

Major Crops - Cropping Patterns in various parts of the country Questions:	8
Major Crops - Cropping Patterns in various parts of the country	8
Overview of Indian Agriculture	8
1) Significance of Agriculture in the Indian Economy	8
2) Major Cropping Seasons (Kharif, Rabi, Zaid)	9
Additional Points	9
Factors Influencing Cropping Patterns	9
1) Climatic Conditions (Temperature, Rainfall, Humidity)	9
2) Soil Type	10
Additional Points	10
Here are five local practices that improve soil health, along with concise explanations:	10
3) Irrigation Facilities	10
4) Technological Availability	11
Additional Points	11
5) Government Policies	11
6) Economic Factors	12
Additional Points	13
Major Food Crops:	13
Rice	13
1) Geographical Conditions (Temperature, Rainfall, Soil Type)	13
2) Major Producing Areas/States in India	13
3) Productivity Trends, Challenges, and Solutions for Improvement	13
Additional Points	14
Wheat	14
1) Geographical Conditions (Temperature, Rainfall, Soil Type)	14
2) Major Producing Areas/States in India	14
3) Productivity Trends, Challenges, and Solutions for Improvement	15
Additional Points	15
Pulses	16
1) Geographical Conditions (Temperature, Rainfall, Soil Type)	16
2) Importance of Pulses in Indian Agriculture and Economy	16
3) Major Producing Areas and Crops	16
4) Productivity Trends, Challenges, and Solutions for Improvement	16
Additional Points	17
Agriculture Contribution in GDP	17
Other Food Crops	18
1) Geographical Conditions (Temperature, Rainfall, Soil Type)	18
2) Major Producing Areas and Crops	18
3) Productivity Trends, Challenges, and Solutions for Improvement	19
Additional Points	19
Major Commercial Crops:	20
Cotton	20
1) Geographical Conditions	20
2) Major Growing Regions in India	20
3) Economic Importance	20
Cotton cultivation thrives under specific geographical conditions:	20
Tea	20
1) Geographical conditions and regional factors	20

2) Economic significance.....	20
3) Challenges and significance of tea plantations in the lesser Himalayas.....	21
The economic significance of tea in India is substantial, impacting various aspects of the national economy.....	21
Major Crops - Cropping Patterns: Oilseeds.....	22
Geographical Conditions.....	22
Government Policies.....	22
Major Oilseeds and Their Distribution.....	22
Distribution of Rubber, Tobacco, Pepper, etc.....	22
Environmental Challenges.....	23
Fruit Production in India.....	23
Overview of Fruit Production.....	23
Specific Fruit Crops.....	23
Indigenous Practices.....	23
Research and Development.....	24
Cropping Patterns: Definition and Types.....	24
Definition of Cropping Pattern.....	24
Types of Cropping Patterns.....	24
Regional Cropping Patterns.....	24
Importance of Crop Diversification.....	25
Related Agricultural Concepts.....	25
Allelopathy.....	25
Significance of the International Year of Pulses.....	25
Specific Case Studies.....	25
Challenges and Solutions.....	25
Declining Productivity.....	25
Environmental Impacts of Cropping Patterns.....	26
Role of Technology in Improving Productivity.....	26
Cropping Pattern, Crop Productivity, Diversity, and Yield Question.....	26
Cropping Pattern, Crop Productivity, Diversity, and Yield.....	27
Significance of Agriculture in India.....	27
Agricultural Productivity in India.....	28
Current Status: Overview of Yield and Productivity Levels for Major Crops.....	28
Why Seed Replacement Matters:.....	28
Reasons for Low Productivity.....	29
1) Technological Backwardness.....	29
2) Inadequate Irrigation Facilities.....	29
3) Small and Fragmented Landholdings.....	29
4) Poor Soil Health.....	30
5) Lack of Access to Quality Inputs.....	30
6) Climate Change Impacts.....	30
7) Poor Post-Harvest Infrastructure.....	31
Measures to Increase Productivity.....	31
1) Technological Inputs (High Yielding Varieties, Precision Agriculture).....	31
2) Improved Irrigation and Water Management.....	31
3) Soil Health Management.....	32
4) Mechanization.....	32
5) Credit and Market Access.....	32
Cropping Patterns in India.....	33

Definition and Types: Multiple Cropping, Monocropping, Intercropping, Crop Rotation.....	33
Factors Influencing Cropping Patterns.....	33
1) Climatic Conditions.....	33
2) Soil Type.....	33
3) Irrigation Facilities.....	33
4) Market Demand and Prices.....	33
5) Government Policies and Subsidies.....	34
6) Technological Availability.....	34
Changes in Cropping Patterns.....	34
1) Historical Changes and Drivers.....	34
2) Impact of High-Yielding Varieties (HYV).....	34
3) Recent Shifts in Response to Market and Consumption Patterns.....	34
Strategies for Crop Diversification.....	35
1) Promotion of Millets and Other Nutri-Cereals.....	35
2) Encouraging Horticulture, Floriculture, and Livestock.....	35
3) Integrated Farming Systems.....	35
4) Role of Technology for Crop Diversification.....	36
Emphasis on Millets.....	36
Reasons Behind Promoting Millets.....	36
Government Measures to Increase Millet Production and Consumption.....	36
Modern Technological Inputs.....	37
High-Yielding Varieties, Precision Farming, Biotechnology.....	37
Mechanization, Irrigation Technologies.....	37
Information and Communication Technologies (ICT).....	38
Impact on Food Security.....	38
Role of Technology in Ensuring Food Production in the 21st Century.....	38
Government Initiatives and Policies.....	39
Subsidies: Impact on Cropping Patterns, Crop Diversity, and Farm Economies.....	39
Minimum Support Price (MSP): Significance for Small and Marginal Farmers.....	40
Crop Insurance: Importance for Risk Management in Agriculture.....	40
Food Processing: Significance for Small and Marginal Farmers.....	40
Steps Taken by the Government to Address Regional Variations in Crop Production and Diversification.....	41
Challenges and Way Forward.....	42
Present Challenges Before Crop Diversification.....	42
Recommendations for Improving Cropping Patterns, Productivity, and Diversity.....	42
Dry Land Agriculture and Practice.....	43
Topic: Dryland farming.....	43
Dryland Farming and Agriculture.....	43
Key Features of Dryland Farming.....	43
Dryland Agriculture Practices.....	44
Dryland Agriculture in India.....	44
Challenges and Solutions.....	44
Government Initiatives.....	45
Challenges of Dryland Areas: Low Productivity Reasons.....	45
Specific Examples of Low Productivity Factors.....	45
Related Factors Impacting Productivity.....	46
Alternative Practices and Solutions.....	46
Crops of Dryland Areas.....	46

Specific Examples and Details.....	46
Other Relevant Points.....	47
Strategies for Enhancing Dryland Agriculture: Water Management Techniques.....	47
Specific Examples and Details.....	48
Related Points on Water Management.....	48
Government Initiatives and Support.....	48
Integration with Other Practices.....	48
Strategies for Enhancing Dryland Agriculture: Agronomic Practices.....	49
Specific Examples and Details.....	49
Additional Agronomic Strategies.....	49
Integration and Support.....	50
Strategies for Enhancing Dryland Agriculture: Soil Management Methods.....	50
Specific Examples and Details.....	50
Additional Soil Management Strategies.....	50
Traditional Knowledge and Practices.....	51
Integration and Support.....	51
Strategies for Enhancing Dryland Agriculture: Technological Interventions.....	51
Specific Examples and Details.....	52
Additional Technological Strategies.....	52
Indigenous Technological Knowledge.....	52
Integration and Support.....	52
Importance of Dryland Farming: Contribution to Food Security, Livelihoods, and Rural Economy...	53
Specific Examples and Details.....	53
Additional Economic and Social Contributions.....	53
Challenges and Strategies.....	53
Government Schemes & Policies for Dryland Agriculture.....	54
Specific Objectives and Relevance to Dryland Farming.....	54
Integration and Support.....	54
Dryland Farming: Sustainability and Climate Change.....	54
Climate Change Mitigation Strategies.....	55
Role of Dryland Farming in Adapting to Climate Change.....	55
Additional Strategies.....	55
Dryland Farming: Essential Data Points.....	56
Dryland Farming: Case Studies.....	56
Shifting / Jhum Agriculture Question.....	57
Shifting / Jhum Agriculture.....	58
Shifting and Jhum Cultivation.....	58
I. Introduction:.....	58
II. Main Points:.....	58
I. Process of Shifting Cultivation:.....	58
II. Methods Used:.....	59
III. Cycle of the Process:.....	59
Geographical Distribution and Major States.....	59
Salient Characteristics.....	59
Consequences (Negative Impacts).....	60
Government Measures to Control/Prevent Shifting Cultivation.....	61
Alternative Livelihood Options.....	61
Sustainability and Community-based Solutions.....	61
Debates on Shifting Cultivation.....	62

