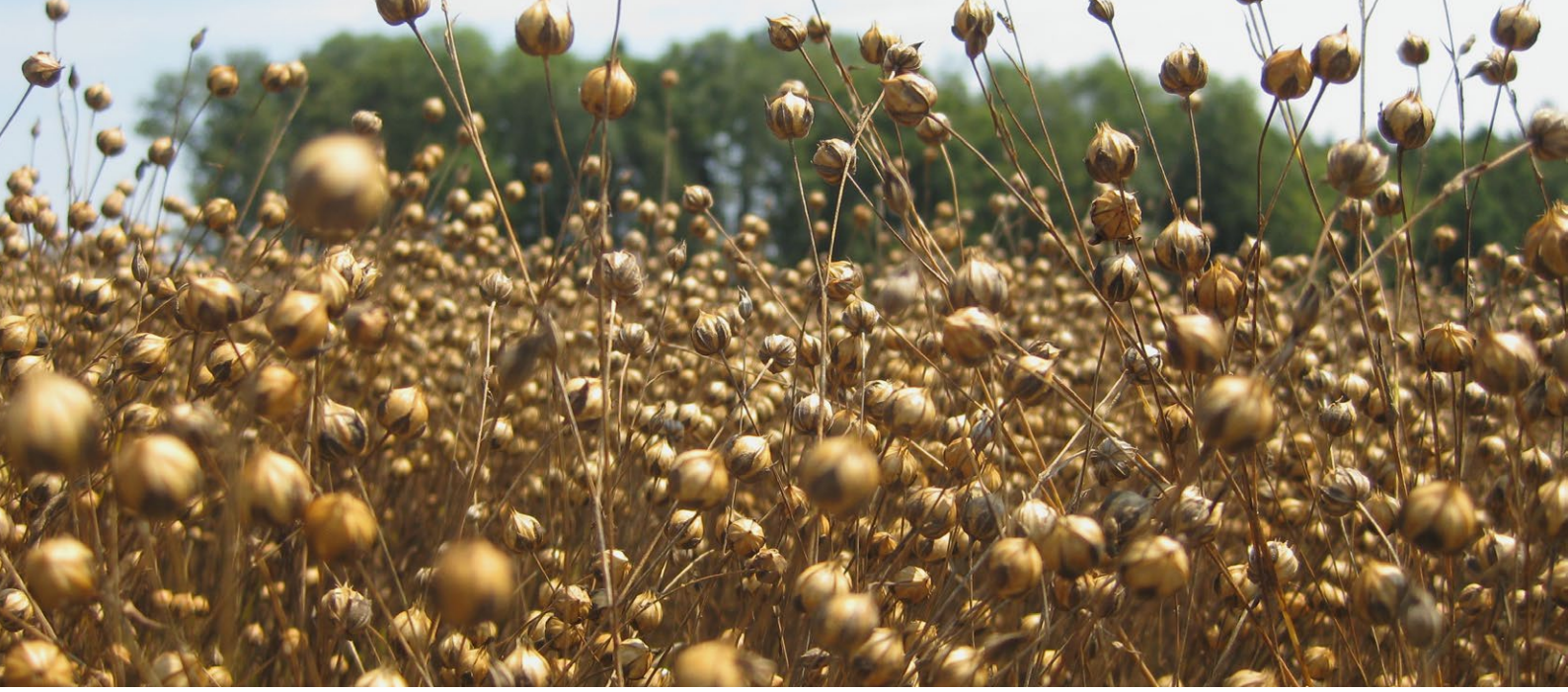
Technical guide
2023 | No. 1244

Organic oilseed production

FiBL



Organically produced oilseeds are gaining relevance in Europe as the demand for certified organic vegetable oils for human consumption and of residual press cakes for organic animal feed continues to grow. In the field, oilseed crops help diversify organic crop rotations. Thus, these crops merit special attention.

This guide provides an overview of the most important oilseed crops in Europe and explains how crop-specific challenges are managed in organic oilseed production with an appropriate crop rotation and cultivation measures.

Content

Organic oilseed production in Europe

A diversity of crops with different importance

Oilseed crops are grown on arable land for their seeds, mainly to produce oil. Soybean is considered the most important oilseed crop worldwide – however, in Europe it is not being considered an oilseed (see box 1). In the European context, rapeseed and sunflower are by far the most important oilseed crops. Linseed, hemp, poppy, camelina and oil pumpkin are other oilseeds that merit attention. The interesting health attributes of oils derived from these latter crops are likely to stimulate the expansion of these minor oilseed crops in the coming years.

Crops of increasing relevance

The continued growth of the organic market entails a sustained increase in demand for oils and oilseed-based feedstuffs from organic production, particularly in Europe and Northern America. The high demand has resulted in a strong increase of the organic oilseed area worldwide in the past years. In the decade from 2009 to 2018, the organic oilseed area has more than trebled. It has grown faster than the organic farmland. However, it is still below the global share for farmland and arable crops.

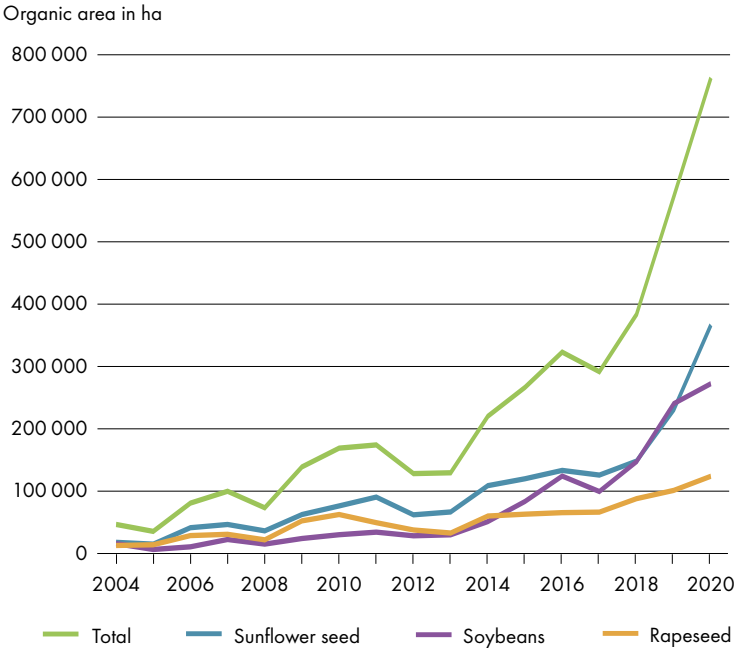
Currently, some of the demand in Europe is covered with imports (see table 2, page 5), mainly from countries in Asia. In Europe, efforts are being made to decrease the dependency on imports, and to increase local and European production.

Box 1: Soybean – a particular case

Soybean *(Glycine max)*, a legume crop native to eastern Asia, has been adapted by breeding to prosper also under colder conditions. Due to its high oil content and its use as vegetable oil and for industrial applications such as biodiesel, soybean is classified worldwide as an oilseed. In fact, soybean makes up about 60 % of the world's overall oilseed production.

In Europe soybean is considered a pulse – together with beans, peas, lentils, and chickpeas. Pulses refer to dry-harvested leguminous grain crops, used mostly for human or animal consumption. The difference results from the history and uses of soybeans in Europe: more than 200 years ago, the crop was introduced as a food crop, and gained later relevance for its high protein content as animal feed source. Until today, oil production from soybeans is of minor relevance, as breeding in Europe has focused on a high protein content primarily, and not on oil content.

Figure 1: Development of organic oilseed production in Europe



The organic oilseed area in Europe has grown strongly due to increasing demand.

Main drivers for organic production

In conventional production, an important driver for the expansion of oilseed crops has been the production of biofuel. In contrast, organic oilseed crops are purely cultivated to satisfy the increasing demand of healthy, tasty and locally produced vegetable oils for human consumption and food processing.

Among organic oils, cold pressed oils with a high share of non-saturated fatty acids are of greatest relevance. For these oils, consumers tend to pay high prices, at least in niche markets.

For baking and frying, oils are used that remain stable at high temperatures. Among vegetable oils, HOLL (high oleic & low linolenic) rapeseed oil and HO (high oleic) sunflower oil are more in demand than classic oils. In this product category, consumers are more price sensitive and the advantage of an organic oil is still less obvious. However, many consumers are not aware of the abundant pesticide use in conventional rapeseed production, for instance. Processors of deep-fried organic products depend on these oils in organic quality.

Table 1: Main uses of oilseed oils in the kitchen, and in medical and cosmetic applications

Oil type	Kitchen			Remedy			Cosmetics	
	Cold kitchen	Steaming	Frying	Pain-relieving	Cell regenerating	Anti-inflammatory	Raw material	Skin care
Hemp	x	x					x	x
Pumpkin	x			x				
Linseed	x			x	x	x		
Poppy	x	x						
Rapeseed	x	x	x					
Soybean	x	x	x	x				x
Sunflower	x	x	x	x			x	x

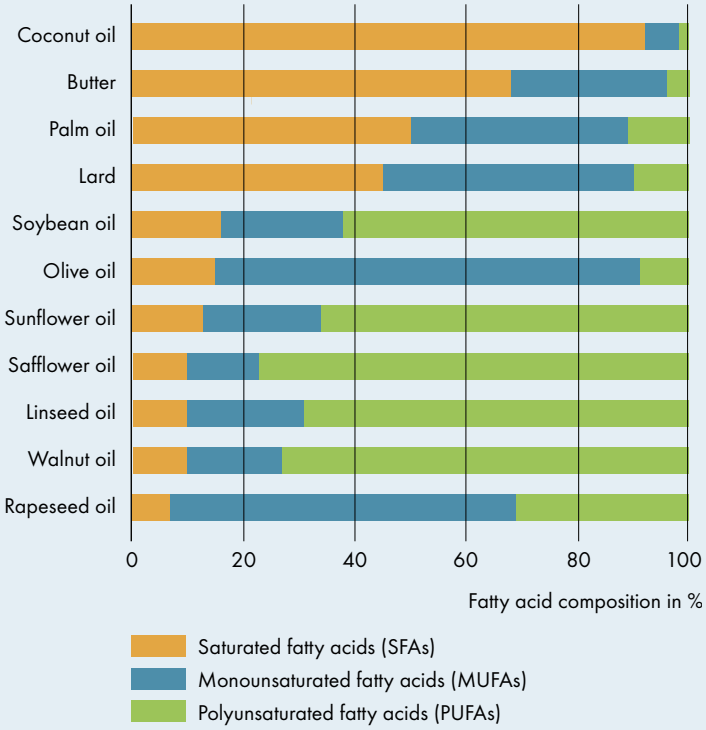
Vegetable oils are used in different areas, based on their composition and properties.

Source: LAP, 2001, shortened

Box 2: Nutrition-related health aspects of vegetable oils and their use

For the assessment of oils for human nutrition, the content of saturated and unsaturated fatty acids is considered. Oils with a high portion of saturated fatty acids contain high levels of low-density lipoproteins (LDL) cholesterol, which tends to increase the risk of cardiovascular problems. Such oils should not be consumed in too large quantities, and should be – at least partially – replaced by oils with high contents of unsaturated fatty acids.

Figure 2: Fatty acid composition of major oils



Oils with fatty acids that the human body cannot produce on its own and that are not provided by other foods, are of special interest from a health perspective. In this regard, especially omega-3 fatty acids are considered very important, whereas omega-6 fatty acids are more abundant in other foods. Scientific studies have shown that omega-3 fatty acids tend to have an anti-inflammatory effect and are beneficial to the cardiovascular system.

As polyunsaturated fatty acids are not stable to heat and light, oils with high levels of omega-3 and omega-6 are cold pressed and should not be used for frying. These oils are ideally used unheated, i. e. in dressings and for food savouring, as they add also taste.

For frying and baking, oils with saturated and monosaturated fatty acids are used. They do not deteriorate when heated and have a long shelf-life. The main sources of saturated fatty acids are butter, coconut oil, margarine, lard and palm oil.

The fatty acid composition of oils from different sources can differ greatly. The composition is decisive for the possible uses of an oil.

Opportunity of substitution of non-European production

Today, many oilseeds from organic production are imported to Europe in large volumes. However, an increasing number of consumers is paying attention to the origin of food. This growing consumer awareness implies that food processing companies and retailers increasingly source raw-materials from local or European production. Products of preferred local origin justify higher prices and production costs. This offers interesting opportunities for European organic producers.

Compared to natural products and regional specialties, the substitution effect is likely to be lower in very industrial products, as the organic quality of the product is the main purchasing factor, and less its origin.

However, some oil crops have some disadvantages when cultivated in Europe, if the cultivation conditions are not ideal, while facing higher production costs than in other regions. This is especially the case for sesame and safflower, which are cultivated in warmer or continental climate conditions and with lower production costs.

Advantages and reasons favouring the expansion of organic oilseed production in Europe

- Increasing market demand for organically produced seed oil.
- Diversification of crop rotations to spread production risks and improve overall soil fertility and weed management.
- Increasing willingness of consumers to favour (more) locally produced organic products
- New business opportunities for farmers and processing companies.
- Growing interest of organic farmers' associations for local production of feed components for animal production – offering opportunities for use of oil press cake etc. for animal feeding.
- Promotion of higher value crops to increase hectare incomes and regional value addition.
- Provision of new feed sources for (organic) beekeeping and insects, including beneficial insects, at flowering.
- Introduction of more advanced technologies in arable crop production, helping to reduce costs for weeding, fertilisation and plant protection. Suitability of certain species to be cultivated as by-crop (camelina) along pulses, or as a second crop (e. g. sunflower, sesame) due to their short cultivation period.
- Subsidy schemes which support the cultivation of new crops.

Thanks to growing experience and technical advances in their cultivation, oilseeds are about to make the breakthrough in organic farming.

Table 2: Main organic raw oilseed imports to the EU from 2018 to 2021

Crops	2018 (in t)	2019 (in t)	2020 (in t)	2021 (in t)	2018–21 changes	Main sourcing countries
Rapeseed	16,638	21,780	22,132	14,886	–11 %	Russian Federation, Turkey, Ukraine
Linseed	28,294	26,946	27,564	25,011	–12 %	Kazakhstan (50 %), India, Ukraine
Sunflower	102,427	57,930	29,122	45,923	–55 %	Ukraine, Russia
Poppy	562	800	939	789	+40 %	Turkey
Safflower	696	1,361	992	398	–43%	Russian Federation, USA
Sesame	15,143	18,707	21,695	22,421	+48 %	India, Uganda, Egypt, Ethiopia, Turkey

Sources: European Commision/Traces

Imports of oilseeds to the European Union have developed differently in some cases in recent years. After the Covid pandemic, the war in Ukraine in particular has led to a decline in imports, although the demand for organically produced oils in Europe is increasing and the continental production is still far from satisfying the market.

