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GS 3 : AGRICULTURE HANDWRITTEN SHORT NOTES

Satyam Jain
(3 UPSC CSE Interviews, Mentor to 300+ Rankers
Including AIR-1, Published Author)



Call For More Info
8377072252

Ground floor, 11B, Bada Bazar Road, Old Rajender Nagar, New Delhi - 110060



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* Agriculture *

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• Land → Water → Production → Storage → Market → Income → Nutrition → Sustainability

8 Major Problems

- 1) Land - Small Land Holdings, Land Productivity, Uneven Terrain, Desertification, Leaching, Mechanisation
- 2) Water - Over Exploitation, Rainfed, Ground Water Pollution, Aquifer Lowering, Low Irrigation
- 3) Soil - Nutrient Deficiency, Erosion, Salinization, Monoculture, Excessive Inputs
- 4) Seeds - Terminator Seeds, Replacement Rate, HYVs, Climate Smart Seeds, R & D
- 5) Security - Food, Income, Nutrition, Environment, Energy
- 6) Market - Fragmented, Accessibility, Transport, Cartelization, Logistics, APMCs, Intermediaries, Pvt Sector
- 7) Climate - Extreme Weather Events - Droughts & Floods, Irregular Monsoons, GHGs, Climate Smart Agriculture, Subsistence Agriculture
- 8) Income - Loan Trap, Informal Lending, MSP, Insurance, Density, Subsidies, Disguised Employment, Allied Sectors, Extension Services, Food Processing Industry, Certification, skills - ICT

Agriculture Value Chain

Input	Production	Post Harvest	Market	Consumer
- Land	- Fertilisers	- Transport	- APMC	- Demand
- Water	- Insecticides	- Logistics	- NAM	- Awareness
- Irrigation	- Pesticides	- Storage	- Mandi	- Preference
- Credit	- Mechanisation	- Labour	- Cartelisation	- Price & Income
- Seed	- Soil	- Processing	- MSP	- Food Health
- Tech	- Millets	- Packaging	- Fortification	- Nutrition
- Labour	- Organic	- Segregation	- SPS Measures	- Security
- Electricity	- 2BNF/IFS/HVS	- Branding	- Export Readiness	- Food Security
		- Supply Chain		- PQS
		- Procurement		- Adulteration

🌾 Frameworks

1) F2F (Farm to Fork)

Production → Procurement → Storage → Transportation → Processing
→ Marketing → Consumption

2) Tech - (F) - Forecasting, (A) - Assessment, (R) - Resource Allocatⁿ, (M) - Monitoring

