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Organic beef a production guide

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organic beef

a production guide

prepared by Steven McCoy

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important disclaimer

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Introduction

Premium markets are expanding worldwide for certified organic and biodynamic beef products – those grown in accordance with recognised organic production and processing standards.

Many agricultural areas in Australia have the potential to produce organic beef, and several Western Australian and Eastern States organic producers are already exporting to Japan. Supermarkets such as Coles and Woolworths have started to build the Australian domestic market.

Converting to an organic system can be easier - requiring fewer changes - in 'low input' rangeland cattle production than in more intensive pasture-based or feedlot production. But regardless of the type of enterprise, managing organic production is different to conventional, involving much more than simply not using synthetic chemicals and fertilisers.

Organic farming systems are typically mixed operations, so cattle production can also include sheep and cropping as important, integrated components of the whole farming system. Crops and pastures are rotated and rested to replenish soils, and to control animal parasites.

In organic production, prophylactic chemical treatments and vaccinations are avoided, animal and plant health is built from increased soil fertility, animal welfare is paramount, and the long term aim is towards a closed system with minimal external inputs.

While conventional producers may be lured by premium prices (typically 20 to 30 per cent) and growing markets (consumer demand is predicted to outstrip supply for many years), those converting to organic beef production need to understand, follow and commit to the principles of organic farming. This shift in management approach is vital to secure and retain organic certification and buyers, as well as loyal and trusting consumers.

The rewards of a commitment to organic production include promotional and marketing advantages over conventional, with opportunities for generic campaigns for both organic food and organic beef, and for individual and regional organic brand promotions.

Conversion is a gradual process

For conventional producers, conversion to an organic system takes time. Before beef can be certified and sold as organic, national organic standards must be met for three years.

Careful planning and financial management is required during this conversion period, and successful producers often begin by converting part of their property to get a 'feel' for the new system and to build-up experience and confidence.

As with conventional beef production, maintaining a reliable supply of consistent product that conforms to buyer quality criteria is essential to develop and retain markets, so a quality assurance system (such as SQF 2000) is recommended to be in place in addition to organic production standards.

Consideration must also be given to the need to build alliances throughout the supply and distribution chain for both fresh and frozen product, and the additional requirement of prepacking organic meats to distinguish between and avoid contamination with conventional meats. There may also be opportunities to add value by moving into processed foods.

Joining forces with other organic farmers, particularly where there are complementary seasonal or other conditions, can make resource use and information gathering more effective and enterprises more profitable for all involved. Such strategic alliances can also provide good marketing advantages - particularly to ensure supply volumes to key buyers, but also for regional, product and brand development and promotional campaigns.

About this guide

Due to the great variation in location and types of cattle production in Australia, only a general outline of organic beef production is possible in this guide. Principles and techniques outlined usually apply to the more intensive types of production rather than low rainfall area rangeland systems. However, evidence from the United Kingdom suggests that the more intensive types of organic beef production may need a higher price premium in order to equal conventional returns.

This guide will aid conventional beef producers interested in producing cattle grown organically in accordance with the Australian 'National Standards for Organic and Biodynamic Produce' and certified by an accredited organic inspection organisation (see Appendix 1).

Important aspects of organic beef production are covered to help producers develop methods that suit individual farm locations and circumstances. Material has been gathered from a wide range of sources, including organic and biodynamic beef producers in New South Wales, Victoria and Western Australia.

Producers will also need to consider organic methods applicable to other crops or livestock produced on the farm if whole farm certification is the aim. Further consideration will need to be given to management concerns not covered in this guide such as farm economic outcomes and financial considerations, and changes to capital plant and equipment.

Market outlook for Australian organic beef

Export markets

Australian organic meat exports have mainly been confined to beef to Japan, including certified biodynamic beef from Western Australia and certified organic beef from South East Queensland. However, beef is also being exported from Queensland which is produced with limited chemical inputs and marketed as 'range grown'. The *Organic Beef Export* group from Queensland is also exporting chemical-free beef while progressively converting to organic standards. Japanese buyers are apparently happy to accept this product as 'chemical-free' in the knowledge that it is a transitional phase to gaining certified organic product.

Organically produced beef is a key product demanded by Japanese consumers of organic foods. Various Japanese companies are reported to want 'safe' beef without growth hormones, because of consumer concerns.

Interest has been expressed in increasing Australian biodynamic beef for export to Japan and in developing beef-based processed products such as organic gourmet beef patties.

Some Japanese buyers are looking for specific cattle types with high marbling scores for the organic market. One recent report from Japan suggested that grass-fed beef was considered less tender than feedlot beef and perhaps more suitable for processing or restaurants rather than for individual consumers. (This perception may require attention if organic grass fed-beef is to attract premium markets.)

Premium organic markets demand tender beef

According to Austrade, the greatest export potential for Australian organic foods to Japan lies in the processed foods and food ingredient sectors. Identified products include beef and beef-based products.

Export competition

Competition for beef export markets can be expected from United States and South American beef producers. Trade reports from Japan suggest that United States organic grass-fed beef has been considered cheaper and better quality than equivalent Australian product. Argentina is reported to have 14 producers with 75,000 ha of land certified organic for beef production, with enormous potential to expand.

Australian markets

Australian domestic demand for organic meat products remains largely subdued. However, renewed interest in organic products by the major supermarkets *Coles* and *Woolworths* may stimulate demand. *Coles Supermarkets* is reported to have trialled biodynamic beef in select stores and plans to introduce the product into its other stores around Australia. Smaller state supermarkets such as Dewsons in Western Australia sell frozen organic beef burgers.

Specialty butcher shops are increasingly offering organic meats as part of their range, and some, such as the Dalkeith Village Butcher in Western Australia, supply frozen organic and biodynamic meats to healthfood shop chains in their own state. Several producer groups have developed supply lines and established markets to specialty butchers and supermarket retail outlets in the Eastern States.

Market summary

There are good prospects on export markets, particularly to Japan and possibly other East Asian destinations. European Union markets are also promising – especially the United Kingdom following its recent foot and mouth crisis.

Markets within Australia are at an early stage of development. However, renewed interest by major retailers provides an opportunity for reasonable volumes of trade.

To secure and retain potential markets, it is vital that product quality is maintained at a high level conforming to both buyer requirements and consumer expectations. Simply labelling a product as 'organically grown' is unlikely to be enough to establish a strong market unless the product also has excellent eating qualities – especially with increasing competition.
As well as organic certification, some form of quality assurance system, and industry and product promotions may be important to ensure organic beef is distinguished as a premium product.

Premium eating quality biodynamic beef

Organic certified and quality assured

Most markets will only buy products certified as organic or biodynamic by a recognised certification organisation, whose symbol can be displayed on product packaging. These are the only products that can be legally labelled organic for export. While markets for full 'organic' are growing strongly, markets for products certified as 'in conversion' to organic (that is, less than three years since conversion) may be less certain and careful assessment may be required to verify demand and price premiums.

In the United Kingdom, leading supermarkets such as Waitrose sell 'in conversion' produce under their generic organic logo with words on the packaging explaining that the food is 'in conversion' and what that means. Customers are happy to pay the premium price knowing the food has not been grown with chemicals and that it is the 'next best thing' when full organic food is not available.

To maintain organic integrity throughout the supply chain, all points must comply with organic standards. This applies to storage, handling, transport and processing, which must ensure that organic product remains uncontaminated and separated from conventional.

Quality assurance (in addition to organic certification), based on a well-recognised scheme such as SQF 2000 can provide buyers with a higher degree of certainty that the product will conform to their specification quality criteria. A quality management system compatible with Hazard Analysis and Critical Control Points (HACCP) principles should also be an integral part of an organic production system.

The United Kingdom example

Evidence in the United Kingdom suggests that domestic demand for organic foods could suddenly soar and the market maintain rapid growth rates over several years. The total market has maintained an annual growth rate of over 40 per cent for several years now after an initial sudden boom in the late 1990s.

Motivating factors there have included food scares (such as BSE, chemical residues, and E coli and salmonella outbreaks) and increased media focus on reported organic benefits and issues such as genetically engineered foods.

Organic foods quickly moved from 'fringe' to 'trendy', and then to mainstream in the United Kingdom within three to four years starting from 1997-1998. Chefs, nutritionists, celebrities, food writers, specialist organic supermarkets and opportunistic traders helped turn organic trendy.

Then major supermarkets including Sainsbury's, Waitrose and Tesco with their large customer bases made it mainstream - competing instore (with promotions, brochures, organic shops within stores and own label ranges) and in the media for organic content – signing five-year contracts to take all production from some individual farmers, funding producer clubs and conferences for information exchange, and funding organic research and development.

As competition increased between organic brands and companies for markets and new product development, so did the amount and sophistication of promotion and advertising of organic - benefiting everyone in the organic food chain.

Organic retailers (including home delivery companies using the internet), restaurants, cafes, consumer and trade shows and magazines multiplied, generating further demand. Farmers' markets spread around the country, giving farmers direct, regular access to consumers in most major towns and cities.

Many organic beef producers added value to their enterprise by developing own brand frozen products, supplying product for supermarket own label products, and running their own home delivery services via the internet.

Market trends experienced in the United Kingdom may well be repeated in Australia.

General principles of organic beef production

Organic farming aims to produce food of high nutritional value and healthy, quality livestock and crops while enhancing and protecting the farm's natural assets. These include fertile, mineral and micro-organism rich 'living' soils which are the foundation of organic production.

Organic farms work within a closed system as far as is practical, avoid pollution resulting from agriculture, and minimise the use of non-renewable resources. Animal welfare is paramount and animal and plant health stems from naturally built up soil health and preventative husbandry rather than relying on synthetic inputs.

This section outlines these and other important guiding principles, practical implications and constraints in planning, converting to and developing a successful organic beef production system. Aspects of organic certification standards relating to beef production are included, however specific details must be confirmed with the organic certifier.

Enterprises aim towards closed systems

As with all organic farming enterprises, organic cattle production should aim to operate within a closed system so far as possible, with all feed requirements and other inputs ideally produced on-farm. To achieve this, organic farms are typically mixed enterprises with a balance of pasture, crops and livestock.

Integrating crops and livestock can be key to making rotational grazing systems work and improving pasture management. Cattle can be profitably fed on pasture used in the fertility-building phase of cropping rotation.

