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Organic horticulture: strategic opportunities in Western Australia

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organic horticulture

Strategic opportunities for Western Australia

prepared by Steven McCoy

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Executive summary

This report considers the potential to develop organic horticulture in WA. The study examines key factors limiting industry scale and scope and identifies preferred soil types, regional locations, prospective crops and potential scale where organic production may offer comparative economic advantage.

Multi billion dollar organic markets are a rapidly expanding sector of the food industry in affluent consumer markets notably the USA, Japan, UK and many EU countries. The growth in organic production is driven primarily by consumer concerns about conventional agricultural production methods and resultant food health and safety scares and environmental problems. These problems have undermined consumer trust in the conventional farming systems and regulation of food production.

Agriculture in Western Australia has yet to develop significant supply capability in order to capture a share of this expanding organic market opportunity.

A key factor limiting the total area of organic horticulture in Western Australia is provision of adequate nitrogen for productive profitable crops. The provision of nitrogen to crops in organic systems is further constrained by the organic standards and certification requirement to adopt a biological approach to feeding soil and plants. This sophisticated indirect approach to feeding plants provides the essential mechanism for simultaneously achieving the key aims of organic agriculture.

Nitrogen self-sufficiency within an organic system is generally not possible. The need for off-farm nitrogen supplements varies according to horticulture crop type and rotational system. Mixed arable / livestock enterprises and perennial horticulture (orchards) have lower dependence for off-farm nitrogen materials than annual horticulture (vegetables) with limited land. The integration of animal / pasture production into vegetable rotations can reduce the demand for off-farm sources of nitrogen.

Soil type can also influence nitrogen use efficiency and gross demand for off-farm sources of nitrogen. In general, loamy soils are likely to be preferred initially, compared to sandy soils due to:

- less total N input required due to less N leaching losses and better water-holding properties;
- greater propensity to accumulate organic matter (OM);
- better accommodation of biologically driven soil fertility functions;
- higher N fixation and biomass production capacity;
- increased capacity to store excess N.

Locations where these preferred soil types predominate are mapped and include areas around the regional centres of Geraldton, Moora, along the Darling Scarp from Gingin to Harvey, Donnybrook, Manjimup and Walpole. Kununurra and Carnarvon are also identified.

Efficient use of limited nitrogen materials suggest intensive vegetable production with high demand for off-farm nitrogen should predominate on the better loamy soil types, whereas the relatively low nitrogen demanding perennial fruit trees may be located on the poorer sandy soil types. The implication here is that sandy soils on the Swan Coastal Plain may be better used for orchards than vegetables as strategy for optimising nutrient and water use efficiency and minimising nutrient pollution.

The main sources of nitrogen used in organic systems according to organic principles and standards are as follows in order of priority:

1. Legume N fixation
2. Green manure incorporation
3. Composted materials / animal manure
4. Nitrogen supplements

Major source materials for nitrogen supplement identified are animal manures and by-products of animal processing. Compost and other sources of plant protein also can contribute useful quantities of nitrogen. Total volumes of nitrogen provided by these materials are estimated to be in the order of 15,000 tonnes of nitrogen per annum. However, the availability of these materials for horticultural industry depends on price and demand by other buyers competing for the same material, especially by animal feed supplement users.

Cost of the N component from these materials varies widely from a range of around $700 / t of N to over $6500 / t of N – the lower cost generally being for bulky animal manure that will require additional costs for composting and transport.

The estimated gross potential area for organic horticulture – based on 4500 t of N/yr (30 per cent of total N identified) – ranges from about 4100 ha for intensive vegetables with high N requirement, to 90,000 ha for perennial fruit trees with low N requirement.

In general terms organic fruit production – based on conventional N levels – can potentially occupy around five to ten times more land area than organic vegetable production for the same amount of input N material.

The regional breakdown of this total area for organic horticulture is difficult to estimate. Majority of nitrogen materials are found around Perth and south to Bunbury. However, some of the high analysis materials like bloodmeal and other high protein materials or composted pelletised poultry manure, etc. may be economically transported to other regions. Bulky materials like compost and animal manures are likely to suffer prohibitive transport costs beyond their regional source.

Prospective crops for organic horticulture are determined using a range of selection criteria, including pest and disease problems, nitrogen demand and market prospects. The following crops were identified as having potential for development.

- Mango
- Olives
- Apples
- Plums
- Grapes
- Citrus
- Carrots
- Melons

Regional locations were also assessed for organic opportunities using a range of selection criteria, including existing horticulture industries, available nitrogen material and interest or activity in organics. Key regional centres with good opportunity for organic horticulture are Harvey (South West Irrigation Area), Perth, Gingin, Manjimup and Kununurra.

The economic relevance of developing organic horticulture in Western Australia is dependent in part on the crops grown and the scale of industry development. Initial targets for organic horticulture should focus on perennial orchard crops and livestock / vegetable rotations situated on the better loamy soil types. The potential scale for organic horticulture is most significant in the Perth region and the Harvey SWIA region. Gingin and Manjimup also have considerable potential especially for orchard production, while organic mango and grapefruit production at Kununurra could potentially cover a significant area.

A number of economic and strategic benefits, additional to private financial returns, indicate that investment in organic horticulture can provide flow-on value to conventional horticulture in terms of systems innovation, market positioning and environmental performance. Increased labour requirements and opportunities for developing high value organic products can contribute to economic development in regional communities, particularly for family farms where increasing management efficiency is possible but increasing scales of efficiency may be difficult.

Background

Consumer demand for safe, healthy food grown with care for the environment has driven the market for organically grown products to expand rapidly (McCoy 1998; Willer 2000; Organic Monitor 2002). World trade is estimated to be valued at US$26 billion in 2001 and has displayed annual growth of 20–30 per cent for the past 10 years in the main markets of Europe, USA and Japan. Western Australia can capture a share of these rapidly expanding markets while at the same time enhancing a regional image of clean and green agriculture.

Conventional agriculture is highly dependent on non-renewable resources namely, chemical fertilisers and pesticides. A growing segment of people in the world, including farmers, are questioning the chemicals and management systems used in conventional agriculture and the impact on their environmental, economic and social well-being. Consequently many individuals are seeking alternative practices that would make agricultural productivity more sustainable. Organic agriculture aims to reduce reliance on high levels of fertiliser and chemical inputs.