↳ Data → AI → Decision Making → Automation → Productivity

3) Income → Yield & Price, Cost, Risk

4) Triple Security Model -



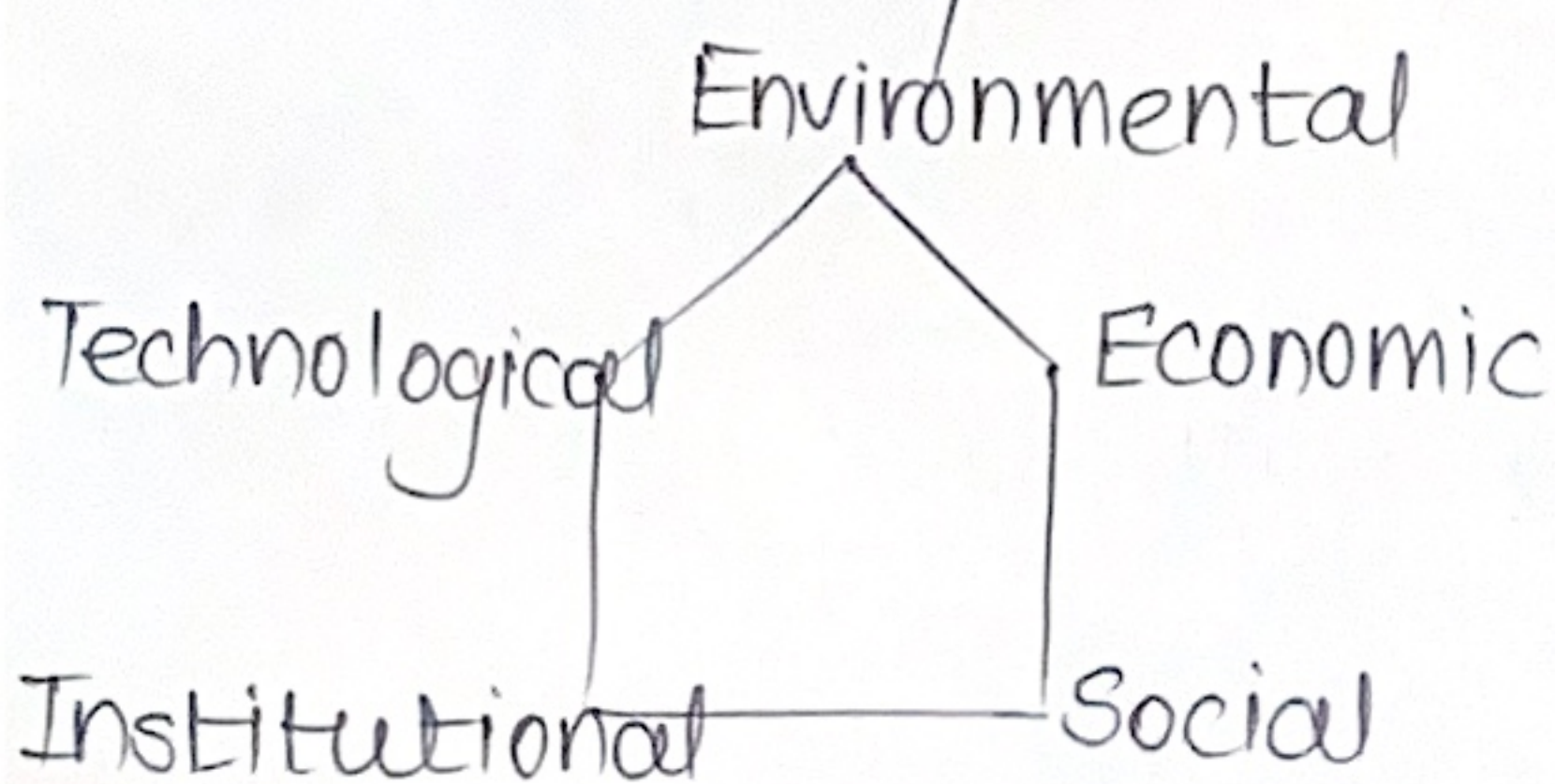
5) Water Efficiency

Flood → Canal → Drip → Sprinkler → IoT, Automation

6) Crop Diversification

Rice/Wheat → Millets, Pulses, Oil Seeds, Horticulture, Live stocks, Fisheries

7) Sustainability

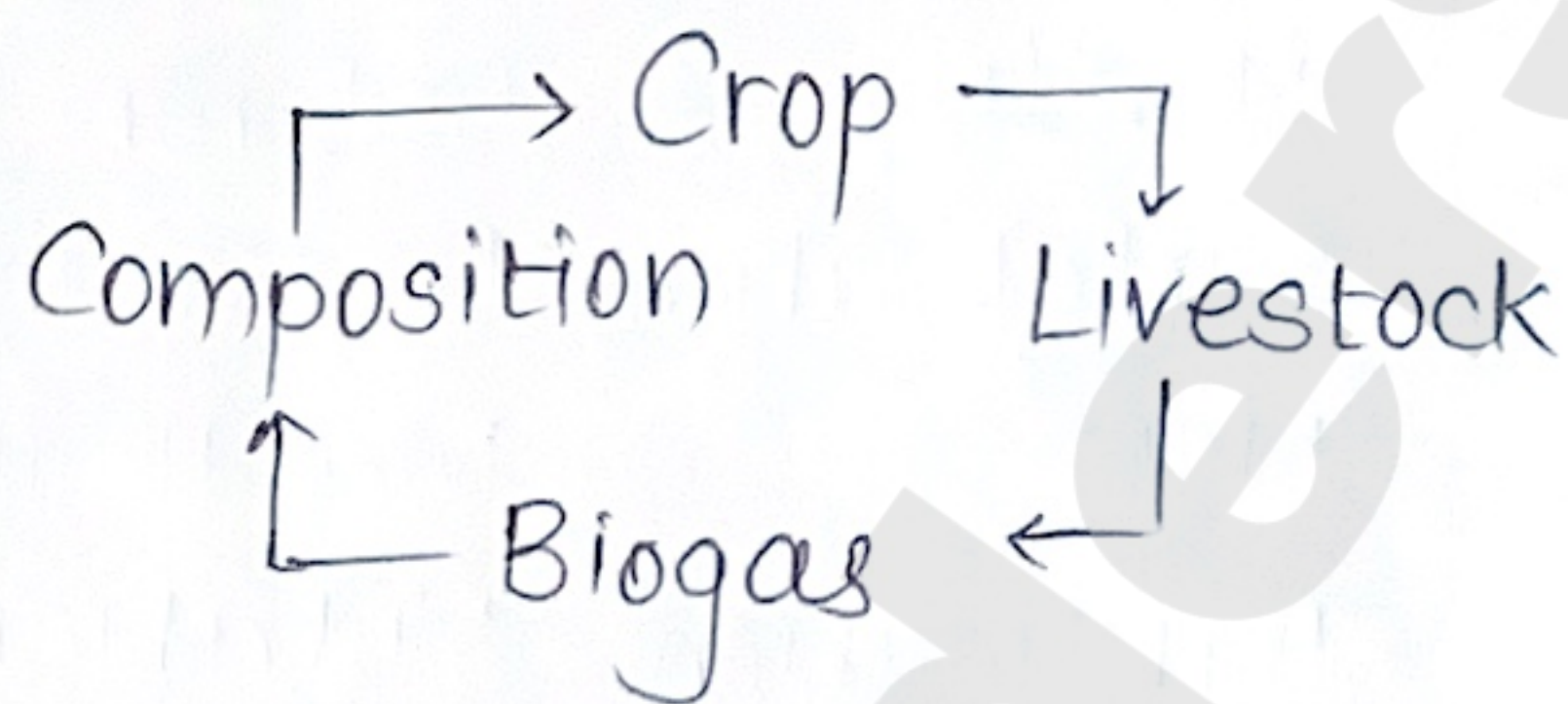


8) Capitals → Human, Social, Economic, Natural

9) Agri Transition Model

Subsistence → Commercial → Mechanised → Digital → Pre

10)



1. Agriculture

Indian Agri: Features & Current Status

- 1) Subsistence Oriented [50% - NABARD]
- 2) Small & Fragmented Landholdings
Avg size = 1.08 Hectors $\Rightarrow$ 86% Farmers
- 3) Low Productivity (contributes 15% to GDP)
- 4) Labour Intensive (46.1% of Workforce)
 $\rightarrow$ Low Mechanisation
- 5) Traditional Techniques
- 6) Govt Support : 23 crops $\rightarrow$ MSP $\leftarrow$ CACP
- 7) Land Use : 59% Land $\rightarrow$ Agri (MoAFW)
- 8) Record Foodgrain Prodⁿ = 357.73 MMT
- 9) Agri Exports (\$34.5 Bn/FY20 $\rightarrow$ 51.1 Bn/FY25)
- 10) Budget Allocation = ₹ 1.30 Lakh Cr
- 11) Avg Annual Growth = 4.4% at constant price
- 12) Irrigation Status $\Rightarrow$ Largest in World
55% of gross cropped area
- 13) Fertiliser Consumption [150 kg/Hectare]
2nd - Consumer 3rd - Producer
13% States $\rightarrow$ 90% Usage
- 14) Agri Credit - 20 Lakh Cr Target
- 15) Digital Agri - AI, IoT, Drones, eNAM etc

