Factsheet

Organic Crop Rotation

Why do I need a crop rotation?

A balanced rotation is the cornerstone of an organic system. It;

- Varies the demands on the soil
- Provides the nutritional requirements of each crop
- Limits the spread of diseases
- Controls weeds
- Breaks pest lifecycles
- Reduces nutrient loss, and
- Helps to build up soil fertility

Rotations should be designed to suit individual farm conditions and marketing strategy, as well as taking into account the following basic principles:

- Shallow rooting crops following deep rooted crops
- High root mass crops following low root mass crops
- Weed susceptible crops following weed suppressing crops
- Nitrogen fixing crops following nitrogen demanding crops

The organic standards

Organic Standards require that certain principles are observed when designing and implementing a crop rotation:

- **A balance must be achieved between fertility-building and exploitative cropping**
  Harvesting the saleable portion of cash crops inevitably results in the removal of nutrients from the soil. These must be replaced, which can be achieved by the inclusion of fertility-building crops in the rotation. In addition, composted farmyard manure and some permitted organic fertilisers may be applied.

- **Rotations must include a leguminous crop to provide nitrogen for subsequent crops**
  The roots of legumes are colonised by bacteria that take nitrogen from the air and convert it into a form that can be used by plants.

- **Crops with differing root systems must be included within a rotation**
  Using crops with different root systems in a rotation helps to utilise nutrients at different depths in the soil, as well as maintain a good soil structure, manage weeds and stimulate soil organisms.

- **Plants with similar pest and disease susceptibilities must be separated by an appropriate time interval**
  The build up of soil-borne diseases such as potato cyst nematodes, onion white rot or club root in brassicas can be prevented by growing non-susceptible crops
  for three or four years after a susceptible crop has been grown. Many soil-borne nematodes and pests which inhabit the soil at some stage in their life cycle can also be avoided or controlled in this way. As a result, the SA organic standards require a minimum of three seasons before potatoes, alliums and brassicas can return to the same area of land.

The exception to this is indoor greenhouse production, where due to the limited range of crops grown a crop rotation is recommended, but not required.

Recommendations

The organic standards also highlight the following good practices to consider when designing a rotation, though they are not a requirement:

- **Minimise the time that the soil is left uncovered**
  More nutrients are leached from uncovered soil than from soil with a cover crop. Therefore nutrients can be conserved in the system by planting a green manure when the ground would otherwise be bare. This can be incorporated back into the soil at the appropriate time, making the nutrients available for the next cash crop.

- **Maintain or increase the organic matter levels in the soil**
  Fertility-building crops and other materials such as composted farmyard manure help to gradually increase levels of organic matter in the soil. This is vital for improving soil structure and also provides a reservoir of nutrients that gradually become available to the crops.

- **Vary weed susceptible crops with weed suppressing crops**
  Certain crops are more susceptible to weed infestations than others. Weed problems can be reduced if weed-susceptible crops, such as carrots or parsnips, are grown after crops that have the capacity to suppress weeds, such as potatoes.

Designing a rotation

1. Collect information about the site

To help design a rotation it is useful to have as much information as possible about the site; what was grown there before? How intensive was it? What thrived and what didn't? Have there been any pest and disease problems?

The certifying body will also usually suggest that a soil analysis is taken and submitted to them before organic conversion begins. It is a worthwhile exercise to take a full soil analysis that covers the soil composition (e.g. proportions of sand, clay, silt, peat and loam); the organic matter content; the pH; and the soil's nutrient status (available and unavailable nitrogen, potassium, phosphorus, calcium, magnesium and trace elements).

Annual soil analyses carried out at the same time each year can then monitor changes throughout the rotation, and practices can be amended accordingly.

2. Consider market outlets

Typical outlets for organic produce are wholesale and marketing co-operatives, supermarkets or a direct marketing system. Often a co-operative will need to know the acreage of each crop a grower intends to supply each year, and cropping plans may need to be adjusted according to what the co-operative can market. Supermarket buyers will also need to know the cropping plan, and continuity of supply within a specified period or season may be important.

If it is intended to direct market a wide range of crops, different varieties and successive sowings will need to be grown to supply the range of produce for as long as possible over the year. This can make rotation planning complicated, but the wide range of crops grown can also ensure that a more robust rotation for pest and disease management can be used.

3. Consider potential crops

Plants from the same family tend to be prone to the same pests and diseases so it is essential that crops from the same family are not grown on the same site in successive years.

Vegetable plant families	Example crops
Chenopodiaceae	Beetroot, Spinach, Swiss Chard, Spinach Beet
Cucurbitaceae	Cucumber, Squash, Courgette, Pumpkin, Marrow, Melon
Apiaceae	Carrot, Celeriac, Celery, Fennel, Parsley, Parsnip
Fabaceae/ Leguminosae	French Bean, Runner Bean, Broad Bean, Pea, Clover, Alfafa, Lupin, Trefoil, Vetch
Amaryllidaceae	Garlic, Leek, Onion, Shallot
Solanaceae	Aubergine, Pepper, Potato, Tomato
Poaceae	Sweet Corn, Grazing Rye, all other grasses
Brassicaceae	Brussels Sprouts, Broccoli, Kale, Cabbage, Swede, Kohlrabi, Cauliflower, Calabrese, Radish, Turnip, Mustard, Oriental Brassicas

Other factors to consider include the crops' nutrient demands and rooting depth. High nutrient-demanding crops should follow the fertility-building phase so that the best use is made of the first flush of available nutrients. Where possible, alternate deep rooting crops with shallow ones to use nutrients at different depths.

