

The importance of oilseed crops

*Afroditi Kakagia, Konstantinos Iordanoglou,
Georgios Tsiadis, Marios Danaskos & Efthymia
Alexopoulou*



**KAPES
CRES**

CENTRE FOR RENEWABLE
ENERGY SOURCES AND SAVING

Midas

MARGINAL LANDS, INDUSTRIAL CROPS
AND INNOVATIVE BIO-BASED VALUE CHAINS



Funded by
the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement No. 101082070.



Introduction

- **Oilseeds** are a key group of arable crops providing high amounts of both **oil** and **protein**.
- **Oilseeds** play a crucial role in European Union's economy by being cultivated in a **total area of 12 M ha** along with **1.48 M ha of protein crops** with significant contribution to the **6.79 million holdings of arable crops** (cereals, oilseeds, proteins).



Camelina



Crambe



Castor bean



Sunflower



Safflower



Cardoon

- In **Europe**, the most important oilseeds are: **rapeseed** (19.6 Mtons), **sunflower** (9.3 Mtons) and **soybean** (2.5 Mtons), while **linseed** is a minor oilseed (0.8 Mtons).
- Apart from the commercially available oilseeds, valuable knowledge has been developed on additional oilseeds that are considered as **minor crops** like **camelina**, **safflower**, **carinata**, **crambe** and **castor bean**.
- In **MAGIC project** the most important oilseeds for marginal lands facing natural constraints were selected and where: **camelina**, **crambe**, **Ethiopian mustard**, **sunflower**, **safflower** and **cardoon**.



Camelina

(*Camelina sativa* (L.) Crantz)



Overview of the following sections



1

Origin of
the crop



2

Description
of the crop



3

Soil and climate
preferences



4

Cultivation
protocol



5

Diseases
and insects



6

Harvesting
of the crop

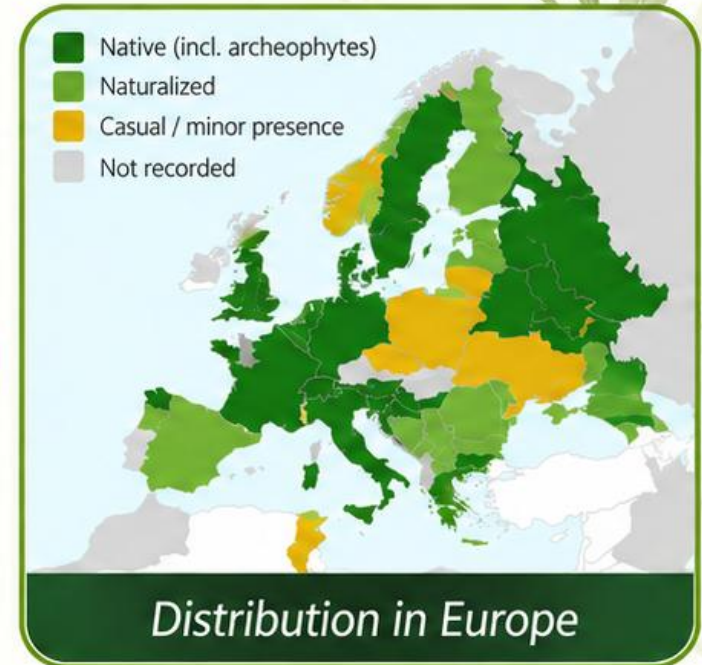
Camelina (*Camelina sativa* L. Crantz)

Family: *Brassicaceae*



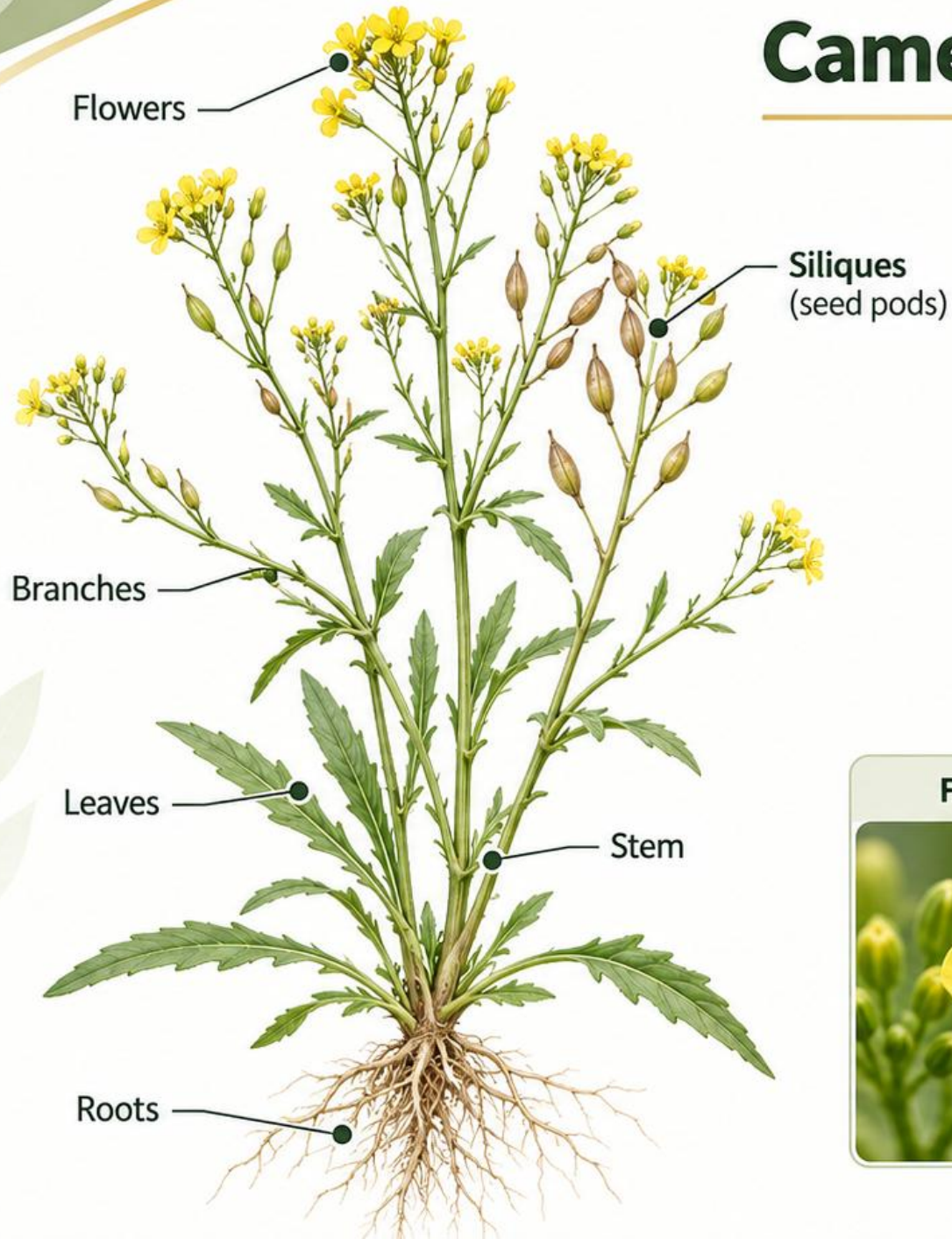
Camelina sativa L. Crantz

- 🌿 Ancient oilseed crop native to **Europe** and **Central Asia**
- 🌿 Annual herb adapted to **cool temperate conditions**
- 🌿 **Low-input** crop with **short growing cycle**
- 🌿 Used for **food, feed, biofuel** and **bio-based products**



Camelina (*Camelina sativa* L. Crantz)

Family: Brassicaceae



Erect annual herb, typically 30–120 cm tall



Narrow lanceolate leaves and branched stem



Small yellow four-petaled flowers



Pear-shaped siliques containing small oil-rich seeds

Flower (enlarged)



Silique (seed pod)



Seeds (enlarged)



1 mm

Camelina: Soil, Climate and Cultivation Requirements



Soil and climate requirements

- Adapted to **cool temperate climates**.
- Germinates at **low temperatures** and tolerates light spring frost.
- Performs best in **well-drained loam or sandy loam soils**.
- Suitable **soil pH**: about **5.5–7.5**.
- **Avoid waterlogging**; moderate drought tolerance once established.
- Best yields with **adequate moisture** during establishment and flowering.



