Helianthus annus

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1.0 Introduction :

Helianthus annuus L. stands as one of the most useful and easily recognizable plants across the globe.(Kennedy, 2021) The sunflower is a fast-growing annual plant from the Asteraceae family which presents itself through its tall stalk and large yellow flower head while using sun-tracking behavior. Sunflowers have existed for thousands of years beyond their food and oil value because they display an impressive capability to thrive under challenging conditions as well as provide beautiful aesthetics to society alongside their cultural significance in various nations. Native Americans cultivated the sunflower for over 4,000 years beginning when they cultivated this species across regions that are now the United States and Mexican territories The early farmers selected excellent wild plants and through breeding produced sunflowers with enlarged seeds and improved oil content while reducing irregularities producing an icon from a wild plant.(Kennedy, 2021)

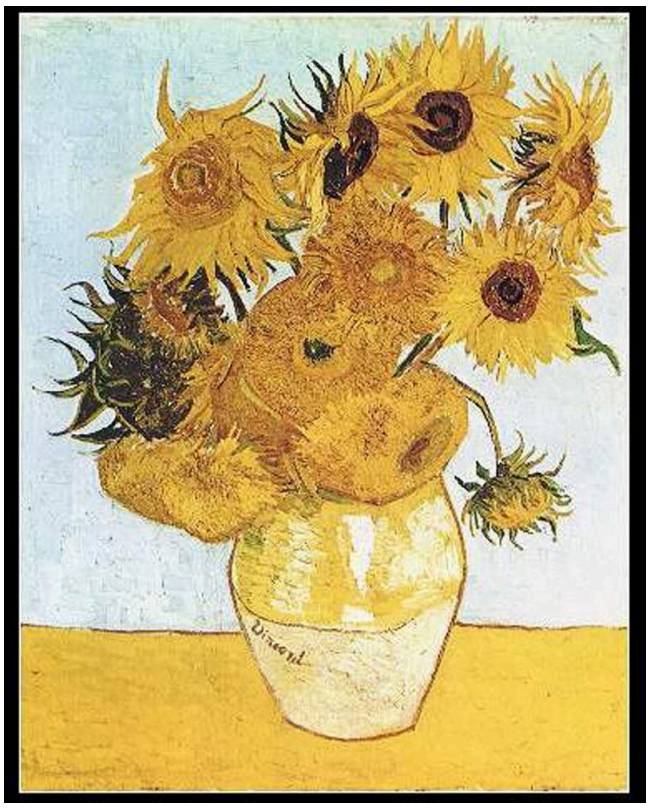
As a member of *Asteraceae* the largest plant family *Helianthus annuus* joins a cluster that also includes other plants. (Brown, 2023)The development of sunflower breeding advanced during the 18th and 19th centuries in Russia and Eastern European farms when farmers focused on improving seed yield and oil content. (Brown, 2023)As of today sunflowers continue to thrive across the globe in regions with temperate and warm weather that includes leading producers Ukraine and Russia in addition to Argentina and China and the United States. (Brown, 2023)

Multiple social groups throughout different cultures attribute special significance to sunflowers in their cultures. Native Americans admired and idolized this plant as sacred before it became symbolic of solar power and sustainable progress for modern times.(Cherlinka,2024) The purpose of this monograph is to understand the uses of the sunflower in an effort to break it of

from the perception of only its beauty and see the significance it has on our daily lives. One of the most influential paintings like the one below

Figure 1

Sunflowers by Van Gogh



Gdn, and Gdn. “Expert Tracks Down Missing Van Gogh &Apos;Sunflowers&Apos; Paintings.” *South China Morning Post*, 5 Sept. 2013, www.scmp.com/news/world/article/1304133/expert-tracks-down-missing-van-gogh-sunflowers-paintings.

2.0 Ecology and Biology:

2.1 Affinities:

The sunflower (*Helianthus an*nuus) belongs to the family Asteraceae, one of the biggest plant families in the world with over 2500 species worldwide (Brown, 2023). The Sunflower shares genetic composition with plants like lettuce, artichoke, daisy, and dandelion. The sunflower has a well-known behavior: redirecting itself according to the sun “from east to west”(Brown, 2023). This behavior is known as heliotropism, and it helps maximize the plant's exposure to sunlight so they can optimize photosynthesis.

The sunflower is classified as a member of the kingdom “Plantae” along with all plants, which produce their food through photosynthesis, using chlorophyll to transfer sunlight into energy in the form of ATP. (Brown, 2023) The sunflower fits into the subkingdom of Tracheobionta which refers to plants with specialized tissue that help transport water and nutrients throughout the plant: plants in the subkingdom Tracheobionta develop stronger and taller stems- Some of the plants that belong to this subkingdom are asparagus, and corn, and cacti. The sunflower belonging to this division, *Spermatophyta* ,means the sunflower reproduces thanks to seed reproduction. Sunflowers are in the Magnoliophyta division which includes all flowering plants, “the most diverse group within the plant kingdom”. *The Magnoliophyta* is characterized by plants with flowers or seeds enclosed within the fruit. (Brown, 2023).. The subclass of the sunflower is the Asteridae subclass This subclass is defined by fused petals which resemble the structure of the daisy.(Brown, 2023). The order in this case is asterales which is a genetic

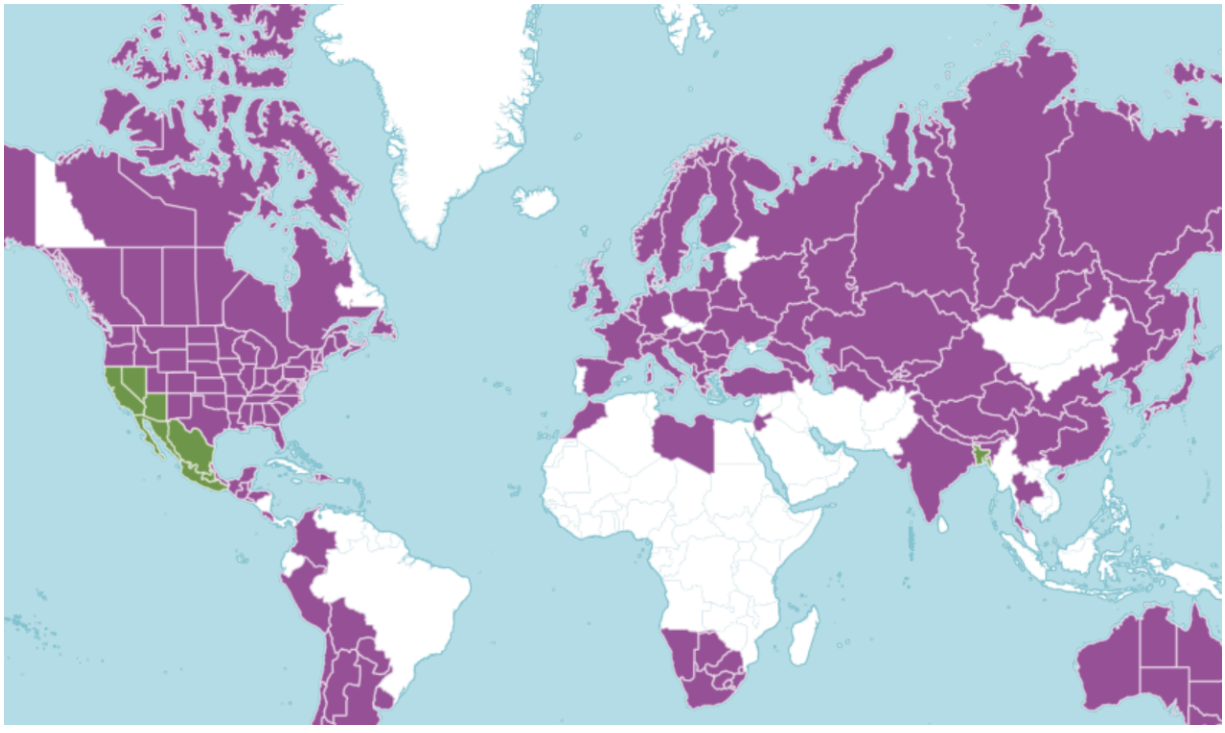
variation that shows how flowers have multiple flowerheads, a single flower is a cluster of smaller flower heads, this is true for the sunflower as it is made up of hundreds of tiny florets. Helianthus annus is the most common sunflower. Thus, genus and species are identified for having all the characteristics stated above. (Brown, 2023).

