45

* See Crean (6).

Management of organic rice and its implications for the environment

Some of the management processes observed on organic farms and their implications for the environment are described below.

Land and water resources. Increasing the productivity of irrigated areas where rice is grown will lead to improved utilisation of land and water resources, a major objective of the region (8). Organic farms had high gross margins per hectare and per megalitre of water use (Table 1). In addition these farms have better opportunities for diversification into other crops and livestock products which may lead to further productivity increases and better utilisation of resources. This is because there is a range of opportunities for specialty food products in the organically certified food industry. Diversification away from agricultural activities with high demands for water is an important step towards reducing groundwater accessions.

Energy inputs/fossil fuel. In addition to lowering costs, reductions in fossil fuel inputs are a major step towards sustainability and resource conservation. Practices which promote lower use of fossil fuel also make a positive contribution to a reduction in global warming. Tillage practices adopted by organic farms in this study reduced energy inputs, particularly during the cropping period. Ground preparation was achieved by grazing sheep on pasture prior to sod seeding. On one farm where rice was the only crop grown, no cultivation or removal of ground cover is practiced. Where growth was too vigorous, hay making achieved the desired pasture length without the use of herbicides. Sales of pasture hay offset the higher fuel and labour costs. Avoidance of fertilizers and pesticides meant further reductions in fossil fuel as both are products of the petrochemical industry. Sod seeded rice crops require less energy inputs than aerially sown crops which is increasingly preferred in NSW; over 80% of total NSW rice crops are now aerially sown (5).

Nutrient contamination of surface waters. Phosphorus enrichment of surface waters commonly results from fertilizer application to field crops (7). Grazing animals and manure spreading are sources of organic phosphorous and nitrates, while legume dominant pastures may result in nitrates in water. When phosphorous is present with sufficient nitrogen this can lead to eutrophication of surface waters and conditions toxic to aquatic life, a problem of increasing importance in the Riverina. Only one farm in this study had applied fertilizer (to pasture in the form of rock phosphate) since conversion to organic production. No farms practiced manure spreading but all had sheep. All farms had a history of superphosphate application prior to conversion. Management systems which allow successful cropping without the use of soluble fertilizer may have a significant impact on reducing nutrient contamination of surface waters downstream of irrigation areas. The crop nutrient requirements on organic farms appeared to be adequately met from several sources including irrigation supply water, the rice cultural system (flooding), biological fixation of nitrogen and the recycling of crop residues.

Nitrate in ground water. The high probability of leaching, combined with large nitrogen inputs, makes irrigated agriculture a major potential source of nitrate ground water. This is particularly the case in the Riverina as accessions to ground water are already a concern; recommended nitrogen applications for rice are up to 100 kg /ha N, and legume based pastures are widely used in the rice crop rotation. In field experiments, flooded rice generally recovers only 20-40% of applied N (16) Organic farms attempted to deliver the crop requirements for nitrogen evenly throughout the growing season by relying on organic N derived from clovers. On farms where very long pasture phases were part of the rotation there may be negative environmental effects from nitrates.

Pesticide residues. Many of the pesticides used in irrigation agriculture are potentially harmful to the environment (4). Limitations on assessing the biological effects of pesticides and their identification have been outlined by Slessar (14). Organic farms carry out a range of management practices throughout the rotation to reduce aquatic weed infestation. The role of livestock was important. In this study, barnyard grass, *Echinochloa* spp. had the greatest effect of any weed implicated in depressing yields on organic rice farms. Farmers reported no other significant problems with weeds, pests or diseases. Manual cleaning of irrigation channels, and in one case the use of trees, meant that herbicides were not required to maintain channels during the rice crop.

Soil conservation, All organic farms had management programs aimed at soil conservation and improved soil fertility. These included landforming, minimum tillage, nutrient cycling and building soil organic matter. Soil acidity did not appear to be a problem (pH-1:5, soil:water) despite organic farms relying on legume based pastures to rebuild soil nitrogen.

Natural habitats. The organic farms surveyed were no different to other irrigation farms in their property and crop design. In common with many farms, tree planting programs were seen as important. Although not studied, soil biota may well differ on organic farms. The differences are probably due to efforts to increase soil organic matter, the absence of soluble fertilizers and pesticides, minimum soil disturbance and less flooding due to less frequent rice cropping. Biodiversity on all irrigation farms is poor with little consideration of its role within an agroecosystem (1).

Conclusion

Sustaining irrigated agriculture will require a better understanding of how production can be designed to meet environmental and economic constraints. Currently, modern farming systems operate only within economic constraints. The four organic rice farms demonstrated that economic objectives can be met through management and technology. The implications of their practices would appear to have a positive effect on environmental issues associated with agriculture.

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