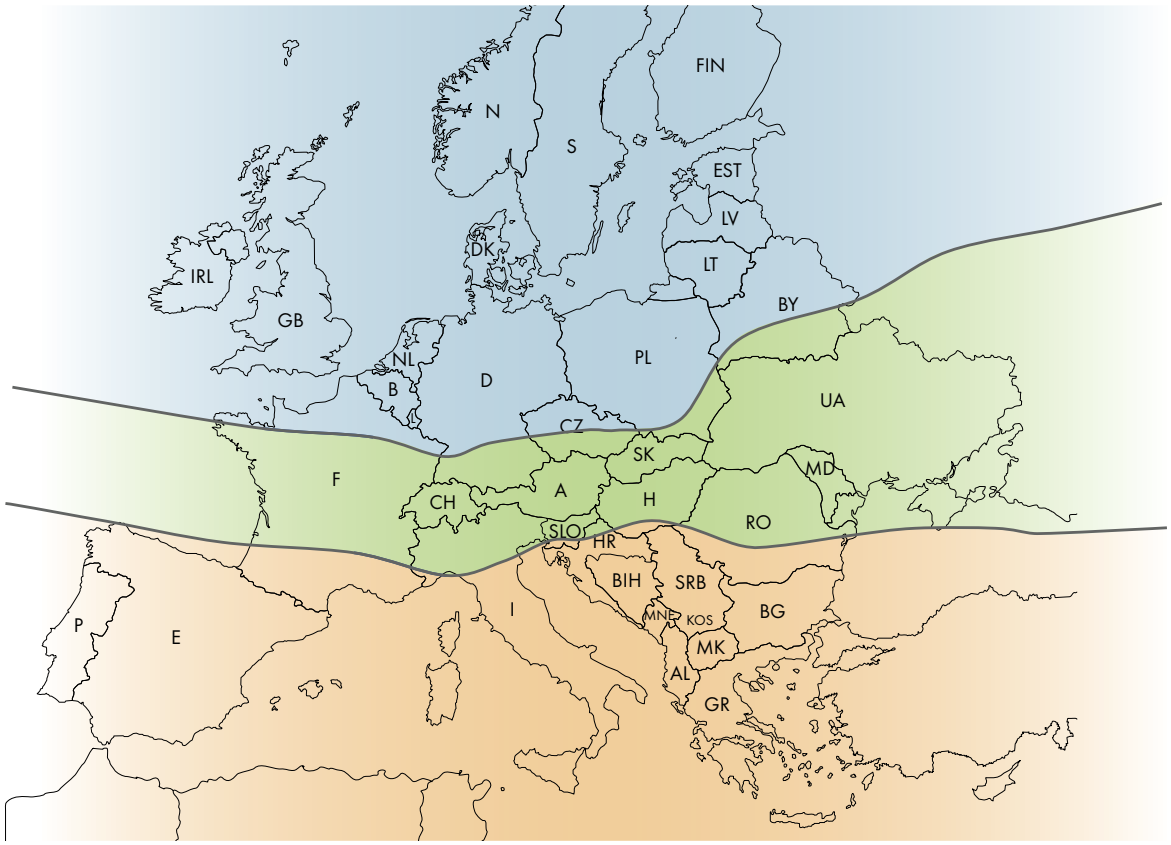
Geographical scope of oilseed cultivation in Europe

Most oilseed crops must be cultivated in areas with high temperature sums for appropriate fat storage in the seeds. Winter oilseed rape and turnip rape are exceptions, preferring a relatively cool maritime climate with high air humidity and rainfall during the vegetation period. In contrast, sunflower, poppy and hemp require a warmer climate, especially during summer, to produce good oil yields. Thus, these species are naturally well adapted to dry and warm conditions. This explains why sunflower is mainly cultivated in southern and south-eastern regions, while rapeseed is mainly grown in temperate zones of Europe.

Yet, important breeding efforts are being done to expand the cultivation areas of these crops, i. e. developing varieties that prosper also in warmer respectively colder conditions. In contrast, soil conditions have little influence on the geographical distribution of oilseed crops. Only very superficial and sandy soils are inappropriate for oilseed cultivation, unless they are irrigated.

A mild spring climate favours early growth of oilseed crops like mustard, spring rapeseed / canola or camelina. Thanks to their short cultivation period, they mature before dry and hot summer conditions. Linseed (or flax) is an exception among oilseeds, as it has the ability to adapt to different climates from maritime to continental climates. For linseed, both winter and spring varieties are available, allowing farmers to choose the crop type that matches best with the local climate. Oil pumpkin, although growing in almost every region of Europe, does not thrive under very cold and warm conditions.

Figure 3: Main European production areas for rapeseed, sunflower and other crops



Zone	Rapeseed	Sunflower	Linseed	Hemp	Poppy seed	Camelina	Pumpkinseed	Safflower	Sesame
Northern Europe	•		•			•			
Central Europe	•	•	•	•	•	•	•	•	
Southern Europe	(•)	•	•	•	(•)	•	•	•	(•)

Challenges in organic oilseed production

From an agronomic point of view, the cultivation of most oilseed crops does not pose particular challenges. The most challenging crop is oilseed rape which requires an integrated approach including pest-diverting companion crops, good growth conditions, and preventive control measures to avoid major damages by autumn or spring pests like flea beetles and leaf beetles. The main challenges in oilseeds include:

- **Availability of suitable varieties:** In minor oilseed crops, availability of adapted hardy varieties with low nutrient needs and high disease resistances may be a problem, as the large seed companies do not invest in varietal diversity for niche market crops.
- **Appropriate crop rotation:** The introduction of oilseed crops to a farm may require a partial reconsideration of the crop rotation to prevent soil-borne diseases. In general, a cultivation break of at least 3 years should be maintained between crops of the same family or potential host plants of key pests and diseases. The most concerning disease is Sclerotinia with different host plant species (e. g. soybean, faba bean, green bean, and cover crops like mustard).
- **Crop production equipment:** Apart from oil pumpkin production, oilseed cultivation does not require special equipment for sowing, weeding and harvesting. In general, the commonly used technology is similar to the one used in organic cereal production, or the cultivation of row-seeded crops. However, when intercropping oilseeds with other crops, suitable harvesting and post-harvesting technologies and knowhow are needed (especially when intercropping with camelina).
- **Drying, cleaning and storage facilities:** After harvesting, most oilseeds need to be dried immediately to 6 to 9 % moisture content for proper storage and pressing. This may require adequate facilities not only for drying, but also for cleaning and storage on the farm.
- **Availability of organic seeds:** The availability of organically multiplied seeds of suitable varieties can be limited. To ensure that the used seeds are conform to the regulation of the applied organic standard, producers and buyers of oilseeds must obtain information from the certification body as to which varieties of organic seed are available or which origins can be used.

Box 3: Organic regulations on the use of organic seeds

According to the EU organic regulation and private organic regulations, organic producers must use organically propagated seeds (certified organic seeds). Yet, when a desired variety of a crop is not available in organic quality, organic regulations can grant exceptions, for instance, allowing the use of the same variety in non-organic quality.

Several countries in Europe use the OrganicXseeds database (www.organicxseeds.com) as a reference tool for the availability of organic seeds at the time of the order.

For the use of conventional seeds, country-specific rules apply. In any case, non-organic seeds cannot be treated or coated with chemical pesticides and must be GMO-free.

Furthermore, standard-specific differences can apply. For instance, Bio Suisse does not allow the use of hybrid seed for oilseed rape with exception of HOLL varieties, whereas the EU organic regulation does allow it.

Some oilseeds present higher challenges and risks than cereals, but generally also offer interesting advantages through rotation and marketing diversification.

General characteristics of major organic oilseed crops in Europe

	Oilseed rape *(Brassica nap. ssp. n.)*	**Sunflower** *(Helianthus annuus)*	**Oil linseed** *(Linum usitatissimum)*	**Hemp** *(Cannabis sativa L.)*
				
Climate requirements	winter type: humid climate; cool, temperate temperatures summer type: mild, humid climate	mild, warm climate	both maritime and warm, dry climate	mild, warm climate
Frost tolerance	winter type: –20 °C summer type: –4 °C	–5 °C	–4 °C	–5 °C
Water requirements (period of main requirements)	winter type: 600–800 mm summer type: 600 mm	400–600 mm (mid to end of July)	400–500 mm (120 mm in Mai to June)	400–600 mm (majority from flowering onward)
Soil requirements	medium to heavy soils; adapted to humus-rich soils	medium soils that warm up easily	light to medium soils	medium to heavy soils; adapted to humus-rich soils
Soil pH	6.2–7.0	6.0–7.2	5.5–6.5	6.0–7.5
Nutrient requirements	high nitrogen demand	moderate requirements, susceptible to boron and molybdenum deficiencies	moderate requirements, susceptible to zinc deficiency	quite high nitrogen demand, low phosphorus and potassium demand, susceptible to magnesium deficiency
Cultivation period (summer/winter type)	winter type: 300 days summer type: 130–150 days	140–160 days	120–125 days	120–140 days
Cultivation break	3–4 years	4–5 years	6–7 years	3–4 years
Average grain yields	winter type: 20–25 (5–30) dt/ha summer type: 15 (5–20) dt/ha	25 (10–30) dt/ha	12 (5–15) dt/ha	8–10 dt/ha
Oil content	36–44 %	40–54 %	33–39 %	30–35 %
Average oil yields	winter type: 6.5–7.9 dt/ha summer type: 4.3–5.3 dt/ha	10.0–13.5 dt/ha	4.0–4.7 dt/ha	2.4–3.5 dt/ha
Main fatty acid	oleic acid	oleic/linoleic acid	linoleic acid	linoleic acid
Protein content	15–25 %	13–20 %	19–22 %	30–35 %

Poppy *(Papaver somniferum)*	**Camelina** *(Camelina sativa)*	**Oil pumpkin** *(Cucurbita pepo subsp. pepo var. 'styriaca')*	**Safflower** *(Carthamus tinctorius)*	
				
mild, warm climate	both maritime and warm, dry climate	both maritime and warm, dry climate	summer-dry, Mediterranean climate	**Temperature requirements**
–5 °C	–5 °C	–2 °C	rosette stadium: –7 °C, later –2 °C	
400–600 mm	400 mm	500 mm (mainly from beginning of flowering onward)	400–500 mm	**Water requirements**
medium soils that warm up easily	light to medium soils	medium soils that warm up easily	light to medium soils (sandy loam to loam), also recultivated soils	**Soil requirements**
6.5–7.0	5.5–6.5	5.5–7	5.0–8.0	
moderate requirements, susceptible to sulphur and boron deficiencies	moderate requirements	moderate nitrogen demand, high phosphorus and potassium demand	moderate requirements	**Nutrient requirements**
120–130 days	100–110 days	120–140 days	110–140 days	**Cultivation period (summer/winter type) (d)**
3–4 years	4–5 years	3–4 years		
5–10 dt/ha	15 (5–20) dt/ha	5–2 dt/ha	20 (10–28) dt/ha	**Average grain yields**
up to 50 %	30–40 %	45–55 %	25–35 %	**Oil content**
3 dt/ha	4.7–6.6 dt/ha	2.5–6 dt/ha	5–7 dt/ha	**Average oil yields (dt/ha)**
linoleic acid	linoleic acid	linoleic and oleic acids	linoleic acid	**Main fatty acid**
18–20 %	22–28 %	28–32 %	10–18 %	**Protein content**

Oilseed rape

Cold-pressed rapeseed oil is in continuous high demand in Europe because of its good health properties. However, the crop's production challenges have hampered its expansion. In particular, nitrogen supply in early spring, pest control and late weed development can result in considerable yield reductions.

Nevertheless, in arable areas with deep, fertile soils, and in open, windy locations with low pest pressure, well-managed rapeseed can achieve up to 30 dt per hectare. On average, yields of about 20 to 25 dt per hectare can be expected over the years on good sites.

Rapeseed, as a cruciferous species, is a valuable crop to break up cereal-based crop rotations. It is also an excellent feeding source for honey bees.

Key agronomic figures

- **Nutrient requirements:** N: 120 kg/ha; P: 50 kg/ha; K: 120 kg/ha
- **Sowing date:** from end of August
- **Min. germination temp.:** 2–3 °C
- **Seed rate:** 5 to 6 kg/ha
- **Plant density:** 70 to 80 plants/m^2
- **Sowing depth:** 2 cm
- **Distance between rows:** 15 to 50 cm

Type and variety selection

For commercial purposes, mainly the winter type is grown, as the summer type yields much less and is more vulnerable to pests. Nevertheless, the summer type is well-adapted to the conditions of Northern Europe (Scandinavia, Baltic countries), where the summer season is rather mild and involves sufficient rainfall.

Variety selection is mostly determined by the potential market for the oil (classic or HOLL – high oleic and low linolenic fatty acid), but also by yield expectations. For chemically stable frying oil under high temperatures, HOLL varieties are used.

In most production contexts, early flowering varieties with a rapid development in spring are favoured, as they partly avoid infestation by rape seed beetles. Furthermore, a high nitrogen efficiency, good resistance to diseases (phoma, sclerotinia) and vigourous early growth are considered.

Nowadays, mostly hybrid varieties are used due to their higher yield potential. However, some organic regulations (e. g. Bio Suisse) do not allow the use of hybrid varieties for this crop.

Climate and soil requirements

Rapeseed can be grown in a wide range of climates and soils. Yet, climatic conditions have a strong influence on both oil and protein content, and yields, directly and indirectly, by possibly favouring the occurrence of pests and diseases.

Criteria for site selection:

- Winter rapeseed does best in a relatively **cool maritime climate**, i. e. with high air humidity and rather high rainfall during the vegetation period.
- Favourable are slightly elevated, **open, windy locations** without nearby forests and hedges to favour a low pest pressure.
- In areas higher than 600 m above sea level or colder climatic conditions towards the North of Europe, the cultivation of rape can be problematic and not sufficiently yielding compared to other crops. On the other side, locations in the South of Europe below the 45th latitude tend to be too warm and dry for competitive rapeseed production.

- Rapeseed favours deep, light to medium-heavy **fertile soils** with a pH of 6.5 to 7.0.
- The rapeseed's taproot is very sensitive to soil compaction and waterlogging. Thus, in heavy soils a sound soil management is critical to avoid compaction and waterlogging.

Crop rotation

Rapeseed can contribute to the diversification of arable crop rotations, and offers a number of other advantages.

Advantages of rapeseed in crop rotations
- Diversification of (cereal-based) crop rotations
- High nitrogen uptake in autumn
- Rapid soil cover and thus good weed suppression in early crop stages
- Loosening of the soil due to the taproot
- Sowing and harvesting in periods with little competition for labour and machinery
- Cultivation with a row distance of 45 cm between rows allows hoeing operations for effective weed control.

Because of cabbage hernia and other diseases, rape seed is not self-tolerant. Therefore, a cultivation break of 4 to 5 years must be maintained between cruciferous crops, including cover crops and green manures. Cruciferous weeds such as the shepherd's purse *(Capsella bursa-pastoris)* must also be controlled.

Rapeseed has a high demand in nitrogen and requires a well-structured soil. This sets special requirements for the pre-crop.

Requirements for the preceding crop:
- Timely field clearance, as sowing takes place in August
- High nitrogen supply from the previous crop

Preceding crops:
- **Grass-clover mixtures and grain legumes** are ideal pre-crops for rapeseed, as they leave a well-structured, refined soil and elevated amounts of nitrogen in the soil. Protein pea is an excellent pre-crop to rapeseed due to its early harvest and rapidly decomposing stalks that easen seedbed preparation for the small seeds compared to cereal pre-crops. Depending on their harvest date, also chickpeas, lentils and other pulses are interesting preceding crops for rapeseed.

Rapeseed is considered a very good preceding crop, which strongly roots and shades the soil and therefore has a positive influence on the soil structure. The crop leaves behind large amounts of easily decomposable crop residues.

