# 9. Vegetable Growing

*Ideally, organic vegetable production should be part of a mixed farm. A balanced crop rotation ensures a sufficient amount of nutrients and organic matter in the soil, and helps to control troublesome weeds, diseases and pests.*

*As opposed to forage crops, vegetables can be directly used for human consumption. Vegetable production can give high yields and very high gross margins compared to other farm enterprises. However, this requires optimal growing conditions and excellent farm management.*




*Quality is an important aspect of vegetable production*

## Growing vegetables – a wise choice?

Most organic vegetable growers in Denmark are trained as farmers, not as horticulturists. Many originally wanted to be crop and livestock farmers, but have later added vegetable production. Growing vegetables is seen as an exciting challenge and a way to earn a good income on a relatively small area of land. However, many of these farmers find out that it is difficult to become experts in many different types of production simultaneously. Often, they either stop growing vegetables entirely, or vegetable growing becomes their main farm enterprise.

Before starting to grow vegetables, one should think twice. Do you really want to become a gardener? This means being strongly tied into the rhythm of vegetable production. The marketing of vegetables can be especially challenging.
Dairy, meat and cereal farmers usually have only one marketing channel, through which they sell their products – not necessarily at a good price, but they are sure to sell in any case. Vegetable growers, on the other hand, can never be sure if they can sell their products at all. In the worst case, top-grade vegetables are used as animal feed or are merely composted.

At present, marketing vegetables is not easy. For some years, sales of organic vegetables in the supermarkets soared, and the cooperation between growers was excellent. At that time, it was quite easy to start growing organic vegetables.

Nowadays it is much harder to gain access to the supermarkets. They demand top-grade products in large quantities and regular delivery. The market is very competitive, especially for crops with a large market share, e.g., carrots, onions and leeks. You have to be an efficient, skilled producer and have a large production volume in order to make a living from vegetable growing under these conditions.
Most organic vegetables are sold by the supermarkets. However, there are alternative marketing channels, and these are becoming increasingly common in Denmark.

The labour input required for vegetable production varies considerably. It depends a lot on having enough labour at hand, and on timing. Organic vegetable growing requires excellent farm management.

## A checklist for vegetable growers

***There are many important things to consider when planning vegetable production. Here is a checklist of various items you should think through before deciding which crops to grow:***

- Which vegetables do I want to grow (species)?
- On how big an area do I want to grow vegetable crops?
- What kind of marketing strategy?
- Is the climate right? Are my soils suitable?
- Can I ensure sufficient nutrient supply?
- Is the soil's pH suitable? Soil drainage OK? Are the fields level enough?
- Is the soil structure all right?
- Are there sufficient opportunities for irrigation?
- What varieties are suitable, and where can I obtain seeds?
- Do I have the right machinery? What is lacking?
- Do I have the right experience, skills and network for growing the planned crops?
- Do I have sufficient access to labour, and enough time for management: Planning, making contracts, spring tillage, weed control, harvesting, marketing and sales?
- Have I considered the economic aspects well enough?
- Where can I get planning and production advice?

## A large investment – and risk

Compared to other crops, vegetables are in many ways quite special. One of the things that characterises vegetable growing is the financial risk involved. For a good variety, seed expenses can often amount to 18 Euro per ha. This is about ten times more expensive than seed grain. In addition, there are substantial costs in connection with soil cultivation and weed control. For example, for a vulnerable crop such as carrots, the cost of weed control amounts roughly to as much as 16 Euro per ha. Then there are all of the hours spent harvesting, sorting, storing and marketing the crop. All of these

expenses must be covered before one gets paid. This means having a good overdraft facility and a solid economy that can stand a year with poor market conditions or a crop failure.

New, specialised machinery can often improve production significantly by saving labour costs. However, such equipment is expensive, and the second-hand market is limited. Making the wrong decisions can thus be expensive. Finally, investments for irrigation, sorting equipment and storage facilities can be substantial, and bind lots of capital for many years.

## What requirements need to be met?

Assuming that you really want to grow vegetables, and the market conditions seem favourable, we can proceed to take a look at other necessary requirements.
Due to the large investments in seeds, labour and special equipment, it is important to make sure that the growing conditions are suitable for the different types of vegetables, thus ensuring reliable yields.