Animal and plant health stems from soil health

The underlying principle of organic animal production is that: 'healthy animals grow from healthy plants, and healthy plants grow from healthy soil'. Well balanced, biologically enhanced soil - measured by adequate organic matter, humus level, crumb structure and feeder root development - forms the basis of organic beef production. Plants are nourished through a soil ecosystem built over time, and not primarily through fast-acting, soluble fertilisers added to the soil.

Well managed soils with adequate organic matter and biological activity tend to be more resilient against land degradation. Problems such as organic matter depletion, soil structure decline, compaction, erosion, and acidification are avoided through good management. Soil problems related to water imbalance, such as waterlogging and salinity can reduce or require specific remedial action.

Animals feed to suit their physiology

Feeding should be suited to the animal's physiology. Ruminants require a high proportion of forage in their diet so their digestive systems can function naturally. The preferred method of nourishing organic livestock is by 'free choice' feeding, where animals are free to select from a wide variety of foods natural to their diet.

Cattle must have access to pasture and only eat certified organic feed. Feeding any portion of 'in conversion' feedstuffs to fully organic livestock will result in labelling of the animal's products as 'in conversion'. Up to five per cent of all feed may be bought in as non-organic feed supplements, provided they meet the requirements of organic standards. Feeding of mammalian material (excluding milk) to ruminants is prohibited, as is the use of growth promoters - including hormones and antibiotics in feedstuffs.

Husbandry systems conform to highest welfare standards

The welfare of animals is paramount in organic farming. Maintenance of livestock must be guided by an attitude of care, responsibility and respect. It is believed that the health and vitality of an animal largely depends on the way in which an animal is kept. Stress is seen as a contributing factor to development of disease, and distressed animals are reportedly less able to adjust to change.

It is important to remember that cattle were originally woodland animals. Their natural habitat was woodland clearings and grassland at the edge of woodlands, so consideration must be given to their natural behavioural patterns. Living conditions should fulfil the natural needs of the animal for free movement, food, water, shelter and shade. Shelterbelts can be useful in providing protection from excessive sunlight, temperature, wind, rain and other climatic extremes.

Mutilation such as castration and dehorning is only carried out where benefits outweigh the consequences of non-treatment, and there are no other acceptable options. Stress, injury and pain inflicted by these treatments must be kept to a minimum.

Animal health is maintained through preventative husbandry, animal welfare and appropriate feeding systems

Organic animal health aims to build immunity and develop resistance to disease, infection, parasitic attack and metabolic disorders through good management. This means practising preventative healthcare, providing sound nutrition, and ensuring good breeding and selection.

The cause of any disorder needs to be corrected, rather than simply treating the symptoms. Sound nutrition can be achieved through correct soil fertility and through diversity in the diet, which in turn provides balanced mineral and dietary input.

Dietary intake should be based on balanced quality forage, and not reliance on supplements or concentrates. Feedlotting is generally considered unnatural - especially for ruminants. Some organic producers consider grain-fed organic beef to be contradictory to organic principles. Organic standards prohibit highly intensive feedlot production.

Prophylactic chemical treatments and vaccinations are avoided

Diseases and parasites are controlled by management practices rather than reliance on substances. If management efforts prove insufficient, use of permissible products such as homeopathic medicines is a secondary measure, and not a substitute for good management practices.

If permissible treatments fail, producers must use other veterinary-recommended medicines which are not permitted in organic standards if continued avoidance of these would result in unnecessary suffering for the animal. Unfortunately, the meat from these treated cattle can then never be marketed or sold as organic.

Animals given such prohibited treatments must be identified and quarantined from organic land and animals for at least three times the withholding period of the treatment. Their offspring can be sold as organic, providing the non-permitted treatment was given prior to the last trimester of pregnancy. Product residue testing may be required.

Natural breeding and rearing

Livestock should be bred using the natural method of sires. Artificial insemination is not recommended, although it may be permitted in some cases. Embryo transfer, genetic engineering and routine use of reproductive hormones or synchronising drugs are not permitted in organic farming.

To give animals natural immunity against infection, calves should be reared by their mother. Suckling or bucket-rearing on organic whole milk for a minimum period after birth can be required in organic standards.

Natural breeding is preferred, although AI is permitted.

Minimum qualifying period

Properties intending to raise organic cattle must have reared the cattle on land managed in accordance with organic standards for at least one year in order to qualify for certification as 'in conversion' to organic. A minimum of three years' compliance is required to qualify for certification as full organic.

Part certification of a property can aid conversion

Producers may initially convert part of a property to organic methods while continuing to use conventional methods on the remainder. Typically, this involves selecting a location with low risk of spray drift or contamination from adjacent land. Buffer zones may be required to ensure adequate separation from conventional cropping.

Sufficient area must be allocated to develop a functioning organic system and to allow for a sustainable rotation to be established where cropping is involved. Some organic certifiers may also require a development plan that aims to convert the whole property to an organic system within a defined period. Generally it is not possible to certify just one crop. Moving into and out of organic certification is also unacceptable.

Avoid contamination and spray drift

Potential sources of contamination, from spray drift, water sources or other means, can require careful consideration. Buffer zones are likely to be required between organic crops and conventional crops. Neighbours must be informed of contamination risk and co-operation sought. Soil tests may be required to check for chemical residues in soil from previous land use.

Genetic engineering is banned

The use of genetically engineered organisms (GMO's) and their products are prohibited in any form or at any stage in organic production, processing or handling. Crops and land must be free of GMO contamination.

Limits on introduced livestock

Livestock should be bred on the property. Animals introduced from other than certified organic sources may be limited to a certain percentage of the herd per year and may need to be quarantined from organic land and stock for a set time. While these introduced animals may never be sold as organic, their progeny can be certified organic if organic management began from (at least) the last trimester. Residue testing of meat products can be required.

Coexisting with and protecting the environment

Maintaining biological diversity on and around the farm is an important feature of organic systems. Avoiding monocultures - where conditions can easily favour pests - by encouraging diversity tends to encourage ecological balance with less dramatic biological fluctuations. For example, insect pests are kept in check by their natural predators, reducing harm to crops and animals and reducing the need for control measures.

Areas of remnant vegetation should be protected. Shelterbelts and areas of remnant vegetation can be important habitat for natural predators of insect pests, which when kept naturally in check reduce harm to crops and reduce the need for control measures.

Stocking rates should be appropriate for the location, taking into account fodder production capacity, stock health, nutrient balance of both stock and soil, and environmental impact. On non-arable land under less intensive management, organic cattle production requires careful matching of suitable breeds and class of animal with seasonal production patterns. Stocking levels must be closely monitored to optimise productivity while maintaining sustainable use of the lands' resources.

Organic farms should also ensure that pollution and other forms of degradation resulting from agricultural practices are avoided. The use of non-renewable resources (which harm the environment) should also be minimised to help extend the availability of these limited resources.

Rangeland special criteria

Grazing cattle in natural and rangeland areas can also be considered for conversion to an organic production system. Additional conditions require that:

- grazing occurs within clearly defined areas, and that those areas have not received non-permitted substances for at least three years; and
- monitoring must be undertaken to verify grazing does not disturb the re-establishment and/or maintenance of native species and stability of the natural habitat.

Handling requirements

Holding paddocks and yards may require testing to ensure that levels of soil contamination (from previous use of chemical treatments) are below maximum permitted residue levels. Excessive contamination may require yards to be relocated or top-dressed with acceptable material. Yards and handling facilities should be designed and maintained to ensure animals are not stressed or injured.

Cattle yards must be free of contamination.

Transport requirements

Loading facilities and transport vehicles may require certification and should be designed and maintained to prevent injury, damage or bruising. Organic quality feed and water may be required before and after transport. The duration of each transport leg can be restricted.

Slaughter requirements

Slaughter of organic animals must be carried out in a organic certified, approved abattoir. A complete clean down and rinse after processing conventional livestock is required before organic animals are processed. Usually organic animals are processed first after a clean down. Similar conditions apply to boning rooms to avoid contamination with conventional meat. An audit trail from the time of receiving an organic animal to time of dispatch must be documented in full.

Production strategies and methods for organic beef production

To meet organic certification requirements, conventional beef production must undergo a number of modifications. Changes to management go beyond simply not using synthetic chemicals and fertilisers.

This section outlines some of the strategies and methods used by organic producers which should be considered when planning conversion of existing conventional production systems. Please note that details provided are general outlines only. Specific techniques and strategies adopted by individual organic growers will vary according to their circumstances, location of the property and type of cattle enterprise.

Good organic managers rely on close observation, anticipation and prevention to develop a robust organic system for each situation.

Overall management strategies need to reflect the following key organic farming principles:
- soil health largely determines animal health;
- organic systems are biological systems;
- husbandry systems must conform to highest welfare standards
- organic farms should operate as closed systems as far as possible: and
- a holistic approach ensures good integration

Therefore, conversion to organic systems is likely to require changes to management strategies and techniques relating to:
- whole farm planning;
- soil fertility management;
- pasture and grazing management;
- animal nutrition and supplementary feed;
- selection, breeding and herd management; and
- pest, parasite and disease control.

Whole farm planning

As with other forms of organic farming, organic cattle production requires a whole farm approach. Increased reliance on management, rather than substances, demands careful planning.

A well designed whole farm plan should devote special attention to the conversion phase – the first three years of transition from conventional to organic management - when markets for 'in conversion' product may be uncertain and while practical experience is being developed. Such a plan can enable an organic system to be easily integrated with all farm activities. Financial risk can be managed and adoption of each new operational component can improve management and enterprise effectiveness.

Details of the progressive changes intended to soils, pasture and animal husbandry will help develop a smooth conversion towards a profitable, productive and sustainable organic system. Good planning reduces management time. For example, implementing a rotational grazing strategy to improve pasture use, soil management and parasite control can result in additional animal movements. Fencing layout modifications (for example designing and using laneways) can reduce management time needed to move stock during rotation.

Planning on a whole farm basis will involve:
- creating an enterprise mix based on target markets and product requirements;
- financial plans, especially during conversion;
- integration of enterprises and strategic alliances;
- farm layout and fencing to soil types;
- rotational plans, and soil and pasture management;
- water management plans and contour tillage; and
- shelterbelts, biodiversity and remnant vegetation protection.

Organic farming systems are typically mixed enterprises - integrating different stock, or stock of the same species but for different purposes, or integrating stock with cropping. Although integration runs counter to conventional trends towards specialist beef herds as a way of gaining economies of scale, it gives organic systems flexibility and increases biological efficiency. For example, cropping can produce a paddock clean of parasites, which is ideal for parasite control in young calves.