2.1.2 Table of affinities:

Kingdom	*Plantae* - Plants
Subkingdom	*Tracheobionta* - Vascular plants
Superdivision	*Spermatophyta* - Seed plants
Division	*Magnoliophyta* - Flowering plants
Class	*Magnoliopsida* - Dicotyledons
Subclass	*Asteridae*
Order	*Asterales*
Family	*Asteraceae* Bercht. & J. Presl - Aster family
Genus	*Helianthus* L. - sunflower
Species	*Helianthus annuus* L. - common sunflower

2.1.3 Origin:

The sunflower was originally grown in North America and used as a food source for humans, cattle, poultry, ornamental plants, and medical purposes (Brown, 2023). The sunflower was first domesticated 4 to 5 thousand years ago in what's now known as the Central United States. “Sunflower was a common crop among American Indian tribes throughout North America. Evidence suggests that the plant was cultivated by American Indians in present-day Arizona and New Mexico about 3000 BC.” (Brown, 2023). The crop would then take over the Americas making it a substantial crop across the continent. The sunflower spread to the United States and southern Canada. The sunflower was used as a first-hand food source as the buds seeds and leaves are edible. (Brown, 2023).The seeds could be cracked and roasted to produce flour for cakes, bread, and mush. or squeezed to produce oil. (The American Society of Agronomy, 1997). The sunflower was also infamous for producing dye for textiles body paint and medicinal purposes. (Brown, 2023).



This is a graphical representation of the origin in green and the places where its cultivated in purple.

Redirecting.

www.google.com/url?q=https://www.kew.org/plants/sunflower&sa=D&source=docs&ust=1741713270470980&usg=AOvVaw3IF9JU16Li5745qX35nweF.

1,271 × 750

2.1.4 Fossil record:

The fossil record of the *Helianthus annus* dates back 47.5 million years ago. Dating back to the Artrecea family, which is related to modern-day plants like chrysanthemums and daisies. (Barreda,2010). The sunflower has been susceptible to genetic variation due to domestication. Heiser,1954). Three main taxa have been recognized as possible ancestors of the common day sunflower. H. annus var. Lenticularis wild from western North America. (Heiser,1954) *H. annus var*. Annus is primarily from the central United States. (Heiser, 1954) and *H. annus var*. Macrocarpus is cultivated and genetically modified to extract oil from the seeds. (Heiser, 1954) one of sunflowers cousins fossil can be observed below.

Figure 2

Fossil of sunflower relatives

(Stuessy, 2010)

Stuessy, Tod. “The Rise of Sunflowers.” *Science*, vol. 329, no. 5999, Sept. 2010, pp. 1605–06. https://doi.org/10.1126/science.1195336.

2.2.0 Environmental Factors and Distribution:

2.2.1 Geology and soil:

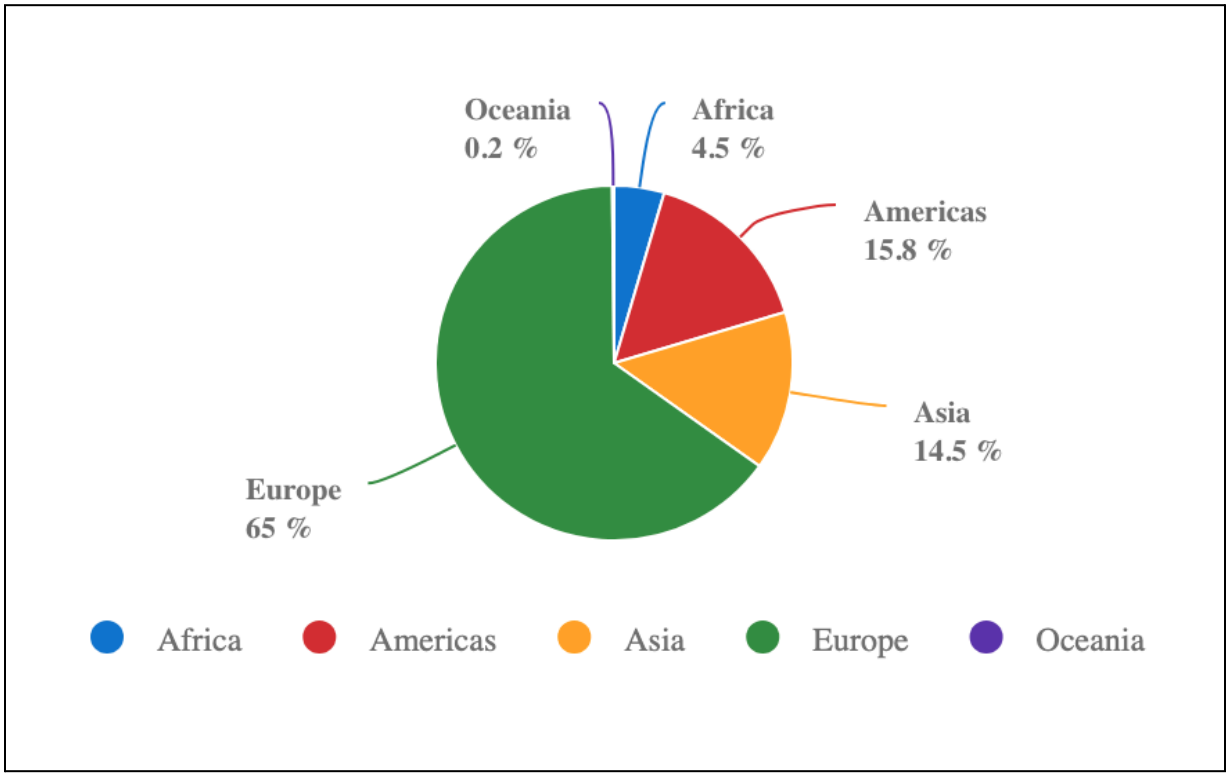
The *Helianthus annus* grows better in loamy soil with good organic matter. (Peña, 2010) Sunflowers grow best in slightly acidic soils with a pH of 6.0 to 7.5. Sunflowers require nitrogen, phosphorus, and potassium.(Peña, 2010) Sunflowers need soil that retains moisture like loamy but doesn't stay soggy. (Peña, 2010) The soil has to have a depth of 12 to 15 inches to accommodate the root system. (Peña, 2010)

2.2.3 Present distribution:

Sunflowers have a huge range of adaptability contributing to their various geographic distributions. (Tyagi,2024) The U.S. has its distribution points in North Dakota, South Dakota, Kansas, and Nebraska. (Tyagi,2024) The international distribution of the sunflower is wide, European distribution mostly consists of Russia, Ukraine, France, and Romania in agricultural regions. (Tyagi,2024) South America produces sunflowers in Argentina and Brazil. (Tyagi,2024) In Asia, Russia is still the largest producer as they are the largest producer of sunflower oil, China and India are also producers of sunflower. (Tyagi,2024)The sunflower is also grown in Africa in countries like Ethiopia and South Africa, which also produce sunflower oil as a food source.

