INTRODUCTION TO THE CULTIVATION OF VEGETABLE SEEDS

- Frank Adams -

SEED
Som fir d'Erhalen an d'Entwécklung vun der Diversitéit

Citizens for Ecological Learning & Living

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INTRODUCTION & BASICS

1. Introduction: purpose of the guide

•This guide is an introduction to the practical aspects of cultivating vegetable seeds in your own garden. Knowledge of vegetable growing is required. The information provided in the guide applies to the climate zone of Northern Europe, between latitudes 48°N and 52°N.

• The importance of maintaining and developing seed diversity within traditional regional seed systems is briefly discussed, but the main focus is on practical work with vegetable seeds.

• All the information needed for growing seeds is provided using 10 vegetable species as examples. This information can be used to draw conclusions for other vegetable species. Otherwise, refer to the many detailed, high-quality instructions on growing vegetable seeds *(see examples in the Specialist Literature).*

Sifting green mustard seeds

CONTEXT: SEEDS OF THE FUTURE - THE FUTURE OF SEEDS

Human beings need food to live. Most of the food we eat comes from agriculture.

Seeds are the basis of agriculture, so everyone should take an interest in them.

Over the last hundred years, the conviction has taken hold in the economies, politics and research of industrialised countries that the best way to obtain high-quality seeds that are suited to modern challenges is through centralisation, technologisation and privatisation. Thus, the seeds of the future should be produced by large professional companies using biotechnological methods, controlled by seed laws and protected as private property by patents.

Biotechnological plant selection ('genome editing', 'targeted mutagenesis', 'genetic scissors') is based on targeted genetic modifications, carried out artificially directly in the DNA, which aim to create plant varieties that are resistant to climatic hazards, diseases and pests, while enabling high yields and better food quality, with savings in time and labour.

Traditional and organic approaches to plant breeding and seed propagation, on the other hand, are based on the principle that sustainable and crisis-resistant food security can only be guaranteed for humanity through decentralised and regional seed systems, in which seeds are propagated and developed as a common good within the agricultural ecosystem (on-farm development). This approach is characterised by a wide diversity of traditional food crop varieties that continuously and permanently adapt to regional conditions and changes and in so doing develop natural robustness against diseases, pests and adverse climatic conditions.

The traditional approach is based on two aspects of diversity: genetic diversity among regional varieties around the world (spatial or horizontal diversity) and varieties evolving in agroecosystems (temporal or vertical diversity).

2. Reasons for traditional seed cultivation and local seeds

Since the dawn of agriculture, seeds have been the **main basis of human nutrition**. Despite their vital importance, today's urban population knows relatively little about the origin and quality of seeds. In industrial agriculture, seeds have increasingly become an input that is no longer produced on the farm itself but purchased on the market.

Since the end of the Second World War, developments in **plant breeding and seed production** have clearly moved towards standardisation, centralisation and privatisation of seeds. Laboratory techniques such as mutagenesis, cell fusion, transgenesis and genome editing are increasingly replacing traditional and artisanal breeding techniques on farms and in gardens. The result is a growing disappearance of regional varieties, which the FAO describes as 'genetic erosion' and presents as a threat to long-term food security. In this context, **local seed cultivation** is neither a folkloric hobby nor an outdated peasant practice, but offers several answers to questions related to sustainable development:

• PRESERVING THE DIVERSITY OF OUR FOOD PLANTS:

With the industrialisation of agriculture, more and more traditional varieties of food crops adapted to local conditions have been replaced by hybrid varieties or varieties patented by the seed industry and have disappeared. Although the seeds of many traditional varieties are stored in seed banks around the world, it is important that these varieties are also cultivated, propagated and developed regularly so that their genetic diversity allows them to adapt to changing growing conditions (e.g. climate change), both in the short and long term.

• DEVELOPMENT OF VARIETIES ADAPTED TO LOCAL CONDITIONS:

Varieties which are repeatedly propagated by seed in gardens or farms undergo continuous and progressive adaptation and development processes. They can thus become naturally resistant to adverse climatic conditions, as well as to diseases and pests. In this way, pesticide-free cultivation can become possible. Industrial seeds are not generally intended for local seed propagation and ecosystem adaptation processes and, in many cases, are not suitable for this purpose (in the case of hybrid or genetically modified varieties).

1 - In mid-2023, an estimated 4.6 billion people out of a total population of just over 8 billion were living in cities worldwide. This represented 57 % of the global population. By 2030, this proportion is expected to reach 60 %. Source: Federal Statistical Office of Germany (https://www.destatis.de/EN/Home/_node.html)

2 - See, among others, the two FAO publications on the 'Report on the State of the World's Plant Genetic Resources for Food and Agriculture'.

• REGIONAL AUTONOMY:

Seeds are the basis of all food production. Without seeds, there can be no food sovereignty, and dependencies on global trade arise. Food sovereignty is particularly important in times of crisis. The global ecological, economic and political crises of recent decades have raised awareness of the need for countries and regions to achieve as high a degree of self-sufficiency as possible.

• JOB-CREATION WITHIN CIRCULAR FOOD SYSTEMS:

Circular food systems, which start with seeds ('from seed to plate'), strengthen rural areas and the regional economy and create jobs. Jobs in local and ecological food systems are particularly interesting for young people.

Courgette plant with bee

3. Networking and policy work

Local seeds do not mean that seed quality criteria as commercial products do not apply. Indeed, small local seed initiatives can only develop and survive on the basis of harvesting, storing and distributing quality seeds.

Locally produced seeds, which are also distributed and used in the region and are therefore not intended for cross-border trade, require a certain degree of **organisation and structuring**. This can be achieved through associations, community gardens, agricultural cooperatives and community supported agriculture.

The development of local community seed initiatives covers the following areas of activity:

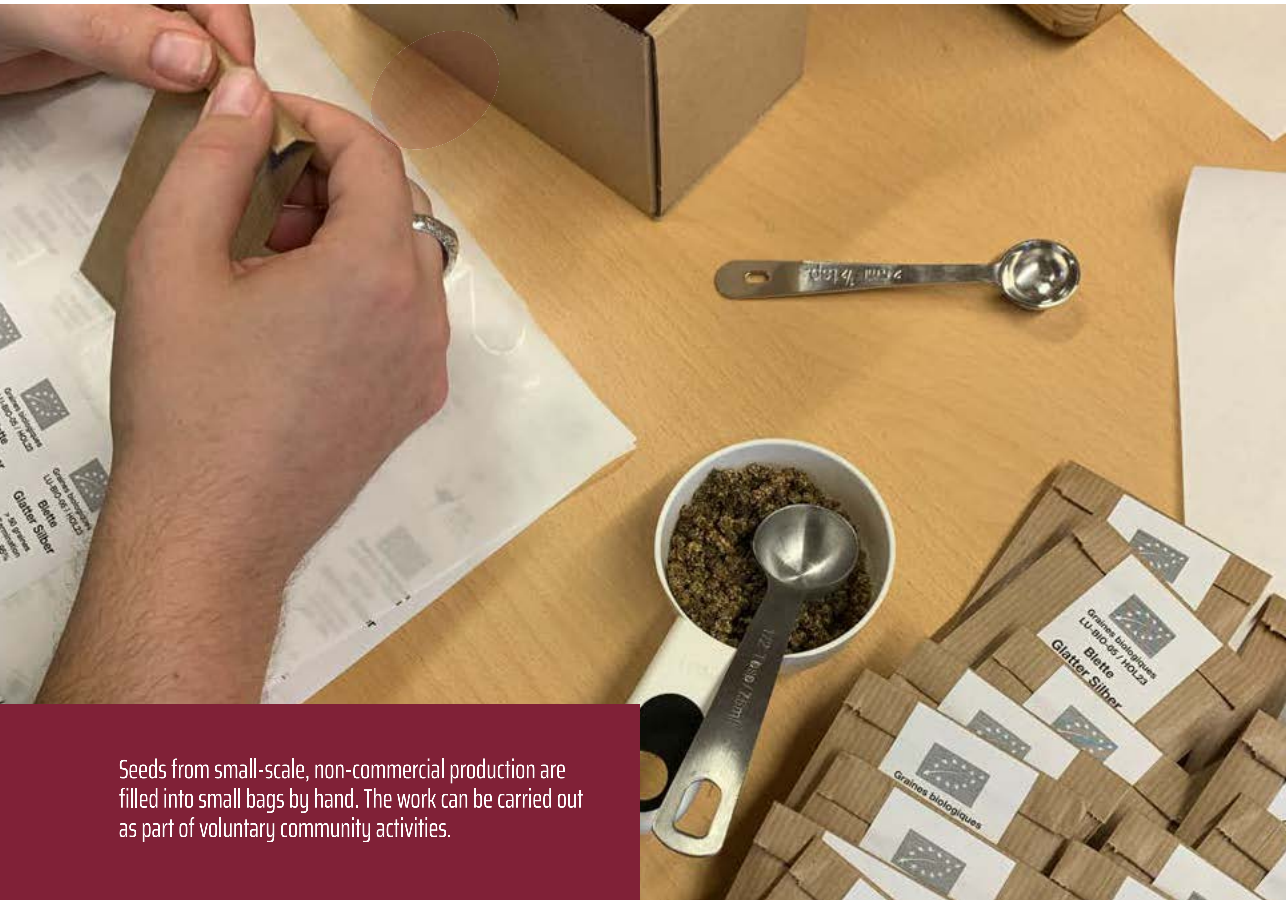
- annual consultations on the species and varieties whose seeds are to be cultivated;
- coordination on cultivation, harvesting, drying, cleaning, quality testing, storage and distribution of the seeds harvested;
- making records on growing conditions and processes followed, quantities of seed harvested, seed quality, quantities distributed, etc.;
- coordination of seed distribution and stock management.

Important technical aspects include:

- compliance with seed quality criteria (see section 4.2. Seed quality);
- technical equipment for cleaning, drying, testing and storing seeds;
- organisation of packaging (production of labelled packets) and seed distribution (exchange fairs, distribution points, markets).

The organisation and structuring of regional seed initiatives go beyond the scope of this publication and are covered in a specific guide on the topic of 'Citizen Seed Houses' (to be published in 2026).

Within a context of tension between genetic erosion and increasing privatisation of seeds, local seed production is also a political task in which all citizens can participate. Local seeds contribute to **crop diversity and regional food sovereignty**. These issues are also increasingly being addressed in food policy councils. It is precisely at the municipal level that interesting projects and structures can emerge, which can then encourage and support each other at the supra-regional level; the prerequisites for this are resources made available by municipal policy and active voluntary participation by citizens.



Seeds from small-scale, non-commercial production are filled into small bags by hand. The work can be carried out as part of voluntary community activities.

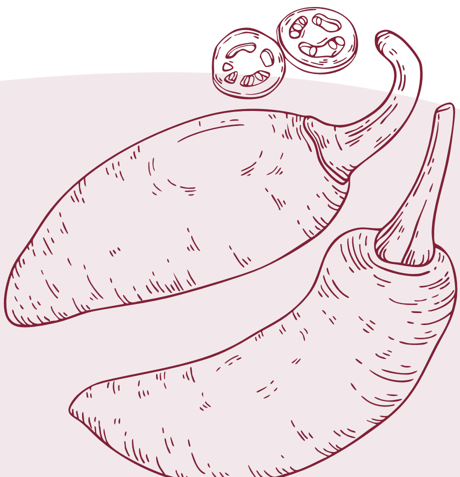
4. Basics of vegetable seed cultivation

4.1. SEED CATEGORIES

For a local seed initiative, where the primary objective is not commercial, the following seed categorisation may help in understanding:

Seed category	**Definition**	**Usable in local seed initiatives?**
Seeds of so-called informal varieties	Old, regional, unregistered varieties	Yes, but the sale of such seeds is restricted by law
Seeds of registered varieties where reproduction by seed is possible and permitted	Traditional varieties, both old and recently created, listed in the EU variety catalogue	Yes, if the variety is not protected by a plant variety certificate
Seeds of registered varieties that cannot or are not permitted to be reproduced	F1 hybrid varieties, GMO varieties	No, either one cannot harvest new seed (hybrid varieties) or it is prohibited by patents (GMO varieties)

Traditional unregistered and registered varieties can serve as basic material for local seed initiatives. They can be found in small seed companies that produce and market organic seeds, as well as in national seed banks.



4.2. SEED QUALITY

There are four official, internationally recognised criteria for seed quality:

1. VARIETAL PURITY:

A variety of a particular species of vegetable has specific characteristics that qualify it and distinguish it from other varieties. For older varieties, these characteristics were often already contained in the name, for example, the turnip 'Purple Top White Globe' or the cherry tomato 'Green Zebra'. Varietal differences are particularly evident in the different varieties of tomatoes: there are red, yellow, black, large, small, oval, round and pear-shaped varieties, which also differ in terms of taste, skin thickness and shelf life. When propagating seeds, care is therefore taken to ensure that varieties retain their identity and do not interbreed (genetically mix) with other varieties (*see section 5.3 Self-pollination* (*autogamy*) *and cross-pollination* (*allogamy*)).

2. SPECIFIC PURITY:

Good seed must be clean and free of seeds from other plant species, as well as from dirt and other impurities. To achieve this, the seeds must be thoroughly cleaned (*see section 7.2. Seed cleaning and sorting during dry extraction*).

3. GERMINATION CAPACITY:

Germination capacity is expressed as a percentage. A germination capacity of 75 % or higher is considered good, meaning that three-quarters of the seeds in a lot will germinate. It is best to have a germination rate of over 80 %. If, during cleaning, small seeds that tend to be empty are removed (by sieving and winnowing), the germination rate can be increased (*see section 7.4. Seed quality testing*).