Significance of Agriculture in India

- 1) Contribution to GDP (15%)
- 2) Employment (46.1% of Workforce - PLFS)
- 3) Food Security
- 4) Forex Earnings (\$50 Bn)
- 5) Socio-Cultural & Envtl Sustainability

Key Initiatives

- 1) PM-KISAN (₹ 6000/yr | 11 cr Farmers) $\rightarrow$ 3L.Cr (MoFAW)
 - 2) PM-FBY - Largest in the world
 - 3) Soil Health Card Scheme ($\uparrow$ AgriTech)
 - 4) PM-KSY - Har Khet Ko Pankh
Per Drop More Crop
 - 5) eNAM - integrates ~1300 APMC Mandis
 - 6) National Mission on Sustainable Agri
 - 7) PKVY - organic farming - certification
 - 8) Digital Agriculture Mission
 - 9) Mission for Atmanirbharata in Pulses
 - 10) NeGP-A $\Rightarrow$ $\uparrow$ ICT 11) MOVCDNER
- "Input Based $\rightarrow$ Tech Based" - says ES Agri

Key Challenges

- 1) Small Land Holding (Avg = 1.08 Hectares)
'Economy of Agrigation' - NITI Aayog
 $\rightarrow$ FPOs can solve SLH problem without changing ownership
- 2) Economic Hardships [₹ 10,218/month - NSO]
50% Agri Household $\rightarrow$ Debt (Monsoons)
- 3) Soil Degradation & Water scarcity
ISRO Desertification Atlas $\Rightarrow$ 30% Land-Desert
PB/HR $\Rightarrow$ 85% Blocks overexploited Ground water
- 4) Weak Agricultural Infrastructure
₹ 90,000 + Cr $\Rightarrow$ Post Harvest Losses (ICAR)
- 5) Underinvestment in Research
Only 0.6% of Agri GDP $\rightarrow$ Agri Research (ICAR)
- 6) Outdated Farming Practices
Flood irrigation in 'Sugar Belt' (MH & UP)
- 7) Market Volatility & Price Fluctuations
Late 2025 : Onion prices (MH) $\rightarrow$ ₹ 2/3/kg
Very small portion of SP $\rightarrow$ Farmers (NITI)
- 8) Policy Related Challenges
Policy Paradox - Fertilisers Subsidy (x crops)
Vs Govt Schemes (y crops)
- 9) Climate Change & Natural Disasters
Unirrigated Region $\rightarrow$ 25% Income Loss due to climate Change (WB)
Rainfed Rice Yield $\rightarrow$ $\downarrow$ 20% by 2050 (NICRA)

Way Forward (Ashok Dalwai Cmt; Swaminathan Cmt)

- 1) Blend Trad^l & Modern Tech eg Drones
 - 2) Precision & Data Driven Farming
Precision Agri $\Rightarrow$ $\downarrow$ 20-30% Fertilisers & Water usage (FAO)
 - 3) Agri R&D & Climate Resilience
eg. ICAR - Sahbhagi Dhan Rice
 - 4) Water Efficiency & Micro-Irrigation
Micro-Irrigⁿ $\Rightarrow$ save upto 50% of water
 $\uparrow$ 40% of productivity
 - 5) Better Market Access & Infra eg eNAM
 - 6) Credit & Co-operatives Support eg KCC
 - 7) Startup Growth
- ## Case Study - Hivare Bazar (MH) - NITI MoRD
- $\rightarrow$ Shri Popatrao Pawar
 $\rightarrow$ Avg income ₹ 832 $\rightarrow$ ₹ 30,000/month

① Millet (Shree Anna or Smart Food - ICRISAT)

India - Largest Producer - 38.4% (FAO, 2023)

② Benefits

1) Farming & Food Security

(Less Water - 75% less than Rice, pest & disease resistance, intercropping)

2) Cultural & Poverty Alleviation

(Trad^l Food - Ragi Habba - KA), Low i/p cost, Preserves traditional cropping system)

3) Nutrition & Health (more cal in Ragi than Rice)

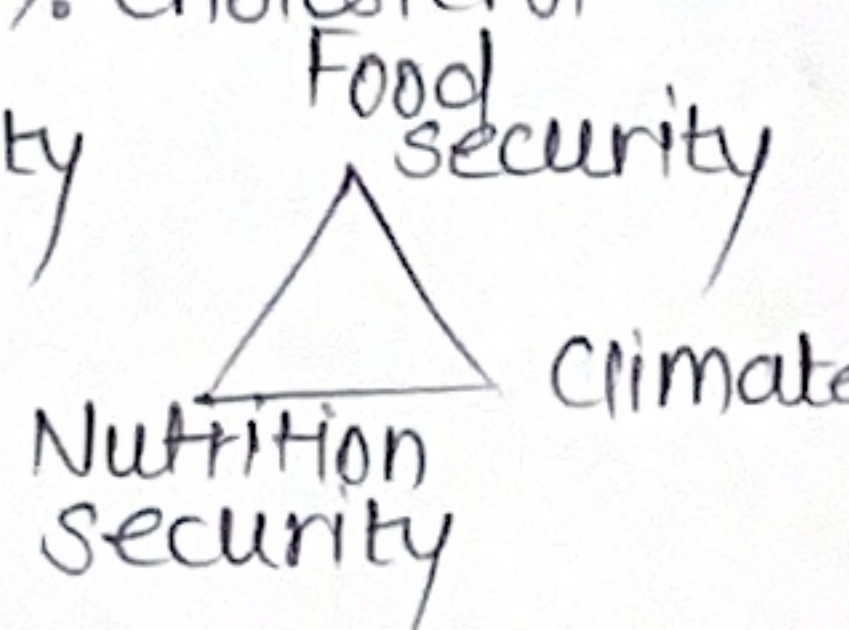
Gluten free, Low GI, ↓ 8-10% cholesterol