Cultivation instructions

- Prepare a **fine, firm seedbed**.
- **Sow shallowly** (about 1–1.5 cm deep).
- Typical seeding rate: **5–8 kg/ha**.
- Row spacing: about **12–25 cm**.
- Use **modest nitrogen inputs**; avoid excessive fertilization.
- **Control weeds early**, especially during establishment.
- **Harvest** when siliques turn yellow-brown and seeds are mature.

Indicative crop development stages



Seedling



Rosette / early vegetative



Stem elongation / budding



Flowering

Camelina: Harvesting and Seed Yield



Harvesting guidelines



Harvest when most siliques turn yellow-brown and seeds are fully mature.



Direct combining is common; swathing can be used if ripening is uneven.



Use gentle threshing / low cylinder speed to reduce seed losses and seed damage.



Harvest at about 8–12% seed moisture.



Dry and clean the seed promptly after harvest for safe storage.



Seed yield



Approximate seed yield range:

0.5–3.0 t/ha



Typical reported European potential under favorable conditions: about **1.3–3.3 t/ha**.



Yield depends on genotype, environment, sowing date and management.

→ Indicative harvest sequence



1. Mature camelina stand ready for harvest



2. Field machinery entering the field



3. Combining camelina



4. Harvested crop and seeds



5. Field after harvest



Crambe

(*Crambe abyssinica* L.)

Overview of the following sections



1

Origin of
the crop



2

Description
of the crop



3

Soil and climate
preferences



4

Cultivation
protocol



5

Diseases
and insects



6

Harvesting
of the crop

Crambe (*Crambe abyssinica* L.)

Family: *Brassicaceae*



Origin:

Eastern Africa;
domesticated in the
Mediterranean region.



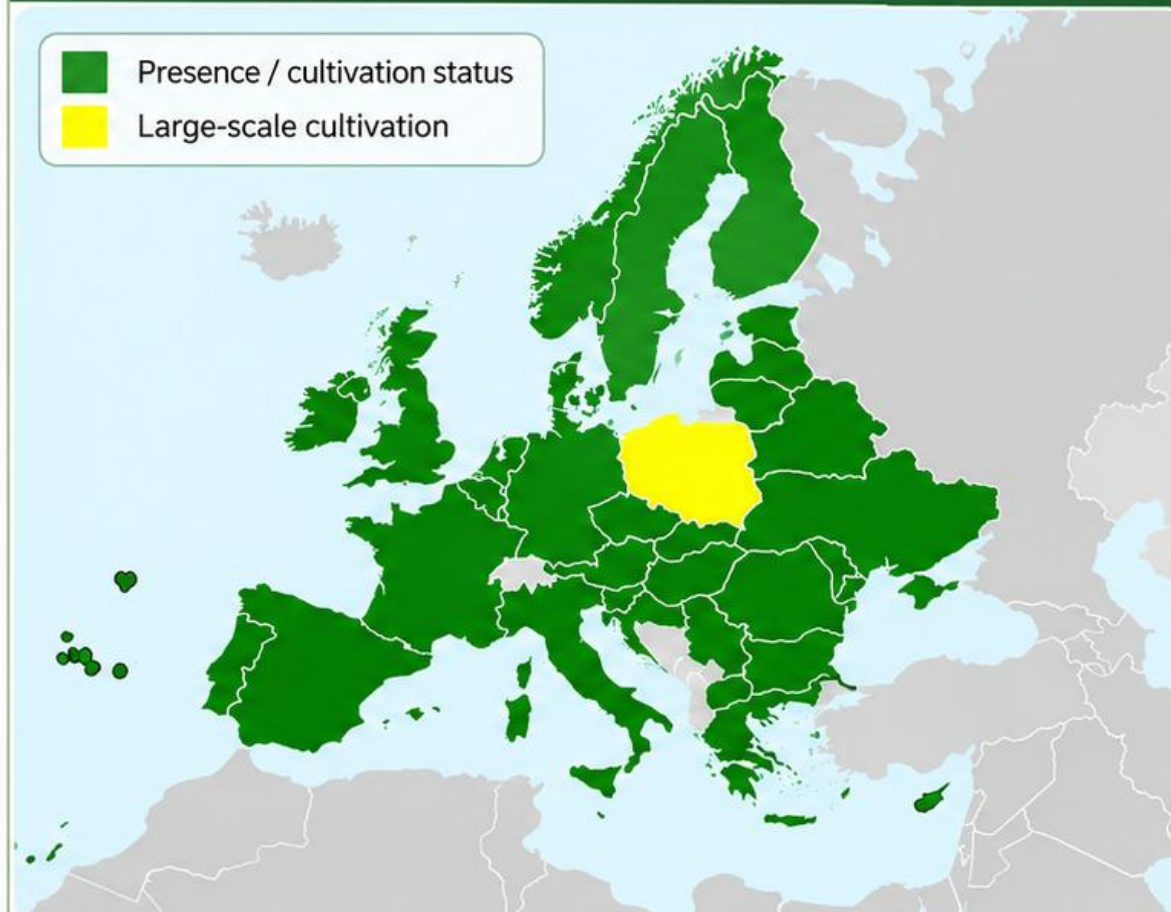
During the last century,
crambe was tested and
cultivated in Northern
Europe, the former USSR,
Canada and the USA.



In Europe, cultivation is
mainly of industrial interest,
with country-to-country
differences in status and
scale.

Cultivation status in Europe

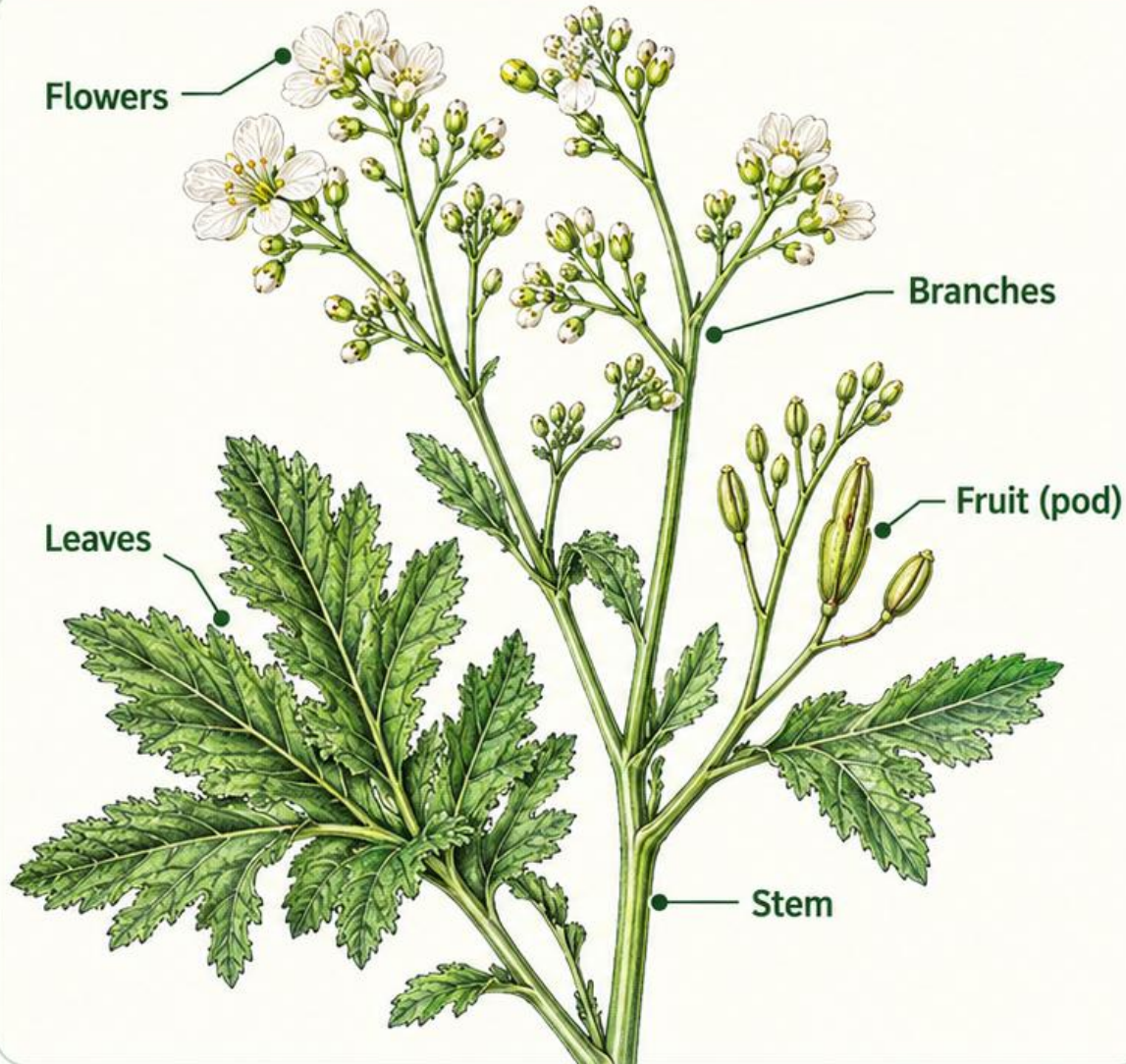
- Presence / cultivation status
- Large-scale cultivation



