1 Agronomy

Definition, Scope, Objectives & Importance

Definition & Scope

- Agronomy is the application of plant, soil, water, climate, and socio-economic sciences to crop production.
- Scope includes crop physiology, breeding, soil science, irrigation, pest management, farm systems.

Scope, Objectives & Importance

Scope

- Crop genetics & physiology
- Soil fertility & nutrient cycles
- Water management & irrigation
- Weed, pest & disease control
- Farm planning & cropping systems

Objectives

- Maximize yield and quality
- Conserve soil and water resources
- Adapt farming to agro-climatic zones
- Enhance farmer livelihoods and food security

Importance

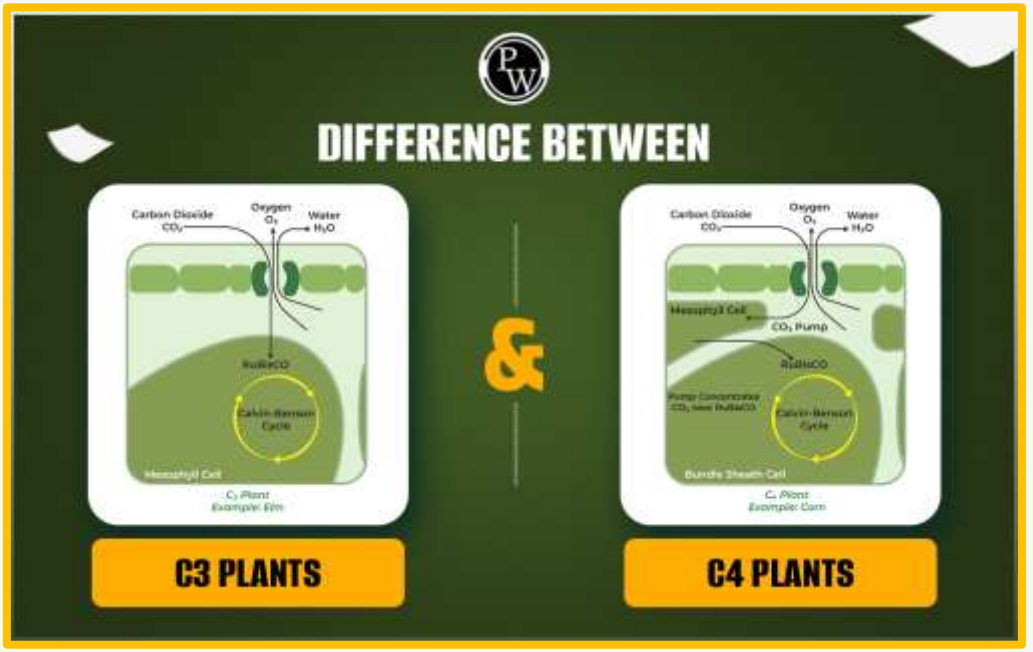
- Foundation of national food security
- Guides policy, research & technology
- Integrates multidisciplinary knowledge

Crop Classification

Crop Classification with Categories and Examples

Criterion	Category	Definition	Example Crops
Life Cycle	Annual	Completes life cycle in one season/year	Rice, Wheat
	Biennial	Completes life cycle in two seasons/years	Sugar beet, Carrot
	Perennial	Lives for more than two years, yields multiple times	Sugarcane, Banana
Photosynthesis Type	C3	Uses Calvin cycle; efficient in cool, moist climates	Wheat, Rice
	C4	Uses Hatch-Slack pathway; efficient in hot, dry climates	Maize, Sorghum
	CAM	Crassulacean Acid Metabolism; adapted to arid conditions	Pineapple, Cactus
Economic Use	Cereals	Grasses cultivated for edible grains	Rice, Maize
	Pulses	Leguminous crops harvested for dry seeds	Chickpea, Lentil

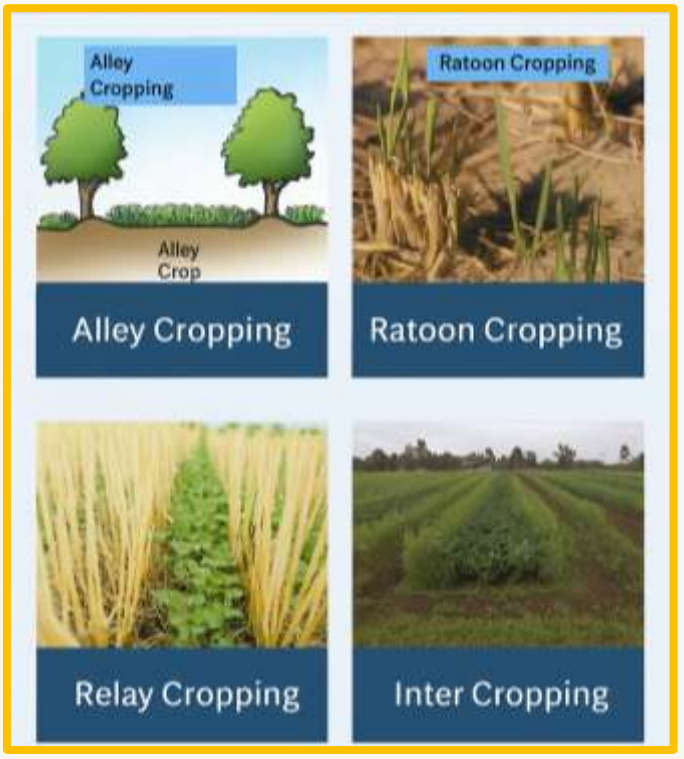
Criterion	Category	Definition	Example Crops
	Oilseeds	Seeds used for extraction of edible oil	Groundnut, Mustard
	Fibre Crops	Grown for textile fibre	Cotton, Jute
	Sugar Crops	Cultivated for sugar extraction	Sugarcane, Sugar beet
Season	Kharif	Sown in June–July, harvested in Sept–Oct (monsoon)	Rice, Maize
	Rabi	Sown in Oct–Nov, harvested in March–April (winter)	Wheat, Mustard
	Summer	Grown between Rabi and Kharif (Feb–May)	Vegetables, Moong
Cotyledon Type	Monocot	Seed with one cotyledon	Grasses, Maize
	Dicot	Seed with two cotyledons	Legumes, Groundnut
Cropping System	Monocropping	Same crop grown repeatedly on the same land	Wheat
	Intercropping	Two or more crops grown simultaneously on same field	Maize + Cowpea
	Relay Cropping	Second crop sown before first is harvested	Rice → Moong
	Ratoon Cropping	Regrowth from previous crop stubble	Sugarcane



