

Rotations in organic and agroecological growing systems

TECHNICAL ADVICE SHEET

1. The importance of rotations

Crop rotations are a cornerstone of organic and agroecological growing systems. They have several important functions including:

- Building and maintaining soil fertility
- Enhancing soil biology and especially microbial activity
- Improving and restoring soil structure
- Managing weeds, pest and diseases

2. Rotational blocks

Crops are allocated to 'rotational blocks', which are the basic units of rotation system. These blocks are groups of plants that have similar characteristics, including:

- Botanical family
- Pest and disease susceptibility
- Weed susceptibility
- Nutritional demand
- Fertility building capacity

Typical rotational blocks are described below.

2.1 Fertility building crops

These are the engine room of organic and agroecological growing systems. In a typical rotation they will account for 30 – 40% of the total outdoor cropping area at any one time. They are the principal way in which soil fertility is built and maintained. They are essential to building organic matter, which in turn supports soil life and has a vital role in developing and maintaining a good soil structure.

Legumes, such as clovers and vetches, fix nitrogen by forming a symbiotic relationship with nitrogen-fixing soil bacteria – rhizobia - that live in the root nodules. Historically, fertility building mixtures have consisted predominantly of legumes and rye grass. More recently, most growers have moved toward diverse herbal leys. Some typical species and their functions are summarised below.



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Family	Species	Primary functions
Legumes	Vetch (crown, hairy); Clover (red, white, crimson, berseem, sweet); Lucerne (common, crown); Sainfoin; Yellow trefoil	Nitrogen fixation; Biomass
Grasses & cereals	Triticale; Rye; Wheat; Barley; Oats; Ryegrasses	Weed suppression; Biomass; Enhancing soil structure
Herbs	Buckwheat; Chicory; Linseed; Phacelia	Biodiversity; Biomass; Enhancing soil structure

During their lifetime, fertility building leys are cut and mulched, or grazed/ cut for hay or silage in mixed systems and the manure returned. At the end of fertility building phase they are terminated usually by shallow ploughing, harrowing or rotavating.

2.2 Potatoes

Potatoes have a high nutrient demand, especially Phosphorous and are therefore usually the first or second cash crop in the rotation. They are weed suppressing. Potato Cyst nematode is a major concern and you should aim to leave long as possible - and a minimum for 4 years - between potato crops.

2.3 Brassicas

Brassicas are the largest and most economically important family in horticulture. They are also demanding in terms of nutrients, especially Nitrogen and therefore also are often the first crop or second crop after fertility break. They are also generally weed suppressing. The soil borne disease Clubroot is serious risk to production which is mainly controlled by rotations. You should leave as long as possible - and a minimum for 4 years - between brassica crops.

2.4 Alliums

Alliums (typically onions, leeks and garlic) are moderate in terms of nutrient demand, and often go in after Brassicas. Because of their upright growth habit, they are weed susceptible, so follow weed suppressing crops such as brassicas and potatoes. Allium white rot is a major challenge, which mainly managed through rotation. Again, you should leave as long as possible - and a minimum for 4 years - between Allium crops.

2.5 Roots

This group is defined by the cropping system rather than the botanical family and includes crops such as Carrots, parsnips, beetroot, celeriac. They are moderately demanding in terms of nutrients, and moderately susceptible to weeds. Because this is more diverse grouping, pests and diseases that are specific to individual plant families are less of an issue.



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2.6 Others

This is 'catch all' group for everything else, and might include crops like lettuce, chard, squash, legumes, sweet corn etc. On the whole, they are moderately demanding in terms of nutrients and variable in their susceptibility to weeds. This is a very diverse block, so persistent pests and diseases are less of a concern in this block.

3. Putting your rotation together – Outdoor crops

3.1 Key considerations

You should try and make your rotations – and the fertility building phase in particular - as long as possible. However, you will have to balance this against the need to run a viable business, and having large areas of land out of cash crop production for long periods may be challenging. As a rule, you should aim for a minimum of 4 years between blocks, and the fertility building phase will typically be 2 out of every 5 – 7 years.

During the cash crop phases of the rotation, you will need to supplement fertility during the cash crop years – short term green manures between crops/ over winter; undersowing; composts and manures.

3.2 Process

1. Decide on how many rotational blocks you need.
2. Work out the area of each crop you to grow to supply your market using the crop planning spreadsheet tool available in [this](#) google folder
3. Divide your land into as many roughly equal parcels as you have blocks. The number of parcels allocated to fertility building corresponds the number of years the ley is down for: If you have 2 years of fertility plus 5 cash crop blocks each down for 1 year you will need 7 parcels
4. Use the pie chart on the crop planning spreadsheet to adjust your cropping areas so you have a balanced rotation – i.e. each block is of a roughly equal size
5. Draw up a plan allocating rotational blocks to each parcel for each year of the rotation. Examples are given below.