Figure 3

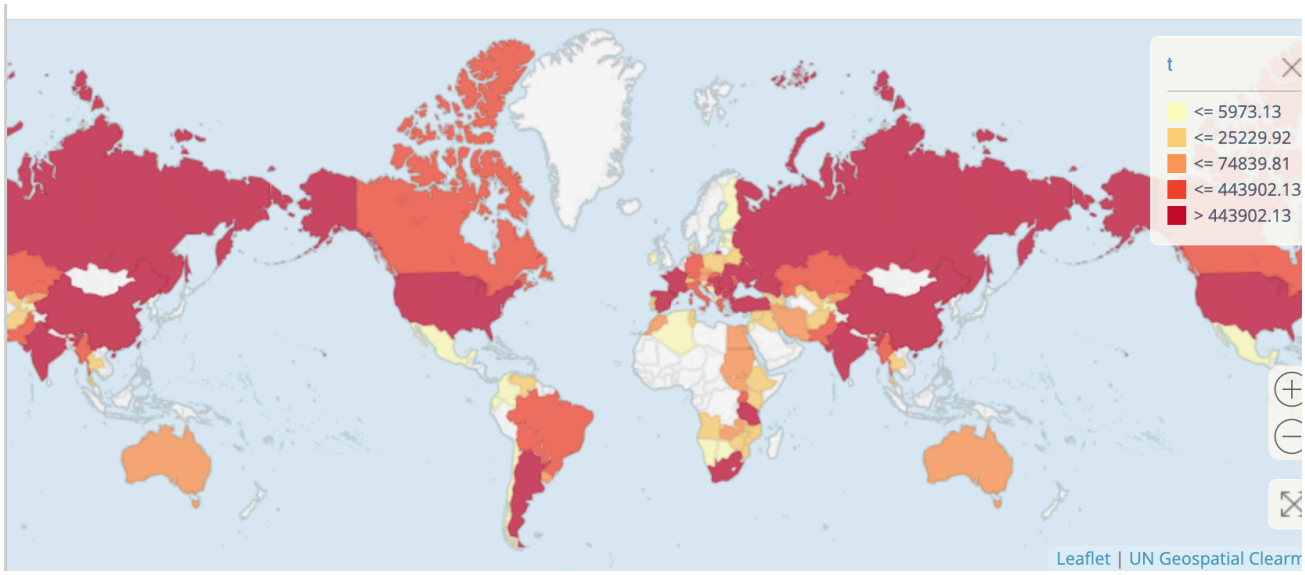
This is a graphical representation of the current distribution of sunflowers worldwide.



(Ourworld, 2024)

Figure 4

Theis a graphical representation of a map representing the production quantities of sunflower seeds.



(Our,world,2024)

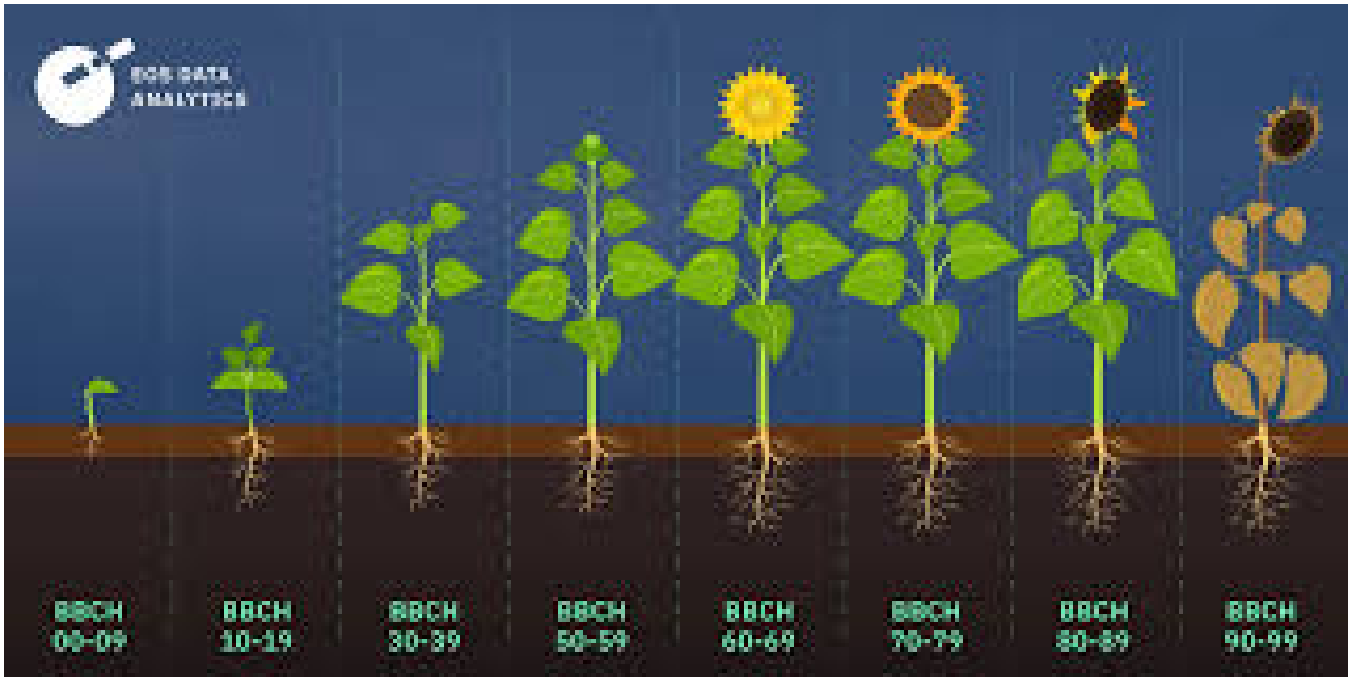
2.2.4 Climate and Elevation:

The growth of the sunflower depends on its genetic makeup and background but the season it's planted in also contributes. The season better for planting *Helianthus annus* is the middle of summer and the beginning of fall. In the central United States and northern European nations (Tyagi,2024). Sunflowers thrive with plenty of direct sunlight. They grow in warm temperatures. About 70°F and 78°F (21°C and 26°C) (Tyagi,2024). Sunflowers can tolerate droughts but need regular watering to optimize growth. Too much heat (above 85°F or 29°C) can stress that plant and affect its root development.(Tyagi,2024) The sunflower is grown in tropical and subtropical

areas. Such as Central America with countries such as Mexico and Central United States, Australia, and southern European countries like the south of Russia, France, and Germany (Tyagi,2024) Sunflowers thrive in a variety of elevations like 1,000 to 2,000 meters above sea level, the growth of the sunflower is mostly related to climate and sunlight. (Cherlinka,2024)

Figure 5

There is a graphical representation of how the taproot develops in the sunflower.