4. HEALTH:

Seeds must be healthy, at least on the outside: no spots indicating disease or mould, no traces left by pests, and no damaged or broken seeds. The health of the seeds can also be determined during the cultivation of seed bearers, for example if the plants show symptoms of diseases that are also transmitted by the seeds. If in doubt, it is advisable to seek advice from experienced specialists.

GENERAL ASPECTS OF SEED CULTIVATION

5. Botanical aspects

Most vegetable species reproduce by seed. Seed formation begins when a male pollen grain lands on the stigma of the female pistil and fertilises an ovule in the ovary. The embryo thus formed then gives rise to a seed.

To understand the **processes involved in seed formation**, which vary considerably from one vegetable to another, it may be useful to establish a few subcategories (*see Summary table 1*).

5.1. ROOT VEGETABLES, LEAFY VEGETABLES AND FRUIT VEGETABLES

Fruit vegetables carry seeds in their fruit (tomato, squash, bean, pea, etc.), while root vegetables and leafy vegetables are generally harvested before flowering and seed formation, and therefore need to be grown longer than normal for seed harvesting.

5.2. ANNUAL AND BIENNIAL VEGETABLES

Annual plants produce new seeds in the same year they are sown, while biennial plants must first go through winter to produce seeds before entering the flowering phase.

With regard to the life cycle of annual and biennial plants it should be noted that plants first develop a mass of roots and leaves (**vegetative development**) before 'bolting' (stem elongation), flowering, and then producing seeds (**generative development**).

In annual plants, the impulse for the generative phase comes when the length of the day or light radiation increases (**long-day plants**). In biennial plants, it is the winter cold that triggers the generative phase. This is called **vernalisation**. In a way, vernalisation is also linked to day length, since biennial plants begin to produce seeds when light radiation and temperatures increase. In both annual and biennial plants, seed formation during the summer and their maturation before the end of autumn are part of their survival strategy.

It also regularly happens that annual plants flower before reaching sufficient vegetative development and that biennial plants start to form seeds in their first year. This phenomenon is called '**stress induced flowering**'. Seeds should not be collected from such plants, as the spontaneous tendency to bolt prematurely could be genetically transmitted to the next generation of plants (*see section 6.1. Selection of seed bearers*).

3 - The categories of annual and biennial plants are only relevant for seed production in regions of the world where there are distinct seasons: spring, summer, autumn and winter. In tropical regions, where day lengths and temperatures are more or less constant, annual and biennial plants can sometimes become perennial, living for several years.

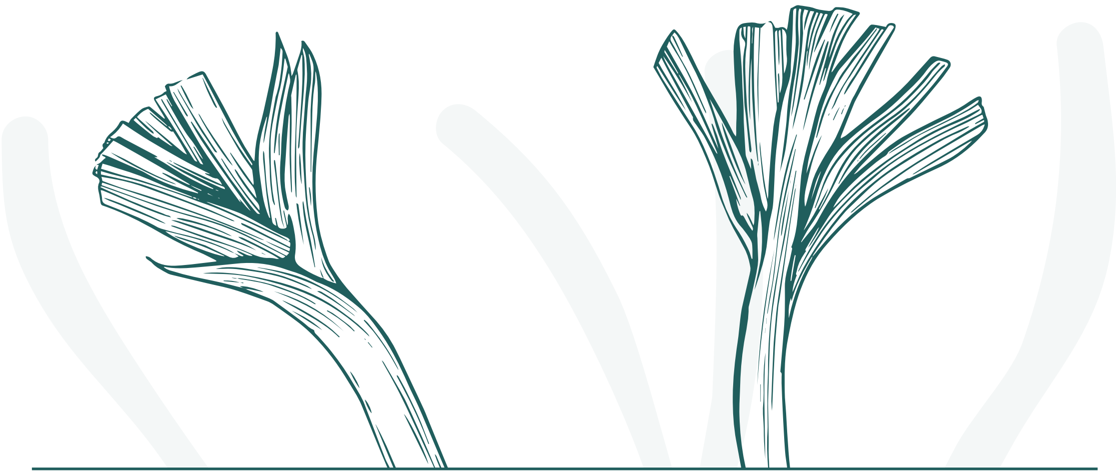
Seeds from perennial vegetables are rarely cultivated, as they regrow each year from their rhizomes or storage organs (bulbs, onions). Examples include horseradish, rhubarb, asparagus, potatoes and garlic. Seed production in these plants requires specialised knowledge and are therefore not covered here.

5.3. SELF-POLLINATION (AUTOGAMY) AND CROSS-POLLINATION (ALLOGAMY)

In self-pollinating plants, pollen arrives on the stigma of the same flower during pollination. In allogamous plants, insects or the wind carry pollen between different plants in a population, resulting in reciprocal fertilisation. The aspect of self-fertilisation or cross-fertilisation is very important in seed production. While two varieties of lettuce, for example, do not interbreed (mix genetically), cross-pollination can occur if, for example, a variety of red onion and a variety of white onion flower together (*see section 6.3. Cultivation of seed bearers and Summary table 1, as well as the individual cultivation notes*).

5.4. POLLINATION BY INSECTS (ENTOMOPHILY) AND BY THE WIND (ANEMOPHILY)

Most common vegetables are pollinated by insects (entomophilous plants); they have colourful, fragrant flowers that attract insects. On the other hand, vegetables with inconspicuous flowers are pollinated by the wind (anemophilous plants, such as beetroot, Swiss chard, spinach and sweetcorn). In the case of self-pollination, pollination and fertilisation take place in the same flower. Allogamous plants can be pollinated by both insects and the wind, as it is sufficient to shake the flowers (tomato, bean, lettuce, etc.).



4 - The term „population“ refers to plants of the same species or variety which, because of their kinship, form a reproductive community and can reproduce with each other when they flower together in a patch or field.

5.5. ARRANGEMENT AND STRUCTURE OF INFLORESCENSES

Among flowering plants, there are different types in terms of arrangement and structure of inflorescences. These botanical aspects also influence seed production. Most vegetable species belong to the category of monoecious and hermaphroditic plants, combining male and female organs in one flower.

Types of plants and flowers	**Description**	**Examples of vegetable species**
Monoecious plants with hermaphroditic flowers	Flowers contain both male (stamens) and female (carpels) reproductive organs.	Bean, beetroot, cabbage, carrot, celery, chicory, corn salad, leek, lettuce, onion, pea, radish, etc.
Monoecious plants with unisexual flowers	The flowers are either female or male, but they are found on the same plant.	Cucumber, courgette, pumpkin, sweet corn
Dioecious plants	The flowers are unisexual, female or male, and are found on separate plants.	Spinach

5.6. SEED FORMATION AND MATURATION

After fertilisation of the ovule, seed formation begins. The finished **seed** consists of the **embryo** (the future plant in miniature form), the endosperm (nutritive tissue that nourishes the seed during seed formation and later nourishes the seedling during germination) and the testa (seed coat that protects the seed from damage and helps regulate the germination process).

Seed formation ends with what is known as **physiological maturity**: the seed has reached its final size and its formation is biologically complete. However, this physiological maturity is followed by the so-called **late maturation phase**, during which specific and rather complex biochemical processes take place in the seed, protecting it, for example, from oxidation processes and promoting its overall longevity. Depending on the plant species, this phase takes place partly on the mother plant and partly after the seeds have detached from the mother plant. An external sign of the late maturation phase is the formation of the final colour of the seeds (*see section 6.4. Seed harvesting*).

6. Technical aspects: selection, cultivation and harvest

6.1. SELECTION OF SEED BEARERS

The selection of plants for seed production is referred to by the technical term 'seed selection'. To do this, only the best plants are chosen, those that are healthy, well developed and well formed, while meeting the described varietal characteristics.

Specific selection criteria can also be considered, such as tolerance to stress factors such as heat, frost, drought or humidity, or tolerance to specific diseases and pests.

It is also important not to use plants that flower prematurely as seed bearers. This occasionally happens with biennial plants that flower prematurely in their first year of cultivation due to stress caused by cold or heat. Onion, celery and Swiss chard, for example, produce stress flowers due to cold weather; heat stress can cause early flowering in chicory, cabbage, carrot and other vegetables (*see section 5.2. Annual and biennial vegetables*).

In general, gardeners should carefully and regularly observe the development of their plants. With a little practice, you will quickly learn to spot and assess the subtle differences between plants.

Selected leeks before transplanting

5 - There are three types of variety descriptions: official descriptions by breeders, brief descriptions in seed catalogues, detailed descriptions of varieties by associations that maintain traditional varieties.

Positive selection of chicory seed bearers after forcing

Negative selection of chicory seed bearers after forcing

CRITERIA FOR SELECTING SEED-BEARING PLANTS

Selected plants:

- are well developed;
- have a good shape;
- correspond to the characteristics of the variety (according to the variety description);
- are healthy;
- are free from pests.

Additional special selection criteria may include:

- tolerance to abiotic stresses (cold, frost, heat, drought, humidity, etc.);
- tolerance to biotic stress (diseases, pests, weeds, etc.).

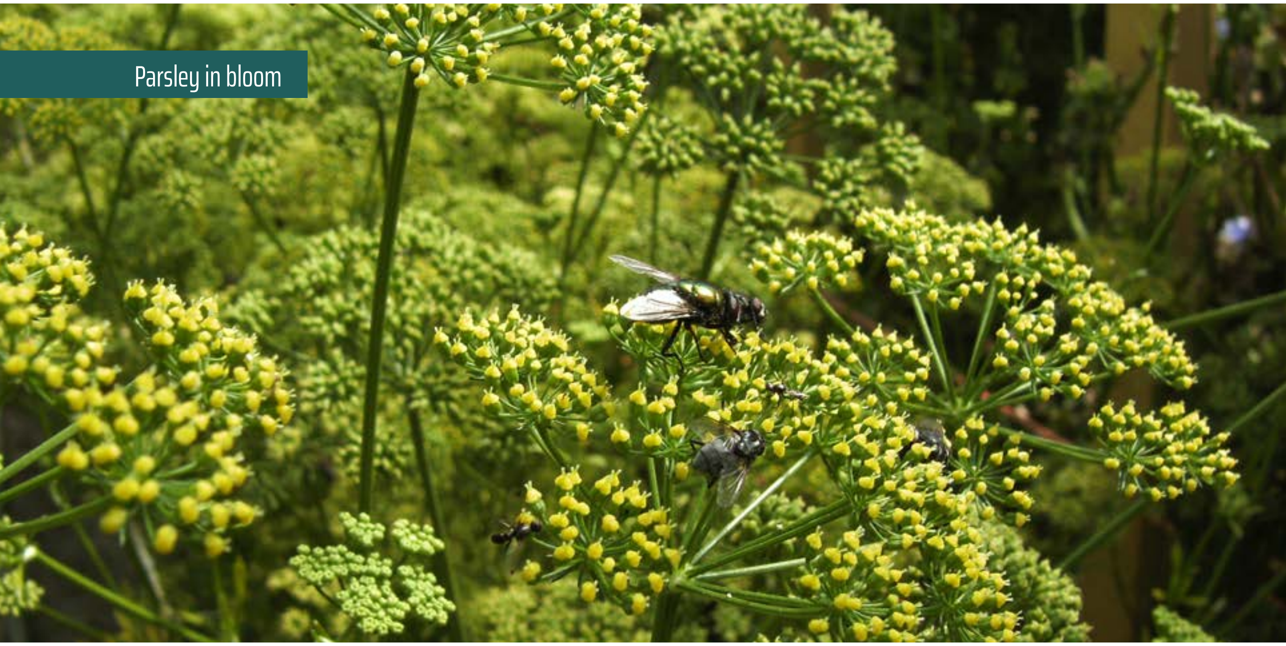
The **number of seed bearers selected** is also very important. To avoid total failure during subsequent cultivation, it is necessary to have a sufficient number of plants as seed bearers. Another reason for choosing several plants is the need for a certain amount of genetic diversity or variability, as plants are not all genetically identical (*see individual cultivation notes*).

NUMBER OF SEED BEARERS

It is important to select a sufficiently large number of seed bearers for two reasons:

• **To prevent potential losses:** Plants can be lost during overwintering or cultivation due to mould or other plant diseases. They can also be attacked by pests or eaten by mice. Seed bearers are particularly valuable plants; if they perish, an entire seed harvest is lost.

• **Preserving genetic diversity within a variety:** Plants of a traditional variety are genetically different from one another. This is referred to as intravarietal diversity. This genetic diversity is important for the ability of plants to respond to stressful situations and changing environmental conditions. Intravarietal genetic diversity gives a variety more opportunities to develop general natural robustness.



Parsley in bloom

6.2. OVERWINTERING AND TRANSPLANTING BIENNIAL SEED BEARERS

For biennial vegetables, it is necessary to overwinter the seed bearers. In northern Europe, only **frost-resistant vegetables** can be left directly in the field or garden, such as winter leek, kale, Brussels sprouts and corn salad. Savoy cabbage, parsley, Swiss chard and chicory can often also be left in the garden over winter. However, there is always a risk in the event of heavy frost. Voles can also be a problem if they eat the last vegetable plants in the garden, i.e. seed bearers, during the winter when food is scarce.

Root vegetables such as carrot, beetroot and winter radish can be stored over winter after harvesting in an earth cellar (root cellar) or a cold room with high humidity. Leafy vegetables such as Swiss chard, leeks and parsley should be dug up with their roots before the winter frosts arrive so that they can be overwintered in pots in a frost-free but cool and bright place (greenhouse, winter garden). Overwintering in pots has also proven successful for beetroot, carrot, celery, and celeriac, as it allows more time for replanting.