Converting to an organic farming system can involve changes to the type and proportions of stock carried, the most appropriate cropping program, or other activities. These decisions should be based on specific aims to work towards and may include:
- increasing establishment and output from permanent or perennial pasture with minimal cultivation;
- reseeding land following cropping with grass, clover and herbal mixtures to improve soil fertility and pasture quality and productivity;
- minimising reliance on bought-in feeds; and
- avoiding the use of drugs, chemical treatments and feed supplements for animal health.

Strategic alliances with other organic producers, processors or traders can be important in defining enterprise mix and production levels. Working with other producers may also allow a relatively closed sustainable system to develop between properties. For example, aligning calving time or other operations may extend supply capability to key buyers and smooth quality variations due to seasonal differences and fluctuations.

Soil fertility management

Soil fertility (along with temperature, rainfall and pasture species) determines pasture productivity and quality, and therefore the number of cattle that can be carried.

Optimal management of soil resources in organic farming requires a balance of not only the nutrient status of a soil, but equally importantly, its biological and physical condition. Long term maintenance of soil fertility is a key management objective of sustainable organic beef production. Soil fertility in organic systems is based on nurturing and maintaining active soil biological activity during the growing season.

Adequate levels of soil organic matter provide the energy needed for soil biology to perform the essential functions of decomposition, transformation and mineralisation for soil structural development and nutrient availability. Soil chemical imbalance and mineral nutrient deficiency can be corrected by applying permitted nutrient inputs. These generally require microbial mineralisation to become available for plant use.

Organic farms aim to develop high humus, well structured, biologically active soils to be the source of plant nutrients. Developing and maintaining good soil structure is critical to allow plant roots to extend deep into the soil and exploit a large volume of soil for moisture and nutrients.

Increasing soil fertility, in conjunction with disciplined grazing management, can also allow desirable pasture species to out-compete weeds. As pasture quality and therefore nutritional value is improved, livestock health benefits.

Rebuilding the soil's biological activity and fertility balance after conventional production is a gradual process. Using suitable soil amendments, together with cultivation which minimises soil structure damage, and careful grazing management, can result in steady improvement to soil fertility and therefore pasture composition and vigour.

Deep ripping has been used as part of an organic soil and pasture improvement program. Good grazing management (such as high impact, short duration, rotational grazing) can stimulate new root growth and provide time for soil structure to recover from stock traffic.

Pasture on land that has improved soil structure and biology is reported to recover much faster after periods of weather extremes, hangs on much longer in a drought and copes better with a soggy winter. Organic producers report that on biologically active and balanced soils, pasture growth extends further into those cold, wet and hot, dry conditions by as much as four to six weeks, reducing feeding costs.

Soil testing can be important to indicate any soil chemical imbalances and monitor longer term changes. Some soils can be naturally deficient in essential elements (such as phosphorous, potassium, calcium, magnesium, sulfur, zinc, selenium, and iodine) which may cause poor or imbalanced plant growth and lead to dietary deficiency. Amendments to soil using allowable forms of these elements may be necessary to correct a deficiency or imbalance. Deep-rooted perennial plants can also draw on mineral reserves deeper in the soil.

Amending soils is preferred to feeding supplements direct to stock or via foliar spays on feed. However, one system used by organic producers relies on making a range of mineral supplements available for free choice selection by stock. In this system animals vary their intake of supplements from paddock to paddock and according to feed and seasonal conditions. Over time, the amount of supplements consumed declines as deficient minerals begin to build up in the soil from residues in the dung. This system is also reported to show remarkable improvement in stock health resistance and performance.

Several different approaches to soil analysis have gained prominence among organic producers. These include interpretations based on Dr William Albrecht, Dr Carey Reams and Dr Rudolf Steiner - see Appendix 3 for a brief overview.

There are many natural products permitted for use as soil amendments - see Appendix 2 for a list of permitted and prohibited inputs.

Amendments commonly used by organic producers include:

- lime - to increase pH and supply calcium;
- dolomite - to increase pH and supply calcium plus magnesium;
- gypsum - to improve structure (especially on salt-affected land) and supply calcium plus sulfur;
- rock phosphate (various forms), guano - to supply phosphorous;
- sulfate of potash - to supply potassium and sulfur;
- crushed mineral-bearing rock - to supply potassium plus other minerals and increase 'paramagnetism' (refer Reams Appendix 3);
- calcified seaweed - to supply trace elements;
- trace elements including natural chelating agents; and
- various formulated fertilisers which are approved for use in organic systems.

Many of these inputs become available to plants through the activity of soil organisms. Therefore plant response may not be immediate as with highly soluble synthetic fertilisers and must be observed over time. Several smaller applications may be preferable to a single large application, particularly on light soils with little buffering capacity.

Organic crops and pastures have been successfully established using composted, pelletised manures, soil conditioners and fish emulsion fertilisers. A maintenance program reported by one producer involved using the rest period to fertilise pasture with rock phosphate and seaweed. Conservation farming techniques, such as green mulching, have been used to grow organic cereal crops for supplementary feeding. Methods for growing organic cereals can be found in the AGWEST publication *Organic wheat: a production guide*.

Nitrogen

Organic producers generally do not apply additional nitrogen (N) fertiliser. Instead they rely on sufficient build-up of soil N through the use of pasture legumes, organic matter accumulation and mineralisation, and to a lesser extent, legume crops. Ploughing in a legume-based green manure crop can significantly raise soil N levels. A range of N sources permitted for organic systems is listed in Appendix 2.

Phosphorous

Phosphorous (P) levels and availability are important issues for many producers - particularly on alkaline soils where P release from rock phosphate can be very slow, resulting in yield declines and poor stands of legumes.

However, many organic producers have reported that they have not applied additional P to paddocks for several years. In this case, plants (in the short term) may use residual soil P from previous superphosphate applications. Availability of this P may be extended by improved soil biological activity, and extracted by a larger root mass as a result of improved soil structure.

While many organic producers expect to apply some form of phosphorous to maintain soil P levels in the longer term, a few contend that P levels will be naturally maintained by a process known as 'transmutation of elements' where certain elements change into other elements. However, research suggests that P levels on organic land tend to decline without an additional source.

Application of soluble P fertilisers, such as superphosphate or DAP, is not permitted in organic farming. Instead, less soluble forms such as reactive phosphate rock (RPR) or guano can be applied. The role of soil biological activity is particularly important in mineralising this P so it is available to plants and retained in the soil biomass.

Other soil conditions such as pH and iron or aluminium binding can affect P release to plants. RPR can be more effective when applied as a fine powder, well distributed in the soil. However, the extended time for applied RPR to become available for plant use needs to be considered.

Formulated organic fertilisers (incorporating various forms of naturally occurring P such as RPR, apatite, and guano) have differing levels of solubility and are permitted for use on a restricted basis. Suitable P sources must not contain high levels of cadmium. Rock phosphate contains negligible amounts of sulfur (unlike superphosphate) so in sulfur-deficient soil a separate source of sulfur, such as gypsum, may be required.

Potassium

While potassium leaches easily through sandy soils, less potassium may be lost on soils with high organic matter and humus content. Sources permitted under organic production include rock dust, basic slag, wood ash, langbeinite and sulfate of potash.

Calcium

Conventional producers often satisfy calcium requirements by using superphosphate (which contains about 20 per cent calcium) or lime. Acceptable sources of calcium - limestone, dolomite and gypsum - can be applied to raise soil pH in organic production. Builder's lime (quick lime) and calcium nitrate are not permitted.

The role of calcium, and its proportion to magnesium and other cations, is considered very important in soil biological processes and nutrient availability by an increasing number of organic producers. These claims are generally based on Albrect principles of plant nutrition (see Appendix 3), where the ratio of major cations on sandy soils should be 60 per cent calcium to 20 per cent magnesium, or 70 per cent to 10 per cent respectively on heavy soils.

Trace elements

Many Australian soils are naturally deficient in important trace elements such as copper, zinc, manganese and molybdenum. Deficiencies can be corrected using a trace element mix of permitted forms of the elements such as copper sulfate or zinc oxide.

As previously mentioned, one reported production system relies on making a range of mineral supplements available for free choice selection by stock. Animals vary their intake of supplements from paddock to paddock and according to feed and seasonal conditions. Over time, the amount of supplements consumed is reported to decline as deficient minerals begin to build up in the soil by residues in the dung.

Biological agents

Biological inoculants have been used in organic production to bolster soil biological activity, increase nutrient availability, enhance soil structure and improve fertility. A wide range of different formulations are now available, including combinations of micro-organisms, hormones and enzymes. Sugar products are also used by some producers as a source of energy to stimulate soil biological activity.

Microbial activity can improve soil structure, allowing plant roots to exploit a greater volume of soil and improve the performance of pastures, especially in dry years. Grower's report pasture plants tend to last longer in dry periods and come back quickly following rain.

Pasture and grazing management

In organic production, pasture contributes to soil fertility as well as providing food for livestock.

Pasture for organic cattle production can cover a range of types; native grass-based pasture, modified native pasture (to include fertilisers and legumes) or pasture based on introduced species sown on a prepared seed bed. With all pasture types, good management requires an understanding of climate, soil type, enterprise needs and goals.

High quality forage is produced by utilising and developing existing soil fertility, relying on legumes for nitrogen fixation and minimising the need for bought-in mineral and nutrient fertilisers.

Soil fertility balance is very important for maintaining plant nutritional balance. When there is an imbalance, nutrient deficiencies can arise in livestock. For example, excess nitrogen in a crop or pasture can lower potassium and zinc levels.

Pasture species

A typical pasture on an organic farm will consist of a mixture of different species and varieties of grasses, clovers (or other forage legumes), and other species referred to as herbs. Livestock production is highest when stock have access to greens all year round. This requires a species mix to suit seasonal climate change and land capability. The use of perennial species is very important in regions with an extended dry season.

Careful pasture species selection can extend the growing season and availability of green feed. Producers should aim to coincide peak feed requirements (for example, lactating or growth) with the natural highest growth period, and match this with desired livestock targets.

An organic beef farm in France is reported to sow as many as 16 different grasses and herbs. These root to various depths and provide the animals with a diet which changes throughout the year, in line with the animals' natural requirements. This biodiversity reflects the organic principle that a greater variety of plants can lead to a greater variety of soil micro-organisms, assisting biological balance, nutrient balance and ultimately animal health.

