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Rotations for Field Vegetables Technical Guide

Mastering rotations for organic, agroecological
and regenerative vegetable production



Agriculture

About this guide

This guide is designed to support growers in planning their cropping sequences in time and space. We will talk through the need for rotations, the fundamentals of rotation design, the practical considerations needed for their effective implementation, and some real world examples. We look at the tools available to help rotation planning, such as nutrient budgeting, and discuss how complex agroecological practices such as agroforestry, living mulches and the integration of diversity impact on rotations. Horticultural cropping systems are in any case complex, considering the number of crops grown, especially for growers concentrating on direct sales. While the principles of rotations and rotational design apply to all scales of production, and also for protected cropping, for this guide we concentrate on field rotations. The author, Phil Sumption, is writing from many years of experience of organic vegetable production, with much of the material in this guide adapted from [‘The Organic Vegetable Grower’](#) published by Crowood Press. However, rotations are not the exclusive preserve of the organic grower and this guide should be useful for any grower or potential grower on a journey or transition towards more sustainable growing.

Why do we need rotations?

Rotations entail keeping closely related crops together and growing them sequentially on one plot of land over different years. Rotations have been around as long as agriculture itself. In terms of history, they have only briefly gone out of fashion with the ‘green revolution’ and monocropping made possible by high levels of external inputs. Rotations are traditionally very important to organic farming systems, and fundamental to ensure that diversity is designed into the farming system in time and space. Despite ‘Natural Farming’ systems challenging the paradigm (see Shumei Natural Agriculture facing page), rotations remain the principal tool in the organic and regenerative grower’s box for managing soil fertility, weeds, pests and diseases.





Shumei Natural Agriculture farm in Yatesbury, Wiltshire

Shumei Natural Agriculture

The concept of Shumei Natural Agriculture was developed by the Japanese naturalist and philosopher Mokichi Okada in the 1930s in Japan who said: *“The principle of Natural Agriculture is an overriding respect and concern for nature.”* Naturally, that precludes the use of fertilisers, but not just artificials – the belief is that any fertiliser inhibits the soil’s natural ability to enrich itself. Soil is considered ‘perfect’ and contains all that is needed for healthy plant growth. Health starts with healthy soils. The use of ‘natural compost’ is permitted, and is not considered a fertility input, but is used for improving the soil temperature, keeping the soil ‘temperate’ and for ‘softening the soil.’ The principal of consciousness guides all life processes and extends to all that grows. Pests are not considered as such, and the principle of non-intervention extends to the prohibition of organic pesticides. The most challenging aspect of Shumei Natural Agriculture is the absence of rotations, with continuous cropping to allow crops to become accustomed to the soil they grow in and wider environment with plants building up resistance to pests and diseases. Seed-saving and adaptation is an important part of this. Science is starting to reveal how the seed biome adapts to its environment over time, and we are learning more about mycorrhizal associations with crops, which can help to explain to an extent how these systems can work. Spirituality is integral to the philosophy, as is a pure mind, gratitude and humility. A caring attitude towards the soil and crops is key – water and soil respond to our hearts, they say.

Fundamentals of rotation design

Inclusion of legumes

The use of legumes which can fix nitrogen (N) biologically is a crucial element of rotations, in order to replace N extracted from the soil by crops ([see page 8 & 9](#)).

Balancing fertility-building and exploitative cropping.

The fertility-building period is crucial to the whole rotation and grass-clover leys and cover crops should be considered as important crops and managed accordingly. It is also a good time to apply phosphorus (P) and potassium through manures and composts, and when needed, lime.

It can be tempting to focus on cash crops and provide N primarily through imported manures, composts or bought in fertilisers. This is, however, contrary to the organic farming principle of self-reliance. There are opportunities to fit short-term fertility-building crops, including quick-growing legumes, into the rotation as alternatives to the traditional two-year grass/clover ley. It is a misconception to consider cropping legumes, such as broad beans, runner beans and peas as fertility-building crops, as any N that they fix is removed in cropping. In N terms they should be considered at best as 'N neutral' crops.

Manures and composts are best applied during the fertility-building phase of the rotation. Further guidance on manures, compost and application rates can be found in Nutrient Management Guide ([RB209](#)).

Lime, when needed on acid soils is recommended to be applied to the fertility-building phase prior to brassica cropping to reduce clubroot risk.



Separating plants according to family or needs

Crops within the same family groups are subject to the same pests and diseases. Allowing time to pass before similar crops return to the same piece of land breaks the reproductive cycle of pests and soil-borne diseases. For alliums, brassicas and potatoes a minimum three-year gap is recommended (up until 2019 it was mandatory in the Soil Association organic standards), but where possible it should be longer, especially when there are known problems. In intensive market gardens there is often a demand to fit more brassica cropping into the rotation, as these are popular crops. As a result, we are seeing many new growers getting club root problems, which may be due to too many brassicas in their rotation with insufficient time periods between them.

Heavy feeding crops, such as brassicas and potatoes, are often placed at the start of the rotation after the fertility-building period. Lower nutrient-demanding crops can come later in the rotation. For some crops it is not just about the nutrients they need, but also there can be adverse effects from too many nutrients (especially with fresh manures), either in the form of excess soft foliage rather than roots or fruit, or hairy root growth and fanging of e.g. carrots. Soft growth of vegetables due to plentiful N can also make plants vulnerable to pest attack.

Rotations should alternate, or balance, deep-rooting crops with shallow-rooting ones in order to improve soil structure and allow access to nutrients from different parts of the soil profile.

Biodynamic growers also classify their crops into leaf, root, flower and fruit groups. The principle is that though crops like spinach, lettuce and cabbage are from different families, they share similar needs, and the grower can concentrate on practices that are focused on those needs, such as N supply for leaf development. For root crops, N should be restricted, and supply of potassium is more important. The groupings are used to plan work, based on the biodynamic sowing and planting calendars.