Case Studies and International Examples.....	63
Sustainable Agriculture Questions:.....	64
Sustainable Agriculture.....	64
Modern Agriculture & Sustainable Practices.....	64
Consequences of Modern Agricultural Practices.....	64
Organic Farming.....	65
Integrated Farming System (IFS).....	65
Green Revolution.....	66
The Green Revolution initially bypassed the eastern region due to a combination of factors:.....	68
Case Studies.....	69
Sikkim's Organic Journey: Challenges.....	70
Agricultural Inputs.....	71
Agricultural Inputs Questions:.....	71
Introduction.....	71
Limitations of mechanization in India.....	72
Integrated Pest Management (IPM).....	72
Agricultural Credit.....	73
How subsidies affect cropping patterns, crop diversity, and economy of farmers.....	73
Positive and negative impacts of different types of subsidies.....	74
Pradhan Mantri Fasal Bima Yojana (PMFBY).....	75
Key features of the PMFBY.....	75
Significance of MSP for small and marginal farmers.....	76
Food Processing.....	77
India: Essential Agricultural Data - Crisp.....	78
Agricultural Inputs: Case Studies.....	78
Fertilizers.....	79
Fertilizers Question.....	79
Types of chemical fertilizers and their uses.....	79
Advantages: Increased productivity, quick growth.....	80
Chemical Fertilizers :Disadvantages.....	80
Different types of biofertilizers and their roles.....	81
Advantages over chemical fertilizers.....	81
Vermicomposting.....	82
Importance of vermicomposting.....	82
Agriculture Data.....	83
Agricultural Policies.....	84
Agricultural Policies Question.....	84
Agricultural Price Policy.....	84
Impact on farmers and consumers.....	85
Industry Status to Agriculture:.....	86
Agricultural Development Policies of the last two decades.....	87
Regionally Differentiated Approach.....	89
Agricultural Produce Market Committees (APMCs).....	89
Digital India and Agriculture.....	91
National Horticulture Mission (NHM):.....	92
India: Essential Agricultural Data - Data Only.....	93
Case Studies:.....	93
Storage, Transport and Marketing of Agricultural Produce and Issues and Related Constraints.....	94
Storage, Transport and Marketing of Agricultural Produce and Issues and Related Constraints	

Questions.....	94
Objectives of dual pricing.....	94
Critical analysis (impact on sugar industry, farmers, consumers).....	94
Agricultural Trade Policies:.....	95
Impact of liberalization on agricultural trade.....	96
Agri-Trade.....	97
Constraints in Transport and Marketing.....	98
1) Main constraints in transportation.....	98
2) Main constraints in marketing of agricultural produce in India.....	98
3) Role of technology and effective management.....	98
Bottlenecks in Upstream and Downstream Processes.....	99
Bottlenecks in upstream processes (procurement, sorting, grading).....	99
Bottlenecks in downstream processes (storage, distribution, processing).....	99
Transition from Net Importer to Exporter.....	100
Reasons for India's transition.....	100
Case Studies.....	101
Successful cases of improving agricultural supply chains.....	102
Examples of farmer cooperatives involved in marketing and storage.....	102
Cases of challenges related to agricultural trade and exports.....	102
How does e-Technology help farmers in production and marketing of agricultural produce.....	102
Subsidies and MSP: Issues related to Direct and Indirect Farm Subsidies and Minimum Support Prices.....	103
Subsidies and MSP: Issues related to Direct and Indirect Farm Subsidies and Minimum Support Prices Questions:.....	103
Minimum Support Price (MSP).....	104
Definition of MSP.....	104
Objectives of MSP.....	104
Impact of MSP on farmer incomes and food security.....	104
How MSP Calculated.....	105
Direct Benefit Transfer (DBT).....	105
Concept of DBT.....	105
Potential benefits (reduced corruption, efficiency).....	106
Limitations and Challenges of DBT.....	106
How DBT Can Change the Subsidy Landscape in India.....	107
WTO and Agricultural Subsidies.....	107
Issues Raised by WTO.....	107
Impact of Subsidies on International Trade.....	108
Role and significance of each element.....	109
Case Studies: Successful Implementation of DBT.....	110
Case Studies: Negative Impacts of Subsidies on the Environment and Market.....	110
Case Studies: Success Stories of Farmers Benefiting from MSP and Crop Insurance.....	110
1. Data on Minimum Support Price (MSP) Procurement.....	111
2. Statistics on Subsidy Expenditure.....	111
3. Data on Farmers' Income and Indebtedness.....	111
4. Data on Digital Penetration and Accessibility in Rural Areas.....	111
Public Distribution System (PDS).....	112
Public Distribution System (PDS) Question.....	112
Functioning of PDS.....	112
Procurement of food grains.....	112

Storage and distribution.....	112
Fair Price Shops (FPS).....	113
Identification of beneficiaries.....	113
Objectives of PDS.....	114
Food security.....	114
Price stabilization.....	114
Poverty alleviation.....	114
Social welfare.....	114
Limitations/Constraints of PDS.....	115
Leakage and corruption.....	115
Inclusion and exclusion errors.....	115
Poor infrastructure and storage.....	115
Lack of transparency and accountability.....	115
Regional disparities.....	116
Targeted Public Distribution System (TPDS).....	116
Rationale for TPDS.....	116
Key features of TPDS.....	116
Advantages and disadvantages of TPDS.....	117
PDS Reforms.....	117
Government Initiatives.....	117
Role of Direct Benefit Transfer (DBT).....	117
Impact of Technology in PDS.....	118
Measures for Improvement.....	118
Improvement of infrastructure and storage capacity.....	118
Reducing leakages and corruption.....	118
Improving transparency and accountability.....	118
Community participation and monitoring.....	119
Use of technology for better targeting and delivery.....	119
Role of Self-help groups.....	119
Promoting awareness and community participation.....	119
1. Data on Public Distribution System (PDS) Beneficiaries.....	119
2. Data on Food Grain Off-take and Stocks.....	120
3. Statistics on PDS Leakages.....	120
Case Studies: Successful Cases of PDS Implementation in Different States.....	120
Examples of Government Initiatives for Improving PDS.....	120
Negative Impact of Corruption and Leakages and the Need for Reforms.....	121
Negative impact of corruption and leakages and the need for reforms.....	121
Food Security: Issues of Buffer Stocks and Food Security.....	122
Food Security: Issues of Buffer Stocks and Food Security Question.....	122
Procurement Price.....	122
Definition and purpose of procurement price.....	122
How does it impact the supply and price.....	122
Post-Harvest Losses.....	123
Causes of post-harvest losses.....	123
Measures to prevent losses (infrastructure, cold storage, technology, farmer awareness).....	123
Per Capita Cereal Availability.....	124
Trends in Cereal Availability in India Over the Last Few Decades:.....	124
Factors affecting this trend (population growth, production levels, policies, consumption patterns).....	124

Agricultural Growth Strategies.....	125
Measures to meet the food grain demand.....	125
Technology driven approach (high-yielding seeds, precision farming, etc.).....	125
Sustainable agricultural practices.....	126
Buffer Stock Operations.....	126
Definition and objectives of government buffer stock operations.....	126
Mid-day Meal Scheme.....	127
Rationale behind the scheme (improved nutrition and education).....	127
Annapurna Scheme.....	127
Objectives of the scheme (food security for senior citizens).....	127
Small holder farms for food security.....	127
Arguments for and against small-holder farms for national food security.....	127
Agricultural Revolution.....	128
Different types of agricultural revolutions in India. Their role in food security and poverty reduction.....	128
National Food Security Act, 2013.....	129
Salient features of the act.....	129
Essential Data Points on Food and Agriculture in India:.....	130
1. Food Grain Production and Consumption:.....	130
2. Post-Harvest Losses:.....	130
3. Malnutrition and Hunger Statistics:.....	131
4. Government Buffer Stocks:.....	131
5. Farmer Income and Productivity:.....	131
Post-Harvest Management.....	131
Effective Food Security Schemes.....	131
Challenges in Achieving Food Security.....	132
International Examples.....	132
International Best Practices for Food Storage and Management.....	133
Economics of Animal Rearing.....	133
Aquaculture (Inland Fish Farming).....	134
Role in food security and employment.....	134
Aquaculture (Inland Fish Farming).....	135
Steps Taken to Promote Sustainable Practices.....	135
Importance of Technology in Aquaculture.....	135
Market and Supply Chain Aspects, Export Potential.....	135
Livestock Rearing.....	136
Potential for non-farm employment and income.....	136
Livestock Rearing.....	136
Role in diversification of farm income.....	137
Importance of technology, credit and marketing support.....	137
Need for disease control and animal care.....	137
Role of animal rearing in sustainable agriculture, organic farming and integrated farming system.....	137
Essential Data Points on Fisheries, Livestock, and Rural Economy in India:.....	138
1. Fish and Livestock Production in India:.....	138
2. Statistics on Employment in the Animal Rearing Sector:.....	138
3. Contribution of Livestock and Aquaculture to the Rural Economy:.....	138
4. Government Spending on Schemes and Projects:.....	138
Successful Aquaculture Projects:.....	138

Case Studies of Communities Benefiting from Livestock Rearing:.....	139
Agriculture Revolutions.....	139
White Revolution in India: A Comprehensive Overview.....	140
Definition and Main Features.....	140
Factors Contributing to the Success of the White Revolution.....	140
Impact on Milk Production and Farmer Income.....	141
Broader Outcomes and Impacts.....	141
Significance of the White Revolution.....	141
Blue Revolution in India: A Detailed Overview.....	141
Definition and Scope.....	141
Advantages.....	142
Environmental Impacts.....	142
Strategies for Promoting Sustainable Aquaculture.....	142
Significance of the Blue Revolution.....	143
Pink Revolution in India: An Overview.....	143
Definition and Importance.....	143
Importance in Food Processing and Value Addition.....	143
Need for Promoting the Pink Revolution.....	143
Measures to Improve the Poultry Sector Sustainably.....	144
Balancing Growth with Sustainability.....	144
Other Agricultural Revolutions in India.....	144
Major Agricultural Revolutions.....	144
Impact on Poverty, Food Security, and Farm Income.....	145
Way Forward.....	146
Pisciculture Development in India.....	146
Problems Faced by the Pisciculture Sector in India.....	146
Strategies for Promoting Sustainable Pisciculture.....	146
Conclusion.....	147
Case Studies: Success Stories of Cooperative Dairy Movements.....	147
Examples of Sustainable Aquaculture Projects.....	147
Cases of Communities That Have Benefited.....	148
Food Processing and Related Industries in India- Scope and Significance, Location, Upstream and Downstream Requirements, Supply Chain Management.....	148
Department of Food Processing.....	148
Functions and objectives of the Department of Food Processing (formulation of policies, coordination, promotion and monitoring).....	148
Role in supporting and coordinating development of the sector.....	149
Mega Food Park Scheme.....	149
Main features and objectives of the scheme (infrastructure, linkages, processing facilities).....	149
Potential impact on the sector and farmer incomes.....	150
Impediments in Marketing and Supply Chain.....	150
Challenges in marketing of food processed products.....	150
Challenges in supply chain management (infrastructure, logistics, wastage, lack of cold chain).....	151
Role of intermediaries in price fluctuations.....	151
E-Commerce in Food Processing.....	151
Potential of e-commerce in addressing supply chain and marketing limitations.....	151
Benefits of e-commerce to improve market access, transparency, and farmer incomes.....	152