- **Cereals** like winter barley, spring barley, winter rye, and winter wheat are good previous crops too, but require additional nitrogen fertilisation before rapeseed. Barley – due to its early harvest – allows the integration of a weed cure prior to sowing rapeseed.
- **Early potatoes** are suitable, too.
- Unfavourable preceding crops are sunflowers and sugar beet.

Nutrient supply

In organic farming, good overall soil fertility is essential to ensure good development of the rapeseed crop and to achieve good yields. To satisfy the nutrient (and especially nitrogen) needs of rapeseed, additional fertilisation is usually necessary.

For proper mineralisation of nitrogen from organic sources, humid and warm soil conditions are necessary. In cool, moist and dry soils, nitrogen mineralisation can be inhibited, which leads to insufficient N supply and yield losses.

Besides nitrogen, rapeseed's demand for phosphorus and potassium should not be forgotten. In contrast to conventional production, due to lower yields and the use of farmyard manure, sulphur deficiencies are not common in organic rapeseed cultivation.

Nitrogen supply

Oilseed rape needs two thirds of the nitrogen in early spring until shooting. Commonly, liquid manure is applied to the crop in early spring to satisfy this

20 to 30 tonnes of mature manure applied to primary tillage cover the general nutrient requirements of the rapeseed crop.

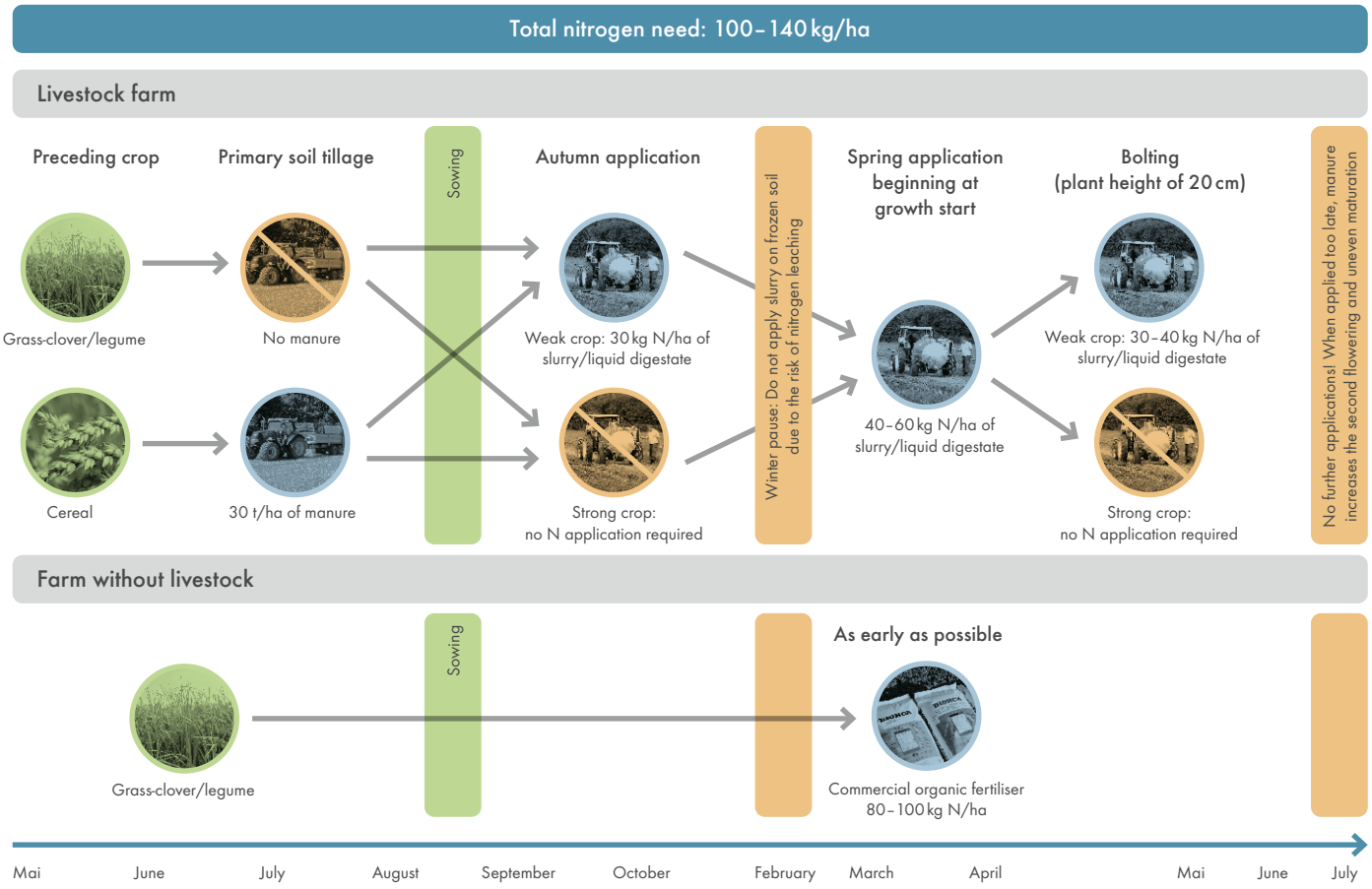
need. Alternatively, liquid digestate can be applied to provide easily available nitrogen.

For average organic yield expectations of 20 to 25 dt per hectare, about 100 kg N suffice. In this logic, oilseed rape needs about 40 kg N per 10 dt of yield. However, this calculation does not consider nitrogen supply from the soil.

Fertilisation in autumn:

- After cereals, 20 to 30 tons of stable manure or manure compost are applied per hectare prior to sowing of rapeseed. A part of the nutrients from these sources will be available in spring. On a short term, the rising crop will mainly feed from available nitrogen in the soil from the previous crop and mineralised organic matter.
- After grass-clover or a legume crop, normally no fertilisation is necessary before sowing.
- On light soils, a fragmentation of the fertilisation reduces leaching of nitrogen during the

Figure 4: Nitrogen uptake and nitrogen input on farms with and without livestock



Different fertilisation strategies are to be used, depending on whether animal manures are available or not.

winter period (maximum 30 kg N per ha for autumn application).
- In case a rapeseed crop develops weakly after sowing, another fertiliser application of 30 kg of N per ha is recommended using a nutrient with rapid nitrogen mineralisation (e. g. slurry or poultry manure). However, over-fertilisation in autumn with readily available nitrogen must be avoided, as this increases the risk of damage of the crop and nitrogen leaching during winter.

Fertilisation in spring:
Additional nitrogen fertilisation of 40 to 60 kg per ha helps promote the formation of side shoots in well-wintered stands and increases the crop's yield potential. The fertilisers should be applied as early in the vegetation period as possible, when conditions allow (i. e. avoiding soil compaction), and in compliance with the organic regulation and national law.
- **Poultry manure** is particularly well suited to stimulate crop growth in early spring.
- Alternatively, **liquid manure** diluted with water at a rate of at least 1 : 1 can be applied.
- Where animal manures are not available, **commercial organic nitrogen fertilisers** can be applied, if available.

Fertilisation at bolting:
- At a plant height of about 20 cm, weak rapeseed crops should receive another 30 to 40 kg of easily available N per hectare from slurry or liquid digestate (unless a high nitrogen supply from the soil is to be expected).

In case of proven sulphur deficiency, application of natural gypsum can quickly and affordably remove this deficiency.

At flowering, an application of foliar fertiliser rich in boron and molybdenum can be applied if there is a risk for deficiency of these oligo-elements. According to Bio Suisse guidelines, foliar fertilisers are only permitted if a deficiency has been proven. Yet, such deficiencies are very seldom, especially where manure or compost is applied.

Sowing

Winter rapeseed should overwinter as well-developed rosettes with 8 to 10 leaves and a root neck diameter of at least 8 to 10 mm, as well as a 15 to 20 cm long taproot to avoid frost damage. Stem formation is not desired before winter. Early sowing is an important prerequisite to obtain the desired development stage of the plants.

Nutrient contents of farm fertilisers
Cattle manure: 5.3 kg N, 2.2 kg P, 10.8 kg per t
Cattle slurry (undiluted): 4.3 kg N, 1.8 kg P, 8.0 kg K per m^3
Pig manure: 7.8 kg N, 7.0 kg P, 8.3 kg K per t
Poultry manure: 27 kg N, 20 kg P, 30 kg K per t

Conversion from tons to m^3:
Mechanically loaded manure (approx. 550 to 650 kg per m^3):
t x 1.5 to 1.8
Manually loaded manure (approx. 700 to 800 kg per m^3):
t x 1.25 to 1.4

The figures given are average values. For reliable values it is recommended to analyse the nitrogen content of slurry and manure regularly.

Oilseed rape requires a shallow and rather fine seedbed. Emergence problems of rape are often due to improper seedbed preparation, weed infestation or slugs.

Sowing time
- The optimum sowing time varies depending on the geographic area. As a general rule, organic rape is sown 2 weeks before conventional rapeseed.
- In central Europe, the crop is sown between mid-August and mid-September.
- In principle, rapeseed is better sown too early than too late, as early sowing favours nitrogen uptake and plant development.

Box 4: Harmonising sowing and fertilisation

A high nitrogen mineralisation in autumn or a slurry application can stimulate growth of rapeseed. However, too vigorously developed plants are rich in water and nitrogen and are susceptible to frost damage. Large plants also suffer from snow pressure, which can lead to stem injuries and increased infestation by Phoma. Larger leaves are pinched off and rot. In spring, the plants will look as if they were flamed: they are pale and have small leaf shoots.

Due to the regenerative power of rapeseed, possible damage caused by too much growth in autumn is difficult to quantify. Despite the risk of early sowing, the advantages outweigh the disadvantages. Seeds sown in late September often develop into small, weak plants. In general, such plants are not capable to compensate for this shortfall – not even under good growing conditions in spring.

With good growing conditions in autumn, oilseed rape goes strongly into the winter season.

Seedbed preparation

Besides timely and appropriate sowing, the preparation of a proper seedbed is crucial for optimal development in autumn. Poor development in autumn can usually not be corrected in spring.

The period between harvesting of the previous crop and sowing of rapeseed determines the tillage procedure. The shorter the period for straw decomposition, the higher the cultivation risk. The requirement of rape for a fine-crumbed, well-settled seedbed is not met by quick and hasty measures. The crop does not tolerate errors in tillage.

How to proceed?

- Avoid soil compaction to allow unhindered deep root growth of rape.
- Optimal stands can be established with both inversion and non-inversion tillage. Reduced tillage is possible, if sufficient time is available for weed control or in case of very low weed pressure.
- Directly after the harvest of the previous crop, a first shallow tillage of 2 to 3 cm depth is applied to incorporate the crop residues as evenly as possible in the top soil layer (do not bury the residues!). Shallow tillage will also stimulate weed seeds and volunteer cereals to germinate. The water-conducting capillaries in the soil should be destroyed to avoid evaporation.
- 7 to 10 days later, another shallow (5 to 10 cm deep) tillage uproots emerged seeds and mixes the remaining crop residues into the soil. The drier the soil, the deeper it should be tilled to ensure sufficient moisture for germination and rotting. The wetter the soil, the shallower the tillage should be to avoid damages to the soil structure.
- Recompaction is essential to create a settled topsoil. The top 3 to 4 cm of the seedbed should be loose and finely crumbled, whereas the soil below should be well reconsolidated. A too fine seedbed, however, silts up easily, making it difficult for the seedlings to emerge.
- If time allows, a weed cure can be applied before sowing of the crop repeating shallow cultivations after emergence of new weeds.

Sowing:

- **Sowing depth:** 1 to 2 cm. Deeper sowing at 3 cm can exceptionally make sense to access soil moisture in very dry conditions.

Row spacing:

- Row spacing is chosen according to available equipment and weed pressure. So far, no difference in yield has been observed up to a row distance of 50 cm. A row distance of 45 to 50 cm allows hoeing in fall and spring in case of high weed pressure, and is essential to control perennials or heavy cereal regrowth. At a row distance below 20 cm, only tine harrowing is

feasible. However, tine weeding alone is not effective enough in case of high weed pressure.
- Broad sowing with a broadcaster seeder and a roller can achieve very good results in mild climates or in irrigated cultivation.
- In heavy soils and wet conditions, the possibilities for weed control are limited. In such soils, a wide row distance and late hoeing are recommended.
- Rolling after sowing favours seed germination and reduces cavities in the soil, thus reducing slug propagation.

Box 5: Targeted stand densities and corrective measures

- Before winter, stand density should be 70 to 80 plants per m^2, at the beginning of the vegetation season 50 to 60 plants per m^2, resulting in a plant stand of about 40 to 50 plants per square metre at harvest.
- In case of a lower plant density in autumn/winter, it must be decided to possibly plough the crop at the beginning of the vegetation period.
- Irregular stands with large gaps and on average of less than 12 healthy, strong plants per m^2 should be ploughed. If not ploughed, the large gaps should be sown with clover-grass to suppress weeds.
- If sown early, in case of unsufficient density after germination, there should still be enough time for sowing a replacement crop.

Weed control

The long cultivation period and the poorly closing stand of rapeseed require much care in weed control.

- A weeding cure with additional shallow soil cultivation before sowing reduces the seed bank in the top soil layer. The measure can prevent weed problems in case the crop cannot be harrowed in autumn or spring due to weather or soil conditions.
- Important root weeds (e. g. blackthorn, thistles) should be removed by hand before sowing.
- Late weed development must be prevented timely. Undersown crops that freeze-off during winter can have a good weed-suppressing effect.
- Blind harrowing (tine-harrowing between sowing and emergence) is not possible due to the shallow sowing depth.

From the 4-leaf stage until the beginning of bolting, rape can be hoed with the duckfoot-tine hoe. Its blades not only control small weeds, but also larger weeds up to the 8-leaf stage. In addition, the blades loosen superficial soil encrustation and stimulate the mineralisation of nitrogen in the soil.

- Early harrowing damages the rape plants. However, from the 3- or 4-leaf stage of rape, one or two passages with a hoe and/or a tine-harrow are possible in case of high weed pressure. Care must be taken not to cover the plants with soil, using the harrow with little pressure and driving at low speed.
- For weed control in the rows, the rotary hoe or rotative cultivator, and tine cultivators are most effective. Especially burdock ragwort and bindweed must be rigorously controlled, as they cause uneven ripening. Also, the burdock seeds are difficult to separate from the rape seeds at harvest.
- Undersowing a cover crop can be promising in fields with herb weeds, but not with grass weeds. For undersowing, very frost-sensitive species must be chosen so that they do not overgrow the rape plants in spring.

Box 6: Benefits of companion plants

Frost-sensitive legumes can be used to cover the soil quickly in autumn and prevent weeds from growing. Their decomposition provides additional nitrogen fertilisation in spring. The following mixture has proven successful in Switzerland (mixture for 1 are): fenugreek (*Trigonella foenum-graecum*) (80 g), lathyrus (80 g), lentils (80 g). In case of dry autumns, some linseed can be added.