Crop	Feeding requirement	Root depth	Weed competition	Biodynamic grouping	Years between crops	
Alliums						
Onions	Low	Shallow	Weak	Roots	At least three, preferably longer	
Leeks	Medium	Shallow	Weak	Stem		
Garlic	Low	Shallow	Weak	Roots		
Chenopods (Beets)						
Beetroot	Medium	Medium	Medium	Roots		
Leaf beet/chard	Medium	Medium	Medium to strong	Leaf		
Spinach	Medium	Shallow	medium	Leaf		
Compositae						
Chicory	Low	Deep	Medium	Leaf/root		
Lettuce	Medium	Shallow	Medium	Leaf		
Endive	Low	Shallow	Medium	Leaf		
Brassicas						
Brussels sprouts	High	Shallow	Strong	Leaf	At least three, preferably longer	
Cabbage	High	Shallow	Strong	Leaf		
Calabrese	High	Shallow	Strong	Leaf		
Cauliflower	High	Shallow	Strong	Leaf		
Kale	Medium to high	Shallow	Strong	Leaf		
Kohl rabi	Medium	Shallow	Medium	Stem		
Swedes	Medium	Medium	Medium	Root		
Oriental brassica salads	Medium	Shallow	Medium	Leaf		
Radish	Low	Shallow	Medium	Stem		
Cucurbits						
Courgettes	Medium	Deep	Strong	Fruit		
Squashes/pumpkins	Medium	Deep	Strong	Fruit		
Legumes						
Peas	Low	Medium	Weak	Fruit		
Broad beans	Low	Medium	Medium	Fruit		
Runner beans	Medium	Medium	Strong	Fruit		
French beans	Medium	Medium	Strong	Fruit		
Solanaceae						
Potatoes	High	Shallow	Strong	Roots	At least three, preferably longer	
Umbellifers						
Carrots	Low	Medium	Weak	Roots		
Celery	High	Shallow	Strong	Stem		
Celeriac	Medium	Shallow	Medium	Roots		
Fennel	Medium	Shallow	Medium	Stem		
Parsnips	Low	Deep	Weak	Roots		
Miscellaneous						
Sweetcorn	Medium to high	Shallow	Strong	Fruit		

Table 1: Plant families (field veg) and their rotational characteristics (Adapted from the Organic Vegetable Grower, Crowood Press)

Weed competition

Some crops are more competitive against weeds than others, so it is good practice to include in the rotation some 'cleaning crops' like potatoes that will be easy to manage and suppress weeds. Fertility-building leys and green manures/cover crops also give a break from the cycle of annual weeds, during which weeds are controlled by mowing, and/or suppressed by competition.

Most weeds have peak times of year for germination, so by growing a range of crops with different sowing or planting times sown or planted at different times should help avoid particular weeds proliferating. If particular weed species are a problem in your system, look into understanding their biology and look at what opportunities there are in the rotation to tip the balance towards the crop rather than the weed.

Keeping the soil covered

This is not only a key principle of regenerative farming. Good planning of the rotation is needed to maximise cropping and avoid bare ground and potential nutrient losses due to leaching.

Other factors

There can be other good reasons for particular sequences of crops in rotations. One example is to crop alliums after brassicas, as when brassicas are incorporated into the soil this can have a suppressing effect on allium white rot. In continental Europe, many organic growers avoid growing potatoes or roots directly after a fertility-building ley that includes grass due to the risk of wireworm damage.

Harvesting times also influence the order of crops in a rotation: for example, leeks planted in mid-summer are best to follow an early harvested crop, such as early potatoes or spring cabbage, or a green manure.

For the no-till grower the sequence of cropping needs to consider the bed preparation requirements of following crops. Following a (non-winter-killed) cover crop with a drilled crop such as carrots is not recommended.

Some cover crops can have an allelopathic effect (releasing biochemicals that inhibit the germination and growth of other crops). This can inhibit crop germination in the following two to three weeks but doesn't affect transplanted crops.

Practical considerations

The market will determine what crops you grow, but the rotation will set the limits. The quantities of each crop grown may be tweaked according to demand or performance on your site. If you are farming on a specific piece of land, the amount of one crop or crop family you can grow will be limited by the size of your rotational blocks. Therefore, the longer the rotation (number of years), the less of each group you will be able to grow in one year. For some crops that have specific associated pest or disease problems, longer rotations or gaps between cropping are recommended. For many crops, especially ones outside the main crop families, you can be a bit more flexible. Quick-growing crops like lettuce, for example, can be fitted in wherever.

There may be other occasions when flexibility is needed. Mechanical harvesting may cause soil damage that needs to be addressed through use of deep-rooted cover crops such as lucerne. Time out of the rotation may be required to deal with an infestation of perennial weeds through cultivations and/or the use of cover crops.

The more intensive the market garden, the more complicated the rotational planning will be. It can be sensible to have a separate rotation for the more labour-intensive crops, alongside a rotation for field crops. Fields are rarely equally sized or uniformly shaped, so you may need to be creative when setting up your plots. If rotational blocks are not equally sized, you will have years when there is too much of one crop group and not enough of another. Field corners or odd shapes that don't fit easily into a plot plan can be planted with perennial vegetables, fruit or energy crops or used for nature conservation. Rotational plots can be marked out clearly with beetle banks, agroforestry strips or paths. It is important to allow enough space for vehicular access, irrigation considerations and to avoid shade from trees or buildings. Nature may not like straight lines, but evenly-sized rectangular blocks can make the grower's life a lot easier!