Mixed pastures can be designed to suit specific paddocks or soil types, creating a range of different pastures to provide a varied diet to suit the farm's seasonal pattern. Paddocks with specialised pastures or forage for specific purposes can be developed, such as lucerne paddocks for finishing, drought-tolerant perennials paddocks for summer green feed, selected mixed herb 'medicinal' paddocks as a tonic for sick or weak animals, and typical mixed grass/legume paddocks for more general grazing.

Selection of a suitable pasture species mixture requires careful consideration and may depend on:

- intended lifetime and purpose of the specific pasture;
- climate and adaptability to soil and environmental factors;
- compatibility between species;
- growth cycles;
- seasonal herbage quality;
- palatability; and
- seed cost.

Pastures consisting of a mix of ryegrasses, strawberry and white clovers are reported to perform well - without the need for frequent renovations - on Victorian dairy land. In contrast, on sandy soils of the mid-west coast of Western Australia, pastures may comprise of dryland lucerne and Rhodes grass with sub clover, rye and other grasses. Western Australian blue lupins and New Zealand blue lupins (Fest) are also grown. Paspalum, kikuyu and strawberry clover are grown on summer moist areas.

In northern Victoria, a mix of short-lived ryegrass, vetch and balansa clover - chosen for their vigour and ability to compete with an extensive Patterson's curse problem - performed well and gave a yield of 11.5 tonnes per ha silage with 23 per cent crude protein. On an organic farm near Dubbo in New South Wales, pastures typically include lucerne, clover and grasses.

Appendix 4 provides a herbal ley pasture species mixture used on biodynamic farms in New Zealand.

Grasses

Grass is vital to organic beef production. According to one producer, cattle kept metabolising efficiently can manufacture much of their own protein requirement. So ample roughage for energy every day is very important and protein feed becomes secondary, although essential in the correct proportion.

Modern grass selections however, such as the aggressive and nitrogen-demanding growth of highly productive ryegrasses, may not be appropriate for organic production. They can out-compete other desirable species in complex organically managed pastures. While ryegrass is commonly used, selections may include annual ryegrass varieties for fast early growth and perennial ryegrass varieties for good persistence - depending on rainfall.

Commonly used pasture grasses include perennial and short-lived rye, tall fescue, cocksfoot and phalaris. Other grasses for consideration include paspalum and Rhodes grass, and native grasses such as *Danthonia* and *Microlaena*.

Legumes

Improving pastures to include a good legume base can increase pasture feed quality. Protein and mineral content and total intake are increased with clover. Cattle may be finished on clover-based grass pasture without the use of concentrate feed supplements. Clover selections, such as strawberry and white clovers, are commonly used in high rainfall areas.

The performance of a legume variety depends on how it reacts with companion grass species, the nature of defoliation (grazing), climate, the *Rhizobium* strains present, and its ability to fix nitrogen and transfer the nitrogen to grass production.

Commonly used pasture legumes include subterranean, white and red clovers, lucerne and annual medics. Other legumes which may be considered include strawberry clover, balansa, serradella, bi-seradella, vetch and peas. Some are used as forage or pasture depending on location.

Legume crops such as field peas and lupins can be grown for feed, cash or green manure as part of a mixed farming system.

Herbs

Herbs may contribute to animal health by enriching the diet and increasing pasture mineral content. Some herbs are believed to have medicinal properties. In addition, deep-rooting herbs may improve soil structure and fertility. However, seed may be expensive and the establishment and persistence of herbs can be difficult in pasture. Herbal pastures can be sown in a separate paddock reserved for the purpose, or sown as herbal strips within a paddock.

These pastures are not used as main grazing land. Instead they offer a health-promoting supplement to the diet with occasional grazing for a few hours at a time (especially by pregnant cows just before calving), or are reserved for haymaking.

Possible herb species, depending on climate and soil, include chicory (*Cichorium intybus*), plantain (*Plantago lanceloata*), yarrow (*Achillea millefolium*), burnet (*Sanguisorba officinalis*), caraway (*Carum carvi*), sage (*Salvia pratensis*), and parsley (*Petroselium saxifraga*).

One rule of thumb is to sow 0.5 kg per ha of each kind, except plantain which is sown at 4 kg per ha. Chicory is a particularly productive and drought tolerant, deep-rooted perennial.

Perennial pastures

The use of perennial pasture plants is becoming increasingly important in organic production to improve feed quality and availability during the dry season. Perennials can help sustain production in areas with rising water tables and salinity by providing greater annual water consumption. Deep-rooted perennial plants can also draw on mineral reserves deeper in the soil profile, and improve soil structure and soil biology.

Callide Rhodes grass and paspalum are two important perennials reported to show promise on light soils in the medium rainfall central west coast. *Tagasaste* has been successful on very sandy soils.

Some perennial native grasses such as *Danthonia* (wallaby grass) and *Microlaena* (weeping grass) are both tough and nutritious. For some areas they appear to offer good potential to improve productivity without the expensive inputs of sowing improved pasture species. Rotational grazing can improve the condition and production from native pasture which has been heavily invaded by weeds.

Feed conservation

Good quality hay or silage is essential for some organic operations to maintain desired productivity and finish quality throughout the year, especially during feed gap periods. Some producers believe it is prudent to retain 18 months' supply of stored feed. Where significant quantities of hay or silage are removed, regular fertilising with acceptable forms of phosphate and potash may be required.

Good quality hay or silage can be essential.

Silage containing legumes can give higher production than grass of similar digestibility, and United Kingdom reports suggest the use of clover in pasture and silage can reduce the cost of organically produced feed supplements. The use of some conventional additives may not be permitted in organic silage production.

Pasture improvement

Pasture productivity can be improved by changing the management of existing pastures or re-sowing a paddock to preferred species. Slashing old rank growth will encourage diversity and improve pasture quality. However, sowing down improved pasture species to improve productivity can be an expensive with no guarantee of success.

Pastures may need to be upgraded or renovated when paddock productivity starts to decline. Simply over-sowing a paddock, rather than ripping or working up, can be successful in some situations. Adding soil amendments to adjust pH and other imbalances, along with deep ripping compacted soil, may assist establishment and persistence - increasing the benefit to cost ratio.

Pasture can be sown and established either during a cropping phase by under-sowing a crop, or as a separate activity. Under-sowing requires a species mixture and sowing rate that will not excessively compete with the crop. Seed can be sown directly with the crop at sufficient rates to produce enough new seed for good pasture establishment in the following year.

Under-sowing is generally more suited to establishing clover in shorter term pastures, rather than perennials in longer term pastures. However, under-sowing cereals with lucerne, clover, rye and cocksfoot has been successful in some situations.

The alternative to under-sowing is direct seeding into a seedbed worked up for the purpose of renewing or renovating pasture. This can increase the chances of establishing a successful and productive pasture, particularly where perennial species are used. Direct seeding into seedbed strips rather than the whole paddock, or seeding into heavily harrowed paddocks, can reduce yield loss often associated with establishing a new pasture.

The persistence of clover in pasture can begin to decline after two to three years when grasses start to dominate. This effect can indicate that clovers have renewed soil nitrogen levels sufficiently to favour grasses. On mixed cropping farms, this clover decline is seen as a signal to bring the paddock under crop again to complete the pasture to cropping cycle.

Another approach following cropping is to turn in stubble together with oats, clovers and other feed species to get fast early growth (oats) and a good clover-based pasture. Timely grazing management is required to ensure good clover growth.

As well as regular grazing and cutting regimes, mechanical topping can be used to control weeds and remove rank, ungrazed material. Harrowing can be important for spreading dung pats. Soil compaction, particularly on heavy soil types, should be minimised by restricting stock and other traffic on waterlogged or excessively wet soil.

Grazing management

Sustainable management aims to match the number and class of animal with the characteristics of the land. One key factor in most types of cattle production management is flexibility to match available pasture types and quality with animal condition and purpose. While this is not always easy given the natural fluctuations and other variables confronting the producer, it is particularly important on organic farms where fertiliser cannot be relied upon to stimulate quick pasture growth.

Grazing management requires flexibility in order to make best use of the changing patterns of pasture composition, growth cycles and seasonal herbage quality and palatability.

A general aim of organic cattle production is to match animal requirements to pasture growth by purchasing or selling at the right time, or calving when pasture matches cow and calf nutritional requirements. Some typical examples would be cattle for finishing get the best feed (possibly lucerne or a feed of pasture sown to oats, clover, and/or grasses), followed by cows with calves. For maximum impact and highest concentration of metabolic energy, crude protein and minerals, forage (and pasture) should be leafy and immature when grazed.

Grazing pressure, as indicated by pasture height, can be important in achieving optimal pasture production and affects:

- leaf area available to trap sunlight, and therefore growth rates;
- proportion of leaves which age and die without being used;
- the total amount of pasture available; and
- the amount which can be eaten, and therefore, animal performance.

For finishing beef cattle while making best use of pasture or forage, one approach is to allow these stock to eat the best feed with a light grazing, followed by other stock with a lower requirement to use remaining feed.

Managing grazing pressure to ensure sufficient plant material or 'litter' is left behind by grazing animals is important to maintain soil organisms. This can improve nutrient release, soil structure, soil water infiltration and water holding capacity.

Rotational grazing

Rotational grazing systems are preferred in organic production, and can be designed to optimise pasture use, maintain pasture composition and control parasites. Rotational grazing can also improve soil structure and fertility recovery, and is believed to allow pasture to develop to its full size so roots penetrate deep into the subsoil.

Rotational grazing systems are preferred.

High intensity 'mob' grazing for short periods, followed by long recovery, can help prevent preferential grazing. This allows the pasture composition to remain mixed, particularly for perennial species including native grasses.

A system known as cell grazing (also known as holistic grazing, crash grazing, time control grazing or high density, short duration grazing) matches stocking rates and duration with rainfall and pasture productivity. Cell grazing creates a rotation system which aims to optimise pasture use while managing pasture composition, growth recovery and soil fertility.

This system aims to maximise time available for pasture or rangeland forage to regenerate. Small paddock sizes are necessary for effective intensive management and this is often achieved using portable or fixed electric fencing, or by redesigning the farm with the use of additional fencing and shelterbelts. Success requires close monitoring of pasture condition to determine optimum grazing pressure.

Stress involved with stock movements should be kept to a minimum. The use of noisy motorcycles, low-flying helicopters or hurrying animals through gates should be avoided. One producer has trained the cattle to respond to a whistle when it is time to move.

Benefits of intensive cell grazing include improved pasture composition, quality and productivity, soil recovery and improvement, and pest and disease control.

Fast-growing pasture typically requires a faster rotation. The duration of the recovery phase in the rotation is critical and can influence total productivity, pasture quality, worm control, and cattle condition.