Biennial vegetables	**Overwintering**		
	Field / bed	**Root cellar**	**Pot (frost-free)**
Chicory, carrot, beetroot, celery, celeriac,onion		x	x
Endive, autumn leek, Swiss chard, parsley	(x)		x
Corn salad, Brussels sprouts, kale and winter leek	x		
Head cabbage			x

The biennial seed bearers are planted back into the garden in spring when the days become noticeably longer again and the temperatures rise, especially in the soil. This would be between the end of March and the end of April.

It makes sense to use special beds for seed cultivation that are easily accessible, easy to monitor and have a water supply. Even though it is ultimately the plant itself that produces the seeds, the cultivation must be monitored very carefully (*see also the individual cultivation notes*).

6.3. CULTIVATION OF SEED BEARERS

As far as the cultivation of the seed bearers is concerned, three categories can be distinguished:

Category	Description	Examples
Individual plants bearing fruit	Individual fruits are selected from well-developed individual plants. The ripe fruits are harvested, and the seeds are extracted.	Cucumber, pumpkin, courgette, tomato, pepper
Individual plants	Individual plants are selected from a group of plants (population) by 'positive selection' and then cultivated as seed bearers until the seeds are harvested.	Chicory, cabbage, lettuce, leek, carrot, radish, beetroot, celery, sweetcorn, onion
Group of plants	A 'negative selection' is carried out: only diseased or malformed plants are removed from the population; seeds are harvested from all other plants.	Basil, beans, corn salad, pea, parsley, spinach

It is important that the seed bearers have sufficient water available. As the seed formation phase often falls in the warm, rather rainless summer period, additional watering is usually necessary. Watering via drip hoses is a good method of getting water to the roots of the plants. You can also use a timer to ensure that the soil is sufficiently moist. When **watering** manually with a hand sprayer, often only the surface gets wet, and the water does not reach the roots. If a seed bearer lacks water, the seeds are not supplied with sufficient nutrients, and it can happen that many of them remain empty and then fail to germinate. However, the opposite can also be the case: too much water is given (or it rains too much). If the soil is then always saturated with water, there is a lack of oxygen in the soil and the soil organisms and plant roots cannot breathe. Waterlogging also disrupts the plant's nutrient supply.

A good combination is the use of drip tubes together with a **layer of mulch**, for example straw, which is spread over the tubes and around the seed bearers on the bed. The mulch not only keeps the soil moist for longer, it also helps to **suppress weeds**. Weeds in the seed bearers have three negative effects: Firstly, more moisture remains in the crop, which encourages the development of fungal diseases. Secondly, seed harvesting is made more difficult and takes longer. Thirdly, seeds are easily lost during harvest if weeds and seed bearers grow into each other.

Another essential measure is to **provide support for the seed bearers.** In the case of direct-sown crops (French bean, corn salad, spinach, etc.), it is usually possible to dispense with supporting devices, but it is not possible without them for tall individual plants. As the seed bearers are usually planted in straight rows, not only drip tubes can be used effectively, but also support stakes and straps to prevent the seed bearers from falling over.

In nature, mother plants fall over naturally when the plant slowly dies and has produced many seeds: the upper part of the plant becomes heavy, while the base becomes weaker, and so the plant eventually topples over, allowing the seeds to get onto and into the soil. The aim of seed production is to prevent what is normal in nature, as the greatest possible number of good seeds should be harvested and stored for a longer period of time. In nature, the vast majority of a plant‘s seeds are actually lost through animal consumption or mould.

There are different approaches and methods in the field of **plant protection measures**. In most cases, the approaches are applied in parallel and in a complementary manner. What is important here is a sensible sense of proportion when assessing the respective situations.

Method	**Description**
Pesticides and traps	Killing of crop pests (insects, voles, etc.)
Mechanical protection	Use of nets to keep out crop pests, protection of roots from voles using mesh baskets or cultivation in pots and planters, collection or suction of pests
Strengthening the plants	Use of fungus-inhibiting and insect-repellent plant extracts
Inactivity	Acceptance of the mechanisms of natural selection as part of evolutionary seed propagation

The agroecological or ecosystem approach assumes that pests and diseases do not occur without reason. As they belong to the degrading forces in the cycle of life and organic matter, their activities indicate a lack of vitality in the soil and in the crops. The use of pesticides does not improve the situation, rather the opposite. Pesticides also kill life-supporting organisms and cause resistance in harmful organisms.

The better way is to **take care of the soil** by **building up humus** and **strengthening plant health** with **plant extracts** and **microbial preparations**. **Local seed cultivation**, in which plants adapt to the environmental conditions of the location or region over the years, is another building block for pesticide-free agriculture.

In this sense, not using pesticides means **natural selection** in which only the healthiest and best-adapted plants can develop and produce seeds.

HARMFUL ORGANISMS

The term harmful organisms in cultivated plants refers to **microbial diseases** caused by fungi, bacteria or viruses as well as **animal pests** such as rodents, birds, insects, arachnids, gastropods, nematodes and others.

Particularly relevant for seed production are harmful organisms that are transmitted via seeds. These are certain **fungal, bacterial or viral diseases,** some of which are so-called **quarantine pests** that must be reported to the national authorities responsible for seed quality, when you are a professional seed producer. The list of quarantine pests can be found in the Annex to EU Regulation 2016/2031 on plant health. Quarantine pests are difficult to contain, either because there is a lack of plant protection products or because the spread and damage can take on significant proportions. For example, there are no authorised plant protection products against bacterial and viral diseases.

Fungicides are available against fungal diseases. However, if you want to grow organically, you should avoid them and use plant strengthening agents such as horsetail extracts. Fungal diseases that are spread via seeds include anthracnose, a leaf spot disease in beans that also affects pods and seeds, and Cercospora, a leaf spot disease that occurs in beetroot and chard, for example.

In professional organic seed production, microbial diseases are usually treated with hot water or steam. Hobby seed production is limited to preventative measures such as soil care, the optimum harvest time and good drying of the seed. It may be possible to wash seeds with **external moulds** using highly diluted acetic acid, but this also requires specific expertise and experience.

Two particular challenges for plant protection in seed production are the **seed beetles** and the **pollen beetles**.

The seed beetles are primarily the bean weevil (*Acanthoscelides obtectus*) and the common pea beetle (*Bruchus pisorum*). In early summer, the mothers lay eggs on the young pods of their host plants, from which larvae hatch a few weeks later, which penetrate the pod skin and reach the seeds. There they feed on the seed substance until pupation and hatching of the new generation of beetles. There can be several animals in one seed. The seeds often lose their ability to germinate. In seed production, the seed beetles can be rendered harmless by freezing the freshly harvested, well-dried seeds for a few days. To avoid condensation moisture on the seeds, thawing should be done slowly, for example in the refrigerator.

If you want to obtain seed from cabbage plants, the pollen beetle (*Brassicogethes aeneus*) can become a problem. In April, the seed bearers of the cabbage plants start to form buds. This is the moment when pollen beetles from neighbouring oilseed rape fields arrive. They pose a serious threat to the seed crop of all cabbage plants. The pollen beetles destroy the buds before flowering in order to feed on the pollen. The flowers die and can no longer form seeds. Pesticides have become much less effective in recent years as the beetles have developed resistance. There is one way of preventing major flower losses in the small-scale seed production of cabbage plants: covering the plants with an insect net in the phase in which the first buds form and gradually begin to bloom. The net is then uncovered again to allow pollinator insects to reach the plants. When the flowers are open, even the pollen beetles act as pollinators.

This method is reserved for experienced seed gardeners, as it involves the use of pollinator insects under the net and the simultaneous flowering of other brassicaceae as trap plants.

A particularly important aspect of vegetable seed cultivation is avoiding the **crossing** or **hybridisation** of two or more varieties of vegetable plants of the same species. This basically only happens with allogamous plant species.

The botanical rule is as follows: Plants of the same species belong to a population (reproductive community) and can reproduce with each other.

Here you need to know that:

- plants are categorised by **family**;
- plants have botanical names consisting of two parts (**genus** and **species**);
- cultivated vegetable plants are differentiated according to **cultivated varieties**.

According to this rule, leeks and onions will not interbreed. Although they belong to the same family (Alliaceae) and the same genus (*Allium*), they are not the same species: the botanical name of leeks is *Allium porrum* and that of onions is *Allium cepa*. Conversely, two different onion varieties can interbreed if they flower side by side, such as the red variety 'Oignon rouge de Huy' and the yellow variety 'Sturon'.

However, genetic interbreeding does not directly result in a new variety; rather, the original varieties are lost and an irregular variety of different shapes and colours is obtained when the seeds harvested after interbreeding are sown again. Developing new heterogeneous populations or even breeding new varieties is a very interesting activity, but it requires a lot of expertise and even more time.

For beginners in the field of seed production it is certainly better to concentrate on the **preservation of existing varieties**. It is therefore better to avoid cross-pollination between different varieties of the same species.

A cross between kale and broccoli. The plant looks very interesting, but its cultural value is questionable. Many types of cabbage belong to the same botanical species Brassica oleracea. They can therefore interbreed when they flower together.

There are various ways to avoid cross-pollination between varieties of the same species:

Method	Description
Temporal isolation	Two varieties of the same species are not cultivated simultaneously in the same place for seed production.
Spatial isolation	In the case of insect-pollinated species, a safety distance of several hundred metres is maintained between two varieties with a tendency to cross-pollinate; in the case of wind-pollinated species, the distance should be around one kilometre.
	Two varieties with a tendency to cross-pollinate are cultivated in isolation tunnels. These are tunnel structures covered with insect netting, where no pollinating insects can get in or out. The necessary pollination must then take place in the tunnel with the help of insects that are released into the tunnel. Flies that you can 'breed' yourself can be used as pollinators: To do this, fill a dark plastic bag with compost, seal it tightly, make a few holes in it and place it in the sun. When the compost starts to rot, flies come and lay their eggs in the holes. When maggots hatch from the eggs, the bag can be placed under the net in the insulation tunnel. This method only works well with apiaceae and alliaceae that flower relatively late, giving the flies enough time to develop in the spring.
	Hand pollination is practised. However, this only works well for vegetables with relatively large, unisexual flowers (pumpkin, courgette, sweetcorn). Pollen is collected early in the morning from male flowers of the variety and applied to female flowers that are fully developed but not yet open. The flowers pollinated in this way must then be sealed with a paper bag or clothes peg to prevent access by pollinating insects (*see pumpkin cultivation note*).

There are two simple rules for beginners in seed cultivation to avoid cross-pollination:

- Only multiply seeds of self-pollinating species (lettuce, tomato, bean, pea, etc.).
- In the case of cross-pollinating plants, use species from which there are no other flowering crops in the immediate vicinity: onion, beetroot, endive, etc.). In the case of sweetcorn, there are often maize crops in the surrounding agricultural fields and the pollen can fly over a kilometre. In the case of pumpkin or courgette, it often happens that other varieties of the same species are cultivated in neighbouring gardens, for example (*see also Summary table 1 and the various cultivation notes*).

TEN IMPORTANT RULES OF SEED CULTIVATION AT A GLANCE:

1.

Choose traditional varieties for seed propagation, no F1 hybrids

2.

Only use the best plants for seed cultivation

3.

Select a sufficiently large number of seed bearers

4.

Avoid cross-pollination between different varieties of the same species

5.

Keep seed bearers watered, supported and weed-free during cultivation

6.

Harvest seeds at the right time of seed maturity

7.

Dry the seed well after harvesting

8.

Store seeds in a dark, cool and dry place, preferably in hermetic containers

9.

Label seeds well (species, variety name, year and location of harvest, quality, germination rate)

10.

Keep a list with details of harvest quantities, seed quality and quantities in storage

6.4. SEED HARVESTING

There are two different harvesting methods:

- cutting off the entire mother plant (without roots, as otherwise soil residues can mix with the seeds) with subsequent seed extraction in the workshop (beetroot, lettuce, corn, spinach, etc.);
- gradual harvesting of the seeds (or fruits) from the mother plant on the bed (basil, bean, cabbage, carrot, leek, etc.).

Choosing the right time to harvest seeds is a decisive factor. It is the seed harvest that reveals whether the labour and effort invested in cultivating the seed bearers can bring a good result.

The general and self-evident rule is that seeds should not be harvested too early or too late. If seeds are harvested too early, they may not be properly ripe and may only have a low germination rate and/or a short germination capacity or lifespan.

If seeds are harvested too late, it can happen that they:

- detach from the mother plant and fall to the ground (cabbage, corn salad, etc.);
- start to mould on the mother plant (beetroot, carrot, etc.);
- germinate on the mother plant (leek, etc.).

Each plant family and each species of vegetable has its own specific characteristics in terms of seed formation and ripening. There are different categories:

Category	**Description**	**Examples**
Seeds in fleshy fruits	The seeds develop in fruits and are ripe when the fruits are fully formed. The seeds should be extracted before the fruits start to soften or even rot.	Cucumber, courgette, pepper, pumpkin, tomato
Seeds in dry hulls	The fertilised flowers form pods (brassicasseae and fabaceae), from which the seeds are extracted after complete drying and yellow colouring of the pods.	Bean, cabbage, navet, pea, radish, winter radish
Seeds without a clearly recognisable hull	When they wither and dry out, the fertilised flowers open and the ripe seeds become visible. In asteraceae and alliaceae, the seeds remain encased in petals, while in the apiaceae and amaranthaceae the petals fall off and the seeds are exposed.	Basil, beetroot, carrot, celery, corn salad, endive, leek, lettuce, onion, parsley, pea, spinach

Full seed maturity is reached when the mother plant has had the best conditions for seed formation and the natural moment has come when it no longer nourishes the seeds. Then the connection ('umbilical cord') is severed, and the seeds can detach from the mother plant and disperse.