The development of organic agricultural systems that function in a profitable and sustainable manner within the constraints of the relatively infertile nature of many Western Australian soils appears impractical. Provision of adequate plant nutrition without the use of chemical fertilisers, suggests both unprofitable low yields and a longer-term depletion of soil nutrient pools. Yet an increasing number of professional primary producers in Western Australia are showing interest in organic systems of production. Indeed, Western Australia already has about 120 certified organic operations, including examples of productive, profitable organic farms in most agriculture sectors. Farmer interest in biological approaches towards management of soil conditions and fertility is confirmed by the large number of growers attending field days and talks by proponents of biological methods. However, scientific understanding and validation of some of these biological methods for Western Australian conditions requires further independent investigation.

One issue of concern is the impact that these lower input biological methods may have on gross productivity, unit cost of production and the competitive status of Western Australian products on export markets. There is a perception that organic farming may have adverse economic implications for gross agricultural output and contribution to State prosperity compared with the current conventional trend toward high input, high output systems. However, new opportunities are emerging for product differentiation in traditional export markets where there is an identified niche for organic products. Furthermore, non-tariff trade barriers are likely to increase for product from conventional production systems deemed not to satisfy sustainability, environmental and safety criteria.

The eco-efficiency of current conventional agriculture in Western Australia is likely to come under increased scrutiny by trading partners looking for preferred suppliers able to reinforce their triple bottom line credentials. For example, a growing trend by European retailers is the development of common buying policies based on EUREPGAP standards, which prefer sustainable production, efficient water use, reduced nutrient waste and energy waste and improved occupational health and safety. The imperative to apply significant amounts of NPK fertilisers to Western Australia's ancient infertile soils, and reliance on agricultural chemicals, runs counter to global trends away from hot, heavy and wet economies, and towards cool, light and dry economies – cool being more energy efficient, light being less input material needed (especially non renewables) and dry being more water efficient.

With organic farming, the farmer has to manage the farm with coherent diversity by utilising all on-farm and adjacent resources. Organic farming is successful on those farms where sufficient organic biomass is generated in and around the farms (Gaur 2001). Understanding and exploiting the efficiency of biological systems, below and above the soil, forms the basis for optimising the relationship between inputs, productivity and sustainability. Scientific evidence is mounting (Fairweather 2001; IFOAM 2000; Soil Association 2001) that shows, compared to conventional counterparts, organic systems are more energy efficient, rely on less input materials and require less water – i.e. they operate as a cooler, lighter and drier economy.

However, reservations exist regarding limits to the potential scale that profitable organic production may achieve under Western Australian conditions. A key limiting factor is the available volume of acceptable sources of nutrient inputs, especially materials to supplement plant nitrogen requirements.

This report considers the potential to develop organic horticulture in Western Australia. The report identifies preferred land types, regional locations, prospective crops and potential scale where organic production may offer comparative economic advantage and provide a significant contribution to the future value, image and social fabric of horticulture from Western Australia.

Defining organic farming systems

Organic farming is well defined in the National Standards for Organic and Biodynamic produce. The standards, administered by AQIS, form the minimum mandatory requirements for product labelled as organic for export from Australia. The same requirements are used for product labelled as organic for the domestic market, but formalisation of a domestic regulation are still under consideration.

Organic farming is defined (OPEC 2002) as practices that emphasise the:

- use of renewable resources;
- conservation of energy, soil and water;
- environmental maintenance and enhancement, while producing optimum quantities of produce without the use of artificial fertiliser or synthetic chemicals.

Expanding organic horticulture: resource constraints

This section examines the scarcity of certain key inputs that may appear cheap and abundant while the industry is small, but in fact may place an absolute limit on industry expansion.

When an industry expands, unit production costs generally do not remain constant. Sometimes they fall, because of economies of scale in a supplier industry. More often they increase because the expanding industry must entice resources away from another sector of the economy or because inputs are scarce (Oelhaf 1978).

In the case of organic farming, certain climates, soils or regions are more congenial to this system of farming than others for a particular crop. There may also be limits due to the number of people willing to become dedicated to developing organic farming systems.

Changes to pest, disease and weed management may involve cost increase under organic systems. However, the extent of increasing cost depends on technological progress in acceptable control techniques. There appears considerable potential for advancement in these aspects of organic farming.

Nutrient management

To maintain production potential, a long-run equilibrium must be established where nutrient inputs balance nutrient outputs. Once fertile soils have been established, the land may maintain its production potential if all material removed eventually finds its way back to the land. In practice losses occur and suitable materials must replace these losses. Nitrogen is perhaps the most important material that is lost from the system. Organic farmers can use natural forms of phosphate and potassium. However, available input materials that replace lost N can limit the scale of an organic agricultural system capable of maintaining the soils' productive potential in the long run.

Nutrient supply principles: a different approach to soil management

The most distinctive feature of organic farming principles relates to soil fertility management and the supply of nutrients to plants. The guiding phrase 'healthy plants stem from healthy soil' belies the fundamentally different approach to feeding plants.

'Plants grown in organic systems take up nutrients that are released slowly from humus colloids, at a rate governed by warmth. In this system, the metabolism of the plant and its ability to assimilate nutrients is not overstressed by excessive uptake of soluble salts in the soil water (such as nitrates).'

This approach to feeding plants is achieved by ***'management practices that create soils of enhanced biological activity, as determined by the humus level, crumb structure and feeder root development, such that plants are fed through the soil ecosystem and not primarily through soluble fertilisers added to the soil'*** (AQIS 1992).

This approach contrasts sharply with the current conventional approach. Organic farming excludes routine excessive use of highly soluble fertilisers. Ammonium nitrate, urea, superphosphate and many other conventional fertilisers are prohibited from use. In addition, the use of many of the 'natural' sources of nutrients such as animal manures, bloodmeal, mineral bearing rocks like RPR, potassium sulphate, lanbeinite and others are also subject to restrictions based on the organic approach defined above. Therefore it is generally not permitted to simply substitute 'conventional' fertilisers with 'natural' equivalents. For example, routine reliance on applying large quantities of dried blood as a source of N is seen as essentially little different from applying a highly soluble form of N such as urea.

As a general rule nutrient budgeting based on gross input substitution of conventional forms of N,P,K with 'natural' forms of the same does not constitute an organic system.