Indicative status based on the provided source material

Crambe (*Crambe abyssinica* L.)

Crop description



Crop description



Annual oilseed crop belonging to the Brassicaceae family.



Erect and branched herbaceous plant, usually about 60–120 cm tall.



Large lobed lower leaves and smaller upper leaves.



Small white flowers borne in terminal racemes.



Produces nearly spherical one-seeded fruits; seeds are rich in industrial oil.

Flower



Fruit (pod)



Seed





Crambe: Soil, Climate Preferences and Cultivation Protocol

Including key insects and diseases



Soil and climate preferences

- Adapted to cool temperate climates.
- Tolerates spring cool conditions; sensitive to prolonged waterlogging.
- Performs best in well-drained loam or sandy loam soils.
- Suitable soil pH: about 5.5-7.5.
- Moderate drought tolerance once established.
- Best performance with good moisture during establishment and flowering.



Cultivation protocol

- Prepare a fine, firm seedbed.
- Sow shallowly, about 1-2 cm deep.
- Typical sowing rate: about 10-15 kg/ha.
- Row spacing: about 15-30 cm.
- Control weeds early during establishment.
- Use moderate fertilisation; avoid excessive nitrogen.
- Harvest when most pods are mature and dry.



Main insects and diseases



Insects

- Flea beetles
- Aphids
- Diamondback moth / other brassica caterpillars
- Pollen beetles



Diseases

- Damping-off
- Alternaria leaf spot/blight
- Sclerotinia stem rot
- Downy mildew
- Blackleg

Severity depends on environment and local crop management.

Indicative crop development stages



a) Emergence



b) Early growth



c) Flowering initiation



d) Full flowering

View of crambe at: emergence, early stages of growth, flowering initiation and full flowering.



Crambe: Harvesting

Indicative harvest operations and outputs



Harvesting guidelines

- 1 Harvest when most pods are mature, dry and straw-coloured.
- 2 Direct combining is possible under uniform ripening conditions.
- 3 Swathing / windrowing can be used when ripening is uneven.
- 4 Use careful threshing to minimise seed losses and seed damage.
- 5 Dry and clean seed after harvest for safe storage.



1 Windrowing /
swathing



2 Combine
harvesting



3 Seed
collection



4 Field after
harvest



5 Residue
management / baling



Illustrative examples of crambe harvest operations.

Castor bean

(*Ricinus communis* L.)

A versatile non-food oil crop
for industrial and bio-based uses



High-value
oil



Grows in
marginal areas



Multiple
industrial uses

1

Origin of the crop



- Native to eastern Africa
- Domesticated and spread to tropical and subtropical regions
- Current cultivation status in Europe

2

Description of the crop



- Botanical characteristics
- Growth habit and life cycle
- Main varieties and traits
- Seeds and oil characteristics
- Main uses and value chains

3

Soil and climate preferences



- Suitable climates and temperature range
- Soil requirements (texture, pH, drainage, fertility)
- Tolerance to drought and marginal soils
- Key limitations

4

Cultivation protocol



- Land preparation
- Sowing time and method
- Seeding rate and row spacing
- Fertilisation
- Irrigation (if required)
- Weed management
- Crop management practices

5

Diseases and insects



- Main insect pests
- Main diseases
- Symptoms and damage
- Integrated management strategies

6

Harvesting of the crop



- Optimal harvest timing
- Harvesting methods
- Seed yield (typical range)
- Post-harvest handling and drying
- Seed quality and storage

Castor bean (*Ricinus communis* L.)

Origin, cultivation area and world production

Family: *Euphorbiaceae*



Ricinus communis L.



Origin

- Native to tropical East Africa, especially Ethiopia and Kenya.
- Domesticated about 3000–3200 years ago and spread through the Mediterranean and West Asia.



Cultivation area



Cultivated in more than 30 countries worldwide.



World production



Global castor seed production:

~1.86
million t/year



Cultivated area:

~1.30
million ha



Average yield:

~1.44
t/ha

Leading producers (castor seed, Mt/year)