Classification of Crops Based on Purpose or Function

S. No.	Crop Type	Definition / Purpose	Example(s)
1	Arable Crop	Requires preparatory tillage before sowing	Wheat, Rice
2	Alley Crop	Grown in alleys or passages between hedgerow	Legumes
3	Augmenting Crop	Supplements the yield of the main crop	Moong with Sugarcane
4	Avenue Crop	Grown along borders or fences	Trees, Shrubs
5	Border / Barrier / Guard Crop	Protects main crop from pests or wind	Safflower
6	Cash Crop	Grown for direct income generation	Cotton, Sugarcane
7	Commercial Crop	Cultivated for market sale and profit	Tobacco, Tea
8	Catch / Contingent / Emergency Crop	Sown when main crop fails or is delayed	Toria, Moong
9	Cleaning Crop	Helps clean the field of weeds or residues	Potato
10	Cole Crop	Belongs to Cruciferae family	Cauliflower, Cabbage
11	Cover / Mulch Crop	Reduces soil erosion and conserves moisture	Groundnut
12	Complimentary Crop	Benefits main crop in intercropping system	Cowpea with Maize
13	Competitive Crop	Competes strongly for resources	Cereals
14	Supplementary Crop	Neither competes nor complements main crop	Moong with Sorghum
15	Nurse Crop	Protects or nourishes another crop	Barley with Lucerne
16	Exhaustive Crop	Depletes soil nutrients heavily	Cereals
17	Restorative Crop	Improves soil fertility by fixing nitrogen	Pulses (Gram, Pea)
18	Energy Crop	Grown for biofuel or high calorific value	Potato, Sweet Sorghum
19	Fouling Crop	Encourages weed infestation	Jute (if unmanaged)
20	Ley Crop	Grown for grazing in rotation with arable crops	Lucerne, Berseem
21	Paira / Utera Crop	Relay crop sown before harvesting the main crop	Lentil, Linseed
22	Trap / Decoy Crop	Attracts pests away from main crop	Mustard for aphids
23	Repellent Crop	Repels pests from main crop	Marigold with Tomato
24	Truck Crop	Grown for fresh market sale	Tomato, Cabbage
25	Ware Crop	Can be stored for long periods	Potato, Onion
26	Ratoon Crop	Regrows from previous crop stubble	Sugarcane, Banana

27	Indicator Crop	Indicates soil or environmental conditions	Rice (Fe toxicity), Mustard (S deficiency)
28	Medicinal Crop	Used for pharmaceutical or therapeutic purposes	Aloe vera, Ashwagandha
29	Aromatic Crop	Grown for fragrance or essential oils	Lemongrass, Rose



Crop Establishment & Management

Methods of Sowing and Planting

S. No.	Method	Definition / Key Features	Examples
1	Broadcasting	Seeds are scattered manually or mechanically over the field surface. • Quick method but uneven spacing. • Lodging common in cereals; unsuitable for mixed cropping.	Wheat, Rice, Mustard
2	Drilling / Line Sowing	Seeds are placed in rows using seed drills or manually. • Ensures uniform depth and spacing. • Facilitates intercultural operations and weed control.	Wheat, Pulses, Maize
3	Dibbling	Seeds are dropped individually into holes made at fixed spacing.	Cotton, Maize, Cucurbits