'Organic farming systems rely to the maximum extent feasible upon crop rotations, crop residues, animal manures, *mechanical cultivation,* ***approved mineral bearing rocks*** *and aspects of biological pest management* ***to maintain soil productivity and tilth, to supply plant nutrients*** *and to control diseases, insects, weeds and other pests'* (AQIS 1992).

Accordingly, the practical farming skills required for organic can be more complex than for conventional methods, and require strong commitment to the organic approach for feeding plants.

The three key platforms for feeding plants are:

1. enhanced biological activity;
2. humus level;
3. crumb structure.

These three features work in concert with balancing the chemical component of soil conditions. Soil and tissue testing can be useful measures to indicate imbalance in soil conditions.

Balancing the chemical components of the soil is a concept that is gaining prominence within both organic and conventional circles interested in biological/ ecological agriculture. Known as the Albrecht model after Dr William Albrecht, the goal of the Albrecht model of balancing nutrients is to create the proper environment for soil biology. This is dependent upon the correct soil chemistry (supplying each nutrient in the proper amount) which influences the physical structure of the soil (Kinsley 2001). Despite conflicting evidence regarding the veracity of the Albrecht model (Schonbeck 2001), the need for adequate and balanced supply of nutrients remains essential for healthy plant growth.

Without these features developed, the simple provision of adequate plant nutrients in the soil water solution alone is unlikely to result in the required biological approach to feeding plants.

A vital concept is to feed the soil, allowing the soil to feed the plant. Essentially the soil can be seen as the plant's stomach. Conventional fertiliser programs are built upon trying to feed the plant directly, they would if possible, by-pass the soil altogether. Creating better conditions for nutrient uptake and building soil fertility requires more than just adding N,P,K.

Why bother with this approach? What is the point or benefit of such an indirect way of feeding plants when we know plants will easily take up N,P,K in soluble form from the soil water? Organic standards indicate that this approach provides the fundamental mechanism of achieving the key aims of organic agriculture as stated (OPEC 2002):

- production of food of high nutritional value;
- the enhancement of biological cycles in farming systems;
- maintaining and increasing fertility of soils;
- working as far as practicable within a closed system;
- the avoidance of pollution resulting for agricultural practices and processing;
- minimising the use of non-renewable resources;
- the co-existence with, and the protection of, the environment.

In other words the main aims of organic agriculture, are derived from this biological approach to feeding soil and plants. This sophisticated approach involves a holistic mix of elements in a management system, designed to provide simultaneous benefits across a range of agricultural objectives.

With organic farming systems, the emphasis for crop nutrition must clearly be on recycling within the system and in particular on maintaining a biologically active soil that can release nutrients from the soil making them available for crop growth. If this can be achieved then dependence on purchased fertilisers, whether mineral or organic can be greatly reduced without necessarily entailing significant yield reductions (Lampkin 1990).

Nitrogen

Of all plant nutrients N has the most significant effect on yield, nutritive qualities, taste, health value, keeping quality, suitability for processing, disease and pest resistance (Koepf 1976), notwithstanding the crucial role other plant nutrients play.

Nitrogen nutrition management is perhaps the most contentious issue in converting to organic farming. Phosphorus can certainly present problems in the short-term when using natural forms of P, but building N reserves is crucial. The reason being that conventional growers know that yield is so often N responsive. Reason suggests the same will hold true for organic – in fact it does (Gaskell 2001; McCoy 2002), however, the source of plant available N is crucial in directing the way plants feed (Podolinsky 1988).

Many different fertilisers are available to conventional growers for overcoming N deficiency. However, organic production avoids excessive use of highly soluble N. Conventional fertiliser sources of N including urea, ammonium nitrate, ammonium sulphate, calcium nitrate, etc. are not permitted. Excessive routine use of 'natural' sources of N such as bloodmeal and other high protein materials are also not permitted – on the basis that essentially these will also provide excessive water soluble N.

In view of the organic approach to feeding plants outline above, the application of artificial highly water soluble N is not considered equivalent to other natural source of N. Natural nitrogen production relates to humus production able to 'hold' natural N – within a soil ecosystem. Reintroducing a natural nitrogen cycle that can meet the needs of a specific soil's biological activity, enabling it to grow a crop, is essential in sustainable organic farming (Morgan 2002). Additions of N rich materials into organic systems are seen as a supplement to, not replacement of, a proper functioning natural nitrogen cycle.

Management of N on the organic farm requires re-establishing the nitrogen cycle based on:

- biological fixation;
- returning all animal manures to the soil in ways that avoid losses;
- reduce leaching by undersowing and using catch crops.

Maintaining adequate N throughout the life of a crop is a major challenge for organic producers especially on coarse textured sandy soils in the establishment years of an organic system. On light, poor sandy soils the build-up of natural N can be slow and difficult and usually requires supplementary sources of N.

Organic management of N involves a number of strategies including:

- enhancing formation of humus and mineralisable forms of organic N;
- rebuilding N levels using legumes and green manures;
- balancing soil conditions (biological, physical and chemical) to enhance N efficacy;

- crop rotation strategies to optimise nutrient pool depletion and minimise losses;
- provision of supplementary N.

In practice the aim of achieving N self-sufficiency on-farm is rarely achieved. Most organic farms depend on purchases of N inputs from outside the system to make up for imbalances or losses in the system itself.

The diagram below shows mixed arable/livestock systems are characteristically on the balanced side of the spectrum of N self-sufficiency, whereas intensive annual horticultural holdings (where land is often limited) tend to be at the high input end.

Perennial horticulture such as fruit trees, typically require less kg N/ha/yr than intensive vegetables, and may provide greater opportunity for organic production where sources of N inputs are limited.

The integration of livestock into annual horticulture rotations can improve N self-sufficiency balance and thereby reduce the system demand for off-farm sources of N inputs.

Farming system spectrum for N self-sufficiency

Balanced system
(low added N input)

Unbalanced system
(high added N input)

Rangeland

Mixed arable/livestock

Perennial horticulture

Annual horticulture with limited land

Soil types and nitrogen input: preferred soils

This section identifies those soil types considered marginally better suited to organic production, specifically relating to the potential to maximise on-farm N balance or self-sufficiency and minimise inputs of N from off-farm materials.