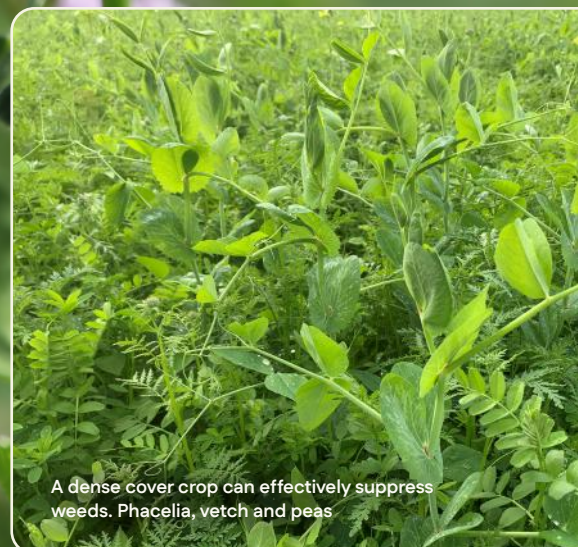


There may be other occasions when flexibility is needed. Mechanical harvesting may cause soil damage, that needs to be addressed through use of deep-rooted cover crops, such as lucerne.



Your market determines the crops you grow

Lucerne is deep-rooted and can help restore damaged soil structure



A dense cover crop can effectively suppress weeds. Phacelia, vetch and peas

Fertility-building leys

In traditional organic farming systems legumes such as a red or white clover and grass are included as part of a long-term fertility-building ley. The advantages of a long-term grass/clover ley are:

- For farmers converting to organic certified production, it can help kick-start soil fertility and provide time needed for building infrastructure, markets and knowledge.
- It creates a break in the rotation, allowing soils to recover after intensive cropping and reducing risks of pests and diseases in the rotation.
- It is an opportunity to reduce weed burdens through suppression/competition, and control perennial weeds through cultivations.
- It provides grazing opportunities for livestock.
- It provides food for pollinators.

However, for more intensive stockless horticultural systems, it is a period of the rotation that does not directly bring in money through cash cropping, so the temptation can be to keep the period as short as possible. One option is to use it as an undersow, so that it is ready to grow when the crop is removed. Another option is to use shorter bursts of green manure crops such as vetches, which can be grown over winter and produce high biomass in the spring.

The grass component is usually perennial ryegrass due to its ease of establishment, yield, persistence, and quality (grazing) in the maritime climates of western Britain. However, on dry sandy soils cocksfoot is a better choice, and timothy is particularly suitable for cutting regimes. Grass is an important component of leys as it takes up the N fixed by the legumes, reducing the risk of leaching, and stimulating the legume rhizobia to fix more N. The grass also raises the C:N ratio prolonging the release of N to following crops. The inclusion of grasses can build leatherjacket and wireworm populations, however. Also, it is more difficult to get rid of in no-till situations and may require multiple cultivations for incorporation to prevent re-growth.

The clover component is commonly red clover, due to its productivity, but it can be susceptible to pathogens and parasites, such as stem eelworm

(*Ditylenchus dipsaci*) and Sclerotinia. 'Double cut' varieties are needed for quick re-growth after cutting. Large-leaved white clovers are better suited to cutting than smaller-leaved varieties. White clovers can also get white clover fatigue, associated with clover cyst nematode, so it may be sensible to alternate the clovers in mixes, use lucerne (alfalfa), or go with more diverse mixes including birdsfoot trefoil, lucerne, yellow trefoil, sainfoin and crimson clover. More complex mixtures can provide greater resilience to extreme weather events, better suppress weeds, extend forage availability for pollinators, and decompose slower with better utilisation of N by subsequent crops.

Management is key, as the fertility-building ley can be considered the most important 'crop' in the rotation.

That entails providing a good firm seedbed for establishment, with irrigation if necessary. On fertile soils leys may need to be mown every two to three weeks – the normal advice is to cut at knee length to ankle height – but of course knees and ankle heights will vary! Regular cutting will keep the ley productive and the weeds under control. If the ley is allowed to grow too high, there can be an excess of material which mulches out re-growth. Cutting and removing (for example as silage, or as transfer mulch) will increase N fixation. Undersowing tall crops such as beans, sweetcorn and brassicas can be a good way to save time and get the ley established. Otherwise, early autumn sowing will avoid peak weed flushes.

The length of time the ley is in the ground will depend on the intensity of the farm system, and whether the ley has another purpose, for example grazing. In any case, the annual accumulation of N in the ley will decrease after two years.



Grass/clover ley

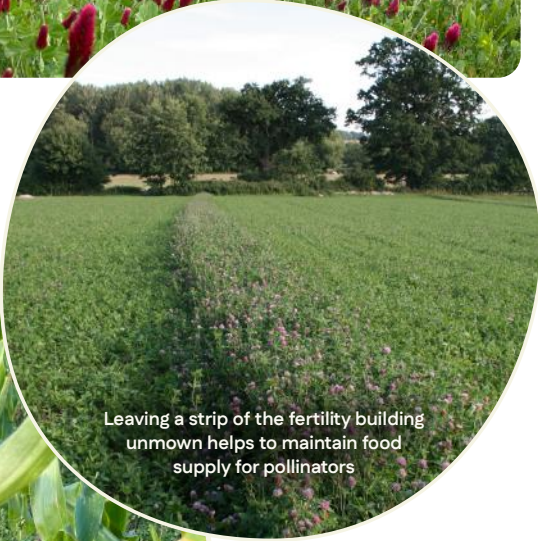


Sweetcorn crop with ley

Crimson clover ley



Leaving a strip of the fertility building unmown helps to maintain food supply for pollinators



Diverse cover crop at Abbey Home Farm. See case study



Top undersown clover

Note on incorporating cover crops

In organic farming cover crops are usually incorporated through cultivations. In systems aiming to reduce tillage and herbicide use, various strategies can be used, such as the use of annual cover crops, or those killed by frost, or that can be terminated by the use of a roller-crimper. On a small scale, tarps (plastic sheets) can be used though this has potential issues of soil contamination.