S. No.	Method	Definition / Key Features	Examples
		• Seed does not come in contact with fertilizer directly. • Suitable for large-seeded crops.	
4	Transplanting	Seedlings are raised in nursery and then transplanted to the main field. • Nursery duration: 1/4th of crop time; nursery area: 1/10th of main field. • Ensures better crop stand and early vigor.	Rice, Tomato, Onion
5	Planting	Vegetative parts (not seeds) are planted directly in the field. • Sugarcane: planted using setts (3-bud pieces). • Potato: whole or cut tubers. • Garlic: cloves; Ginger: rhizomes; Turmeric: mother rhizomes.	Sugarcane, Potato, Garlic, Turmeric, Ginger
6	Mat / Dapog Nursery	Seedlings raised densely on polythene sheets or banana leaves without soil contact. • Seed rate: 3–4 kg/m^2; transplanting at 11–14 DAS. • Nursery area: 25–30 m^2 sufficient for 1 ha.	Rice (SRI, hybrid)
7	Drum Seeder	Pre-germinated rice seeds are sown in lines using a drum seeder over puddled fields. • Seed rate: 30–40 kg/ha; reduces labor cost.	Direct Seeded Rice (DSR)
8	Ridge & Furrow	Seeds are sown on ridges with furrows for irrigation. • Improves drainage and root development.	Maize, Cotton, Vegetables
9	Bed Planting	Seeds are sown on raised beds with furrows between rows. • Enhances water use efficiency and aeration.	Wheat (FIRB), Pulses

Tillage & Seed Handling

Tillage Types

Type	Objective
Primary (ploughing)	Loosen soil, bury residues
Secondary (harrowing)	Level seedbed, break clods
Minimum tillage	Reduce soil disturbance
Zero tillage	Direct seeding into residues
Conservation tillage	Leave ≥30% residues on surface

Effects

- ↑ Porosity & infiltration
- ↓ Bulk density
- Impacts residue breakdown and carbon cycling

Seed Treatments

Treatment	Purpose
Scarification	Break hard coats (legumes)
Stratification	Cold treatment to break dormancy
Hot Water (75–100°C)	Fungal pathogen control
Leaching	Remove inhibitors
Hormonal (GA_3)	Enhance germination /dormancy break
Priming (Hydro/Halo)	Synchronized emergence
Biocontrol (FYM/slurry)	Microbial health; nutrient supply
Solarization	Pathogen reduction via heat
Rhizobium Inoculation	Biological N fixation (legumes)

Sowing Specifications

Method	Typical Seed Rate (kg/ha)	Spacing (if applicable)	Common Crops	Key Features / Remarks
Broadcasting	100–120 (cereals)	Not specified; random scatter	Cereals	Risk of lodging; less uniform.
Drilling/Line Sowing	60 (rice), 100 (wheat)	Rows, but spacing not specified	Rice, Wheat	Improves uniformity and crop stand.
Dibbling	25–30 (wheat)	Not specified	Wheat	Seeds are placed in precise points (point placement).
Transplanting	Not applicable (uses seedlings)	20 x 10 cm	Rice, Vegetables	Seedlings are raised in a nursery and then moved to the main field.
Planting	Not applicable (uses vegetative parts)	Not specified	Potato, Ginger	Uses tubers, rhizomes, or other vegetative planting materials.

Method	Typical Seed Rate (kg/ha)	Spacing (if applicable)	Common Crops	Key Features / Remarks
Special Methods				
Drum Seeder	Not specified	Rows, but spacing not specified	Rice	A specific implement for direct seeding of rice.
SRI Planting	Not applicable (uses seedlings)	25 × 25 cm	Rice	Part of the System of Rice Intensification (SRI); wider spacing.

Soil & Water Management

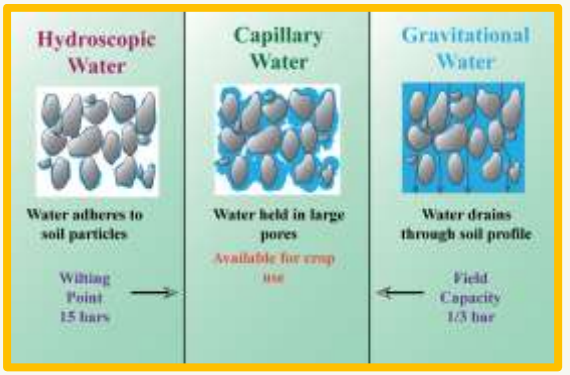
Soil Properties

- Texture & structure: optimum loam–clay loam for most crops
- pH: neutral to mildly acidic (6–7.5) optimal; saline-alkaline (<8.5) for tolerant crops (barley, sorghum)
- Organic matter: improves water retention, structure, nutrient supply