Some species can be sown together with rapeseed to create a diverse plant stock to confuse the different pests and divert the rapeseed glossy beetle away from the rape. The following mixture has proven useful (mixture for 1 ha): rapeseed (4 kg), extra early rapeseed variety (e. g. ES Alicia) (0.3 kg), berseem clover (*Trifolium alexandrinum*) (3 kg), lentils (*Lens nigricans*) (7 kg), vetch (*Vicia sativa*) (7 kg), chickling peas (*Lathyrus sativus*) (6 kg), nyger (*Guyzotia abyssinica*) (2 kg), buckwheat (7 kg), spring linseed (3 kg). In order to achieve an optimum soil cover, a cereal drill with a small row spacing should be used.

Pest management

Of all arable crops, oilseed rape is the most affected by pests. While, in autumn, infestations of the black caterpillars of the leaf wasp rarely cause serious damage, slugs and rapeseed fleas can cause major damage to emerging plants. However, the most important pest is the rape glossy beetle that can lead to total crop failure.

The pests relate to different plant development stages. Therefore, the crop requires continous monitoring to anticipate infestations and apply control measures timely.

Germination/emergence

In temperate regions, slugs can cause important damages in the earliest stages of rape development. Damages occur especially in wet weather. After the 3-leaf stage of rape, the risk of damage is reduced. Damage can especially be high along meadow and wildflower strips, from where slugs invade.

Emergence until rosette formation

Oilseed rape flea (*Psylliodes chrysocephala*) is an important pest of young rapeseed plants. Especially under wet conditions (i. e. soil flooding), occasional serious damage can occur.

Length growth stage

Weevils (*Ceutorhynchus*) can cause important damage in bigger rapeseed plants – especially the rape stem weevil and cabbage shoot weevil.

Controlled pest pressure at flowering and good fertilisation contribute substantially to the formation of numerous pods.

Bud formation stage

The rape leaf beetle (*Meligethes aeneus*) is the most important rapeseed pest. In the worst case, rape leaf beetles can cause total loss of the crop when they destroy the majority of the flower buds. The beetles gnaw the buds to get the pollen, and thus dramatically impact the onset of flowers. The infestation is encouraged by late flowering, frequent rape cultivation in the region, and the cultivation near forests (the beetle hibernates in forest edges).

Pod formation stage

Cabbage pod gall midges (*Daniseura brassicae*) feed on the rapeseed pods. Infestations occur mainly on the edges of the field and rarely develop inside the plots. Thus, yield losses are rather low.

Between flowering and ripening

Aphids tend to feed infest rapeseed during this development stage mainly. Infestations develop in nests, causing the dying of upper plant parts and the falling out of seeds. Weather conditions can favour the fast spreading of aphids. Neither preventive measures nor direct control measures can be recommended.

Slugs

Limax spp.

How to prevent

- Burry crop residues as part of seedbed preparation.
- Repeated disturbance of the topsoil (false seedbed) prior to planting decreases the slug population.
- Sow rape only into dry soil.
- Roll the soil to reduce cavities. Spiked rollers (e. g. Cambridge or Crosskill types) contribute to direct control.
- Double the sowing density on the edges.

How to control

- Apply allowed products according to the targeted organic standard. Some standards allow slug baits with iron phosphate. Such products are best applied to the entire area with a fertiliser spreader up to two weeks after emergence of the crop. If slug pressure is low, only the edges of the field may be treated.

Oilseed rape flea

Phyllotreta sp.

How to recognise

- Scraping or small holes on the leaves due to feeding by the 3 to 4 mm large beetles.
- Later, the larvae feed in the stems.

How to prevent

- Avoid late sowing of the crop.
- Apply stone meal, ash or lime at the 2-leaf stage of the crop (reduces damage).
- Sow companion plants with a suppressive effect on the larvae (see box on page 16).

How to control

- Direct control is not allowed in certified organic rapeseed production.

Flea beetles

Psylliodes chrysocephala

How to recognise

- Initial scraping damage on the underside of the leaves (similar to earth flea infestation); later, holes in the leaves
- Bare patches in the field in case of heavy infestation.
- Leaf wasp larvae: initially green, later velvety black and 1 – 2 cm long.
- The larvae are best observed early in the morning or in the evening, and in humid weather.

How to prevent

- Promote favourable conditions for rapid crop development.
- Avoid the vicinity to previous season's rapeseed fields.

How to control

- Direct control is not allowed in certified organic rapeseed production.

Weevils

Ceutorhynchus spp.

How to recognise

- At first slimy, later whitish edged puncture marks on the stem (egg laying) about 1 cm below the shoot tip.
- Stunted plant growth due to feeding larvae and possibly bursted stems.
- Rape stem weevil: 2 weeks after egg laying, first slightly, later strongly S-shaped spots on the stem.
- Cabbage shoot weevil: no curved stem, as the larvae are mainly in the leaf midribs; damaged side shoots in the leaf axils.
- The pest overwinters in the soil.

How to prevent

- Avoid cruciferous crops on the same plot for at least 2 years prior to rapeseed cultivation (including cover crops, e. g. mustard).
- Do not cultivate the soil after harvest to achieve maximum exposure of the eggs to sunlight.
- Avoid sowing rapeseed in proximity of previous year rapeseed crops.
- Promote quick crop growth in spring.
- The application of liquid manure or slurry before the start of the vegetation period can have a repulsive effect.

How to control

- Pesticides are not allowed in certified organic rapeseed production.

Rape leaf beetle

Meligethes aeneus

How to recognise

- Shiny black bug, 1.5 to 2.5 mm long.
- Strongly attracted to white or yellow surfaces.
- Flowers fall off (i. e. missing pods).

How to prevent

- Well-developed plants with strong main shoots tolerate a high infestation of up to 10 to 12 beetles per plant.
- Promoting optimal plant development through optimal soil condition, sowing time and nutrient availability is the most important preventive measure.
- Sowing a super-early rapeseed variety (e. g. ES Alicia) at 7 % of the total seed amount together with a regular variety acts as a trap for beetles. The beetles go for the early open flowers and will therefore not feed on the still closed buds from the main variety. This technique is widely used in Europe.

How to control

- Pesticides are not allowed in certified organic rapeseed production.

Cabbage pod gall midges

Daniseura brassicae

How to recognise

- Yellowish and thickened pods.
- 1 – 2 mm long, white maggots in the pods.
- Premature cracking of the pods, and seeds falling out of the pods.
- No preventive and direct control measures are justified in organic production.

How to prevent

- Avoid cruciferous crops on the same plot for at least 2 years prior to rapeseed cultivation.

How to control

- Pesticides are not allowed in certified organic rapeseed production.

Disease management

Phoma stem canker (blackleg) is the most important fungal disease on oilseed rape, causing seedling death, lodging or early senescence. The epidemiology and severity of phoma stem canker differs between different cultivars, varying climatic conditions, and agricultural practices.

Rape canker (white stem canker) is the second important fungus affecting oilseed rape.

Cabbage hernia infects the roots and causes the so-called clubroot disease in brassica species. The spores of the soil-borne pathogen can survive in the soil for more than 15 years. Yield losses can range from 10 to more than 50 % in case of very high disease pressure.

Phoma stem canker

Leptosphaeria maculans

How to recognise

- In autumn: light, round spots with small, black dots on the leaves.
- Brown root neck on heavily infested plants.
- Later, cracked corking on the root neck.

How to prevent

- Ensure a cultivation break of at leasts 4 years between rapeseed crops.
- After harvest, promote fast decomposition of rapeseed crop residues.
- Ensure sufficient air circulation sowing at a row distance of 45 to 50 cm to reduce infestations.

How to control

- No direct control measures possible.

Stem rot

Sclerotinia sclerotiorum

How to recognise

- From pod filling stage onwards, white areas about the width of a hand in the middle of the stem.
- Grey fungal tissue and black sclerotia (irregularly shaped fruiting bodies) in the hollow stem.

How to prevent

- Select varieties with low phoma susceptibility.
- Maintain a cultivation break of at least 4 to 5 years between rapeseed crops and other host plants like peas, carrots, and potatoes.

How to control

- No direct control measures possible.

Cabbage hernia

Plasmodiophora brassicae

How to recognise

- Stunted young plants.
- Yellow to reddish discolouration of older leaves.
- Irregular thickening on the roots (white inside and without cavities).

How to prevent

- Maintain a cultivation break of at least 4 years between rapeseed crops and to cruciferous plants in catch crops.
- Cruciferous weeds can also transmit the disease. Thus, they should be controlled consistently.
- Application of elemental sulphur to lower the soil pH below 6.5 can reduce the risk of infestation.

How to control

- No direct control measures possible.

Harvest and postharvest management

Depending on the location, rapeseed can be harvested from mid-June onwards, as soon as the seeds are black and the pods are green-grey. The following aspects are relevant for harvesting:

- The pods in the lower part of the plants must no longer be green. For a correct estimation, plants within the stand must be controlled, as the plants on the edges ripen faster.
- There should be no more than 20 to 30 % green stems. Green stems are still wet, heavy and not very flexible, and thus require an increased threshing speed and ventilation, resulting in higher losses.
- New varieties are more resistant to shattering, allowing harvest at a moisture content of less than 9 %.
- Threshing in the morning or evening is recommended, when the pods are slightly moist and therefore open less.
- The use of combine harvesters with cutting table extensions and rapeseed shears can save seed losses of up to 300 kg per ha.
- Fields with heavy (grass) weed infestation should be harvested last to avoid spreading of weed seeds to other plots.
- After harvest, the seeds should be delivered quickly to the collection point as they develop a musty and pungent off-flavour in cold-pressed rapeseed oil when stored in a moist place overnight. In case of on-farm storage, the seeds should be ventilated thoroughly to prevent moisture and potential infestation with Salmonella.

Box 7: Managing germinating seeds after harvest

Fallen rape seeds can keep their germination capacity in the soil for years. After harvesting, the soil should be worked to a maximum depth of 5 cm to encourage the fallen seeds to germinate. Ideally, the rape straw is mulched once most seeds have germinated. To promote straw rotting, a small amount of liquid manure can be applied. If time allows, a weed cure can be inserted by tilling the soil superficially in intervals of 10 to 14 days prior to seedbed preparation for the following crop.

Rapeseed volunteers can also provide a very good summer fodder for pasturing sheep. Intensive grazing of the regrowth also ensures active slug and rodent control during intercropping, while accelerating nutrient recycling to the soil.

For harvest, the bottom pods must be dry, whereas the stems may still be green.

Superficial soil cultivation after harvest encourages germination of rapeseed seeds.

Sunflower

Sunflower, a species of the Compositae family, can be cultivated for oil, hulled seeds, as a green manure or even for flowers. The crop complements well cereal-based rotations. Sunflower fields also contribute to a colourful landscape and provide food for bees and beneficial insects.

The cultivation of sunflower is less demanding than the cultivation of rapeseed. However, the crop requires a favourable climate for good oil yields.

Cold-pressed and high-oleic sunflower oils are in good demand. In addition, the residual press cake is an excellent ingredient for animal feed. Especially the press cake of organic quality is highly demanded for organic feed mixtures.

Sunflowers are the most important crop for oil production in organic farming after oilseed rape (and soybeans).

Key agronomic figures

- **Nutrient requirements:** N: 50 kg/ha; P: 40 kg/ha; K: 30 kg/ha
- **Sowing date:** from 10th of April to mid-Mai
- **Soil temperature:** min. 8 °C, opt. 10 °C at 8 cm soil depth
- **Seed rate:** 75,000 seeds/ha (4 to 5 kg/ha)
- **Plant density:** 50,000 to 60,000 plants/ha
- **Sowing depth:** 3 to 4 or 5 cm
- **Distance between rows:** 50 cm (45 to 75 cm)
- **Distance in the rows:** 26 cm

Variety selection

For oil production, only hybrid varieties are used. The availability of organic seeds is limited to varieties that are best suited for the production of cold-pressed oil in different locations. Unlike conventional seeds, organic seeds are not treated with synthetic fungicides.

High oleic varieties, which are used for frying and deep-frying, are highest in demand. A growing niche market relates to hulled kernels, for which special varieties are used. As with all special crops, the type of variety (linoleic or high oleic) to be grown is specified in the sales contracts.

In Eastern and Southern Europe with hot summers and optimal growth conditions for sunflower cultivation, high yielding late maturing varieties are used. In contrast, in locations with less hot summers, early-maturing varieties with lower yield potential are grown.

Box 8: Specific management for high oleic versus linoleic varieties

- For oleic sunflower varieties, the recommended sowing dates must be respected. Late sowing must be avoided, as low temperatures after flowering reduce the oleic acid content in the seeds.
- A minimal distance of 100 to 200 m must be maintained to avoid cross-pollination with linoleic sunflower varieties.
- At harvest, the seeds of high oleic sunflower varieties must not be mixed with linoleic varieties. Margarine manufacturers look for sunflowers with a linoleic acid content of over 60 %, a level that would not be reached if mixed with oleic varieties.

Climate and soil requirements

Sunflower prefers medium-heavy, well-aerated soils, but grows well in heavy clay soils, too. Less suitable are humus-rich or marshy soils. Heavy soils must be loosened deeply and compaction avoided.

Sunflower prefers a warm and dry climate, similar to grain maize and soybeans. Its water requirements are low, except during flowering. Humid regions with autumn fog are not suitable. Low temperatures at the beginning of the season are less critical, as sunflower tolerates late frosts with temperatures of up to -5 °C up to the 4-leaf pair stage.

Crop rotation

A cultivation break of 5 years is recommended due to stem rot (i. e. Sclerotinia). Since Sclerotinia infests also other plants, it must be well-monitored throughout the entire crop rotation. In general, it is recommended to have a time span of 3 years or more between a sunflower crop and other Sclerotinia host plants including cruciferous volunteer plants and crops like rapeseed, oil radish, turnip as green manure, soybeans and beans.

Suitable preceding crops to sunflower are cereals and corn followed by a freezing green manure intercrop.

After sunflower, the soil should not remain bare over winter followed by a spring crop, as sunflower volunteers can become uncontrollable weeds during the next season. Instead, winter cereals or multiannual leys with clover or alfalfa are recommended.

Sunflower is well suited to break crop rotations. Furthermore, its strong root system makes it a highly valuable preceding crop.

In southern and south-eastern Europe, an early maturing linoleic sunflower hybrid with a cultivation period of 120 to 130 days can be sown as a second crop, under good growth conditions, provided that it can be sown before 15th to 20th of June. However, earlier sowing is recommended, as every day that is saved on the planting date will result in a 4 days earlier harvest! Suitable preceding crops with early harvest are immature crops for silage, winter barley or winter pea.

Nutrient supply

Sunflowers have a good nutrient absorption capacity thanks to their branched root system. With exception of potassium, nutrient requirements are low, including for nitrogen. On nitrogen-rich soils, e. g. after legumes, no nitrogen fertilisation is required. Excessive nitrogen promotes vegetative growth and delays maturity, increases sensitivity to diseases and risk of lodging.

The following fertiliser application rates can be recommended:

- In autumn, 10 to 20 tons of cattle manure can be applied per hectare to a frost-sensitive catch crop.
- Poultry manure is preferably applied in spring at 3 to 5 tons per ha a few weeks before sowing the sunflowers. The manure is worked-in superficially only.
- Liquid manure is applied at 20 to 30 m^3 per hectare in one or two applications between emergence of the crop and the 6-leaf stage before hoeing.
- Livestock-free farms can apply 40 to 50 kg of nitrogen per hectare with a nitrogen-rich, fast-acting commercial fertiliser. The fertiliser is preferably applied to the rows.