Cover crops and green manures

The terms cover crops and green manures tend to be used interchangeably as crops grown for the benefit of the soil; to retain nutrients (reduce leaching), boost N through fixation, and feed the soil through adding organic matter. They tend to be short-term in use, filling gaps in rotations, whereas fertility-building leys are in for longer periods. While it is easy to focus on leguminous green manures such as vetches, clovers and trefoils, they will not fix much N over the winter period, making the timing of incorporation crucial, as an extra few weeks in the spring can make a big difference to the amount of N fixed. Therefore, it is crucial to plan them in properly to rotations to make the best use of them. Also, there are many non-leguminous green manures that have useful functions. Cereal or 'grazing' rye (*Secale cereale*), with its large fibrous root system, is extremely effective at retaining N and can be sown as late as mid-October in some areas. Buckwheat can be an effective tool against couch grass, and is also a P lifter, making P available to subsequent crops. Phacelia is another quick-growing summer green manure that is also an excellent nectar provider for bees and other beneficials.

There can be many advantages of growing single species green manures – simplicity of sowing, establishment and management. It is worth getting to know which species work well on your land. However, we can also extend the principle of diversity to green manures. There is increasing interest in green manure mixtures backed up by growing evidence that diversity above the ground is linked to diversity below ground.

Australian soils ecologist Dr Christine Jones emphasises the importance of fungi in transporting carbon compounds around the soil and supplying energy to the bacterial community. Diversity of plants is needed as a variety of different leaf structures can intercept more light, increasing photosynthesis and the rate root exudates draw down carbon through the fungal pathway. Below ground, plants from different groups cooperate with each other sharing microbes from each other's microbiome. Her message is to prioritise diversity and recommends including at least one mycorrhizal plant (e.g. oats, barley, rye, vetch, linseed) in a cover crop mix.

There are some simple established mixes that work well such as vetch and rye for over-winter, but it is worth experimenting with different species that grow well in your sowing or cropping window. Many growers also throw out-of-date vegetable seeds into the mix for added variety!

≡ Arable rotations with vegetables

While vegetables are normally grown on a vegetable holding with a permanent rotation, they can also be grown as part of a wider farming system – an arable farmer diversifying into vegetable production for example, or a grower entering into an agreement with an arable farmer to rotate vegetables around the farm. There are advantages for the grower, as the vegetables can be grown on ground that should be clean of pests and diseases. It may be a few years before returning to the same field, which means the usual needs of balancing crop families and having more brassicas in the rotation than is healthy don't apply. If it is a share farming agreement then primary cultivations and muck spreading could be done by the farmer, meaning less machinery requirements. On the other hand, arable farms are less likely to have irrigation, and electric fencing may be required to keep rabbits, badgers and the like out of the crops.

🌿 Mixed farming systems with vegetables

A mixed farm that includes grazing land might also incorporate arable and vegetable crops into the rotation. In mild coastal locations like Cornwall traditionally they would follow (at least) three years of grass/clover with early potatoes and winter cauliflowers and a summer re-seeding of the grass leys. Animal manure from grazing animals (normally dairy or beef suckler herds) would provide fertility.

📶 Nutrient budgeting and monitoring your rotation

Nutrient budgets are useful tools to help farmers and growers make the right nutrient management decisions. They can help to evaluate the viability (in nutrient terms) and sustainability of rotations, to make optimum use of available nutrients, and to indicate surpluses of N that could leach and pollute ground and surface water. As part of the budget, the quantity and nutrient content of all inputs (seeds, manures, mulches, animal food) is calculated, including N fixation, together with outputs as crops, meat and livestock (see Table 2). Losses due to leaching are also included.

Soil analysis at a fixed point in the rotation can also aid understanding of how a rotation is performing. However, yield monitoring, regular crop health observations and gut instinct are also vital.

🕒 Rotations as guide not dogma

It is important to be flexible in your approach to rotations. Unforeseen changes in market demand for crops or marketing systems (wholesale, direct, catering etc) can mean adjustments are needed. Monitoring may indicate that fertility-building periods need to be increased or reduced. Perennial weeds may need dealing with and land taken out of production to allow cultivations or the use of allelopathic cover crops. In short, the world can get in the way of the ideals. Therefore, it is useful to look at real life examples of rotations on farms and how they have developed and changed and why, which leads us into our case studies.



Table 2: Nutrient offtake for vegetable crops

Crop	Approximate yield (t/ha)	N	P		K		
		Approximate offtake					
		Kg/t	Kg/ha	Kg/t	Kg/ha	Kg/t	Kg/ha
Potatoes	36	2.7	97.2	0.6	58.32	4.9	285.8
Cabbage	30	3.4	102	0.4	40.8	10	408.0
Calabrese	7	2.3	16.1	0.3	4.83	22.2	107.2
Lettuce	20	1.4	28	0.2	5.6	25	140.0
Leek	12	2.8	33.6	0.4	13.44	8.2	110.2
Onion	20	1.4	28	0.3	8.4	9.6	80.6
Carrot	36	1.2	43.2	0.3	12.96	8.3	107.6
Swede	30	1.1	33	0.4	13.2	9.1	120.1

Adapted from Watson et al. (IOTA, 2010)



“It is important to be flexible in your approach to rotations. Unforeseen changes in market demand for crops or marketing systems (wholesale, direct, catering etc) can mean adjustments are needed.”



Case study:

Andy Dibben at Abbey Home Farm

“The systems approach is key. There are so many different things you’ve got to manage in your head as an organic grower – your cash crop, fertility building, weed management, pest management. Rotation is the key tool for integrating all of those in an efficient way.”

[Andy Dibben](#) is head grower at Abbey Home Farm, a diverse mixed, family-owned 650 hectare (ha) / 1,600 acres (ac) farm near Cirencester in the Cotswolds. Andy grows a wide range of vegetables and fruit on 6 ha (15 ac), including an intensive market garden, polytunnels and glasshouse cropping, to supply their thriving farm shop. We focus on his field rotations.