Soil Water Classification

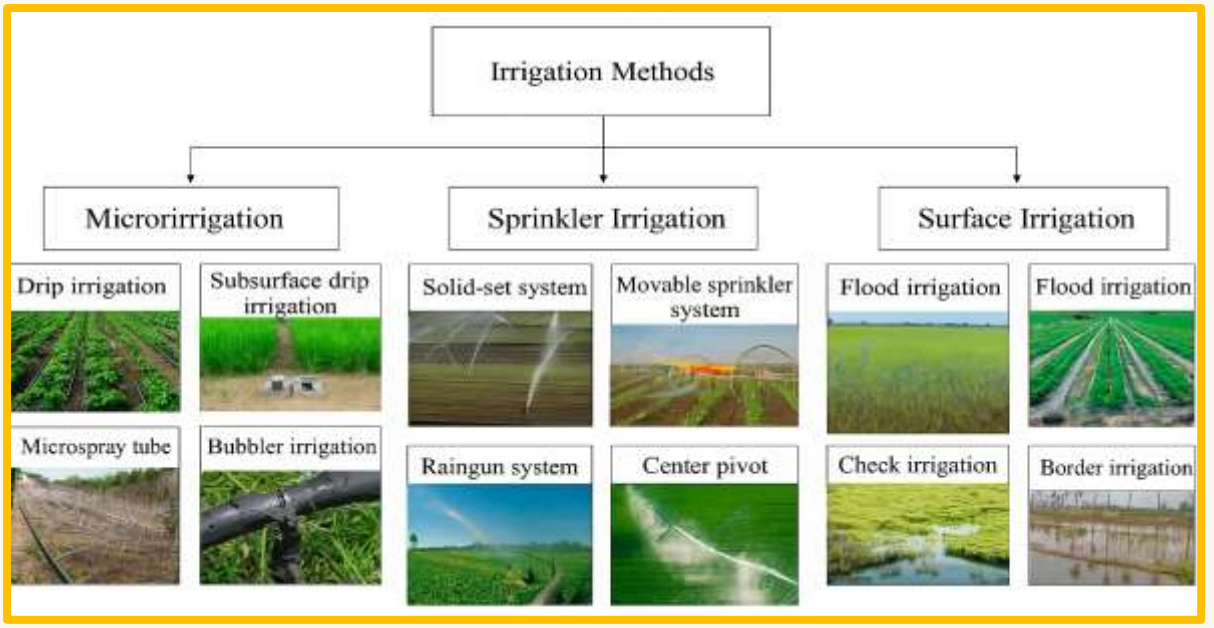
Class	Definition
Gravitational	Free drainage beyond field capacity
Capillary (Available)	Between field capacity & wilting point
Hygroscopic (Unavailable)	Adsorbed tightly to particles

Field Capacity ≈ –0.033 MPa; Wilting Point ≈ –1.5 MPa.



Irrigation Methods & Efficiency

Method	Water Use Efficiency	Notes
Flooding	40–60%	Rice paddy
Check Basin	50–70%	Field crops
Border Strip	50–70%	Wheat, cotton
Furrow	60–75%	Maize, sorghum
Drip	80–95%	Orchards, vegetables; 2–10 L/hr
Sprinkler	60–85%	Frost control; 1000 L/hr
Subsurface	70–90%	Leaching control



Nutrient Management & Precision Agronomy

Nutrient Management

- Micronutrients: Zn in rice & wheat; B in sugar beet; Si in rice for lodging pest resistance.

Biological N Fixation

- **Legumes:** Rhizobium spp. fix 20–60 kg N/ha.
- **Rice:** Azolla + cyanobacteria 10 kg/ha BGA fixes 20–30 kg N/ha.

Precision Agronomy & Weather

Precision Tools

Tool / Technology	Primary Function	How It Works / Key Principle	Main Application / Outcome
Leaf Colour Chart (LCC)	Measures leaf greenness (indicator of N status)	Compares leaf colour to a set of green strips; nitrogen (N) is applied when the leaf colour matches strips 3–4.	Guides real-time, in-field decision-making for nitrogen fertilizer application.
SPAD Meter	Measures leaf chlorophyll content	Uses a non-destructive, optical method to give a relative chlorophyll reading, which is directly related to leaf nitrogen (N) status.	Provides a more precise, numerical value for chlorophyll to fine-tune nitrogen management.
GreenSeeker	Assesses crop biomass and vigor	An active optical sensor that calculates the Normalized Difference Vegetation Index (NDVI) to create a vigor map of the field.	Enables Variable Rate Technology (VRT) for applying inputs (like fertilizer) based on crop needs in different zones.
GPS/GIS	Provides spatial reference and data management	Global Positioning System (GPS) for accurate location data; Geographic Information System	Creates precise field maps, allows for zone management, and is the foundation for all other spatial data layers.

Tool / Technology	Primary Function	How It Works / Key Principle	Main Application / Outcome
		(GIS) for mapping and analyzing field data.	
Yield Monitor	Measures spatial yield variability	A sensor on a combine harvester that continuously records grain yield and moisture, linked to a GPS position.	Generates yield maps to identify variability within a field, informing management decisions for future seasons.

Green Seeker

LCC

Spad meter

Weather Forecasting

Type	Validity	Uses
Nowcasting	≤ 2 hours	Immediate operations (irrigation)
Short-range	1–3 days	Pest/disease alerts
Medium-range	3–10 days	Planning field operations
Long-range	>10 days	Seasonal crop choice

Cloud Seeding

Cloud Type	Seeding Agent
Cold	Silver iodide; Dry ice
Warm	Common salt; Water drops

Atmosphere Layers

Layer	Altitude (km)	Temperature Trend	Significance
Troposphere	0–10	↓	Weather events, 80% mass
Stratosphere	10–50	↑	Ozone absorption UV
Mesosphere	50–85	↓	Meteors burn up
Thermosphere	85–500	↑	Ionosphere for radio comm.
Exosphere	>500	Very low density	Transition to space

Detailed Crop Management

CEREALS

Rice (Oryza sativa)

