ORGANIC FARMING - A Growing Role in Australian Agriculture?

BACKGROUND INFORMATION BRIEF NO 20

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CONTENTS

SYNOPSIS

A large majority of Australians say that they prefer their food free from chemical residues, and, moreover, are prepared to pay more to buy it that way. Most Australians therefore have an interest in organic farming.

Organic farming is popularly understood to be farming without the use of chemical pesticides. This is a correct description in the same sense that the Queensland Parliament can be described as one without a Legislative Council. However the two definitions are similarly incomplete because they focus on what their topic lacks. In the case of organic farming, while the practices from which it abstains are popularly known, less well understood are the means by which organic farmers protect their crops and animals from pest attack, how they nurture and enhance the fertility and ecology of their soil, and what precisely is meant by the label "organic" on produce in the supermarket or roadside stall. Proponents of organic farming say that all our food can and should be grown in this way.

Critics of organic farming point out that the use of pesticides is strictly regulated in Australia and produce is regularly tested to ensure that residues do not exceed the minute maximum levels determined by health authorities, below which no detrimental effects on health have ever been shown. Further, organic farming is said to deplete the soil of many nutrients because chemical fertilizers are not used, and to result in lower food production.

This Background Information Brief considers these issues and describes the current and potential impact of organic farming on Australian agriculture and food supply. While precise estimates are difficult, there are currently around 1200 organic farmers in Australia, nearly 1% of the farming population, but they farm only 0.1-0.2% of Australia's agricultural land and provide a similar proportion of fresh produce sold. However the organic movement, and the demand for its products, is growing. The rate of growth and the ultimate level of demand are key issues which are addressed in this BIB.

1. INTRODUCTION

In a survey conducted throughout Australia in May 1989, 83% of people said they would prefer to buy food which had no chemicals added or used in its preparation, even if it cost them more, compared to only 16% who said that it is sensible to use chemicals in the growing and preserving of food[1]. This implies that the potential demand for organic food is huge, and that a large proportion of Australians have a direct interest in the development of the organic farming industry.

The widespread demand for organic food is a relatively new phenomenon. In December 1976 an international expert visiting Brisbane for a public lecture on organic farming said that Australia had a high potential as an organic farming nation and could earn valuable export income from the sale of organic produce[2]. Yet this message caused little apparent reaction, apart from the already committed, as the public awareness of organic food and pesticide residues had clearly not yet been developed. In May 1990 a report published by the Rural Industries Research and Development Corporation (RIRDC 1990) investigated in detail the potential markets for organic food and suggested that the domestic market could expand at up to 30% per annum for the next ten years. The public, and to some extent the farming community, are now ready.

The reasons for this are several. Primarily, with the awakening of public awareness of environmental issues, attention has been focussed on negative aspects of agricultural fertilizers and chemicals such as contamination of groundwater and streams, spray drift in populated areas, and chemical residues in food. As knowledge of the persistence and toxicity of some chemicals has increased, so too has the ability to detect them in minute quantities, culminating in adverse publicity and even bans on some Australian export produce. Some consumers and marketers also claim that organic food tastes better. At the same time, but less obviously, organic farmers have also been active: refining production systems, developing markets, and growing in numbers, so that they are now well-placed to take the initiative in the promotion of their operations and products.

But what exactly do we mean by "organic farming"? The short answer, and the one most commonly given, is farming without agricultural chemicals (primarily pesticides, but also mineral fertilizers). But what organic farmers don't do is at best only half the answer, and a more complete explanation, along with descriptions of other related terms, is given in the next section on definitions. Some other questions also require answers, such as "how does it work?", "how important is it really?" and "what is the future?", and those are the subject of the remainder of this background

[1] **Sydney Morning Herald** 15 May 1989

[2] **Courier-Mail** 2 December 1976

information brief.

2. DEFINITIONS

Several definitions of organic farming have been proposed, all more complex than the one suggested in the previous paragraph. But firstly, what of the word "**organic**" itself? Dictionary definitions include fundamental, coordinated and complete, giving the sense of the essential or intrinsic elements of an object or concept. This may have some application to our topic. The chemical definition of organic substances is those containing carbon, which is the basic building block of all living things. This may also have some relevance, but by this definition many pesticides, whose molecules contain rings or strings of carbon atoms, are organic compounds, so that is obviously too technical a definition for our purposes. A more general definition, and suitable for our purposes, is "substances or materials derived from animals or plants".

In soils, **organic matter** is the term used to describe animal and plant material undergoing decomposition, with humus as the end product. The organic matter content of soils is usually between 0 and 3% of the soil mass, but its importance is much greater than this would suggest. Organic matter acts as a readily-available reservoir for much of the nutrients taken up by plant roots (the rest of the soil, termed the mineral fraction, may also contain significant amounts of plant nutrients, but not in a readily soluble form, and so not available for uptake by plant roots). Organic matter also improves soil structure and water-holding capacity, particularly in lighter textured soils (sandy and loamy soils, as opposed to clay soils). Soil structure refers to the consistency and density of soils, so that in a high density, poorly structured soil, the entry of water and the growth of roots are restricted. As described by Reganold *et al.* (1990), "Soil is not just another instrument of crop production, like pesticides, fertilizers or tractors. Rather it is a complex, living, fragile medium that must be protected and nurtured to ensure its long-term productivity and stability".

Organic matter is relatively high in native soils, but usually declines with cultivation (Davidson 1986) (see Figure 1). Decomposition of organic matter is hastened by exposure to the air and the higher temperatures that result from the sunlight reaching the soil, and because less plant material is being added. The numbers of soil animals (such as earthworms) and micro-organisms generally decline as well.