4) Environmental Sustainability

✓ Drought Tolerant

✓ Restores microbes

✓ ↓ Chemical fertilisers



• Odisha Millet Mission - NITI Best Practices

③ Government Initiatives

1) International Yr ⇒ 2023 by UNGA

India ⇒ 40% of World prodⁿ - Agri Diplomacy

2) PM Modi's Campaign - Shree Anna

3) Union Budget: HYBD - Centre of Excellence

4) CAPF/NDRF Diets: 80% meals - Millets

5) Millet Missions - OD, AP, CHH, KA

6) Startup & FPO Support

7) RAD Scheme ⇒ 25% Area → Millet cultivatⁿ

④ Achievements

1) Steady production growth

2) Seed production & distribution

⑤ Challenges

1) Skewed Agri-policy (Millet Policy Paradox)

2) Changing Dietary Habits 3) Perceptⁿ issue

4) Processing & Value Chain Gaps

5) Low Yields & Profitability

6) Taste Preference Shift 7) High Market Prices

8) Limited market presence

⑥ Way Forward

1) PDS & MDM 2) MSP 3) Startups 4) R&D

5) Awareness 6) Rebranding 7) Subsidies

8) ↑ Availability 9) ↑ Exports 10) CSC

• Millets can be the next big brand from India after Yoga - NITI Aayog

• FPO Led Millet Value chain - NABARD

• Calorie Security → Nutrition Security

↑
Millets can help (RBI)

• Triple win - Nutri, Agri Sustainability, Climate Resilience

⑦ Organic Farming

India → #1st - No. of organic Farmers {IFOAM 2022}
#4th - Certified Organic Area

→ Scale Certificatⁿ Mismatch

⑧ Benefits

1) Low input cost (14-19% lower prodⁿ cost)

2) Soil Health (↑ Soil organic carbon - FAO)

3) Water Conservation (↓ Eutrophication) ↑ Moisture Retention

4) Healthier Food

5) Biodiversity - 30% More species richness

Mixed Farming & Agro Forestry - High BD

6) Climate Resilience (↓ GHG emission by 20% - FAO)

7) ↓ Fossil Fuel Intensive Fertilisers (FAO)

8) Compost Cycle

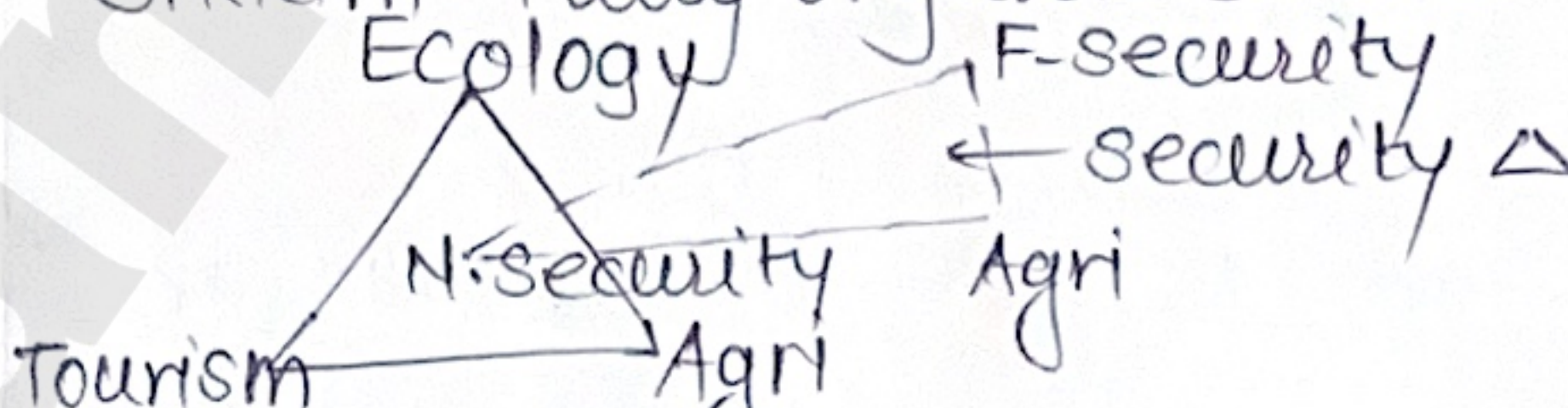
⑨ Govt Initiatives

1) PKVY 2) MOVCONER 3) NPOP

4) Soil Health Mngt 5) OFEP Program

• Organic Large Cardamom Prodⁿ - Nagaland
• NITI Best Practices

• Sikkim - Fully Organic State



Sikkim Organic Convergence Model (NITI)

• Role of Tribal Communities - Tradition
Tribals Rich States → 3/4 organic prodⁿ area
NE - Low Chemical Intensity {NITI
Low Fertilisers Damage}

⑩ 2 Different Certification Mechanism

NPOP

1) by APEQA (MOTI)

2) 3rd Party certⁿ

3) 1^o Export Market

4) High Costs

5) Extensive Documentⁿ

PQS-India

1) NCONF (M.A & FW)

2) Peer Review

3) Domestic/Local Market

4) Low/Nil

5) Simplified

⑪ Challenges

→ 20% Yield ↓

1) Farmers - Certifⁿ, Training, High i/p costs, Seeds

2) Infra & Market - cold storage, logistics,

Imtd market access, competition, Branding

3) Export & Trade - Non tariff barriers - 'stds'

4) Ecological & Technical - Lack of R&D, poor access

⑫ Way Forward [Sikkim & Nagaland - POCM]

1) Policy & Certⁿ → Blockchain → Digital certifⁿ

2) Market Development 3) Consumer Awareness

4) Support to Farmers (FPOs) 5) R&D 6) Training centres

Zero Budget Natural Farming (ZBNF)