- **Botany & Types:** 2n = 24; cultivated: O. sativa (Indica, Japonica, Javanica), O. glaberrima (African). Panicle; caryopsis; self-pollinated; C3, short-day.
- **Growth & Management:**
  - **Nursery:** wet (50 kg/ha), dry, dapog (3 kg/m^2 → 25 m^2/ha), mat (3–4 kg/m^2)
  - **Transplant:** 20 × 10 cm; SRI 25 × 25 cm; drill 60 kg/ha; broadcast 100 kg/ha
  - **Water:** 5 cm flood until dough; drain 10 days before harvest; total 1200 mm
  - N:P:K = 100:40:40 kg/ha; split at 21, 45, 65 DAT; $ZnSO_4$ 25 kg/ha at last puddling
- **Systems:**
  - **SRI:** young seedlings, intermittent wetting, yields 6–7 t/ha; seed 7.5 kg/ha; water saving 30–50%
  - DSR: drill 60 kg/ha; seedling 20–25 kg/ha; water saving 18–27%
- **Varieties & Hybrids:**
  - **TN-1:** 1st semi-dwarf (1949 Taiwan)
  - **IR8:** "Miracle rice," photo-insensitive
  - **IR36:** Multi-disease resistant
- **Problems & Solutions:**
  - Khaira (Zn def.) → foliar $ZnSO_4$
  - Browning (Fe toxicity) → tolerant variety (Phalguna)
  - Akiochi (H_2S) → avoid reduced soils; use raised beds
- **Post-harvest:** Hulling (66%) < milling (60%), polishing; parboiling preserves B-vitamins

Wheat (Triticum spp.)

- **Botany & Types:** 2n = 42 (bread wheat, AABBDD); Triticum aestivum; caryopsis; C3, long-day; self-pollinated
- **Growth & Management:**
  - **Stages:** Germination (5–7 days); CRI (20–25 DAS); Tillering (40–45 DAS); Jointing (45–60); Booting; Flowering (70–90); Milking/Dough; Maturity (115–120 DAS)
  - **Seed rate:** 100 kg/ha broadcasting; 25–30 kg/ha dibbling; FIRB:75 kg/ha
  - **Spacing:** 22.5 × 8^{-10} cm (irrigated); 25 × 5^{-6} cm (rainfed)
  - **N:P:K:** 120–150:60:60 kg/ha; $ZnSO_4$ 25 kg/ha; apply N in splits at CRI, tillering, booting
  - **Irrigation:** 4–6 times at CRI, late tillering, booting, flowering
  - **Weeds:** Phalaris minor → Isoproturon, sulfosulfuron; Pendimethalin pre-emergence
- **Varieties:**
  - **Gene Type:** Single dwarf (Lerma Rojo 64, Sujata), Double dwarf (Sonalika, Kalyansona)
  - **Biofortified:** Atlas 66 (high Zn & protein)
  - **Disease resistant:** HD-2329, WB 2 (Zn rich)

Maize (Zea mays)

1. **Botanical:** 2n = 2 × = 20; inflorescences separate tassel (male) and ears (female); caryopsis fruit. C4, cross-pollinated; starch 65%, zein protein 8–10%, oil 4%.

2. **Climate & Soil:** Germination: 6–7 °C; optimum growth 30–32 °C; base 10 °C. Soil: well-drained loam–clay loam; pH 6.5–7.5; intolerant of waterlogging.
3. **Seed & Sowing: Seed rate:** grain 20 kg/ha; hybrid 20–25 kg/ha; composite 18 kg/ha; fodder 50 kg/ha; sweet 8 kg/ha; baby 25 kg/ha; popcorn 12 kg/ha. Spacing: general 60 × 20 cm; sweet 75 × 30 cm; fodder 30 × 10 cm; baby corn 60 × 15 cm. Drill/depth: 4 cm; row orientation east–west for uniform light.
4. **Nutrients & Water:** N:P_2O_5:K_2O = 120:60:40 kg/ha; splits at V4, V8, VT, grain fill; FYM 10–15 t/ha; $ZnSO_4$ 25 kg/ha. Water: 4 irrigations at knee-high, tasseling, 50% silking, dough; total 500–800 mm.
5. **Weeds & Pests:** Weed: Atrazine 1 kg/ha pre-emergence; paraquat 0.5 kg/ha post-emergence. Pest: stem borer, leaf aphids; control with chlorpyriphos.
6. **Yield:** Grain: 40–60 q/ha hybrids; 30–40 q/ha composites. Fodder: 300–400 q green/ha. Baby corn: 6 t/ha cob; 25 t green fodder.

Barley (Hordeum vulgare)

1. **Botanical:** 2n = 14; spikelets 2-rowed (H. distichon) or 6-rowed (H. vulgare); caryopsis; C3.
2. **Climate & Soil:** Optimum: cool season 12–15 °C; ripening ~30 °C. Soil: well-drained loam; pH 6.5–7.5; tolerates drought.
3. **Seed & Sowing:** Seed rate: 75–100 kg/ha; spacing 22.5–25 cm; depth 4–6 cm; sow Oct–Dec.
4. **Nutrients & Water:** N:P_2O_5:K_2O = 60:30:30 kg/ha; limit N (<80 kg) for malt quality. Irrigation: 1–3 at tiller, booting, milking; total 300–400 mm.
5. **Weeds & Pests:** Weed: Pendimethalin 1 kg/ha pre-emergence; one hand weeding. Diseases: powdery mildew; use resistant varieties.
6. **Yield:** Irrigated: 40–50 q/ha; rainfed: 15–25 q/ha.