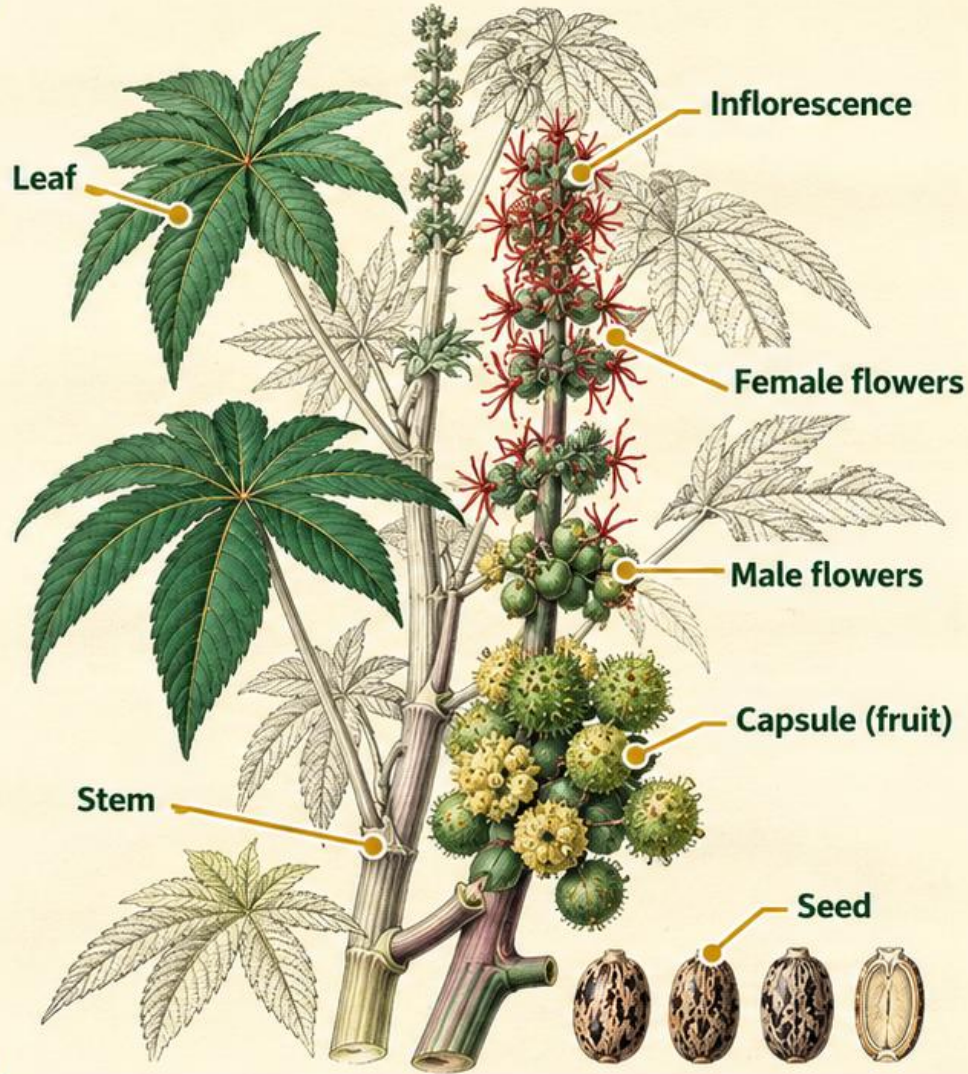


Indicative recent FAO/open-access values.

Castor bean (*Ricinus communis* L.)

Crop description

Family: *Euphorbiaceae*



Key characteristics



Annual to short-lived perennial industrial oil crop.



Usually 1–3 m tall in cultivation; can reach 5–12 m in warm tropical conditions.



Erect, robust, often glaucous plant with hollow stems and strong branching.



Leaves are large, alternate, palmate, usually with 5–11 lobes.



Monoecious inflorescence: male flowers are mainly in the lower part, female flowers in the upper part.



Fruit is a spiny or smooth 3-lobed capsule, usually containing 3 seeds.



Seeds are oval and mottled, rich in oil; typical seed oil content about 40–55%, rich in ricinoleic acid.



Important safety note: seeds and seed cake contain toxic ricin; handle with care.



Flower (detail)



Male flower



Female flower



Capsule (fruit)



Seed (detail)



Castor bean: Soil, climate preferences and cultivation protocol

Including key insects and diseases

Ricinus communis L.



Soil and climate preferences

- **Warm-season crop** adapted to tropical, subtropical and warm-temperate climates.
- Sensitive to frost; best growth under full sun and temperatures around **20–30°C**.
- Performs best in **deep, fertile, well-drained loam or sandy loam soils**.
- Suitable soil pH: about **5.0–8.0**.
- Tolerates moderate drought once established, but is sensitive to waterlogging.
- Good moisture is important during establishment, flowering and seed filling.



Cultivation protocol

- Prepare a **fine, firm seedbed**.
- Sow **in spring** after frost danger, when soil is warm.
- Typical sowing depth: about **3–5 cm**.
- Use **moderate plant spacing** according to variety and mechanisation needs.
- **Control weeds** early during establishment.
- Apply **balanced fertilisation**; avoid excessive nitrogen.
- **Irrigate when needed**, especially in dry environments.
- **Harvest** when most capsules are mature and dry.



Main insects and diseases



Insects

- Aphids
- Whiteflies
- Spider mites
- Caterpillars / semiloopers
- Capsule or seed-feeding insects



Diseases

- Damping-off
- Fusarium wilt
- Alternaria leaf spot
- Cercospora leaf spot
- Powdery mildew

Incidence depends on environment and local crop management.



Indicative crop development stages



1. Emergence / seedling



2. Early vegetative growth



3. Crop development



4. Maturing crop

Illustrative views of castor bean at several stages of growth.

Castor bean: Harvesting

Indicative harvest operations and key considerations

Ricinus communis L.



Castor harvesting



Harvesting guidance

-  Harvest when most capsules are **mature, dry and brown**.
-  **Mechanical harvesting** is possible with adapted combine harvesters.
-  **Uniform ripening** improves harvest efficiency and reduces losses.
-  **Avoid harvesting** when capsules are too green or seed moisture is high.
-  **Dry and clean seed** after harvest for safe storage.
-  **Handle seed carefully** because castor seed and plant residues are toxic.



Indicative outputs

-  **Seed collection** for oil extraction.
-  **Crop residues** for further management.
-  **Good post-harvest drying and storage** are essential.



Sunflower

(*Helianthus annuus* L.)

Family: Asteraceae

Contents



1

Origin of
the crop



2

Area of
cultivation &
world production



3

Crop
description



4

Soil and climate
preferences



5

Cultivation
protocol



6

Harvesting
and uses



Sunflower (*Helianthus annuus* L.)

Origin, cultivation area and world production

Family: Asteraceae



1 Origin



Native to **North America**; domesticated in east-central North America around **3,000–5,000 years ago**.

Introduced to **Europe** in the **early 16th century**; modern oilseed types developed at industrial scale in **Russia**.

2 Cultivation area



Cultivated mainly in **temperate and warm-temperate regions** for oilseed and confectionery markets.

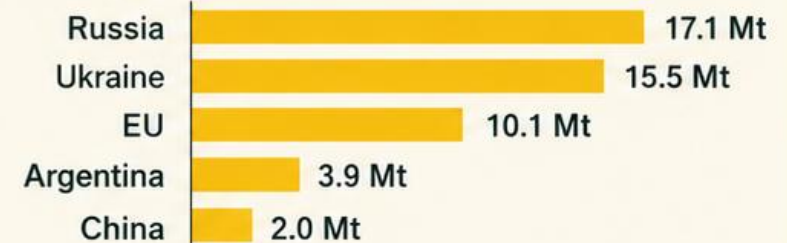


3 World production



~56.0 Mt
sunflowerseed (2023/24)

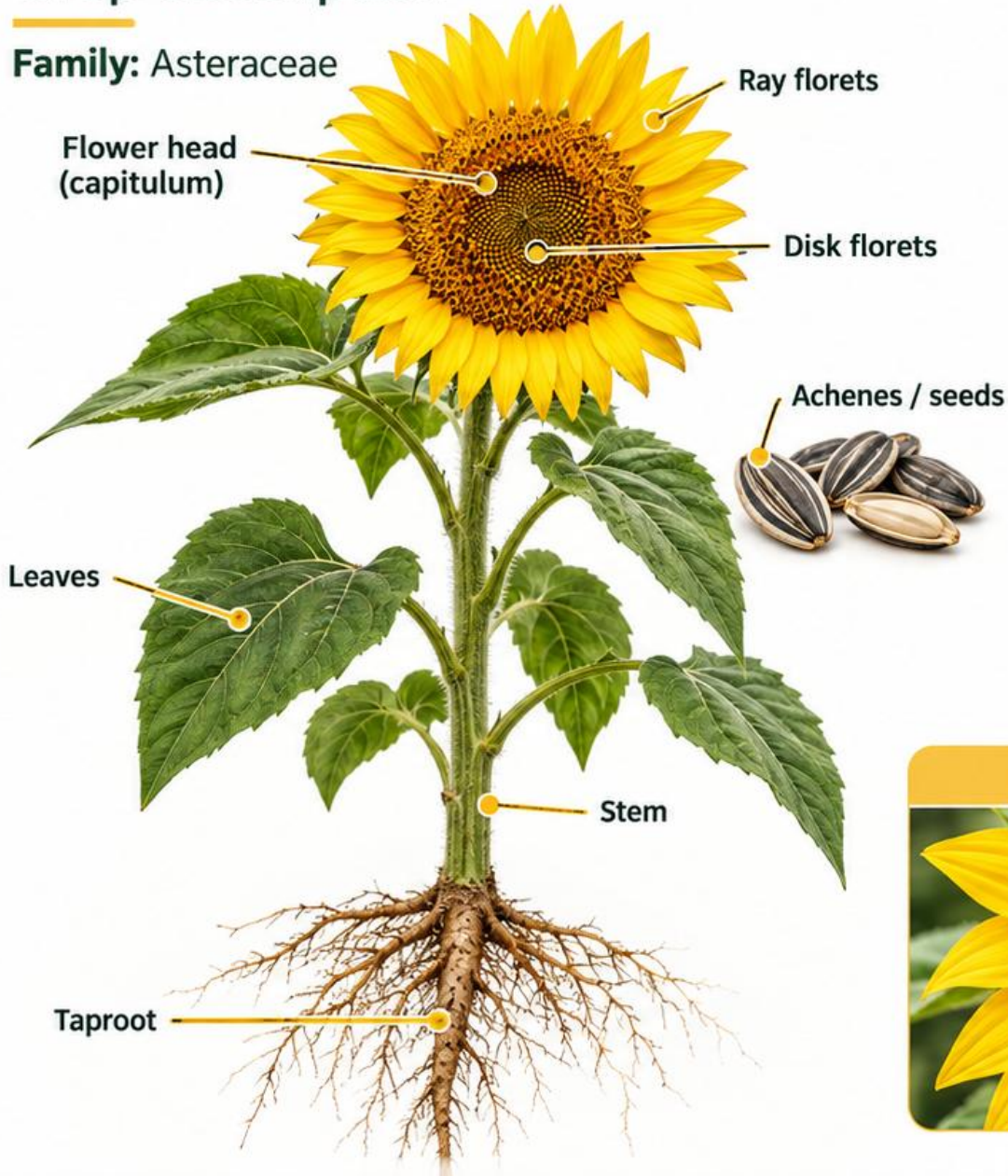
Leading producers (2023/24)