### Climate

Many vegetable species require specific climatic conditions. For many vegetables, Denmark is the farthest north these can be grown, and high yields and good quality can only be achieved in the most favourable areas. For most crops, this means a mild climate without late spring frosts. It is possible to extend the growing season quite a bit, by using early crops, growing different crops in succession and growing late-season crops. For example, when growing crops such as lettuce or cauliflower, one grows them in batches, of which the first-planted batch can be delivered very early, the last ones very late in the season. For crops such as carrots and potatoes, prices are often highest for the first batches to reach the market. For this reason, many of the islands in southern Denmark with a mild climate have longstanding vegetable growing traditions.
Of course, vegetables requiring a lot of warmth can also be grown elsewhere, especially on so-called warm soils, i.e., relatively light, well-drained soils. A southern exposure is always the best. Some crops do well in rougher climates. It is therefore no problem to grow late carrots, potatoes, beetroots, cabbage and strawberries in the harsher climate of central and western Jutland. There are even some benefits, since certain pests may not survive as well in these areas.

### Soil

The requirements regarding soil conditions vary a lot, depending on the crop in question. Many vegetables, such as root crops and potatoes, prefer loose soil rich in organic matter. Soils with compact layers present problems for carrots, resulting in stunted or twisted growth.
In general, loamy sand or sandy loams are preferable, since these are generally easy to cultivate and tolerate traffic better than heavier soils. Rocks can cause problems for a lot of farm implements, and rocky soils are therefore a big disadvantage.

Organic soils are suitable for growing carrots. With no mineral particles in the soil, one avoids scraping up the carrots during harvest. These carrots will keep their fresh appearance, and will not get the greyish look that other carrots often get during storage.
Peat soils are suitable for potato cultivation, since they are loose and do not damage the surface of the potatoes. Since peat soils have a low pH, there are no problems with scab. However, these soils are often waterlogged in autumn, which can create difficulties during harvest.
Sandy soils are excellent for growing many root crops and potatoes. When driving with heavy equipment on a wet sandy soil, much less damage is done than on a heavier soil.
Clay soils are difficult to work with. Root crops and potatoes can become deformed by the soil's structure. Carrots grown in clay soils are often extremely tasty (sweet), but twisted and crooked and difficult to wash. On the other hand, clay soils are excellent for growing cabbage, which requires lots of nutrients.

### Crop establishment and weed control

In typical vegetable-growing areas, it is possible to rent or lease special equipment for seeding, planting, harvesting, etc. It may also be possible to join a machinery pool. However, in many areas, these possibilities do not exist.

Using machine contractors gives a lot of flexibility. One only uses the machine for the specific operation in question, and isn't committed to future production. For small areas, one should try to purchase simple,

inexpensive equipment, if there is no access to rented machinery. This will perhaps result in higher labour costs, but all in all it is still more profitable.

The following machinery is considered necessary on a mixed vegetable farm.

The **seedbed cultivator** creates a uniform seed and planting bed in tractor width. It can be adjusted to loosen the soil in deeper layers and for optimal seedbed preparation in the upper soil layers.

The **precision drill** ensures optimal and uniform seeding depth. Single seed drills can be adapted to seed size and the individual crop. In organic production, organic seed must be used, in any case untreated seed. This can cause difficulties, since very few organic vegetable varieties are available as pelleted seed. Non-pelleted seeds vary considerably in form and size, and are thus much harder to seed accurately with a precision drill.

**Transplanters** are available in many different models. Conventional models have a share, which ploughs a planting furrow. Further, it has rotating rubber discs that grab the plant and guide it into the furrow. Crouching on the transplanter, one has to insert every plant in the disc. These machines are somewhat difficult to adjust for precision planting, but they are cheap. More advanced machines allow for a better sitting position and are twice as effective. Thus, they are quickly paid off on large-scale operations.

There are many different types of **weed control** equipment, including flame weeders, between-row cultivators, etc. See Chapter 6 on weed control for details.