Soil nutrient modelling work by the Department of Agriculture, Western Australia (Bowden 2002) suggests that total nutrient N loads required for equivalent yield would not differ significantly across soil (texture) types given optimal irrigation management. Water management is likely to be the most influential factor in N use efficiency between different soil types due to soil water field capacity and wilting point differences. Nitrogen loss is likely to be greater on coarse textured sandy soils through leaching and reduced uptake due to poor hydraulic conductivity compared to finer texture loamy soils. As a consequence N use efficiency and therefore total N input required for equal yield may be less on loamy soils compared to sandy soils. (Note: The terms sandy soil and loamy soil are used in a generic sense to illustrate contrasting soil textural types.)

In contrast, given organic management aims to increase OM and humus levels in soil, the impact of increased OM for sandy soils is likely to have greater marginal increase on N use efficiency compared to loams – mostly by improving water-holding properties. In other words, for improving N use efficiency, a 1 per cent increase on OM on sand would have greater percentage benefit than a 1 per cent increase in OM on loam. So for equal yield, total N required on sands would drop more rapidly as OM levels increase compared to loam.

However, raising and maintaining higher OM levels on sand is more difficult and can take longer than on loam. Clay particles in loam assist in protecting OM fractions from destruction. Therefore the beneficial effects of higher OM in sandy soils is likely to take many more years to be significant, compared to loam, unless large quantities of compost or other organic material are applied to the soil.

In addition to this problem of slow OM accumulation on sandy soil relative to loam soil, is sandy soils' relatively poor propensity to accommodate microbial populations and activity. Coarse textured sandy soils have small surface area and low cation exchange capacity (CEC) compared to the clay fractions in loamy soils. Soil particles with small surface area and low CEC have limited capability to nurture and maintain high soil biological activity and resultant soil fertility functions compared to loamy soils' clay fraction with large surface area and high CEC. This is also likely to give loamy soils increased capacity to store excess N and other nutrients after cropping, compared to sandy soils.

For loamy soils, faster OM accumulation and greater biological accommodation should also have a compounding effect on stimulating the productivity of legumes and green manure phases used in soil fertility building cycles. Therefore biomass production in general and N fixation via legumes is likely to be greater on loamy soils compared to sandy soils.

Overall, loamy soils are likely to be preferred initially, rather than sandy soils due to:

- less total N input required due to less N leaching losses and better water-holding properties;
- greater propensity to accumulate OM;
- better accommodation of biologically driven soil fertility functions;
- higher N fixation and biomass production capacity;
- increased capacity to store excess N.

Although sandy soils are likely to show greater marginal benefit from each unit increase in OM content than loamy soils, the net nutrient use efficiency and reduction in total N inputs required is unlikely to match that of a well managed loamy soil.

Possible preferred loamy soil types are listed in Table 1.

Sandy soil types characterised by low CEC may be amended to raise the CEC using materials with high negative surface charge. This may improve the net nutrient use efficiency and reduction in total N inputs required, although cost of amendment would require careful consideration. Surface charges of various soil components are listed below.

Soil component	***Surface charge (C mol kg^{-1})***
Humic acid	*-340 to -330*
Vermiculite	*-195 to -124*
Montmorillonite	*-127 to -10*
Smectite	*-117 to -72*
Illite	*-120 to -8*
Kaolinite	*-13 to 0*

Extracted from Bolan (1999).

In general, loamy soils are considered to offer the greatest potential for developing nutrient N input efficient organic horticulture in WA. However, some of these soil types may present difficulties with P lock-up in iron and aluminium complexes.

Location of preferred soil types

Preferred soil types potentially suitable for organic horticulture, as described above and listed in Table 1, can be found in many locations and to varying extent, from small pockets to extensive regions. Map 1, shows where the majority of these soil types can be found. Geographically small pockets are not shown on this map but nevertheless may be large enough to support significant horticultural operations.

A number of major regional centres are situated where suitable soils can be found. These include the following towns:

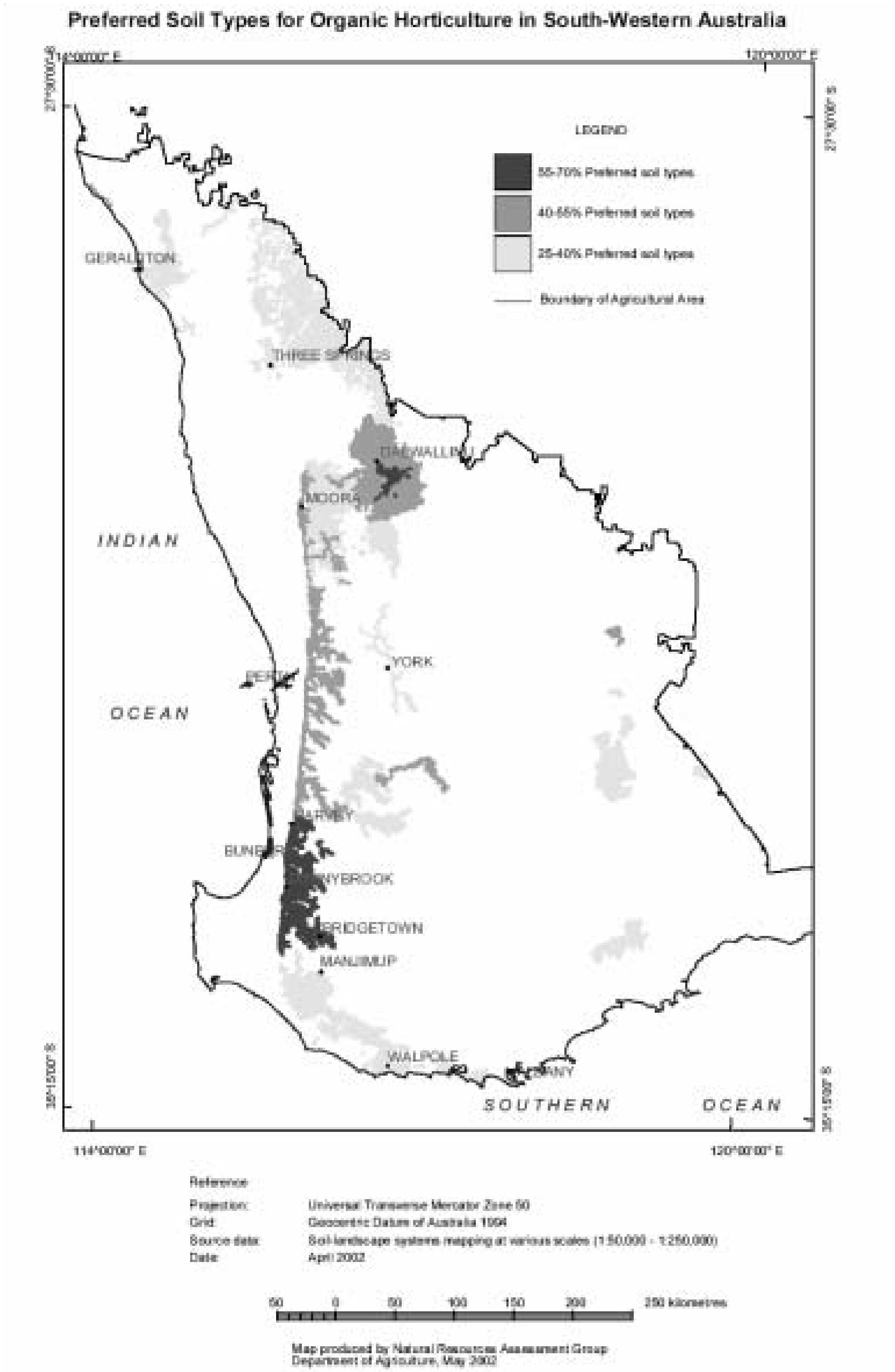
- Geraldton
- Moora
- Gingin east
- Perth hills
- Harvey
- Donnybrook
- Bridgetown
- Manjimup
- Walpole