(Eos, 2013)

2.2.5 Rainfall, Potential Evapotranspiration, and Water Deficits:

Evapotranspiration of the *Helianthus annus* isn't strictly related to irrigation. The sunflower is extremely adaptable, sunflowers can survive with a lack of irrigation, as sunflowers have a deep root system. The sunflower has a certain resilience to water stress.(Goldberg,1990)

2.3.0 Vegetation component:

2.3.2 Pests and Diseases:

The *H. annuus* has a long list of insects including the Sunflower moth, which feeds on the seeds in the flower head. (Carter,1978) The Sunflower Seed Weevil is a larva that feeds on developing seeds. (Carter,1978) *Aphis fabae* is an insect which sucks the sap out of the stem limiting the plant's growth. (Carter1978) Cutworms chew through the stems and the roots, killing the seedlings. (Carter 1978) Grasshoppers also damage the leaves. (Carter,1978,) There is a variation of other pests that aren't insects, which include sparrows and blackbirds, These birds usually feed on the seeds before they mature. (Carter, 1978) *Sclerotinia* stem rot is a fungal infection that creates white fungal growth and wilting plants. (Griffin,2010). *Puccinia helianthi* is also a fungal disease that reduces photosynthesis. (Griffin,2010) *Alternaria helianthi* is also a fungal disease that creates brown or black spots in the leaves. (Carter,1978) Some viral diseases include TMV, which stunts growth and creates genetic variations that interrupt leaf development. (Griffin,2010)

Figure 6

This picture is a flower that has died because of *pucciana helianthi.*

(Sagrainmag, 2023)

Figure 7

In this picture, we can see a sunflower beetle, a very harmful pest and a danger to the prosperity of our sunflower.

(crop-protection)

3.0. Biology:

3.1.0 Chromosome Complement:

Scientists studied *H. annuus's* chromosome complex extracted from a clone named HAG004N15 (Ceccarelli, 2007). This DNA sequence was found in every sunflower species, but in larger quantities in perennial species. (Ceccarelli, 2007). In sequences, these patterns were discovered at the tips of the plant, except for one chromosome (a metacentric pair) these pairs didn't show this sequence(Ceccarelli, 2007). In Ribosomal DNA (rDNA) this type of DNA carries the instructions to make the ribosomes.(Natali, 2008*) Helianthus annus* has rDNA in four pairs of chromosomes. (Natali, 2008). Annual and perennial species vary due to hybridization (crossing two different species)(Natali, 2008).

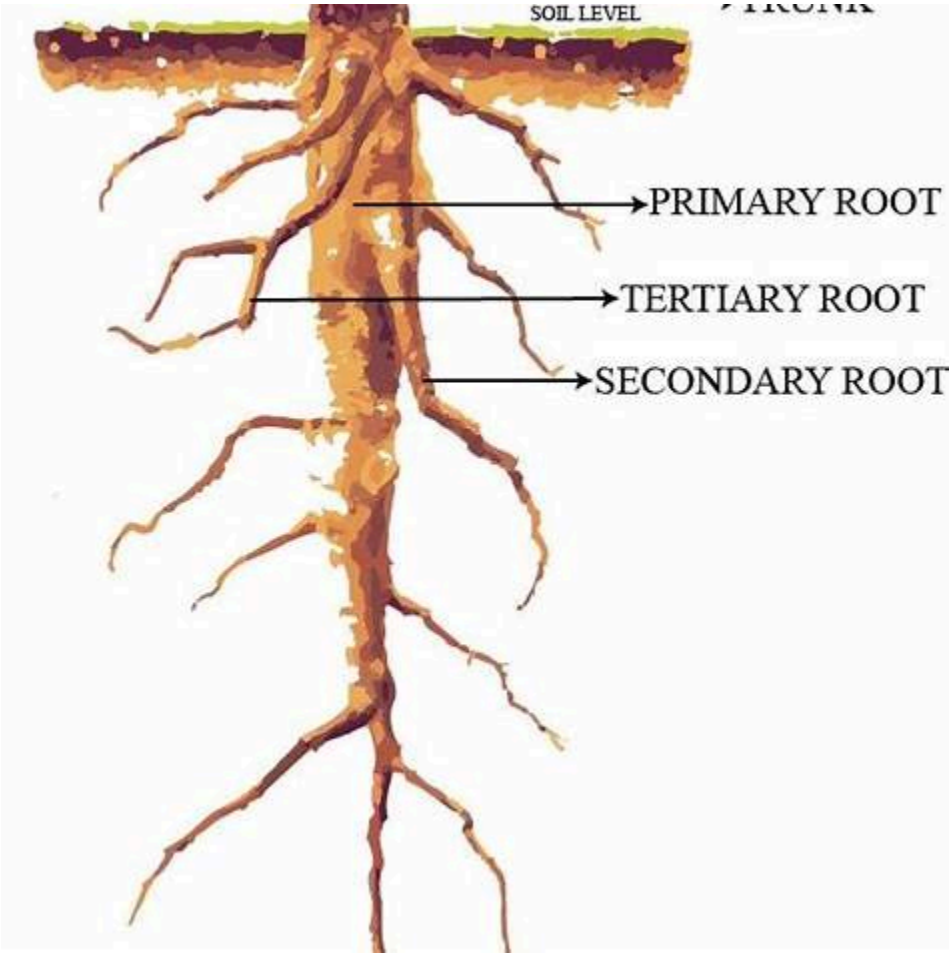
3.2.0 Life cycle and Phenology:

3.2.1 Root system:

H. annuus has a taproot that anchors the plant vertically into the ground. (Brown, 2019). The taproot grows up to 1 to 1.2 meters deep.(Natali, 2008) This taproot allows water to be absorbed throw the layers of soil. (Natali, 2008). As shown in the picture below.

Figure 8

This is a graphical representation of the root system in a sunflower.



(GeeksforGeeks 2024)

3.2.2 Seed germination:

The seed germination process for *H. annuus* begins with scarification, as there is no need for prolonged chilling or seed dormancy. Sunflower seeds germinate best in temperatures of around 10-30 degrees Celsius, peaking their optimal stage at around 20-25 degrees. (Jones, 2020).

When the seed is exposed to warmth and moisture. The seed absorbs the water through the seed coat, which triggers metabolic activity inside the seed. (Brown, 2019). The radical or (embryonic root) emerges first, anchoring the seedling, which facilitates water and nutrient uptake. (Brown, 2019). After the hypocotyl elongates, push the seed leaves above the soil surface. This is how the first stage of vegetative growth begins. (Brown, 2019).

Figure 9

In the picture above, we can see a sunflower seed while in its germination process.