Sorghum (Sorghum bicolor)

1. **Botanical:** 2n = 20; panicle inflorescence; caryopsis; C4, short-day; cross-pollinated.
2. **Climate & Soil:** Germination: 7–10 °C; growth 26–30 °C; rain 450–650 mm; tolerates drought & moderate salinity.
3. **Seed & Sowing:** Seed rate: 8–10 kg/ha; spacing 45 × 15 cm; depth 3–4 cm; sow Jun–Jul.
4. **Nutrients & Water:** N:P_2O_5:K_2O = 80:40:40; FYM 5–8 t/ha. Irrigation: 4 at seedling, booting, flowering, grain fill; total 450–650 mm.
5. **Weeds & Pests:** Weed: Atrazine 0.75 kg/ha; weeding at 30 and 60 DAS. Pests: stem borer; control by chlorpyriphos.
6. **Yield: Grain:** 20–30 q/ha; fodder: 50–70 t/ha.

Pearl & Minor Millets

Millet	2n	Seed rate (kg/ha)	Yield (q/ha)
Pearl Millet – ***Pennisetum glaucum***	14	4–5	12–15
Finger Millet – ***Eleusine coracana***	40	8–10	30–50
Foxtail Millet – ***Setaria italica***	36	10	10–12
Little Millet – ***Panicum sumatrense***	20	8–10	8–10
Proso Millet – ***Panicum miliaceum***	20	8–12	6–10
Kodo Millet – ***Paspalum scrobiculatum***	20	8–10	2–5
Barnyard Millet – ***Echinochloa crus-galli***	20	10	10–15

PULSES

Chickpea (Cicer arietinum)

- 2n=14; hypogeal; C3; long-day; self-pollinated.
- Seed 75–100 kg/ha (desi), 100–125 kg/ha (kabuli); spacing 30×10 cm; sow Oct–Nov; depth 8–10 cm.
- N:P_2O_5:K_2O = 20:40:20 kg/ha; FYM 10–15 t/ha; 1 light irrigation at flowering.
- **Weed:** Basalin 1 kg/ha PPI; Dharamcil or Golomitazone; two hand weedings at 30 & 60 DAS.
- **Varieties:** Vijay, JG 74, Pusa 1003; disease resistant: Avrodhi; drought tolerant: ICC 4958.
- **Yield:** 12–20 q/ha.

Pigeonpea (Cajanus cajan)

- 2n = 22; C3; short-day; cross-pollinated.
- Seed 12–15 kg/ha; spacing 60 × 30 cm; sow Jun–Jul.
- N : P_2O_5 : K_2O = 20 : 60 : 40; FYM 10 t/ha; rainfed, optional 0.4 IW/CPE.
- **Varieties:** ICPH 8 (1st hybrid), ICPL 87, UPAS 120; late: Bahar, UPAS 120.
- **Weed:** Fluchloralin 0.75 kg/ha pre; one weeding at 25 DAS.
- **Yield:** 20–25 q/ha; stalk 50–60 q/ha fodder.

Green Gram & Black Gram (Vigna radiata, V. mungo)

Crop	Seed (kg/ha)	Spacing (cm)	N:P:K (kg/ha)	Rain (mm)	Maturity (days)	Yield (q/ha)
Mungbean	20–25	30 × 10	20:40:20	600–800	75–85	6–8
Uradbean	15–20	30 × 10	20:40:20	600–900	65–75	6–8

- **Weed:** Basalin 1 kg/ha PPI; one weeding at 25 & 45 DAS.

Lentil (Lens culinaris)

- 2n = 14; C3; hypogeal; long-day; self-pollinated.
- Seed 30–40 kg/ha; spacing 30 × 10 cm; sow Oct; depth 4–6 cm.
- N : P_2O_5 : K_2O = 20 : 60 : 20; FYM 10–15 t/ha; 1–2 irrigations.
- **Varieties:** L 4147 (blast & wilt resistant), Pusa Ageti, Priya.
- **Weed:** Pendimethalin 0.75 kg/ha PPI; one hand weeding.
- **Yield:** 12–15 q/ha.

Field Pea (Pisum sativum)

- 2n = 14; C3; hypogeal; self-pollinated.
- Seed 75–100 kg/ha; spacing 30×10 cm; sow Oct–Nov; depth 4–5 cm.
- N : P_2O_5 : K_2O = 20 : 60 : 20; FYM 20 t/ha; 2–3 irrigations at flowering & pod fill.
- **Varieties:** Arkel, Jawahar Matar-1, Kashi Nandini.
- **Weed:** Alachlor 1.5 kg/ha PPI; hand weeding at 25 DAS.
- Maturity 110–140 days; yield 20–25 q/ha.

Chickling Pea & Horse Gram & Moth Bean

Crop	Seed (kg/ha)	Spacing (cm)	N:P:K (kg/ha)	Rainfall (mm)	Maturity (days)	Yield (q/ha)
Chickling Pea	40–50	30×10	20:40:20	400–600	100–120	8–10
Horse Gram	40–50	30×10	20:40:20	300–500	90–100	6–8
Moth Bean	8–10	30×10	20:40:20	250–400	70–80	5–7

OILSEEDS & FIBRE CROPS

Groundnut (Arachis hypogaea)

- 2n = 40; legume; hypogeal germination; pegging habit.
- **Seed rate:** 100 kg/ha (bold); 80 kg/ha (small); spacing: 30 × 10 cm.
- N : P : K = 30 : 50 : 30 kg/ha; gypsum 250 kg/ha at pegging.
- **Water:** 4–5 irrigations; critical at flowering and pod development.
- **Varieties:** TG 37A, GG 2, ICGV 86015.
- **Yield:** 20–30 q/ha; oil content: 45–50%.