There are two phases of seed maturation:

• The **physiological ripening phase**, in which the seeds fill up with minerals, carbohydrates, lipids and proteins and reach their final size, but still contain a lot of water;

• The **late ripening** phase, which consists of various biochemical processes in which the chlorophyll is broken down, the seeds develop their final colour and also lose a lot of water.

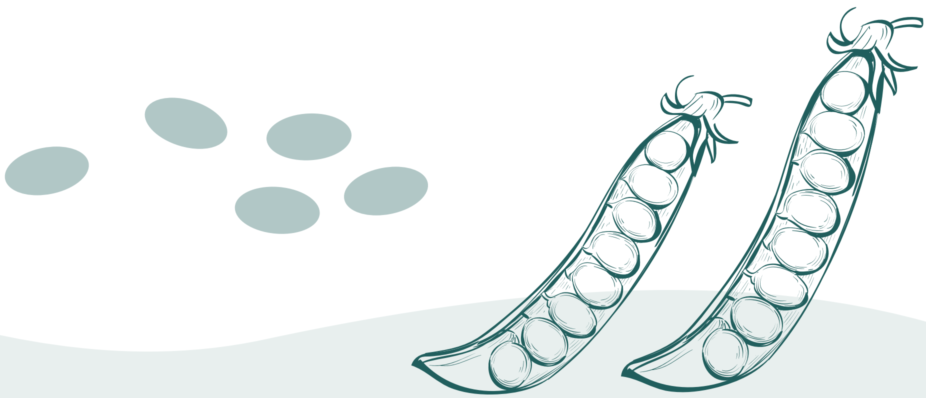
SEED MATURATION

It is important that seeds can absorb all the necessary nutrients and reach their final size during the physiological ripening phase. If the mother plant lacks water or nutrients, the seeds it produces may remain empty or too small.

Just as important as physiological maturity is biochemical maturity, which begins when the seeds start to detach from the mother plant.

In the so-called late ripening phase, various biochemical processes take place in the seeds that primarily ensure their longevity. These processes include

- the breakdown of chlorophyll;
- the replacement of water with carbohydrates (mainly starch);
- the formation of antioxidants to protect against oxidation (oxidation causes degradation processes that reduce the vitality and robustness of the seeds).



7. Technical aspects: Seed processing and storage

Seed processing primarily involves drying and cleaning.

The seed bearers or mother plants of most vegetables die in the course of seed formation and ripening; the seeds are harvested relatively dry on the bed or in the field. Fruit vegetables such as courgette, cucumber, pepper, pumpkin and tomato have a special status, as it is not the seed bearers that are harvested as whole plants, but only the fruits containing the seeds.

Seeds that were harvested relatively dry from the bed or field are further dried in the workshop and than extracted; this is known as **dry extraction**. In the case of fruiting vegetables, the seeds are usually surrounded by moist to wet pulp. The seeds are then washed during extraction; this is referred to as **wet extraction**. [6]

Peppers of the 'Corno di toro rosso' variety ready to harvest. Sweet pepper seeds rot relatively quickly in the fruit. They should be extracted at the time of normal of normal fruit ripeness, even if they have not yet reached their final colour.

6 - An exception to the fruit vegetables are peppers and chillies, where the seeds are not washed but only dried.

7.1. SEED DRYING IN THE CASE OF DRY EXTRACTION

It is just as important to dry the seeds properly before storing them as it is to harvest them at the right time. Seeds that are too moist can easily go mouldy after harvesting, and then all the effort will have been in vain just before the end.

It is not easy to determine by feel when seeds are dry enough for storage. Also, many vegetable seeds are not harvested until autumn, when the days are shorter, colder and wetter, so seeds harvested relatively dry from the bed or field sometimes even reabsorb moisture from the air in the workshop.

Important for good seed drying are:

- a drying room in which you can achieve good air circulation and the lowest possible humidity;
- a rapid, but not too fast drying process, which on the one hand allows the seeds to ripen (late ripening phase) and on the other hand prevents the development of mould;
- various technical aids such as fans, heaters, dehumidifiers, hygrometers and desiccants.

The three different phases of the drying process for plant species with dry extraction:

Drying phase	**Description**
On the bed/field	During the process in which the mother plant dies and the seeds ripen, the plants and seeds dry naturally. It is then advantageous to choose a sunny, perhaps windy, day for the seed harvest, on which the ripe seed bearers are not damp from morning dew or fog or wet from rain. The drier the seeds arrive in the drying room, the better.
After the harvest in the drying room	• In the drying room, heat for drying seeds can be obtained through solar radiation and air circulation through open windows. However, fans, heaters and dehumidifiers, which are available at any DIY store, can also be used for this purpose. • Drying should not take place too quickly, as the late ripening phase takes place in the seeds shortly after harvesting, for which the seeds not only need time, but also a certain amount of moisture. • Ideally, the drying achieved during the day should not be lost again during the night.

	• Hygrometers that display the humidity of the room air are useful as a guide, as the humidity of the seeds and the air humidity always stabilise at the same value (equilibrium relative humidity).
Shortly before final storage	If seed is relatively dry after harvesting (felt by hand or checked with a hygrometer), it can be temporarily filled into hermetic containers (buckets, boxes, jars) so that they do not absorb any new moisture. During this period of temporary storage, seed cleaning, germination tests, weighing and labeling can be carried out. Before final storage, the relative humidity of the seed can be checked again with small hygrometers placed in the seed container and possibly reduced with reusable drying agents such as silica gel, clay balls or dry rice seeds. Ideally, the residual moisture in the seed should be around 30 % before final storage.

(*see also section 7.3. Seed processing in the case of wet extraction*)

7.2. SEED CLEANING AND SORTING DURING DRY EXTRACTION

After the seeds have been dried, they should be cleaned. Although this is not absolutely necessary if you want to sow the seeds again in your own garden, it does have some advantages.

The removal of dirt and plant debris as well as the removal of small, empty and damaged seeds results in:

- an accurate weight of the harvested quantity;
- a clear idea of the number of seeds;
- an increase in the germination rate;
- a more accurate result of the germination testing.

If seeds are to be exchanged and/or distributed among gardeners, for example in a community garden or even in a local seed network, clean seeds are always the better alternative.

Even if the smallest impurities can remain in the seeds without affecting their quality, the care and rigour applied to seed cleaning has an influence on the germination capacity of the respective seed lots. It goes without saying that damaged seeds cannot germinate, but the same applies to seeds that are empty or too small. The more damaged, empty or undersized seeds you remove from the seed lot, the higher the germination rate will be.

The three options for seed cleaning without professional machines are:

- cleaning with special sieves with different mesh sizes;
- cleaning with wind or draught (in the sieve or in front of a fan);
- cleaning by hand by sorting out impurities.

Normally all three methods are used in combination. Large seeds (bean, pumpkin, etc.) are naturally easier to clean than small ones (lettuce, endive, celery, etc.), where the plant residues are often the same size as the seeds.

SEED CLEANING USING SPECIAL SEED SIEVES

Specialised seed sieves make it possible to achieve a relatively high level of seed cleanliness. Sieves specially made for seeds can be obtained from specialised manufacturers (see addresses in the appendix); kitchen strainers or masonry sieves are less expensive, but their function in seed cleaning is limited. Seed sieves are offered in fine gradations of mesh sizes; there are standardised sizes. With a set of 10 sieves of the numbers 4, 6, 8, 10, 12, 14, 16, 18, 25 and 30, most vegetable seeds can be cleaned well. The larger the number, the smaller the meshes.

Sieve cleaning follows two principles: Larger meshes retain plant debris such as stems and flowers and allow the seeds to fall through, smaller meshes retain the seeds and allow fine dirt and dust to pass through. Special skill is required to remove light impurities, which are

7.3. SEED PROCESSING IN THE CASE OF WET EXTRACTION

In the case of fruiting vegetables of the Solanaceae and Cucurbitaceae families, the ripe fruits are harvested from the mother plants and left to ripen for a few days or weeks in a place safe from animals or extreme temperatures. In any case, the fruits should not start to soften or even rot, as this makes seed extraction more difficult and can even reduce seed quality due to mould.

To **extract the seeds**, the fruit is then cut open and the seeds are extracted with fingers or spoons. Pumpkin seeds can be washed directly in a strainer to remove any remaining pulp. Removing the pulp prevents the formation of mould and shortens the drying time of the seeds after washing.

Tomato and cucumber seeds are surrounded by a gelatinous skin that protects the seeds from germinating in the watery flesh of the fruit. In nature, seed germination in the still intact fruit would result in low survival rates for the seedlings. In the case of less wet fruits such as pumpkins, courgettes and peppers, this protective cover is not necessary by nature.

After extraction from the fruit, tomato and cucumber seeds can be left to ferment in a jar together with the pulp or fruit water for a maximum of two days, during which time the gelatinous protective cover will dissolve. The seeds are then rinsed in a strainer to make them perfectly clean.

As with dry extracted seeds, **seeds from fruit vegetables are dried** with good air circulation at temperatures that should not exceed 40 °C. Seeds can also be dried with a draught of air only and without heat, for example with a simple fan. In any case, the seeds should be spread out as much as possible in order to achieve quick and even drying.

You should also make sure you have a favourable surface for drying: If you dry seeds on kitchen paper, it is difficult to remove any paper residue sticking to the seeds afterwards. A cloth would be better. Drying seeds on a hard surface can damage the seed coat when the seeds come loose. To prevent the seeds from sticking to a cloth or a hard surface in the first place, the seeds should be turned once and loosened shortly after the drying process begins. This can be repeated several times until they are completely dry.

Cleaned chicory seeds

A **special form of wet cleaning** can be used for the Alliaceae (onion, leek, etc.): the seeds, which have been pre-cleaned using sieves, are placed in a bowl filled with water. The last flower remnants and the light seeds float, while the good seeds sink to the bottom. The floating parts are poured off over the edge of the bowl, and the remaining water with heavy seeds is poured through a kitchen strainer, which retains the seeds. After water cleaning, the seeds must be dried again as quickly as possible.

IMPORTANT POINTS FOR SEED PROCESSING

I. DRYING

- Allow harvested seeds (seed bearers, pods, flowers, washed seeds, etc.) to dry in a ventilated place, if possible hang them up or place them on air-permeable grids.
- If there is insufficient heat and air movement in the drying room, set up a fan and a dehumidifier to support the drying process.
- Monitor the humidity (RH) in the room with a hygrometer (RH < 60 % if possible).
- Do not allow similar lots (same genus/species or seed size) to dry next to each other to prevent the seeds from mixing in the event of unintentional movement.
- Carefully label each harvested seed lot: Label with the name of the variety, the year of harvest, the place of harvest and possibly a quality indication (1st or 2nd choice).

II. CLEANING

- Do not extract seeds that are stuck (= insufficiently ripe seeds); for reasons of time and quality, be satisfied with 80 to 90 % of the seeds.
- Sort out damaged, stained, too small or empty seeds and throw them away; keep second choice seeds (smaller calibre) as a safety reserve.
- Keep seed processing material (tables, sieves, cans, tarpaulins, brushes, shovels, tools, machines) strictly clean. Thoroughly clean the material between two lots of seed to be cleaned (possibly using an air compressor).
- Do not pick up seeds that have fallen to the ground in order to avoid mixing them with other similar-looking fallen seeds (exception: large, easily recognisable seeds such as beans).

III. STORAGE

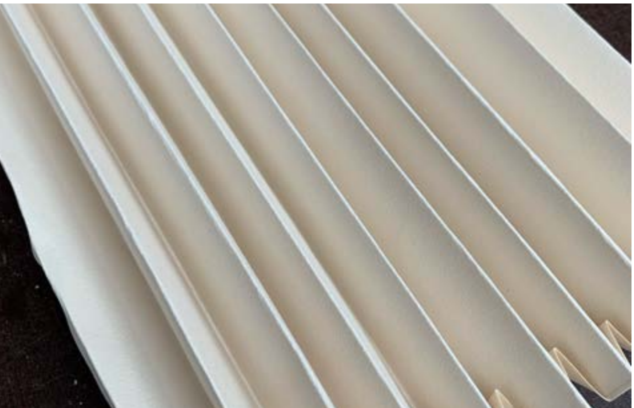
- Before storing in airtight containers, determine the humidity of the seeds with a hygrometer using the relative humidity (RH); ideally, store seeds only at a relative humidity of between 30 and 40 %; use desiccants (silica gel or clay balls) (i.e. enclose seeds with desiccant in airtight containers).
- Place the dried and cleaned seeds in precisely labelled packets or bags.
- Store the seed packets and bags in airtight boxes, jars, buckets or barrels to protect the seeds from moisture, oxygen and pests.
- Store containers in a dark place and at a constant, preferably low temperature (~ 15 °C).

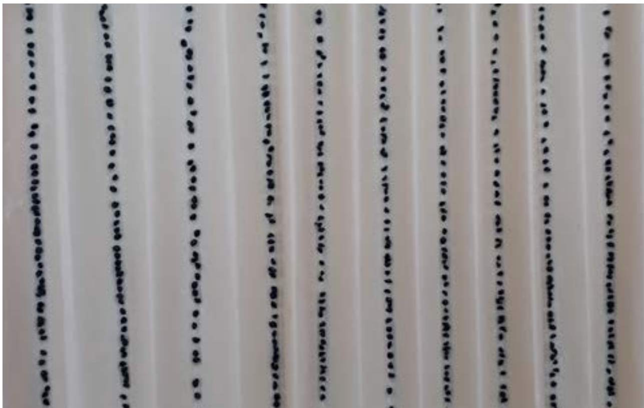
7.4. SEED QUALITY TESTING

After cleaning and drying the seeds as thoroughly as possible, it is appropriate to carry out a germination test. Even if seeds are not to be officially sold as market goods, but are only intended for exchange between hobby gardeners, it can be very helpful to have an idea of the quality of the seeds. This becomes even more important if you want to develop a project for a seed network for private gardens, community gardens or other garden projects. With poorly cleaned seeds that also do not germinate well, you will quickly lose your initial enthusiasm.