The maintenance or enhancement of soil organic matter is the second key aspect of **organic farming** (what organic farmers do rather than don't do). This is achieved by regularly incorporating into the soil animal manures and/or plant materials of a high nutrient content. In the wider scope of the term "organic", organic farming includes the sense of a return to the basic, or natural elements of farming, exemplified by the use of only "natural" materials such as ground rocks as a source of minerals and plant extracts or biological agents for pest control.

Several formal definitions of organic farming appear in the literature. A study commissioned by the US Department of Agriculture (USDA 1980) prepared the following which has since been widely quoted or adapted:

> "**Organic farming** is a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock additives. To the maximum extent feasible organic farming systems rely on crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation, mineral-bearing rocks, and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients, and to control insects, weeds, and other pests."

The National Association for Sustainable Agriculture Australia (NASAA) refers to **organic agriculture** which it defines as:

> "A system of agriculture able to balance productivity with low vulnerability to problems such as pest infestation and environmental degradation, while maintaining the quality of land for future generations.
>
> In practice this involves a system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, livestock feed additives and other harmful or potentially harmful substances. It includes the use of technologies such as crop rotations, mechanical cultivation and biological pest control; and such materials as legumes, crop residues, animal manures, green manures, other organic wastes and mineral-bearing rocks" (Wynen and Fritz 1987).

Several other terms are used more or less interchangeably with organic. These include natural, biological, ecological, holistic, alternative and sustainable. Some authors are quite hostile to the word organic because of its range of meanings, many imprecise, while others consider organic farming as one form of sustainable agriculture (Santich 1990). However "organic" is the term in popular usage and it is almost certainly here to stay.

The phrase **sustainable agriculture** is related to the current buzzword "sustainable development". Many users of this jargon beg the question of what is to be sustained, but descriptions of sustainable agriculture usually refer to sustainability of land rather than to that of the productivity of plants or animals growing on it. For example,

> "In its current popular usage the term applies to those land-use practices which successfully replenish the land, and resupply at least as many nutrients - including carbon - as the crop or livestock mixture removes from that land on an inter-seasonal basis" (Friend 1990).

Most definitions describe organic farming as a **system** of agriculture, rather than simply a set of practices, and others extend this concept to that of a lifestyle and/or a philosophy. For example,

> "**Organic agriculture** is seen by practitioners as a holistic endeavour, with attitudes and lifestyle of the farm family being inseparable from the well-being of the other components of the farm system. The all-important holistic nature of the farm implies interactions between components such as crops with crops, crops with animals, and soil condition and fertility with insect and disease incidence in the crops and livestock" (Harwood 1984).

Also,

> "An organic farm, properly speaking, is not one that uses certain methods and substances and avoids others; it is a farm whose structure is formed in imitation of the structure of a natural system; it has the integrity, the independence, and the benign dependence of an *organism* [emphasis added]" (Berry 1981).

Widdowson (1987) stresses the modernness of what he terms "**holistic agriculture**" which is not simply

> "a return to the farming employed by our ancestors; it is a system which takes all the modern knowledge of the agricultural and other natural scientists, and develops practical methods of putting the knowledge into practice, ideally with no damage to the environment, but at the worst with the very minimum of harm."

Two other terms which have similar but distinct meanings to organic farming are biodynamic agriculture and permaculture. The biodynamic movement was established by the Austrian philosopher Rudolph Steiner, and **biodynamic agriculture** was first propounded by him in a lecture series in 1924. Biodynamics adds a spiritual or religious dimension to organic farming, based on a pantheistic philosophy of the unity of all creation. Biodynamics describes

> "the basic new way of thinking about the relationship of earth and soil to the formative forces of the etheric, astral and ego activity of nature. ...The health of soil, plants and animals depends on bringing nature into connection again with the cosmic creative, shaping forces." (Koepf *et al.* 1976).

Apart from standard organic farming practices, biodynamic farming is characterized by the use of lunar, planetary and zodiacal phases to govern the timing of various operations, and the use of specific preparations made from manure and parts (mainly flowers) of certain plants. The most well-known is Preparation 500 which is derived from cow manure that has been buried over winter in a cow horn. Only small amounts are applied to the soil but they are said to act as a catalyst, somewhat in a mystical sense, to biological activity in the soil. Biodynamic products are sold (world-wide) under the *Demeter* trademark, named after the Greek goddess of agriculture.

Many organic farmers in Australia use Biodynamic procedures or preparations without necessarily subscribing to its spiritual concepts, or being able to determine the effects of each practice, because a range of Biodynamic and other techniques are applied simultaneously.

Permaculture is a condensation of `permanent agriculture'. The concept was developed in Australia by Bill Mollison. It has similarities to biodynamics, and adopts a similar philosophical stance based on Lovelock's Gaia hypothesis, which "sees the earth, and the universe, as a thought process, or as a self-regulating, self-constructed and reactive system, creating and preserving the conditions that make life possible, and actively adjusting to regulate disturbances. Humanity however, in its present mindlessness, may be the one disturbance that the earth cannot tolerate." (Mollison 1988). Permaculture stresses the goal of self-sufficiency on a plot of land through design which incorporates intermingling and close interaction of crop plants, trees, farm animals and aquaculture with minimal inputs from the world outside.

3. ORGANIC FARMING PRACTICES

For simplicity, organic farming practices may be described under three key headings: the control of soil erosion, the maintenance (or enhancement) of soil fertility, and the protection of the crop or animals from pests, including weeds.

3.1 Control of Soil Erosion

Most farmers, organic and conventional alike, take active steps to minimize soil erosion. Organic farmers, however, are at some advantage, as will be seen below. Soil erosion is caused primarily by wind and rain, and the latter is the most serious in Australia. The two main approaches to minimizing water erosion on cultivation are to decrease the flow of runoff down slopes, and to protect the surface of the soil from the direct impact of rainfall.