4 Components -

- 1) Beejamrit
- 2) Jeevamrit
- 3) Acchadana
- 4) Waaphasa

Benefits

- 1) 50-60% Less power & Water
- 2) Low input cost
- 3) ↑ Soil organic content (Microbes)
- 4) ↓ CH₄ Emission
↓ Residue Burning
- 5) ↑ Drought Resilience
- 6) ↓ Import Dependence for Fertilisers

Challenges

- 1) Labour Intensive
- 2) Time Consuming
- 3) Yield Variations & Unpredictability
- 4) ↑ Maintenance (cow)
- 5) Lmt'd scientific study
- 6) Hidden Costs
Overestimation - Profits
- 7) Transition phase cost

Govt Steps

- 1) BPKP under PKVY
- 2) Fin. Assistance
- 3) MOVCD-NER
- 4) Subsidies
- 5) ICAR Research
- 6) AP - 80 Lakh Hectares by 2027

States Practicing ZBNF

HP - Prakritik Kheti Khushhal Kisan
KA, KR, MH etc

Way Forward

- 1) R & D
- 2) Training
- 3) ↑ Market Access
- 4) ↑ Cow Breed Conservation Program
- 5) Avoid Forced Adoption
- 6) ↑ Localised experimentation

Empowering Farmers: The Success Story of MAHA FPC

646 FPOs → 1.7 Lakh Farmers

Case Studies: ES (2025-26)

- 1) Innovation in Land & Resource Governance
AP → Digital Land Titling
- 2) Market Reforms & Digital Market Access
MP → Digital MSP Purchases - Souda Patra
AP → e-Farmarket - Rythu Bharosa Kendras
- 3) Climate Resilient Agri & Water Governance
KR → KERA Project supported by WB
OD → Pani Panchayat
- 4) Tribal Farming & Trad^l Knowledge
JH → Solar Irrigation Co-operatives
↳ Oraon Farmers → Year round cultivation

WRI → AP - Largest Agroecological Transition Experiment
✓ Phased Local Experiments

Israel - FAO

Agri Extension + Tech support

Cereals Based → High Value Base Agri
HVA ⇒ Horticulture + Livestocks + Fisheries
↓ (13% GR) (14% GR)

Nashik Grapes Study

Prodⁿ → Processing → Exports → Eco. Growth
(Value Chain Approach)

2. Major Cropping Patterns.

What is the Cropping Pattern?

The proportion of area under diff. crops at a given point of time in a region (M & A)

Crops → Food Crops & Cash Crops

Factors affecting cropping pattern -

1) Historical Factors -

Permanent Settlement, Ryotwari, Mahalwari
Famines | Land Reforms | Green Revolutⁿ

2) Natural Factors -

- Climate & Temp ⇒ 15 Agroclimatic
- Regions & 125+ AgroEco. Zones (ICAR)

3) Rainfall Patterns & Monsoon | Topography

4) Economic Factors

Farm Size & Structure | Inputs Access
Investment Capacity | Market Infra
Eco Incentives | Irrigation

5) Govt Policies & Market Factors

- MSP & Procurement
- Viksit Krishi Sankalp Abhiyan
↳ Green Manure + SHC based Fertilisers + Mixed Cropping
- Taxation & Infra

6) Socio-cultural Factors (Plate & Farm)

Food Habits | Diet | Religion | Festivals

7) Consumption Pattern

NSS : Consumption Survey

Rising Income ⇒ Cereals Based Consumpⁿ
to Protein + Fruits + Processed Food

8) Marketing Conditions -

APMC Access | Market Integration
Export Demand | Contract Farming
Infrastructure

① Benefits of Crop Diversification

- 1) ↑ Soil Health (Legumes → N-Fixation)
- 2) Curbing Disease Outbreak
- 3) Blocking Pests & Bugs
- 4) Taming Weeds
- 5) Better Use of Farm Resources
- 6) ↓ Total Crop Wipeout
- 7) ↑ Food supply & wallet security

• Floriculture → sunrise sector
↳ 100% export promotion / ✓ small lands } ES
↳ Income/Hectare > other crops

② Challenges Associated With Current Cropping Pattern-

- 1) Overdependence on Rice & Wheat
MoSPI: ↓ Area under coarse cereals
28.48% (1970-71) → 11.7% (2020-21)
• Green Revolution → Ensured food security but (ES)
increased regional concentration & GW stress
- 2) Soil Degradation & Monoculture
NPK (PB) ⇒ 29.8 : 6.5 : 1 (ICAR)
ISRO Desertification Atlas → 30% Land
- 3) Water Security & GW Depletion
PB/HR → 85% Blocks - Overexploited GW
WB → (I) Largest GW Exploiter
Nearly 90% Fresh Water → Agri (says WB)
Nearly 55% cultivable area → ✓ Irrigatⁿ
- 4) Climate Vulnerability - Erratic Monsoon
1°C ↑ Temp ⇒ 5 Mn Tonne Wheat prodⁿ ↓ (WB)
- 5) Agro-climate misalignment
- 6) Inadequate Market & Storage Infra
- 7) Price Volatility & Debt stress (50% farmer)
✓ Cobweb Phenomenon

③ Changing Cropping Pattern in India

Wheat/Rice → Millets, Pulses, Oilseeds
Coarse cereals → Fruits & Vegetables
Sugarcane → Oilseeds & cotton
Rainfed cereals → Commercial Crops

④ Impacts of Changing Cropping Pattern

+ve Impacts

- 1) ↑ Farm income & Eco. sustainability
 - 2) Better water mngt & sustainability
 - 3) ↑ Food & Nutritional security
 - 4) ↑ Soil Health & Biodiversity
- Crop Diversification = virtual water conservatⁿ
↳ F-security → N-security → ↓ Hidden Hunger - NITI

-ve Impacts -

- 1) Market Volatility & Fluctuations
 - 2) ↓ Food grain self-sufficiency
 - 3) Loss of trad^l & Indigenous crops (NE-I)
 - 4) Lack of Extension support & Knowledge
- Ashok Dalwai Cmt → Tech adoption depends more on extension services than tech availability itself.