Soybean (Glycine max)

- 2n = 40; C3; self-pollinated; short-day.
- Seed rate: 75–80 kg/ha; spacing: 45 × 5 cm.
- N:P:K = 20:80:20 kg/ha; $ZnSO_4$ 5 kg/ha.
- **Biofertilizer:** Bradyrhizobium japonicum.
- **Water:** 3–4 irrigations; critical at flowering and pod fill.
- **Varieties:** JS 335, NRC 37, MAUS 71.
- **Yield:** 20–30 q/ha; oil content: 18–20%.

Sesame (Sesamum indicum)

- 2n = 26; C3; self-pollinated; capsule fruit.
- **Seed rate:** 2.5–3 kg/ha (line sowing); spacing: 30 × 10 cm.
- N : P : K = 20 : 10 : 10 kg/ha; sowing: June–July.
- **Water:** 2–3 irrigations; critical at flowering and capsule formation.
- **Varieties:** TKG 22, RT 46, Gujarat Til 1.
- **Yield:** 6–8 q/ha; oil content: 50–52%.

Sunflower (Helianthus annuus)

- 2n = 34; C3; cross-pollinated; capitulum inflorescence.
- **Seed rate:** 5 kg/ha; spacing: 60 × 30 cm.
- N : P : K = 60 : 60 : 30 kg/ha; $ZnSO_4$ 25 kg/ha.
- **Water:** 3 irrigations; critical at bud initiation and flowering.
- **Varieties:** Morden, KBSH 1, CO 4.
- **Yield:** 15–20 q/ha; oil content: 38–45%.

Castor (Ricinus communis)

- 2n = 20; monoecious; epigeal germination.
- **Seed rate:** 6–8 kg/ha; spacing: 90×60 cm.
- N:P:K = 45:30:30 kg/ha; gypsum 250 kg/ha.
- **Water:** 3–4 irrigations; critical at flowering and capsule development.
- **Varieties:** GCH 4, DCH 177, Aruna.
- **Yield:** 15–20 q/ha; oil content: 48–50%.

Cotton (Gossypium spp.)

- G. hirsutum (American); G. arboreum (Desi); 2n = 52 and 26.
- **Seed rate:** 15–20 kg/ha (desi); 2–3 kg/ha (hybrid); spacing: 90×60 cm.
- N:P:K = 120–150:60–75:60–75 kg/ha.
- **Water**: 4–6 irrigations; critical at square formation, flowering, boll development.
- **Varieties:** H 4, MCU 5, Bt hybrids (Bollgard II).
- **Yield:** 20–30 q/ha lint; ginning %: 33–35%.

Jute (Corchorus spp.)

- C. capsularis (white); C. olitorius (tossa); 2n = 14.
- Seed rate: 6–8 kg/ha; spacing: 25×5 cm.
- N:P:K = 60:40:40 kg/ha; FYM 5–8 t/ha.
- Water: 2–3 irrigations; retting in stagnant water 8–30 days.
- Varieties: JRO 524, JRC 698.
- Yield: 30–35 q/ha fibre.

VEGETABLE & SPECIAL CROPS

Potato (Solanum tuberosum)

- 2n = 48; tuberous stem; vegetative propagation.
- **Seed rate:** 20–25 q/ha whole tubers; spacing: 60×25 cm.
- N:P:K = 150:80:120 kg/ha; FYM 20 t/ha.
- **Water:** 5–6 irrigations; critical at tuber initiation.
- **Varieties:** Kufri Jyoti, Kufri Bahar, Kufri Pukhraj.
- **Yield:** 300–450 q/ha.

Sugarcane (Saccharum officinarum)

- 2n ≈ 80; ratoonable; C4.
- **Planting:** 3-bud setts; spacing: 90×60 cm.
- N:P:K = 150–250:100:120 kg/ha; FYM 10–15 t/ha.
- **Water:** 8–10 irrigations; critical at formative stage (60–130 DAP).
- **Varieties:** Co 86032, Co 0238, Co J 64.
- **Yield:** 60–120 t/ha cane; sugar recovery: 10–12%.

Tobacco (Nicotiana tabacum)

- 2n = 48; leaf crop; C3.
- **Nursery:** 20–30 g/100 m^2; transplant at 6-leaf stage.
- **Spacing:** 60×90 cm; N:P:K = 100:25:100 kg/ha.
- **Water:** 5–6 irrigations; topping and desuckering improve quality.
- **Varieties:** Bidi tobacco (A 145), FCV tobacco (Vaishnavi).
- **Yield:** 15–20 q/ha cured leaves.

