Food and Agriculture Organization of the United Nations

Lebanese Republic
Ministry of Agriculture

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Good Agricultural Practices for chickpea cultivation and introduction to informal seed system

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Training of Trainers (TOT)

Dr. Rola EL AMIL

Head of Plant Breeding Department

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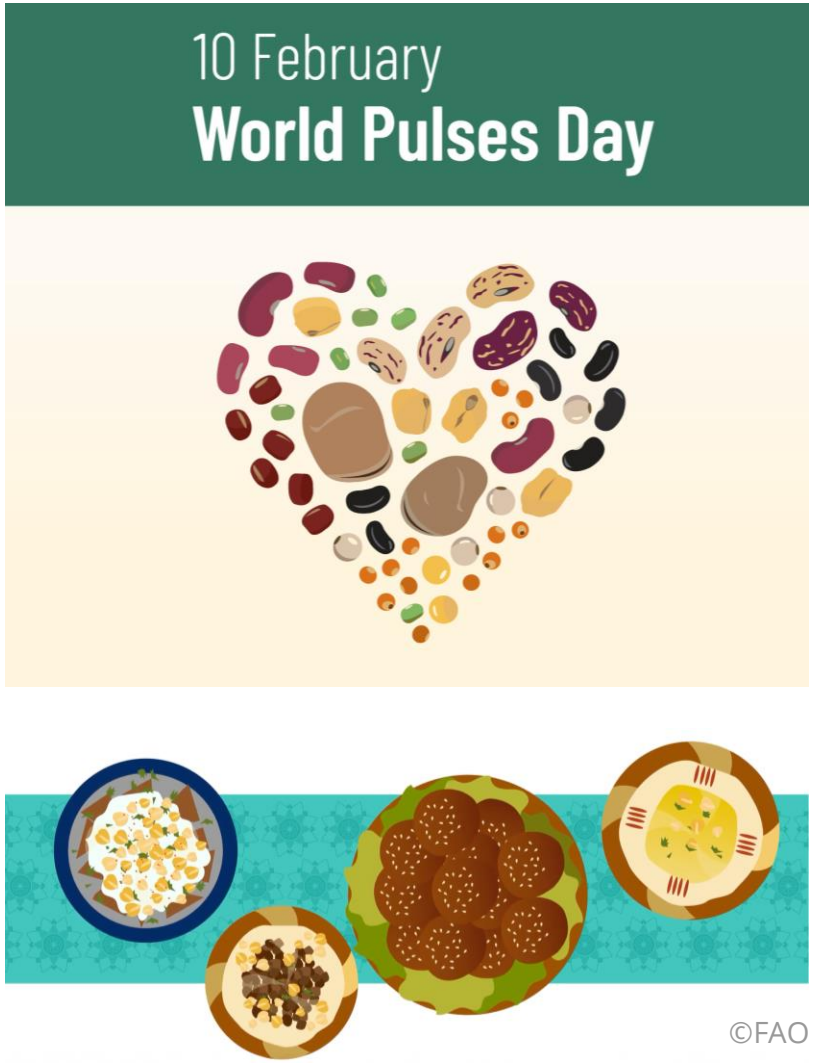
World Pulse Day : 10 February

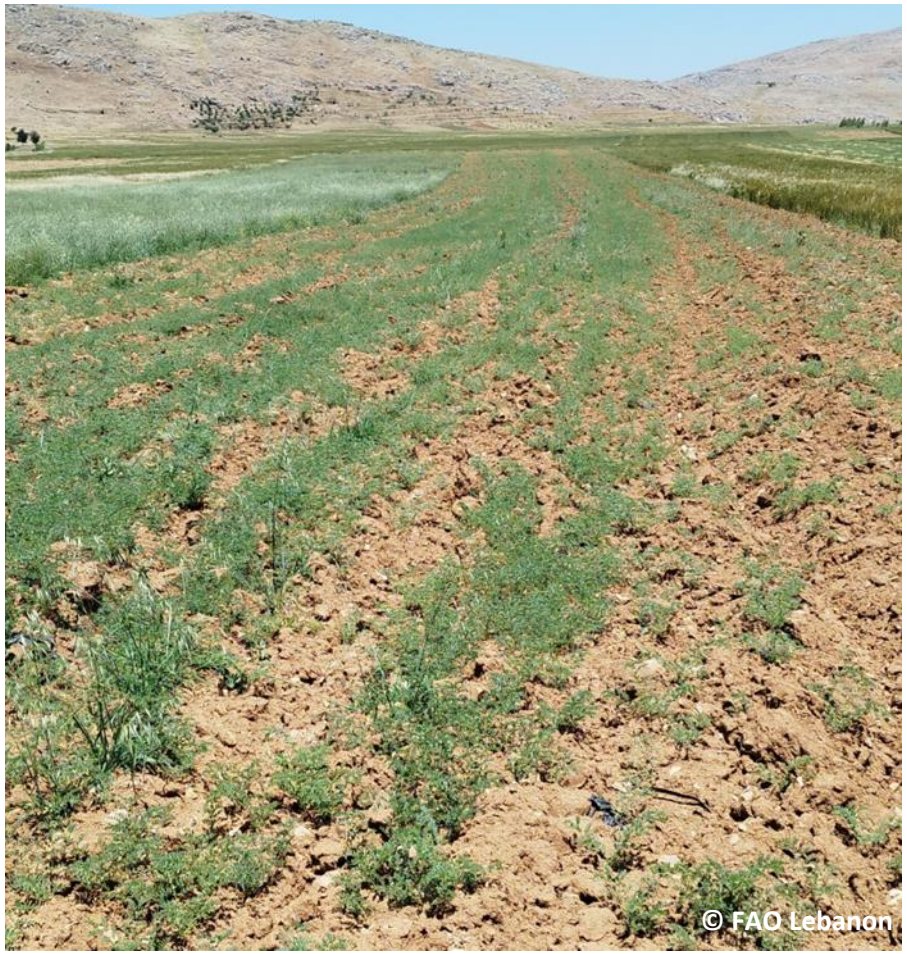
Pulses: Bringing Diversity to agrifood systems