Small Processing Units.....	152
Reasons for poor acceptance of cost-effective small processing units.....	152
Potential of small scale units to uplift the socio-economic status of poor farmers.....	153
Need for hand holding, training and support for small units.....	153
Location of agro based industries:.....	153
Factors influencing location of agro based industries in North West India.....	153
Government Policies:.....	154
Government policies and initiatives for promotion of food processing sector.....	154
Role of technology in improving quality, hygiene and processing techniques.....	155
Scope and Significance:.....	155
Scope and importance of the food processing industry in India.....	155
Role in ensuring food security and reducing wastage and post harvest losses.....	156
Challenges and opportunities.....	157
Challenges and opportunities for the food processing sector in India.....	157
Case Studies: Successful Implementations in Food Processing.....	158
E-commerce Impact in the Food Processing Sector.....	158
Small-Scale Processing Units Empowering Farmers and Creating Jobs.....	159
Supply Chain Management, Upstream and Downstream Requirements.....	159
Impediments in Marketing and Supply Chain.....	159
Lack of storage facilities, poor transportation networks, inadequate cold chain.....	159
Inefficient handling, delays in transit, high transportation costs.....	159
Impediments in Marketing and Supply Chain.....	160
Market inefficiencies: Lack of market information, price volatility, cartelization and lack of transparency.....	160
Role of intermediaries: Multiple layers of intermediaries, low price realization for farmers and their dependence on middlemen.....	160
Post-harvest losses and wastage: Spoilage, handling damage, lack of proper storage.....	160
E-commerce in Supply Chain.....	160
Potential for direct market access for farmers.....	160
Role in reducing intermediaries and enhancing transparency in the supply chain.....	160
Use of technology for improved tracking, inventory management and efficient delivery.....	161
Benefits for consumers (convenience, better quality, competitive prices).....	161
Impact on supply chain management of fruits, vegetables, and other food items (direct procurement, contract farming, organized retailing).....	161
Mechanisms for eliminating intermediaries (direct sourcing, improved supply chain practices).....	162
Role in quality control, standardisation, and promoting sustainable practices.....	162
Integration with farmer cooperatives and producer groups.....	163
Upstream Bottlenecks.....	164
Challenges in procurement (aggregation issues, fragmented land holdings).....	164
Challenges in sorting and grading, lack of standardization.....	164
Challenges related to lack of information and awareness of market trends.....	165
Downstream Bottlenecks.....	165
Challenges in storage (lack of storage infrastructure, inadequate cold chains).....	165
Challenges in transportation and logistics (poor roads, connectivity, limited transportation options).....	165
Challenges in processing and distribution (lack of processing facilities, poor last mile delivery).....	165
Post-Harvest Losses in India:.....	166
Investment in Infrastructure Projects:.....	166

Market Prices and Price Fluctuations:.....	166
Farmer Incomes and Economic Status:.....	166
Case Studies: Successful Supply Chain Management.....	166
Land Reforms in India.....	167
Land Reforms.....	168
Social justice, equity, and empowerment.....	168
Improved agricultural productivity, rural development, and poverty alleviation.....	168
Efficient resource utilization and equitable distribution.....	168
Abolition of intermediaries (zamindari, jagirdari).....	168
Tenancy reforms (security of tenure, rent regulation).....	169
Land ceiling (imposing a limit on land holdings).....	169
Consolidation of holdings and land records digitization.....	169
Implementation of Land reforms.....	169
Success and failures of land reforms in different parts of the country.....	169
Role of centre and state governments.....	170
Socio economic and political challenges in implementation.....	170
Impact on Agricultural Growth.....	170
Relationship with productivity, investment, access to resources, technology and credit.....	170
Impact on the lives of small and marginal farmers.....	170
Relationship with Poverty Alleviation.....	171
Improved incomes, employment, and social equity, and economic opportunities.....	171
Land Acquisition Act 2013.....	172
Key provisions, compensation, rehabilitation, consent procedures.....	172
Implications for industrialization and agriculture.....	172
Contract Farming and Land Leasing.....	173
Pros and cons, its applicability to current scenario.....	173
Safeguards for small and marginal farmers.....	173
Land Ceiling Policy.....	174
Rationale behind the policy and its role in economic reform.....	174
Impact of land ceiling on distribution of land, and its contribution to social justice.....	175
Successful Cases of Land Reforms in Different States.....	175
Land Distribution in India:.....	175
Implementation of Land Reforms:.....	175

Major Crops - Cropping Patterns in various parts of the country Questions:

- ☐ Which are the States in India that produce (i) groundnut, (ii) tea, (iii) tobacco, and (iv) pepper (80/3)
- ☐ Name the cotton growing areas of India. Describe the various factors which favour its cultivation in these areas. What part does cotton play in the present day economy of India? (83/15)
- ☐ Government of India has given high priority to Oilseeds Development Programme. What strategy has been adopted to accelerate the efforts for increasing their production? Name important oilseeds cultivated in India with their distribution. (84/15)
- ☐ Give an account of the tea plantations of Assam and West Bengal and state the economic significance of these plantations. (02/10)
- ☐ Write about Fruit Production in India (09/3)
- ☐ Write brief note in about 30 words: 'Vegetable Gold'. (09/3)
- ☐ Whereas the British planters had developed tea gardens all along the Shivaliks and Lesser Himalayas from Assam to Himachal Pradesh, in effect they did not succeed beyond the Darjeeling area. Explain. (14/10)
- ☐ What is allelopathy? Discuss its role in major cropping systems of irrigated agriculture. (16/12.5)
- ☐ Mention the advantages of the cultivation of pulses because of which the year 2016 was declared as the International Year of Pulses by the United Nations. (17/10)
- ☐ Describing the distribution of rubber producing countries, indicate the major environmental issues faced by them. (22/15)
- ☐ Discuss the geographical conditions favoring the cultivation of wheat or rice in India and describe the steps taken for improving its productivity. (82/30)

- ☐ What are the important wheat growing regions in India and why? Are we now growing enough wheat in India to meet our own demand for it? (85/20)
- ☐ Why was a variant of Basmati rice in news recently? (98/6)
- ☐ How has the dwindling of barbed variety of rice affected the Siliguri - Bagdogra belt with respect to man-animal conflict? (02/10)
- ☐ What are the major reasons for declining rice and wheat yield in the cropping system? How crop diversification is helpful to stabilise the yield of the crops in the system? (17/15)

Major Crops - Cropping Patterns in various parts of the country

Overview of Indian Agriculture

1) Significance of Agriculture in the Indian Economy

- Agriculture is the primary source of livelihood for about **58% of India's population**.
 - Agriculture and allied sectors contributed **19.9% to India's GDP** in 2020-2021.
- India ranks **first in the world** with the highest net cropped area.
 - This is followed by the US and China.
- The dominance of cereal crops shows the **poverty of low-income** people.
 - A large proportion of income is spent on cereals, but **pulses** are not grown significantly.
- Agriculture provides **employment** to 54% of the workforce, as per the 2021-22 Economic Survey.
 - The agriculture sector contributed **17% to the national GDP** in the 2022-23 Economic Survey.
- Agriculture is crucial for **food security**, providing sustenance for a vast population.
 - **GM crops** with high productivity are vital to ensure food security and reduce import dependence.

2) Major Cropping Seasons (Kharif, Rabi, Zaid)

- **Kharif** crops are sown at the beginning of the monsoon and harvested after the rainy season.
 - **Rice and cotton** are major Kharif crops.
- **Rabi** crops are sown in the winter and harvested in the spring.
 - **Wheat and mustard** are major Rabi crops.
- **Zaid** crops are grown in the short season between Rabi and Kharif, typically during the summer.
 - Cucumber, pumpkin, tomato, bitter gourd

Additional Points

- There is a need to shift from cereal-dominated production to include other crops like pulses to improve nutrition.
- Climate change is impacting cropping patterns in various parts of India by altering temperature and rainfall patterns.
 - Heat waves and untimely rainfall has led to reduced production of wheat crop.
- There is an increasing need to use technology and good agricultural practices to ensure food security.
- **Integrated weed management** and use of technology are essential to sustainable crop intensification.