All pastures must be given adequate time to recover before the next grazing. It is essential that paddocks not be grazed too soon after rain so the perennial pastures can be allowed to get a head start. Where there are distinct wet and dry seasons this can require disciplined management.

Weed management

To effectively control an undesirable weed species in pasture, it is necessary to understand the weed's life cycle and any conditions present which favour the species. Weeds can be seen as indicators of soil conditions, soil management and the environment. For example, dock is reported to thrive in compacted soil with abundant raw manure and wetter areas. Treatment to relieve compaction, together with prevention of seeding and repeated cultivation during summer, can help prevent severe dock build-up. However, care must be taken to reduce erosion risk.

A number of producers report that improvements to soil structure and soil fertility balance reduces weed problems. Constant monitoring and removal of any weed before seed set is important to maintain weed-free areas. Any tactics to reduce seed set, such as slashing, can have a positive effect on weed burden. Hand-hoeing spot weed incursions also works to prevent weed establishment.

Sowing a vigorous annual pasture mix can be used to swamp-out emerging weed seedlings. Correct choice of species and careful management can give good weed control. A productive silage pasture of fast growing rye, vetch and balansa clover has been shown to significantly reduce Patterson's curse numbers in Victoria.

Perennial grass-dominant pasture can reduce invasion by most weeds. Therefore, a management system designed to maintain perennial grass-based pastures with high ground cover will not only provide maximum weed control but also reduce the risk of surface erosion.

Spelling a perennial grass-based pasture just before the weed germinating period can reduce survival of weed seedlings through pasture competition. Purchased stock can introduce unwanted weed species into clean paddocks and should be held in a small quarantine paddock as a prevention measure. The same principle applies when shifting stock from dirty country to clean country.

Rotational grazing management is reported to improve both the condition and production from native pasture which has been heavily invaded by weeds. Sheep are reported to be more effective than cattle in controlling dandelion, capeweed and Patterson's curse. Mixed livestock operations can provide more weed management options than single livestock farms.

Biological control agents are being developed for some weeds. These bioherbicides use a range of fungi, bacteria and other micro-organisms which kill or reduce the vigour of weedy plants. A number of commercial bioherbicides are available on international markets but are not yet available in Australia. Target weeds for developing bioherbicides in Australia include Bathurst Burr, Noogoora Burr, wild oats and other grass weeds of cereals. The Crown Boring weevil has been released for control of Patterson's curse.

Animal nutrition and feed supplements

Ideally, all livestock feed should be produced on-farm to allow development of a closed, self-sustaining system within the land's productive capacity. However, some farms may not be capable of being totally self-sufficient due to drought or other reasons, and may have to buy in additional feed.

Limits may be set on the percentage of bought-in feed in organic standards. While feed given to organic animals must be certified organic, a maximum five per cent of the animals' total diet (on a daily basis) may be from non-organic sources.

Ruminants require a high volume of roughage to enable their rumen to function properly. Emphasis should be placed on nurturing and maintaining the natural bacterial flora in the rumen through sound nutrition. The balance of this living symbiotic system within the rumen is critical to the animal's health and vitality. Sudden changes in diet can disrupt vital fermentation.

One report on dairy cattle production suggests that to avoid health difficulties it is important to avoid grazing too soon on heavily fertilised young grass. When plants are a little older, the ratio of substances they contain is more balanced. Young grass, particularly after heavy fertilising early in the season, contains a high proportion of nitrogen and little fibre or carbohydrates. Synthesis of this nitrogen into proteins in the leaves is thought to be incomplete, resulting in greater amounts of intermediary nitrogen compounds such as free amino acids, urea and nitrate. This can lead to rapid breakdown in the rumen and cause bloating. Liver problems can also arise. Straw or hay must be given if grazing is to start on young grass.

If using fodder high in potassium, it may be necessary to give salt. Mineral supplements containing phosphate, ground lime, magnesium, kaolin and charcoal – as well as salt - are used. These can help avoid diarrhoea caused by salts intake from high water and low fibre content forage.

Diets with high levels of concentrates (especially protein) and low quantities of roughage can lower the rumen pH, resulting in problems such as rumen acidosis, fatty liver syndrome and foot problems.

Rumen modifiers and activators may be permitted on a restricted basis depending on rates of application, purpose of use and product purity. Growth hormones and other growth stimulants are not permitted.

Animals must have free access to pasture.

Animals must have free access to pastures. Free choice feeding, where animals are allowed to follow their natural inclination, is the preferred method of feeding in organic production. However, low voluntary intake of feed is the nutritional factor that usually limits productivity, especially when forage is the only feed given.

Voluntary intake is reduced by high fibre and low digestibility, or by deficiency of protein or minerals. Provision of a wide variety of food natural to their diet allows livestock to maintain an appropriate balance between fibrous roughage feeds and grain feed or supplements.

As a general principle, feeding valuable grain to ruminants is considered an inefficient use of resource. Where protein or energy supplements are required, organic standards can limit the quantity of bought-in feed supplement for organic stock.

Supplementary feeding to maintain weight gain is possible using organic grain or silage. Intensive finishing on high quantities of grain or feed concentrates is not permitted.

A range of supplementary feeds can be used (for example oats, barley and canola meal), but organic standards may limit quantities allowed. In the United Kingdom during the feed gap, one organic producer finishes cattle on organic silage, supplemented with organic cereal and seaweed as a source of minerals.

In Western Australia, one organic producer uses silage and pasture hay together with mineral and vitamin supplements to maintain productivity throughout the dry season when pasture feed quality is low. In addition, perennial pastures are being established on the farm to improve feed quality in the dry season.

Energy
Where an energy supplement is required, oats are preferable to wheat and barley. The higher digestible fibre, higher fat and lower starch content of oats causes fewer digestive upsets.

Protein
Natural protein sources may include grain legumes or canola, sunflower and linseed meal, or dried lucerne. The use of artificial protein sources, such as urea, is prohibited.

Protein balance in the whole diet can be a problem in high rainfall areas. Organic farms with good clover-based pastures may have excess protein and a shortage of energy. Excess protein can lead to health problems similar to those in conventional farming with high nitrogen loads, such as excess ammonia production, liver and fertility problems. High protein levels can be compensated for by feeding straw, hay or other high energy fodder crops.

Minerals and vitamins

Mineral concentration in plants varies considerably and is influenced by concentrations of minerals in the soil, by plant species, growth stages and soil moisture. Dietary deficiencies can result from a soil deficiency, and poor management of fodder production and can lead to a wide range of problems including loss of appetite, reduced productivity and fertility.

Many soils in grazing areas of Australia are naturally deficient in one or more minerals such as copper, zinc, cobalt, selenium, iodine, magnesium, phosphorous, sulfur, and calcium.

In the first instance, efforts should be made to rectify the underlying cause of deficiency. Mineral and vitamin supplements are permitted where demonstrated deficiencies exist, and where preferred remedies such as amending soil imbalances are ineffective. Amendments to soils may be required, and additional soil treatments may also be needed to correct other possible causes of a deficiency (for example, water logging or other factors locking up nutrients).

Minerals and vitamins derived from acceptable natural sources such as seaweed (calcified, meal or extracts), simple mineral salts, cod liver oil or yeast can be added to feed supplements where other preferred management measures to correct the cause of the deficiency are ineffective or have been exhausted. Appendix 2 provides a list of permitted substances.

Routine reliance on mineral salts and vitamin supplements in the diet is not acceptable, however a number of organic producers provide animals with free choice access to permitted mineral licks. One grower reports always having a mix of kelp, lime and copper available for animals. Free choice access allows animals to determine their own requirements as seasonal feed quality changes.

Careful consideration should be given to the balance of minerals, in particular the potassium to sodium ratio. In the United Kingdom it has been reported that in some situations, the potassium content of forage can increase following the elimination of conventional fertilisers during the conversion period. Under low sodium conditions this increased potassium level can potentially lead to fertility and other problems.

Blood tests on several animals may be useful every year or two as a way of monitoring the effectiveness of soil amendments used to correct specific mineral deficiencies. However, when interpreting test results, bear in mind that cattle can deplete body reserves of some minerals (like phosphorous and possibly others) in order to maintain blood levels.

Feed supplements to improve digestibility of poor feed quality and generally improve metabolism and feed conversion have been used by some growers, although the cost of these inputs can be high.

Selection, breeding, rearing and herd management

Cattle breeding and selection for organic systems should be based on hardiness and resistance to pest and disease, as well as the more conventional measures of productivity and quality attributes.

Unfavourable genetics are unlikely to do well even in the best environment. Choosing hardier, more robust breeds suitable for organic production systems tends to run counter to current trends towards larger animals that can be slaughtered earlier when still immature and therefore with less fat.

Breeding for leanness and growth rates may not necessarily be the most appropriate for organic systems and limiting genetic diversity is undesirable. Breeding animals able to thrive with good growth rates on a predominantly roughage diet with a minimum of inputs, particularly protein rations, rather than growth rates dependent on large amounts of inputs, may be more suitable for organic production.

The general requirements of health and a strong constitution, high forage intake capacity, regular cycling/fertility and longevity should be considered by organic cattle producers when planning genetic selection.

Selection of appropriate cattle breeds must suit the specific environment and include factors such as good maternal capabilities (a combination of fertility, fecundity, ease of calving and milk production), ability to thrive in the environment, good growth rates without too much fat, and very efficient food conversion. For example, South Devon cows with Red Angus or South Devon bulls are used for biodynamic beef production from rangeland-bred cattle finished on the mid-west coast of Western Australia.

Livestock fertility is affected by many factors including nutrition, stress and the presence of bulls. A well balanced diet of organic forage without high levels of feed concentrates is important to maintain optimum fertility.

Careful consideration must be given to calving dates. Late spring calving may conform closely to the animal's natural nutritional and feeding cycle, while autumn calving can place additional stress on the animal at a time when its own system is trying to build up mineral reserves for the winter. If large numbers of calves are born during winter, problems such as pneumonia and scouring may be more severe.

Spring-born calves generally thrive, but cows may suffer excess milk production. Heifers rarely have this problem, so for these animals late spring calving may be best, with the cows calving two to three months later. This allows heifers an extra two to three months' recovery after their calves have been weaned before joining the rest of the herd on a 365 day calving index.

Careful consideration must be given to calving dates.

However, calving policy may need to be designed to suit market requirements. If finished cattle are required all year round, then two calving dates may be appropriate. For example winter calving in July-August and summer calving in January if green feed or irrigation is available.