- ✓ Pulses are nutrient-dense, providing a good source of vitamins and minerals that are vital for good health
- ✓ Pulses have a long shelf-life and help to increase the diversity of diets, while reducing food loss and waste
- ✓ Pulses in multiple cropping systems enhance agrobiodiversity, climate change resilience and ecosystem services
- ✓ Pulses fix atmospheric nitrogen into the soil, contributing to improving soil biodiversity and fertility
- ✓ Including pulses in crop rotations can improve chemical fertilizer use efficiency
- ✓ Pulses provide employment and entrepreneurial opportunities for rural women and youth



1.1 Taxonomy, Botany and Morphology

- ✓ Chickpeas originated in the Middle East (area between south-eastern Turkey and adjoining Syria) and spread to European countries in the west to Myanmar in the east.
- ✓ Chickpea belongs to the monogenetic tribe : Cicereae of the family Fabaceae.
- ✓ Cicer arietinum is a short annual herb, attaining a height of less than a meter.
- ✓ Depending on the angle of the branches and the soil surface, the plant assumes ‘erect, semi-erect, spreading, semi-spreading and prostrate’ growth habit.
- ✓ Except the petals of the flower, all the plant parts are covered with glandular and non-glandular hairs.



1.1 Taxonomy, Botany and Morphology

- ✓ The glandular hairs secrete a mixture of acids containing malic, oxalic and citric acids. This acid mixture acts as a defence mechanism against sucking pests. The exudation from the roots helps in solubilizing the soil nutrients.
- ✓ The plant produces three types of branches—primary, secondary and tertiary. The lowest nodes of the plant produce 1–8 primary branches.
- ✓ Root: The root system is characterized by a thick tap root with several side roots developing into a robust system. The epidermis is hairy.
- ✓ The presence of nodules on roots indicates symbiotic relationship between chickpea and the Rhizobium bacteria (Mesorhizobium ciceri) leading to biological nitrogen fixation. The tap root system is so robust that it reaches more than 3 m in soil favouring the plant to survive in moisture stress conditions

1.1 Taxonomy, Botany and Morphology

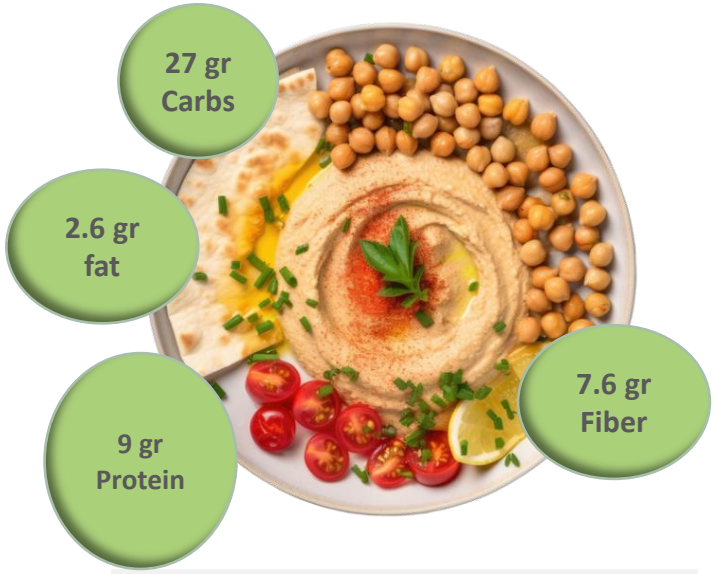
- ✓ Chickpea is a highly self-pollinated crop.
- ✓ The typical papilionaceous flower, with one big standard, two wings and two keel petals (boat shaped), has 9 + 1 diadelphous stamens and a stigma with 1–4 ovules.
- ✓ Anthers dehisce a day before the flower opens leading to self-pollination.
- ✓ In four weeks after pollination, pod matures with one to three seeds per pod.
- ✓ There is no dormancy in chickpea seed.