(*Agri Farming*, 2020),

3.2.3 Juvenile vegetative state:

The plant *H. annuus* enters the juvenile vegetative stage, which features fast growth as well as development. Seed germination leads to taproot development while the plant forms its primary shoot, containing simple leaves.(Webster & Wertheim, 2003). The plant dedicates this vegetative period, lasting between 20 to 60 days, to perform vegetative growth without flowering. (Wiley Online Library, 1981).

3.2.4 Flowering and reproductive state:

When *H. annuus* (common sunflower) plants reach maturity, the reproductive processes begin the reproductive cycle within the plant. The sunflower plant undergoes each developmental stage throughout the annual timeline because it follows seasonal life patterns. Under variable environmental influences and cultivar type,s the blooming period lasts for 60 to 90 days starting from seed germination (Brown, 2019).

H. annuus evolve continuously from germination until their seeds become ready after pollination happens. Sunflowers with premature characteristics allow bees and insects to complete pollination because male parts release pollen before female receptivity becomes possible for cross-pollination (Brown, 2019). Pollination successfully ends when flower heads produce seeds to finish the life cycle before reorganization takes place. (Webster & Wertheim, 2003).

3.2.5 Fruit Development:

A successfully pollinated *Helianthus annuus* plant develops the dry achene fruit through the maturation of its ovaries. (Brown, 2019). Seed dimensions during the initial development phase from days ten to fifteen,n result from rapid cellular multiplication, which creates most of the future seed proportions (Dash, 2013). Seeds require three specific growth signals made up of auxins and gibberellins, and cytokinins because these substances promote seed growth while building reserve materials (Greene, 2000).

3.2.6 Senescence and Death:

The life cycle of *Helianthus annuus* causes productivity decline in the final stage of plant development. The annual life cycle of sunflowers enables them to finish their development along with the formation of flowers and seeds during periods of 3 to 4 months (Webster & Wertheim, 2003). The lifetime of sunflowers ends when mature seeds distribute to new locations thus eliminating their lifetime continuity.(Webster & Wertheim, 2003).

In the picture below we can see a variety of sunflowers that are dying, this is because the main purpose of this species is to regenerate and spread its offspring, a process that can only be obtained by dying.

Figure 10
In the picture above, we can see a sunflower seed while in its germination process.

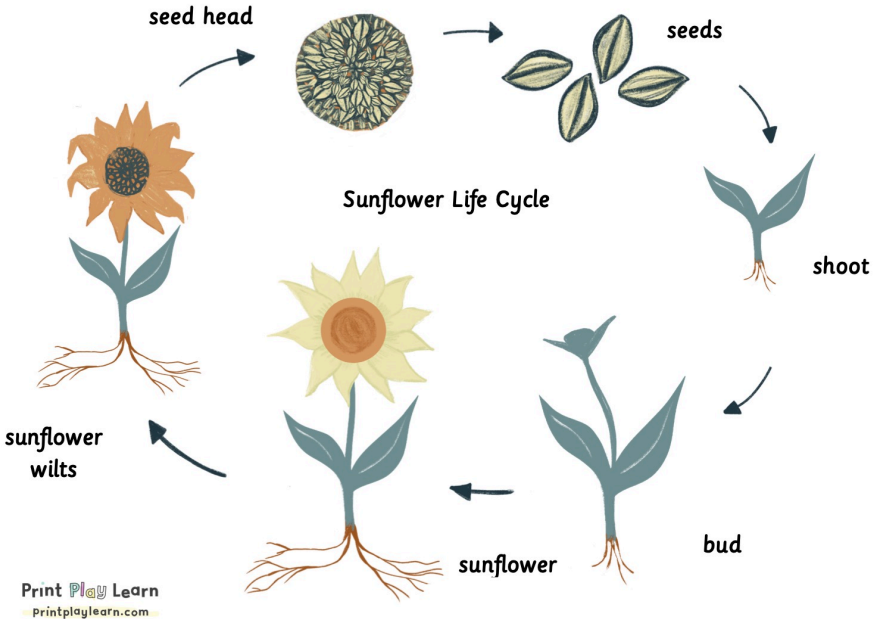
(Enrouteksm 2023)

The conditions of seeds and plants decline due to various environmental factors that involve dry conditions and pest infections as well as disease occurrences (Webster & Wertheim, 2003). Growth of sunflowers comes out negatively because of soil nutrient loss in intensive farming systems where sunflowers serve as a monoculture (Webster & Wertheim, 2003). Every year, throughout their commercial sunflower fields, farmers run rotations that protect the soil from erosion while keeping pest numbers low to maintain steady yields.(Webster & Wertheim, 2003).

3.2.7 Picture or Lifecycle of sunflower:

Figure 11

This is a graphical representation of the sunflower and the stages it goes throw.



(Layola, 2006)

3.2.9 Year-to-year variation in flowering and fruiting:

Yearly seed production combined with flowering patterns for sunflower shows natural variations because of temperature patterns and pollinator presence as well as plant condition status (Canadian Food Inspection Agency, 2013). Temperature variations affect seed production figures and flowering durations as well as oil composition (Wertheim, 2003).

Fertilization requires pollinators, mainly bees, to succeed in its process. The inconsistent supply of pollinators and environmental disturbances and the staggering decline of pollinators diminish

seed production numbers(Wertheim, 2003). The combination of poor seed yield and decreased quality emerges because phosphorus and nitrogen deficiencies prevail in the soil (Wertheim, 2003)

3.2.10 Temperature fluctuations:

Helianthus annuus and its seed development process mainly function because of constant temperatures. When unexpected frosts strike during flower bud development, the seed production becomes impaired, thereby reducing crop yield level (Wertheim, 2003). The extremely cold temperatures that impact sunflowers because they are warm-season cultivars lead to delayed flowering periods and limited growth, while making plants more vulnerable to infections and reducing their pollination success (Melchor,2023)

During the reproductive stage, temperatures above their average range make it so premature blooms occur as pollinators are not active at that time, which affects successful fertilization (Melchor,2023). The combination of excessive heat causes pollen sterility because of heat stress, resulting in ruined seed formation capabilities (Melchor,2023). The high temperatures increase water loss during plant water circulation while reducing water availability, which deteriorates seed development along with oil measurement .(Melchor,2023)

3.2.11 Plant health:

Sunflower needs to maintain proper health for it to produce regular flowers and continue seed production as normal. Sunflowers reach their highest potential growth through correct plant

cultivation, which is because of proper water delivery together with essential nutrient supply ,while controlling weeds (AgriLife, 2023).