Factors Influencing Cropping Patterns

1) Climatic Conditions (Temperature, Rainfall, Humidity)

- **Temperature and rainfall** are major determinants of crop productivity, especially in rain-fed areas.
 - Climate change impacts agriculture through altered temperature and precipitation patterns.
- **Hot and humid** conditions favor pest multiplication, affecting crop yields.
 - **Rice** is an important commodity, with pests multiplying in hot and humid conditions.
- **Untimely rainfall and heat waves** can reduce crop production, impacting cropping patterns.
 - For example, heat waves in March 2022 led to shrinking of wheat grains.
- **Climate change** causes extreme weather events like heavy rainfall, leading to reduced crop production.
 - Extreme rainfall in Punjab, Himachal, and Haryana in 2023 led to a fall in production.
- **Water availability** dictates which crops are grown and can lead to water depletion issues.
 - Paddy cultivation in Punjab has led to groundwater depletion.
- **Monsoon** onset determines sowing time for **Kharif** crops such as rice and cotton.
 - These crops are harvested after the rainy season.
- **Winter** season is suitable for sowing **Rabi** crops like wheat and mustard.
 - These crops are harvested in the spring.
- **Humidity** level affects disease and pest occurrence in crops which in turn, impact the yield.
 - High humidity creates optimal condition for pests in crops such as rice.

2) Soil Type

- **Soil type** influences the choice of crops grown in a particular region.
 - Farmers choose crops based on the suitability of soil type to the specific crop requirements.
- **Soil health** is a key factor in determining the success of any cropping pattern.
 - Practices like **conservation agriculture** improve soil health for sustained production.
- **Soil fertility** is a critical factor influencing crop selection and productivity.
 - **Organic manures, green manuring, and tank silt** are used to improve soil fertility.
- The **availability of nutrients** in the soil dictates the need for fertilizers.
 - **Urea** is the most commonly used fertilizer in India to provide nitrogen to the soil.
- **Sandy soils** require addition of clay to improve their physical condition.
 - This is an indigenous practice used to improve water retention capacity of sandy soil.
- **Crop rotation** is used by some farmers to improve soil fertility.
 - This also helps in controlling pests, diseases, and weeds.

Additional Points

- **Diversified cropping systems** can improve soil health and resource-use efficiency.
 - Including pulses in cropping systems improves system productivity.
- Farmers use **indigenous soil testing methods** to assess their land's suitability for crops.
 - This helps them determine the nutrient deficiencies and improve soil health.
- **Traditional knowledge** plays a role in understanding soil types and crop compatibility.
 - Local practices include using specific plants to manage pests and replenish nutrients.

Here are five local practices that improve soil health, along with concise explanations:

- **Samkor method of ploughing:** This technique involves specific ploughing patterns to **conserve moisture** in sandy loam soil.

- **Use of paddy stalk:** Spreading paddy stalks suppresses weeds and helps **retain moisture** in sandy loam soil.
- **Deep ploughing:** This practice, done between rows, **retains rainwater** and improves root development, particularly beneficial for crops like *mehandi*.
- **Application of pond soil:** Soil from pond bottoms, rich in decomposed organic matter, is spread on fields to increase **nutrient content** and reduce fertilizer needs, boosting crop yields by 25-30%.
- **Use of ash:** Ash from cow dung or fuelwood is applied to **soften hard soils** and improve their fertility.

3) Irrigation Facilities

- **Irrigation** is essential for crop production, influencing cropping patterns, especially in water-scarce regions.
 - Areas with good irrigation tend to have more intensive cropping.
- The type and **availability of irrigation** facilities can determine crop choice and intensity.
 - Regions with better irrigation use more chemical fertilizers.
- **Over-reliance on groundwater** for irrigation can lead to depletion of water resources.
 - Paddy cultivation in Punjab is leading to ground water depletion.
- **Water conservation** practices, such as replenishing water bodies, are important for sustainable agriculture.
 - Zero Budget Natural Farming (ZBNF) includes replenishing water bodies to ensure water availability.
- **Efficient irrigation systems** can promote diversification of crops by providing water security.
 - Different types of irrigation systems are a key component of agriculture.

4) Technological Availability

- **Technological advancements** play a crucial role in modernizing agriculture, impacting cropping patterns and yield.
 - Precise sowing and weeding tools are essential for sustainable crop intensification.
- **Farm mechanization**, including machinery like harvesters and threshers, enhances crop intensification.
- The government is promoting custom hiring centers to make machinery accessible to farmers.
- **Genetically modified (GM) crops** can increase productivity and reduce dependence on imports.
 - Bt cotton technology has shown resistance to bollworm, improving agronomic practices.
- Use of **high-yielding variety (HYV) seeds** is essential for improving agricultural productivity.
 - The Indian Council of Agricultural Research (ICAR) develops new crop varieties.
- **Bio-fortification** of crops can address nutritional deficiencies in the diet.
 - Infusing nutrients into grains at the seed stage increases nutritional value.
- **Use of technology** in public distribution system, like ePoS, has improved identification of beneficiaries.
- Electronic Point of Sale devices are being installed in Fair Price Shops for distribution of food grains.
- **Drones** and other advanced tools are being used for tasks like spraying pesticides and herbicides.
 - This is one way to integrate technology into agricultural practices.

Additional Points

- **Mobile applications** can provide farmers with essential information and advisory services.

- For example, an "Onion Crop Advisor" mobile application provides relevant information.
- **Integrated nutrient management (INM)** promotes judicious use of fertilizers and organic inputs.
 - This practice enhances soil health and crop productivity.
- **New technologies** such as liquid nano urea can help in reducing the use of chemical fertilizers.
 - Liquid nano urea is sprayed on leaves and then is transported to whole plant.
- **Seed replacement rate** and quality of farm saved seeds are upgraded to enhance production.
 - Sub-Mission on Seeds and Planting Material (SMSP) aims to increase production of certified/quality seed.

5) Government Policies

- **Government policies** significantly influence cropping patterns, including pricing, subsidies, and trade.
 - The Minimum Support Price (MSP) is a key government policy to protect farmers from market risks.
- **Subsidies** on inputs like fertilizers and electricity affect crop choices.
 - Urea is the most subsidized and consumed fertilizer in India.
 - Centre on Wednesday cleared the continuation of the urea subsidy scheme for three years, up to 2024-25, with an outlay of Rs 3.68 lakh crore.
- The **Public Distribution System (PDS)** impacts cropping by procuring grains at government set prices.
 - The PDS ensures food security by distributing food to the needy.
- **Land reforms** including tenancy reforms, aim to ensure equitable access to land and increase production.
 - These reforms seek to reduce exploitation of tenants.
- **National Food Security Mission** promotes oilseed cultivation to make India self-sufficient in edible oils.
 - The mission focuses on specific crops like rapeseed, mustard, and sunflower.
- Government schemes promote **sustainable agriculture practices** such as natural farming and conservation agriculture.
 - The PM-PRANAM scheme promotes balanced use of fertilizers and regenerative agriculture.
 - PM-PRANAM incentivizes states to reduce chemical fertilizer use by returning 50% of the fertilizer subsidy saved, compared to the previous three years' average consumption, back to the state/UT. This promotes **balanced fertilizer use and encourages the adoption of regenerative agriculture** and alternative fertilizers like nano urea and organic options.
- **Policies** related to trade can impact import and export of agricultural products.
 - The government may impose export bans to ensure domestic food security.
- The **Scheme for Modernization and Reforms through Technology in Public Distribution System (SMART-PDS)** aims to transform the PDS.
 - The scheme has the potential to improve food security in India.
- The government provides **financial assistance** for scientific research and development in agriculture.
 - This also includes promoting innovation by agricultural institutions.

6) Economic Factors

- **Economic factors**, like market prices, input costs, and access to credit, impact cropping decisions.
 - Farmers may choose crops based on their profitability and market demand.
 - Growth of wheat and rice due to MSP and growth of sugarcane due to International Demand and FRP

- The **cost of cultivation**, including expenses on fertilizers, labor, and machinery, influences crop choices.
 - The cost of cultivation is a key component in determining the MSP for crops.
- **Access to credit** and the availability of loans influence a farmer's ability to invest in inputs.
 - Small and marginal farmers often depend on informal sources for credit.
- **Trade policies and global prices** can affect the profitability of different crops.
 - If the international price of a crop is high, exports will increase and domestic supply decreases.
- **Value addition** through food processing can enhance farmers' income.
 - Food processing can increase the value of agricultural products.
- **Market intelligence** networks provide real-time data on demand, supply, and prices.
 - This data helps farmers make better informed decisions about what to grow.
 - Agricultural Market Intelligence Centre (AMIC) in Guntur
- **Contract farming** is a system where farmers grow crops for large retailers.
 - However, contract farming can divert land from food crops to exotic fruits and vegetables.
- **Post-harvest losses** due to poor storage and transport affect market prices and farmers income.
 - The lack of storage facilities leads to post-harvest losses.

Additional Points

- **Small and marginal farmers** often face challenges in accessing inputs, credit, and markets.
 - These farmers typically have less than 1 or 2 hectares of land, respectively.
- **Agricultural exports** contribute to the economy; India is a major exporter of rice and buffalo meat.
 - Major markets for Indian Basmati rice include West Asia and North America.
- **The share of agriculture** and allied sectors in India's GDP was 19.9% in 2020-2021.
 - Agriculture employs 58% of India's population.
- **Zero Budget Natural Farming (ZBNF)** helps reduce input costs for farmers.
 - ZBNF encourages farming without chemicals, credit, or purchased inputs.
- **Crop diversification** can enhance economic returns and improve resource use.
 - Growing different crops can help stabilize yields and manage risks.

Major Food Crops:

Rice

1) Geographical Conditions (Temperature, Rainfall, Soil Type)

- Rice cultivation requires **high temperatures**, abundant rainfall, and suitable soil types for optimal growth.
 - **Rainfall** should be more than 150cm/year, ideal for rice cultivation.
- **Clayey** and loamy soils with good water retention capacity are best suited for rice cultivation.
 - **Tropical regions** with high humidity are ideal for rice production.
- **Hot and humid conditions** are favorable for pest multiplication in rice crops.
 - Bacterial blight is a common problem in Basmati rice.
- **Climate change** is affecting rainfall and temperature, impacting rice production.
 - Untimely rainfall leads to flattening of wheat crops.