Sunflower (*Helianthus annuus* L.)

Crop description

Family: Asteraceae



Key characteristics



Annual herbaceous oilseed crop



Usually 1–3 m tall, depending on genotype and conditions



Erect, rough hairy stem with broad alternate leaves



Large capitulum composed of yellow ray florets and central disk florets



Produces achenes commonly referred to as sunflower seeds



Deep taproot supports drought tolerance and nutrient uptake



Used for edible oil, confectionery seed, feed and bio-based products.

Flower head



Achene / seed



Root system



Sunflower: Soil and climate preferences & cultivation protocol

Helianthus annuus L.

Family: Asteraceae



Soil and climate preferences



Warm-season annual crop adapted to temperate and warm-temperate regions.



Best growth under **full sun**.



Optimal temperatures generally around **20–30°C**.



Sensitive to **severe frost**, especially at early stages.



Performs best in **deep, fertile, well-drained loam to sandy-loam soils**.



Suitable soil pH: about **6.0–7.5**.



Tolerates **moderate drought** thanks to a deep root system, but does not perform well under **waterlogging**.



Good **soil moisture** is important during establishment, flowering and seed filling.



Cultivation protocol



Prepare a **fine, firm seedbed**.



Sow in **spring after frost danger**, when soil is sufficiently warm.



Typical sowing depth: about **3–5 cm**.



Use **moderate plant density** and **row spacing** according to hybrid, target use and mechanisation.



Early **weed control** is important during establishment.



Apply **balanced fertilisation**, especially nitrogen, phosphorus and potassium according to soil conditions.



Irrigate when needed, particularly under dry conditions during flowering and seed filling.



Crop monitoring is important for stand establishment and uniform flowering.



Indicative crop development stages



1. Early vegetative stage



2. Flower bud stage



3. Flowering



4. Field crop stand

Illustrative views of sunflower at several stages of crop development.

Sunflower: Harvesting and uses

Helianthus annuus L.

Family: Asteraceae



Harvesting guidance



Harvest when the back of the head turns **yellow-brown to brown** and bracts are dry.



Physiological maturity is reached before final dry-down.



For direct harvest and storage, seed moisture is typically about **10–14%**.



With mechanical harvest, **higher seed moisture** may be acceptable followed by post-harvest drying.



Combine harvesting with **adapted sunflower headers** is commonly used.



Timely harvest helps **reduce field losses** and **protect seed quality**.



Main uses



Edible oil production.



Confectionery and snack seeds.



Sunflower meal or cake as a protein-rich livestock feed after oil extraction.



Hulls and residues for energy, fiber, bio-based materials or other industrial valorisation.



Seeds and by-products can also support **feed and bioeconomy value chains**.

Illustrative harvesting views and summary of major end uses.

Carinata

(*Brassica carinata* A. Braun)

Family: Brassicaceae

Contents



1

Origin of
the crop



2

Area of
cultivation &
world production



3

Crop
description



4

Soil and climate
preferences



5

Cultivation
protocol



6

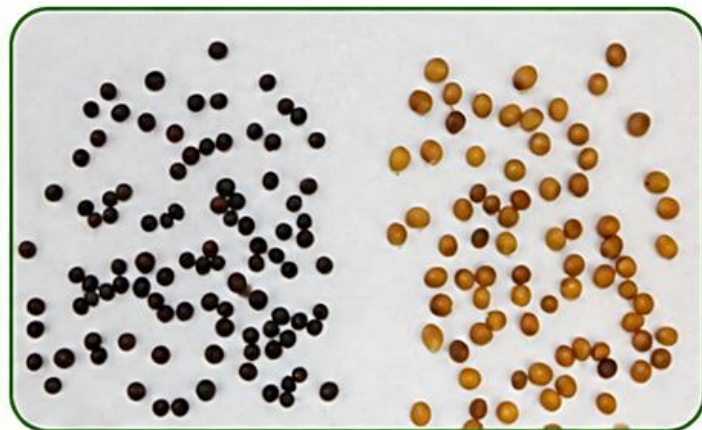
Harvesting
and uses



Ethiopian mustard (*Brassica carinata* A. Braun)

Origin, cultivation area and world production status

Family: Brassicaceae



Seed colour variation and flowering stem
(source material provided)

1 Origin

- Originated in the Ethiopian highlands; often referred to as Ethiopian mustard.
- Traditionally used in Ethiopia as an oilseed and leafy vegetable.

2 Cultivation area

- Oilseed crop mainly in Ethiopia; leafy vegetable in parts of Eastern, Southern, West and Central Africa.
- Studied or grown as an industrial oilseed in Mediterranean Europe, South Asia, Canada, the USA, Australia and South America.

Reported / emerging production and trial regions

Ethiopia

Southern Europe

South Asia

Canada / USA

Australia

Argentina / Uruguay

Mediterranean systems

3 World production status

No consolidated global production figure is commonly reported in the open-access sources checked. Carinata is still an emerging / specialty non-food oilseed crop, mainly developed for industrial oil, advanced biofuels and SAF feedstock.

Key message

Promising for marginal / semi-arid areas and double-cropping systems, but global statistics remain sparse compared with rapeseed or sunflower.

Ethiopian mustard (*Brassica carinata* A. Braun)

Crop description

Family: Brassicaceae



Flowering stem

Key characteristics

- Erect annual Brassica grown as oilseed or leafy vegetable.
- Plants are branched; average height around 1.4 m under crop conditions.
- Waxy or glabrous stems; lower leaves ovate to oblong and lobed.
- Yellow flowers; self-compatible with some cross-pollination.
- Linear siliques up to about 5 cm, usually with several seeds.



Seeds and industrial value

Seeds are globose, finely reticulated, yellow to dark brown. They are valued for high oil content and erucic acid, supporting renewable fuels, lubricants and other bio-based products.