Seedbed preparation

Sunflowers require a well-settled and sufficiently fine seedbed. Inappropriate seedbed preparation and sowing increase the risk of crop damage during blind harrowing.

A winter furrow is optimal for seedbed preparation. On medium to heavy clay soils, deep tillage (subsoiling or ploughing) must be carried out in the previous autumn under good weather and soil conditions.

Sowing

Sunflower is sown rather late in the season to encourage fast emergence and a good weed suppression. In many production regions in Europe, sunflower is sown from mid-April onwards. Organic sunflowers are recommendedly sown 10 to 15 days after conventional sunflowers. In regions with colder springs, the crop can be sown until the end of May.

A high emergence density and a good initial plant vigour are decisive to achieve good yields. Both depend on a soil temperature of at least 10 °C at 8 cm of depth and favourable weather conditions in the 7 days after sowing without heavy rain or sudden cooling.

- The crop is sown into dry, well-levelled soil at a low speed of max. 6 km per hour. Ideally, a precision seed drill machine is used.
- Normal **sowing depth** is 3 cm. In case of blind harrowing before crop emergence, deeper sowing is recommended to prevent damage on the sprouted seedlings in the soil.
- The recommended **seed rate** is around 75,000 seeds per hectare, considering possible damage from birds, snails and wireworms.
- **Row distance** varies depending on the available sowing and weeding equipment.
- Before harvesting, a **crop density** of 50,000 to 60,000 plants per hectare is aimed for. Due to expected losses during early growth, 75,000 plants per hectare are normally sown. However, a too high plant density tends to reduce plant stability and increase the risk of Botrytis and Sclerotinia infestations. In contrary, a too low crop density bears the risk that the flower heads become too big, which can cause plants to fall over during storms.

Very low crop densities below 30,000 plants per hectare (3 plants per m^2) due to pests or mechanical damage during early growth suggest re-seeding of sunflower.

Weed control

Sunflowers are especially sensitive to weed competition until the 5- to 6-leaf pair stage (i. e. 30 to 40 days after emergence). To reduce weed pressure in early crop stages, blind weeding with a tine or a rotary tine harrow prior to emergence is recommended.

Between hook stage (1 to 2 days before emergence) and the development of the first pair of true leaves, weed control operations are not possible.

With a row spacing between 50 and 75 cm, sunflowers can be hoed fairly easily with common arable weeding equipment.

Between the 1- and 2-leaf pair stage, the rotary hoe is ideal to control young weeds in the rows. Interventions are most effective a few days after rain or irrigation, when emerged new weeds are easily uprooted.

Mostly, two hoeing passes are sufficient for effective weed control in sunflower. The first hoeing pass should be carried out very early, when most plants are visible in the rows. The hoeing must be done with much care to prevent covering of the young sunflower plants with soil.

The second (and possibly third) hoeing must happen before the plants reach a height of 30 cm (5- to 6-leaf pair stage) respectively latest before the plants close the rows. At this stage, hoeing can be done with a goosefoot hoe or a star hoe. In the last hoeing pass, the star hoe has the advantage of mounding the soil in the rows and burying the young weeds in the rows that cannot be reached directly by the hoe elements.

Pest management

Pests are only of major relevance in the early stage of the crop's development and at harvest. Most important are slugs, wireworms and birds.

Slugs

Slugs can cause important damage in spring. Favoured by the humid conditions at night, they invade the field from adjacent meadows and wildflower strips. Small field slugs are a special danger for sunflowers, as they can cause total damage when they eat the plant tops. If the damage is on lower leaves only, the plants may recover and yield normally.

Wireworms

Wireworms is a common name for the larvae of *Agriotes* spp., given their appearance of filiform brownish worms, with a hard and cylindrical lengthy body of 2 to 3 cm. When being present from a previous crop – they also feed on maize, green forage and legumes – they can be a real threat to sunflower seedlings.

Crows

Crows are fond of sunflower kernels and thus can cause meaningful damage in freshly sown crops. But damage is also possible at harvesting, when they feed on the matured kernels.

Sunflower seedlings damaged by slugs.

Hares

Hares can also cause severe damage to young seedlings, eating long rows of young plants (up to the 4-leaf stage). Being mainly water seekers in dry periods, they collect a drop of sap before moving on to the next plant, leaving the plant head aside. In case of high pressure, watering points on the field edges can keep hares away.

Aphids

Aphids may be a problem under certain circumstances. However, economic damage only occurs when more than 50 percent of the sunflower leaves have shrivelled. In case of lower damage, plants recover. Possible direct control measures need to be clarified with the certification body.

Disease management

With a five-year cultivation break, good choice of the location and sound cultivation practices that ensure a good aeration of the crop stand, disease infections can be largely avoided. As important preventive measures, regrowth of sunflower volunteers should be avoided, and the decomposition of crop residues should be promoted with intensive shredding of the stalks and shallow tillage after the harvest.

Downy mildew

Downy mildew is the disease with the biggest damage potential in sunflowers. The disease is caused by the fungus *Plasmopara halstedii*, which is highly contagious. The pathogen is spread with infected seed, and the fungal spores can survive in the soil for up to 10 years. Given the danger of this pathogen, an infestation with it must be reported immediately to the corresponding plant protection authorities.
Other diseases in sunflower cultivation relate to other, less relevant fungi, for which there is no direct control in organic production. Most important are Botrytis grey rot (*Botrytis cinerea*), sunflower canker (*Sclerotinia sclerotiorum*), Phoma (*Phoma macdonaldi*) and Phomopsis (*Phomopsis helianthi*).

Slugs
Limax spp.

How to recognise
- Large bites on or partially missing young cotyledons.
- Slime marks around missing plants.

How to prevent
- Work the residues of the previous crop well into the soil as part of seedbed preparation.
- Prepare a rather fine seedbed.
- Cut adjacent meadows and wildflower strips.

How to control
- Apply allowed products according to the targeted organic standard. The products are best applied to the entire area with a fertiliser spreader up to two weeks after emergence of the crop. If slug pressure is low, only the edges of the field may be treated.

Wireworms
Agriotes spp.

How to recognise
- Perforated seeds, or cut-off underground young stems.
- Often, the larvae can be found in proximity of the damaged plants.

How to prevent
- Avoid critical preceding crops (e. g. maize, legumes) and fallow or grassland.
- Work the soil in dry conditions and after the egg-laying period of the wireworms (late spring, early summer) to kill many wireworm eggs and young larvae.
- Sow late into warm soil to shorten the critical emergence phase of the crop.

How to control
- No direct control measures known to be effective against the larvae.

Crows
Corvus spp.

How to recognise
- Pulled out or missing young plants, often dozens in a row.

How to prevent
- Choose a sufficiently large plot (at least 1.5 hectares) so that the birds can only consume a small share of the entire crop.
- Use scarecrows, poppers and balloons to scare the crows away.
- Some varieties have a completely inverted head at maturity, preventing birds from feeding on seeds.

How to control
- No direct control measures possible.

Downy mildew
Plasmopara halstedii

How to recognise
- Dying seedlings.
- Stunted growth of plants (i. e. dwarfism).
- Alteration of the leaves in advanced stages (pale green to yellowish lightening of the upper sides of the leaves along the veins, white felt on the underside of the leaves).

How to prevent
- Use seeds from a pathogen-free production area.
- Use varieties with low susceptibility to a wide range of downy mildew species.

How to control
- No direct control measures allowed.

Harvest and post harvest management

Oleic sunflower varieties are harvested between August and October when the moisture content of the kernels has dropped below 9 %. Fallen off tubular flowers, clearly visible kernels, and mostly died leaves are characteristics of harvest maturity.

Depending on the size of the sunflower field, different harvesting technologies are used:

- Smaller producers may adapt the cereal header of a combined harvester (i. e. using crop dividers and reel plates) to get good results.
- For larger fields, specific headers should be used that allow a greater throughput and thus reduce harvesting losses to a minimum.
- Corn headers with a specific adaptation kit for sunflower are another option, if they match with the row spacing. They also have the advantage to pick up sunflowers laying on the ground, which other equipment cannot do. Yet, corn headers have a much higher loss rate due to intense shattering.

Appropriate picking equipment enables efficient harvesting of large fields with minimal grain losses.

Thresher settings

- The drier the crop and the lower the drum speed, the gentler the threshing must be. The empty flower heads should come out in one, two or three pieces only.
- When harvesting varieties are grown for hulling, particular attention must be paid to ensure smooth threshing to avoid broken or split seeds.
- Producers with an on-farm sorting facility should not attempt to clean the crop too thoroughly at harvest. Instead, they should apply a smoother harvesting setting with lower fan speed and larger sieve clearance to minimise harvest losses. Such settings will also remove many weed seeds from the field.

Cleaning and storing

- In organic production, clean storage and very hygienic handling are essential measures.
- The seeds should be cleaned with the farm's grain cleaner to have a more homogeneous seed mass. This allows better drying and cooling by ventilation.
- In case of heavy infestation of sunflower plots by *Datura stramonium*, the harvested crop should be cleaned with lower screens with round holes of 3.5 mm diameter. This will avoid exceeding the legally required maximum limit of 0.1 % of Datura seeds in animal feed.
- The humidity of the seeds must be reduced to 7 to 8 % to avoid mould and acidification of the seed oil (the product can get musty and rancid).
- Below 14 % seed moisture, ventilation drying with slightly warm air may be enough.
- Above 14 % seed moisture, rapid drying with hot air is essential to quickly reduce the moisture content in the kernels. This procedure requires special precautions to avoid dryer fires.

Well-dried sunflower kernels have a long shelf-life and can be stored in silos. In due time, sunflower kernels are processed in industrial mills to ensure optimal pressing yields.

Oil linseed

Linseed *(Linum usitatissimum)*, also known as flax, has traditionally been grown in Europe for both food and fibre. For many centuries, linen produced from flax fibre provided the raw material for manufacturing bed sheets, clothes, and table linen. Today, oil from linseed is used as an ingredient in human consumption and industrial specialty products (e. g. wood-finishing).

Linseed belongs to the *Linaceae* family and includes two types of different colours, brown and yellow/golden.

Cold-pressed linseed provides a tasty and very healthy edible oil. One to two teaspoons of linseed oil cover the daily requirement of omega-3 fatty acids. Organic linseed oil is gaining popularity among health-conscious consumers. The market for linseed as a whole grain is also growing, both for brown and yellow varieties. Even the ground press cake (linseed meal) is highly valued by conscious consumers.

Key agronomic figures

- **Nutrient requirements:** N: 60 kg/ha; P: 40 kg/ha; K: 40 kg/ha
- **Sowing date:** winter type: mid to end of September; spring type: mid of March to early April
- **Minimal germination temp.:** 2–3 °C
- **Seed rate:** spring type: 600 to 800 seeds per m^2 (30 to 60 kg per ha), winter type: 400 to 600 seeds per m^2 (20 to 35 kg per ha)
- **Plant density:** 400 to 600 plants per m^2
- **Sowing depth:** 2 to 3 cm
- **Distance between rows:** 15 to 33 cm
- **Moisture content at harvest:** 9 to 12 %

Variety selection

The seeds of both linseed types have similar favourable nutritional characteristics with a high level of omega-3 fatty acids. While the oil from both types is almost identical, also in colour, the residual oil cake differs in colour. Since animal feed manufacturers prefer brown oil cake for its colour effect, mostly brown varieties are grown for oil production.

Linseed is mainly cultivated as a spring crop. However, winter varieties, which are sown in September, exist also.

Box 9: Advantages and disadvantages of winter linseed varieties

Advantages:

+ Harmless autumn weed flora covers the soil and may reduce germination of problematic spring weeds such as salvias and ragwort.
+ Potentially higher yields due to probable flowering and seed filling before summer drought.
+ No need for cover crops, which saves additional costs.
+ Stronger branching capacity (3 to 4 tillers) resulting in better compensation in case of plant losses.

Disadvantages:

- Risk of poor overwintering.
- Longer crop duration without option of sowing a cover crop.
- High competition from weeds possible (low competitiveness especially against grass weeds).
- Depending on the region, likely simultaneous harvest with wheat or oat, i. e. potential difficulty to access available threshers.

With its pretty blue flowers, linseed is one of the most beautiful crops. The crop has gained in importance in recent years because of its various uses.

Climate and soil requirements

- Linseed is well suited for maritime climates as well as for warm and dry locations.
- For good yields, good water supply is essential before and during flowering, i. e. in mid-June. Plots that tend to dry out in summer should therefore be avoided.
- Linseed prefers humus-rich, deep and well-drained loams. Heavy clays are unsuitable, as are gravelly or dry sandy soils.
- Due to its low competitiveness against weeds, linseed should only be cultivated on fields with a low (grass) weed pressure.
- Linseed reacts sensitively to poor soil structure, compaction and silting. Therefore, soil and seedbed preparation through the entire crop rotation should be carried out under favourable dry soil conditions only.
- In soils with good structure, linseed can easily be cultivated with minimum tillage.

Under favourable conditions, seedbed preparation can be carried out with reduced tillage before oil linseed.

Crop rotation

- Linseed belongs to another plant family than most arable crops, which makes it an interesting rotation crop.
- As linseed is not self-tolerant, a **cultivation break** of at least 4 to 5 years is advisable.
- **Spring varieties** can be easily integrated in crop rotations due to its short vegetation period of 120 to 125 days.
- **Winter linseed varieties** can be sown between two cereal crops.
- Linseed should not be sown after oilseed rape, as both crops are hosts to the flea beetle, and because rape regrowth is difficult to manage in linseeds with little soil cover.

Nutrient supply

Linseed has low nutrient requirements. Nevertheless, it depends on appropriate nutrient supply during its long growth period before flowering.

- **Nitrogen:** If phosphorus, potassium and magnesium supply from the soil is sufficient, no fertilisation is needed. In general, a basic fertilisation targeting 40 to 60 kg N per ha is appropriate. Excessive nitrogen supply leads to lodging and thus to yield and quality losses. A light application of slurry is beneficial. In contrary, manure or compost can delay ripening.
- **Zinc:** Application of a zinc fertiliser may be appropriate based on soil analysis, as a shortage of zinc can limit the growth of linseed. In most cases, zinc-based seed coating provides enough zinc to prevent deficiency. As zinc can be blocked in soils with a high pH, liming of the field must be avoided prior to linseed cultivation.

Sowing

Good seedbed preparation is key to successful linseed cultivation.

- Weed cures prior to sowing are highly recommended especially in case of high weed pressure.
- Linseed requires a fine, crumbled, and well-settled seedbed.
- Row spacing of 15 to 33 cm allows hoeing between the rows, whereas narrower row spacing (e. g. 12 cm) allows tine harrowing only.
- For the spring types, a **sowing density** of 600 to 800 seeds per square metre has proven to be good under normal conditions. In unfavourable conditions, the seed rate should be increased by 10 to 20 %. Winter varieties produce side shoots and should therefore be sown slightly thinner to avoid a too high crop density and lodging.
- Aimed **plant density** is of 400 plants plants per m². Low plant densities of 150 to 200 plants per m² in winter linseed, and 350 plants per m² in spring crops can be compensated by the crop, unless weed infestation is too high.

Weed control

Linseed's slow juvenile development favours weed growth. Especially high growing (grass) and nest building weeds (e. g. thistle, orache, amaranth) can become critical. Cleavers *(Galium aparine)* hamper drying and cleaning of the crop as they have similiar seed size as linseed.