Field rotations

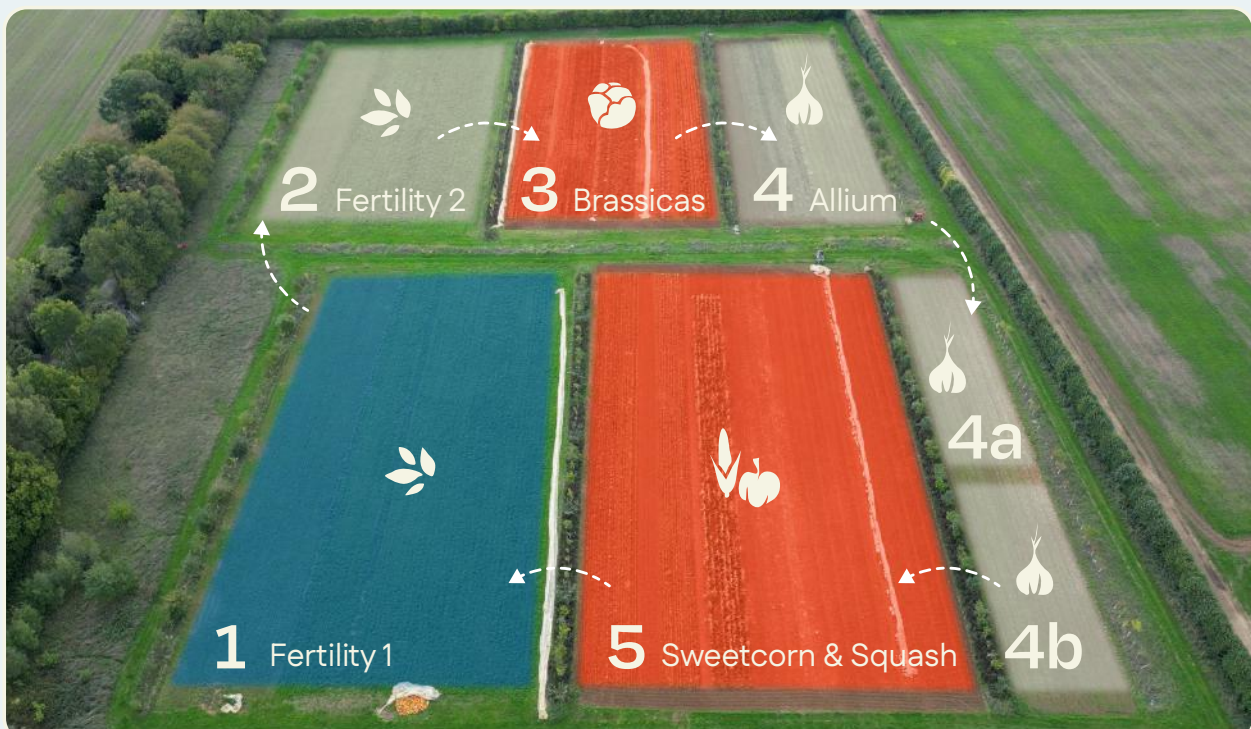
We have two field scale rotations, and they are based around two things. I have two fields with very different soils. I also need more brassicas than anything else to meet the demand from the farm shop.

Rotation one (2 ha / 5 ac)

Year One	Multi-species fertility-building ley
Year Two	
Year Three	Winter/long-season brassicas
Year Four	Alliums – main crop onions and leeks
Year Five	Sweetcorn, squash (undersown with fertility-building ley) and main crop beetroot

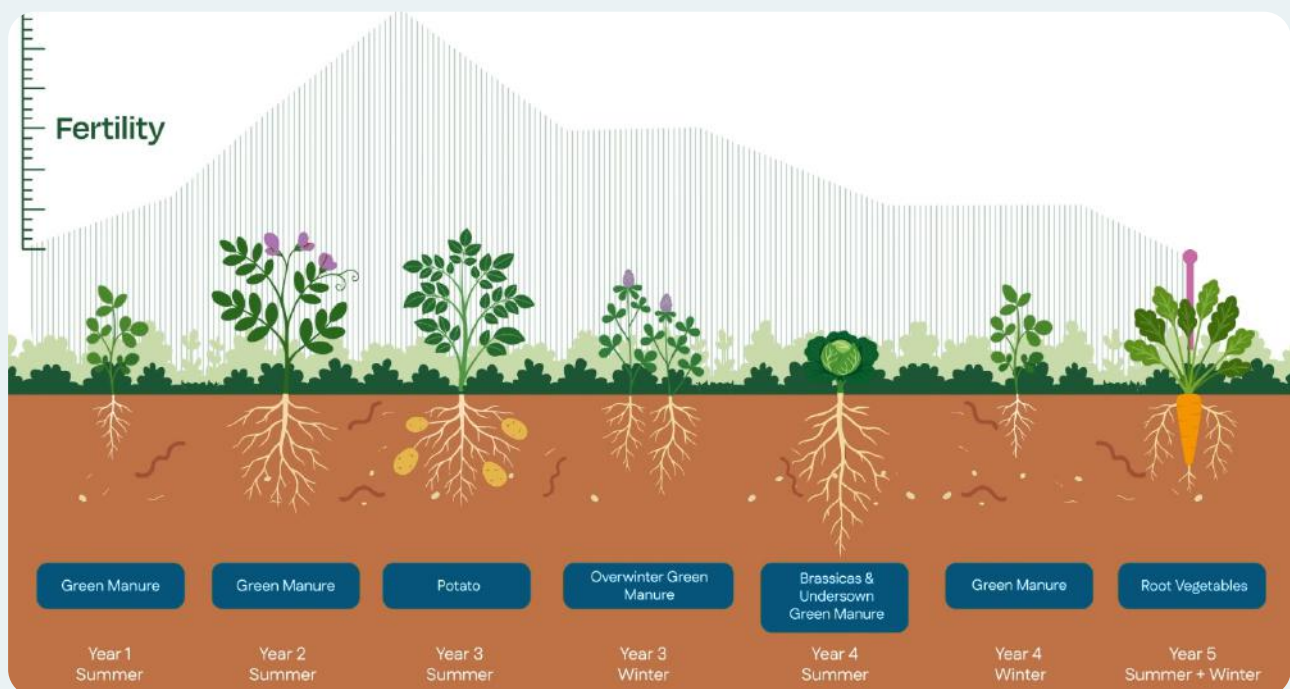


We're on Cotswold brash which is inherently stony, but we call this field 'The Patio' as it so stony! Therefore, we don't grow any crops that need drilling or mechanical harvesting.