Both runoff and erosion increase dramatically with steepness of slope, and the best erosion control practice on slopes greater than 5% is to avoid cultivation completely, in favour of permanent pasture or trees. The next defence against runoff down slopes, particularly on cultivation, is a group of practices termed "contour farming", which includes ploughing and growing crops in strips along the contours and building water control structures such as contour banks. Contour farming is practised by many organic and conventional farmers. Because most organic farms include livestock, they are possibly more readily able to convert any cultivation on marginally steep land to permanent pasture.

The main advantage for organic farmers lies in the protection of the soil surface. Green manure and fodder crops are grown when a conventional farmer might have a bare fallow. Livestock are used for weed control to minimize cultivation, although conventional farmers may also reduce cultivation with herbicides. High organic matter provides protection from both wind and water erosion as the soil particles are bound together more strongly. Finally, organic farmers are more likley to retain crop stubbles on the soil surface, although this is a practice of many conventional farmers as well.

Studies have shown that the differences in erosion can be substantial. Reganold (1990) compared adjoining farms on a loam soil in the USA. Both had been cultivated for around 75 years, one always organically, the other reliant on pesticides and chemical fertilizers for the last 35 years. Soil organic matter was 35% higher on the organic farm, and there was 16 cm more topsoil, because erosion had been much less. Arden-Clarke and Hodges (1987) quoted a British report that associated declining soil organic matter levels nationally with increasing soil erosion, and concluded that organic farming was one method of reversing this trend.

3.2 Maintenance of Soil Fertility

3.2.1 Background

Maintenance of soil fertility on organic farms could be said to involve the three following goals:

(1) improving soil organic matter levels

(2) maintaining adequate soil nitrogen levels

(3) maintaining other nutrients at levels adequate for plant growth

Nitrogen is the nutrient required in greatest quantities by plants, and is highly labile, i.e., its concentration in the soil is highly variable. It is the basic building block of protein, in all living things. It is the nutrient most likely to be applied in fertilizer. Entire books have been written about nitrogen cycles in soils and plants. Like all nutrients, it occurs in soils in complex molecules that cannot be absorbed by plant roots, and in simple, soluble forms that can be. The latter, termed available nitrogen, is released by the decomposition of organic matter, but may be readily lost from the soil by leaching into the subsoil or groundwater, or by volatilization into the atmosphere.

One group of plants, legumes, are particularly useful as they are able to absorb nitrogen from the atmosphere through bacteria that live in their roots. Legumes generally contain high levels of protein, and are used as foods (peas, soybeans, peanuts, pulses), fodders (for animal feed or hay, such as clovers, lucerne, acacias) and green manure crops (those intended to be ploughed in to the soil). Legumes are believed to build up soil nitrogen, though this is not always the case, as they will in fact use any nitrogen already present in the soil in preference to fixing their own. Legumes will only add nitrogen to the soil if the amount they fix from the atmosphere is more than that harvested and removed from the field. This is generally so in green manure crops and pastures, but less likely in grain crops, because of the amount removed at harvest. However legume crops may still improve soil nitrogen for following crops because the form released by their stubble is more readily available than other forms of nitrogen in the soil.

All other plant nutrients (there are around 20 elements essential for plant growth, mostly in minute amounts) also cycle between available and unavailable forms in the soil. A deficiency of any nutrient is caused by a low level of the available form of that nutrient, regardless of the total level in the soil. In conventional agriculture, nutrient deficiencies are overcome by mineral fertilizers which are usually in a highly available form. In general, high levels of organic matter and biological activity in the soil increase the transformation of nutrients from unavailable to available forms. Thus a soil high in organic matter is less likely to require fertilization. However some soils because of the nature of their parent rocks are inherently low in some nutrients. In these cases, an alternative to mineral fertilizer is ground rocks of a type high in those elements required. These act as a form of "slow release" fertilizer.

With this background, those organic farming practices directed to the improvement of soil fertility can be described. The maintenance of superior soil fertility is a fundamental aspect of organic farming, and the enhancement of soil organic matter and biological activity are key strategies therefor.

3.2.2 Farming Practices

Organic farmers build up soil organic matter and nitrogen by including green manure crops, fodder crops and/or sown pastures (leys) in their crop rotations. Green manure and fodder crops are usually legumes, and pastures include legumes, which increase organic matter and nitrogen in the soil through natural decomposition or being ploughed in. Nitrogen is also provided by animal manures, either imported to the farm or from grazing animals.

Examples of rotations used by Queensland organic farmers are presented in Tables 1 and 2. Legumes used include medic, lablab, fenugreek, mungbean and soybean. Medic is a short plant that can be sown along with a cereal such as wheat or barley, and grazed after harvest along with the cereal stubble. Lablab and fenugreek are primarily green manure crops, while mungbean and soybean are grown for grain but could be ploughed in if grain production was poor because of drought or other problems.

TABLE 1. EXAMPLES OF CROP ROTATIONS USED ON THE ORGANIC GRAIN PROPERTY `HEREWARD', DALBY, AND ON CONVENTIONAL FARMS IN THAT AREA (Wylie and Powell 1990)

Year	Season[1]	Hereward		Conventional	
		A[2]	B	A	B
1	W	Wheat/Medic	Barley/Medic	Wheat	Wheat
	S	Lablab	Lablab	Fallow	Fallow
2	W	Medic	Medic	Fallow	Fallow
	S	Fallow	Mungbean	Sorghum	Sorghum
3	W	Wheat/Medic	Fallow	Fallow	Fallow
	S	Fallow	Sorghum	Sorghum	Sorghum
4	W	Barley/Medic	Medic	Fallow	Chickpea
	S	Mungbean	Mungbean	Fallow	Fallow
5	W	Medic	Fallow	Wheat	Wheat
	S	Fallow	Sorghum	Fallow	Fallow
Estimated Nitrogen Balance kg/ha		**-7**	**-26**	**-256**	**-226**