1 Plant habit: Annual, erect, highly branched; elongated taproot supports adaptation to dry conditions.



2 Leaves: Alternate, waxy, glabrous to slightly hairy; lower leaves lobed and larger than upper leaves.



3 Flowers & pods: Yellow flowers; fruit is a linear silique that turns light brown at maturity.



4 Uses: Industrial oilseed for biofuels/SAF and bio-products; protein-rich meal after oil extraction.

ETHIOPIAN MUSTARD (*Brassica carinata* A. Braun)

Soil and climate preferences, cultivation protocol, diseases and insects

Family: Brassicaceae



1. Soil & climate preferences

- Adapted to Mediterranean, semi-arid and subtropical environments; grown as a winter crop in mild regions or a spring crop in cooler areas.
- Performs best on well-drained fertile loam to clay-loam soils; avoid waterlogging.
- Tolerates drought and moderate heat better than many oilseed brassicas, but establishment and flowering benefit from adequate moisture.
- Suitable pH: slightly acidic to neutral, around 5.5–7.5.



2. Cultivation protocol

- Prepare a fine, firm seedbed and use clean seed.
- Sow shallow, about 1–2 cm deep; autumn sowing in Mediterranean areas, spring sowing in cooler climates.
- Typical seed rate: about 4–7 kg/ha for oilseed production.
- Row spacing commonly 15–30 cm; ensure good early weed control.
- Apply balanced fertilisation, especially N and P, according to soil fertility.
- Use crop rotation with cereals and avoid short rotations with other brassicas.



3. Main diseases and insects



Diseases

- Alternaria leaf spot
- Sclerotinia stem rot
- Black rot
- Downy mildew
- Clubroot (mainly in infested acidic/wet soils)



Insects

- Flea beetles (e.g., *Altica* / *Phyllotreta* spp.)
- Aphids
- Diamondback moth and other brassica caterpillars
- Nysius bugs in dry conditions

Monitor regularly and follow integrated pest management (IPM).

Crop stages from emergence to harvest (source material provided).



Management tip

Best performance is usually achieved under low-input systems when sowing date, early weed control, drainage and rotation are well managed.

ETHIOPIAN MUSTARD (*Brassica carinata* A. Braun)

Harvesting

Family: Brassicaceae



Harvest maturity

- Harvest when most siliques/pods and stems have turned yellow-brown and the crop is fully mature.
- Direct combining is preferred when the stand is uniform and seed moisture is around 8–10%.
- Timely harvest is important to minimise shattering losses and preserve seed quality.



Mature pods
(yellow-brown)



Harvest method

- Ethiopian mustard is commonly harvested with a conventional grain combine.
- Use careful machine adjustment and moderate threshing intensity to reduce seed loss and seed damage.
- In uneven stands, harvest timing should balance complete seed filling with the risk of pod shattering.



Post-harvest handling

- Clean the seed after harvest and dry it further if needed for safe storage.
- Store seed in cool, dry conditions to maintain oil quality and germination.
- Residues can remain in the field or be incorporated, depending on the cropping system.



Management tip: Monitor maturity carefully and avoid delayed harvesting, especially under hot, dry or windy conditions.



View of Ethiopian mustard harvesting time
(source material provided by user).



Safflower

(*Carthamus tinctorius* L.)

Family: Asteraceae

Safflower is a hardy, drought-tolerant oilseed crop valued for its edible oil, high-oleic varieties and natural dyes, and well adapted to semi-arid and Mediterranean farming systems.



Oilseed crop



Drought tolerant



Well adapted to marginal and low-input systems



Presentation contents



1

Crop description

Botanical characteristics and key traits



2

Origin and distribution

Centre of origin, global cultivation area and production



3

Soil and climate preferences

Agro-climatic requirements and suitable environments



4

Crop establishment and cultivation

Sowing, plant density, fertilisation and crop management



5

Diseases and insects

Main pests and diseases and management options



6

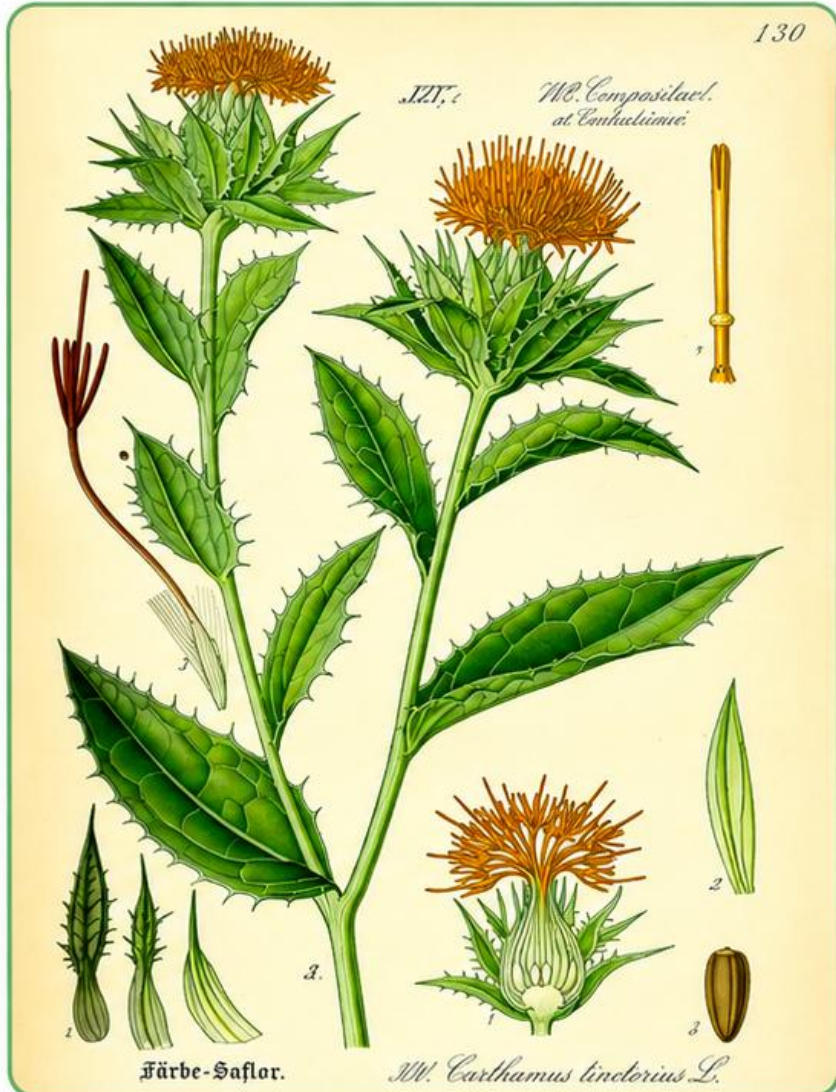
Harvesting and uses

Harvest timing and methods, seed yield and main applications

SAFFLOWER (*Carthamus tinctorius* L.)

Crop description

Family: Asteraceae



Growth habit

- **Annual**, erect and branched oilseed crop.
- Usually **0.4–1.5 m** tall, depending on cultivar and growing conditions.



Root system

- Develops a **strong, deep taproot** with lateral roots.
- Deep rooting helps the crop to access water, which explains its **good drought tolerance**.



Leaves

- Leaves are **lanceolate to ovate**, sessile, and often glossy.
- Margins may be **spiny or nearly spineless**, depending on genotype.



Flower heads

- Inflorescences are **terminal capitula (flower heads)** with many tubular florets.
- Florets are typically **yellow, orange or red**.



Seeds

- Fruit is an **achene**.
- Seeds are usually **white to cream** and contain about **25–40% oil**, depending on cultivar and environment.



Main uses

- Valued primarily as an **oilseed crop** (high-quality edible oil).
- Also used as a **natural dye** (e.g. for textiles and food).
- Traditionally used in **medicine** in various cultures.

SAFFLOWER (*Carthamus tinctorius* L.)

Origin and cultivation area

Family: Asteraceae



Ancient crop domesticated in the **Fertile Crescent / Middle East**; the wild progenitor is widely considered to be *Carthamus palestinus*.