Harvesting time also influences the order of crops in a rotation. For example autumn-sown crops need a clear site in the summer and/or autumn to allow the necessary cultivations, and so are restricted to following crops that are out by the summer. Conversely summer-sown crops such as winter brassicas normally follow overwintered vegetables or green manures, which leave the land free earlier than any spring-sown crop.

The harvesting procedure is a factor in addition to the harvesting time. For example harvesting field scale carrots in a wet autumn can churn the land up and damage soil structure, meaning that a structure-building ley has to follow.

4. Think about green manures and building fertility

Fertility-building green manures are divided into the following categories; legumes, non-legumes, one growing season, two or more growing seasons.

> **Legumes:** Legumes that can be used as a green manure include clover, vetch, trefoil, beans, peas and Lucerne. These crops have an association with nitrogen-fixing bacteria which take nitrogen from the air so that it becomes available to the crop and eventually to other crops via the soil. In addition some deep-rooted legumes are able to extract nutrients from deep soil and improve drainage.

Non-legumes: Non-legumes that may be used as green manures include grazing rye, phacelia, mustard, chicory and grass. These crops do not increase the nitrogen content of the soil, however they keep the ground covered and take up nutrients that would otherwise be leached. Grazing rye, which is especially good at doing this, grows relatively quickly in the autumn, making it a good overwintering cover crop. Incorporating these green manures back into the soil releases nitrogen that can be used by following crops.

5. Look at example rotations

A typical rotation might start with a 2 year fertility-building ley, followed by a 3 year cash cropping phase. The cash crops could be potatoes or a brassica, onions or leeks and finally a deep-rooted crop such as carrots or parsnips.

Fertility-building phase:
Whilst under organic conversion a two-year fertility building phase is common. Often a grass/clover ley on a stocked system will be grazed. If the holding has no stock the ley should be mown every three to four weeks during the growing season, at a cutting height of 12-15cm, and the mowings left to rot down. Regular mowing or grazing is essential to stop weeds setting seed and to maximise the general productivity of the sward.

Where land is already organic and under arable/horticultural production a one year fertility-building period for every three years of cash cropping may suffice. However, this system is only suited to well structured soils, and green manures need to be fitted in between cash crops wherever possible e.g. over the winter. This type of rotation is also likely to require supplementation with composted manures.

A rotation that relies solely on fertility-building crops for nitrogen supply will probably need a longer fertility-building phase, for example two years of grass/clover ley followed by two or three years of cash cropping (and short term green manures wherever possible), then returning to two years grass/clover ley.

Cash cropping phase:
After the fertility-building phase cash cropping can begin. Normally a high nutrient-demanding crop, such as potatoes or a brassica, is grown first. These crops will make the best use of the large amounts of nutrients that become available when the ley or green manure is first turned in. Due to their growth habit and the cultivations they require, potatoes are also good at keeping the land free of weeds.

The second crop will usually be a vegetable that can make use of some residual fertility and can benefit from the weed clearing abilities of the previous crop e.g. onions and leeks. The last crop in the rotation is usually a low nutrient demanding crop e.g. carrots or parsnips. When the rotation has completed one full cycle it should return to a fertility-building crop.

6. Plan the rotation

Draw a year planner to cover a full cycle of the rotation and divide the years up into months. Mark in when the crops are to be planted and harvested to see at a glance if the rotation is going to be feasible. Avoid excessively long gaps between crops; some can be filled with a green manure, but longer ones might indicate that the rotation is too generous and needs to be altered. Remember that the rotation is not written in stone; it will need to be continually adapted to take into account the demands of the market, pest and disease problems or nutrient balance.

If the land is in conversion mark in the planner when the land will reach full organic status. You can then check that crops you intend to market as organic will be planted after that date.

7. Consider:

a) Nutrient budgets

Calculating a nutrient budget can give a rough indication of whether a rotation is balanced by estimating the overall nutrient gains and losses for its duration. If necessary the rotation can be adjusted to make the figures balance, or manures and allowable fertilisers can be applied to correct any deficiencies.

b) Financial budgets

A financial budget can be used to compare the financial returns from different rotations. The simplest way to do this is to use Gross Margins (output minus variable costs). See Organic Farm Management Handbook (Organic Research Centre) for more details.

As important as the financial budget is, there is little point in examining the financial implications of a rotation if it is not first balanced nutritionally. The ideal is to maximise financial returns from the rotation at the same time as maintaining a nutrient balance.

c) Labour and machinery demands

Organic holdings require constant management and operations need to be carried out in a timely fashion, so rotations must be planned to facilitate the labour requirements. The year planner showing each year of the rotation should help identify any labour requirement clashes.

d) Balancing the range of crops

In practice, a rotation is easiest to plan and manage if the holding is divided into the same number of areas as there are years in the rotation. For example, a four-year rotation will work best if the holding is divided into four areas, or multiples of four. This may be tricky if the holding is not converted to organic status in one go.

In some cases parts of a holding may need to follow a different rotation in order to balance the acreage under fertility-building crops with cash crops in order to achieve the right balance of crops for marketing.

8. Monitor the rotation

All rotations require constant monitoring, not just for nutrient status but also for subtle soil structure changes whether for the better or for the worse. Symptoms that may reflect a problem include gradual changes in the land such as staying wet for longer, more passes required to make an adequate tilth, compaction at deeper layers, and fewer earthworms being found in the soil. Deterioration in soil conditions means that the rotation is not sustainable and must be reassessed. Alternatively if these aspects are improving you know you're on the right track!

Factsheet

Useful websites or publications

Horticulture Research International (HRI)
http://www.hriresearch.org/

National Institute of Agricultural Botany (NIAB)
http://niab.com/

East Malling Research
http://www.emr.ac.uk/

Garden Organic
http://www.gardenorganic.org.uk/

www.soilassociation.org Tel: 0117 314 5100
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