Carnarvon and Kununurra are also considered to have some suitable soils for organic production. Sandy soils on the Swan Coastal Plain and other locations are not included. However, some of the better sandy soil types containing useful clay fractions, such as the red / brown Spearwood sands may also be considered.

Table 1. Preferred soil types for organic horticulture *(Extracted from Moore 1998; Schoknecht 2001.)*

Soil group	***Possible deficiencies***	***Distribution***	***Aust. Soil Class.***
Loamy surfaced soils			
Friable red/brown loamy earth • *red to brown* • *neutral to acid pH* • *friable topsoil* • *porous throughout* • *gravel may be present*	*P, N, S, Zn, Mo, occasionally Cu*	*South West (Karri loam)*	*Dermosols* *Kandosols*
Brown loamy earth • *brown or grey brown topsoil* • *neutral to acid pH* • *grey-brown phase often mottled* • *often formed in recent alluvium*	*P, N*	*Alluvial flats*	*Tenosols* *Kandosols*
Red loamy earth • *red within top 30 cm* • *usually massive or poorly structured* • *neutral to acid pH, but sometimes calcareous at depth* • *hardsetting or crusting* • *sometimes with red brown hardpan at > 50 cm* • *gravel may be present*	*P, N*	*Northern wheatbelt* *Avon Valley*	*Kandosols*
Yellow loamy earth • *yellow within top 30 cm* • *usually earthy fabric but occasionally well structured* • *neutral to acid pH* • *gravels may be present in subsoil*	*P, N, occasionally Zn*	*South West* *Eastern wheatbelt*	*Kandosols* *Dermosols*
Red deep loamy duplex • *red within top 30 cm* • *subsoil pH neutral* • *firm to hardsetting surface*	*P, N, S*	*South West* *Chapman valley*	*Chromosols* *Sodosols*
Brown deep loamy duplex • *grey or brown topsoil* • *subsoil pH neutral* • *firm to hardsetting surface*	*P, N*	*South West* *Yate loams (south coast)*	*Chromosols* *Sodosols*
Deep sands and sandy earths			
Deep brown sands	*N, P, Cu, Zn*	*Widespread, but of minor extent on valley floors*	*Rudosols* *Tenosols*
Brown sandy earths	*N, P, Zn, occasionally Cu*	*Widespread on alluvial flats but of minor extent*	*Tenosols* *Kandosols*

Cu = copper, S = sulphur, Zn = Zinc, Mo = molybdenum.



Map 1. Location of preferred soil types for organic production in south-west WA.

Nitrogen input: available materials

The major sources of nitrogen used in organic systems according to organic principles and standards are as follows in order of priority:

1. Legume N fixation.
2. Green manure incorporation.
3. Composted materials / animal manure.
4. N supplements.

Composted material and N supplement materials are the two components that can be added from off-farm sources. The National Organic Standards (OPEC 2002) qualify the use of these materials as follows:

- Inputs from outside (the farm) must be kept to a minimum and used on the basis of need only.
- Inputs must not be used to support a poorly designed system.
- A high or routine use of brought inputs is not indicative of a stable and sustainable enterprise.
- Animal manures and products from fish / animal processing – from untreated sources and must be composted or cycle through at least two green manure crops in an annual cropping system.
- Plant by-products – from untreated sources only.

Some individual organic certifiers may place additional restrictions on the use of outside (off-farm) materials. For example NASAA restricts the use of compost to 20 t / ha / yr, and BFA suggest 20 t / ha / yr as a guide. However, these limits are under review.

Table 2 lists the main available materials permitted to supply additional N, together with an estimation of gross quantities and cost per unit of N.

The main source materials for N are animal manures and by-products of animal processing. Compost and other sources of plant protein also can contribute useful quantities of nitrogen.

Total volumes are estimated to be around 15,000 t of nitrogen / yr, however, the availability of these materials for horticultural business depends on price and demand by other buyers competing for the same material, especially by animal feed supplement users.

Cost of the N component from these materials varies widely from a range of around $700 / t of N to over $6500 / t of N – the lower cost generally being for bulky animal manure that will require additional costs for composting and transport.

The range of potential source materials for supplying N (and other nutrients) could possibly be extended beyond those listed in Table 2. Opportunities may be identified to efficiently use and reuse materials across and between industry sectors. Other examples may come from animal industry wastes and organic wastes from the food industry. Nutrient rich wastes can also come from non-agricultural sectors and even heavy industry. The production of protein by fermentation of cellulose may also provide future sources of nitrogen.