Feeding colostrum to calves is essential for their well-being and early immunity. Calves should suckle within the first few hours after birth and for at least two to three days. As a minimum, calves should receive organic whole milk for five weeks. The rumen should be trained to cope with high forage intake by feeding high quality forage or hay. Changes to diet should be gradual.

Natural weaning without forced removal of the cow from her calf should be considered, although this is not always possible with some production systems. Allowing cows to decide for themselves when to wean their calves can be very beneficial compared to forced weaning at nine months. Live weight gains can be considerable and calves have a high degree of finish, only requiring time to grow out to be fit for slaughter. However, forced weaning may be required as indicated by conditions, and if a production target of a calf per cow per year is desired. In addition, cows may tend to feed right up until calving again, allowing no time to recover body reserves. This can have a detrimental effect on the new calf, especially if the first calf continues feeding.

Castration of male calves should be carried out as soon as possible after birth. Consideration may be given to leaving young meat animals entire, if the aim is to produce a young carcass at less than 15 months with tender meat and little fat.

Cattle are gregarious animals with a herd instinct. They develop social structuring within the herd. The herd instinct is important for maintaining daily natural rhythms such as eating, ruminating and resting. These rhythms should be considered as part of the management system - for example, the highest feed intake typically occurs at sunrise and sunset so interference at these times should be avoided.

Cattle are often run as separate mobs according to age, sex, condition and purpose. As an example, one enterprise that aims to turn off 14 month old animals weighing 400-420 kg runs three separate mobs, consisting of steers plus heifers for fattening, old cows with calves, and calving cows. The fattening steers and heifers mob get the best feed, and the old cows with calves get the next best feed. Yearlings are weaned at 12 months and go onto lucerne pasture to reach 400-420 kg at 14 months.

Pest/parasite and disease control

Regular and routine use of medication is not permitted in organic cattle production systems, and any need for treatments generally indicates management action should be taken to correct an imbalance in the farming system. The underlying cause of the problem needs to be identified and modifications made to the system to prevent it recurring.

Many veterinary problems are believed to result from mineral or vitamin deficiencies caused by soil imbalances. Prevention of disease rather than relying on treatments is the preferred approach to organic animal health.

Close observation and attention to individual animals is the key to early identification and treatment of pest or disease problems. Early treatment can be critical for the success of some natural remedies. Good record keeping may help find the origins of a problem.

The ability of an animal to fend off disease through its own defence mechanisms can be enhanced and nurtured by appropriate forms of good quality feeding and levels of production, and by creating the right environment so that stress and other factors do not impair natural resistance. Pastures which are too lush should be avoided.

The degree of immunity or resistance can vary depending on a range of factors. Detrimental effects on well-being and resistance may result from pregnancy and lactation, veterinary medication, vaccinations, contact with antigens, pesticide residues, contact with humans, nutrition, stress, shelter and weather conditions.

Young cattle can acquire a degree of resistance via colostrum and suckling. Colostrum is the starting point for building immunity, and suckling can also stimulate an immune response that can be passed from cow to calf.

A rigorous and ongoing culling program for susceptible and weak animals is very important to improve genetic traits related to pest and disease resistance.

A range of treatments including herbs, vitamins and minerals, homoeopathy, acupuncture and dietary additives are used by organic producers. However, routine use of such treatments should not be used to mask poor preventative management.

Homoeopathic remedies are being used by a number of organic producers. Homoeopathy treats diseases with extreme dilutions of substances which stimulate the level of resistance needed to overcome a disease rather than destroy organisms. Preparations called nosodes are sometime used as preventative treatment. They are similar to vaccines, but no antibodies are produced. The effectiveness of homoeopathic remedies is contentious and a high level of skill is required in deciding and administering treatment.

Mastitis

In general, mastitis is not as big a problem in low milk yielding beef breeds. Some producers in the United Kingdom have reported switching to homoeopathic treatments for mastitis without any adverse impact on their plate counts. A number of dietary supplements, such as dolomite and garlic, may have a positive effect on the control of mastitis.

Bloat

Bloat is usually not a problem when the general health of animals and pasture is improved, according to one biodynamic dairy farmer. The risk of bloat can increase when grazing very high clover (or other legume) content pasture. If bloat does occur, one homoeopathic remedy reported is to put 5 mL of chamomile in the trough to settle a cow's digestive system. The use of vegetable oils may be permitted for occasional treatment.

Grass tetany

This was a major problem for one producer in south eastern Victoria when farming with high conventional inputs and high stocking rates to try and boost productivity. Changes to improve soil health and balance plant nutrition reduced the problem, which is now treated by administering magnesium salts. Grass tetany can also result from excess potassium in the diet which is believed to lower the absorption of magnesium.

Parasites

Preferred parasite control measures involve husbandry and environmental management such as good nutrition, rotational grazing, mixed grazing and reduced stocking rates. The lower stocking rates adopted by many organic growers can benefit parasite control by providing a higher plane of nutrition, and aid the ability to spell or rotate pastures. Bought-in stock can also be a source of parasite introductions.

Internal parasites

Parasite control aims to reduce worm burden to an economically and physiologically acceptable low level - not necessarily eliminate it. Young stock or stock subject to stresses, like weaning or marking, are likely to be most susceptible and can benefit from clean pasture. Good nutrition is important to maintain natural resistance. Some producers believe that adequate copper in the diet prevents worm infestations.

Control of internal parasites in organic cattle can be achieved by rotational grazing management designed to achieve a clean grazing system. Clean grazing systems require a detailed understanding of the life cycle, seasonal cycle, and hosts, of problem parasites. Paddocks are designated according to parasite burden.

Clean paddocks are uncontaminated (usually after cropping or long period without host) and safe paddocks have low burden unlikely to affect production in susceptible animals. The availability of clean and safe pasture will vary over time and can be used strategically to prevent, evade or dilute parasite problems.

Safe or clean paddocks can be established by:

- spelling a pasture - duration varies to suit parasite life cycle, season and local circumstances;
- alternate grazing - grazing older resistant stock or different species first can reduce parasite numbers for following younger stock;
- mixed grazing - different ages or species run together can dilute worm burden while running susceptible age cattle together can increase risk – for example, combining sheep with cattle has been used to control internal parasites in cattle;
- strip grazing - prevents cattle feeding near their own recent faeces;
- cropping - breaks parasite life cycle, for example, a crop of mustard ploughed in as green manure is reported to clean up parasites; and
- hay making - provides a clean pasture after the paddock is spelled.

In dry summer areas the free living worm larvae tend to die faster (due to lack of moisture), so spelling a pasture during this period can be more effective in reducing an existing worm burden.

In summer rainfall areas, barber pole worm outbreaks can be sudden following heavy rains. Stock movements may need to be advanced to clean pasture to prevent expected worm burden.

Exposing worm eggs and larvae to sunlight, heat and drying by harrowing pasture after grazing may reduce worm burden.

Pasture herbage species are reported to influence worm numbers. Chicory and lucerne appear to be less conducive to roundworm larvae development, with lucerne perhaps offering an opportunity for reduced larvae intake.

Rotations and cell grazing techniques have been successful for internal worm control. Monitoring or testing parasite burdens is important to confirm the effectiveness of management strategies.

Close observation is a crucial factor. Despite the management techniques outlined, drenching individual animals with permitted substances (see Appendix 2) may be required on occasions. However, any drenching program should be on a needs basis only, rather than as a prophylactic treatment over the whole herd.

External parasites

Management strategies should be directed at the cause of high parasite numbers. Bad infestations of external parasites such as lice and ticks are believed to be related to poor or imbalanced nutrition, particularly where sulfur is deficient. Feeding cattle sulfur, either through the feed or directly in licks, can help keep animals free of lice.

Purchased animals can be a source of parasite introductions. New animals may need to be placed in a quarantine area and remedies applied until the risk of introducing parasites to other stock is low. Good fences are important to prevent neighbouring stock from introducing parasites.

As a last resort, a range of acceptable treatments are available. Derris can be used to control lice, and neem oil extracts and cattle rugs have also been used. A soil fungus is being developed by Queensland Department of Primary Industries as a biopesticide to control cattle tick.

Organic standards and certification

A grower who proposes to establish serious commercial production of organic beef should seek organic certification to verify that the product is truly organically grown in accordance with reputable organic standards.

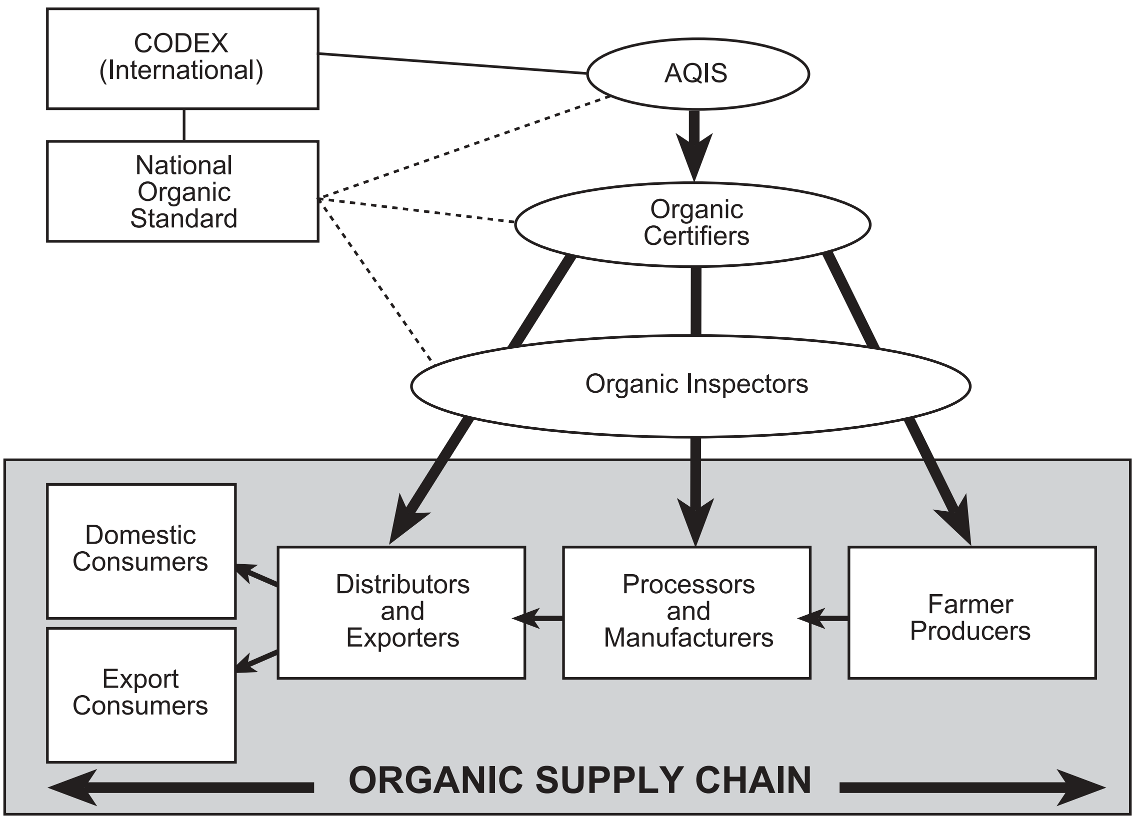
This section describes in general terms the requirements and procedure for gaining organic or biodynamic certification within Australia.