Rotation two (2 ha / 5 ac)



Year One	
Year Two	Multi-species fertility-building ley
Year Three	
Year Four	Potatoes
Year Five	Early season or summer brassicas followed by a leguminous green manure
Year Six	Roots: carrots and parsnips

This field is more loamy and thus more suitable for drilling root crops and mechanically harvesting potatoes.

We're currently changing this six-year rotation into a five-year rotation because our footfall and demand is going up, so it feels like having a 50/50 rotation (three years of fertility, three years of cash cropping) is a bit luxurious. It gives me lovely crops, but I need more crops, so we're reducing the fertility-building period to two years to align with the other rotation.

How did the rotation develop?

I inherited the veg system here which had been going for seventeen years under the previous grower. I took over from him ten years ago and he hadn't settled on a field scale rotation. We're on very difficult soil here and I think he was eternally in search of better soil and the rotation went around many of the different arable fields close to the shop and cafe.

From an infrastructure point of view – mainly rabbit fencing and irrigation logistics – I took the decision to settle the rotation down into permanent locations to stop having to move and re-fence new fields a lot.

Now I've got agroforestry systems everywhere, so I can't move them. That is a constraint. It also defines the rotational plots.



Key elements of the rotations

Fertility building

We use no farmyard manure or compost. I need cash crops, but I build up fertility with a long fertility-building ley – I would never do less than two years – and then throughout the rotation, maintain fertility. An example of that is we manage to fit a leguminous green manure in after the summer cropping brassicas (Rotation 1). If it was all one rotation, I would be double cropping the brassicas. So that gives me a little bit more time and space to effectively use green manures.

“I feel green manures can do everything. I don't think I need manures – too much nitrogen is a danger. I'm still living with the legacy of fat hen from manure brought on to the land.”

It's designed to be a green manure system with under-sowing winter green manures and summer green manures wherever possible during cash cropping, as well as the original fertility build at the beginning. They are my most important crops, and they get the same attention to detail with ground preparation that I give my cash crops.

In Rotation 1 the fertility-building ley goes in the last cash-cropping year, undersowing sweetcorn and squash in July with a multi-species mix, including clovers, cocksfoot grass, phacelia, buckwheat, and loads of perennial and annual wildflowers. This is sown at 30% more than the recommended rate as I broadcast it. Undersowing squash: I've got ten 100 metre rows and I walk every row and put all the runners in a straight line, do the last weed, broadcast the seed with a fiddle drill by hand, roll it with a hand roller, and then irrigate it or let the rain water it in, if I'm lucky.

In Rotation 2 we finish the rotation with carrots and parsnips that we hand dig all the way through the winter. The soil structure is damaged, and we end up with quite a high weed burden. So, I spend a bit of time in the next spring/early summer knocking the weeds back and just getting a nice tilth and then in late May/early June we sow the fertility-building ley.



Fertility-building and green manure seed mixes

Our basic fertility-building mix is Cotswold Seeds' *Humus Builder Soil Structure Improver Two-Four Year Mixture*:

- 53.3% Garant red clover 9.9 kg/ha (4 kg/ac)
- 40% Treponso cocksfoot 7.4 kg/ha (3 kg/ac)
- 6.7% Puna/Endore chicory 1.23 kg/ha (0.5 kg/ac)
- I add some Cotswold Seeds' Yellow Trefoil/White Clover Intercrop Mixture to all long term mixes to aid longevity and weed suppression.
- 60% AberAce wild white clover (small-leaved) 4.5 kg/ha (1.8 kg/ac)
- 40% Virgo Pajbjerg yellow trefoil (black medick) 3 kg/ha (1.2 kg/ac)

I add a small amount of Cotswold Seeds' Cotswold Wild Flora (29 species of native perennial and annual wildflowers and grasses) to all long-term mixes, to add diversity, restore the natural seedbank, and because it is good for natural pest management.

I also put a handful of Cotswold Seeds' Cornfield Annuals Mixture in all my green manures, for natural pest management benefits and to stock the seedbank with good stuff. I weed out if not wanted, or allow to flourish if not a problem, depending on where it is in the rotation or cash crop maturity.

Over-winter green manures: If being sown before end of August/mid September or going to stay in till midsummer the following year, I sow a Cotswold Seeds' Quick Mix supplemented by the cornfield annuals mix.

- 20% Pirat mustard 3 kg/ha (1.2 kg/ac)
- 10% Iris fodder radish 1.5 kg/ha (0.6 kg/ac)
- 21.7% Alex berseem clover 3.2 kg/ha (1.3 kg/ac)
- 25% Opolska crimson clover 3.7 kg/ha (1.5 kg/ac)
- 8.3% Sweet clover 1.2 kg/ha (0.5 kg/ac)
- 8.3% Sirius Persian clover 1.2 kg/ha (0.5 kg/ac)
- 6.7% Krynia red clover 1 kg/ha (0.4 kg/ac)

If later than mid-September I generally use Phacelia.

Seed rates shown are Cotswold Seeds' recommended rates. I sow 30% higher as I broadcast the seed.





Managing the ley

After sowing the ley, it normally explodes with a huge burden of fat hen which I let grow to just before the viable seed stage and then top to about 30 centimetres (cm). That tends to knock it out and we're left with a nice thick, well established green manure. I do that with all my green manures. We cut and flail it in place, which drops it evenly over the field. I had previously used a rotary topper which would mulch out one of the wheelings.

This year with the drought, last year with the floods, the fertility- building leys suffered. Getting them established is getting harder in an increasingly unpredictable climate. This year the fat hen went to seed at about 10 cm tall, which is challenging. I've taken a ride-on mower out over one of the leys because I couldn't get a topper to go low enough.