Table 2. Potential source materials for supplying N for organic farming

Source material		***Blood meal***	***Poultry by-product***	***Feather meal***	***Meat and bone meal***	***Meat meal***	***Chicken mortalities***	***Lupins***	***Canola meal***	***Brewery malt waste***	***Chicken manure***	***Prawn waste***	***Fish emulsion***	***Mushroom spent compost***	***Compost***	***Pig manure[1]***	***Dairy effluent***
	% N	*14.0*	*12.0*	*12.0*	*8.7*	*8.0*	*7.7*	*5.6*	*5.3*	*4.0*	*3.5*	*2.9*	*2.5*	*1.8*	*1.4*	*0.7*	*0.6*
***Total N** (tonnes/annum)*	***14,291***	***270***	***218***	***218***	***846***	***1,168***	***40***	***1,120***	***1,336***	***200***	***4,200***	***3***	***19***	***252***	***1,692***	***2,508***	***201***
Total material	*Vol.(tpa)*	*1,928*	*1,820*	*1,820*	*9,720*	*14,600*	*520*	*20,000*	*25,200*	*5,000*	*120,000*	*100*	*740*	*14,000*	*120,875*	*374,400*	*35,200*
Horticulture region																	
Kununurra (ORIA)	*174*										*60*		*150*		*12,000*		
Carnarvon	*15*											*100*			*875*		
Geraldton	*9*										*260*						
Gingin	*690*															*103,000*	
Perth	*7,347*	*728*	*1,820*	*1,820*	*8,320*		*520*			*5,000*	*118,000*		*590*	*14,000*	*102,000*		*3,500*
Harvey (SWIA)	*2,518*	*1,000*				*14,600*			*20,000*		*338*				*5,000*		*12,000*
Donnybrook	*2*																*400*
Bridgetown	*3*																*600*
Manjimup	*41*															*5,200*	*1,000*
Albany	*505*										*147*					*73,300*	*1,500*
***Others**/unknown location*	*2,983*	*200*			*1,400*			*20,000*	*5,200*		*1,195*				*1,000*	*192,500*	*16,200*
Cost average $/tonne		*922*	*700*	*700*	*460*	*490*	*400*	*210*	*300*	*27*	*30*	*10*	*1,400*	*20*	*46*	*10*	*10*
Cost $/tonne N		*6,586*	*5,833*	*5,833*	*5,287*	*6,125*	*5,195*	*3,750*	*5,660*	*675*	*857*	*345*	*56,000*	*1,111*	*3,286*	*1,493*	*1,754*

Notes: [1] Significant increase in piggery operations from the current 36,000 to 60,000 sows, may develop, especially in the Gingin/Moora region. Also a general move towards straw based deep litter system – currently about 25 per cent of total sows.

NB: Data is incomplete – total quantities are likely to be greater than indicated.

Generalised nitrogen input budget

Crop requirement for nitrogen varies according to plant species, as well as a range of climatic, soil and other factors.

Typically, perennial fruit trees require around 80–90 per cent less kilograms N / ha / yr than intensive vegetable production. Table 3 shows some generalised values for total N required by different horticultural systems.

Organic horticulture appears to use about 50 per cent less N for vegetables than conventional and about 15 per cent less for fruit production.

Table 3. Gross nitrogen requirements

	Range kg N/ha/year		
	Low N	***High N***	***Average N***
Conventional horticulture system *			
Fruit production	*50*	*150*	*100*
Vegetable production (2 crops per year @ around 250–550 kg/ha per crop)	*500*	*1100*	*800*
Organic horticulture system **			
Fruit production	*68*	*104*	*86*
Vegetable production (2 crops per year @ around 120–250 kg/ha per crop)	*243*	*599*	*372*
Research Station organic trials ***			
Carrots (2 crops per year @ around 50–200 kg/ha per crop)	*100*	*400*	*200*

* Figures from Baxter 1981; Lantzke 1999.

** Figures for organic horticulture derived from grower interviews 2002. Estimated yields about 80–100 per cent of conventional by weight, or 100 per cent of conventional by number.

*** Figures derived from trials conducted Medina Research Station 2001-02. Carrot yield response to blood meal supplements as source of N (McCoy 2002 unpublished).

Estimated potential area for organic horticulture

The gross volume of N from various identified available source materials is estimated to be around 15,000 tonne of nitrogen per year. Competing demand for this source material is assumed to account for 70 per cent of the nitrogen available, leaving 4500 t of N / yr for organic horticulture. In gross terms the potential crop area this N can supplement depends upon type of horticulture crop and N levels applied as shown in Table 4.

The gross potential area for organic horticulture - based on conventional N levels – ranges from 4091 ha for intensive vegetables with high N requirement, to 90,000 ha for perennial fruit trees with low N requirement.

In general terms organic fruit production – based on conventional N levels – can potentially occupy around five to ten times more land area than organic vegetable production for the same amount of input N material.

Table 4. Gross potential area for organic horticulture

Total available nitrogen = 4500 tonne of N/yr	*4500*			
	kg N/ha/yr		***Total area (ha)***	
	High N	***Low N***	***High N***	***Low N***
Organic crop (N budget conventional levels)				
Intensive vegetables (2 crops/yr)	*1,100*	*500*	***4,091***	***9,000***
Perennial fruit trees	*150*	*50*	***30,000***	***90,000***
*Vegetable/livestock rotation**	*550*	*250*	***8,182***	***18,000***
Organic crop (N budget organic levels)				
Intensive vegetables (2 crops/yr)	*600*	*243*	***7,500***	***18,519***
Perennial fruit trees	*104*	*68*	***43,269***	***66,176***
*Vegetable/livestock rotation**	*300*	*121*	***15,000***	***37,190***

* Assumes 50 per cent reduction in kg N/ha/yr supplement required.

Regional estimates – potential area for organic horticulture

On a regional basis, close proximity to significant sources of available materials can be important to reduce transport costs, especially for bulky materials such as manures, processing wastes or compost.

An estimated breakdown of input materials for each regional centre is shown in Table 5. The Perth region and the South West Irrigation Area (SWIA) centred around Harvey have the greatest potential supply of N rich input materials. Most other regional centres listed also have useful quantities of N rich input materials.

The potential area for organic horticulture depends on crop types and cropping system. Table 5 indicates the potential area of organic horticulture possible for each regional location. Data of available materials is incomplete for most regions, so volumes or area are likely to be greater than indicated.