There are several **methods for germination testing**. Seeds can be sown in boxes with soil or substrate or placed in trays with absorbent paper as a base. In professional practice, absorbent paper folded into grooves is used; the seed lies in the grooves and the paper is well moistened. The folded paper with the seeds can then be placed in a plastic bag to prevent the seeds from drying out. If sowing in boxes or trays, a lid can be used to retain the **moisture**. Germination samples should not dry out at any time, otherwise the results will not be meaningful.

The correct **temperature** for the germination tests varies from plant species to plant species. The International Seed Testing Association (ISTA) has determined specific temperatures for germination testing of different plant species. In general, an average temperature of 20 °C is a good germination temperature for most vegetable species.


Folded absorbent paper


Germination tests of leek seed

A list should be drawn for the germination testing, on which the variety name, year and location of the seed harvest, number of seeds sown and date of the germination testing, as well as the results of the testing (germination rate in percent) are noted. Such an overview list can be very interesting to compare the seed quality of different years or to get an idea of the lifespan of seeds.

The seeds normally germinate quite quickly. On contact with water, they first swell and then push out their radicle. After this, the cotyledons unfold. In the case of brassicaceae, the cotyledons appear after just a few days, while in the case of apiaceae it can take up to two weeks.

It is not only the germination rate that is interesting, but also the germination vigour. It is determined by the vitality of the seeds and is expressed in a relatively uniform emergence of the seeds, i.e. they all germinate more or less at the same time.

Well-matured, well-dried, airtightly stored and relatively fresh seeds have a high vigour; in older and poorly stored seeds, vigour decreases rapidly. The speed and uniformity of germination is one indication of the vigour of the seeds; another is the shape of the cotyledons. To observe cotyledon development, it is good to place the germination tests in a bright location. If the cotyledons are not well formed or even misshapen, this indicates low seed vigour.

It is therefore interesting to check not only the freshly harvested seeds each year, but also the seeds from previous years. Regular notes provide a meaningful documentation of the ageing processes of the seeds.

In general, germination tests of self-harvested seeds that you not only want to use yourself, but also want to exchange with other gardeners, are a worthwhile investment of time. Before sowing the seeds in the garden, you already have an idea of the quality of the seeds. It is often the case that the reason why seeds do not germinate is not due to the quality of the seed, but to mistakes made during sowing:

- seeds planted too deep or too shallow in the soil;
- seeds that have dried out briefly during the germination phase;
- seeds that have been kept too wet.

If germination tests give poor results, you have three options:

- If the seeds are relatively old, enter the value in the overview table and put the seeds in the compost. However, if no fresher seed of the same variety is available, it is time to propagate new seed of the same variety.

- If the seeds are fresh, you can repeat the germination testing in case the germination conditions were not optimal.

- The third option applies to both older and fresh seed. In order to increase the germination rate, the seed lot in question can be cleaned again and more thoroughly (either with larger sieve meshes or with a stronger air flow).

Germination tests of various lettuces and basil in substrate

DETERMINATION AND EVALUATION OF THE GERMINATION RATE

According to the international ISTA rules, a germination test of a seed lot should be carried out in four repetitions of one hundred seeds each in order to provide a reliable result. This is not necessary in the hobby sector. Using 400 tomato seeds alone for germination testing is disproportionate for non-commercial use and small seed quantities.

It is sufficient for amateur use:

- to take 10 to 15 seeds for a germination sample for large seeds (bean, pea, pumpkin, but also tomato and pepper);
- 30 for medium-sized seeds (beetroot, cucumber, spinach, etc.);
- 50 for small seeds (cabbage, carrot, herbs, leek, lettuce, etc.).

The germination rate is calculated as a percentage:

$$\frac{\textbf{Number of germinated seeds x 100}}{\textbf{Number of seeds sown}} \textbf{ = germination rate in per cent}$$

The current EU law on the marketing of vegetable seed (Directive 2002/55/EC) stipulates minimum germination rates for the marketing of seed lots. For example, the minimum germination rate is 65 % for corn salad, leek, parsley, pepper, 75 % for many types of bean, cabbage, lettuce, spinach, and tomato, and 80 % for cucumber, pea, pumpkin, runner bean.

Hobby gardeners do not have to adhere to these minimum germination rates, but they can be used as a guide. Of course, seeds with a germination rate of only 50 % can also be sown; this can even be an advantage if, for example, carrot, corn salad, lettuce or radish are sown directly into the soil. If not all the seeds germinate, you avoid sowing too densely and all the plants can develop well.

7.5. SEED STORAGE

Once you have successfully cultivated, harvested and cleaned the seeds you have cultivated yourself, it is important to ensure that you can preserve the quality you have achieved for as long as possible. **Optimal storage conditions** for seeds are inevitably the opposite of the conditions that seeds need in order to germinate. Accordingly, seeds should be stored in a dry, dark, cool and **low-air** environment. Wire bail jars with rubber rings have proven to be good hermetic containers.

The basic prerequisite for proper storage to **maintain a high germination rate and good germination power in the long term** is sufficient drying of the seeds, which should be checked with a hygrometer if possible. For beginners, it is sufficient to dry the seeds well with a fan or on a heater that is not too hot and then put them directly into packets or bags and then in hermetic containers. In any case, you should avoid packing seeds that feel moist in an airtight container; otherwise mould growth and seed loss are guaranteed (*see also section 7.1 Seed drying in the case of dry extraction*).

Good **labelling** is also important for storage. The packets and bags in which the seeds of the different lots are stored separately should be labelled:

- Vegetable species and variety name
- Year and location of harvest
- Quantity/weight
- Germination rate
- Quality (1st choice or 2nd choice)

Parallel to labelling the individual seed lots or containers, you can keep a **list of varieties, harvest years, harvest quantities, seed quality, germination rates and remaining quantities in storage**. This is less of a bureaucratic measure and more of a basis for gathering experience and knowledge. It also makes it easy to see when the seed of a variety is getting too old or scarce, so that it should be reproduced.

More detailed information on the storage factors humidity, air, temperature and light:

Storage factor	Description
Humidity	Moisture is the most important factor influencing the lifespan of the seeds. In combination with oxygen and higher temperatures, moisture promotes metabolic processes in which the seeds 'breathe' and break down reserve substances. It is therefore important to prevent respiration processes in the stored seeds. Respiration processes involve enzymes, and these only function in the presence of water. Scientific tests have shown that a relative humidity of 30 % is the best condition for long-term seed storage. The humidity of the seed should be checked before storage in hermetic containers and corrected if necessary (*see section 7.1. Seed drying in the case of dry extraction*).
Air	Air or oxygen is the second most important factor that should be taken into account for long-term seed storage. Oxygen in the air promotes oxidation processes, which should not be confused with respiration processes. Oxidation removes electrons from substances, which is equivalent to material decomposition (see rust in metal). When lipids, proteins and DNA in the seed oxidise, its lifespan is shortened. In professional seed production, seeds are stored with little or no oxygen by vacuuming or by increasing the nitrogen or carbon dioxide content of the air. The idea that seeds need to breathe in order to survive is therefore scientifically incorrect. To reduce the oxygen content, the individual seed lots can be packed individually if possible. If you store many seed packets in a large, albeit hermetic, bucket, all the lots will be flooded with oxygen when the bucket is opened to remove a little seed.
Temperature	In general, a rather low temperature is better for seed storage. However, it is more important that the temperature remains constant and is not subject to fluctuations. The best temperature for seed storage is 15 °C, according to scientific tests.

Light	The UV spectrum in light can have a damaging effect on the lipids, proteins and DNA of the seeds. Light also becomes problematic when seeds are exposed to direct sunlight in a hermetically sealed jar: A greenhouse effect occurs inside the jar and the seeds are exposed to high temperatures. They also evaporate residual moisture, which condenses on the walls of the jar and can then lead to mould growth.

Note: Cultivated plants cannot be compared with wild plants, as the natural germination inhibition has been bred out of most cultivated plant seeds. Seeds of wild plants, on the other hand, can lie in moist soil for years without germinating and without losing their ability to germinate.

Average duration of germination capacity under optimal storage conditions:

Vegetable	Duration
Bean	3–4 years
Beetroot	5–6 years
Cabbage	4–5 years
Carrot	4–5 years
Celeriac/celery	5–6 years
Chicory/endive	4–5 years
Corn salad	4–5 years
Courgette	4–5 years
Cucumber	4–5 years
Leek	3–4 years

Vegetable	Duration
Lettuce	4–5 years
Onion	3–4 years
Parsley	4–5 years
Parsnip	1–2 years
Pea	3–4 years
Pumpkin	4–5 years
Radish	4–5 years
Spinach	4–5 years
Sweet corn	3–4 years
Tomato	3–5 years

CULTIVATION NOTES FOR TEN VEGETABLE SPECIES

Cultivation notes for ten vegetable species

Practical aspects of seed cultivation are explained using ten vegetable species as examples. Each description also includes vegetable species for which seed production is similar or identical.

The vegetables are divided into three levels of difficulty: For the first level, no special knowledge or skills are required, and seed production is very simple. The plants at the second level require a little more attention and technical support. The third level is reserved for experienced seed gardeners.

SEED GROWING AT BEGINNER LEVEL

Tomato (+ pepper, aubergine)

Bean (+ broad bean, pea, runner bean, soya)

Lettuce (+ Asian salad, spinach)

SEED CULTIVATION AT ADVANCED LEVEL

Cucumber

Onion (+ leek)

Beetroot (+ Swiss chard)

SEED CULTIVATION AT EXPERT LEVEL

Pumpkin (+ courgette, melon)

Endive (+ chicory)

Carrot (+ celeriac, celery, fennel, parsley, parsnip)

Head cabbage (+ kale, Brussels sprouts)

TOMATO (*Solanum lycopersicum*),

SOLANACEAE, ANNUAL, AUTOGAMOUS

CULTIVATION OF SEED BEARERS: In the case of the tomato, plant cultivation and seed cultivation are the same thing. If you give the tomato plants the best conditions for development, you also create the best conditions for harvesting good seeds. During cultivation, you can focus on the healthiest and strongest plants right from the start, which may also be the first to develop fruit. However, the long-term health of the plants is the more important factor.

SELECTION OF SEED BEARERS: In late summer, select beautiful fruit from plants that have been productive and remained healthy. The plant produces the best seeds when the summer is coming to an end and the plant has passed its peak of development. The plant will now concentrate more on producing good seeds for its survival through the next generation.

MATURITY OF FRUITS: At harvest, the fruits should ripen as long as possible on the mother plant in order to benefit from its metabolism for as long as possible. After harvesting, the seeds can also ripen further in the fruit. However, the fruit should not become overripe or even mouldy, as it is possible for the seeds to become mouldy or even germinate in the fruit.

Selected tomatoes

NUMBER OF SEED BEARERS/FRUITS TO BE HARVESTED: As the tomato is an autogamous plant, there is no pollen exchange between the plants. It is best to take fruit from several plants to ensure the widest possible genetic diversity between the plants/fruits. Ten different plants should be the minimum.

SEED EXTRACTION AND CLEANING: To extract the seeds, cut the tomatoes horizontally, opening all the seed cavities at the same time. The seeds are removed from the cavities with a spoon and placed in a jar with the fruit juice and flesh.

The seeds should ferment in the jar for one to a maximum of two days. To speed up the process, you can add a little sugar and keep the jar warm. The fermentation dissolves the gelatinous coating of the seeds and the seeds can be rinsed perfectly clean in a kitchen strainer. The seeds can then be dried in the strainer on a heater at around 30 °C.

SEED QUANTITY PER FRUIT: Cherry tomatoes can contain up to 100 seeds, large fruits up to 300 seeds. One thousand seeds of cherry tomatoes weigh about 1 to 2 g, large-fruited varieties weigh about 3 to 4 g.

Pepper and aubergine seeds can be obtained in a similar way. In the case of pepper, it is advisable to extract the seeds from the ripening fruit at an early stage, as they mould relatively quickly. It is also not necessary to wash the seeds of pepper.


Seed extraction from horizontally sliced tomatoes


Cleaned seeds

FRENCH BEAN (*Phaseolus vulgaris*),

FABACEAE, ANNUAL, AUTOGAMOUS

CULTIVATION OF SEED BEARERS: With the bean, seed production is a very simple matter: you plant a few seeds in the soil and wait until the plant has completed its life cycle. The seeds are harvested the same year they are sown and there is no need to worry about cross-pollination between different varieties. In the private garden, beans can be harvested for consumption and only a few pods per plant can be allowed to reach seed maturity.

SELECTION OF SEED BEARERS: The bean is cultivated in direct sowing and the plants remain on the same bed until the seeds are ripe. You can either only harvest seeds from the well-developed, healthy plants that are typical of the variety (positive selection) or remove the plants that are unsuitable for seed production from the bed (negative selection).

NUMBER OF SEED BEARERS/FRUITS TO BE HARVESTED: In the case of beans as an autogamous plant, it is best to take fruits from many plants in order to ensure the widest possible genetic diversity between the plants/fruits. Thirty different plants can be considered a minimum.

MATURITY OF THE FRUITS: The pods should mature on the mother plant until they have completely lost their green colour and are so dry that the seeds make a noise like a rattle when the pods are shaken.

Flowering beans

However, if there are longer periods of rain during the ripening period, it may be better to harvest the pods before the seeds are fully ripe to prevent the seeds in the pods from rotting. The whole plant can be pulled out of the ground and left in a dry, well-ventilated place for the seeds to mature completely.