The stress from either pests or disease infections, or lack of nutrients makes sunflower plants weak and results in irregular flowering patterns and reduced seed yield. (Texas A&M AgriLife, 2023). Sunflower moths and aphids are sunflower pests that damage seeds and their qualit,y while downy mildew and rust diseases create conditions for plants to face growth challenges (Butler,2024)

3.2.12 Effects due to climate change:

Patterns together with the seed development timeline of sunflower plants are influenced by climate change (Butler,2024). The combination of higher temperatures in specific regions causes plants to awaken early from their dormant period, but fails to get sufficient fertilization from bees and resulting in diminished seeds and lower oil content (Melchor,2023)

3.3.0 Reproductive Biology:

3.3.1 Sexuality:

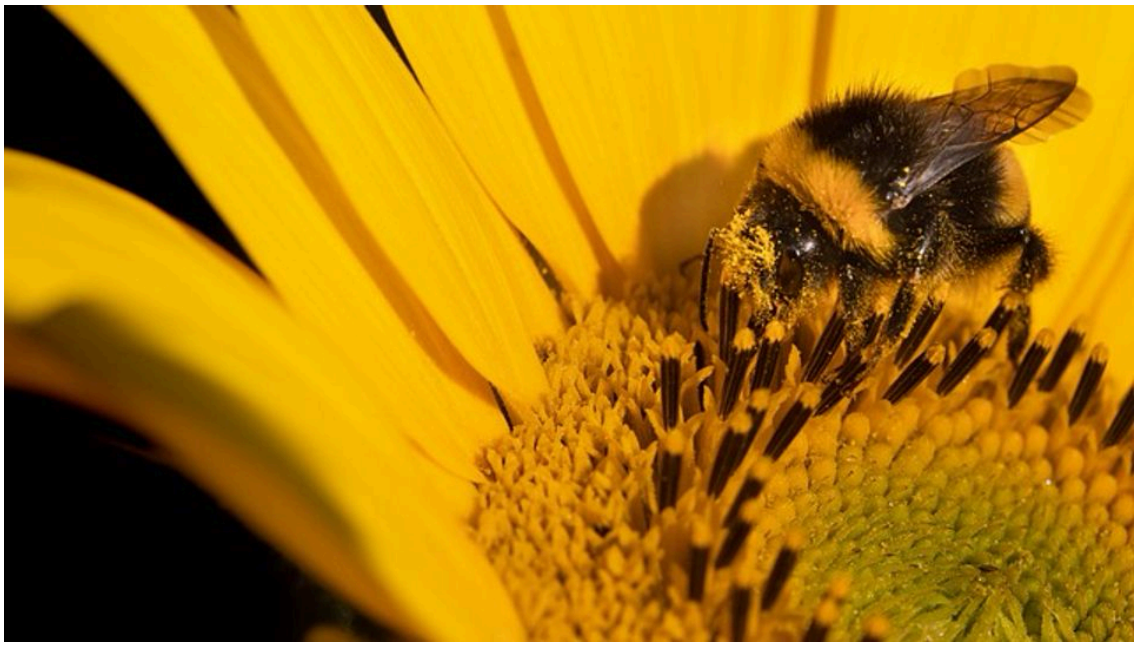
Sunflowers generate pollen from their male reproductive organs before their female dflowers evelop readiness to accept it. (Smith, 2019).

The sunflower controls self-fertilization by using its pollination approach to increase cross-plant fertilization for population diversity development (*Melchor, 2023)*. Sunflowers perform lower self-pollination than cross-pollination through bees since more advantageous seed qualities and larger yields occur when bees are present (Smith & Brown, 2019).

3.3.2 Pollen:

Plants of *Helianthus annuus* develop pollen cells throughout their multiple floral parts inside the anthers. The sunflower head contains numerous florets managed independently through their reproductive features (Hambler,2024). The process of sunflower seed development succeeds through pollen dispersal since bees utilize pollen for transferring plant materials between sunflower flowers on individual flowers or different plants. Pollen dispersal performance within agricultural sunflowers controls the number of seeds produced and improves oil yield outputs.(Butler, 2024).

In the picture below we can see a pollinator doing its job. There for the importance of pollinators such as bees, wasps, butterflies etc.



Technology Networks. “Sunflower Family’s Spiny Pollen Benefits Bumblebee Health.” *Applied Sciences From Technology Networks*, 6 Apr. 2023,

www.technologynetworks.com/applied-sciences/news/sunflower-familys-spiny-pollen-benefits-bumblebee-health-371908.

3.3.3 Ovule development:

Pollination, together with fertilization, takes place in sunflower floret ovaries to initiate seed development from ovules. (Butler, 2024). The proper development of ovules establishes vital conditions for seed viability by determining seed measurements and oil content, and total yield quantity (Butler, 2024). Seed quality mainly depends on temperature conditions and requires successful pollination along with appropriate environmental nutrient availability.(Butler, 2024).

3.3.4 Ovary wall development:

The growth of sunflower seeds leads to the development of hardened protective tissue that forms the pericarp shell surrounding the seeds. Sunflowers develop thin and strong pericarps, which later develop into seed hulls (Kennedy, 2021). Seed size, together with weight and oil content, depends on the growth pattern of the pericarp in oilseed production. The combination of ideal environmental conditions and efficient plant breeding techniques enables seed production of high-quality oil.(Kennedy, 2021)

3.4.1 Ecophysiology:

The development and seed production together with oil quality in Sunflowers *(Helianthus annuus)* strongly depend on appropriate temperature and light conditions and sufficient water supply(Kennedy,2020)

The damages from heat stress to pollen match the delays caused by cold temperatures, according to (Kennedy,2020). Irradiation of sufficient sunlight remains crucial for sunflowers to develop their seeds and oil correctly. Plant spacing, together with efficient watering system,s enhances water utilization to improve both seed quality and water efficiency(Kennedy,2020)

Managing water and temperature becomes vital for producing healthy sunflower seeds because drought causes seed size reduction alongside oil content.(Kennedy,2020)

4.0.0 Propagation & Management

4.1 NATURAL REGENERATION

Helianthus annus mainly functions through seed dispersal mechanisms made possible by small mammals and birds. (Blackman,2011). *H. annuus* wild populations achieve cross-pollination through insects such as bees, which produce various genetic variations in offspring. (Blackman,2011). *H. annuus* in captivity still has strong regeneration capabilities. Even though breeders select traits via selective breeding, the plant still holds vast capabilities of using its regeneration methods to keep reproducing. (Bruke,2002).

4.2 NURSERY PROPAGATION

4.2.1 Propagation from seed

4.2.1.1 Pre-preparation and implications for germination

Helianthus annuus seeds develop dormancy because of the combined influence of embryo structures and seed coat material. (Vasquez,2013) The natural process of dry storage breaks seed dormancy gradually, thus enhancing seed germination rates under various temperature conditions (Vasquez,2013). Light seed scarification and a 18-hour water soaking period serve as a method of accelerating seed germination, this process is also used in most plant species. (Vasquez,2013). *H. annuus* germination processes are influenced by seed size, density, and environmental factors. (Vasquez,2013)

4.2.1.2 Sowing and germination process

Helianthus annus needs moist well drained soil for there seeds. The seeds should be placed at a depth of approximately 2 inches (5cm)to grow. (Corbineau, Bagniol, Come,2013). Sunflower seeds will begin to germinate at a temperature of 4 degrees celsius, but have best results in soils at temperatures of 8-10 degrees. (Corbineau et al, 2013). Seedling emerge from soil in a span of 5 to 10 days. (Corbineau, Bagniol, Come,2013)

4.2.1.3 Storage

H. annuus seeds require appropriate storage conditions to thrive. (Selemani,2023) Seeds stored at 5°C while maintaining seed moisture at 6-8 percent and have the best chance of germinating properly. Sunflower seeds have a 90-day preservation period (Selemani,2023). Proper storage techniques make it so the seeds to be stored for at least a year or a decade. Seeds fail to survive in areas with high humidity, heat exposure, excessive light, or pests. (Selemani,2023).