## *Harvesting and market preparation*

Standard **harvesters** are available for most crops. The company Asa Lift has several different models. On larger farms, it is common to use a standard machine, to which various implements can be attached for harvesting root crops, leeks, onions, etc. On smaller farms, a root crop lifter can be used to harvest many different kinds of vegetables, e.g., root crops and leeks. The model shown on the photo loosens the soil underneath a bed of vegetables, and the depth can be regulated via the tractor's three-point linkage. This type is easy to make, but has to be welded together strongly in order to withstand the pressure. It makes the following manual harvest much easier.
A single furrow plough without a mouldboard can also be used to loosen vegetables.

*Photo: Knud Schmidt*

***Crop lifter***
*This implement can be used to loosen and lift root crops and leeks for easier harvesting.*

**Sorting, washing and packing facilities** are also necessary if the crop is to be prepared for sale on the farm. Nowadays, root crops have to be washed, since consumers are not used to seeing soil on the products anymore. Leeks are difficult to clean. Washing leeks either means a lot of tiresome manual work or investing in an expensive leek washer.

A good sorting table is very important. It should be possible to refill the table directly from large crates with a crate tipper, etc.

For weighing and packing, there is equipment that automatically and precisely weighs, packs and closes bags. When packing manually, e.g., carrots, you will on average have 0,5 carrot overweight in each bag. An electronic packing machine can compose the contents of a bag from a selection of carrots, resulting in bags which barely weigh a few grams more than the desired weight. This may be annoying for consumers, but for a large carrot grower, such small margins add up to a lot of money. However, such extremely costly machines have to process tons and tons of vegetables before they starts returning good interests.

## *Buildings for vegetable production*

### Producing transplants

If you choose to produce your own transplants, some greenhouse space and certain other facilities are necessary. In general it is more profitable to order transplants from professional nurseries, since they can produce plants much more efficiently. This can be especially advisable in a busy start-up phase, since the quality of the transplants is very important for the final results.

### Storage facilities

Root crops can be stored the "old-fashioned" way in field clamps. Nowadays clamps are covered with straw and plastic, and no longer with soil. Nevertheless, clamp storage requires a lot of work, and it is hard to control aeration and temperature.

For long-term storage of vegetables, cold storage is necessary, and the humidity of the storage room must be controllable. Check humidity with a hygrometer. A simple air moisturiser can be made from a water container and a water pump connected to a little nozzle. The pump can be controlled by a timer. If the nozzles are fastened right above the water container, excess moisture can be reused.

Finally, there are also oxygen-free storage facilities. In the first few months of storage, these rooms must be kept as airtight as possible and not opened. This helps to reduce the rate of natural ripening and maturing processes. Especially for fruit, such storage can extend the storage period considerably. The question is if it makes sense to use so much technology in order to satisfy the consumers' demand for fresh produce throughout the entire year. Many organic farmers would probably answer "no".

Photo: Knud Schmidt

***Preparing for delivery***

*Small-scale vegetable production requires lots of manual labour. Here, parsley is being harvested and prepared for a vegetable subscription service.*

# The key to success: marketing

As mentioned, marketing is the key to success as a vegetable grower. It is impossible to avoid involvement in the marketing process, and one must therefore be aware of the fact that vegetable production means working on both fronts: as a gardener and a merchant. Roughly speaking, two different forms of marketing can be distinguished: wholesale or direct marketing.

## Wholesale

By far the largest volume in Denmark is sold wholesale. Typically, a livestock farmer choosing to add a single vegetable crop would sell to a wholesaler. This approach requires specialised equipment and know-how in order to optimise production. Wholesale dealers demand large quantities, good quality and consistent, precise deliveries. Prices are generally rather low, and it is thus absolutely necessary to have a highly efficient production to ensure a profitable business. Most of the vegetables marketed in this way are sold via the large supermarket chains.

## Direct marketing

Selling products directly from the farm to the consumer has several benefits:

- No profits are lost in the wholesale and retail trade
- Quality standards do not have to be met
- Increased producer-consumer contact, which makes it easier for the farmers to get feedback on their work.

### Vegetable subscription services

This concept includes the subscription of a crate of vegetables or other products, which is regularly delivered right to the customers' front door. Consumers pay a fixed price beforehand, and have merely agreed on general guidelines for what these crates contain. It is up to the producer to determine the contents of the crates from week to week, depending on what is in season, in demand, etc. In addition, the crates often include some written information, e.g., recipes, background info about the products, etc.