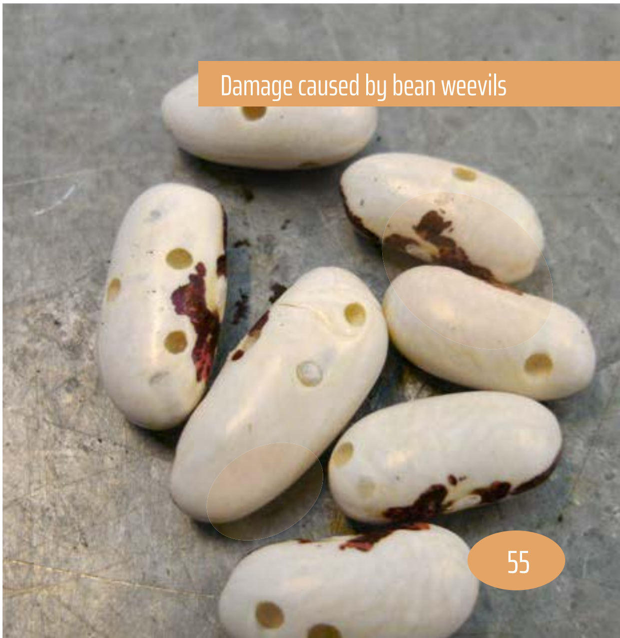
SEED EXTRACTION, CLEANING AND TREATMENT: To extract the seeds, the beans can be removed from the pods by hand. For larger quantities, the dry pods can be crushed and then the seeds can be separated from the pod remains by means of a fan. Spotted, cracked, shrivelled or too small seeds are sorted out.

The seeds should be frozen for a few days immediately after drying to kill the larvae and pupae of the bean weevil. This is a quarantine pest that can completely destroy seed stocks. Frozen seeds should be thawed gradually (in the refrigerator) to avoid condensation moisture on the seeds.

SEED QUANTITY PER SQUARE METRE: For dwarf French beans, you can expect around 100 to 300 g of seed per square metre, for climbing French beans double to triple this amount.

The same method can be used to obtain seeds for broad beans, peas, runner beans (Phaseolus coccineus) and soya. Freezing the seeds for plant protection applies to all species.


Ripe pods and seeds


Damage caused by bean weevils

LETTUCE (*Lactuca sativa*),

ASTERACEAE, ANNUAL, AUTOGAMOUS

SECTION OF SEED BEARERS: As an annual plant, lettuce needs about seven months from sowing to seed harvest. The first spring sowings should therefore be used for seed production, otherwise there is a risk that the seeds will not ripen in autumn. On the bed, select at least ten beautiful heads from the largest possible stock (> 30 plants) according to development, shape, colour and health. Late bolting is also an important selection criterion. Repeated seed cultivation with selection can reduce the tendency to bolt of lettuce over the years.

CULTIVATION OF SEED BEARERS: The easiest way is to leave the selected seed bearers on the bed and support them individually with stakes and strings. However, it is also possible to transplant the plants to another bed and then support them in a row.

Three rules apply when transplanting mature plants:

- Dig out as large a root ball as possible;
- Remove a certain number of large leaves to reduce evaporation;
- Water abundantly and repeatedly until the plant has re-established itself.

Lettuce needs a good supply of water for seed formation, otherwise the seeds will remain empty. When the seeds are ripening, however, care should be taken to ensure that the plants do not receive too

Bolting lettuce

much rain, so as to prevent the seeds from going mouldy. If the seeds are not yet ready for harvest in September, rain protection is recommended in any case.

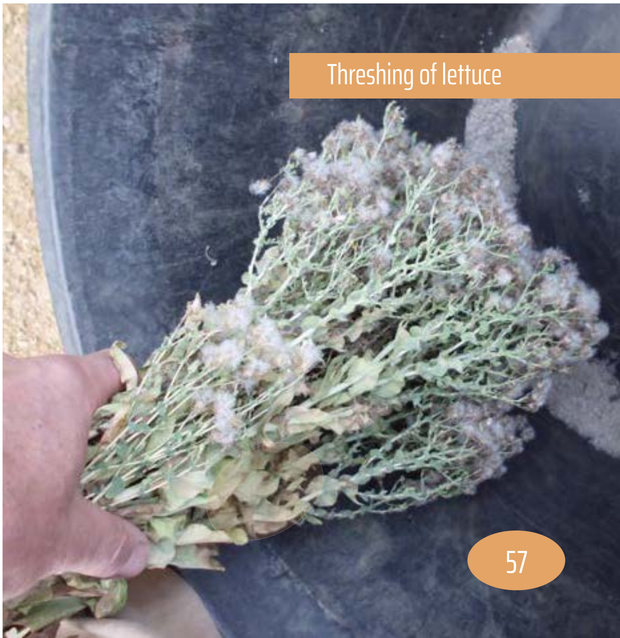
SEED HARVESTING / SEED QUANTITY PER PLANT: The flowers of lettuce plants grown in greenhouses or polytunnels open, and the seeds become visible. Outdoors, the flowers often remain closed after flowering. A lettuce seed bearer can produce more than 10 g of seed, which equates to at least 10,000 seeds.

It is advisable to harvest the mother plants with the ripe seeds by cutting them off just above the ground, taking care not to take any soil particles with them. They can then be hung upside down in a dry, well-ventilated room, with a cloth spread underneath to catch any seeds that may fall.

SEED CLEANING: The harvested seed bearers can be threshed in a barrel or rubbed through sieves to extract the seeds. Subsequent cleaning in a draught allows fine plant residues and empty seeds to be sorted out. Sieves or a fan can be used for wind cleaning.

Mustard greens and spinach seeds can be obtained in a similar way. However, threshing is not the correct method of seed extraction for spinach; the seeds must be stripped from the stems by hand.


Open flowers, ripe seeds


Threshing of lettuce

CUCUMBER (*Cucumis sativus*),

CUCURBITACEAE, ANNUAL, ALLOGAMOUS

CULTIVATION OF SEED BEARERS: As a fruit vegetable, the cultivation of the plants and the cultivation of the seeds are the same thing with the cucumber. During cultivation, you can look for the healthiest and strongest plants right from the start, which may also be the first to develop fruit. However, the long-term health of the plants is the more important factor.

SELECTION OF SEED BEARERS: It is better not to take the first cucumbers for the seed harvest, but to allow the mother plants to develop well. For normal cucumber cultivation, the first fruits should be removed up to a plant height of about 60 cm. This allows the mother plants to concentrate on their vegetative growth and develop leaf mass. To ensure sufficient genetic diversity between the plants, leave one or two cucumbers on 10 plants for seed ripening.

MATURITY OF FRUITS: Before harvesting, the fruits should ripen as long as possible on the mother plant in order to benefit as much as possible from its metabolism. After harvesting, the seeds have the ability to ripen further in the fruit. However, the fruit should not become soft and start to rot, as this can reduce the seed quality.

Overripe cucumber

SEED EXTRACTION AND CLEANING: To extract the seeds, cut the cucumbers lengthwise into three parts, as cucumber fruits are divided into three parts, each with two rows of seeds. The seeds are extracted with a spoon and placed in a jar. You can add a little sugar to the jar and leave the seeds to ferment for one, maximum two days. The gelatinous coating dissolves and the good, heavy seeds sink to the bottom. Drain the light seeds and rinse the good seeds in a strainer under running water.

SEED DRYING: After washing, the seeds should be dried as quickly as possible. This should not be done on kitchen paper, as it sticks to the seeds and cannot be removed easily. Drying can be done directly in a strainer on a heater or with a fan.

SEED QUANTITY PER FRUIT/GERMINATION: Cucumber varieties with short fruits contain about 5 g of seed, which corresponds to 200 seeds. The seeds generally only germinate well from the second year after harvest and can still have a very high germination capacity 5 years after harvest.

As cucumbers are allogamous plants, different types of the species Cucumis sativus can cross-pollinate and interbreed with each other. Most modern cucumber varieties are doubly unsuitable for seed production: on the one hand, they are F1 hybrids, and on the other hand, they are purely female plants that produce fruit without fertilisation, in which no seeds form.

Samenextraktion

Abspülen der Samen

ONION (*Allium cepa*),

ALLIACEAE, BIENNIAL, ALLOGAMOUS

SELECTION OF SEED BEARERS: In late summer, after harvesting the ripe onions, the best onions are selected as seed bearers: well developed, healthy and corresponding to the varietal characteristics. It is advisable to select about 60 beautiful bulbs in order to have sufficient genetic diversity and to prevent losses during winter storage.

OVERWINTERING AND PLANTING THE SEED BEARERS: The bulbs selected as seed bearers are kept in a dry and cool place over the winter. In spring, when the days get longer again and the temperatures rise, the bulbs are selected once more and then the most beautiful ones that have not yet sprouted are planted on a bed, where they remain until the seeds are harvested. The distance between the plants should be at least 10 cm, between the rows at least 20 cm.

CULTIVATION OF SEED BEARERS: As soon as the bulbs are planted back into the soil, they form new roots, then leaves and finally flower stalks. To prevent the flower stalks from being bent over by wind or rain during seed formation, they should be supported with sturdy wooden stakes or slats (e.g. 48 x 24 mm cross-section) and strings.

Selected onions

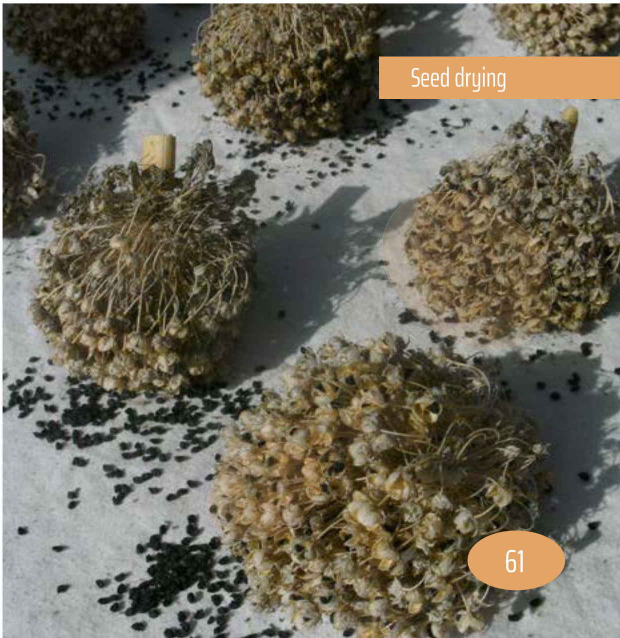
SEED HARVESTING: The best time to harvest seeds is in early autumn when the seeds turn black. If you wait too long to harvest the seeds, there is a risk that the seeds will either be scattered on the ground or germinate on the mother plant in damp weather. When harvesting, cut off the onion heads with secateurs. One onion seed bearer can produce about 6 to 9 g of seed, which corresponds to about 1,700 to 2,500 seeds per plant.

SEED DRYING: After harvesting, the onion heads can be dried in a large, fine-meshed sieve or on a wire mesh covered with a cloth. If the flowers were already open when they were harvested, the seeds will fall out by themselves or by gently shaking them. If the flowers are still closed, the seeds must be rubbed out in a sieve and freed from their hulls.

SEED CLEANING: Onion seeds can be cleaned more or less well using sieves with different mesh sizes. You can also clean the seeds in a bowl of water: Flower remains and light seeds float, while the good seeds sink to the bottom. After cleaning with water, the seeds should be dried again as quickly as possible.

Leek seeds can be obtained in a similar way. Frost-sensitive autumn leeks are overwintered in pots, winter leeks can be left in the garden/field over winter and then transplanted to a seedbed in spring.


Onion flowers / Fly as pollinator


Seed drying

BEETROOT (*Beta vulgaris*),

AMARANTHACEAE, BIENNIAL, ALLOGAMOUS

SELECTION OF SEED BEARERS DURING CULTIVATION: During the cultivation of beetroot, at least 50 well-developed, healthy plants typical of the variety should be marked with sticks; selection criteria include, for example, the health of the leaves (preferably no traces of leaf spot disease) or the narrowest possible leaf base on the beet head with only one shoot.

SELECTION OF SEED BEARERS AND OVERWINTERING: When harvesting in late autumn, the underground part of the plants is also selected. The beets should not be burst or pitted and should only have one root tip. The beetroots selected as seed bearers can be stored over the winter either in a dark, cold but frost-protected place with high humidity (root cellar) or preferably in pots in a frost-protected greenhouse or winter garden, where they can be watered from time to time over the winter.

NUMBER AND CULTIVATION OF SEED BEARERS: In spring, the beetroot is planted on a bed, where it remains until the seeds are harvested. To ensure sufficient genetic diversity between the plants, you should have at least 30 seed bearers. The distance between the plants in the row should be at least 30 cm, between the rows at least 40 cm. To prevent the flower stalks from being bent over by wind or rain during seed formation, they should be supported with sturdy wooden stakes or slats (cross-section e.g. 48 x 24 mm) and string.

Bolting beetroot

SEED HARVESTING: The best time to harvest seeds is in summer, when the seeds have lost their green colour. If you wait too long to harvest the seeds, there is a risk that either the seeds will be scattered on the ground or mould will form in damp weather. When harvesting, cut the seed stalks with secateurs and lay them on a bed sheet next to the bed, and they can be dried further on it in the workshop.

SEED DRYING AND CLEANING: The seeds are dried well on a spread out sheet on a grid. For extraction and cleaning, the seeds are stripped from the stems by hand. The seeds are cleaned using two sieves placed on top of each other. The upper sieve with slightly larger meshes holds back the large seeds, the lower small-mesh sieve holds back the small seeds and allows dust and small plant residues to pass through. In the coarser sieve, leaf residues can still be removed by draughts. The small seeds can be kept as a second choice. A seed bearer can produce around 15 to 30 g of seed, which corresponds to around 1,000 to 2,000 seeds per plant.