Cash crops

The crops grown are determined by our market (the farm shop), with crops needing more attention grown in the market garden or protected cropping areas, and by the equipment available or needed. We sometimes double crop, for example new potatoes come out early enough that I can do a bit of ground preparation before planting garlic in November. The ground is ready in September and then we let it sit there and get a weed strike in if the weather's right before we plant. We also intercrop. For example, this year we alternated 1 Brussels sprout and 2 kohlrabi plants in the row, then we crop the kohlrabis out and the Brussels sprouts take over. We also put in middle rows – growing lower short season catch crops in-between kales and purple sprouting broccoli.

Pest control

Rotation is a key natural pest management tool. Fertility-building leys have got so many flowers. They are huge breeding grounds for beneficial insects and are managed accordingly.

After the three- year ley with grass in it, we can get a small amount of wireworm, but not at commercially damaging levels. I think our soil type (shallow and stony) is not good for wireworm, as it is not as big an issue here as in other places.

Leather jackets

When the ley is followed by brassicas, we plough one third of the area in the previous August, so it is bare during the flight time of the crane fly, then we establish Phacelia to hold nutrients and protect the soil over winter. We don't plant the other two thirds till late May when leatherjackets have emerged and flown.





Care

Onions, brassicas, potatoes are kept as far apart as possible in the rotation, at least five years. With brassicas, we're a bit lucky as we're on alkaline soil and clubroot is kept at bay by our pH. In a dry year like this (2025) we get some white rot problems in the field but mostly it is in check. It's an old system getting on for twenty seven years of cropping the same land organically, so we have to be careful.

Flexibility and weed management

All the rotations are a work in progress, and I'm always up for changing them. I didn't like coming out of winter brassicas into carrots in one of the rotations, so we've just moved it around a bit and put summer brassicas a year ahead of carrots. It gives me a bit of time to stop cropping the field and put a green manure in. This is about reconditioning the soil, not so much about fertility. It's more about improving soil structure and weed management ahead of carrots.

This year there is a bit of a couch problem where the sweetcorn is (due to the wet season last year), so I haven't undersown it because I want to do some couch bashing (cultivations) after it's finished. I'll put in an overwinter green manure... I'm very flexible with the green manures.

There are some positive signs that if we graze green manures with sheep rather than cut them, it has a better controlling effect on creeping thistle.

I quite like my six-year rotation because it gave me some wiggle room. It gave me the opportunity to jump forward a year and stick buckwheat anywhere I wanted in the rotation to deal with couch if we get out of control, so I quite like that. But I think now with increased demand I've got to make better use of my land for cash crops.





Planning and monitoring your rotation

We crop plan with excel spreadsheets using cascades, looking at the crop rotation to identify gaps in time and space. Then there are two questions. 1) Can I get a cash crop in? 2) Can I get a green manure in? If we have at least eight weeks, we can build N in the summer with a green manure. On the field scale, because we're space luxurious, almost always the answer is 'put a green manure in.'

I soil test once in a rotation, always at the end. If I'm honest, I take a cursory glance at that soil test, it pretty much says similar things every year. I know the answer to almost all the problems is organic matter, and that is either to add compost or green manure, depending on what part of my system I'm in. I judge my rotations by gut feeling, crop observation, and knowledge of preceding weather, and it's a long-term view. For example, the last two years of insanely heavy rain caused N leaching which I saw evidence of in long-season brassicas in their colour and their vigour.

We have low P indices and we've been using a lot more buckwheat in the rotation, so it'll be interesting if that's brought our P up. Using ramial woodchip – ultimately from the agroforestry but currently 50/50 from the estate/tree surgeons – is my long-term plan for addressing P. We see manganese deficiency symptoms every year on long season brassicas and as our soil tests show really good levels of manganese, we put that down to lock up due to our high pH.



Photo shows: 11 polytunnels 200 m² each,
2 propagation polytunnels 36 m² each, 9 0.4 ha (1 ac) blocks divided
by agroforestry fruit trees – 2 of these are in veg production annually,
6 in herbal leys 3 year rotation, 0.4 ha (1 ac) permanent wild flowers
for pollinators and 7000 m³ reservoir



Case study:

David Newman at Bucksum Salads

“Rotation is key. Because we’re not using any artificial inputs or anything to help with pest control, rotation makes sure that we’re not perpetuating problems in the soil which would harm the crops and make the system not viable”

David Newman and Tracy Russell grow 1.6 ha (4 ac) of seasonal vegetables on a 6.5 ha (16 ac) holding on David's parents farm in Buckinghamshire. Celebrating twenty years as a business partnership, they are solely funded by the production and sales of 40+ plus crops, mainly direct to the customers through their own farm shop and a few restaurants.

Field rotation

We have two ac (0.8 ha) of open field production and up to two ac (0.8 ha) of covered polytunnel production, which has a separate seven-year rotation. We have a four-year rotation in the field with two one-ac (0.4 ha) blocks of vegetables which rotate around the field.



Rotation

The start of the rotation is the end of the herbal ley, then the next spring we will plough to get our seed beds and then everything is cropped in those open field areas for that twelve-month period. At the end of that cropping year we establish the herbal ley by minimal cultivations, then that's going to run for three years, generally grazed by sheep and the minimum amount of topping just to stop things seeding.

In the last three years we've started also putting AberAce white clover between the beds as a living mulch. So in the year that we're taking the cash crop off we're also feeding the soil with this clover and establishing it.

Year One

Year Two

Year Three

Year Four

Herbal ley

Mixed vegetable cropping

How did the rotation develop?

We started off nearly twenty years ago experimenting with baby leaf salad and for a long time that was really all that we were selling. Then once we had set the farm shop up, we had to start growing more crops. We now grow up to 40 different crops. The rotation has developed into one acre plots, plus the protected crops for winter salads and to extend the season. We grow really early potatoes in polytunnels, but we also have a small area of outdoor potatoes which we've been planting through straw and that's been working quite well. We're trying to reduce our cultivations and suppress weeds and save any mechanical movement of the soil as much as possible.