1.1 Taxonomy, Botany and Morphology

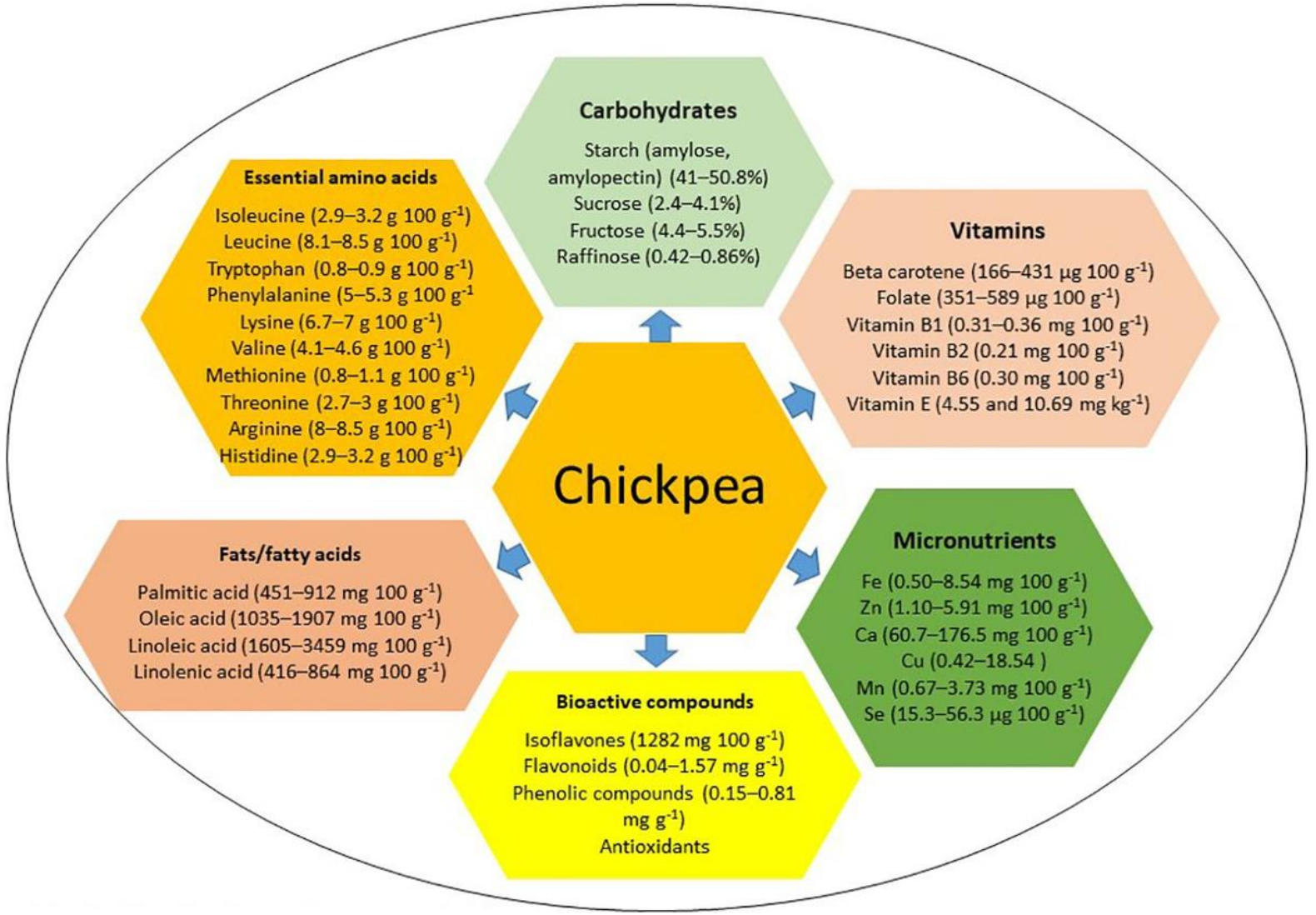
Desi chickpeas: These are split peas, and are relatively small in size, with a thicker seed coat than the kabuli (around 0.2 g per seed). Desi chickpeas are dark brown in color and can be used and served in many ways. The stem and leaves may contain anthocyanin pigmentation. Grown in tropical regions.

Kabuli chickpeas: These have a whitish-cream color, are relatively bigger in size and have a thinner seed coat(around 0.3–0.5 g per seed) to extra large (more than 0.5 g per seed). Kabuli chickpeas are generally used in soups and salads, hummus, and to make flour. The plants will not have anthocyanin pigmentation. Grown in Mediterranean regions.