Background - Organic and biodynamic regulations in Australia

Internationally it is accepted that the veracity of claims on the labels of organic products must be underpinned by product and producer certification. The reputation and recognition of the organic certification system is often of great importance to importing countries.

Australia has a well-regulated system for organic and biodynamic production and processing that has gained a good international reputation. The 'National Standards for Organic and Biodynamic Produce', administered by Australian Quarantine Inspection service (AQIS) form the minimum mandatory requirements for export of products labelled as organic or biodynamic. These standards are implemented by seven independent AQIS accredited certification organisations, who conduct whole farming system inspections and ensure a comprehensive record keeping system is in place that allows trace back and verification of inputs used, management practices, yield and sales. Organic standards can also apply to processing and distribution, as shown in Figure 1, to ensure integrity of the certified organic product throughout the supply chain.

Figure 1. Certification Framework of the Australian Organic Industry



(Taken from: Comparison of the Australian National Standard for Organic and Biodynamic Produce with Key International Organic Standards and Regulatory Texts. By Mr May Rod and Dr Andrew Monk. Rural Industries Research and Development Corporation)

On the Australian domestic market no mandatory requirements currently exist regarding the labelling of products as organically grown. However, there is a trend across all markets for objective proof to support claims relating to product attributes. Most reputable retail outlets require independent organic certification by one of the AQIS accredited organisations for product labelled as organically grown.

Contact details of the seven AQIS accredited organic certifiers are listed in Appendix 1.

Organic Production Standards aim to:

- Protect consumers against deception and fraud in the market place and from unsubstantiated product claims;
- Protect producers of organic produce against misrepresentation of other agricultural produce as being organic;
- Harmonise national provisions for the production, certification, identification and labelling of organically and bio-dynamically grown produce;
- Ensure all stages of production, processing and marketing are subject to inspection and meet minimum requirements; and
- Provide a guide to farmers contemplating conversion to organic farming.

Copies of the national standards are available through the certifying organisations, Australian Government Bookshops and the AQIS web site (www.aqis.gov.au).

General requirements for organic certification

The 'National Standards for Organic and Biodynamic Produce' (OPAC 1997) provide a general definition of organic farming as follows:

Definition

"Organic farming means produced in soils of enhanced biological activity, 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. 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 over stressed by excessive uptake of soluble salts in the soil water (such as nitrates).

Organic farming systems rely to the maximum extent feasible upon crop rotations, crop residues, animal manures, legumes, green manures, mechanical cultivation, approved 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."

Aims

The principle aims of organic agriculture include:

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

Features

One essential feature of organic agriculture is the emphasis on biologically healthy, nutritionally balanced soil as the basis for healthy resilient (against pest and disease) plants.

Production avoids the use of synthetic fertilisers, pesticides, growth regulators and other chemical substances detrimental to nature. Genetically modified organisms are prohibited.

In practice, organic certification takes into consideration the whole farming system and typically requires a farm management plan, farm map and record keeping system. The grower must demonstrate and verify that a system is in place and operating in compliance with organic standards. This typically includes a sustainable crop rotation, and strategies to maintain soil fertility, control weeds, pests and disease, as well as water management and buffer zones.

High levels of chemical residues in soil from previous land use can disqualify land from organic certification, as can excessive contamination in plant or animal tissues. Buffer zones and windbreaks can be required to protect certified areas from contamination by adjacent properties. Organic growers should seek cooperation from neighbours who use chemicals on adjacent properties.

Where growers intend to value-add or process product, compliance with organic processing standards is required in order to retain organic certification over the final processed product.

Certification of all production, processing, handling, transport, storage, and sale of organic products is contingent on accurate up-to-date records of the enterprise concerned, to allow scrutiny of the products and processes. Records required typically relate to:

- rotations, soil cultivations and other treatments;
- inputs - type, source, application and timing;
- outputs - production and sales details.

Conversion Period

Provision can exist for part certification where part of a property is converted to an organic system while the remainder is farmed using existing conventional methods. Development plans for converting the entire farm to an organic system within a defined period can be required by some certifiers.

The usual progress towards full organic certification is as follows:

Year 0-1 = 'pre-certification' (no certification status).
Year 1-2 = 'in conversion' to organic certified.
Year 2-3 = 'in conversion' to organic certified.
After 3 years = full 'organic' certified.

During the first year of compliance no organic certification is granted. In the second year of compliance, certification as organic 'in conversion' may be granted. A system certified as organic 'in conversion' typically should progress to full 'organic' after a minimum of three years verified compliance with standards.

Penalties may be imposed for failure to comply with organic standards or breach of rules of certification. This may involve cancellation of certification or reversion to an earlier stage in progress towards full organic certification.

How to gain organic certification

Once you have decided that organic or biodynamic production has potential for your enterprise, follow these steps to become a fully certified producer:

- choose an organic or biodynamic certification organisation;
- read the organic standards;
- begin farm conversion;
- apply for certification;
- have farm inspected;
- inspection report submitted; and
- receive organic certification contract

Choose an organic or biodynamic certification organisation

Contact several organic or biodynamic certification organisations (see Appendix 1) about becoming a certified producer and choose one based on the verbal and written information gathered, on your enterprise needs and goals, fees involved and market requirements. To find out if there is a preferred or highly recommended certifier, set of standards and requirements (as these can differ – especially between organic and biodynamic), it may be helpful to contact existing certified producers, organic manufacturers and/or specialist organic retailers or major retailers selling organic products.

Read the organic standards

Read the organic farming or processing standards, which your farm must comply with. Producers must demonstrate a good understanding of organic farming principles and knowledge of practices and inputs permitted as well as those prohibited according to the certifier's organic standards. If there is little or no extension help offered before implementing and establishing changes to your production system, find out if there are any workshops or field days being run, or experienced organic producers willing to show you around their enterprise. Qualified farm consultants may also be available. Have soil samples taken and analysed prior to, during and following conversion to aid farm planning and management.

Begin farm conversion

Changes to the existing production system must be made – either all at once to convert the entire property, or in planned stages. The producer must demonstrate that an appropriate system is in place and that it successfully operates in compliance with the organic standards.

Apply for certification

When changes to the farming system have begun, application for organic certification can be submitted. Upon receipt of an application, the organic certifier will issue a farm questionnaire seeking all relevant details describing the farming system. Information to be provided includes land use history, rotations, inputs used, details of farming practices and a map of the property and surrounding land use. The questionnaire forms a Statutory Declaration relating to farm practices and inputs used.

Have the farm inspected

A site inspection by an experienced organic farm inspector will follow soon after the questionnaire has been returned to the certifier. The purpose of this inspection is to verify details of the farming system as described in the questionnaire, and to ensure the producer has a good understanding of the principles and methods of organic farming. As well as discussing the farming system, the inspector will view paddocks, crops, livestock, equipment, sheds and storage areas. The producer must also provide evidence of a complete documented audit trial covering all inputs used, output produced and sales details for all organic products. Soil samples or tissue samples may also be taken for testing.

Inspection report submitted

Following the inspection, the inspector compiles a report confirming details of the farming system established. This report, together with other relevant documents, is considered by the certifier to determine the appropriate level of organic certification. Specific conditions may be imposed where certain practices or circumstances require attention.

Receive organic certification contract

The certifier offers the producer a contract stating which land and crops certification applies to, and any conditions that must be met. Acceptance of the contract and payment of fees allows the producer to market and label relevant product as certified 'in conversion' or 'organic', and use the logo of the certifier on packaging and promotional material.

Organic certification contracts are generally subject to annual inspection of the site and a viewing of farm records. The producer is required to complete a statutory declaration confirming compliance with standards and detailing yields and sales figures for the year.

Producers may be subject to random, unannounced onsite inspections as part of obligations certifiers must fulfill to satisfy Australian Quarantine Inspection Service (AQIS) accreditation. Some properties may also be subject to inspection by AQIS representatives as part of the regulation of the certifying bodies.

Further Reading

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Simpson, P.C. (1997). Organic management of pastures. NSW Agriculture.

Appendix 1. Organic industry certification organisations accredited by AQIS as of June 2000

Bio-Dynamic Research Institute
POWELLTOWN VIC 3797
Phone: (03) 5966 7333
Fax: (03) 5966 7433

Biological Farmers of Australia Co-Operative Ltd
PO Box 3404
TOOWOOMBA VILLAGE FAIR QLD 4350
Phone: (07) 4639 3299
Fax: (07) 4639 3755
E-mail: bfa@icr.com.au

National Association for Sustainable Agriculture (Australia) Ltd
PO Box 768
STIRLING SA 5152
Phone: (08) 8370 8455
Fax: (08) 8370 8381
E-mail: nasaa@dove.mtx.net.au

Organic Herb Growers of Australia Inc.
PO Box 6171
SOUTH LISMORE NSW 2480
Phone: (02) 6622 0100
Fax: (02) 6622 0900
E-mail: herbs@lis.net.au

Organic Vignerons Association of Australia Inc.
1 Gawler Street
(PO Box 503)
NURIOOTPA SA 5355
Phone: (08) 8562 2122
Fax: (08) 8562 3034
E-mail: boss@dove.net.au

Organic Food Chain
PO Box 2390
TOOWOOMBA QLD 4350
Phone: (07) 4637 2600
Fax: (07) 4696 7689
E-mail: organicfoodchain@hotmail.com

Tasmanian Organic-Dynamic Producers
PO Box 434
MOWBRAY HEIGHTS TAS 7248
Phone: (03) 6383 4039
Fax: (03) 6383 4594
E-mail: plowe@vision.net.au