In contrary, the light stands of linseed crops enable growth of less common weeds like corn cockle, lady's mantle and cornflower. These species have little or no impact on linseed yields, but contribute to a higher biodiversity and provide food for beneficial insects.

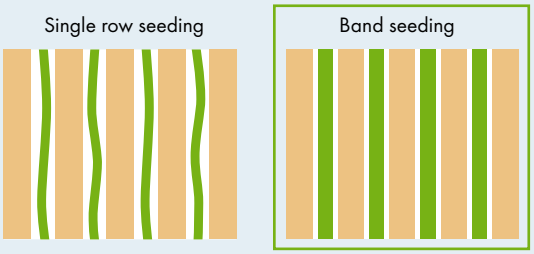
In general, the following measures are recommended for weed management:

- 1 to 2 weed cures before sowing.
- Harrowing is possible after the plants have reached a height of 5 cm.
- Ideal is a combination of hoeing and harrowing.
- Band seeding favours effective weed control (see box).
- Critical weeds may need to be removed by hand.
- Spots with cleavers (*Galium aparine*) should be raked out before beginning of pod maturation. This can be done using a tine weeder held up high on the tractor hitch to rake the cleaver out of the field.

For high yields, a dense stand without gaps is necessary that suppresses competing weeds at the best. However, too dense stands encourage lodging and disease development.

From a row spacing of 20 cm, the crop can be hoed with or without automatic guidance technology.

Box 10: Band seeding for more effective weed control



Sowing linseed crops in bands instead of single rows enables a more precise adjustment of the hoeing width to the interrow space. Within the bands, weed growth is hindered due to the high plant density.

Band seeding allows precise hoeing of the inter-row space in crops with narrow spacing.

Pest and disease management

Linseed is a moderately disease-prone crop. Most relevant diseases are septoria, kabatiellosis, powdery mildew and Fusarium.

The main preventive measures to avoid disease development in linseeds are:

- Maintaining a cultivation break of 4 to 5 years between linseed crops.
- Avoiding too dense, thus not well-ventilated crops (i. e. broadcast seeding is not recommended).
- Avoiding injuring the plants by too aggressive weeding.
- Using certified seeds rather than farm-saved seeds, as certified seeds are not very costly.
- Under humid climatic conditions, spring varieties have a shorter cultivation period and are thus less susceptible to diseases.

In regard to pests, slugs may be a problem under humid conditions during plant emergence. Yet, the greatest danger in terms of pests relates to ground flea infestations in spring.

The dark green to black coloured, 1 to 2 mm large, jumping beetles feed on young plants. Under favourable dry conditions, ground fleas can eat all sown linseed seedlings. Increased infestation pressure must be expected in fields that lay in proximity of forests and hedges.

Linseed fleas are mainly a threat in spring sown crops. The risk of damage is highest in the period from sowing to a plant height of 5 to 6 cm, when the fleas are flying in from their winter quarters. Damage can also occur in later crop stages, but causes less harm to the more developed plants. Winter linseed varieties that are sown in autumn have outgrown the sensitive stage during the flight period of the ground fleas.

To avoid or reduce potential damage, fast and early growth of the crop should be favoured. Other preventive measures against ground fleas include:

- Avoid cultivation after cruciferous crops and intercrops, as well as peas, even if they aren't infested by the same flea beetle species.
- In regions with prior damage, increase the seed rate by up to 10 kg per hectare.

Due to the mostly unavoidable late weed growth, swathing (preliminary cutting) of linseed before threshing is often necessary. Threshing and subsequent cleaning are much better when the linseed and weeds can dry for a few days in the field.

Harvest and post-harvest management

Harvest

- Harvest maturity is reached when the seeds rustle slightly in the capsules, the uppermost stem section (approx. 5 cm) is brown, and the lowest leaves on the still green stem have fallen off. Since there is no danger of sprouting, the harvest can be delayed as long as the seeds are not affected by fungi.
- For threshing, the crop must be well-dried. For this, the crop is best harvested in the afternoon.
- As a fibre crop, linseed has very tough straw, implying that the combine harvester or the knife bar for swath threshing must have well sharpened knives. It must be avoided that the straw wraps itself around rotating machine parts, which then would strongly hamper harvesting.

Basically, there are two **harvesting methods**:

a) **Direct threshing:** recommended in case of low weed infestation in dry weather conditions.
b) **Swath threshing:** in case of high weed infestation. The plants are cut with a swather at a height of 10 to 20 cm when anticipating good weather conditions. The cut plants are then dried for 2 to 3 days in sunny weather before being threshed.

Swath threshing eases harvesting, results in a cleaner product and reduces drying costs. Swathing equipment allows to intercrop linseed with lentils or peas, even if the maturities of the two crops do not exactly match.

The disadvantage of swath threshing, apart from the effort required for windrowing, is the risk of seed loss, even if the pods are not particularly susceptible to shattering. Windrowing during the warmest period of the day should be avoided.

Drying

After harvest, the crop must be further dried to a moisture content of 9 %, which is managed with powerful ventilation during dry and warm weather.

Residue management

Since linseed is a very fibrous plant, post-harvest residue management is essential to avoid mechanical problems in the following crop. If the straw is not sold (for insulation material or on-farm composting), it must be shredded to encourage decomposition.

Hemp

Hemp, or industrial hemp, are specific cultivars of *Cannabis sativa* L. grown for industrial or medicinal use. The plants are robust and have low requirements for the growing conditions.

Hemp can be used in many ways: the seeds can be consumed fresh or pressed for oil, the inflorescences can be used for medicinal purposes, and the fibres can be used for the production of textiles, paper, rope or construction material. When the seeds are used for oil production, the remaining press cake is a valuable component for animal feeds.

Hemp, originally a pioneer plant, establishes quickly and is very competitive.

Key agronomic figures

- **Nutrient requirements:** N: 60 kg/ha; P: 50 kg/ha; K: 100 kg/ha, Mg: 15 kg/ha
- **Sowing date:** early April to early Mai
- **Ideal soil temperature for sowing:** 10 to 12 °C at 8 cm of soil depth
- **Seed rate:** 250 to 300 seeds/m^2 (30 to 50 kg/ha)
- **Plant density:** 200 to 250 plants/m^2
- **Sowing depth:** 3 to 4 cm (in light soils: 6 cm)
- **Distance between rows:** 12 to 25 cm

Cultivar selection

Hemp is an annual, originally dioecious plant (i. e. with female and male plants). Through breeding, also monoecious cultivars with female and male flowers on the same plant were created. The monoecious cultivars produce higher yields, mature more evenly, and have a more uniform fibre quality.

Depending on the intended use, different cultivars are used and cultivation practices are applied.

Climate and soil requirements

- Although being tolerant to different soil conditions, hemp prefers deeper soils, as it is sensitive to soil compaction and waterlogging.
- While young plants are susceptible to drought, the crop benefits from its long taproot.
- The optimum pH value of the soil is between 6 and 7.5.

Hemp can complement existing arable crop rotations very well.

Box 11: Difference between hemp and marijuana

Hemp and marijuana belong to the same cannabis species. The distinction in the name has a legal logic mainly. Marijuana relates to cannabis with a tetrahydrocannabinol (THC) content of more than 0.2 % by dry weight having narcotic effects, whereas hemp relates to cannabis cultivars with a THC content below 0.2 %. Latter is mainly used for medicinal purposes.

As THC-rich cannabis is considered a drug in many countries, its cultivation is strictly regulated in most countries. In some countries, even the cultivation of hemp is prohibited. In others, hemp cultivation is legal, but bound to national registration. In Europe, only cultivars with low THC content can be grown. Authorised varieties are regulated and listed by authorities. Cultivating hemp from farm-saved seed is forbidden to prevent crops with a THC content above 0.2 %.

Crop rotation

Hemp belongs to a different botanical family (*Cannabaceae*) than all other arable crops. Therefore, it does complement well existing crop rotations.

- Due to its relatively high nutrient demand, hemp is best grown after leguminous crops or grass-clover.
- Hemp is an excellent preceding crop for almost any other crop. With its deep root system, it loosens the soil deeply and brings up nutrients and water to upper soil layers. It furthermore suppresses weeds effectively and is known to repell a large number of pests. This makes it a good pre-crop to crops that are susceptible to weeds and insects.
- A 3-year cultivation break is recommended between two hemp crops on the same plot to minimise infestations from diseases like Botrytis, Sclerotinia, Rhizoctonia and Pythium.

Nutrient supply

Hemp's nutrient requirements are similar to those of winter wheat. Available nitrogen in the soil is efficiently taken up by the crop's extensive root system. A continuous release of nitrogen from a nutrient source such as a terminated ley or cow manure is advantageous for the crop.

Solid or liquid fertilisers are best applied in spring before sowing. An application of, for example, 2.5 tons of poultry manure per hectare is sufficient to ensure proper nutrition of the crop.

Sowing

The seedbed should be fine, crumbly and well-settled, as hemp seeds are very small. Since hemp has a relatively short vegetation period, sowing should not be done too early, also because seedlings and young plants are frost sensitive. The ideal soil temperature for sowing is 10 to 12 °C at 8 cm depth.

Sowing depth is analogous to cereals at 3 to 4 cm. Row distance for hemp for seed production is wider than for fibre production to encourage abundant flowering and many seeds. The crop is sown with a standard seed drill.

Box 12: Relevance of daylength for sowing

Flowering of hemp is induced by short days after the summer solstice. On average, the threshold lays at a day length of about 10 hours. As a result, hemp will flower at the same time each year. The later sowing takes place, the shorter the period between sowing and flowering will be. Too late sowing will result in a too short development of the crop until flowering. Seed maturity is achieved about 40 days after full flowering.

Thanks to its pioneering character, hemp often out-competes early spring weeds.

Weed control

Especially in warm soil, hemp emerges very quickly and is very competitive against upcoming weeds. However, as hemp for seed production is sown less densely, mechanical weed control can be necessary. False seedbed preparation before seeding can reduce weed pressure during crop growth.

In case of high weed infestation, weeding can be carried out from the 4-leaf stage of hemp onwards using a tine-harrow, or a hoe if the crop was sown with with the required row spacing.

One or two passes are usually sufficient to control the weeds in oil hemp.

Pest and disease management

In general, hemp has a good natural tolerance to insect pests. Nevertheless, some species can cause significant damage, including the European corn borer and the two-spotted spider mite. In rarer cases, also locusts and aphids may cause certain damage.

The most important disease in hemp that needs attention and potentially good monitoring is Botrytis. The fungus may easily invade from other crops under humid conditions and infest especially weak, damaged, or senescing tissue. Where climatic conditions tend to favour the spreading of Botrytis, a slightly larger row spacing is likely to improve aeration of the crop to reduce moisture levels within the crop.

In any case, crop residues should be buried after harvest with sound soil cultivation to prevent Botrytis from overwintering on diseased plant residues. Also, a cropping break of at least 3 years is recommended to mitigate the proliferation of the fungi in a field. In case of botrytis infestation, hemp should not be grown on neighbouring fields.

Hemp can also be subject to Sclerotinia infestation. In this case, it is not recommended to grow hemp after soybean or rapeseed.

Box 13: The Secuieni method

A research institute in central Romania with long experience in hemp cultivation has developed a method to increase the number of inflorescences per hectare while reducing and equalising the height of the plants to be harvested.

After thin sowing at 25 to 30 seeds per m^2, the plants are pruned twice:

- The first pruning is done at the stage of 5 to 6 pairs of true leaves above the 3rd leaf node, i. e. at a height of 30 to 35 cm.
- The second pruning is done after regrowth 15 to 20 cm above the level of the first pruning.

The method results in abundant flowering along the entire length of the shoots compared to uncut plants where inflorescences develop only on the tips or lateral branches of branched plants. With this method, yield is increased by up to 20 % and harvesting is facilitated.

Pruning is carried out with a wide mowing bar, such as a windrower or a weed cutter. Run-over plants usually recover.

Harvest

Defining the ideal moment for harvest is a challenging task in hemp cultivation. **Seed maturity** is reached when the seeds in the seed coat rustle when shaken, and seeds turn brown. Yet, as not all seeds ripen at the same time, the moisture content of different seed samples must be carefully monitored.

- Seeds should be harvested with a maximum percentage of 5 % of green seeds (ideal: 3 %).
- Moisture content of the seeds should be not more than 20 % in average (ideal: 15 %).

The seeds are harvested from September onwards. Threshing is demanding because the hemp fibres easily wrap themselves around rotating parts and thus clog the machine. Therefore, harvest is done with a modified combine harvester, which only harvests the top part of the plants. The more uniforme the crop's height is, the easier the harvest.

- Simple harvesters such as axial types or classic single threshing machines with disconnected rear chopper may be preferable to avoid wrapping of fibres around moving parts.

Hemp can be harvested with conventional equipment, although some adaptations and special care are required.

- The cutting bar must be adjusted as close to the heads as possible.
- Harvesting is easier in dry weather and after morning dew due to the woody and tough stems. Fine teeth knives should be used on the header.
- After the harvest of the seeds, the hemp stalks can be harvested as raw material for fibres. However, the quality is lower than that of hemp that is grown purely for fibre due to later harvest.

Hemp seeds often need to be dried shortly after harvest, as their moisture content is often too high at the optimum time for harvesting.

Post-harvest management

- After harvest, the hemp seeds must be dried quickly (ideally within 4 to 5 hours after harvest) to reduce moisture content to less than 10 % (ideally 7 to 8 %) to avoid degrading of unstable fatty acids like omega-3 and -6 and prevent oil rancidity and acidity.
- Drying of ventilated piles, preventing unventilated pockets, can be delayed.
- For drying, ambient air or controlled hot air with less than 45 °C are used, as fatty acids are also very sensitive to heat.

Poppy

Poppy *(Papaver somniferum)* is an ancient crop from which a valuable edible oil can be obtained. The oil is rich in unsaturated fatty acids, with linoleic acid being the main component. Poppy seed oil is particularly suitable for cold dishes, but can also be used excellently as a marinade oil for meat.

As oils with similar qualities are produced from other oil seed crops at lower cost, the scope of poppy seed oil production is very limited. Instead, organic poppy seeds have become popular as an ingredient for the food and bakery industry.

Poppy cultivation is challenging, mainly due to the small size of the seeds and the slow growth in early crop stages. Cultivation is only recommended on plots with low weed pressure.

Key agronomic figures

- **Nutrient requirements:** N: 60 to 80 kg/ha;
- P: 40 kg/ha; K: 40 kg/ha
- **Sowing date:** winter type: mid to late September; summer type: end of March to mid-April
- **Opt. soil temperature for sowing:** 6 to 8 °C
- **Seed rate:** 0.8 to 1.5 kg per ha (TKW: 0.3 to 0.7 g)
- **Plant density:** winter type: 60 to 80 plants per m^2; summer type: 80 to 100 plants per m^2
- **Sowing depth:** 0.5 to 1.0 cm
- **Distance between rows:** 12 to 25 cm

Poppy is a demanding crop, but very interesting for innovative farmers. The end product is exclusive.