“We are farming in a regenerative way; we don't use any artificial inputs. We're not registered organic. We're fairly mechanised which means we can survive on a fairly small labour force.”

Key elements of the rotations

Fertility building

The open field cropping is wholly fed by the herbal leys. The break in the cropping from a cash crop with three years of herbal ley and the sheep is what's feeding that soil. We don't put any extra nutrients on the soil and we are making our own compost for the polytunnels.

Herbal fertility builder three-year mix

- Applied at 27.2 kg per ha (11 kg per ac)
- *Lofa festulolium*
- Calibra tetraploid perennial ryegrass
- AberEve tetraploid hybrid ryegrass
- Donata cocksfoot
- AberSwan white clover
- Avisto red clover
- Aurora alsike clover
- Puna / Endure chicory blend
- Leo birdsfoot trefoil



Sheep grazing the herbal ley

Managing the ley

The herbal ley is quite diverse with different grasses, chicory and clovers included. They are grazed by somebody else's sheep and he manages them the whole time. We just say which plots are to be grazed and the sheep are moved around through the growing season as and where they're needed. It's a small flock – 15 to 20 maximum – mostly ewes so less troublesome. It's not a high number, but it saves us having to use fossil fuel to top it. We've got the manure coming from them, which is helping with the microbes in the soil. The sheep are checked mostly daily, but certainly every other day.

Cash crops

Of the two acres about 40% is down to salad production and then the rest is a mixture of brassicas, root crops, leeks, sweetcorn and squashes. So, starting in January with a baby-leaf salad on a 1.5 metres (m) wheelings bed system, and ending with broad beans as the last crop which are harvested the following spring – this is the trigger then to get the herbal ley in.

“It's quite a simple system. We don't necessarily need to map where each crop was in each acre each year. We're trying not to crop the land too hard, we're trying to regenerate it as much as possible. We could expand our business, there's demand, but we've decided that's not the route we want to take.”

Pest control

We find that using rotations to break up the lifecycles of the pests is really good, and I find it a very simple approach. The clover living mulch and a few weeds works quite well as it means the pests aren't always eating just your crop, as there's something else to eat. We had a nice trial last winter of broad beans growing with phacelia, buckwheat and clovers. When it came up, we thought, oh no, this is going to be a nightmare crop. But we had the least amount of pest damage in a crop of broad beans which normally gets damage from slugs and hares particularly. And we had the best crop of broad beans we've ever had.

The whole field is rabbit fenced – 1 m high and buried a spade spit deep – and this keeps rabbits out quite comfortably, but we do get some hares coming in for broad beans and corn on the cob.

Weed management

Our system helps with the weeds because we cultivate as little as possible to get the herbal ley going and we're trying not to bury weed seed that's fallen onto the surface. So then hopefully in the next three years they're germinating on the surface and keeping the soil as clean as possible, and we try not to get over-stressed about weeds anyway. We live with what we've got and try not to spend too much time weeding.

Constraints

The infrastructure was put in place in the early days with rabbit fences around the whole perimeter. In the lower field where the reservoir is, we laid out main feeder drain irrigation pipes underground, so it's all set out on these 8 one-ac plots with water points at the corner of each plot.

I set the plots out originally to be one ac plots around 50 x 100 m which works out at roughly 24 beds of 100 m length. Now we have agroforestry lines between them, so it will stay that way.



Phacelia growing with broad beans



First early potatoes, sweetcorn plugs just planted out with squash inter cropping & white clover living mulch sown but not germinated yet. These are watered using T-tape drip irrigation

Planning and monitoring your rotation

We have had the soils tested every few years, but we're monitoring what is coming off in terms of yields. The other thing to remember is that even with the best plan in the world you're going to get failures and you have to accept that if you grow enough variety, you're going to be fine. If you try and focus on one crop you're going to be in trouble. It's important to have that diversity and accept that you are going to get failures, but don't get hung up on them because there's always something you can learn from them.

We do monitor and we're doing some trial work with the Organic Research Centre and with ADAS and trying different things and seeing what's going on. Also, I don't pretend to know it all.

Not every year the same things successfully germinate. This year I only got my herbal ley in at the end of August. Normally, I'm trying to get it in at the end of May, but it just went so dry, and it is not easy to water whole blocks with our set up. This year with the dry weather the trefoil did a lot better than the white clover as it is deeper rooting, which shows it is important to have that diversity in your mixes.

Further information

To explore the topics in this guide further, head to the Agricology website and the Rotations Hub, which pulls together a wide range of videos, webinars, tools and guides for further study at your leisure.



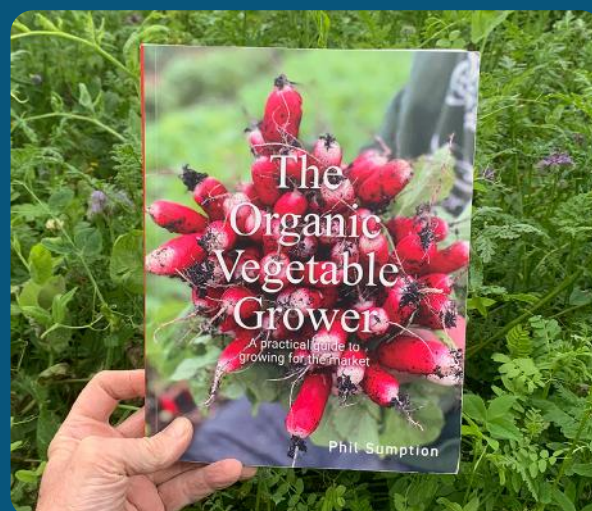
See the accompanying video to this written guide, featuring Andy Dibben.

Thanks

Our thanks to all those who contributed photos, time, energy and knowledge to the creation of this guide. With special thanks to our case study farmers Andy Dibben and David Newman, but also Matt Smee, Janie Caldbeck and Alice Farmery.

Source material

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Sumption P (2023) The Organic Vegetable Grower. A practical guide to growing for the market. Crowood Press.

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