2) Major Producing Areas/States in India

- India has the **largest area under rice cultivation** and is the second-largest producer globally.
 - India is also a large exporter of rice.
- **West Bengal, Uttar Pradesh, and Bihar** are major rice-producing states in India.
 - These states are the major rice producers in the country.
- **Punjab** is the third-largest producer of rice in India.
 - However, Punjab's rice production is depleting ground water.
- **Andhra Pradesh** is a key state for rice production, including both upland and rice-fallow conditions.
 - New varieties of rice are being developed for both Kharif and Rabi seasons.
- **Odisha** is another state with significant rice cultivation, impacted by the stunting disease.
 - Surveys found a 1-20% incidence of stunting disease in rice fields in the state.

3) Productivity Trends, Challenges, and Solutions for Improvement

- **Rice yields** are declining due to various factors including climate change and monoculture.
 - Extreme rainfall can lead to a fall in production.
- **Stunting disease** caused by Southern rice black-streaked dwarf virus is affecting rice crops.
 - This disease has been found in the North-West Indian rice growing areas.
- **Monoculture** of rice contributes to ground water depletion and loss of soil fertility.
 - 87% of groundwater is used for cultivation of rice, wheat, cotton, and sugarcane.
- **Crop diversification** and using new rice varieties can help stabilize yields and manage risk.
 - ICAR developed a rice variety called Jaladhi, which can survive in waterlogged areas.
- **Integrated nutrient management (INM)** can improve soil health and crop productivity.
 - The PM-PRANAM scheme promotes balanced fertilizer use.
- **Technology** such as precision sowing, bio-fortification, and new seed varieties can increase rice production.
 - Punjab Agricultural University developed a bio-fortified variety, PBWRS1, for wheat.
- **Traditional methods** like 'Beushening' in direct-seeded rice can help in flood and drought-prone areas.
- This system helps in getting an assured yield in aberrant rainfall conditions.
- **Proper water management** including replenishing water bodies can make rice cultivation more sustainable.
 - Zero budget natural farming involves replenishing local water bodies.

Additional Points

- The government provides **Minimum Support Price (MSP)** for rice to ensure farmers get a fair price.
 - The MSP is announced before the cultivation season by the government.
- **Procurement** of rice for the Public Distribution System (PDS) is mainly from Punjab and Haryana.
 - Around 60% of the wheat and 30% of the rice procured for the PDS is from these states.
- **Paddy harvesting** happens first in Punjab, and then harvesters are transferred to Haryana.
 - The government is promoting custom hiring centers for harvesters.
- **Rice is a staple food**, and its production impacts food security, especially for low income people.
 - Dominance of cereal crops, such as rice, in the foodgrains points to poverty of people.
- **Export of basmati rice** is also important for the Indian economy.
 - Major markets for basmati rice are West Asia, North America, and Western Europe.

Wheat

1) Geographical Conditions (Temperature, Rainfall, Soil Type)

- Wheat requires **moderate temperatures**, moderate rainfall, and well-drained loamy soils for optimal growth.
 - Wheat is a **Rabi crop** that is usually sown in winter and harvested in spring.
- It thrives in areas with **cool and moist conditions** during the growing season and sunny conditions during harvest.
 - The ideal temperature range is between 10-15°C during sowing time and 21-26°C during harvesting time.
- Wheat grows well in **well-drained loamy or clayey soils** that are not waterlogged.
 - These soils should have good water retention capacity.
- Wheat requires less water than rice and can be grown in areas with moderate rainfall.
 - Areas with less than 100 cm of rainfall are suitable for wheat cultivation.

2) Major Producing Areas/States in India

- **Uttar Pradesh, Punjab, Haryana, and Madhya Pradesh** are the major wheat-producing states in India.
 - These states are located in the **Indo-Gangetic plains**.
- **Punjab and Haryana** contribute a large share of wheat to the central pool for the Public Distribution System (PDS).
 - About 60% of the wheat procured for PDS comes from these states.
- **Other significant wheat-producing states** include Rajasthan, Bihar, and parts of Gujarat and Maharashtra.
 - The eastern parts of Maharashtra, called Vidarbha, are dry regions where wheat is grown.
- Wheat is a staple food for a large part of the Indian population.
- Wheat meets the demand of low-income people, who spend a large portion of their income on cereals.

3) Productivity Trends, Challenges, and Solutions for Improvement

- **Wheat yields are facing challenges** due to climate change and unsustainable agricultural practices.
 - Heat waves in March 2022 led to shrinking of wheat grains.
- **Monoculture of wheat** depletes soil fertility and contributes to ground water depletion.
 - The rice-wheat system has become a bane, despite its initial success.
- **Climate change** and extreme weather events are impacting wheat cropping patterns.
 - Untimely rainfall and hailstorms in March and April 2023 flattened wheat crops.
- **Crop diversification** and adoption of pulses can help improve soil health and reduce the impact of monoculture.
 - Incorporating summer mungbean into rice-wheat and maize-wheat systems can improve productivity.
- **New high-yielding and climate-resilient wheat varieties** are being developed to address these issues.
 - The Indian Council of Agricultural Research (ICAR) has released 24 new varieties of wheat.
- **Conservation agriculture** practices can help in improving soil health and reduce the impact of climate change.
 - These practices promote minimum soil disturbance, permanent soil cover and crop diversification.
- **Integrated weed management** using manual, mechanical, and chemical methods, along with crop rotation, is essential for effective crop intensification.
- Use of precise sowing and weeding tools can enhance sustainable crop intensification.

- **Technological advancements**, including precise sowing, spraying drones, and mechanical harvesters can enhance production.
 - The government is promoting custom hiring centers to make this technology more accessible.

Additional Points

- The government provides **Minimum Support Price (MSP)** for wheat to ensure fair prices for farmers.
 - The MSP is calculated by the Commission for Agricultural Costs and Prices (CACP).
- **Wheat is procured** by the Food Corporation of India (FCI) for the Public Distribution System (PDS).
 - About 60% of wheat procured for the PDS is from Punjab and Haryana.
- The **government is promoting the use of bio-fertilizers and organic fertilizers** to improve soil health and reduce dependence on chemical fertilizers.
 - The PM-PRANAM scheme incentivizes states to reduce chemical fertilizer use.
- **Stubble burning** is a major problem in wheat-growing areas like Punjab and Haryana, which contributes to air pollution.
 - The government is promoting the use of 'Happy Seeders' to sow seeds while managing stubble.
- **Wheat is primarily grown for domestic consumption**, and exports are minimal.
- India has an almost minimal difference between the import and export of wheat.

Pulses

1) Geographical Conditions (Temperature, Rainfall, Soil Type)

- Pulses generally require **moderate temperature, less rainfall, and well-drained light soils** for their growth.
 - They can grow in diverse climatic conditions, but specific varieties have unique requirements.
- They are often grown as **rain-fed crops**, particularly in areas with limited irrigation facilities.
 - Pulses do not tolerate waterlogging, so well-drained soil is essential.

2) Importance of Pulses in Indian Agriculture and Economy

- Pulses are a **crucial source of protein** for a large part of the Indian population, especially low-income groups.
 - They are also vital for nutritional security and sustaining agricultural systems.
- Pulses play a significant role in **improving soil health** through nitrogen fixation.
 - They enhance soil fertility and reduce the need for chemical fertilizers.
- India is the **largest producer, consumer, and importer** of pulses in the world.
 - The country produces 25% of the world's pulses but consumes 27%.
- **Despite their significance**, pulses are not grown on a significant scale in India.
 - This impacts nutritional security and leads to reliance on imports.

3) Major Producing Areas and Crops

- **Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and Karnataka** are major pulse-producing states.
 - These states contribute a large portion of the total pulse production in India.
- **Major pulse crops grown in India include** chickpea, pigeon pea, mung bean, urd bean, and lentils.
 - Chickpea and pigeon pea are the most important pulses, both in terms of area and production.
- **Pulses are often grown in rotation with cereal crops** like rice and wheat in different cropping systems.
- Intercropping pulses with cereals can improve overall farm productivity.

4) Productivity Trends, Challenges, and Solutions for Improvement

- **India has not been able to achieve self-sufficiency** in pulse production.
 - This is due to lower productivity, lack of high-yielding varieties, and climate change.
- **Pulses are often grown on marginal lands** with poor management practices, which limits yield.
 - Lack of assured irrigation also results in low yields and unstable production.
- **Climate change and extreme weather** events have also impacted pulse productivity.
 - Untimely rain and temperature changes cause crop damage and yield losses.
- **Crop diversification** that includes pulses can help in improving soil health and income of farmers.
 - Diversified cropping systems with pulses have shown higher productivity and returns.
- **ICAR has released 59 high-yielding varieties** of pulses, including urdbean, chickpea, and mungbean.
 - These new varieties aim to increase productivity and climate resilience.
- **Government initiatives** like the National Food Security Mission (NFSM) promote pulse production.
 - These missions emphasize seed distribution and other technological interventions.
- **Integrated nutrient management practices** that include organic and bio-fertilizers can improve productivity.
 - These practices can help in better utilization of inputs and improve soil health.
- **Farmer awareness** and technological interventions such as using of new seed varieties are needed to increase pulse production.
 - Awareness programs can help in adopting suitable farming practices to increase yields.