1. W - Winter; S - Summer
2. A - 4 crops in 5 years
   B - 5 crops in 5 years

TABLE 2. EXAMPLES OF CROP ROTATIONS USED ON THE ORGANIC FARM `KIALLA', GREENMOUNT (NEAR TOOWOOMBA), AND CONVENTIONAL FARMS IN THAT AREA (Gaffney 1990 and Wylie and Powell 1990)

Year	Season	Kialla		Conventional	
		A	B	A	B
1	W	Oat/Medic	Rye/Medic	Barley	Wheat
	S	Lablab	Soybean or Mungbean	Sunflower	Sunflower
2	W	Wheat/Medic	Wheat/Medic	Fallow	Fallow
	S	Buckwheat	Mungbean	Sorghum	Sorghum
3	W	Fenugreek	Fenugreek	Chickpea	Fallow
	S	Millet or Soybean	Sunflower or Maize	Fallow	Maize

3.3 Pest Management

A surprisingly large array of approaches is available for the management of pests without the use of synthetic pesticides. The term "management" is used rather than "control" to emphasize that eradication of pests is not generally feasible (it is virtually impossible even with chemicals). Instead, once a pest is present it is much simpler to manage (or even exploit) it, in part so that a population of its natural enemies may also be sustained.

Expenditure on pesticides is related to the anticipated value of the crop. Fruit, vegetables, sugar cane and cotton are high value products and their pest control aproaches are the most dependent on chemicals. Broadacre crops are sprayed less often, with those in more favourable environments more likely to receive pesticides than those in marginal, lower yielding areas. Thus the changes in farming practices required to avoid the use of chemicals may be relatively large or relatively small.

The most common groups of agricultural pests are weeds, insects, larger animals and plant diseases. Various examples of control measures are described below, and it is clear that many management approaches apply to more than one category of pest. In general the testimony of organic farmers is that the combination of non-chemical methods is successful in the majority of cases, and the occasional failure is both a learning exercise and an opportunity to plough some more organic matter back into the soil.

During this century, **weed control** has seen two major shifts in emphasis, especially in broadacre farming. Firstly, with the advent of the tractor and its implements, cultivation became the key strategy for weed control. More recently, the focus has moved (but not completely) to the use of herbicides. Herbicides have several advantages in that they avoid the adverse effects of tillage, which include compaction of the subsoil, loosening and exposure of the surface (increasing vulnerability to erosion), and evaporation of soil water that might otherwise have been available to subsequent crops.

To avoid these problems, organic farmers use a judicious combination of cultivation and other approaches, many shared to some extent with conventional farmers. Crop and livestock rotation (a sequence in time of varying crops, fodders and livestock on the one area of land) are key strategies. Weed species germinate at different times of the year, so a field may be ploughed or grazed in one season to minimize weed germination in a crop planted in that season the following year. Animals may also be introduced after harvest to eat both weeds and any crop missed by the harvester. Dense planting may be used so that germinating weeds are shaded out by the developing crop. Finally, in many situations the task may be achieved by walking through the crop with a hoe.

As the degree of **insect** attack varies widely between crops, the first insect management strategy of many organic farmers is simply to avoid growing crops known to suffer a high level of damage in their area. The second is to tolerate some damage, in order to maintain populations of natural enemies, and because some loss of income from the crop is recompensed through not purchasing insecticide.

Farming practices can be an important part of insect management. Examples include crop rotation to prevent the buildup of particular insects, selection of sowing times to avoid peak insect activity, removal of weeds and crop waste that might harbour pests, and growing trees to encourage natural predators such as birds and other insects. Predators and parasites may be released, and many are commercially available, including mites, insects and diseases. On conversion to organic farming, insect damage may be relatively severe for the first one or two years until these natural enemies are established.

Chemicals extracted from plants or animals may be used to repel or attract (to traps) insects. Some organic farmers will use these natural chemicals or extracts such as garlic concentrate as insecticidal sprays. One of the most promising is azadirachtin, an extract from the seeds of the neem tree, a native of India but well-adapted to parts of North Queensland.

Insect damage is a major problem of grain in storage. Organic control methods include modified atmospheres (adding nitrogen or carbon dioxide or eliminating humidity) and temperatures (high and low).

Many documents written in support of organic farming include the claim that insects are less attracted to organically-grown crops, possibly because the plants do not contain high concentrations of elements such as nitrogen supplied in fertilizers (e.g. Wynen and Fritz 1987, Austin 1989). Many organic farmers cite anecdotal experiences in support of this claim, but there appears to be little scientific evidence available one way or the other.

Fungicides are mainly used against **diseases** of high value crops. The main defence for most crops is resistant varieties, while cultural controls such as crop rotation and avoidance of sensitive crops are also effective. There is some evidence that high levels of soil organic matter encourage the growth of fungi that attack the species that cause plant disease (Wynen and Fritz 1987).

4. EVALUATION OF ORGANIC FARMING

4.1 Comparisons with Conventional Farming

The most obvious items to consider when comparing organic and conventional farms are productivity (crop and/or animal) and net income, but several other characteristics could also be considered, including energy and labour inputs, nutrient balances, effluents, and regional and national economies. Moreover, comparisons may be simulated, using average yields and incomes, or based on actual farm production.

The examples which follow are from both overseas and Australia. The former are broader in scope, while the local comparisons are more at the individual farm level. The general indication is that organic farming compares very respectably with the current chemical-based alternatives. However local information is important in specific cases because a crop grown successfully by organic methods in one locality may suffer a particular insect or disease problem in another.

Stanhill (1990) compared 205 published comparisons of productivity from experimental studies in various countries. The yields under organic conditions ranged between 50% and 150% of those produced under conventional conditions, with an average of 91%. Organic yields were higher in about one third of cases.