Regions with the greatest potential area are Perth, Harvey (SWIA) and Gingin. Some high analysis materials such as bloodmeal and other animal processing wastes or composted pelletised chicken manure may feasibly be transported to distant regions. Low analysis, bulky materials are more likely to be feasible only within close proximity to source to minimise transport cost.

Table 5. Area (ha) estimates for organic horticulture based on input sources of N materials

			Vegetables		Fruit		Vege/Livestock		
			High N	Low N	High N	Low N	High N	Low N	
Nitrogen req'd	kg N/ha/yr		600	243	104	68	300	121	
Available N	Total tonne N/yr	Available for hort.[1] tonne N/yr	**Potential area organic horticulture (ha)**						**Data**[2]
Kununurra (ORIA)	174	**174**	290	716	1,673	2,559	580	1,438	**V good**
Carnarvon	15	**15**	25	62	144	221	50	124	**V good**
Geraldton	9	**9**	15	37	87	132	30	74	**Poor**
Gingin	690	**690**	1,150	2,840	6,635	10,147	2,300	5,702	**Poor**
Perth	7,347	**5,510**	12,245	30,235	70,644	108,044	24,490	60,719	**Mod**
Harvey (SWIA)	2,518	**1,889**	4,197	10,362	24,212	37,029	8,393	20,810	**Mod**
Donnybrook	2	**2**	3	8	19	29	7	17	**Good**
Bridgetown	3	**3**	5	12	29	44	10	25	**Good**
Manjimup	41	**41**	68	169	394	603	137	339	**Good**
Albany	505	**505**	842	2,078	4,856	7,426	1,683	4,174	**Mod**
Others/ unknown location	2,985		4,975	12,284	28,702	43,897	9,950	24,669	**Poor**
Totals	14,289		23,815	58,802	137,394	210,132	47,630	118,091	

Notes: (1) Other industries may compete for limited supply of N materials, especially animal feed industries.
(2) Data of available N materials is incomplete for most regions, so N volumes or potential area is likely to be greater than indicated.

Crop selection advantage

Where expansion of organic farming is limited by available input materials to replace lost N, selection of crops with relatively low N requirements will maximise the potential scale of industry development.

In addition, a range of other crop selection criteria are considered to assist in identifying crops with relatively low production risk, and greater likelihood of reliable, high quality production at competitive cost that may attract investment in industry development.

The following criteria are used to assess specific crops for potential in organic systems.

- **Pest/disease** – freedom; is the crop free of serious pest / disease suffered by competitors? - Key problems; what are the main pest / disease problems in WA?
- **Nutrient load** – does the crop need high levels of nutrients especially nitrogen? List kg N / ha / yr.
- **Seasonality** – what are the seasonal limits especially relating to pest and disease pressure? Problems may prevent reliable supply continuity.
- **Management intensity** – relative management intensity, and major management changes for organic? Low intensity generally implies conversion to organic is less dramatic practically and financially.
- **Comparative** – is conventional crop competitive on export markets? Extent and destination of exports?
- **Main competitor** – who are the major conventional or organic competitors?
- **Organic status** – extent and location of existing organic industry in WA – production and trade etc.?
- **Prospects** – known prospective grower, processor or trade interest in developing organic?

The following crops are identified as having potential for organic production development:

- **Mango** – relatively low pest disease risk, very low N requirement, existing conventional exports to SE Asia, Middle East, emerging exports to France, UK, USA, one existing organic grower (ORIA), conventional grower interest (ORIA), potential to offer organic product to some existing conventional markets.
- **Carrots** – relatively low pest disease risk, relatively low N requirement, significant existing conventional exports to SE Asia, (although under increasing competitive pressure) several existing organic growers, good demand domestic and export interest, fresh product useful leader for market entry, several companies wishing to develop juice supply especially for Japan, some conventional grower interest.
- **Apples** – relatively low to moderate pest disease risk, low to moderate N requirement, significant existing conventional exports especially to strong UK organic market, several existing moderate scale organic growers, potential to offer organic product to some existing conventional markets, interest from several conventional growers and juice processors.
- **Melons** – relatively low pest risk, some fungal risk, low to moderate N requirement, existing conventional exports to Hong Kong and SE Asia, several existing small organic growers, prospect as rotational crop with pasture livestock system, conventional grower interest (ORIA).
- **Plums** – relatively low to moderate pest disease risk except fruit fly problem in some regions, low to moderate N requirement, significant existing conventional exports Hong Kong, several existing small organic growers, export market prospects on the back of conventional trade needs investigation, some interest from conventional growers.
- **Grapes** – relatively low pest risk, moderate to high fungal risk, low N requirement, very significant existing conventional exports as wine to key organic markets (EU, USA, Japan), some table grapes, a little dried fruit, several small existing organic wine producers and table grape growers. Demand for organic wine increasing, prospect for dried product and table grape. Interest from several leading WA wine labels in biological approach.
- **Citrus** – relatively low pest disease risk except fruit fly, low to moderate N requirement, no significant exports although significant new plantings, several small existing organic growers, fresh and juice organic orange product imported from Eastern States, organic orange juice re-exported from WA, interest from two juice companies, grapefruit prospect and interest Carnarvon and ORIA.
- **Olives** – relatively low pest disease risk, low to moderate N requirement, several existing organic growers, significant grower interest in organic, many small scale holdings unlikely to be viable without product differentiation such as organic.
- **Avocados** – relatively low pest disease risk, low to moderate N requirement, no significant existing export, good domestic market. Several organic growers. Some interest from conventional growers. Domestic prospect, possible future export to destinations without tight fruit fly controls.

Many other crops not considered in this assessment may be highly suitable for organic production in specific locations and could potentially open new market opportunities.

Regional location analysis: opportunities for organic horticulture

Soil type and available sources of input materials for N replacement, indicates a number of regional towns are potentially suited as centres for organic horticulture development.

Key criteria used for assessing town / region relative advantage for organic horticulture development are:

- **Existing horticulture industries** – main crops grown, expertise and infrastructure.
- **Availability of nutrient inputs** – volumes of acceptable sources of input nutrient materials, particularly materials providing sources of N.
- **Existing organic activity** – extent of existing organic industry / expertise / leaders.
- **Interest/resistance toward organic** – known interest in organic among conventional industry growers / processors / exports etc. (especially leaders).