Additional Points

- Pulses are **essential for sustainable agriculture** because of their nitrogen-fixing properties.
 - They help reduce reliance on chemical fertilizers that impact soil health and the environment.
- Despite being a major producer, **India is also a large importer of pulses** to meet domestic demand.
 - The value of imported fruits and vegetables, including pulses, was over 214 billion rupees in 2023.
- **The government encourages the use of bio-fertilizers** to reduce reliance on chemical fertilizers.
- This can improve soil health and enhance the overall sustainability of pulse cultivation.
- **Conservation agriculture** is also essential to improve the productivity and sustainability of pulses.
 - It includes practices that minimize soil disturbance and promote crop diversification.
- The **Sub-Mission on Seeds and Planting Material (SMSP)** increases the production of certified and quality seeds.
 - This initiative can help enhance the availability of improved seeds for farmers.

Agriculture Contribution in GDP

India's agricultural GDP growth has shown fluctuating trends over the years, with a significant decline in its share of the total GDP.

Historical Trends:

- The share of agriculture and allied sectors in India's GDP at current prices was **19.9% in 2020-2021**.
- This is a considerable decline from the **50% share of GDP in the 1950s**.

- From 2012-13 the share of Gross Value Added (GVA) of agriculture & allied sectors has increased by **3.3%** over the past decade.
- The **overall GDP growth** and agricultural growth rates have seen fluctuations, with agricultural growth sometimes lagging behind overall GDP growth. For example, the average annual growth rate of agriculture was less than 3% for the periods 1985-90, 1992-97, and 1997-02, with the lowest rate around 1% between 1997-02.

Recent Trends:

- The agriculture sector's contribution to the total GVA of the economy was **18.8% in 2021-22**, a decrease from **20.2% in 2020-21**.
- The share of GVA from crops declined from **12.1% in 2011-12 to 10.7% in 2019-20**, while the share of livestock increased from **4% to 5.2%** and fishing and aquaculture from **0.8% to 1.2%** during the same period.
- In 2022-23, agriculture contributed **18.3% to GVA**.
- The Economic Survey of 2023-24 reported agriculture's share in GDP at **18.2%**.
- The sector employs **42.3% of the population**.

Growth Rates:

- The annual growth rate of agriculture was 4.1% in the last five years.
- The agricultural sector recorded a growth of **3.4%** in 2020-21.
- Between 2004-05 to 2006-07, agricultural credit grew rapidly at 35% annually and at a compound annual growth rate (CAGR) of **21.47%** from 2003-04 to 2016-17.
- The compound annual growth rate (CAGR) of production of foodgrains was around **2.37%** over the last seven decades.

Factors Influencing Growth:

- **Monsoon:** Agriculture in India is heavily reliant on the monsoon, with only 33% of cultivated land irrigated.
- **Technology:** Technological advancements and the adoption of high-yielding seed varieties, chemical fertilizers, and pesticides have significantly increased agricultural output.
- **Investments:** Public and private investments in the agriculture sector have been growing.
- **Diversification:** There is a push for diversification into high-value segments like fruits, vegetables, livestock, and fisheries.
- **Credit:** Agricultural credit has seen substantial growth, with the Kisan Credit Card (KCC) scheme playing a key role.
- **Research & Development:** Investments in agricultural research and development (R&D) have shown to give substantial returns.
- **Policy:** Government policies and initiatives, like the National Food Security Mission (NFSM), influence agricultural growth.

Challenges:

- **Declining share in GDP:** The share of agriculture in India's GDP has been declining.
- **Low productivity:** Crop yields in India are lower compared to international standards.
- **Climate change:** Climate change and dependence on erratic monsoons create vulnerabilities and can affect productivity.
- **Small landholdings:** Indian agriculture is characterized by small landholders, which can limit productivity.
- **Post-harvest losses:** Inadequate post-harvest operations lead to wastage of agricultural produce.
- **Input subsidies:** A large portion of public expenditure in agriculture is allocated to input subsidies rather than investments in infrastructure and research.
- **Food inflation** is a challenge that affects food affordability.

Future Growth Sources

- The future growth in agriculture is expected to come from technological change and crop diversification.

- High-value segments such as fruits, vegetables, livestock, and fisheries are considered important for growth.

Other Food Crops

1) Geographical Conditions (Temperature, Rainfall, Soil Type)

- **Millets** are generally grown in **dryland regions** with **low to moderate rainfall and moderate temperatures**.
 - They can thrive in poor soils with low fertility and are known for their drought resistance.
- **Maize** requires **warm temperatures, moderate to high rainfall, and well-drained fertile soils**.
 - It grows well in alluvial and loamy soils, but is sensitive to waterlogging.

2) Major Producing Areas and Crops

- **Rajasthan, Maharashtra, Karnataka, Uttar Pradesh and Madhya Pradesh** are major millet-producing states in India.
 - Major millets include pearl millet, finger millet, and sorghum and little, proso, kodo, and foxtail millets.
- **Karnataka and Tamil Nadu** are significant producers of finger millet, also known as ragi.
 - Millets are part of the farming and diet systems in hilly and tribal areas.
- **Major maize-producing states include Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh.**
 - Maize is grown in various parts of India, both as a food and a fodder crop.
- **Rice** is largely cultivated in **Punjab, Haryana and Western Uttar Pradesh** where it is a commercial crop.

3) Productivity Trends, Challenges, and Solutions for Improvement

- **Millets are considered economically viable** and culturally acceptable in many regions.
 - However, lack of assured market prices and crop damage by wild animals pose challenges.
- **Diversified millet-based farming** interventions and bee-keeping are profitable for farmers.
 - Farmer-led extension strategies, including millet producer groups, enhance knowledge and yields.
- **The productivity of maize is affected by various factors** including soil fertility, water management, and pests.
 - Intercropping maize with pulses can improve productivity and soil health.
- **The ICAR has released several high yielding varieties of millets and maize** suitable for different agro-ecological regions.
 - In 2023-24, 21 maize and 9 sorghum varieties were released.
- **Adopting improved production technologies** such as precision sowing and weeding tools can increase yield.
- Integrated weed management strategies, including crop rotation, are also crucial.
- **The use of hybrid seeds and bio-fortification** can also help enhance crop production of maize and millets.
 - Bio-fortification involves infusing nutrients into the grain at the seed stage.
- **The government promotes crop diversification** to address issues like water depletion and climate change.
 - Encouraging crops such as maize can solve the GW depletion problem in regions that are largely dependent on rice.
- **A shift from water-intensive crops** to less water consuming crops such as millets can help solve issues of drought.
 - The government has announced 85% profit on crops like bajra (pearl millet) and jowar (sorghum), though not implemented well.

- **Technological intervention like happy seeders** can simultaneously sow seeds and cut the stubble.
 - Punjab government provides 50-80% subsidy to farmers to use this machine.
- **Conservation agriculture** promotes maintenance of permanent soil cover and minimum soil disturbance.
 - This can help enhance soil health and improve overall sustainability of crops like millets and maize.
- **The 'Millet Market' android app** facilitates marketing and provides advisory on improved millets.
 - This technology enables farmers to get better prices and enhances knowledge about millet farming.

Additional Points

- **Maize is used as a raw material** for various industries, including the food and feed sectors.
 - It is an important component of poultry and livestock feed in India.
- **Millets are nutrient-rich** and offer food security, particularly in dryland and tribal regions.
 - They are a good source of essential minerals, vitamins and fiber.
- **There is a need for improved market linkages** for millets to incentivize farmers.
 - This can include better procurement policies and support for farmer producer organizations (FPOs).
- **Crop rotation and intercropping** can enhance soil fertility and reduce pest and disease incidence.
 - This practice will also increase the nutritional content of the food produced.
- **Stubble can be fed to cattle** and also be used as a biomass for generating electricity.
- The **government is promoting custom hiring centers** to make farm machinery accessible to all farmers.
- This helps in enhancing farm mechanization, which leads to increased productivity.

Major Commercial Crops:

Cotton

1) Geographical Conditions

- Cotton requires less rainfall, making it suitable for drier regions.
- It is a Kharif crop, which means it is grown during the monsoon season.
 - Pests multiply due to hot and humid conditions, common during Kharif.

2) Major Growing Regions in India

- **Gujarat and Maharashtra** are major cotton producing states in India.
 - Saurashtra is a key area for cotton cultivation.
 - The Vidarbha region in eastern Maharashtra is a dry region suitable for cotton.
- **Telangana** is another state with significant cotton production.

3) Economic Importance

- India produces **Bt Cotton** (GM Crops).
 - Bt cotton was introduced in India in 2002.
 - Bt cotton is resistant to the bollworm.
- Cotton seeds are crushed and oil is extracted for cooking purposes.
 - The dried cake after oil extraction is used as cattle fodder.
- India is the largest producer of sugar this year.
 - In 2021, Brazil was the largest producer of sugar.
- The value of fruit and vegetable imports in India was over 214 billion Indian rupees in fiscal year 2023.
 - More than 16 percent of the total imports came from China in 2017.

Cotton cultivation thrives under specific geographical conditions:

- **Temperature:** Cotton is a **tropical crop** that needs **warm temperatures**, ideally between **21°C and 30°C**. The flowering stage requires clear skies.
- **Rainfall:** Cotton requires moderate rainfall, ranging from **50 cm to 100 cm** annually. **Rainfed conditions** are suitable, especially in semi-arid regions. However, excessive rainfall can be detrimental.
- **Soil Type:** Cotton prefers **well-drained loamy soils** and **regur (black cotton soil)**. The black earth soils of **Maharashtra and Gujarat** are particularly well-suited. **Saline soils** may also be suitable, with specific varieties developed for tolerance.