1.2 Nutritional composition of chickpea

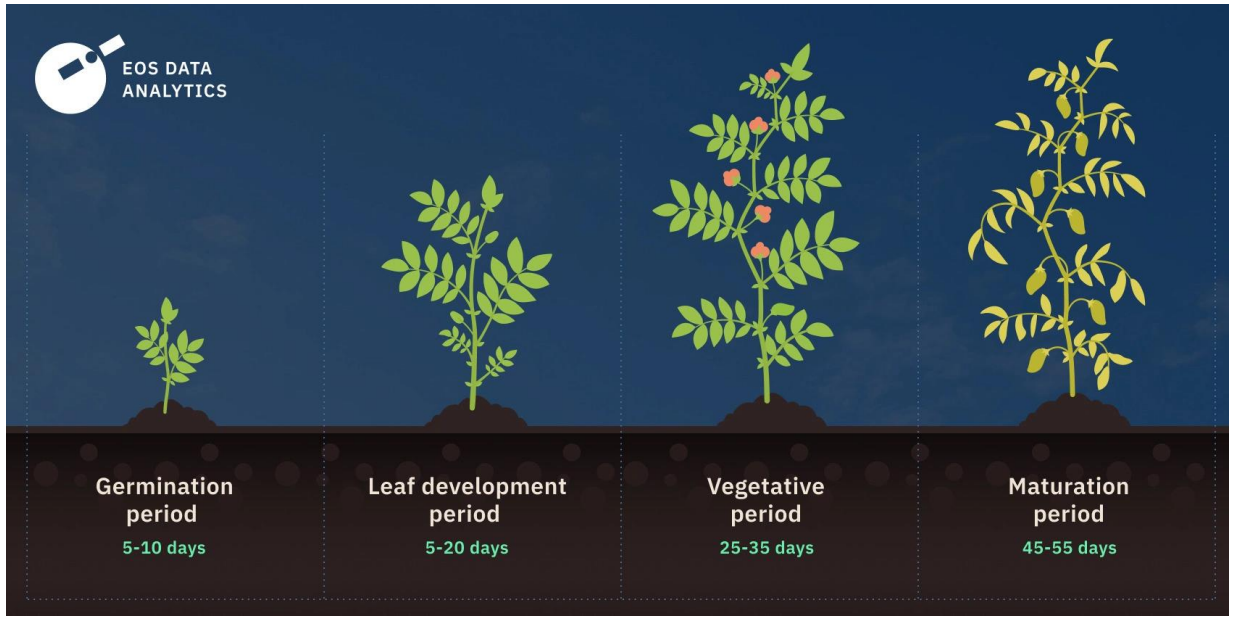


Good source of protein
100g cooked



1.3 Growth habit

- ✓ Chickpeas are a medium-duration crop, usually with maturity varying from 90–120 days, depending on type, photoperiod and temperature.
- ✓ Chickpea is a photoperiod sensitive, long-day plant, where flowering is delayed as day length becomes shorter than a base photoperiod (17 hours).
- ✓ Chickpea can withstand a wide range of soil pH (5.5–8.6), but it is very sensitive to saline and alkaline soils.
- ✓ Plant chickpea in fall using cold tolerant varieties for a more productive crop compared to a spring planted crop.
- ✓ Autumn planted chickpea grows taller and thus suitable for machine harvesting , manual harvesting involves higher cost than machine harvesting, and higher biomass produced suitable for animal feed.

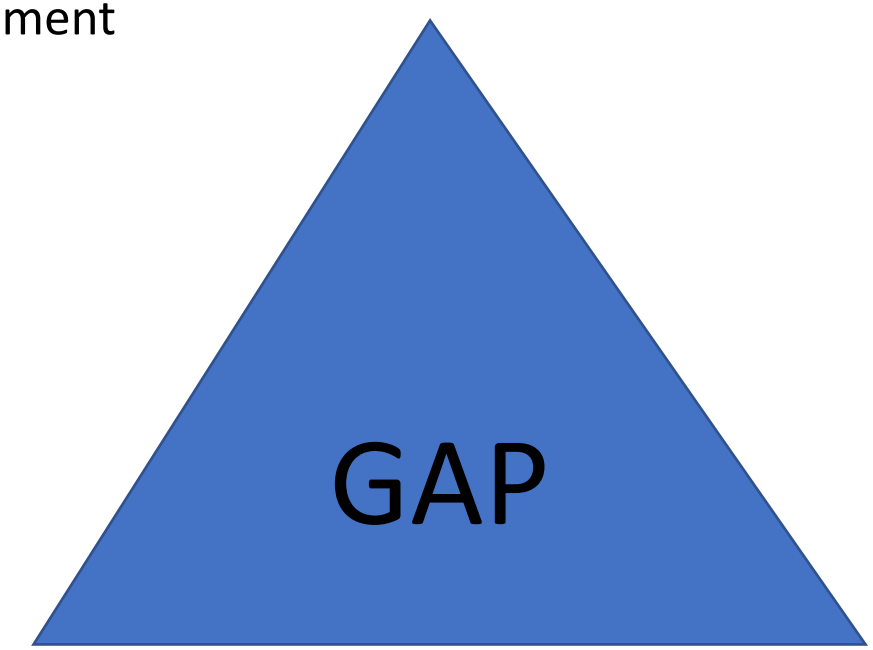


1.4 Phenological stages

- ✓ Sowing to germination.
- ✓ Germination to emergence.
- ✓ A period of vegetative growth after emergence, called the basic vegetative phase (BVP), during which the plant is unresponsive to photoperiod.
- ✓ A photoperiod-induced phase (PIP), which ends at floral initiation.
- ✓ A flower development phase (FDP), which ends at 50% flowering.
- ✓ A lag phase prior to commencement of grain-filling (in chickpea this period can be very long, up to two months in some cases).
- ✓ A linear phase of grain filling.
- ✓ A period between the end of grain-filling and physiological maturity.
- ✓ A harvest-ripe period prior to grain harvest.

2. Good Agricultural Practices for quality and healthy seed production

Management : choice of planters, seed rate, fertilization, Irrigation, timely application of pesticides and integrated pest management



Genotypes: Cold tolerant, pests tolerant/resistant, seed class or single plant

Environment: Land history, previous crops, soil bed preparation

2.1 Land preparation and choice of seeds

- **Create a clean medium for seeds by soil preparation**

✓ Ploughing and harrowing: clean seed bed, levelling,

✓ Planting in equal distances: seed spacing (15-20 cm), and row (30-45 cm), depth (7-10 cm).

✓ Rolling, proper drainage…

- **Certified seeds/declared seeds**

✓ Seed size : affecting seed rate: 12-15 kg/dn

✓ Seed germination (>80%) and vigour

✓ Seed purity

2.2 Pests and diseases

- ✓ Chickpea has a natural resistance to insects due to the hairy nature of the plant's leaves, stems, and pods.
- ✓ The plant excretes malic acid from these hairs, leaving the crop unattractive to most insects.
- ✓ Worldwide the insect that causes the most economic damage in chickpea is the corn ear worm (Helicoverpa armigera).
- ✓ Seedling insects such as armyworm (Spodoptera sp.) can cause stand loss and fields should be scouted early for signs of damage.
- ✓ So, monitoring is the key step for early detection of the insect!