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	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Parcel 1	Fertilty	Fertilty	Potatoes	Brassicas	Alliums	Roots	Other
Parcel 2	Other	Fertilty	Fertilty	Potatoes	Brassicas	Alliums	Roots
Parcel 3	Roots	Other	Fertilty	Fertilty	Potatoes	Brassicas	Alliums
Parcel 4	Alliums	Roots	Other	Fertilty	Fertilty	Potatoes	Brassicas
Parcel 5	Brassicas	Alliums	Roots	Other	Fertilty	Fertilty	Potatoes
Parcel 6	Potatoes	Brassicas	Alliums	Roots	Other	Fertilty	Fertilty
Parcel 7	Fertilty	Potatoes	Brassicas	Alliums	Roots	Other	Fertilty

Credit: Iain Tolhurst, Tolhurst Organic Partnership

Parcel	Year 1	Year 2	Year 3	Year 4	Year 5
1	Fertilty	Potatoes/ overwintering GM	Brassicas	Alliums	Peas, beans, spinach family, roots
2	Peas, beans, spinach family, roots	Fertilty	Potatoes/ overwintering GM	Brassicas	Alliums
3	Alliums	Peas, beans, spinach family, roots	Fertilty	Potatoes/ overwintering GM	Brassicas
4	Brassicas	Alliums	Peas, beans, spinach family, roots	Fertilty	Potatoes/ overwintering GM
5	Potatoes/ overwintering GM	Brassicas	Alliums	Peas, beans, spinach family, roots	Fertilty

The inclusion of maincrop potatoes and brassicas mean that this rotation requires relatively large amounts of land. Composted manure or compost, up to 25t/ha (10t/acre) applied where appropriate

Credit: Roger Hitchings

Parcel	Year 1	Year 2	Year 3	Year 4	Year 5
1	Fertilty	Brassicas	Peas, beans, lettuce, other salads	Alliums	Spinach family, roots
2	Spinach family, roots	Fertilty	Brassicas	Peas, beans, lettuce, other salads	Alliums
3	Alliums	Spinach family, roots	Fertilty	Brassicas	Peas, beans, lettuce, other salads
4	Peas, beans, lettuce, other salads	Alliums	Spinach family, roots	Fertilty	Brassicas
5	Brassicas	Peas, beans, lettuce, other salads	Alliums	Spinach family, roots	Fertilty

Compost applied in Year 4. Typical winter green manures include grazing rye and vetch as single crops or as a mixture

Credit: Roger Hitchings

3.3 Common challenges

There are many challenges you will face, but these are a few of the most common

- **Too many brassicas!** The importance of brassica crops to the business on the one hand and limited land on the other often makes it difficult to balance rotations. There are a several



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approaches you could take. You could reduce number/ increase area of blocks. For example, you could source potatoes from another grower or wholesaler, freeing up additional land on your site, or consider accessing additional land from local farmers and growers. You could also combine the 'roots' and 'other' blocks, so each block is larger.

- **New or different markets emerge.** You have little flexibility with respect to the potato, brassica and allium blocks, but can play around with the species composition of the others to meet your market's needs
- **Irregularly shaped parcels.** If you have the flexibility to change the layout of the farm, think about the best configuration of your blocks, taking into account for, example whether you need to include headlands for machinery to turn and the minimum row length that is practical for all crops in the rotation – It may be fine to grow beans in triangular piece of land, but down the line there will be potatoes on that block.

4 Putting your rotation together – Protected crops

4.1 A different approach to fertility

Protected cropping is often the economic powerhouse of a market garden business, and there is pressure to maximise production and income from polytunnels and glasshouses. In practice this means usually more than one crop is grown on the same bed in the same year, and intercropping is very common. From a fertility building perspective it is rarely, if ever, economic to put entire polytunnels down to year-long leys, let alone for multiple years. We therefore need to take a different approach to rotations and fertility building in protected crops.

In terms of fertility this different approach could include:

- Greater use of composts and manures
- Short term green manures between winter and summer crops.
- Undersowing tall crops with green manures
- 'Transfer' mulching (green manure is grown outside and cut, and brought in)
- Using mobile structures such as caterpillar tunnels, or mobile polytunnels. Fertility is built in outdoor rotations and you take the structure to the crop – effectively making long term fertility leys economic for protected cropping. This approach is used mostly for summer crops because winter storms carry a high risk of damage to temporary structures.

4.2 Protected cropping rotations

For all the reasons above, rotations under cover are more flexible compared to outdoor crops. It is still important to leave gaps between different families/ groups of crops, but the time between crops of the same family is often much shorter. You should also try and group crops with the same growing conditions together. For example, cucumbers favour lower humidity compared to tomatoes, so ideally you want to grow them in separate tunnels so you can manage the humidity according to the needs of the crop.



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It is difficult to set out rotation guidelines in the same way we have for outdoor crops, but below are some examples which put the principles above into practice.

	Season	Crop
Year 1	Summer	Tomatoes
Year 1	Winter	Second planting brassica leaves
Year 2	Summer	Climbing french beans, early courgettes
Year 2	Autumn	First planting brassica leaves
Year 2	Winter	Early beetroot/ carrots
Year 3	Summer	Fertilty
Year 3	Winter	First planting brassica leaves
Year 4	Summer	Cucumbers, Peppers
Year 4	Winter	Second planting brassica leaves

Source: R Hitchings (2009) in 'The Organic Vegetable Grower, Phil Sumption

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	Lettuce / Spinach					Clover				European Brassica			
2	European Brassica			Early Cucurbit					Leaf beet / Chard				
3	Leaf beet / Chard			Solanaceae (tomato)								Oriental Brassica	
4	Brassica > Umbelifer / Allium / Legume / Herbs > Lettuce / Endive												
5	Lettuce / Endive > Umbelifer / Allium / Legume / Herbs >												

Credit: Pete Dollimore, Hankham organics



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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Brassica					Clover				Leaf beet		
2	Leaf beet		Solanaceae (pepper / aubergine)							Oriental Brassica		
3	Oriental Brassica					Late Cucurbit				Endive / Chard		
4	Endive / Chard / Lettuce > Umbelifer / Allium / Legume / Herbs > Eur. Brassica											
5	Brassica > Umbelifer / Allium / Legume / Herbs >											

Credit: Pete Dollimore, Hankham organics



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