Archaeological evidence indicates **human use since about 7500 BC** in the Near East.



Historically spread across North Africa, the **Mediterranean Basin, India and East Asia** as a dye, medicinal and oilseed crop.



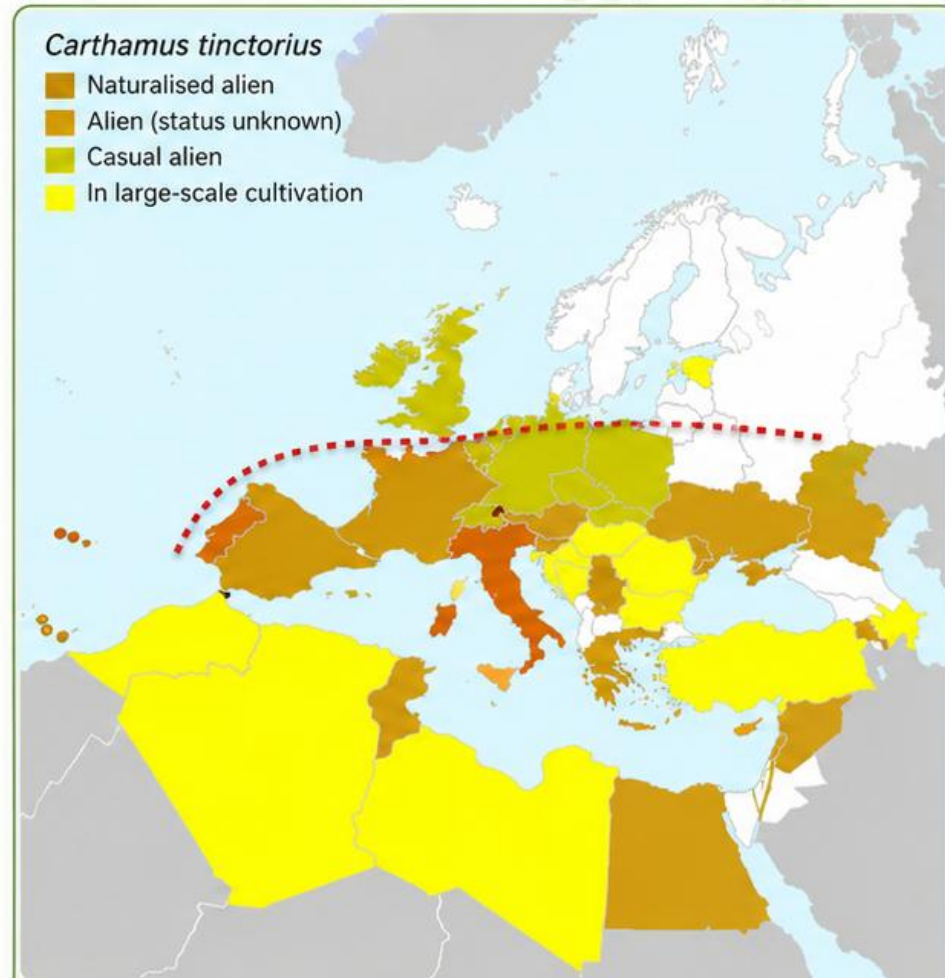
Today safflower is cultivated mainly in **dry and semi-arid regions**; major producers include India, Kazakhstan, Mexico, the USA, China, Argentina and Australia.



In Europe, cultivation is concentrated mainly in **Mediterranean and southern to south-eastern regions**, as reflected in the distribution map.

Carthamus tinctorius

- Naturalised alien
- Alien (status unknown)
- Casual alien
- In large-scale cultivation



Distribution / cultivation status in Europe

SAFFLOWER (*Carthamus tinctorius* L.)

Soil & climate preferences, cultivation protocol and expected yields

Family: Asteraceae



SOIL PREFERENCES

- Well-drained loam to sandy-loam soils.
- Performs on low-fertility soils but responds to balanced nutrition.
- Best at pH about 6.0–7.5; tolerates slight alkalinity and salinity.
- Avoid heavy waterlogged soils.



CULTIVATION PROTOCOL

- **Sow** in late winter to early spring; in mild Mediterranean areas autumn sowing is also possible.
- **Sowing depth:** 2–4 cm.
- **Seed rate:** about 15–25 kg/ha.
- **Row spacing:** about 25–45 cm.
- Apply moderate N and adequate P/K according to soil test.
- Keep the crop weed-free during early establishment; irrigation is mainly needed at establishment and, if necessary, around flowering/seed filling.



CLIMATE PREFERENCES

- Best adapted to arid and semi-arid regions.
- Drought tolerant thanks to a deep taproot.
- Prefers warm, sunny conditions and relatively low humidity.
- Rosette stage tolerates cool conditions; severe frost during reproductive stages can reduce yield.



EXPECTED YIELDS

- **Typical seed yield:** 0.8–2.5 t/ha under rainfed or moderate-input conditions.
- Under favorable management and environment, yields may approach 3.0 t/ha.
- **Oil content** commonly 25–40%.



Safflower at several growth stages (source: CRES).

SAFFLOWER (*Carthamus tinctorius* L.)

Harvesting and uses

Family: Asteraceae



HARVESTING

- Harvest when plants, leaves and flower heads are dry and brown, and seeds are fully mature.
- Direct combine harvesting is commonly used; target seed moisture is about 10–12%.
- Uniform ripening and dry weather improve harvest efficiency and reduce losses.
- Spiny cultivars require careful handling during harvest and post-harvest operations.



MAIN USES

- Seed oil for edible use; varieties may be high-linoleic or high-oleic.
- Feedstock for biodiesel and other bio-based industrial products.
- Press cake/meal can be used in animal feed after oil extraction.
- Petals are used as natural colorants, in herbal products, and in cosmetics/traditional applications.



Typical oil content: 25–40%



Safflower seeds and petals



Mature safflower crop ready for harvest



Combine harvesting of safflower

Cardoon (*Cynara cardunculus* L.)

Crop description

Family: **Asteraceae**



Perennial herbaceous thistle

Long-lived herbaceous species in the Asteraceae family.



Robust, deep-rooted plant

Forms a large basal rosette and deep root system, conferring drought tolerance.



Tall flowering stems

Produces tall, branched stems, often 1.5–2.0 m or more.



Leaves large and spiny

Leaves are large, deeply lobed, grey-green and often spiny, with a silvery appearance.



Flower heads

Terminal capitula (flower heads) with purple-violet florets.



Fruit

The fruit is an achene (seed), typical of Asteraceae.



Adaptation and distribution

- Well adapted to dry Mediterranean conditions.
- Grows on a wide range of soils, with good tolerance to drought and poor soils.
- Cultivated mainly in Mediterranean regions of Europe, North Africa and parts of Western Asia.

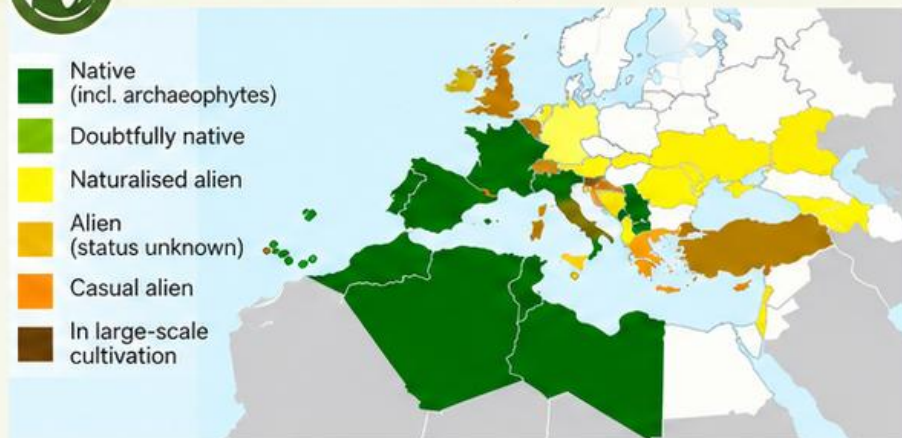


Value and uses

- High biomass crop (lignocellulosic feedstock).
- Used for multiple bio-based applications, including bioenergy, bioproducts, paper, bioplastics and fibers.
- Also of interest for soil conservation and cultivation on marginal lands.