Tea

1) Geographical conditions and regional factors

- Tea cultivation in India includes regions with varied geographical conditions.
 - **Uttarakhand and Himachal Pradesh** have less tea cultivation, but good quality.
 - Some tea cultivation also occurs in **Karnataka**.
- Tea production requires specific climate conditions with varying temperature.
 - Hot and untimely rainfall, that is high humidity, are best for pests.
 - Changes in temperature and precipitation patterns affect agriculture.

2) Economic significance

- India is a major producer and exporter of tea.
 - **Russia**, CIS countries, Iran, UAE, Germany, and UK are major markets.
- Tea production is a major economic activity in the producing regions.
 - The tea industry provides employment and supports livelihoods.

3) Challenges and significance of tea plantations in the lesser Himalayas

- Tea plantations in the Himalayas face unique challenges.
 - Climate change is affecting temperature and precipitation patterns.
 - Heat waves and untimely rainfall leads to a fall in production.
- The lesser Himalayas offer suitable conditions for certain types of tea.
 - High quality tea is produced in the lesser Himalayan regions.
 - The region plays a significant role in tea production.

Tea cultivation thrives in specific climatic and soil conditions. **Temperature** requirements range from 20°C to 30°C. **Rainfall** needs vary depending on the region and cultivation methods, ranging from 100 cm to 300 cm annually. **Soil types** best suited for tea include well-drained, light loamy soil, although it can also grow in undulating topography and hilly areas. Specific examples of tea-growing regions include the Brahmaputra valley of Assam, the Sub-Himalayan region of West Bengal (Darjeeling, Jalpaiguri, and Cooch Bihar districts), and the lower slopes of the Nilgiris and Cardamom hills of the Western Ghats.

Tea cultivation necessitates specific geographical features. **Temperature** is crucial, ideally ranging from 20°C to 30°C. **Rainfall** is also a significant factor; adequate and well-distributed rainfall is essential, with amounts varying from 100 cm to 300 cm annually, depending on the region and cultivation method. The **soil** should be well-drained and light loamy. However, tea can adapt to undulating topography and hilly areas.

Here are some geographically specific examples:

- **Assam's Brahmaputra Valley:** This area is known for its high humidity and abundant rainfall, creating ideal conditions for tea growth. Assam accounts for more than half of India's tea production.
- **West Bengal's Sub-Himalayan Region:** Darjeeling, Jalpaiguri, and Cooch Behar districts within this region provide suitable conditions for tea cultivation, contributing significantly to India's tea production. These areas are characterized by their unique climate and soil conditions, leading to distinctive tea flavors.

- **Lower Slopes of the Nilgiris and Cardamom Hills:** These areas in the Western Ghats also offer suitable conditions for tea production.
- **Other areas:** Some tea cultivation occurs in Uttarakhand, Himachal Pradesh, and Karnataka, although these regions contribute less to overall production. Uttarakhand and Himachal Pradesh may have less cultivation, but their tea is known for its high quality.

The economic significance of tea in India is substantial, impacting various aspects of the national economy.

- **Major Producer and Exporter:** India is a leading global producer and exporter of tea, with Assam alone accounting for over half of the nation's total production. This substantial production contributes significantly to the country's agricultural GDP and overall export earnings. In 2022-23, agricultural exports reached USD 53.1 billion, with APEDA contributing a significant 51%.
- **Major Markets:** Key international markets for Indian tea include Russia, CIS countries, Iran, the UAE, Germany, and the UK. The demand from these countries drives a significant portion of India's tea exports and influences pricing.
- **Regional Economic Activity:** Tea cultivation is a major economic activity in many regions, primarily in Assam, West Bengal (Darjeeling, Jalpaiguri, and Cooch Behar), and the Nilgiris and Cardamom Hills. The industry creates numerous jobs, from cultivation to processing and export, supporting livelihoods and driving local economies.
- **Employment and Livelihoods:** The tea industry is a substantial employer, directly supporting millions of people in tea-growing regions. This makes it a crucial factor in regional development and poverty reduction.
- **Value Addition and Processing:** Though the share of processed food in agricultural exports is only 16% compared to 25% in the USA and 49% in China, there is significant potential to increase the economic impact of tea by focusing on value addition and processing.

Major Crops - Cropping Patterns: Oilseeds

Geographical Conditions

- **Oilseed** crops have varying needs for temperature, rainfall and soil type.
 - While **palm** requires a lot of water.
 - **Mustard** is a major oilseed, and the **rapeseed** needs well-drained loamy soil.

Government Policies

- The Government has launched several schemes to promote oilseed production in India.
 - **National Mission on Edible Oil-Oil Palm (NMEO-OP)** promotes oil palm cultivation.
 - **National Food Security Mission-Oilseeds (NFSM-OS)** includes special programs for rapeseed and mustard.
- The government aims to make India self-reliant in edible oils.
 - Government is implementing special projects to increase sunflower cultivation through hybrid seeds.
- The government is promoting balanced use of fertilizers through the PM-PRANAM scheme.
 - This scheme aims to promote balanced use of chemical fertilizers and regenerative agriculture.
- **Sub-Mission on Seeds and Planting Material** aims to increase certified seed production.
 - The aim is to upgrade the quality of farm-saved seeds.

Major Oilseeds and Their Distribution

- India is a major producer of various oilseeds, but also imports a significant amount.
 - **Groundnut, mustard, sesame, soybean, sunflower, and linseed** are among the major oilseeds.
- India imports large quantities of **palm oil**, mainly from Malaysia and Indonesia.
 - **Palm oil** is used to produce hydrogenated vegetable oil.

- **Andhra Pradesh** and **Telangana** are endemic to palm oil trees, with 90% of the total production.
 - However, palm trees require a lot of water, which is not easily affordable in these dry areas.
- **Gujarat** is a major producer of **cotton**, followed by Maharashtra and Telangana.
 - Saurashtra is an important area for cotton cultivation.
- **Mustard** is grown in a sequence with sorghum or as a fallow crop, and its yield is improved with gypsum use.
 - **Topping** the main stem of mustard at 35-40 days before flowering increases yield by 15-20%.
- Traditional methods include using neem and ash for pest control in stored grains.
 - Neem leaves have insecticidal and repellent properties.
- **Groundnut** hulls and tamarind residues are used as organic matter in paddy fields to improve soil structure.
- The extraction of deodar oil using an earthen pot is a traditional practice with multiple uses.
 - This oil also acts as a repellent to insect pests.

Distribution of Rubber, Tobacco, Pepper, etc.

- **Rubber** trials have been rejected in India by Kerala, but they are conducted in North East.
 - **Rubber** is a major commercial crop in some regions of India.
- **Tobacco** leaves are used as an insecticide and pest repellent when blended with stored food.
 - Farmers mix **tobacco** with other substances to control pests in cotton.
 - Some farmers apply **tobacco** with other substances on crops for pest control.
- **Pepper** is a spice that is grown in some parts of India.
 - **Black pepper** is used with other ingredients for treating flatulence in animals.
- **Tea** cultivation is seen in Karnataka and **coffee** is also grown in some parts.
 - Uttarakhand and Himachal Pradesh cultivate tea of good and high quality.
 - Russia, followed by CIS countries, Iran, UAE, Germany and UK are major markets for tea production in India

Environmental Challenges

- **Climate change** is affecting agriculture through changes in temperature and precipitation.
 - Heat waves and untimely rainfall have impacted wheat production.
 - Extreme rainfall events have led to a fall in production.
- **Pest attacks** are more likely under hot and humid conditions.
 - Temperature increases can lead to warmer oceans, inundating paddy-growing areas.
- **Excessive fertilizer** use leads to soil degradation and water pollution.
- The government is promoting balanced fertilizer use through the PM-PRANAM scheme.
- There is a need to correct distortions in fertilizer prices and link subsidies with recommended use.
- **Stubble burning** after harvesting is a major source of pollution.
 - It releases oxides of carbon, nitrogen, and sulfur into the air.
 - Pusa Bio-decomposer capsules can turn stubble into manure in 30 days.
- The use of **chemical pesticides** can have harmful effects on humans, animals, and the environment.
 - Overuse of pesticides leads to pests developing resistance.
- **Monoculture** practices, where one crop is continuously cultivated can lead to depletion of the soil.
- The MSP policy favors a few crops from select regions leading to regional disparities.
 - Farmers should grow crops based on agro-climatic conditions to prevent issues like groundwater depletion.

Fruit Production in India

Overview of Fruit Production

- **India ranks second** globally in the production of **fruits and vegetables**.
 - Despite high production, **India** imports a considerable amount of fruits and vegetables.
- The value of **fruit and vegetable** imports was over 214 billion rupees in fiscal year 2023.
 - **China** accounted for over 16% of India's total fruit and vegetable imports in 2017.
- Integrated cropping systems can include **mango, pineapple, and dragon fruit**.
 - A mango-based system with **dragon fruit** and **pineapple** showed high production efficiency.

Specific Fruit Crops

- A standardized spray schedule helps prevent flower/fruit drop in **pomegranate**.
 - An integrated nutrient management schedule for **sweet orange** has also been standardized.
- Traditional practices utilize **neem** to protect fruits from pests and diseases.
 - **Neem** has insecticidal and pest-repellent properties.
- Some farmers mix **castor shells**, cow dung, and water to protect fruit trees from termites.
 - This is a traditional pest control method used in fruit cultivation.
- **Tobacco** is also used in traditional practices for plant protection.
 - **Tobacco** is used to improve the quality of fruits and vegetables.

Indigenous Practices

- Various indigenous methods exist for fruit cultivation and pest control.
 - Some farmers mix **morthuthu, citric acid, hirakashi, and tobacco** for pest control.
- Farmers use cow urine mixed with **Vitex negundo** and **Ferula asafoetida** for pest management.
 - These mixtures are used as treatments for pests in crops such as chickpea.
- **Amaltas** fruit is used in a mixture with other ingredients to treat flatulence in animals.
 - This traditional mixture is administered to animals suffering from flatulence.
- In **Himachal Pradesh**, traditional pest control includes using **neem cake**, cow urine and wood ash.
 - These methods are often used in apple orchards.