⑤ Need of the Hour

- 1) ↑ Crop Diversificatⁿ & support system
- 2) ↑ Infra & Post-Harvest Systems
Post Harvest Losses ⇒ 40% Fruits & vegetables
- 3) ↑ Water-Efficient & microirrigation
- 4) ↑ Market Access & Institution Building
- 5) Broaden Risk Mitigation & Insurance
Income Risk ← Productⁿ Challenges? (ES)
& Price Volatility
- 6) ↑ Knowledge, Extension, Tech Adoption
Agri 4.0 (FAO) / Annadata → Agripreneurs
- 7) Agroforestry & Natural Farming

⑥ Some Success Stories -

- 1) Dharwad-Haveri (KA) → Millet Magic Project
CROPS4HID
↳ i/p intensive → Climate smart farming
- 2) Enabawi Village (TS) → 1st Organic Village
↳ Ecology + Livelihood + Health ← FAO
- 3) Barahnaja System (UK) - Trad^l Multi-crop-
ping

⑦ Integrated Farming System

(Whole farm management approach)
Prodⁿ Maximizⁿ → System Optimizⁿ (ICAR)
Waste of one → i/p of another (ICAR)

⑧ Benefits

- 1) ↑ Farm Income
- 2) ↑ Livelihood Security
- 3) ↑ Recycling
- 4) ↑ Soil Health
- 5) Environmental Protection

⑨ Challenges

- 1) Knowledge & Technical Skills gap
- 2) High initial investment & credit constraints
- 3) Small & Fragmented Landholdings
- 4) Lack of infra
- 5) Cultural Resistance & social constraints
- 6) Risk & longer transitⁿ

⑩ Way Forward (Swaminathan Commission)

- 1) FPOs
- 2) Single window credit
- 3) Micro Processing Units

① Crop Diversification (Portfolio Strategy)

CD → Virtual Water Conservatⁿ (NITI)

Produce More → Produce Smart (NITI)

eg. - Alappuzha (KR) = Pokkalia + Prawns
Rice Farming

Barahaja (UK) → Multicropping

② Benefits -

- 1) ↓ Risk
- 2) ↑ Climate Resilience
- 3) ↑ Income
- 4) ↑ Employment
- 5) ↑ Soil Fertility
- 6) ↓ Input Cost
- 7) Food & Nutritional Security

③ Challenges

- 1) Policy Bias towards Monoculture
- 2) Lack of market access & infra
- 3) Water scarcity & Climate eg. Marathwada
- 4) Limited awareness & extension services
- 5) Cultural & Traditional Preferences

④ Emerging Technologies → ↑ 20% crop intensity (ICAR)

- 1) Precision Agri & Remote Sensing
- crop suitability mapping (ISRO)
(Intuition → Data Based Agriculture)
- 2) AI & Mobile Based Advisory Platforms
Apps - Kisan Suvidha, AgNext, CropIn
John Deere's See & Spray
- 3) Biotechnology & Improved Varieties
✓ 2nd cropping window
✓ Nutrients Mining
- 4) Hydroponics, Vertical Farming & Protected Cultivation
- 5) E-Marketplace & Supply Chain Tech
eg. DeHaat's → UP

② Wheat-Rice Dilemma in India

① Concerns -

- 1) Crop Residue Burning: Air pollutⁿ - Delhi
- 2) Soil Health ↓: Ludhiana (N) decreased by 22%
- 3) Groundwater Depletion
PB & HR → 85% Blocks overexploited GW
Exporting Rice → Exporting GW (NITI)
- 4) WTO Disputes
- 5) Genetic Diversification, Skewed MSP, Methane Emission, Fossil Fuel Based Fertilisers etc.

② Way Forward

- 1) ↑ Crop Diversification
- 2) Water use Efficiency
- 3) Soil & Nutrient Mngt
- 4) AI & IoT
- 5) In-situ crop residue mngt (Happy Seeder)
- 6) Integrated policy
- 7) Procurement Based Risk Reductⁿ (NITI)
- 8) HR - Mera Paani, Meri Virasat

Agroclimate Suitability (ES)  Alternate Income Support (ES)

③ Determinants of High Value CD.

- 1) Eco. incentives & price signals
- 2) Agro-climatic suitability
- 3) Market Access & Infrastructure
- 4) Risk perceptⁿ & Risk Mitigatⁿ capacity
- 5) Access - Credit, Tech, Extension
- 6) Govt policy & institutional support
- 7) Landholding structure & tenure security

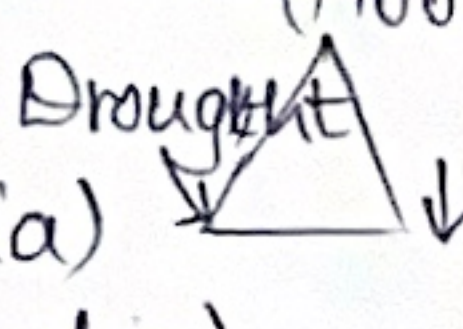
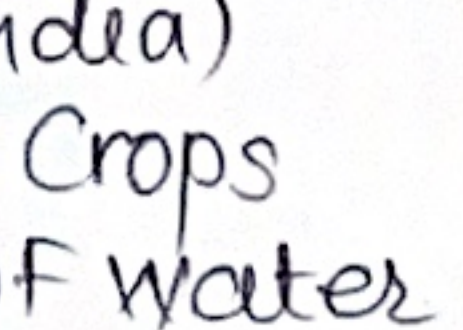
3. Irrigation & Irrigation System