Cultivation status in Europe and the Mediterranean



Cardoon (*Cynara cardunculus* L.)

Origin and area of cultivation

Family: Asteraceae



Native to the Mediterranean basin, in wild form, including North Africa and parts of southern Europe.



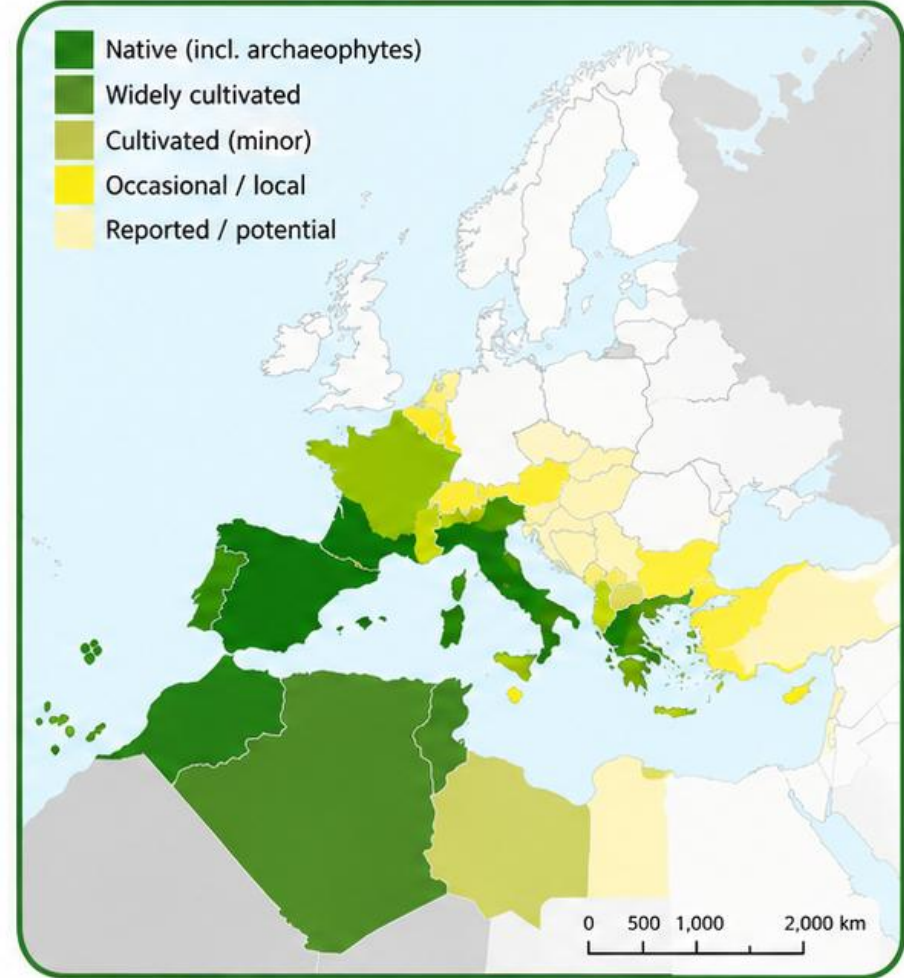
Domesticated and diversified in southern Europe and North Africa.



Cultivated mainly in **Spain, Italy, France, Portugal and Greece**, with occurrence or cultivation also in other Mediterranean and some temperate regions.



Grown as a **vegetable**, for **biomass/energy**, and for **seed/oil and biorefinery uses**.



Mediterranean perennial crop with expanding interest in bioeconomy applications.

Cardoon (*Cynara cardunculus* L.)

Family: Asteraceae



1 Lignocellulosic biomass for solid biofuel



- High biomass with low input requirements
- Suitable for combustion, gasification and pyrolysis
- Production of heat, electricity and biochar



2 Seeds for oil and renewable fuels



- Seeds rich in linoleic acid (unsaturated oil)
- Edible oil applications
- Biodiesel and other renewable fuel uses



3 Stems and fibres for biobased materials



- Fibres rich in cellulose and hemicellulose
- Pulp and paper production
- Biocomposites, boards, insulation and other bio-based materials



4 Green biomass, forage and crop residues



- Young shoots/leaves can be used as forage (ruminants)
- Crop residues (stems, leaves, heads) for mulching, organic amendment or bioenergy



5 Phytochemicals and high-value biorefinery products



- Polyphenols (e.g. cynarin), flavonoids and antioxidant compounds
- Natural dyes (e.g. from flowers)
- Potential for pharmaceuticals, cosmetics and nutraceuticals



6 Roots as a source of inulin and other extractives



- Roots contain inulin (fructan) with prebiotic applications
- Additional extractives with potential food, feed and industrial uses



A multipurpose
Mediterranean
biorefinery crop

Cardoon (*Cynara cardunculus* L.)

Harvesting



1 Crop at maturity

- Plants reach maturity in late summer to autumn (depending on region).
- Flower heads turn brown and dry.
- Seeds reach 8–12% moisture content.

2 Ready for harvest

- Harvest when most capitula (flower heads) are dry and seeds are easily released.
- Avoid excessive shattering losses.
- Ideal seed moisture content: ~8–12%.

3 Mechanical harvesting

- Direct combine harvesting with a modified cereal or sunflower header (e.g. strip-header or picker header).
- Low forward speed and adjusted cylinder speed to reduce seed losses.
- Can also be harvested in swath and later threshed.

4 Post-harvest handling

- Cleaning to remove chaff, plant debris and spines.
- Drying if necessary to reduce seed moisture to <8–10%.
- Storage in dry and cool conditions to maintain quality.

5 Harvested seeds

- Typical seed yield: 0.5 – 2.5 t/ha (common: 0.8 – 1.5 t/ha).
- Oil content: 20 – 35% (depending on variety and environment).
- Seeds for oil, bioenergy or other industrial uses.

July – September
(flowering to early seed set)

August – October
(seed maturation)

September – October
(harvesting)

Cleaning and drying
(post-harvest)

Stored seeds
(for multiple uses)

Midas

MARGINAL LANDS, INDUSTRIAL CROPS
AND INNOVATIVE BIO-BASED VALUE CHAINS



midas-bioeconomy.eu



midas-project



@MIDAS_EUProject



MIDAS Project



info@midas-bioeconomy.eu

Thank you



ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
AGRICULTURAL UNIVERSITY OF ATHENS



WAGENINGEN
UNIVERSITY & RESEARCH



UNIVERSITY OF
HOHENHEIM

etaflorence
renewable
energies

UCLM Universidad de
Castilla-La Mancha
CAMPUS DE EXCELENCIA INTERNACIONAL

RE-CORD

NOVAMONT

Università
di Catania

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA
E INNOVACIÓN
Ciemat
Centro de Investigación
Energética, Medioambiental
y Tecnológica

crea
Consiglio per la ricerca in agricoltura
e l'analisi dell'economia agraria

Nova
NOVA SCHOOL OF
SCIENCE & TECHNOLOGY

SOILTUB

EUROPEAN CARBON
FARMERS

Investwood



ΕΛΠΕ
ανάπτυξης

UDS Université de
Sherbrooke

kaiiima® GuateCS

CHIMAR.

CZECHEMP

ITAP
INSTITUTO TECNOLÓGICO AGRARIO DE ALBACETE



nokian
TYRES



Funded by
the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement No. 101082070. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or REA. Neither the European Union nor the granting authority can be held responsible for them.