4.2.1.4 Fertilizers

Fertilization is crucial to optimize growth. It's crucial to test the soil before applying any fertilizer; this guarantees we target the plant's specific needs. Nitrogen, phosphorus, and potassium are only some of the fertilizers best fit for the plant. Before plantin,g place phosphorus and potassium in the soil. As soon as the plant starts to blosso,m add fertilizer, but never on the stem as sunflowers are not accustomed to salts in these products. You can add liquid fertilizer to the leaves of the plant for quick nutrient consumption. (Boeckmann,2025)

4.3 PLANTING

Sunflowers are when planted in the northern hemisphere, thrive in late spring only when temperatures exceed 10 degrees Celsius.(Boeckmann,2025). Sunflowers need direct sunshine for up to 6 to 8 hours a day. Sunflowers thrive in conditions of well-drained soil. (Boeckmann,2025). Sunflowers prefer sandy loam, clay loam, and silt loam. (Boeckmann,2025). They grow best in earth conditions ranging from slightly acidic to neutral to basic, where the soil pH measures between 6.0 and 7.5. Different sunflower varieties need different spacing. (Boeckmann,2025). Sunflowers with heights of 2-5 feet need to be planted 6 inches from one another. Denser plant varieties need at least a foot of space between them. Giant sunflowers need about 2 feet of distance from one another. (Boeckmann,2025)

Figure 12

This is a graphical representation of the different soil types.

(Lambuni, 2005)

4.4 MANAGEMENT

4.4.1 Tending

Water is the most vital element for sunflowers. (Hynes,2024). Sunflowers need a constant moisture supply. When organic material is applied to plant beds, there are two benefits: It keeps moisture and it prevents weeds from growing. (Hynes,2024). Its important to remove leaves from the stick of the plant to reduce disease risk through improved air circulation. (Hynes,2024).

4.4.2 flowering and seed production:

Sunflowers take from 70 to 100 days to bloom. (Hynes,2024) The flowering duration depends on the species and environmental factors. (Hynes,2024) Flower head size and seed quality improve when growers perform proper thinning of their plant,s combined with efficient distribution of healthy seedlings on individual sunflower varieties. The ultimate seed level for sunflowers is reached through germination of insects like bees. (Hynes,2024)

4.4.3 Pest and disease control

Beetles (*Zygogramma exclamationis*) and moths (*Homoeosoma electellum)* are the most harmful insects that attack sunflowers. (Hynes,2024)To optimize pest control in sunflowers it's important to keep track of the pest population with their natural enemy and using *insecticide*. Sunflowers face three major diseases that include downy mildew (*Plasmopara halstedii*), rust (*Puccinia*

helianthi) and *Sclerotinia* stem rot (*Sclerotinia sclerotiorum)*. Many of these are because of insects. (Hynes,2024). It's important when treating the sunflower to add esfenvalerate, *beta-cyfluthrin, deltamethrin, chlopyrifos* or *lambda/ gamma* to treat diseases. This pest normally feeds on leaves and lays eggs on the stem. It's important to apply insecticide on the stem and leaves. (Butin,2018).

4.5.0 Importance of sunflower as an oilseed product

Sunflower is important around the world due to its oil and also because it is often grown for industrial purposes. As the world's fourth-biggest oilseed producer after soybean and palm. Sunflower seeds supply nearly 10% of annual vegetable oil (FAO, 2021). The sunflower serves an indispensable purpose in the global market and in many cases your French fries, nuggets or even fried chicken, is a byproduct of this vital seed oil. (Hynes,2024)

4.5.1 Crop rotation

The rotation of the sunflower croup is vital for natural regeneration. Planting *H.annus* after wheat, barley, or maize helps stop the spread of *Sclerotinia sclerotiorum* and *Homoeosoma electellum,* as well as improves both the structure and nutrient levels of the soil (Seiler,2017) H. annus is recommended to be planted for 3-4 years maximum, as the plant has a habit of absorbing the soil's nutrients at impressive rates. (Seiler,2017)Mixing sunflower with legumes like cowpea or groundnut improves soil nitrogen and helps keep weeds under control. (Seiler,2017)

4.5.2 Signs of maturity and optimal harvest time

By harvesting *H. annus* at the right time, we can ensure that we minimize yeild loss and maintain seed quality at its best rate. When *Helianthus annus's* head color is yellow and brown, the seed moisture is from 30 to 35 percent, indicating that the grain is fully mature. (Berglund, 2007). For the most effective seed, harvest should occur between moisture levels of 10 and 12 percent, when there's no mold, shattering, or oil damage (FAO, 2004).

5.0 Sunflower commercial importance

5.1.0 Exports and Imports

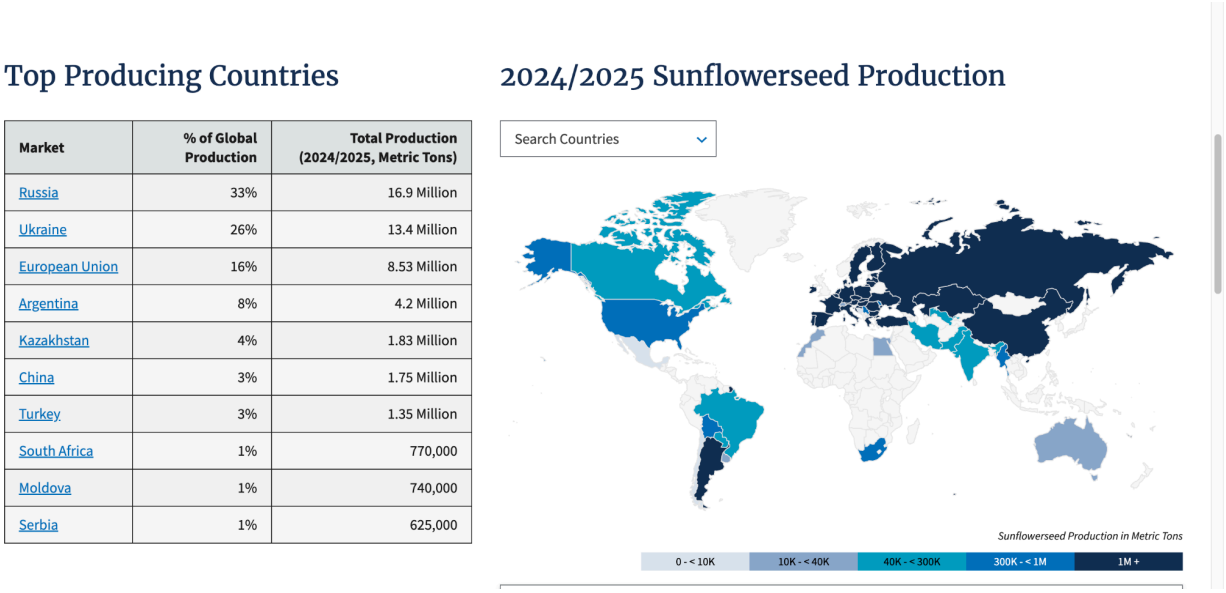
As the sunflower plant (Helianthus annuus) serves as a fundamental agricultural crop worldwide, its major production value originates from its oil-rich seeds. During the period from 2016 to 2021 global sunflower seed production reached 52 million metric tons through cultivation spreading across 27 million hectares in 73 countries yearly. (Drummond, Bramel, Lohwasser, Giovannini, 2023) Ukraine, together with Russia, dominatedthe production of over fifty percent of sunflower seeds worldwide. (Drummond, Bramel, Lohwasser, Giovannini, 2023)