For the producer, the benefit is knowing exactly how much she will be selling from week to week. The scheme should include enough customers to enable rational packing routines. However, delivery is difficult, since there always is a flux of old and new customers. As a result, administrating orders, deliveries and invoices can be quite challenging.

Such "vegetable subscriptions" have become very popular in recent years. The first attempts of a so-called "crate service" were made about ten years ago. Now, there are many subscription schemes around Europe. While some are very local, with less than 50 crates a week and centred around a single farmer, others are quite big enterprises. All in all, about 35,000 crates are being presently delivered in Denmark each week, and the number is increasing.

There are several reasons for the popularity of this marketing form. Not only do the consumers get fresh produce conveniently delivered to their doorstep, they also establish a personal relationship to the farmer via newsletters, farm visits, etc. Furthermore, the contents of the crates are often carefully composed, and this can be exciting and rewarding for the consumers. For example, new or rare products may be in the crate, perhaps with a few serving suggestions.

### Farm shops

Farm shops are another common form of direct marketing. This especially suits farms in areas with a relatively high population density. One of the benefits is excellent contact with consumers. However, farm shops should have a wide assortment of products in order to attract customers, and to keep them coming. One disadvantage is that farm shops require a lot of work (time), and often the turnover is rather modest. Some farms thus have limited opening hours, e.g., one day a week, in order to minimise the time spent as a shopkeeper.

### Farmers' markets

Even though most Danish cities have market days, the Danes are not as used to buying food on the market as people in many other parts of the world.

Some vegetable growers have for many years sold their products on the market once or twice a week. Reliability is important, since many customers are regulars. When using the market as a marketing channel, it is important to be there on fixed days,

and at times when one doesn't have many home-grown products to sell. This implies that one may have to purchase goods for resale from other farms or wholesalers.

Market turnover can vary considerably, so there is always the risk of returning home with a lot of unsold leftovers. Finally, one has to consider that it doesn't take many farmers to satisfy the need for market sales. In bigger towns, one farmer may be enough, in the biggest cities, there should be room for a few more.

Photo: Jesper Veber Knudsen

***Farmers in town***
*At first, one farmer opened up a farm shop in town, close to the customers. This has developed into a joint operation between five specialised farms, which all sell their products in the shop, thus providing a wide assortment of fresh produce.*
*These are the initiators Jacob Dan Nielsen and Gert Jensen.*

## A quality issue

The issue of quality can be approached from many directions. A crooked, branched carrot, for example, may taste wonderful, be nutritious and without residues of harmful substances – but nevertheless such a carrot is often discarded – to the delight of the horses fed such rejects.

There are EU norms for quality grading, which are often used by the supermarkets. The norms regulate standards for the vegetables' freshness, appearance, pest damage, size, colour, smell and taste. The standards are published in handbooks which can be obtained from the Danish Plant Directorate.

When delivering to wholesalers, the EU standards need to be followed. However, it is possible to sell directly to consumers without worrying about them. Consumers buying directly from a farmer are usually less interested in standard products, and not so concerned about the outer appearance of the produce. Freshness and taste are more important. Another aspect for the consumer is the experience of coming to a farm, feeling the atmosphere there and getting an impression of the farmer's life. This is enjoyable for children and adults alike.

# Diseases and pests

Pest attacks in vegetable crops can be disastrous. Not necessarily for yields, but rather for the crop's quality. The problem is that the existing norms for how much pest and disease damage can be tolerated on fruit and vegetables are obviously based on the optimised application of chemical pesticides.

However, when working in ecological systems, there is always a certain balance between pest organisms and their natural enemies. It is difficult to produce crops without the slightest sign of pest attack.
Before starting to grow a certain vegetable crop, one should examine which pests and diseases are most relevant, and what can be done to prevent attack or infestation. Growers manuals for both crops and harmful organisms usually contain important information. Finally, lots of help can be found in professional magazines and by contacting the extension service in your area.

A few general considerations regarding pests and diseases in vegetable production are presented below.