For a simulation of energy and labour inputs on farms in the USA (Pimentel *et al.* 1983), yields of organically-grown maize and wheat were assumed on the evidence available to be 1% and 4% lower than those of conventional crops. Organic systems were then estimated to require 22-49% more labour input per unit of production than conventional ones, but to result in 29-70% greater productivity per unit of energy input. Energy input includes both that used on the farm (electricity and tractor fuel) and that required for the manufacture and transport of physical inputs such as fertilizers and pesticides. Another study from the USA, based on actual production data for maize and soybean, concluded that the value of production per unit of energy input on organic farms was 2.4 times that on conventional farms (Lockeretz *et al.* 1981).

Wynen and Edwards (1990) compared the actual performance of eight pairs of organic and conventional broadacre farmers in south-eastern Australia, for the 1985/86 cropping year. In that year, organic farmers' average gross incomes were 69% of the conventional farmers', their costs were 59%, and their profits 78%.

Gaffney (1990) prepared budgets based on anticipated yields for four-year rotations on simulated organic and conventional farms in three areas of the Darling Downs. Table 3 provides a summary of these. On the assumptions used, which did not include a price premium for organic produce, the organic farming rotation produced a higher net income at two of the three locations. Gaffney commented as follows:

"1. The problems with these comparisons are -

* the results are highly dependent on the yields, prices and costs assumed, different assumptions give quite different results.

* the long-run steady states are compared. There is no indication how best to implement the change [from conventional to organic farming], or the order of cost involved.

2. That said, the comparisons do indicate the order of cost and income associated with adoption of organic farming and reveal that they can be comparable with the conventional systems. They also provide concrete examples of what precisely an organic farming system looks like.

3. The overall conclusion must be that `organic farming' is no longer the exclusive province of weirdos and eccentrics. As a topic, it clearly warrants the serious attention it is receiving at this conference."

TABLE 3. ECONOMIC COMPARISONS FOR SIMULATED CONVENTIONAL AND ORGANIC FARMS AT THREE LOCATIONS ON THE DARLING DOWNS (From Gaffney 1990)

Farm Location and Type[1]	Gross Income	Fixed Costs[2]	Variable Costs[3]	Net Income
1. Eastern Highlands				
Conventional	120,000	63,000	32,000	25,000
Organic	123,000	69,000	20,000	34,000
2. Central Downs				
Conventional	210,000	62,000	105,000	43,000
Organic	183,000	67,000	83,000	33,000
3. Western Downs				
Conventional	230,000	70,000	134,000	26,000
Organic	208,000	70,000	108,000	30,000

Note: [1] Farm Sizes (ha):

	Total	Cultivation
Eastern Highlands	400	240
Central Downs	500	500
Western Downs	1,200	800

[2] Fixed costs include depreciation, rates etc. not related to crop and animal production.

[3] Variable costs include seed, chemical etc.

Wylie and Powell (1990) also published estimates for organic and conventional farms on the Darling Downs, based on different rotations covering five years. Organic wheat was priced at $135 per tonne, a premium of $20. (Farmers are currently receiving up to $180 per tonne because supplies are limited[3].) Except for the rather artificial case where livestock were excluded, organic farms were estimated to be at least equally profitable as conventional farms.

Farmers express several reasons for converting to organic production techniques. Two prominent organic farmers on the Darling Downs both say they were primarily concerned about the fertility and physical character of their soils, and sought ways of overcoming the decline in condition that they were observing (McNally 1990, Von Pein 1990). By contrast, a survey of US farmers indicated that the most common reason for adopting organic methods was a concern about the usage of chemicals (Lockeretz *et al.* 1981). While there are no doubt Australian farmers with the same concerns, the difference in primary motivation in the above examples may reflect the fact that chemical usage on grain farms is much lower in Australia than it is in the USA.

4.2 Criticisms of Organic Farming

Criticisms of organic farming have come from researchers and farmers in areas where major pest problems currently require chemical control, and/or soil nutrient deficiencies are overcome by fertilizers, and, not surprisingly, from manufacturers and suppliers of agricultural chemicals. A summary of these criticisms was presented by the Agricultural and Veterinary Chemicals Association of Australia Ltd. in its submission to the Senate Select Committee on Agricultural and Veterinary Chemicals in Australia (AVCA 1989).

Briefly, the major points are as follows:

(a) The lower yield from organic farming would result in a significant world-wide food shortage, increased cultivation, and for Australia, an estimated loss of export income of $2 billion annually (or around 13% of the value of agricultural exports).

(b) Poorer quality and shorter shelf-life would exacerbate the problem of lower yield.

[3] **Queensland Country Life** 12 April 1990

(c) Production of some crops would cease because pest losses would be severe without chemicals.

(d) In many cases there are no other means of avoiding the suffering of animals that results from the attacks of parasites and diseases. Major examples in Australia include blowflies, gut worms and heart worms.

In summary, the AVCA says that routine sampling of foods for residues reveals levels below maximum residue levels in over 99% of cases, and that there is no evidence of health problems from residues at these levels. They agree that farmers should be free to farm organically to meet genuine demand but assert that the additional costs and possibly reduced food range associated with organic farming should not be imposed on the community in general.

4.3 Advantages and Disadvantages

This section summarizes the advantages and disadvantages that have been claimed for organic farming.

Advantages

1. Enhancement of soil fertility through high organic matter levels.

Strictly speaking, soil fertility can only be maintained if nutrients removed in crop produce are replaced, for example in the form of manures or ground rocks imported to the farm. In practice, the available levels of most nutrients appear to be sustained in biologically active soil through the gradual breakdown of soil minerals and underlying rocks, and nitrogen can be enhanced through green manure legume crops.