2.2 Pests and diseases

Pest/Disease	Symptoms	Control measures
Aphids	• Yellowing and curled leaves; • Sticky honeydew on leaves; stunted plant growth; • Reduced pod formation.	• Insecticidal soap applications; neem oil spraying; • Natural predators (ladybugs, lacewings); • Companion growing of marigolds or mint;
Thrips	• Silvery-white leaf Discoloration; • Distorted leaves; • Scarred and deformed pods.	• Insecticidal treatments; • Blue sticky traps; • Field sanitation; • Watering near the root zone

2.2 Pests and diseases

- ✓ **Ascochyta Blight:** caused by the fungus ***Didymella rabiei*** (Teleomorph) / Aschochyta rabiei (Anamorph), is the most significant challenge in the production of chickpeas.
- ✓ Necrotrophic fungus, infects all aerial parts of the plant, which results in severe yield loss (Stem, leaves, pods, grains).
- ✓ In the field, symptoms of Ascochyta blight are observed as distinct, circular or oblong lesions containing concentric rings. The darkened rings present in the lesions containing small brown-black fungal structures called pycnidia are the key diagnostic feature of the disease.

2.2 Pests and diseases

Disease monitoring and treatment for AB

- ✓ Proper destruction of diseased stubbles can also reduce the fungal inoculum load.
- ✓ Crop rotation with nonhost crops is critical for controlling the disease.
- ✓ Planting moderately resistant cultivars and prudent application of fungicides is also a way to combat AB disease.

2.2 Pests and diseases

Disease monitoring and treatment for AB

- ✓ Seeds should be treated with systemic fungicides (Tebuconazole).
- ✓ Crop residues are a major source of inoculum; therefore, a minimum rotation of 3 years is recommended.
- ✓ Chemical control: before and after flowering : (Tebuconazole + Azoxystrobin, Bixafen + Prothioconazole and Fludioxonil + Pydiflumetofen), Chlorotalonil to prevent pod infection.
- ✓ If disease is observed or weather remains favorable, additional applications are recommended every 10 to 14 days.

2.2 Pests and diseases

- ✓ **Damping off and seed root rots** of pulses are a disease complex caused by several species of fungi. Pythium, Fusarium, and Rhizoctonia are most often the cause of both disorders.
- ✓ To prevent both root rot and damping off, all pulse seed should be treated with systemic fungicides
- ✓ Avoid planting in heavy soil; well drained soil is perfect to avoid the complex of root diseases.

2.3 Weed management

One of the biggest challenges for growing chickpeas is weed control.

- ✓ Chickpea is a poor competitor with weeds at all stages of growth. Slow growth during the seedling stages, in addition to an open canopy architecture and low growth nature of chickpea plants, reduces its ability to compete with weeds.
- ✓ Preventive methods: Field's weed history, clean fields with history and records.
- ✓ Cultural methods: Crop rotation, sanitation, seeding rate, tillage…
- ✓ Effective use of herbicides: Pre-emergence : Pendimethalin and post-emergence: Hyaloxyfop-methyl in the season.

2.4 Fertilization

- ✓ Chickpea is an excellent nitrogen fixer, and the nodules can be easily seen when a plant is pulled from the ground.
- ✓ Normally about 70% or more of the N in the plant comes through biological fixation, with the remainder supplied through the soil as nitrate mineralized from organic matter or from starter fertilizer.
- ✓ Nodules should develop within four weeks of plant emergence and are healthy and working to fix N if they are pink on the inside.
- ✓ When plants fail to nodulate or nodulate weakly, N deficiency will begin to occur as available N from the soil is exhausted. Soils rich in N may reduce nodulation leading to longer periods of vegetative growth with delayed flowering and seed set.

2.4 Fertilization

- ✓ Soil Testing
- ✓ Pre-planting fertilization: 100 kg/ ha N P K (20 20 20)
- ✓ Post-emergence fertilization: Not recommended
- ✓ Fertilization during phenological stages: urea (46%) 100 kg / ha with supplemental irrigation at pod filling and seed formation.

Amount of fertilizer needed=Percentage of nitrogen in the fertilizer/ Desired nitrogen amount

2.5 Irrigation management

- ✓ As a rule, in-crop irrigation should start early when there is a soil moisture deficit of between 30 mm and 40 mm for germination (emergence can be delayed till 30 days).

- ✓ Irrigations should also commence prior to vegetative phase and to flowering phase to prevent moisture stress and high temperatures impacting on grain size, quality and yield. This is particularly important with kabuli types where premiums are paid for larger seed sizes.

How much water do chickpeas need to grow?

They need about **152–254** mm of water from precipitation and/or irrigation for the chickpea on critical stages. So, they are perfect for arid or poorly irrigated growing regions

2.6 Harvesting

- ✓ Chickpeas can be harvested when most of the plants are yellow, and most pods are mature (yellow to brown in color). At this stage, the top of the plant may still be green.
- ✓ Chickpea is relatively easy to harvest as they are erect, do not lodge and rarely shatter unless harvest is delayed in case of improved varieties.
- ✓ If left in the field too long following maturity, seed weathering can reduce quality.
- ✓ As chickpeas are indeterminate, desiccants can be very useful for advancing harvest and evening up maturity.
- ✓ Receival moisture content for chickpea harvesting is 14% and storage above this will require aeration.

3. Introduction to national seed program

- Seed is a basic and fundamental input for crop production determining yield and affecting food and nutrition security

- A sustainable seed system will ensure **high quality seeds or declared quality seeds**

- The dissemination and use of high-quality seeds have great benefits to **increase and continue crop production**, improve household incomes, minimize risks of insect pests and plant diseases, and enhance the crop production patterns, which would increase agriculture sustainability.

- Therefore, viable seed supply system strategies are important to ensure the availability of good quality varieties of seed to farmers in a timely and affordable way.
- The existing types: **Formal, informal** and **semi-formal** seed supply system

Harvested Chickpea FLIP97-706C Type / Winter Crop trials at Tel Amara site – LARI 2023 (Credit: © FAO Lebanon)

3. Introduction to national seed program

- **Quality declared seed** is essential for good crop yields and it minimizes the likelihood of crop failure. (FAO)

- On the contrary, seed from unknown sources may result in poor stand establishment, unsatisfactory field performance and low yield. In case of seed contamination with undesirable species or infected with pathogens, farmers may have to resort to the use of extra herbicides or pesticides.