## Resistant varieties

Disease resistance has a significant effect on how long a crop can withstand infestation, and how much damage is done. Very few varieties are 100 % resistant, but in any case, choosing the right variety can be critical for obtaining high yields and a good quality crop.

## Crop rotation

Diseases and pests that survive the winter underground are naturally a potential risk if the same or a related crop is grown on the same field the following year. The best known example of such diseases is clubroot, which attacks all cruciferous species. It is also the disease which hits hardest if the required cropping interval is not observed.

Certain pests are somewhat mobile. One example is the carrot fly. It overwinters in the soil, then in spring it flies to the field edge, where it hides in trees and bushes. From there it swarms out in different directions, looking for a new carrot field. If possible, one should therefore grow carrots at least 500 m away from where last year's field was. Preferably, the field should be moved against the prevailing wind direction.

## Using row covers

A single cabbage worm in a delivery of cauliflower to a supermarket can be enough to discard the entire shipment. For that reason, row covers are sometimes used over cabbage crops.

Row covers are made of spunbonded synthetic fibres. These fibres allow light and water to pass through, but protect the covered crop from all kinds of insect attack. The use of row covers is effective, but costly and labour intensive. The temperature under the row covers is about two degrees higher, and both crops and weeds grow faster. The row cover must be removed for inter-row cultivation, and replaced immediately afterwards.

Spunbonded row covers are mostly used in different brassica crops, where cabbage white butterflies and cabbage root flies are the problem, but also in carrots, in areas heavily infested by carrot flies.

## Biological pest control

There are many naturally existing beneficial organisms, ranging from predatory and parasitic insects to bacteria and fungi. Some of these have been studied in great detail, before actually raising large numbers for use in pest control. Before being marketed, such organisms have to be approved.

Two examples of such beneficial organisms are widely known from the greenhouse industry. Both are so efficient, that they are applied in nearly all conventional greenhouses.

The first are predatory mites, which are used in cucumbers. They are released as soon as the first symptoms of the red spider mite are visible, and are extremely efficient if applied correctly.

The second example is the use of parasitic wasps for the control of white flies on tomatoes. The wasps lay eggs in the white flies, and the flies die when the eggs hatch. Thus, a new generation of parasitic wasps develops, which can infest even more white flies. The extremely short generation interval of the wasps make them very efficient.

*Bacillus thuringiensis* – or just Bt – is a bacteria that effectively kills certain larvae. These bacteria have been developed with regard to their effect on different larva species. Now there are several Bt-preparations on the market which can be used in pest con-

trol. The bacteria products are diluted in water and sprayed on the leaves. When the larvae eat the leaves, they ingest the bacteria and die as a result of "food poisoning". This practice is approved for use in organic farming. However, it is not widely used, partially because many farmers do not support the idea of spreading such organisms in nature on a large scale, even if they already are "natural" organisms to begin with.

Similarly, there are a few other beneficial organisms that have been commercialised, and which can be applied in greenhouses or on fields. So far, their use is not very common. Luckily, most pest problems can be avoided or controlled more naturally.

# Choosing seed and transplant varieties

## Varieties make a difference

As we have seen, choice of variety has quite an effect on disease resistance and crop quality, and also on yields. For example, trials have shown significant variations of marketable white cabbage yields between different varieties. Many of the tested varieties were old ones, which gave poorly formed and too loose cabbage heads. The percentage of harvestable heads was 45 %, while the best varieties had harvestable yields of nearly 90 %. This means that with the same labour input throughout the harvesting process, about twice as many cabbage heads of the best varieties were harvested than of the poorest ones. This can easily spell the difference between success and failure.

### Germination temperature and speed of various vegetable crops

| Species | Germination temp. (°C) (optimum) | Minimum temp. (°C) | Maximum temp. (°C) | Days to germination | |
|---|---|---|---|---|---|
| | | | | at 5 °C | at 15 °C |
| White cabbage | 15 - 18 | 1 | 25 | 27 | 8 |
| Cauliflower | 15 - 18 | 1 | 28 | 30 | 8 |
| Chinese cabbage | 16 - 20 | 1 | 21 | * | * |
| Lettuce | 15 - 18 | 4 | 21 | 47 | 6 |
| Celery | 19 - 20 | 5 | 22 | 59 | 22 |
| Leek | 18 - 20 | 2 | 25 | 67 | 16 |
| Cucumber | 20 - 25 | * | * | * | * |
| Tomato | 22 | * | * | * | * |
| Squash | 20 - 25 | * | * | * | * |
| Parsley | 18 - 20 | * | * | * | * |
| Onions | 15 - 20 | * | * | * | * |
| Turnip-rooted cabbage | 15 - 18 | * | * | * | * |
| Sweet corn | 18 - 20 | * | * | * | * |