2. Minimization of land degradation through erosion and salinization.

Erosion has been shown to be reduced on organic farms through higher soil organic matter content, and protection of the soil by green manure and fodder crops. Tree planting (practised by many farmers but particularly encouraged by organic farming groups) potentially reduces both erosion and salinization.

3. Elimination of possible health and environmental problems associated with agricultural chemicals.

Whether the allowable residue levels (termed Maximum Residue Limits, MRLs) associated with recommended applications of many agricultural chemicals cause potential or actual health problems is a contentious issue. But problems have occurred with illness in operators, crop damage and illness from spray drift, surface and groundwater pollution, accumulation of residues in animal tissues, development of pesticide resistance in target species, and residue levels in produce unacceptable to importing countries.

4. Financial benefits to farmers.

These include avoidance of the costs of pesticides and price premiums on organic produce. There is also a potential national benefit through export of organic produce. However price premiums will dissipate as more and more farmers produce organically.

5. Labour requirements.

The higher labour requirements on organic farms (for hand weeding, animal husbandry, etc.) could mean a smaller average farm size and more farms, or more employment opportunities in rural communities, in either case less urbanization of the population.

6. Research incentives.

Increased demand for organic produce and pressure from organic farmers will lead to increased research in areas such as biological control of agricultural pests and composting and recycling of biological wastes.

Disadvantages

1. Inability to grow certain crops.

Particular crops may not be able to be grown organically in some areas because insects or weeds cannot be controlled without pesticides. Examples include cotton, tomatoes and some legume crops (chickpea, pigeonpea) which can be completely destroyed by insects. There have been cases however when a persistent organic farmer has been able to grow a crop which was previously considered impossible.

2. Decreased production.

The overall production from organic farms is generally lower because of the use of the land for green manure crops part of the time, and in some cases lower yield. Currently most individual farmers are compensated by lower costs and higher unit prices. On the national level, food supplies would not be threatened but export income from major commodities such as wool, wheat and sugar would probably drop if the majority of produce was organic, because production would be reduced but the volume would still be sufficient to eliminate any price premium. On the other hand many enterprises specializing in animal production, eg dairying, report that productivity is higher under organic conditions (Stanhill 1990, Vonhoff 1990).

3. Limited sources of organic material

The costs of transport and application of manures and other biological wastes can be considerable because of their bulk, and often only farmers relatively near to sources can make use of them. Supplies can be limited and in some cases are seasonal. However more biological wastes will become available as disposal problems grow and technology is developed to enable processing of wastes into concentrates that can be transported more economically.[4] On the other hand some wastes contain chemical residues which would preclude their use on organic farms.

4. Increased cultivation.

Where increased cultivation is necessary for weed control without herbicides, associated problems may arise including soil compaction and increased erosion, along with the additional costs associated with operating the machinery.

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[4] Such a process has been developed in Brisbane for abbatoir waste. The fertilizer value of the product is curently being tested and venture capital sought for commercial development. **Queensland Country Life**, 24 May 1990.

5. Infertile soils.

Most succesful examples of organic farming have come from areas of inherently fertile soils, such as the Darling Downs in Queensland. Less fertile soils may not be able to provide sufficient nutrients through natural decomposition alone, and may require regular inputs of nutrients in some form, or their productivity may be limited if the farmer is unaware of the potential deficiencies or is unwilling to correct them through outside sources.

6. Blemished food.

Organically-grown foods may be blemished or damaged by insects and diseases, which may decrease the price obtainable or cause consumers to avoid those foods completely. Inconsistency of supply is a related problem, because pest levels can vary considerably with climatic conditions from year to year. Some organic produce is said to have improved keeping quality, but shelf-life will be shorter than conventional produce if it has been damaged and/or if post-harvest diseases occur.

7. Competition for land.

Because productivity per unit of land is lower in organic systems, more land is needed to produce the same amount of food. This may lead to increased destruction of native forests, particularly in developing countries where pressure on land and food supplies is greatest. This point has been argued by Adams (1990).

8. Loss of employment in chemical industries.

Agricultural chemical companies employ and support significant numbers of people in the manufacture, distribution, marketing and application of their products. Agricultural chemical suppliers in rural areas provide other services including equipment, spare parts and seed but chemical sales are their major source of income. The factory value of agricultural chemicals sold in Australia in 1989 was approximately $600 million[5] and the flow-on value to the economy may be five times that amount. On the other hand, most chemicals are imported into Australia in the active ingredient form and only packaged here so a significant proportion of their value would be lost overseas. Further, the rural suppliers could become involved in the marketing of organic products such as waste concentrates and natural pesticides, although the same level of employment may not be able to be supported.

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[5] Source: Agricultural and Veterinary Chemicals Association

5. GOVERNMENT INVOLVEMENT IN ORGANIC FARMING

5.1 Regulation

Most regulatory interest in organic farming lies in the labelling, marketing and testing of produce. Regulation of farming activities is limited to registration of organic pest control agents (biological control organisms and natural pesticides), and matters that concern all farmers, such as statutory marketing and catchment soil erosion control programs (where they exist).

The National Health and Medical Research Council sets Maximum Residue Levels for chemicals in all produce, and the State Goverments conduct random sampling and residue analyses. In principle, organic produce should not have any residues, but there is no reason why it should not be included in testing programs. In Queensland, sampling may be conducted where illegal or fraudulent chemical application is suspected, and this could include produce labelled organic.

Labelling of organic produce is a major concern, not least with the recent finding in Melbourne of chemical residues in a range of "organic" produce.[6] Most consumers are also unclear of what the label "organic" on a product really means and certainly have no way of confirming that the claim on the label is valid. Moreover, any nation purchasing "organic" produce from Australia would have to be confident that our labelling was scrupulously reliable.