Botany and variety selection

- Poppy is the only species of its family that is agriculturally used.
- The plants form a strong taproot with few lateral roots.
- Juvenile development is relatively slow, before the plant grows to a height of about 1 metre.
- Being a distinctive long-day plant, poppy flowers in summer.
- Single flowers sit at the end of branched stems with one or two flowers per plant. After pollination by insects and wind, up to 2,000 seeds develop in a fruit capsule with an outer shape that is typical of the variety.
- The seeds are small (up to 1.5 mm in size), thick, kidney-shaped and white, red, blue or purple, depending on the variety.
- Winter and spring types exist.
- Agricultural production is limited to genotypes with a morphine content of less than 0.03 %.

The seeds develop inside protective capsules. The ripe seeds fall to the bottom of the capsule.

Climate and soil requirements

- Poppy favours deep soils that are rich in organic matter (loamy sands or sandy loams) and a warm climate with average precipitation.
- For efficient mechanical weed control, only soils with few stones should be used for poppy cultivation.
- Soils with a good phosphorus and potash supply are to be preferred.
- Only fields with low weed pressure should be used. Particular attention should be paid to low levels of white goosefoot (*Chenopodium album*).
- Soils that warm up quickly in spring are particularly suitable.

Crop rotation

- Due to its high nitrogen requirement, poppy best follows a nitrogen-fixing crop (in soils of moderate fertility) or a crop with low nutrient demand. Suitable preceding crops are sugar beet and fodder legumes. Poppy grows also well after cereals, if the field is weed-free, and the soil is not compacted.
- Potatoes are not a suitable pre-crop, as they inhibit or disturb the germination of poppy seeds and the development of the young plants.
- Cultivation breaks of 3 to 5 years are recommended between poppy crops, rapeseed and sunflower to lower the risk of fungal infestations, especially of Sclerotinia and Botrytis.
- The poppy crop can be followed by a cereal crop, as it leaves a crumbly soil.

Nutrient supply

- In well-structured, biologically active soils, the nitrogen requirements of poppy are fully covered through nitrogen mineralisation in the soil.
- On sandy soils, a light organic fertilisation may be applied before sowing.
- Fertilisation during crop growth is not recommended, as too much nitrogen fosters plant growth delaying ripening and encouraging lodging.
- The availability of sulphur and boron can be critical, for example after cereals. It is recommended to test the soil for sufficient sulphur content before poppy cultivation. Boron can be limiting in alkaline soils, as it is not easily available at high pH.

Seedbed preparation and sowing

- Seedbed preparation must be carried out carefully when the soil is dry.
- Poppy requires a sufficiently reconsolidated seedbed, as the small seeds are sown at a depth of 0.5 to 1.5 cm only. Ideally, the field is rolled before and after sowing.
- Winter poppy is sown between early and mid September, so as it reaches the 4-leaf stage before winter.
- The summer type is sown between mid-March and early April at temperatures above the minimum germination temperature of 3 °C.
- The crop tolerates light frosts without damage.
- A seed rate of 0.8 to 1.5 kg per hectare is needed (depending on the TKW of the variety) to obtain the targeted stand density of 60 to 100 plants per m^2. Due to the low seed rate, it is recommended to stretch the seed volume by adding either dead poppy seeds or sheat grits.
- Precision seed drills, as used in vegetable production, are particularly suitable for sowing poppy. In case conventional drilling technology is used, the seed rate should be increased by 1 kg per hectare, as the shallow sowing depth commonly cannot be maintained for a high germination rate.
- For hoeing, a row width between 30 and 45 cm is necessary.

Weed control

The slow juvenile development of poppy results in a low competitiveness of the young plants against weeds. Application of the false seedbed technique before seeding reduces weed seed stock in the soil and can reduce necessary interventions after emergence.

As soon as the rows are visible, the poppy crop can be hoed to control the developing weeds.

Disease and pest control

Poppy commonly does not suffer from heavy pest and disease problems. However, expansion of poppy cultivation can result in a local increase of occurrences of pests and fungal diseases.

Planned crop rotation with recommended cultivation breaks reduces the risk of damages by helminthosporiosis (*Alternaria papavericola* and *A. penicillata*), *Sclerotinia sclerotiorum* and *Botrytis cinerea*.

Other potential fungal diseases are root blight and leaf drought (*Dendryphion penicillatum*), and downy mildew (*Peronospora asborescens*).

Regarding pests, attention might be paid to poppy root weevil (*Stenocarus ruficornis* Stephens) during first stages, while the poppy boll weevil (*Ceutorhynchus macula alba*) and the poppy gall midge (*Dasineura papaveris*) are of little importance. In some situations, damages can be caused after seeding by soil caterpillars, slugs and hares, while birds can be a concern during ripening.

A poppy field approaching harvest. The seeds are ready for harvest when the plants and the capsules are dry, and the seeds are loose in the capsules.

Harvest and post-harvest management

The seed capsules of current varieties do not open during the ripening process. Therefore, full ripeness of all seeds can be waited for harvesting.

Poppy harvest usually follows wheat harvest, when machines and labour are available again. Poppy is harvested with a combine harvester. As the seeds are extremely small, special attention must be paid to possible losses on the harvester. A careful inspection of the grain path in the machine should be carried out beforehand. Smallest visible openings (e. g. conveyor doors, lower auger covers) should be plugged with a silicon tube.

Harvesting should be carried out at the lowest possible moisture content of the seeds (9 %) with a high cutter bar. The goal is to prevent losses in quality and quantity due to injured seeds.

After harvest, the seeds must be cleaned and further dried to a moisture a content of 7 to 8 % for storage and marketing.

Camelina

Camelina (*Camelina sativa*), a cruciferous species, is one of the oldest indigenous crops in Europe. It is assumed that it evolved as a secondary crop from linseed. In ancient times, it was widely cultivated in the northern coastal regions of Central Europe. Yet, its cultivation declined in the Middle Age and remained at a low level until modern times.

The crop's low nutrient, soil and climate requirements, and its suitability for mixed cropping have led to an increased interest for this crop, especially in organic farming. Since 2018, camelina is not listed anymore as undesirable feedstuff in the European Union. This makes the crop also attractive for its press cake that can be used for animal feed mixtures.

A flowering camelina crop with terminal, light to dark yellow flowers on individual shoots.

Botany and oil specifications

The plants reach a size of 50 to 100 cm and have a characteric thin, spindle-shaped root. The plants first build a single shoot before developing branches in the upper third.

Cross-fertilisation by insects is possible, but self-pollination predominates. The fruits are pear-shaped pods with 8 to 16 yellow-orange to reddish coloured seeds.

With an average oil content of 35 %, camelina seeds have a lower percentage of oil than rapeseed and sunflower.

Camelina oil has a pleasant, pea-like flavour, and is used in gourmet cuisine in countries like France. The oil is also used in the pharmaceutical, cosmetic and chemical industries as well as for bio-

fuel production. It has a very high proportion of polyunsaturated fatty acids of more than 50 %, and the ratio of alpha-linolenic acid to linoleic acid is very favourable for human nutrition. The content of erucic acid is higher compared to other brassica species (e. g. rapeseed, mustard), but still below the acceptable limit.

Key agronomic figures

- **Nutrient requirements:** N: 50 kg/ha; P: 40 kg/ha; K: 40 kg/ha
- **Sowing date:** winter type: early October, spring type: end of March
- **Minimal soil temperature:** 4 to 6 °C
- **Seed rate:** 4 to 6 kg per ha (TKW: 1.5 g)
- **Plant density:** 400 plants per m^2
- **Sowing depth:** 1 cm
- **Distance between rows:** 12 to 40 cm

Camelina belongs to the cruciferous family, like rapeseed. Therefore, the risk of sclerotinia infestation may be elevated if both crops are grown in the same rotation.

Climate and soil requirements

Camelina is an undemanding plant, is very fast-growing and has a good drought tolerance. As a result, the crop can also be cultivated on sandy soils. Due to its adaptability to extreme environmental conditions, it has a high yield stability and a higher yield potential than other summer oilseed crops (i. e. spring rapeseed, oil linseed) on poor soils.

The winter varieties are quite frost tolerant. Their temperature requirements correspond to the ones of winter pea.

Crop rotation

Camelina is not self-compatible and should not be planted after other cruciferous species, or in cruciferous-rich crop rotations. Besides this, there are no special crop rotation requirements.

With exception of cruciferous species, all crops are suitable as preceding crops, as long as the weed pressure is low or that emerging weeds can be managed well.

Camelina offers interesting options for intercropping with crops such as peas or lentils. Intercrops suppress weeds better while increasing the turnover per hectare.

Nutrient supply

The nutrient requirements of camelina are moderate, including for nitrogen. To avoid lodging and overgrowth, it is advisable to limit nitrogen fertilisation to not more than 40 to 50 kg per hectare. After a productive legume crop (e. g. winter pea), no fertiliser application is recommended.

Sowing

Spring varieties have a good late frost tolerance. This allows for early sowing at the end of March or even earlier when a mild oceanic climate prevails in the location. Winter varieties might be sown in early October to allow the plant to reach the rosette stage, which is most suitable for overwintering.

For shallow sowing at 1 cm, and good and even germination, camelina requires a fine, reconsolidated seedbed.

Seeds are available from Spain, France, Switzerland and Austria mainly. Some breeders also multiply organic seeds of both, summer and winter types.

Weed management

Weed management in camelina cultivation is challenging as the plants are very fragile in early growth. To reduce weed pressure, it is recommended to apply a weed cure prior to seeding.

Camelina is reported to have a certain suppressive effect (allelopathy) on weeds. In fact, camelina is increasingly intercropped with legumes to improve weed suppression and serving as supporting crop to the legume. Intercropping also increases total yield and yield stability. For good results of intercrops, the partner crops must not compete strongly, ripen uniformely, and have significantly different seed sizes for easy separation at harvest.

Box 14: Intercropping camelina with peas

When intercropping camelina with peas, the grain legume is sown at the normal seed rate of 160 to 200 kg/ha and camelina at 3 to 5 kg/ha. Due to the different sowing depths (peas: 4–5 cm, camelina: 1 cm), the two crops are sown separately. Ideally, the peas are sown with the seed drill first followed by camelina 3 to 4 days later with the broadcaster, and rolled after blind harrowing the peas before emergence.

Camelina is often sown together with weed-sensitive crops such as spring white peas or lentils.

Cultivation of camelina as a second crop is suitable where rain is abundant in summer and when the previous winter crop can be cleared until mid-July. As camelina seeds are very small and can germinate on the surface, broadcasting into a ripening cereal can also give good results.

In intercropped camelina, mechanical weeding can be omitted. When grown as a pure crop, camelina can be harrowed a first time 1 month after sowing, when the pivot is well developed.

Disease and pest management

Camelina rarely suffers disease and pest problems. This is partly due to the minor cultivation surface, but also due to the phytoalexins produced by the plants inducing resistance to stem and root rot (*Rhizoctonia solani*) and Alternaria leaf spot disease (*Alternaria brassicae*), but also against Phoma (*Leptosphaeria masculans*).

Nevertheless, some diseases can affect camelina, such as downy mildew, grey mould rot and white stem rot.

The most common pests are the same as the ones of oilseed rape. Camelina can be affected by oilseed rape fleas (*Psylliodes chrysocephala*) or rape leaf beetles (*Meligethes aeneus*). But camelina seems less attractive than oilseed rape or mustard. Intercropping of camelina significantly reduces the risk of pest damage.

Harvest and post-harvest management

Camelina is harvested when the pods are ripe and the stems are beginning to dry. The risk of shattering is limited.

Due to the very small seeds, the combine harvester must be inspected for holes that could result in seed losses. The use of a rape header and a side cutter are recommended.

After harvest, the seeds should be stored with a moisture content of 8 %.

Oilseed pumpkin

Styrian oilseed pumpkin (*Cucurbita pepo pepo Styriaca*) has hull-less seeds with a very high oil content of 40 to 50 %. In contrast to other pumpkin varieties, oilseed pumpkin varieties are bred for fruits with many seeds and a high total oil yield. The seeds can be marketed as whole seeds or can be processed into oil.

Pumpkin seed oil is renowned to be very healthy due to its high antioxidant qualities (i. e. higher than extra virgin olive oil, oil from walnuts, hemp or sunflowers).

Organic oilseed pumpkin offers interesting opportunities for innovative farmers to diversify their production and market their produce in niche markets.

Key agronomic figures

- **Nutrient requirements:** N: 50 to 80 kg/ha; P: 80 to 100 kg/ha; K: 90 to 160 kg/ha
- **Sowing date:** Mai/June
- **Minimal germination temp.:** 12 to 15 °C
- **Seed rate:** 15,000 to 20,000 seeds per ha (4 to 5 kg/ha)
- **Plant density:** 1.2 to 1.8 (max. 2) plants/m^2
- **Sowing depth:** 2 to 3 cm (deeper in case of spring drought)
- **Distance between rows:** 140 to 180 cm
- **Distance in the rows:** 25 to 45 cm

Botany and variety selection

The large plants build 2.5 to 3 m long vines, and the fruits reach a weight of in average 6 kg with about 500 g of seeds each. The coarse and stringy flesh is a suitable animal feed. In recent years, bush type varieties with earlier maturity, smaller fruits, and more uniform ripening have been bred.

- The crop grows well in a broad climatic range.
- It prefers light to medium soils with a pH between 6 and 7.
- In central Europe, oilseed pumpkin is often cultivated on good soils that are too dry or not fertile enough for intensive production of field vegetables, for instance. As a general rule, pumpkins thrive, where wine grows.
- Soils prone to compaction are not suitable, as well as soils with a high risk of pesticide residues, as pumpkins easily absorb such molecules.

Crop rotation

As a vegetable that is harvested for its seeds, pumpkin fits well into cereal-based crop rotations. The crop requires a low workload during the harvest period of relevant arable crops such as cereals.

Most important crop rotation considerations are:

- Pumpkin should not be cultivated after crops that leave a compacted soil (e. g. beets or corn).
- A cultivation break of at least 3 years is recommended between pumpkin crops.
- Cultivation after weed-suppressive crops such as lucerne, grass-clover, mixes of cereals and pulses (barley/peas, triticale/vetch), winter field beans, forage peas, spelt, rye, triticale and long-straw wheat, or oats reduces weed pressure in the pumpkin crop. Weed-free fields are much easier and faster to harvest.

Nutrient supply

Seed yield is enhanced by high levels of phosphorus and boron, but reduced by high levels of nitrogen. Nitrogen requirements can be fully covered by a legume-based green manure or a ley.

An oversupply of nitrogen delays ripening of the pumpkins. Therefore, solid farmyard manure (e. g. 10 to 15 tons per ha) or liquid manure should only be applied before sowing, when nitrogen supply from the previous crop is not sufficient. Also, small quantities of diluted chicken manure can be used.

Soil preparation and sowing

- In rather heavy soils, ploughing in autumn is recommended. In medium and light soils, ploughing in spring reduces nitrogen losses. However, in latter case, enough time is needed for the soil to settle or to carry out a weed cure. In spring, reduced tillage is also possible.
- A weed cure with a light cultivator or a rotary tine harrow to a depth of about 5 to 7 cm is recommended.
- The water content of the soil should not be disturbed by too deep cultivation, especially in dry periods.
- In any case, soil compaction must be avoided by working the soil only under dry conditions.

- The crop requires a fine-crumbed seedbed with good soil contact.
- Oilseed pumpkin is sown late, in May/June, to avoid cold conditions after sowing.
- The seeds should not be sown too deep. In warm soils, a sowing depth of 3 to 4 cm is possible. The row distance is chosen according to the available equipment.
- After sowing, the seedbed should be rolled.