Regional centres with good potential for organic industry are as follows:

- **Harvey (SWIA)** – significant horticulture industry especially citrus, grapes and vegetables on adjacent coastal sands; wide range and volume of available N materials; areas of preferred soil types; several smaller organic growers, certified abattoir, processor interest; interest from conventional vegetable, fruit, dairy and beef producers; prospect for grapes, olives, citrus, vegetables, melons and vegetable / livestock rotation.
- **Perth** – major vegetable industry and some fruit on coastal plain, orchards in foothills; wide range and volume on N materials; preferred soil types in foothills, patches of better sands on coastal plain; various small organic growers, juice bottler, manufacturing, wholesalers, export; wide ranging interest in organic; prospect for grapes, olives, citrus, avocado, vegetables, melons.
- **Gingin** – expanding olives, citrus, grapes, some avocados, mangoes; range of input N material, possible significant piggery expansion; preferred soil types in foothills; various small organic growers; prospect for olives, grapes, mango, vegetables, melons.
- **Manjimup** – significant vegetables, pomefruit, stone fruit industries; some volume of N materials; good area of preferred soil types; one large organic vegetable grower, other smaller growers; Interest from various large growers; prospects for apples, plums, avocados, vegetables and vegetable / livestock rotation.
- **Kununurra** – significant melon, banana, mango, grapefruit industries; good quantity compost from sugar mill; useful soil types; one existing organic mango grower; significant interest from growers; prospect for mango, grapefruit and melons.

Economic relevance: potential industry scale

The scope for organic industry development goes well beyond the few crops and locations highlighted in this study. Indeed, developing mixed horticulture / livestock systems has received little attention, yet these systems are likely to offer significant potential for eco-efficiency gains and sustainable productivity.

Ultimately the farmers must understand their soil and farm landscape, the local naturally inherent physical and biological limitations of soil, climate and the natural environment. Only this understanding will determine the most appropriate land use and farming system required to maintain soil fertility and productivity at sustainable levels.

However, to gain a feel for the prospective economic scale that organic horticulture may achieve, the following case examples are presented. The key limiting factor used in these examples is available material to maintain N balance within the organic farm system.

Industry scale estimates

Example 1

Regional centre – **Kununurra**
Crop rotation – **Mangoes**

N requirement = 30 kg N / ha / year
N material available = 174 t N / year

Potential area 174,000 kg N / yr
@ 30 kg N / ha / yr
= **5800 ha**

Example 2

Regional centre – **Harvey**
Crop / rotation – **Carrots > green manure > lettuce**

N requirement = 250 kg N / ha + 260 kg N / ha
= 510 kg N / ha / year
N material available = 2518 t N / year @ 50 per cent available for horticulture = 1260 t N / yr

Potential area 1,260,000 kg N / yr
@ 510 kg N / ha / yr
= **2470 ha**

Example 3

Regional centre – **Manjimup**
Crop / rotation – **Apples**

N requirement = 70 kg N / ha / year
N material available = 41 t N / yr + 510 t N / year (adjacent regions) = 550 t N / year

Potential area 550,000 kg N / yr
@ 70 kg N / ha / yr
= **7860 ha**

Strategic benefits of organic horticulture

The following strategic implications should be considered when assessing the merits of expanding organic horticulture in WA.

Optimising the value of waste streams

The linking of agricultural and industrial waste streams to horticultural enterprises can improve natural resource management efficiency. Organic horticulture provides a useful commercial vehicle for demonstrating the value of these waste streams. Locate organic horticulture in regions with waste streams of available N materials.

Nutrient and water use efficiency – Crop type focused on preferred soil type

The targeting of intensive vegetables (relatively high nutrient loads) onto stronger (loamy) soil types rather than weaker (sandy) soil types can improve N use efficiency. This provides greater capacity to maximise natural N cycling thus reducing gross N inputs, N leakage and environmental problems. Perennial fruit production (relatively low nutrient loads) may be considered for sandy soil types. On the Swan Coastal Plain target fruit rather than vegetable production – for example low chill requirement fruits like grapes, citrus, olives, avocados, mangoes. Use an organic system based on compost, banding soil amendments (clays, humates, zeolites to raise CEC), surface mulch and N fixing cover crop / green manure. Compared to vegetables this would require less nutrient and water input, improve nutrient and water use efficiency and reduce nutrients lost to the environment – especially water bodies.

Water allocation

Water use efficiency and protection of water quality benefits from the strategy above. The net reduction in irrigation water needed for fruit trees compared to vegetables suggest an opportunity for re-allocation of water resources to wetland preservation or pumped to areas with better soil types for intensive vegetable production.

Integration of horticulture with livestock

The development of innovative and integrated horticulture rotations into pasture / livestock (beef, dairy) production can improve whole farm nutrient cycling as well as contribute to weed, pest and disease management. Existing livestock producers may generate additional value from the farm resource base via owner operation, sharefarming or contract arrangements from horticulture rotation cropping.

Nitrogen imports and energy balance

Increasing the emphasis on natural nitrogen cycles within farming systems can help decrease net N imports and improve energy balance within agriculture. Organic systems have been shown to be more energy efficient than conventional counterparts.

Public good benefits from organic

A range of public good benefits from organic horticulture, include decreased use of some chemicals, improved soil quality and decreases in land degradation costs, improved water quality, improved human health (Wynen and Edwards 1990), and energy inputs, biological diversity, landscape and social benefits (Fairweather and Campbell 2001).

Trade barriers

Innovations from organic systems that are adopted by conventional systems provide a contingency for responding to mounting pressure from export markets keen to demonstrate integrity to consumers when promoting their triple bottom line credentials or image.

Rural community and employment

Management intensive organic farming can provide options for high value production suitable for family farms unable to expand farm size. Increased labour requirements and on-processing possibilities can generate greater regional industry and employment opportunities.

System and product innovation

Research and development into refining organic systems can add value to the productive capacity of agriculture by generating specialist, highly integrated and resource efficient innovative systems and products.

Resource accounting

Accounting for total resource assets deployed. A natural resource inventory balance sheet based on organic systems – maintaining resource asset value, minimising waste, maximising eco-efficiency.

Preferred supplier status

Including organic products within the portfolio of agricultural offering from WA, can enhance a clean green image and bolsters preferred supplier status.

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