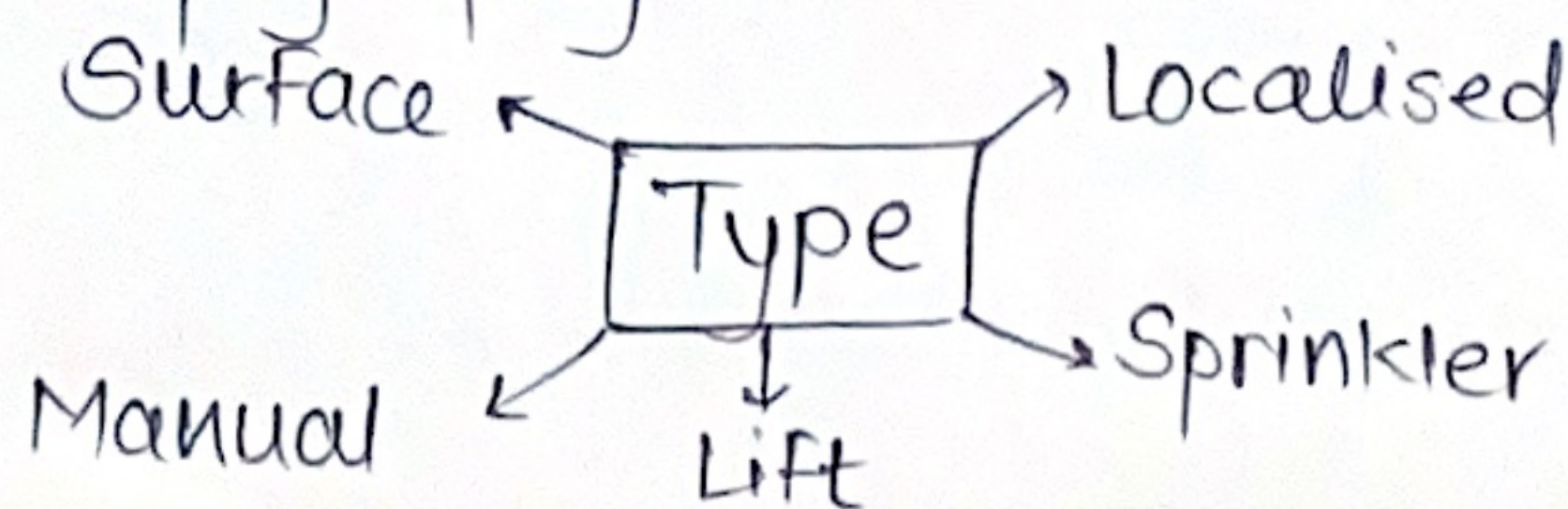
① Irrigation - Artificial supply of water
A tool to improve soil health & productⁿ mngt.

② Data -

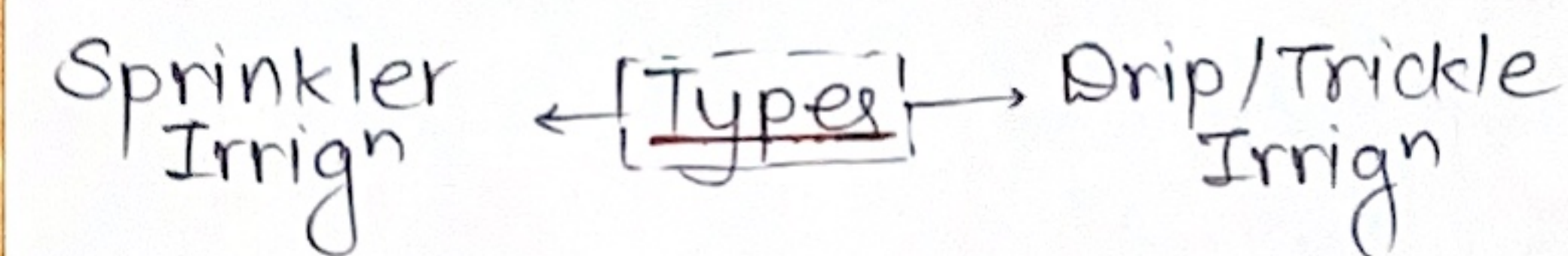
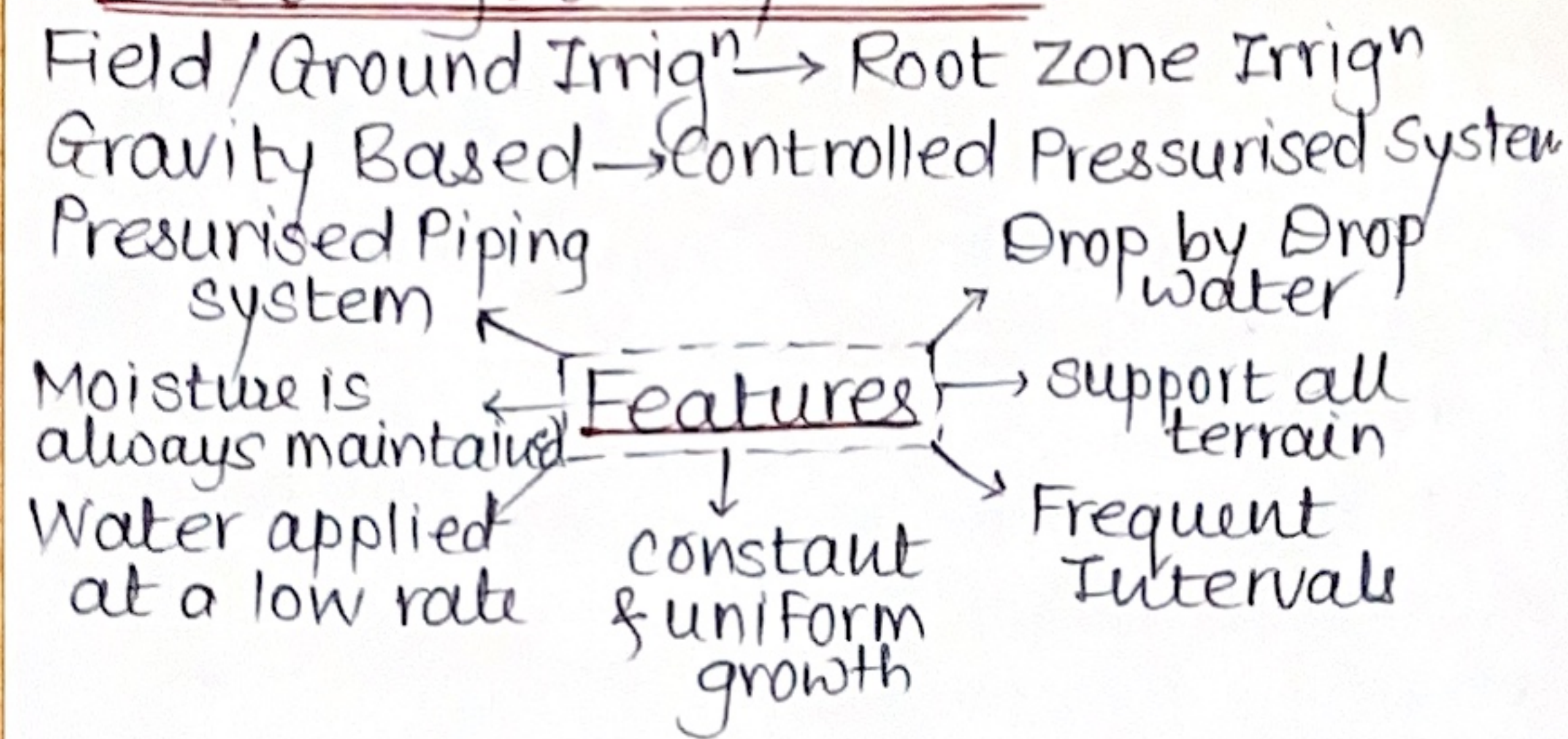
- 1) Irrigatⁿ cover → 55% Gross Cropped Area
- 2) Irrigatⁿ Intensity → 155% (over irrigatⁿ)
- 3) PB & HR → 98% & 94% GW Extraction
- 4) Micro-irrigatⁿ → India: 8% | USA - 68%
- 5) Total Irrigated Area = 68 Mn Hectares
- 6) Share of Irrigated Area = 48% net sown area
- 7) Groundwater → Nearly 68% of irrigatⁿ
- 8) Canal Irrigatⁿ → 24% of irrigatⁿ
- 9) Crop-wise → 90% → wheat & rice
- 10) Tube Wells → 50 Lakh
- 11) Tank Irrigatⁿ → Peninsular States