The national organic farming organizations and various governments are aware of this problem. A Queensland Government Green Paper in March 1989 on a review of regulations under the **Fruit and Vegetables Act 1947-1988** said

> "With the market for `organically' produced fruit and vegetables increasing it is proposed that producers and consumers be protected by defining the circumstances under which terms such as `organically grown' may be used in association with fresh produce."

[6] Sunday Sun (Brisbane) 24 June 1990.

The three main national organic farming associations who have independent certification systems are the Biological Farmers of Australia (BFA), the Bio-Dynamic Agriculture Association of Australia (BDAAA), and the National Association for Sustainable Agriculture Australia (NASAA). At May 1990, BFA had around 54 full and 350 associate members, BDAAA around 600 members, and NASAA had 25 affiliated organizations, representing about 5000 individuals, and 670 associate members. A brief outline of their certification schemes and logos is given in Figure 2. Currently, the Australian Quarantine and Inspection Service permits the use of the term "organic" on export produce only when it has been certified by one of the national associations.

In February 1990 the Federal Minister for Primary Industries and Energy formed the Organic Produce Advisory Committee (OPAC) to develop a national standard for organic produce. The committee consists of the three organizations mentioned above, together with the National Farmers Federation, the Australian Federation of Consumer Organizations, and the Standing Committee on Agriculture. The secretariat is based in the Australian Quarantine and Inspection Service.

OPAC published a draft Australian Standard for Organic and Bio-Dynamic Produce in December 1990. The draft is being circulated for public comment until 31 March 1991 after which OPAC intends to publish the formal Standard. The draft Standard includes production requirements, labelling, certification and inspection.

Briefly, key points in the draft Standard include the following:

(1) No synthetic chemicals or ionising radiation may be used on the crop or the produce at any stage of growing or processing, and the land or other crops on it must not have had any such application for three years prior to harvesting. Any processing equipment must be used exclusively for organic produce. Animals may only be given feedstuffs produced according to the Standard, except under certain circumstances in limited quantities.

(2) All crops and produce must be certified by an organization that is approved by OPAC. Requirements for approval include that the organization must have an inspection and sampling program, and compliance and punishment procedures.

(3) All produce must be labelled to indicate the name and address of the producer or processor, and the name of the certifying organization, but the label may not otherwise indicate or imply that the product has superior nutritional, health or sensory qualities.

(4) Producers must keep records of all inputs applied and all produce sold so that the source of any contamination can be traced.

The draft Standard does include potential for variability in two key areas:

(1) The label must include a word such as "organic" or "bio-dynamic" to indicate the method of production, but no particular word or words are specified. Rather, any word "of similar intent" may be used, which is likely to lead to confusion for consumers.

(2) Although the procedures of the certifying organizations must be approved by OPAC, there is no requirement for them to be standardised. Thus, there may be variation in the frequency and conduct of inspections and sampling, and in procedures dealing with infringements of the Standard. The Standard mentions the possibility of unscheduled inspections but gives no guidelines on their conduct. Further, the certification organization may reduce or extend the three year conversion period for an individual farmer at its discretion.

The draft Standard also includes a list of natural soil fertility and pest control products which may be used on organic farms. Curiously, genetically engineered material is precluded. This will prevent the use of several biological control agents currently being developed. Contradictions will arise such as in the use of a bacterium, *Bacillus thuringiensis*, which controls certain pest caterpillars by producing a toxin after being eaten by the caterpillar. Live bacteria are available in a form that may be sprayed onto crops, including organic ones. The isolated toxin is also avaiable but that is produced by a genetic engineering process (Fritz 1989), and so forbidden under the draft Standard. Other insecticidal toxins isolated from plants, including pyrethrum, neem and rotenone, are permitted, because their manufacture does not involve genetic engineering.

Internationally, the principal co-ordinating and regulating organization is the International Federation of Organic Agriculture Movements (IFOAM), whose headquarters is in Germany. It has around 300 member groups from 60 countries. IFOAM has devised a basic standard for production, inspection and certification of organic produce which was used in formulating the draft Australian Standard.

Several countries have regulated national standards for organic produce, including New Zealand, United Kingdom, Canada, Netherlands, Sweden and Austria (AQIS 1989). The European Community is currently developing proposals for uniform regulation and the Australian draft Standard has been prepared to conform with the latest EC proposals, important because the EC is likely to be a key export market for Australian organic produce.

The US has no uniform standards although in 1979 California was one of the earliest legislatures to enact statutes regulating labelling standards for organic produce, and several other states have since followed suit. In November 1990 California voted on a citizen-initiated referendum dubbed "Big Green" which proposed several environmental initiatives including severe restrictions on the use of agricultural chemicals. Despite general preferences for residue-free food similar to those expressed in the Australian survey mentioned in the introduction to this BIB, the Californian proposals were defeated, apparently because the scope of the Bill was so wide-ranging that the costs in terms of food prices and job losses were considered to be too high (Anon 1990).

5.2 Research and Promotion.

Various State Governments offer research or advisory support to organic farmers. Victoria and New South Wales have each appointed a full-time organic farming specialist. In Victoria, the Organic Farming Project is one part of the Clean Agriculture Program which is investigating a range of measures aimed at reducing chemical usage and land degradation. Similarly, the Queensland Department of Primary Industries' emphasis is on "sustainable agriculture", in which minimization rather than elimination of chemicals is stressed as part of a range of conservationist farming practices, rather than on organic farming *per se* (Behncken 1990). Queensland's major research initiative is in reducing insecticide use in vegetable production, based at Gatton Research Station. However several other research programs are relevant to organic farming, including studies of stubble management, crop rotations, integration of crops and livestock, and biological pest control.

Overseas, governments are undertaking a range of research and promotion activities. Most notable are programs in Denmark, Sweden and Norway in which those governments provide grants of up to $520 per hectare to assist farmers to convert to organic production.