For the 2024/2025 marketing year, Russia will dominate international sunflower seed production by yielding 16.9 million metric tons, which represents 33% of the worldwide total. (Drummond, Bramel, Lohwasser, Giovannini, 2023) The sunflower seed output from Ukraine totals 13.4 million metric tons, whereas Europe produces 8.53 million metric tons. (Drummond, Bramel, Lohwasser, Giovannini, 2023) The notable sunflower seed producers also comprise Argentina and Kazakhsta,n and China, along with Turkey. (Agatha,2018)

Academic research reveals the sunflower seed market maintains exponential expansion, whereas the worldwide market value evolved from $23.01 billion in 2024 to $24.24 billion during 2025, displaying a 5.4% compound annual growth rate. (Agatha,2018) The expansion of the sunflower seed market results primarily from increasing demand for plant-based oils, biofuel,s and sustainable agricultural practices. (Agatha,2018)

Figure 13

The picture below is a graphical representation of sunflowerseed production worldwide.



Top Producing Countries

Market	% of Global Production	Total Production (2024/2025, Metric Tons)
Russia	33%	16.9 Million
Ukraine	26%	13.4 Million
European Union	16%	8.53 Million
Argentina	8%	4.2 Million
Kazakhstan	4%	1.83 Million
China	3%	1.75 Million
Turkey	3%	1.35 Million
South Africa	1%	770,000
Moldova	1%	740,000
Serbia	1%	625,000

(*USDA Foreign Agricultural Service*, 2025)

Sunflower seeds have deep global market participation as both shipping and receiving nations. The United Kingdom and Poland, and Kazakhstan, along with other nations, stand as the leading importers, as Poland bought 58.9 million kilograms of sunflower seeds during 2021. (Agatha,2018) The quantity of sunflower seeds traded internationally depends on the agricultural output and worldwide demand for sunflower oil, as well as political changes within key production areas. (Agatha,2018)

The production market dynamics of Helianthus annuus maintain a strong connection to worldwide agricultural developments, together with economic elements in global trade patterns. (Hynes,2024)

5.2.0 Economic importance

The sunflower plant Helianthus annuus functions as an essential agricultural producer in both national and international economic sectors. Sunflowers rank as the fourth most vital oilseed plant after soybean, oil palm, and canola to produce worldwide oilseed crops, thereby being crucial to the agricultural industry. (WITS,2021)

Figure 14

In this picture, we can see the biggest brand that produces sunflower oil. Kernel is the biggest exporter of sunflower oil, the company is based in Ukraine.

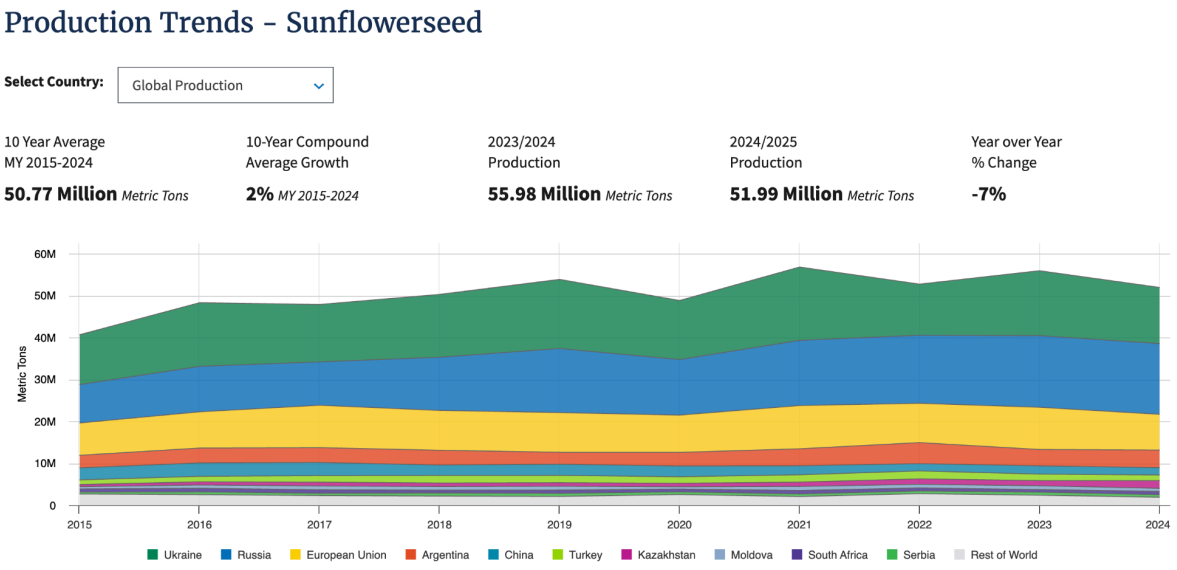
(kernel,2010)

Major sunflower producing nations like Ukraine together with Russia and Argentina alongside the USA, maintain agricultural companies through sunflower farming, which brings rural employment opportunities. (WITS,2021)The crop thrives across different climate conditions, along with its brief growth times that allow farmers to establish sustainable food sources while benefiting their economic stability in targeted areas .(WITS,2021)

Besides generating oil from sunflower,s the plant serves other uses, which include feeding animals and making biofuel, and recreational farm activities known as agritourism. (Butin,2018). The multiple uses of sunflowers create economic value for the crop as well as generate diverse activities throughout various sectors of the economy. (Butin,2018).

Figure 15

This picture is a graphical representation of production trends throughout the world.



(USDA Foreign Agricultural Service,2025)

6.0 Cultural Significance:

Traditional attachments between many regions of history relate to the *H Annus* through artistic interpretations that avert both religious insights and national identity. (Cheshire,2025) Different North American Indigenous groups living between modern-day Mexico and the United States used sunflowers in religious practices while at the same time exploiting them for medicine and both food and coloring elements. The sharp, dazzling display of the flower draws viewers to make associations about life energy because the flower seems to emit a sunlight effect. (Cheshire,2025) During the 18th and 19th centuries,s Europeans began loving sunflowers as expressions of devotion through artistic representation and literary works. Through his Sunflowers series, Vincent van Gogh made sunflowers signify artistic influences and passionate emotional energy. (Cheshire,2025) The sunflower continues its status as a symbolic representation of optimism and sustainability as well as solar energy and environmental and peace causes in contemporary global campaigning. Worldwide fascination for human nature combined with creative thought makes the sunflower stay permanently relevant in folklore and religion, as well as modern visual culture. (Cheshire,2025)

In the pictures below, we can see the importance of art in our modern world. We can see how indigenous tribes used sunflowers, how Gustav Klimt portrayed sunflowers in art in 1907, or perhaps the most notable, Vincent Van Gogh's sunflower series. Its important to highlight that most of these artworks, except the first one, were depicted in Europe; the global market shifted after the americas were discovered and the sunflower was introduced into Europe.

Figure 16

Indigenous depiction of sunflower.

(Thursd,2023)

Figure 17

Van Gogh “ Floral arrangement”

(Thursd,2023)

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