Swiss chard seeds can be obtained in a similar way. Caution: As Swiss chard and beetroot belong to the same plant species (*Beta vulgaris*)*, the two can interbreed. Cross-pollination is also possible with fodder beet and sugar beet* (*also Beta vulgaris*)*.*

Harvesting the seed bearers on a cloth on the bed

Seed cleaning by sieve

PUMPKIN (*Cucurbita maxima*),

CUCURBITACEAE, ANNUAL, ALLOGAMOUS

CULTIVATION OF SEED BEARERS: Seed production is actually extremely simple unless pumpkins of the Cucurbita maxima species are also grown in neighbouring gardens. Due to the flight of pollinating insects such as bees and bumblebees, which can distribute pollen within a radius of several hundred metres, cross-pollination between different varieties of the maxima species is almost inevitable.

HAND POLLINATION TO AVOID CROSS-POLLINATION: To avoid cross-pollination between *Cucurbita maxima* varieties, hand pollination is carried out. The evening before, female and male flowers that are already yellow but not yet open are sealed with bags and pegs. The next morning, pollen is collected from the male flowers, which is then transferred to the female flowers. After pollination, the female flowers must be closed again to prevent further pollen being brought in from outside by insects.

SELECTION OF SEED BEARERS: The selection of seed bearers is primarily related to the fruits and here especially to shape and colour. In order to have a sufficiently broad genetic diversity, fruits from at least 10 different plants should be harvested. Attention should be paid to the health and good development of the mother plants. Both depend crucially on the condition of the soil and good organic fertilisation.

Young, immature fruit

MATURITY OF FRUIT: The pumpkins should be allowed to ripen on the mother plant to ensure good seed development. Fruit ripeness can be seen from the browning of the pedoncule and the change of colour of the skin, which takes on its final colour and becomes matt. After harvesting, however, the seeds can continue to ripen further in the fruit for a few weeks.

SEED EXTRACTION, CLEANING AND DRYING: To extract the seeds, cut the pumpkins open and remove the seeds by hand or with a spoon. The seeds should be washed immediately. Under no circumstances should they be left to ferment, as they do not have a protective shell like tomatoes and cucumbers and could swell when soaked in water. After washing, the seeds should be spread out well and dried as quickly as possible. Drying can be done either on a heater or with a fan.

SEED QUANTITY PER FRUIT/SPROUT: Pumpkins contain an average of around 200 seeds, which corresponds to a weight of around 30 to 40 g per fruit.

Seeds from courgettes or melons can be obtained in the same way. Note: There are also pumpkins of the species pepo, such as the 'Sweet Dumpling'; these therefore also hybridise with courgettes (Cucurbita pepo). Butternut squash (Cucurbita moschata) and Hokkaido pumpkin (Cucurbita maxima), on the other hand, do not interbreed as they belong to different species.

Selected, variety-typical fruits of the 'Green Hokkaido'

Cut up pumpkin

ENDIVE (*Cichorium endiva*),

ASTERACEAE, BIENNIAL, ALLOGAMOUS

CULTIVATION METHODS: With endive, there are two ways to cultivate the seed bearers:

1. sowing in summer (mid-June to early July), selection of plants ready for harvest in autumn (October), overwintering the seed bearers in pots;
2. sowing in late summer (August), overwintering of the young plants in a bed in the greenhouse, selection of the best plants as seed bearers in April (cultivation without transplanting).

SELECTION OF SEED BEARERS AND OVERWINTERING: In the first method, the plants selected at harvest maturity for shape, state of development and health are dug up with the root ball and placed in pots. To avoid rotting during the winter, the plants should be placed relatively high in the pot and the outer large leaves removed. Removing the leaves also reduces the plant's stress from digging and potting by reducing water evaporation. It is sufficient if the plants still have a diameter of around 25 cm after leaf removal.

NUMBER AND CULTIVATION OF SEED BEARERS: The plants overwintered in pots are planted on a bed in spring and begin to bolt around the end of April. This lengthens the main shoot of the plants and prepares them for the flowering phase. With the second method (sowing in late summer and overwintering in a greenhouse bed), bolting starts before the plants are fully formed.

Dug up and potted endive for overwintering

Unfortunately, it is then not possible to select for the shape at harvest maturity. The advantage of the second method is the lower failure rate of plants over the winter.

With both methods, at least 20 seed bearers should be present to ensure sufficient genetic diversity. The seed bearers should be mulched, well-watered and supported like all other biennial seed bearers.

SEED HARVESTING AND DRYING: Endive seed maturation is a relatively long process in which ripe seeds and new flowers can be found on a plant at the same time. The risk of ripe seeds being scattered on the ground before harvesting is relatively low, as the endive seeds are relatively well protected in a deep 'cup' (calyx) after the flower has faded. Harvesting is initially carried out by cutting off the dry mother plants just above the ground and drying them in a well-ventilated drying room.

SEED QUANTITY PER PLANT: An endive plant can produce an average of around 8,000 to 10,000 seeds, which corresponds to a weight of around 12 to 15 g.

Chicory seeds can be obtained in a similar way, except that the seed bearers are selected from the most beautiful sprouts after forcing.


Endive flower with bumblebee


Staggered seed harvesting

CARROT (*Daucus carota*),
APIACEAE, BIENNIAL, ALLOGAMOUS

SELECTION OF SEED BEARERS AFTER HARVEST: The actual selection of seed bearers takes place when the carrots are harvested. The selection criteria are a smooth skin (no transversal grooves, no small lateral roots), the shape of the head and the tip, the width of the leaf base and the straightness of the carrot (no twisted or forked carrots).

OVERWINTERING SEED CARROTS: To prevent losses, overwinter about 80 or more carrots. The carrots selected as seed bearers can be kept over winter either in a dark, cold, but frost-protected place with high humidity (root cellar) or in pots in a frost-protected greenhouse or winter garden, where they can be watered from time to time.

NUMBER AND CULTIVATION OF SEED BEARERS: In spring, when the days get longer and the temperatures rise again, the carrots are planted on a bed where they remain until the seeds are harvested. To ensure sufficient genetic diversity between the plants, it is best to have no fewer than 40 seed bearers. The distance between the plants in the row should be at least 20 cm, between the rows at least 40 cm. The biggest challenge in growing carrot seed is the wild carrot, which grows everywhere in nature. An isolation tunnel with fly netting and pollinator insects is therefore recommended. This is a practice for experienced seed gardeners.

Selection of seed bearers during harvest

SEED HARVESTING: When the carrot flowers have faded and the visible seeds have lost their green colour, they can be harvested. It is best only to cut off the primary umbels with secateurs. The primary umbels sit on the main shoots and are easy to recognise as the largest umbels. The secondary and tertiary umbels often only produce relatively small seeds. At the beginning of autumn, when the humidity rises, there is an increased risk of mould forming on the seeds.

SEED DRYING AND CLEANING: The cut umbels are dried well on a sheet spread out on a grid. For extraction and cleaning, the umbels are rubbed in a sieve that allows the seeds to fall through into a fine sieve placed underneath. The seeds are also rubbed again in the second sieve to completely rub off the spikes of the seeds. Otherwise, the seeds could become entangled with the spikes during sowing. One seed bearer can produce around 5 to 10 g of seed, which corresponds to around 5,000 to 10,000 seeds per plant.

Seeds of other biennial apiaceae such as fennel, parsnip, parsley, celeriac and celery can be obtained in a similar way, except that their seeds have no spikes.


Carrot seed bearers in bloom


Ripe carrot seeds with ‘spikes’

HEAD CABBAGE (*Brassica oleracea*),

BRASSICACEAE, BIENNIAL, ALLOGAMOUS

METHODS OF OVERWINTERING THE SEED BEARERS:

There are two ways of cultivating the seed bearers of head cabbage (white and red cabbage):
1. Harvesting the heads and overwintering the stalks;
2. Overwintering the plant with the developed head.

Both methods involve overwintering in pots. The advantages of overwintering the stalks are that you can harvest the head of cabbage, that overwintering requires less space and that planting out is less labour-intensive. The disadvantage is that the (large) cut surface of the head often does not heal and dry well after harvesting and that rot fungi develop. Here it can help to apply ground or crushed charcoal to the cut surface, which keeps mould and rot fungi at bay.

If whole heads are to be brought through the winter, the leaves must be gradually removed between November and February following the rhythm of the rotting outer leaf layers. In February, only a central bud may remain from the head. Otherwise, the remaining head should be removed by cutting off the leaves with vertical lateral cuts so that a cuboid remains in which the central bud is located. This is done especially with storage cabbage with its tightly packed leaf layers so that the central shoot has an easier time in spring. In loosely layered autumn cabbage, the central shoot breaks through the remaining leaf layers on its own. In the case of seed bearers without a head, a central shoot can no longer be formed; the plant then produces side shoots, which can, however, break off relatively easily.

Red cabbage stalks overwintering without heads

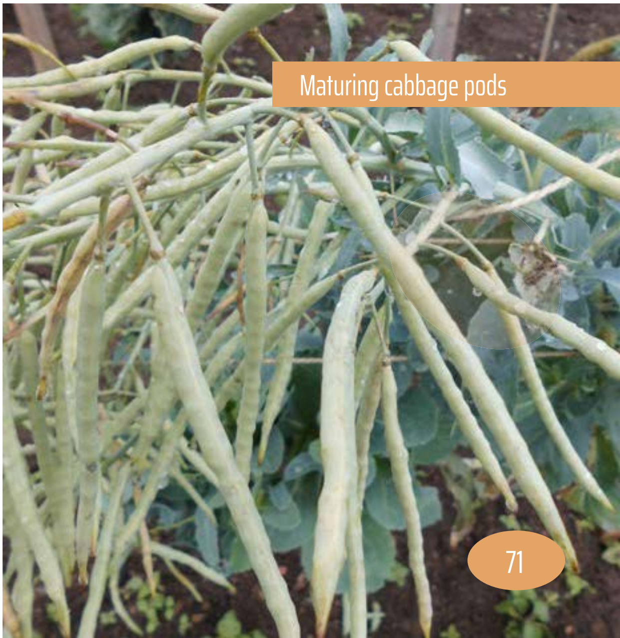
NUMBER AND CULTIVATION OF SEED BEARERS: As plants can be lost during overwintering, no fewer than 40 seed bearers should be overwintered if possible. The seed bearers should be mulched, well-watered and supported like all other biennial seed bearers.

SEED HARVESTING AND CLEANING: Seed ripening in cabbage is completed before the middle of summer when the pods turn brown in colour. Ripe pods can burst open under the influence of fluctuating humidity and heat between day and night, releasing the seeds. This should be avoided. The pods can be easily opened after complete drying by rubbing them in a sieve; this also separates the seeds from the empty pods.

SEED QUANTITY PER PLANT: Depending on the species, a cabbage plant can produce between 3,000 and 10,000 seeds on average, which corresponds to a weight of around 10 to 30 g.

Note: There are many Brassica oleracea species that can all interbreed when they flower together: White, red and savoy cabbage, kale, Brussels sprouts, cauliflower, broccoli and kohlrabi. In the case of kale and Brussels sprouts, seed production is relatively easy as the plants overwinter on the bed.


Central shoot breaking through the head


Maturing cabbage pods

SUMMARY TABLES

Summary table 1:

LIFE CYCLE, POLLINATION, FERTILISATION AND RISK OF CROSS-POLLINATION

Vegetable	Botanical name	Family	Life cycle	Pollination	Fertilisation	Cross-pollination possible with
Aubergine	*Solanum melongena*	Solanaceae	annual	entomophilous, anemophilous	autogamous	-
Bean, Dwarf French	*Phaseolus vulgaris var. nanus*	Fabaceae	annual	entomophilous, anemophilous	autogamous	-
Bean, Climbing French	*Phaseolus vulgaris var. vulgaris*	Fabaceae	annual	entomophilous, anemophilous	autogamous	-
Beetroot	*Beta vulgaris var. conditiva*	Amaranthaceae	biennial	anemophil	allogamous	other varieties of the same species (chard, beetroot, sugar beet, fodder beet)
Cabbage, Broccoli	*Brassica oleracea var. italica*	Brassicaceae	annual	entomophilous	allogamous	other varieties of the same botanical variety (var.) and other botanical varieties (var.) of the species *Brassica oleracea*
Cabbage, Brussels sprouts	*Brassica oleracea var. gemmifera*	Brassicaceae	biennial	entomophilous	allogamous	
Cabbage, Cauliflower	*Brassica oleracea var. botrytis*	Brassicaceae	annual	entomophilous	allogamous	
Cabbage, Kale	*Brassica oleracea var. sabellica*	Brassicaceae	biennial	entomophilous	allogamous	
Cabbage, Kohlrabi	*Brassica oleracea var. gongylodes*	Brassicaceae	biennial	entomophilous	allogamous	
Cabbage, Red cabbage	*Brassica oleracea var. capitata rubra*	Brassicaceae	biennial	entomophilous	allogamous	
Cabbage, Savoy	*Brassica oleracea var. capitata sabauda*	Brassicaceae	biennial	entomophilous	allogamous	
Cabbage, White cabbage	*Brassica oleracea var. capitata alba*	Brassicaceae	biennial	entomophilous	allogamous	
Carrot	*Daucus carota*	Apiaceae	biennial	entomophilous	allogamous	other varieties of the same species