For more information on the production and marketing of Australian organic produce, contact the Organic Federation of Australia at the address below:

Organic Federation of Australia
P.O. Box Q455
QVB Post Office
SYDNEY NSW 1230
Phone: (02) 9299 8016
Fax: (02) 9299 0189
E-mail: info@ofa.org.au

Appendix 2. Input products for use in organic production

(From: National Standards for Organic and Biodynamic Produce)

2.1 Permitted materials for use in soil fertilising and soil conditioning

Substances	Specific conditions
Slurry from certified sources	-
Aerobic compost	Compost is the conversion of organic materials into humus colloids
Anaerobic compost	-
Straw	-
Mined carbon-based products such as peat, or coal Blood and bone, fish meal, hoof and horn meal, or other waste products from fish or animal processing	-
Seaweed or seaweed meal	-
Plant and animal derived by-products of the food and textile industries	-
Sawdust, bark and wood waste	From untreated sources
Basic slag only	Only after residue testing for heavy metals
Dolomite and lime	From natural sources
Gypsum (calcium sulphate)	From natural sources
Calcined or rock phosphate and other crushed mineral bearing rocks	Excluding those minerals which are more than 20 per cent soluble
Phosphoric guano	-
Rock potash and sulphate potash	-
Wood ash	From untreated sources
Sulphur	-
Clay, bentonite	-
Attapulgite	-
Perlite	-
Trace elements includes materials such as borax. Natural chelates are acceptable, e.g. ligno sulphonates and those using the natural chelating agents such as citric, malic, tartaric and other di- and tri- acids	Not synthetically chelated elements
Homeopathic preparations	-
Approved microbiological and biological preparations	-
Naturally occurring biological organisms (e.g. worms and worm castings)	Excluding products derived from genetic modification technology
Fish products	-
Zeolites	-
Vermiculite	-
Potassium glauconite	-

2.2 Permitted materials for plant pest and disease control

Substances	Specific conditions
Pyrethrum extracted from *Chrysanthemum cinerariaefolium*	Without piperonyl butoxide
Rotenone extracted from *Derris elliptica*	-
Quassia extracted from *Quassia armara*	-
Neem oil and extracts	-
Ryania extracted from *Ryania speciosa*	-
Propolis	-
Diatomaceous earth	In non-heat treated form
Stone meal	-
Meta-aldehyde baits	In traps or enclosed from the environment
Baits for fruit fly	Substances as required by statutory regulation and must be fully enclosed within traps
Copper, in forms such as Bordeaux mixture and Burgundy mixture	Hydroxide is the preferred form except for Bordeaux on dormant tissue
Sulphur in a wettable or dry form	-
Sodium silicate (waterglass)	-
Sodium bicarbonate	-
Potassium soap (soft soap)	-
Biological controls	Naturally occurring organisms and approved cultured organisms such as *Bacillus thuringiensis*
Pheromones	-
Granulose virus preparations	-
Essential oils	-
Vegetable oils	-
Light mineral oils (white oil)	-
Seaweed, seaweed meal, seaweed extracts, sea salts and salty water	-
Homoeopathic preparations	-
Natural plant extracts, excluding tobacco, such as garlic extract, etc. and used as a repellent, antifeedant or pest/disease control	Obtained by infusion and made by the farmer without additional concentration
Potassium permanganate	-
Carbon dioxide and nitrogen gas	-
Vinegar	-
Wetting agents	Caution needs to be exercised with product which may be contained in some commercial formulations of the above products. Acceptable wetting agents include some seaweed products and plant products

2.2 (cont) Permitted material for animal pest and disease control

Substances	Specific conditions
Pyrethrum extracted from *Chrysanthemum cinerariaefolium*	Without piperonyl butoxide
Rotenone extracted from *Derris elliptica*	-
Quassia extracted from *Quassia armara*	-
Neem oil and extracts	-
Garlic oil, garlic extract or crushed garlic	-
Seaweed, seaweed meal, seaweed extracts, sea salts and salty water	-
Sulphur	-
Potassium permanganate	Homoeopathic preparations
Natural plant extracts obtained by infusion	Excluding tobacco
Essential oils	-
Methylated spirits	-
Tallow	-
Cider vinegar	Certified organic
Nettle	-
Diatomaceous earth	Non heat-treated form
Selenium and other trace elements	To correct identified deficiencies only
Zinc sulphate	-
Copper sulphate	-
Vitamins	-
Biological controls	-
Charcoal	-
Clay	-
Vaccines	May be used only for a specific disease which is known to exist on the organic farm or neighbouring farms and which threatens livestock health and which cannot be effectively controlled by other management practices
Wetting agents	Caution needs to be exercised with product which may be contained in some commercial formulations of the above products. Acceptable wetting agents include some seaweed products and plant products

Appendix 3. Understanding soil conditions: Alternative concepts

Management of soil fertility for biological systems has attracted a number of alternative approaches to understanding soil conditions and plant growth. The following outlines indicate several concepts for consideration.

Dr Rudolf Steiner - was the initiator of the concepts that form the basis of biodynamic agriculture. Biodynamic farming is a method designed biologically to activate the life of soil and plants. Plants are fed naturally through the soil ecosystem and not primarily via soluble salts in the soil water. Essential features relate to the use of special preparations and other techniques that enhanced soil biological activity, humus formation and soil structural development as the basis for allowing plants to selectively assimilate nutrients as dictated by sun warmth and light.

Dr William Albrecht - was primarily concerned with a soil fertility approach based on nutrient balance (or ratios) as the foundation for achieving proper fertility relevant to optimal plant growth. The nutrient balance equations he developed are related to soil total exchange capacity. Ideal ratios or percentages of cations and anions are defined for different soil types, with the total availability of these nutrients generally increasing (except magnesium and manganese) with their percentage saturation. The optimal base saturation (cation exchange) ratios are 60 per cent Ca, 20 per cent Mg on sandy soil and 70 per cent Ca, 10 per cent Mg on heavy soil, with 3-5 per cent K, 10-15 per cent H and 2-4 per cent for other bases. The relative values and relationship between nutrients, especially Ca and Mg is considered of great importance.

Dr Carey Reams and Dr Phil Callaghan - this work is based on the concept of defining the potential for plant growth and fertiliser performance in terms of energy release and energy exchange. The contention is that fertilisers in themselves did not stimulate plant growth. It was the energy released (electromagnetic influence or paramagnetic energy fields) from these fertilisers that enhanced production. A distinction is made between fertilisers (nutrients) that produce growth energy, i.e. calcium, potash, chlorine, and nitrate nitrogen, to those that produce reproductive (fruiting energy), i.e. ammonium nitrogen, sulphate sulfur, manganese and phosphate. The approach also involves a proposition that the nutrient energy potential was dependent on microbial activity, and that energy availability is determined by nutrient balance. The approach also argues that phosphate is the primary catalyst in photosynthesis and subsequent plant sugar production. Increasing sap sugar levels (brix) is believed to reduce susceptibility to pest and disease attack and that plant sap sugar levels is directly related to plant pest and disease susceptibility.

Various approaches and analyses relating soil conditions and plant growth continue to be developed and a vast array of alternative input products are available. Scientific verification of many of these contentions and products has yet to be established. As a consequence the decision to adopt particular approaches tends to rely on anecdotal information and experience rather than rigorous scientific testing and understanding.

Appendix 4. A herbal ley pasture seed mixture

(Taken from 'Grasp The Nettle - making biodynamic farming and gardening work', by Peter Proctor, Random House, New Zealand. 1997.)

Note: This mixture was developed by Grasslands, DSIR (now AgResearch) for New Zealand conditions (temperate climate). It contains legumes for nitrogen fixation; many deep-rooted species which tolerate drought, increase soil porosity, and access more minerals; several herbs with high mineral content; and species which give a low risk of sheep facial eczema. Not all species will grow in all districts. Sow in early autumn or early spring. Recommended sowing rate is 11.5 kg (25 lb.) per acre. The species in the mixture are in approximate balance on a seed-weight basis. Consult local agronomists for other species which grow well in your district.

1. *Chicory* - 'Puna': a persistent deep tap-rooted pasture herb which is high-producing, high in minerals and has high-quality summer forage. Excellent animal performance has been recorded with this species. It is suited to free-drainage soils.
2. *Yarrow* - a mineral-rich forage herb, persistent, with an extensive *rhizome* system.
3. *Sheep's Burnet* - a fast-establishing perennial herb producing palatable summer forage. Performs well in dry, low-fertility sites and withstands cold winters.
4. *Plantain* - narrow-leaf plantain: deep-rooted summer-growing herb.
5. *Trefoil* - a deep-rooted legume, non-bloating, excellent summer growth, particularly suited to dry, acid, low-fertility soils.
6. *Lucerne* - 'Oranga': deep tap-rooted legume, very drought-tolerant, producing quality summer forage.
7. *Sulla* - 'Aokau': short-lived perennial legume, rapid establishment, very productive during winter. Produces non-bloating forage.
8. *Subterrranean Clover* - an annual legume, low-growing, with excellent winter growth, able to persist through vigorous reseeding, thus surviving dry summers.
9. *Pink Serradella* - 'Koha': a deep-rooted winter annual legume, tolerant of acid soils.
10. *White Clover* - 'Pitau': a persistent legume adapted to a wide range of environments. Creeping, prostrate habit with a network of spreading stolons.
11. *Red Clover* - 'Pawera' and 'Hamua': a tap-rooted perennial legume. Produces high-quality summer forage and is drought-tolerant. Early and late flowering types combined.
12. *Prairie Grass* - 'Matua': a perennial grass with a good winter growth. Best suited to higher-fertility soils which are free-draining. Grows well during winter and dry summers.
13. *Yorkshire Fog* - 'Massey Basin': a perennial grass, very palatable. Grows well on low-fertility and acid soils.
14. *Browntop* - 'Muster': pasture browntop suitable for low-fertility and acid soils. A perennial grass with a dense *rhizomatous* growth habit.
15. *Hybrid Ryegrass* - 'Greenstone': a persistent tetraploid hybrid ryegrass, very palatable. No endophyte, giving excellent winter and spring growth. Tillers strongly.
16. *Cocksfoot* - 'Wana': a perennial ryegrass with a deep root-system, well adapted to dry, low-fertility soils. Active over the summer.
17. *Phalarus* - 'Maru': perennial grass with active cool-season growth. Tolerant of dry, harsh environments and of insect pests, including grass-grub.
18. *Timothy* - 'Kahu': high forage-quality grass, especially good on moist sites.