The Senate Select Committee on Agricultural and Veterinary Chemicals in Australia (1990) presented the following conclusion on organic farming:

> "10.48 Although practised by only a very small percentage of producers, the Committee considers that organic farming methods have a legitimate role to play in Australian agriculture. Evidence to the Committee indicates that there is an increasing demand for agricultural produce which has been grown organically. There is also an increasing number of growers investigating the feasibility of organic production and in some cases converting to organic methods. Other farmers are adapting particular organic techniques while still using some farm chemicals judiciously. The Committee understands that this interest in organic farming techniques is being reflected in government research and extension programs. In the Committee's view, the Commonwealth Government, through the Rural Industry Research Fund and other agencies, is well placed to take a leading role in research into and the development of organic farming methods and sustainable agricultural systems.
>
> 10.49 *The Committee recommends that the Commonwealth Government, through its various research and funding agencies, extend research and development of organic farming methods and sustainable agricultural systems."*

6. STATUS AND PROSPECTS OF ORGANIC FARMING

6.1 Australian Statistics

There are no official statistics kept of organic farming in Australia, partly because of the lack of precise definitions of organic farms and organic produce. At the end of 1989 it was estimated that there were between 980 and 1510 organic farmers in Australia, with a mid estimate of 1260, or 0.8% of all farmers. For Queensland, the mid estimate was 124, or 0.4% of farmers. The area farmed using organic practices was estimated at 117,000 to 340,000 hectares, with a mid estimate of 183,000 hectares, or around 0.14% of total farm area outside the pastoral zone (RIRDC 1990).

Based on a smaller sample (those growers registered with one organization, NASAA) the majority of organic growers (88%) produce horticultural crops, with relatively small numbers in broadacre farming and livestock (8% and 4% respectively) (see Table 4).

The volume of production is difficult to estimate, but the value of organic produce sold in the capital city markets including Canberra was estimated to be $28 million in 1989/90, or around 0.13 percent of total market sales (RIRDC 1990). The highest market share, 0.2 percent of sales, was recorded in Melbourne/Geelong.

TABLE 4. NUMBER AND AREA OF FARMS REGISTERED WITH NASAA AT MAY 1990 (RIRDC 1990)

Farm Type	Number	Total Area (ha)	Area Certified (ha)
Queensland			
Broadacre	1	16 187	3 156
Horticulture	13	714	565
Livestock	-	-	-
Total	14	16 901	3 721
Australia			
Broadacre	15	32 876	10 508
Horticulture	159	5 064	2 717
Livestock	7	531	523
Total	181	38 471	13 748

6.2 Production Prospects

Agricultural consultants Hassall and Associates estimate that by the year 2000 organic produce could account for up to 3 percent of food sales in Australia (RIRDC 1990). Up to 8000 farmers, five percent of the total, could be organic producers by then, farming up to three million hectares, or 2.5 percent of agricultural land. Wylie and Powell (1990) consider that the true number of current organic farmers is only around 25 percent of that estimated by Hassalls, and therefore that their future estimates are likely to be similarly excessive. The Hassall estimates could perhaps be considered as an upper limit.

Several factors are likely to limit the growth of organic farming. According to Wylie and Powell, the most serious of these is the lack of detailed and substantiated information available to farmers who are contemplating changing their farming system. Nevertheless, a small number of organic farmers are producing successfully in almost the entire range of agricultural enterprises in Australia, and their experience may be sufficient to encourage others to start.
The other serious limitation is the likely loss of income, at least in the transition period, when natural soil fertility is being built up and farmers are learning which crops are most likely to be successful in their area under a natural pest control regime.

Marketing will have a major influence on production growth, in a manner that could be described as chicken-and-egg. Farmers naturally rely on markets for their produce, and growth in production depends on their confidence in the market. But the true level of demand, in terms of both volume and price, will only be known once the production is there to test it.

6.3 Marketing Prospects

The domestic and export markets are distinct potential destinations for organic produce. The export market is potentially larger, but more difficult to access. The most promising importers are European countries including the UK. The markets in those countries are considerably larger than in Australia, possibly because of greater awareness of pollution including fallout of radioactive materials. In the UK, several supermarket chains are active in purchasing and marketing organic produce, and one large marketing company alone expects to have five percent of the total food market by the end of the century (Bryant 1990).

Along with the potential for export markets are several limitations. Not least of these is the growth of organic farming within Europe. In Germany alone, up to 20 percent of food production could be organic by 2000 (RIRDC 1990). In Denmark and Sweden, farmers are offered government grants to convert to organic farming. Competition will also come from countries such as New Zealand, which has had a national certification scheme and promotional program in place for several years. Other severe limitations include the necessity for reliability in supply and quality, and the nascent nature of our certification procedures (AQIS 1988). These problems notwithstanding, an infant export program from Australia is currently worth $1 million per annum and growing.

Perhaps the only agreed fact about the domestic market is that demand currently exceeds supply. The big question is to what extent the 83% of people who said they would pay extra for organic produce (see Introduction) would actually do so if it was readily available, and the supplementary question is how much of a premium they would pay. Current experience is that consumers resist paying more than a 35% premium, and in the long term, stable premiums of 10-30% are predicted (RIRDC 1990). The bulk of consumers are also likely to resist organic produce if it is overly blemished, ungraded and/or poorly packaged, so organic producers can take several steps to improve the marketability of their produce. However consumer behaviour may change quite rapidly. It may only take one or two new discoveries of residues above legal limits or potential health problems from a widely-used chemical to precipitate a rapid change in consumers' willingness to search out and purchase organic produce.

Probably the most likely medium-term scenario is that supply will increase at a conservative rate and demand will at least parallel that increase and possibly exceed it. It is the uncertainty facing farmers of techniques, productivity, markets and finally income that will constrain growth in organic farming for the time being. However that uncertainty could be supressed if or when the incentives (financial and other) for organic farming become sufficiently high.

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