** No information available*

It is recommended to inquire about how the different varieties perform in different parts of the country. Such information can be provided by seed companies, vegetable growing consultants and those that perform variety tests.

## Organic seed – or maybe not?

For commercial use, one should be highly aware of buying approved seed. Be careful when buying seed that hasn't been sufficiently tested. If organic seed is only available for varieties that obviously are not suitable, it is still possible to be granted permission to buy conventionally grown, but untreated seed. Many growers still avoid using organic seed, in order to make sure they get the right variety and to have seed with a high germination percentage.

Each year, a list of available organic seed is compiled in Denmark. The list is published on the website of the Danish Agricultural Advisory Centre. Hopefully, the big seed companies will enable the production of organic seed for all approved varieties in the future.

Size-sorted seed is another important aspect. For example, one can get sorted carrot seed, in which only the largest seeds have been sorted out. This gives a faster, more uniform germination.

Finally, some growers point out the importance of using a large, respected seed company when planning to plant a specialty crop on a large scale. If it should be shown that the seed quality was poor, the large companies have enough capital to make good for the loss. Also, they are interested in keeping up their good image.

## Germination temperature

Most of our vegetable crops need a lot of warmth, also for germination. The table on the opposite page shows that a germination temperature of 5 °C unrealistically extends the germination phase, compared to a temperature of 15 °C. Many vegetables crops do not germinate until the temperature is so high in order to avoid cold spells, which can induce bolting. This applies especially to cauliflower, Chinese cabbage and celery.

## Production of transplants

Some equipment and greenhouse space are required to produce home-grown transplants. Good quality transplants are the result of optimal soil mixtures, temperature and light conditions, irrigation and nutrient supply. Plants must have a high growth rate from the start, because if growth stagnates before they are transplanted, it is difficult to get them growing again out in the field.

Organic transplants can be obtained from Danish and Dutch growers. When ordering, you can specify the species, variety and delivery date. For large quantities, it is hardly possible to grow your own transplants as cheaply as such large-scale producers are able to. However, you are completely dependent on the producer delivering the right plants at the right time.

If you choose to grow your own transplants, you can either make your own soil mixtures or buy finished mixtures. For beginners, we suggest to raise the transplants in large soil blocks or pots, so-called speedling trays. This way, it is easier to achieve optimal nutrient and water supply.

## Hardening transplants

Before the transplants are set out, they need to be hardened. This means they have to become accustomed to outdoor conditions, e.g., by putting them in a protected corner of the yard for a few days. In case it gets very cold while the plants are hardening, they can be protected with a spunbonded row cover.

## Field setting

Commercial transplants are usually delivered in 4x4 cm or 5x5 cm pressed soil blocks. This supplies each plant with much more soil than those systems that only use very small transplant pots. The young plants must not dry out before being set out in the field. It's actually better they are totally drenched than too dry. Especially if one does not have sufficient field irrigation, it is vital they have a water reserve in the soil block.

# *Transplants or direct seeding?*

***Pros and cons of using transplants instead of direct field seeding.***

**Advantages:**

- Longer growing season (necessary for such crops as celery, useful for others)
- Early seeding (which enables earlier harvest of early crops)
- Allows establishment of several batches on the same area in one season
- Warmth early in growth reduces the risk of bolting (Chinese cabbage, celery, etc.)
- Establishment of a more uniform crop (poorly developed plants are discarded)
- Weed control prior to planting, easier weed management during the growing season
- Better disease (e.g., damping-off) and pest (e.g., cabbage root flies) tolerance
- Uniform crop enables efficient harvest

**Disadvantages:**

- Higher initial costs
- Weaker root system in early growth phase
- Irrigation needed after planting