50 Most Important Points

1. Agronomy integrates plant, soil, water, and climate science for sustainable production.
2. Annual cereals (rice, wheat, maize) vs. annual legumes (pulses) vs. perennial (sugarcane).
3. C4 crops (maize, sorghum, millet) outperform in hot, arid climates.
4. Minimum tillage conserves moisture; zero tillage best in rice–wheat rotations.
5. Seed priming (hydro- or osmopriming) enhances uniform emergence.
6. Broadcast rice: 100 kg/ha seed; direct drill: 60 kg/ha; SRI: 5–8 kg/ha.
7. Rice phases: 50–60 day vegetative; 35 day reproductive; 25–35 day ripening.
8. LCC value 3–4 guides N topdressing in rice—saves 25 kg N/ha.
9. Deep placement of ammoniacal N (ammonium sulfate) reduces denitrification.
10. SRI boosts rice yield 20–100% with 90% seed saving.
11. Wheat CRI stage (20–25 DAS) is most sensitive to water.
12. Wheat tolerates 4 °C base temp; frost hardy to –20 °C (spring vs. winter).
13. Wheat seed rate: 100 kg/ha broadcast; 25 kg/ha dibbling; FIRB: 75 kg/ha.
14. Phalaris minor control in wheat: Isoproturon 1 kg/ha post-emergence.
15. Maize QPM (Opaque-2) doubles Lysine content over normal maize.
16. Maize critical water stage: tasseling–silking (45–65 DAS).
17. Barley 2-row vs. 6-row: 2-row best for malting; 6-row highest yield.
18. Pearl millet seed rate 4–5 kg/ha; spacing 45×15 cm; drought escape 60–90 days.
19. Finger millet calcium 0.34% vs. rice 0.03%; WUE 13.4 kg/ha·mm.
20. Chickpea N fixation meets 70–80% N needs; sow at 30×10 cm.
21. Pigeonpea deep tap root enables 500 mm rainfall adaptation; spacing 60×30 cm.
22. Green gram critical weed period 30–45 DAS; seed rate 25 kg/ha.

23. Lentil cold tolerance germination to 5 °C; sow at 30×10 cm; weed at 30 & 60 DAS.

24. Groundnut pegging stage (40–50 DAS) needs adequate moisture; 30×10 cm spacing.

25. Azolla in rice fixes 20–30 kg N/ha; BGA inoculum 10 kg/ha.

26. Castor oil 90% ricinoleic acid; harvest at 145–280 DAP; spacing 90×30 cm.

27. Sesame "dehiscence" capsule bursts only at full maturity—harvest timing critical.

28. Safflower 90% PUFA (linoleic); sow Sep–Oct; spacing 45×20 cm.

29. Linseed baking (flax) maturity in 120–140 days; dual fibre & oil crop.

30. Cotton hybrids (H-4) first by C.T. Patel in India; Bt-cotton Cry1Ac for bollworm.

31. Cotton most sensitive to poor soil aeration; ideal pH 5.5–8.5; spacing

32. Rice seasons by area share: Aus 7%, Aman 84%, Boro 9%; key transplanting windows for each.

33. Rice seed rates: broadcasting 100 kg/ha; drilling 60 kg/ha; hybrid 15 kg/ha; SRI 7.5 kg/ha.

34. Maize yields drop sharply if 50% silking stage experiences moisture stress; irrigate at 40–50% ASM.

35. Sorghum residue C:N > 30 causes temporary N immobilization ("sorghum sickness"); overcome with +25% first N dose.

36. Pearl millet's deep fibrous roots and C4 metabolism confer highest drought resilience among cereals.

37. Sweet sorghum juice reaches 16–23 °Brix sugar; first hybrid CSH-1 released 1964; ideal for bioethanol.

38. Barley malting quality demands 2-row H. distichon; sow late Oct–early Nov; seed rate 75–80 kg/ha; 3 irrigations at tiller, boot, milk stages.

39. Wheat biofortified variety Atlas 66 elevated grain Zn & Fe; future breeding lever for micronutrient security.

40. Chickpea dormancy broken by 0.2% GA_3 or hot-water treatment at 75 °C; treated seed can store 18 months.

41. Pigeonpea intercrop with castor or sorghum attracts pod borer away from main crop; spacing 60×30 cm.

42. Green gram nodulation onset at 12 DAS, peaks 45 DAS; avoid basal N to maximize BNF.

43. Lentil critical weed-free period 30–45 DAS; Pendimethalin at 0.75 kg/ha controls early weeds pre-emergence.

44. Groundnut pegging (40–50 DAS) demands adequate Ca; apply 250 kg gypsum/ha at pegging to prevent popping.

45. Soybean seed 75–80 kg/ha in kharif; Bradyrhizobium japonicum fixes 20–30 kg N/ha, cutting N fertilizer by 25%.

46. Cotton H-4 hybrid (G. hirsutum×G. arboreum) pioneered India's hybrid era; modern hybrids need only 2–3 kg/ha seed.

47. Jute retting at 30–34 °C for 8–30 days employs anaerobic bacteria to dissolve pectin; fiber yield 30–35 q/ha.

48. Potato true potato seed (TPS) nursery uses 100–120 g/ha in 75 m^2; TPS transplants 30–40 days after sowing.

49. Sesame pods dehisce at full maturity—harvest at 30–35% capsule moisture to prevent seed loss.

50. Rice–wheat–chickpea rotation raises cropping intensity to 180%, breaks pest cycles, and enhances soil N via pulses.