③ Necessity of Irrigation

- 1) Uncertainty of Monsoonal Rainfall (Flood)
- 2) Highly seasonal rainfall 
- 3) Winter Rainfall (North India)  ↓ GW
- 4) Cultivation of High Yielding Crops
1 kg Rice → 1500 - 2000 Ltrs of water
- 5) Difference in water holding capacity
- 6) (I) → Land of Rabi Crops
- 7) Topography



① Microirrigation Systems



② Advantages of Micro-irrigation

- 1) Saves Water (45-60%)
Micro-irrigⁿ can save upto 50% of water & ↑ 40% productivity
 - 2) Uniform water application → moisture is maintained
 - 3) Saves electricity
 - 4) Better Chemical Application
 - 5) Reduces weeds & diseases
 - 6) Tolerates soil salinity
 - 7) Suited to varied topography & soil
 - 8) Allows automation (IoT / Moisture Activⁿ)
 - 9) ↓ Labour cost
 - 10) ↑ Crop quality & yield
- 11) Fertigation

③ Challenges

- 1) High Initial Cost
- 2) Emitter clogging
- 3) Low Technical know-how
- 4) Power supply issue
- 5) Poor maintainance
- 6) Animal damage risk
- 7) Unsuitable for tall crops

④ Govt Steps-

- 1) CSS → Per Drop More Crop
- 2) Micro Irrigⁿ Fund - NABARD - ₹5000 cr
- 3) Sahi Fasal Campaign
- 4) State Govt Subsidies

⑤ Problems : Irrigation

- 1) Waterlogging & Salinity
- 2) Difficulty in infra creation
- 3) Sustainability & falling yields (HR-GR)
- 4) Conflict over water eg. Cauvery
- 5) Neglect envtl Flows eg. Yamuna
- 6) Siltation - eg Bhakra & Hirakund reservoirs
- 7) Health Impacts

⑥ Major schemes : Irrigⁿ Sector

- 1) PM-KSY → Har Khet Ko Pani
→ Per drop more crops
Irrigⁿ Expansion → Irrigⁿ Efficiency
 - 2) Atal Bhujal Yojana → 8000 Gram Panchayats
↳ Community led GW governance
 - 3) PM-KUSUM → Solar pumps & grid connected RE. Energy Agri
 - 4) Polavaram Irrigⁿ Project, Sharyu National Project etc
- Water availability → Water mngt problem (NITI)
Irrigⁿ → Agri : single to multi season

⑦ Measures to improve water storage & Irrigation System

- 1) ↑ Micro-irrigation
- 2) Modernise canals & watercourses
- 3) Water Harvesting
- 4) ↑ Conjunctive use of surface & groundwater
- 5) ↑ Rainwater Harvesting in fields
- 6) Use Treated wastewater
Waste Water Reuse = New Water Source (WB)
- 7) Crop diversification
- 8) ↑ on-farm water management
- 9) Maintain minimum ecological flows
- 10) Precision Irrigation
- 11) IoT & AI → Fixed Scheduling

⑧ Some Innovative Solutions

- 1) Smart IoT & AI Irrigatⁿ systems
- 2) Floating solar power pumps
- 3) Modern Subsurface Storage (Tanka 2.0)
- 4) Digital Water Credits & Trading
- 5) Rooftop & Road Runoff Harvesting
- 6) Biochar & Hydrogel Soil Amendments
- 7) Automated Canal Gates & smart Distributaries.

⑨ Tal Shakti Abhiyan

- 1) Water Conservation & rainwater Harvesting
- 2) Renovation of trad^l & other water bodies
- 3) Reuse & Recharge of Borewells
- 4) Watershed Development
- 5) Intensive Afforestation