Other benefits include:

- increased productivity
- nutrient- and water-use efficiency
- increased resistance to insect pests and diseases
- greater tolerance to environmental factors (drought, flood, frost etc.)
- improved nutritional value.

In summary, farmers who use quality declared seed can realize the full potential of modern high-yielding varieties

Harvested Chickpea FLIP97-706C Type / Winter Crop trials at Tel Amara site – LARI 2023 (Credit: © FAO Lebanon)

3. Introduction to national seed program

High/declared quality seeds can also :

- Ensure that the best quality seeds are produced and sold to farmers.
- Prevent the spread of weeds, pests and diseases, particularly invasive types.
- Meet consumer demands for specified qualities.
- Cater for the needs of specialized farming.
- **Comply with mechanization of agriculture**.
- Encourage healthy competition among seed traders

Harvested Chickpea FLIP97-706C Type / Winter Crop trials at Tel Amara site – LARI 2023 (Credit: © FAO Lebanon)

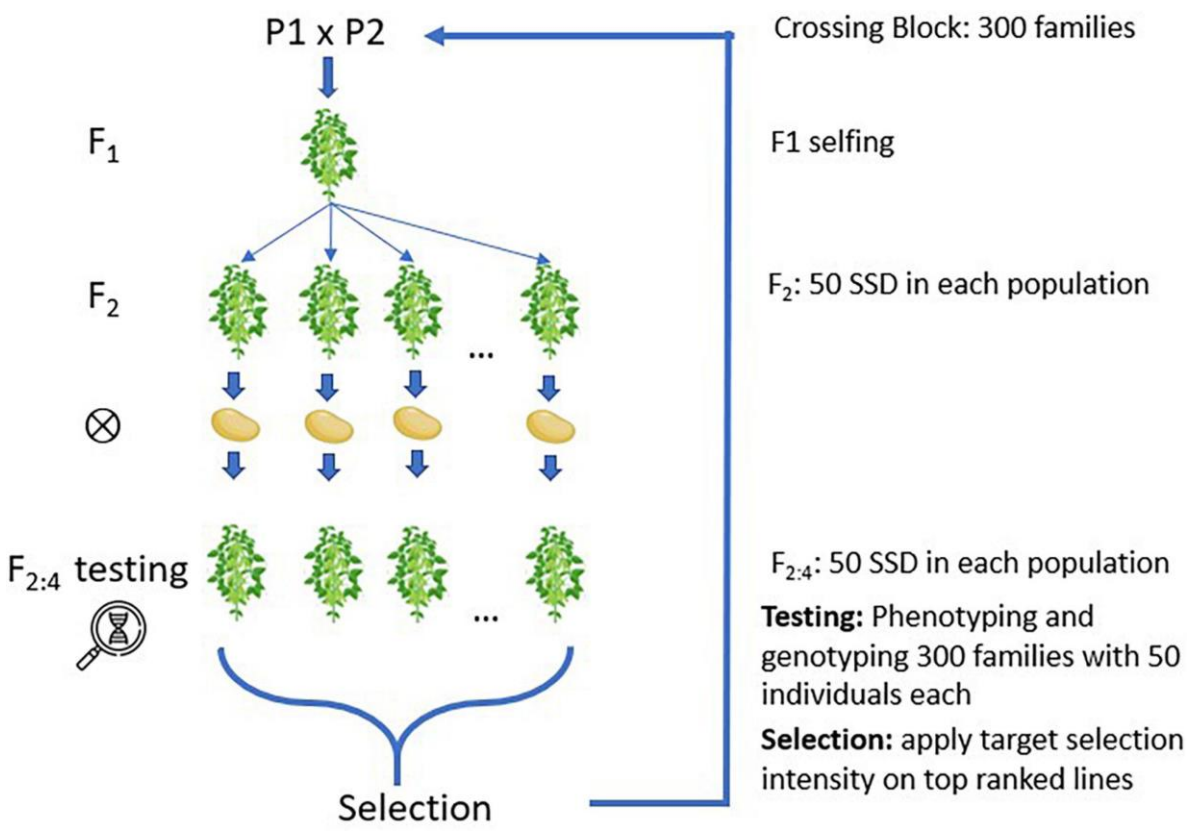
3.1 Seed Certification

- Seed certification is a **regulatory process** designed to maintain and make available to farmers high quality seeds and propagating materials of superior crop varieties, grown and distributed to ensure **genetic identity** and **genetic purity** (International Crop Improvement Association, 1968). It also ensures other factors, including absence of weeds and diseases, analytical purity and viability.

- The seed certification authorities adopt predetermined **standards and systems** for the production, multiplication and marketing of seed.