LIFE CYCLE, POLLINATION, FERTILISATION AND RISK OF CROSS-POLLINATION

Vegetable	Botanical name	Family	Life cycle	Pollination	Fertilisation	Cross-pollination possible with
Celeriac	*Apium graveolens var. rapaceum*	Apiaceae	biennial	entomophilous	allogamous	other varieties of the species *Apium graveolens*
Celery, Pascal celery	*Apium graveolens var. dulce*	Apiaceae	biennial	entomophilous	allogamous	
Chicory, Sugar loaf, Radicchio	*Cichorium intybus*	Asteraceae	biennial	entomophilous	allogamous	wild chicory and other varieties of the species *Chicorium intybus* and *endivia*
Chives	*Allium schoenoprasum*	Alliaceae	biennial to perennial	entomophilous	allogamous	other varieties of the same species
Corn salad	*Valerianella locusta*	Caprifoliaceae	annual or biennial	entomophilous, anemophilous	autogamous	-
Cucumber	*Cucumis sativus*	Cucurbitaceae	annual	entomophilous	allogamous	other varieties of the same species
Endive	*Cichorium endivia*	Asteraceae	biennial	entomophilous	allogamous	other varieties of the species *Chicorium endivia*
Florence fennel	*Foeniculum vulgare*	Apiaceae	biennial	entomophilous	allogamous	other varieties of the same species
Garden cress	*Lepidium sativum*	Brassicaceae	annual	entomophilous	allogamous	other varieties of the same species
Leek	*Allium porrum*	Alliaceae	biennial	entomophilous	allogamous	other varieties of the same species
Lettuce	*Lactuca sativa*	Asteraceae	annual	entomophilous, anemophilous	autogamous	-
Melon	Cucumis melo	Cucurbitaceae	annual	entomophilous	allogamous	other varieties of the same species
Mustard greens	Brassica juncea and rapa var. japonica	Brassicaceae	annual	entomophilous	allogamous	other varieties of the same species
Onion	*Allium cepa*	Alliaceae	biennial	entomophilous	allogamous	other varieties of the same species

LIFE CYCLE, POLLINATION, FERTILISATION AND RISK OF CROSS-POLLINATION

Vegetable	**Botanical name**	**Family**	**Life cycle**	**Pollination**	**Fertilisation**	**Cross-pollination possible with**
Parsnip	*Pastinaca sativa*	Apiaceae	biennial	entomophilous	allogamous	other varieties of the same species
Pea	*Pisum sativum*	Fabaceae	annual	entomophilous, anemophilous	autogamous	-
Pepper	*Capsicum annuum*	Solanaceae	annual	entomophilous, anemophilous	autogamous	-
Radish	*Raphanus sativus*	Brassicaceae	annual	entomophilous	allogamous	other varieties of the species *Raphanus sativus*
Winter radish	*Raphanus sativus var. niger*	Brassicaceae	annual	entomophilous	allogamous	
Rocket	*Eruca sativa*	Brassicaceae	annual	entomophilous	allogamous	other varieties of the same species
Spinach	*Spinacia oleracea*	Amarantha-ceae	annual	anemophil	allogamous	other varieties of the same species
Squash	*Cucurbita maxima, pepo or moschata*	Cucurbitaceae	annual	entomophilous	allogamous	other varieties of the same species
Sweet corn	*Zea mays*	Poaceae	annual	entomophilous	allogamous	other varieties of the same species
Swiss chard	*Beta vulgaris var. flavescens*	Amarantha-ceae	biennial	anemophil	allogamous	other varieties of the same species (chard, beetroot, sugar beet, fodder beet)
Tomato	*Solanum lycoper-sicum*	Solanaceae	annual	entomophilous, anemophilous	autogamous	-
Turnip	*Brassica rapa*	Brassicaceae	biennial	entomophilous	allogamous	other varieties of the same species
Watermelon	*Citrullus lanatus*	Cucurbitaceae	annual	entomophilous	allogamous	other varieties of the same species
Winter-purs-lane	*Montia perfoliata*	Portulacaceae	biennial	entomophilous	allogamous	other varieties of the same species
Zucchini	*Cucurbita pepo*	Cucurbitaceae	annual	entomophilous	allogamous	other varieties of the same species

Summary table 2:

CALENDAR FOR CULTIVATION OF SEEDS OF DIFFERENT VEGETABLES (CLIMATIC ZONE BETWEEN LATITUDES 48 °N - 52 °N)

LEGENDE ZUR ÜBERSICHTSTABELLE 2:

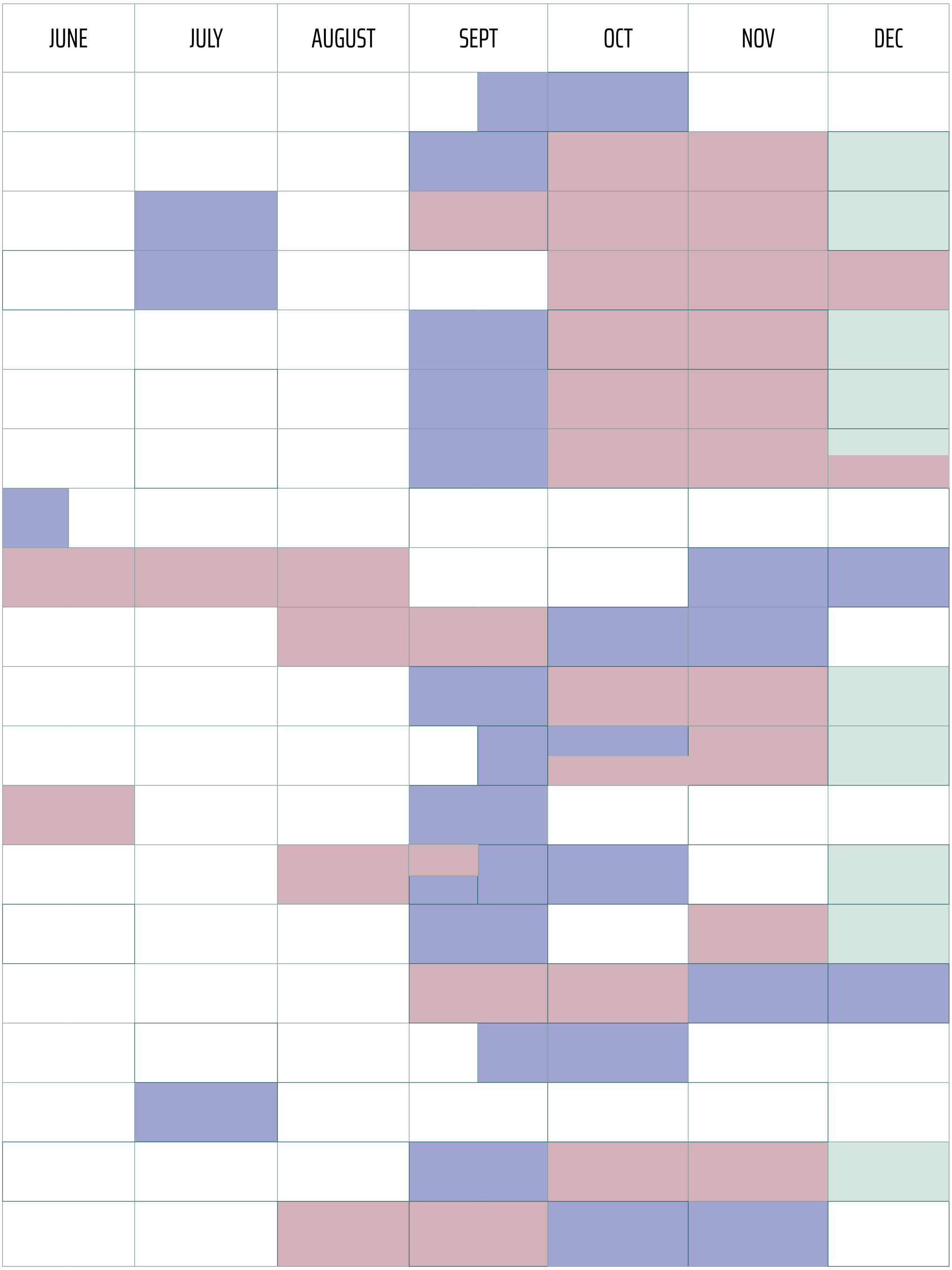
1. SELECTION	Starting point: selection of the best plants to serve as seed bearers: either 'positive selection' by selecting the most beautiful specimens (lettuce, leek, cabbage, carrots, onions, beetroot, celery ...) or 'negative selection' by removing the unsuitable plants from the crop (spinach, lamb's lettuce, beans, peas, radishes ...)
2. OVERWINTERING	For biennial plants that need to endure a winter period before producing seeds, there are several methods: 1. potting (light, frost-free): Swiss chard, celery, cabbage, parsley, chicory ... 2. cellaring (cool and dark): Carrot, onion, beetroot ... 3. overwintering in the open: winter leek, winter cabbage, lamb's lettuce ...
3. TRANSPLANTING	Cultivation of seed carriers of biennial plants in spring: Two methods: 1. planting out plants that have overwintered in pots or cellars (carrot, chard, parsley, etc.). 2. transplanting the hardy seed bearers from their growing areas to the patches intended for seed production (winter leek, winter cabbage ...)
4. HARVEST	There are several possible methods for harvesting seeds: 1. harvesting the whole seed bearers (for additional drying inside): Bean, lettuce, leek, cabbage ... 2. harvesting the seeds from the plants: carrot, parsley, runner beans ... 3. extraction of the seeds from the fruits after additional ripening: pumpkin, courgette, cucumber, tomato ...

Overview Table 2:

CALENDAR FOR CULTIVATION OF SEEDS OF DIFFERENT VEGETABLES (CLIMATE ZONE LATITUDES 48°N - 52°N)

	JANUARY	FEBRUARY	MARCH	APRIL	MAY
Bean					
Beetroot					
Cabbage, Head					
Cabbage, Winter					
Carrot					
Celeriac, Celery					
Chicory					
Corn salad					
Courgette					
Cucumber					
Endive					
Leek					
Lettuce					
Onion					
Parsley					
Pumpkin					
Radish					
Spinach					
Swiss chard					
Tomate					

SELECTION | OVERWINTERING | TRANSPLANTING | HARVEST



SPECIALIST LITERATURE & ADDRESSES FOR EQUIPMENT

Specialist Literature

Ashworth, Suzanne

SEED TO SEED

Seed Savers Exchange, 1991, second edition 2002

Boué, Christophe

PRODUIRE SES GRAINES BIO

Terre Vivante, 2012, second edition 2021

Goust, Jérôme

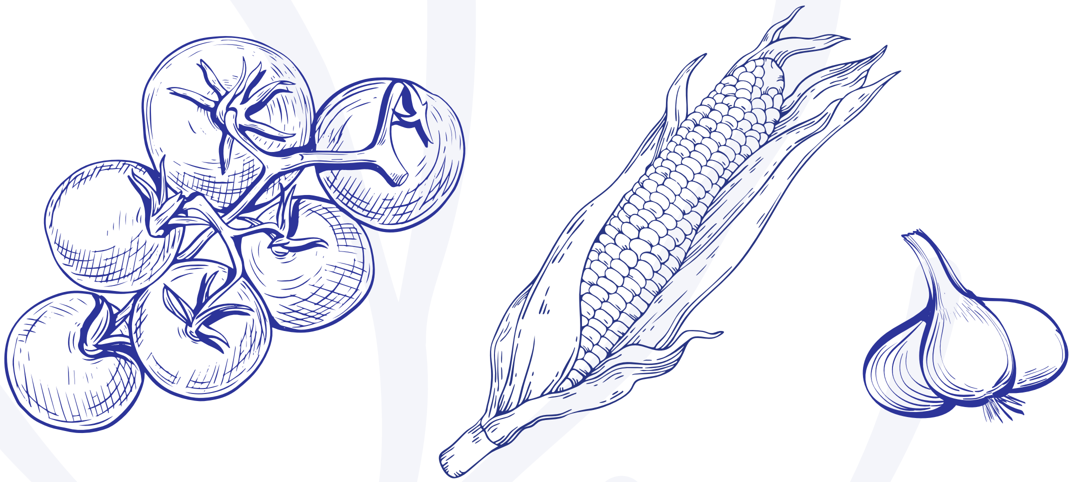
LE PLAISIR DE FAIRE SES GRAINES

Terran, 2005

Heistinger, Andrea

HANDBUCH SAMENGÄRTNEREI

Löwenzahn, 2005, 12th edition 2024



Addresses for Equipment

WOODEN SIEVES

Maria Schulz

https://www.holzsiebe.com/

La Tamiserie

https://tamisbois.fr/presentation

WIRE-FRAME JARS

Flaschenland, Am Kirchenwald 1, 56235 Ransbach-Baumbach, Deutschland

https://www.flaschenland.de/

SILICAGEL

Questill Kft., 8000 Székesfehérvár, Dobsinai u. 2., Ungarn

https://www.silicagelshop.de/

INTRODUCTION TO THE CULTIVATION OF VEGETABLE SEEDS

Text: Frank Adams
Photos: Frank Adams
Layout: Lea Schroeder
Proofreading: Colin Robertson, Frank Adams
Coordination: Karine Paris
Publisher: SEED Luxembourg asbl and CELL asbl
September 2025

With the support of:

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Environnement, du Climat
et de la Biodiversité

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SEEDS FROM YOUR OWN GARDEN: COMBINING THE PLEASANT WITH THE USEFUL

Growing vegetables in your own garden has many advantages. Physical activity in the fresh air, contact with nature, and harvesting fresh vegetables all have a positive effect on our health.

Moreover, it contributes to local and sustainable food production.

Those who also produce their own seeds and share them with other gardeners make an additional contribution to preserving the diversity of traditional crop varieties, on which long-term food security ultimately depends.

Anyone who wants to combine the pleasant with the useful will find in this guide an introduction to the practice of seed saving for vegetable plants.

The author shares over thirty years of experience in this field.

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