Weed control

The wide row spacing of oilseed pumpkin allows intensive weeding on a large part of the soil surface during early growth stages.

- During early growth, weeding operations should be limited to the interrow space, not to injure the young plants. Injuries could favour virus infections.
- 2 to 3 weeding passages should do. The last weeding should be carried out at beginning of shoot growth.
- In case of strong weed infestation, manual weeding in the row is recommended.
- Depending on the following crop, white clover can be undersown at 8 to 10 kg per ha at the last weeding pass.

Instead of a harrow, an adapted tine harrow with gaps in the range of the plant rows can be used.

Promoting pollination

High oil pumpkin yields depend on effective pollination by insects. As fruit set, size and weight depend on the number of visits by pollinators, presence of pollinating insects in and around the field during flowering is essential. Alternatively to promoting pollinators with natural habitats, 5 or more honeybee hives per hectare may be hired. In cool and damp weather, bumblebees are more effective.

Disease and pest control

A sound crop rotation and promotion of beneficial organisms will help prevent most pests and diseases. However, to avoid the zucchini yellow mosaic virus, the main disease in pumpkin production, virus-free seeds and the control of potential vectors of the virus (e. g. aphids and striped cucumber beetles) are critical. On small surfaces, the vectors can be deterred by floating row covers. In larger fields, the use of neem oil is effective on both species (check permission with the certification body). Powdery mildew can occur in humid weather conditions and high crop densities. Late sowing together with a moderate plant density help prevent relevant infestations.

In dry weather conditions and low pest pressure from the field edges, pest problems are very limited. Slugs can cause certain damages in early stages, when soil moisture is high. A fine, well-settled, rolled seedbed can disturb the slug population. In case of high slug infestation risk, iron phosphate pellets may be used (until 2 weeks after emergence) – possibly only on the field margins.

Harvest and post-harvest management

Flawless and well-ripened seeds provide best oil quality. Timely harvest has a high relevance for the oil content. Maturity is reached, when the dry stem detaches from the fruit. Oil pumpkin is often harvested by swathing the fruits in rows with a front blade or a special rake in a first step. Stones or weeds should not be swathed and pumpkins not piled-up. In a second step, the fruits are picked up with a pumpkin thresher, which separates the seeds from the fruit flesh. Latter is left on the ground.
After harvest, the seeds are washed in a washing facility and dried to a moisture content of 8 %.

Minor oilseed crops

Organic safflower and sesame are crops of minor relevance in Europe. Currently, only a few hundred hectares are cultivated in southern Europe. Safflower is primarily produced by farmers with own oil processing facilities on the farm, and is sold directly to consumers as exclusive products.

Productive safflower varieties are becoming more commonly available, and sesame varieties with higher tolerance to moderate temperatures and humid conditions than original African cultivars are bred. New varieties are also more resistant to shattering, allowing mechanical harvest.

As market opportunities for organic specialty crops are increasing, both crops merit attention to further develop organic production techniques and explore their economic potential in areas with hot and dry summers due to climate change.

Safflower

Key agronomic figures

- **Soils:** loamy to light clay; adapted to humus-rich soils
- **Nutrient requirements:** N: 80 kg/ha; P: 30 kg/ha; K: 40 kg/ha
- **Sowing date:** from end of May
- **Min. soil temperature:** 22 °C at 6 cm depth
- **Seed rate:** 30 seeds/m² (3 to 5 kg/ha)
- **Plant density:** 20 to 25 plants/m²
- **Sowing depth:** 2 to 3 cm
- **Distance between rows:** 45 to 75 cm
- **Cultivation period:** 90 to 110 days
- **Average yield:** 10 to 15 dt/ha
- **Oil content:** 47 to 55 %

- **Benefits:** good, edible, cold-pressed oil for direct sale, low nutrient requirements, good competitiveness against weeds, high drought tolerance.
- **Disadvantages:** low oil yield, requires warm conditions in summer.
- **Production areas:** similar to sunflower.
- **Varieties:** available from Italy, Spain, Czech Republic, Hungary; also high oleic varieties.
- **Diseases:** main diseases include Botrytis and rust. Promotion of natural ventilation of the crop (sowing in wind direction and avoiding too dense stands), and the use of certified seeds reduce disease pressure.
- **Pests:** not relevant.
- **Nutrient requirements:** low; avoid excess nitrogen supply not to delay ripening.
- **Harvest:** harvested with the grain harvester, when the entire plant is dry.
- **Storage:** at max. 9 % moisture content.

Sesame

Key agronomic figures

- **Soils:** loam to heavy, black soils
- **Nutrient requirements:** N: 80 kg/ha; P: 40 kg/ha; K: 40 kg/ha
- **Sowing date:** from end of March
- **Minimal soil temp. for sowing:** 6 to 8 °C
- **Seed rate:** 40 seeds/m² (40 to 60 kg/ha)
- **Plant density:** 25 to 35 plants/m²
- **Sowing depth:** 2 to 3 cm
- **Distance between rows:** 15 to 45 cm
- **Cultivation period:** 120 to 150 days
- **Average yield:** 15 dt/ha
- **Oil content:** 35 to 45 %

- **Benefits:** high oil content, demanding market both on oil and whole seed condiment for EU origin; high drought resistance; can be cultivated as a second crop.
- **Disadvantages:** requires very warm climate, seed losses at harvest (in case of non-improved varieties); availability of seeds.
- **Production areas:** southernmost Europe, regions with warm summers.
- **Varieties:** from Bulgaria (Sadovo), but also from Israel, Australia and America with resistance to shattering (for mechanical harvest).
- **Diseases:** in general no major problems. Fusarium wilt and root rot can occur. Promotion of natural ventilation of the crop (sowing in wind direction and avoiding too dense stands), and the use certified seeds reduce disease pressure.
- **Pests:** aphids, cutworms and flies.
- **Nutrient requirements:** nitrogen demand comparable to cereals.
- **Harvest:** with a grain harvester, as soon as the crop has reached maturity. Particular attention must be paid not to damage the kernels.
- **Storage:** at max. 8 % moisture content.

Profitability and marketing of oilseed crops

Besides good producer market prices, profitability of oilseed crops strongly depends on good yields and low production costs. For latter, favourable cultivation conditions are essential. In general, oilseed crops are amongst the most secure organic crops from a profitability perspective. Except for rapeseed, their yield levels are quite stable, and producer prices are consistent. As a result, oilseeds often are a safer economic option for producers than cereals which are frequently in overproduction in Europe, resulting in annual price fluctuations.

Sunflower, linseed and hemp produce consistent yields due to their natural hardiness to diseases and drought, and their low nutrient requirements. When it comes to farm gate sales, oilseeds are among the most suitable arable crops to produce processed products (i. e. cold pressed oil) to increase farm value added. A small press, a filtering station and a bottling system are likely more affordable than farm-scale milling units intended to add value to cereals. Also, pressing requires less technical skills, and the level of quality required for the seeds is less critical.

In the case of delivery of harvested products to intermediaries or processors, their requirements on the product properties must be clarified. This is primarily relevant for variety selection.

Safe sales contracts refer to the harvest of a production area (e. g. the production of a farm) rather than to a specific product volume to be delivered. A contract should settle the acquisition of the harvest (possibly with a maximum), but without an obligation to deliver a minimum quantity, so as not to create a difficult situation in case of a poor harvest. Depending on the mutual trust and the track record of the partners, signature of the contract may be delayed until after the winter for autumn sowing or after the emergence of the young plants for spring sowing, in order to avoid commercial problems in the event of crop loss in early stages being the most frequent incidence.

Organic oil processing

In order to meet the consumers' interest in healthy, high-quality oils that originate from organic production, cold pressing is more appropriate in most cases. For that, the oil is extracted from the raw material by pressing without heat or by another gentle mechanical method. Thereby, the oil can be washed, centrifuged and filtered with cloth and paper filters or chemically inert filters.

Small-scale pressing of linseed oil.

In contrast to conventional production, organic oils are produced without the use of chemical solvents in the extraction process. Also, pre-heating of the kernels is not allowed. Equally, refining methods that involve steps such as degumming (removal of mucilage), deacidification (removal of free fatty acids), bleaching (removal of colourants), and deodorising (distillation with steam) are forbidden. Furthermore, organically produced oils must be free from water, salt, flavourings and other food additives, including vitamins.

As only 'gentle' processing methods are involved in organic oil processing, organic oils have a somewhat slightly shorter shelf-life compared to conventional oils of the same type, which are commonly extracted and refined. A positive influence on the quality of the edible oils is brought by the dehulling of the rape seed before pressing, which is practised by some oil mills. The peeling prevents the undesirable substances (free fatty acids, mucilage) from entering the oil. Dehulling is also applied to some specific sunflower oil processing.

Box 15: Factors influencing the quality of cold-pressed oils

- Raw material quality (influenced e. g. by variety, harvest time, storage, purity and moisture content)
- Processing method (influenced e. g. by the diameter of the pressing screw)
- Storage after pressing (influenced e. g by exposure to oxygen, temperature levels, and light).

Organic certification

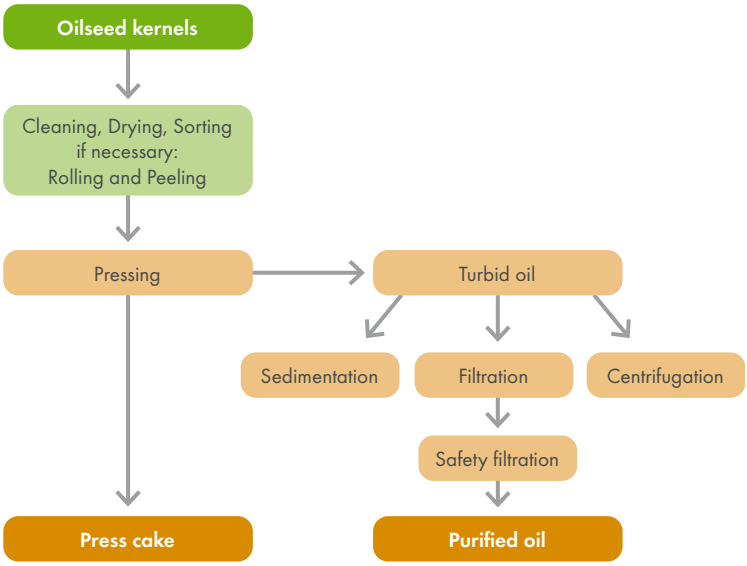
Principles of organic certification

Marketing and labelling oilseeds and other agricultural products as organic requires certification. This is the process by which an organic inspection and certification body gives a written and reliably confirmed assurance that the products have been produced in accordance with specific organic standards. Certification is crucial to building confidence among producers, processors, distributors and consumers.

In Europe, the new Regulation (EU) 2018/848 is the legal basis of organic agriculture. However, organic imports into the EU are still certified under the previous Council Regulation (EC) 834/2007 until the end of 2024. These regulations define the rules for organic production, processing and labelling of agricultural products as 'organic' in the EU. For the export of organic products, farmers would have to comply with the legal standards of the country of import.

In some cases, additional certification against private organic standards is necessary. The standards from private label organisations are stricter than national regulations. Whereas the EU regulation permits farms to operate both an organic and a non-organic production unit under special restrictions, most private organic label organisations require that the entire farm must be managed organically. Generally, for smaller farms, only the conversion of the entire farm is recommended, as the farm unit would become too small to enable establishment of a diverse production system, allow proper crop rotation and introduction of livestock. Parallel production, i. e. the production of the same livestock or plant species under organic and non-organic management, is not allowed even under the EU Regulation.

Figure 5: Steps of organic oil processing



For the production of high-quality natural oils, organic oilseeds are processed purely mechanically without the use of additives and without the addition of heat. The results are organic oils that convince with typical colours, characteristic aromas and valuable ingredients.

The marketing of organically produced oil under an organic label requires a prior certification of the farm or the farm section corresponding to the requirements of the label.

After the completed formal conversion period and the first organic certification the development of the farm continues. It usually takes several years to establish a balanced farm ecosystem and restore natural soil fertility.

Certification process

The certification process starts with the signature of a contract with an organic certification body operating in the country. The conversion begins when the farmer renounces the use of synthetic pesticides, fertilisers, GMO and chemically treated seeds, and starts to apply all organic crop and livestock production rules including the use of organic animal feed, good husbandry practices, etc.

For plant production and pastures, the conversion period to organic is 2 years before sowing for annual crops and 3 years before harvest for perennial crops. Land that has not been treated with forbidden substances for at least 3 years can be certified with a retroactive recognition of the conversion period.

After the first 12 months of conversion, products can be marketed as 'organic in conversion'. Once the conversion period is finished, the products can be certified and sold as organic. A stepwise reduction of agrochemical use is not considered part of the conversion period.

The national organic movement or organic certification bodies operating in the country can provide further guidance and support for organic certification. Farmers should first consult the national organic movement and then sign a certification contract with an accredited organic certification body operating in the country. Producers should work with a certification organisation that has the necessary accreditations for the required standard and target markets.

Imprint

Published by:
Research Institute of Organic Agriculture FiBL
Ackerstrasse 113, P.O.Box 219, 5070 Frick, Switzerland
Phone +41 (0)62 865 72 72, info.suisse@fibl.org, www.fibl.org

Authors: Nicolas Lefebvre and Thomas Bernet (both FiBL Switzerland)

Review: Ludek Mica, Mathias Christen (all FiBL)

Editing: Gilles Weidmann (FiBL Switzerland)

Design: Sandra Walti (FiBL Switzerland)

Photo credits: Thomas Alföldi (FiBL): pages 44; BanksPhotos/istockphoto.com: p. 37; Katrin Carrel (Kompetenzzentrum Strickhof): p. 30; Mathias Christen (FiBL): p. 5, 8 (1), 11, 13, 14, 15, 17 (1), 19 (1), 20 (1), 31, 32, 33; Whitney Cranshaw (Colorado State University): p. 17 (2); Claudia Daniel (FiBL): p. 18 (1, 3); Hansueli Dierauer (FiBL): p. 8 (2), 9 (1, 2, 4), 16, 18 (2, 4), 20 (2), 23 (1), 24, 25 (1, 3, 4, 5), 27, 28, 29 (2), 36 (2); Giselher Grabenweger (Agroscope): p. 25 (2); Jürg Hiltbrunner (Agroscope): p. 2, 29 (1); Goran Horva/Pixabay: page 1; Bertold Kocsis: p. 34 (1); Stefan Kristoferitsch (Gemeinschaft Steirisches Kuerbiskernöl): p. 40; Nicolas Lefebvre (FiBL): p. 7, 12, 21, 23 (2), 26; Verena Leo (Bio Suisse): p. 8 (3); Jeremias Lütold (FiBL): p. 38; Ludek Mica (FiBL): p. 36 (1); Bernhard Mülhens/Pixabay: p. 9 (3); Pixabay: p. 22, 34 (2), 43; Astrid Oldenburg (Landfotos.de): p. 19 (2, 3); sandsun/istockphoto.com: p. 42; René Schulte (Bio Suisse): p. 8 (4); Andy Slater/Wikimedia Commons: p. 17 (3); Mario Spichiger (Inforama Hondrich): p. 10.

FiBL No. 1244

This guide is available for free download at shop.fibl.org

1st edition 2023