3.1 Seed Certification

Breeding scheme



Crossing Block: 300 families

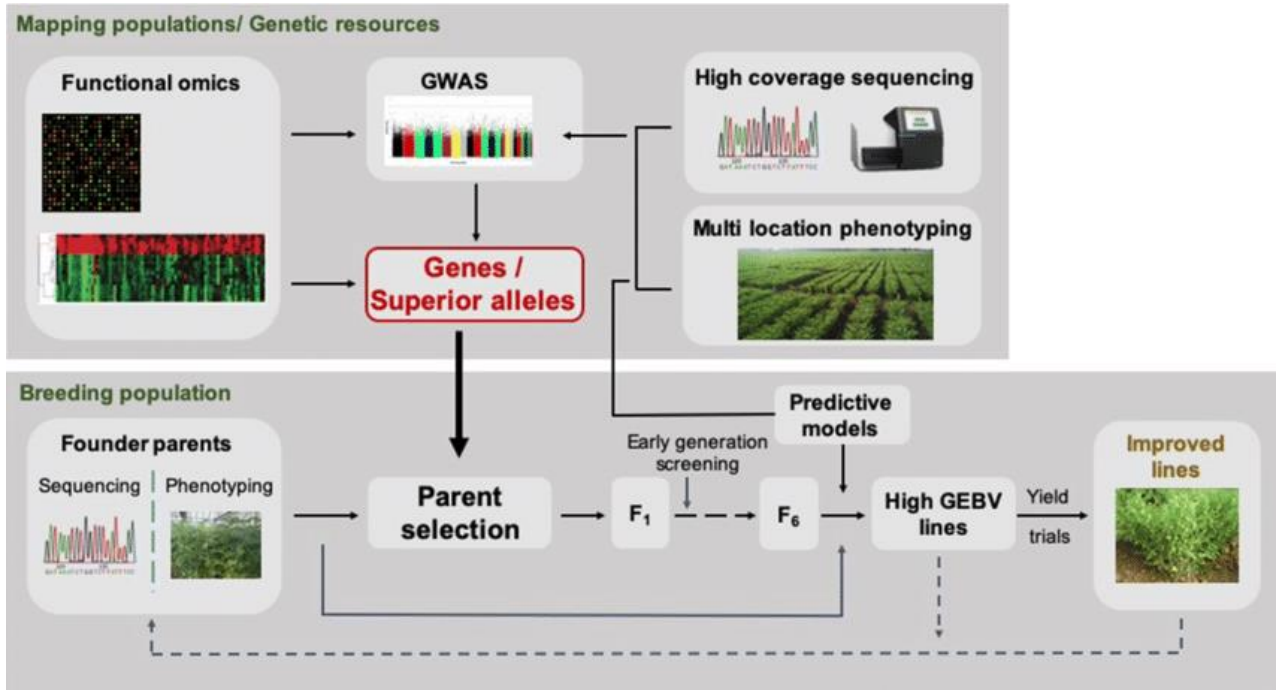
F1 selfing

F_2: 50 SSD in each population

$F_{2:4}$: 50 SSD in each population

Testing: Phenotyping and genotyping 300 families with 50 individuals each

Selection: apply target selection intensity on top ranked lines



Registration

First step in breeding/variety creation: conventional versus high throughput

3.1 Seed Certification

Varieties Evaluation and Testing

one variety, one name, one description

Objectives:

- Establish the identity of the variety.
- Set performance standards.

In order to be included in the **national Catalogue/list**, testing must be done over at least two cropping seasons involving two series of **evaluations**:

- **DUS** testing - **D**istinctness, **U**niformity and **S**tability
- **VCU** testing - **V**alue for **C**ultivation and **U**se

3.1 Seed Certification

Varieties Evaluation and Testing

DUS: Morphological, physiological, cytological or chemical characters are used to establish the varietal identity by assessing the distinctness, uniformity and stability. The test is usually conducted for a minimum of 2 years in at least one location, where the variety is going to be released.

VCU : Variety trials and national performance trials. VCU trials are multilocation trials and are conducted in different agroecological zones to assess the variety's response to different agroecological conditions. VCU trials are usually performed for 3 years.

In a VCU trial, the seed is sown in plots with a harvest area 2 m wide and 10 m long. The plots are replicated in each trial, the number of replicates depending on the size of the trial and the number of trials carried out.

3.1 Seed Certification

In formal seed production system, **different classes (5 in case of nucleus seed)** of standard are known, though each country has its own specification based on the affiliate international protocols such as International Seed Testing Association (ISTA) or OECD (Organization for Economic Cooperation and Development (Europe) seed schemes, or Union for the Protection of Varieties (UPOV).

1.Breeder seed: the highest purity of the new cultivar and maintained and multiplied by breeder.

2.Foundation seed: This is a class of seed produced from breeder seed. The breeder and research institutions are the ones who help to keep genetic purity and identity.

3.Registered seed: This class of seed is produced from foundation seed and is produced by selected farmers and seed companies under the seed regulation agency to keep varietal identity and purity.

4.Certified seed: This class of seed is produced from foundation or registered seed, or sometimes from certified seed and is available to farmers for general production. It is grown by selected farmers who have experience and capacity to produce the certified seed. This helps to maintain varietal purity. Production of certified seed is subjected to field and seed (lab) inspection priority to approval by certifying agency.

3.1 Seed Certification

Seed classes and Nomenclature in WANA regions

Generation	OECD	AOSCA	Egypt	Ethiopia	Morrocco	Syria
First generation	Breeder	Breeder	Breeder	Breeder	Epis-Lignes (G0)	Nucleus
Second generation	Pre-basic	Foundation	Foundation	Pre-basic	Prébase (G1, G2, G3)	Foundation
Third generation	Basic	Registered	Registered	Basic	Base (G4)	Registered
Fourth generation	Certified 1	Certified	Certified	Certified 1	Reproduction R1	Certified
Fifth generation	Certified 2	Certified	Certified	Certified 2	Reproduction R2	Certified

Research

Research &key seed producer

Key seed producer

3.1 Seed Certification

Labelling

Name of Crop , Name of variety ,Tag number ,Lot number, Production Year, Physical Purity Percentage , Moisture percentage , Germinating percentage , Seed weight, Date of seed testing , Name of entity , Address of producer, Treated chemical name

3.1 Seed Certification

Variety Maintenance

Purification , Mass selection, and plant to row

- ✓ Purification aims at producing a very clean starting stock for further multiplication. The best available seed field is selected, and obvious contaminants are removed from the field.
- ✓ Mass selection: the best individual plants are selected from a field. These selected individual plants are bulk-harvested.
- ✓ Plant to row: the best method for variety maintenance of chickpea. Single plants typical of the variety are selected and harvested and kept separately. These seeds are planted in rows (plant rows); during production, off-type rows and off-type plants within the rows are discarded.

3.2 Scheme of seed multiplication

Year 0

Select 500 plants typical of each variety: Harvest and thresh each selected plant separately

Year 1

Sow seed from each plant in a single progeny row Inspect progeny rows and discard all rows with off-types

Select again 500 plants for next cycle of maintenance Bulk-harvest remaining seed to constitute breeder seed

Year 2

Sow 500 progeny rows and repeat the above cycle “maintenance”

Sow breeder seed bulk to produce pre-basic seed “multiplication”

3.3 Seed production

Key components of producing quality seed of chickpea varieties include:

- ✓ Site selection to avoid high risk environments and Isolation from sources of contamination;
- ✓ Clean field selection to eliminate volunteer plants and noxious weeds from preceding crops;
- ✓ Previous cropping to avoid build-up of volunteers and soil-borne pests;
- ✓ Rouging to remove contaminants;
- ✓ Limited generations of multiplication to reduce contamination; Maintaining the cleanliness of farm machinery during planting, harvesting and transportation;
- ✓ Maintaining the cleanliness of machinery to avoid admixtures during cleaning, treatment and storage;
- ✓ Production arrangements using specialized contract key producers
- ✓ Implementation of quality assurance systems.

3.4 Quality and healthy seed post-harvest

- **Seed health :**

The **presence or absence** of disease-causing organisms e.g. fungi, bacteria, viruses, nematodes, phytoplasma, parasitic plants, and ecto-parasites like insects and mites.

- **Seed pathology :**

The study of seed-borne diseases, including **the infection mechanism**; seed transmission; **role of seed-borne inoculum** in disease development; **techniques for detection** of seed-borne pathogens; seed certification standards; **deterioration due to storage fungi**, mycotoxins and mycotoxicosis; and **control of seed-borne inoculum**.

- **Prescribe seed treatment.**
- **Enable seed certification.**
- **Determine the need for plant quarantine.**
- **Conserve seeds in gene banks**.

3.4 Quality and healthy seed post-harvest

Management of seed-borne pathogens

1- Crop production practices: good practices and management along all crop production stages from seed to harvest.

2- Seed fumigation: reaching hiding places; and no hazardous residues; high precaution in applying (Phostoxin).

3- Seed treatment: physical e. g. hot water, dry air; chemical e.g insecticides; Biological e.g. Bacillus and Trichoderma.

4- Seed certification: Certification goes hand in hand with seed quality control in which the most important seed qualities are viability, purity and health.

5-Plant quarantine: prevent the entry of **dangerous pathogens** and regulations to exclude pathogens from invading into the areas where they do not exist by **monitoring the import and export** of plant, seed or planting material to **prevent spread of diseases and pests.**

3.5 Introduction to informal seed

An **informal seed system** refers to the non-commercial, community-based practices through which farmers acquire, produce, exchange, and manage seeds. Unlike formal seed systems, which are regulated and involve the commercial sale of certified seeds by specialized companies, informal seed systems are characterized by the following features:

1. Local Seed Exchange: Seeds are often exchanged directly between farmers through barter, gifting, or informal sales. These exchanges are usually based on trust and social networks within the community

2. Farmer-Saved Seeds: Farmers save seeds from their own harvest to use in the next planting season. This practice helps maintain locally adapted varieties that are well-suited to the specific environmental conditions of the area.

3. Diversity and Adaptation: Informal seed systems typically involve a wide variety of crops and cultivars, promoting **genetic diversity and resilience**. These systems are crucial for maintaining landraces and traditional varieties that might not be available through formal channels.

3.5 Introduction to informal seed

4. Traditional Knowledge: The system relies heavily on the traditional knowledge and expertise of farmers regarding seed selection, storage, and planting practices. This knowledge is often passed down through generations.

5. Low Input Requirements: Seeds in informal systems generally require fewer inputs (like fertilizers and pesticides) compared to commercial seeds, as they are adapted to local conditions and traditional farming practices.

6. Community Seed Banks: These are local repositories where seeds are stored, shared, and managed collectively by a community. They serve as a source of diverse and resilient seeds for local farmers.

7. Lack of Regulation: Unlike formal systems, informal seed systems are not subject to stringent regulatory controls. This allows for more flexibility and adaptation to local needs and conditions but can also pose challenges in terms of seed quality and disease management.

3.5 Introduction to informal seed

In summary, informal seed systems are essential for sustaining agricultural biodiversity, ensuring food security at the local level, and supporting the livelihoods of small-scale farmers.

They operate primarily through local, non-commercial mechanisms that emphasize community involvement, traditional practices, and the conservation of genetic resources.

At Farmer's level

The best method for variety maintenance of chickpea is Plant to row . Single plants typical of the variety are selected and harvested and kept separately. These seeds are planted in rows (plant rows); during production, off-type rows and off-type plants within the rows are discarded.

3.5 Introduction to informal seed

Limitations of Informal Seed System

1. Quality Control: Lack of formal testing for germination rates and disease resistance
2. Scalability: Challenges in meeting large-scale agricultural demands
3. Market Access: Limited market opportunities for informal seed producers

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Thank you

Dr. Rola AL AMIL

Head of Department of Plant Breeding