Research and Development

- The **Indian Council of Agricultural Research (ICAR)** has contributed to fruit crop research.
 - They have developed disease-resistant and high-yielding fruit varieties.
- **ICAR** has developed technologies aimed at improving fruit quality.
 - They have also created management practices for fruits like mango, pomegranate, and sweet orange.

Cropping Patterns: Definition and Types

Definition of Cropping Pattern

- A **cropping pattern** is the yearly sequence and spatial arrangement of crops on a piece of land.
 - It indicates the temporal and spatial arrangement of crops in a specific area.
- **Knowledge of cropping patterns** is crucial for crop production and land-use intensity.
 - Different factors influence cropping patterns including resources and environmental conditions.

Types of Cropping Patterns

- **Monocropping** involves growing a single crop on the same land year after year.
 - This practice can lead to soil nutrient depletion and increased pest and disease issues.

- **Mixed cropping** is growing two or more crops simultaneously on the same land.
 - This provides insurance against weather uncertainties, efficient use of growth factors.
- **Crop rotation** involves growing different crops in a planned sequence on the same land.
 - It helps in maintaining soil fertility, improving pest and disease control.
- **Intercropping** is growing two or more crops simultaneously with distinct row patterns.
 - It promotes efficient resource utilization and reduces risk of total crop failure.

Regional Cropping Patterns

- In **Himachal Pradesh**, maize is intercropped with oilseeds and pulses.
 - This practice is common in the wet temperate zone of the mid-Himalayas.
- **Cotton** is intercropped with **lady's finger** in some areas of Madhya Pradesh.
 - Lady's finger attracts bollworms, reducing their incidence on cotton.
- **Mustard** is grown in sequence with **sorghum** using gypsum for higher profit.
 - Use of gypsum with sorghum and mustard provides more profit.
- **Green manure, greengram, or summer maize** in sequence with mustard increases mustard yield.
 - Fallow-mustard-sunflower sequences can lead to reduced mustard yield.
- A diversified cropping system in the **Indo-Gangetic Plain** includes rice, wheat, and mungbean.
 - This system aims to enhance resource use and improve climate resilience.
- **Maize** is grown with **dhaincha** followed by **chickpea** and **mungbean** in some areas.
 - This has shown higher productivity and economic efficiency.
- **Pearl millet** is grown with **lentil** and **linseed** in a 4:2:2 ratio in some regions.
 - These diversified systems improve system productivity.

Importance of Crop Diversification

- Crop diversification reduces dependence on a single crop for food security.
 - It helps mitigate risks associated with climate change and market volatility.
- It can reduce the need for imports, such as cooking oil by growing GM crops.
 - GM crops have high productivity and resistance to pests and diseases.
- Crop diversification may include incorporating pulses into cropping systems.
 - Pulses provide nutritional security and sustain agricultural production systems.
- Diversification using millets improves farmer income and food security in hilly areas.
 - Millets are economically viable and culturally acceptable in tribal areas.
- Crop diversification enhances soil health through the inclusion of different plant species.
 - It supports biodiversity and improves the soil's capacity to retain moisture.

Related Agricultural Concepts

Allelopathy

- **Allelopathy** is a biological phenomenon where plants release biochemicals influencing other plants' growth.
 - These biochemicals can either inhibit or promote the growth of neighboring plants.
- **Allelopathic effects** play a crucial role in natural and agricultural ecosystems.
 - Understanding this interaction can lead to better crop management strategies.

Significance of the International Year of Pulses

- **Pulses** are a category of superfoods, including chickpeas, lentils, and dry peas.
 - **India** is the largest producer, consumer, and importer of pulses globally.
- Pulses offer dual benefits of nutritional security and sustaining agriculture.
 - They are an important source of protein for a large segment of the population.
- Despite these benefits, **India** has not achieved self-sufficiency in their production.
 - **Pulses** are not grown on a significant scale, impacting nutritional security.

Specific Case Studies

- **Basmati Rice:** India has the largest area under **rice** cultivation, and is a large exporter of **basmati rice**.
 - Major markets include West Asia, North America, and Western Europe for Indian **Basmati**.
- **Non-Basmati Rice:** African nations and Bangladesh are major markets for **non-basmati rice** from India.
 - 90% of rice production in Punjab is non-basmati which is procured by FCI.
- **Man-Animal Conflict:** Farmers use barbed wire to prevent animal damage, but can injure animals.
 - Use of *Madhuca* flower traps for animals are also used to protect sugarcane crops.
 - Farmers sometimes hang dead animals in fields to deter other animals.
- **Barbed wire fencing** may deter animals but also injure them, highlighting the need for alternatives.
 - There is a need to explore non-lethal and effective methods for managing man-animal conflicts.
- A "**drought-tolerant**" *Shahbhagi Dhan rice variety* has been formulated for rain-fed areas.
 - The variety may be beneficial in areas with water scarcity.

Challenges and Solutions

Declining Productivity

- **Declining rice and wheat yields** are a major concern in cropping systems.
 - **Crop diversification** can help stabilize yields and address this issue.
- **Climate change** and **extreme weather** significantly impact crop productivity.
 - **Heat waves** and untimely rainfall flatten wheat crops impacting yields.
- **Low adoption of millet cultivation** despite its numerous advantages contributes to declining productivity.
 - Lack of assured prices and crop damage are major problems in millet cultivation.
- **Monoculture**, like rice-wheat cropping, leads to **groundwater depletion**.
 - This is especially concerning in areas with high water usage crops.
- **Lack of awareness** among small and marginal farmers about government schemes impacts yields.
 - Tenant farmers often lack documentation needed for government support.

Environmental Impacts of Cropping Patterns

- **Stubble burning** in North India leads to heavy pollution.
 - Burning releases oxides of carbon, nitrogen, and sulfur, contributing to smog.
- **Methane emissions from livestock** are higher than those from paddy cultivation.
 - The diet given to cattle affects the amount of methane they produce.
- **Excessive use of chemical fertilizers** can degrade soil health and pollute water.
 - Some states have very high usage of chemical fertilizers while others use very little.
- **Overuse of pesticides** leads to pest resistance and environmental contamination.
 - Many pesticides used in India are banned in other countries.
- **Climate change** affects cropping patterns via changes in temperature and precipitation.
 - Extreme rainfall leads to reduced production.

Role of Technology in Improving Productivity

- **Integrated weed management** using manual, mechanical, and chemical means enhances crop intensification.
 - Crop rotation can also facilitate effective crop intensification.
- **Precision tools** for sowing, weeding, and harvesting are vital for sustainable intensification.
 - Spraying drones, and mechanically operated harvesters are also useful.
- **Genetically modified (GM) crops** offer higher productivity and pest resistance.

- Bt cotton is an example of successful GM technology.
- **Electronic Point of Sale (ePoS)** devices ensure fair distribution of food grains.
 - ePoS devices use biometric authentication to confirm beneficiary identification.
- **"Happy Seeder"** machines enable sowing without removing stubble, reducing burning.
 - These machines cut and sow seeds simultaneously.
- **Liquid Nano Urea** is more efficient and reduces import dependence.
 - Liquid Nano Urea is sprayed on leaves, reducing wastage.
- **Soil health cards** help farmers rationalize fertilizer use.
 - They provide information on 12 parameters for rational fertilizer use.
- **"Millet Market"** android app facilitates marketing and provides advisory on millet crops.
 - This helps in promoting millets in hilly and tribal areas.
- **Conservation Agriculture** prevents land loss and regenerates degraded lands.
 - It promotes permanent soil cover, minimum disturbance, and species diversification.

Cropping Pattern, Crop Productivity, Diversity, and Yield Question

- ☐ Can the agricultural development we have achieved so far, be considered adequate? If so, why? If not, why not? (80/20)
- ☐ 1982 has been described as the Productivity year by the Government of India. What scientific practices have been identified for increasing production in Agriculture and Animal Husbandry? (82/45)
- ☐ What is multiple cropping? (82/3)
- ☐ Discuss the role of modern technological inputs on agricultural development in India. How would it be helpful for food security during 21st century? (99/40)
- ☐ Agricultural Productivity in India remain low. Explain the reasons for this situation. (08/15)
- ☐ Elaborate the steps taken by the Government for regionally differentiated approach to increase crop production and diversification in the country. (09/15)
- ☐ How do subsidies affect the cropping pattern, crop diversity and economy of farmers? What is the significance of crop insurance, minimum support price and food processing for small and marginal farmers? (17/15)
- ☐ How has the emphasis on certain crops brought about changes in cropping patterns in recent past? Elaborate the emphasis on millets production and consumption? (18/15)
- ☐ What are the present challenges before crop diversification? How do emerging technologies provide an opportunity for crop diversification? (2021/15)
- ☐ Explain the changes in cropping pattern in India in the context of changes in consumption pattern and marketing conditions. (250 words) (UPSC GS 3 2023/15 marks)

Cropping Pattern, Crop Productivity, Diversity, and Yield

Significance of Agriculture in India

- **Agriculture** is the primary livelihood source for approximately **58% of India's population**.
 - This highlights agriculture's crucial role in employment generation.
- **India** ranks first in the world with the highest net cropped area, followed by the **US** and **China**.
 - This positions India as a major player in global agricultural production.
- The share of **agriculture and allied sectors** in India's **GDP** was **19.9% in 2020-2021**.
 - This demonstrates agriculture's significant contribution to the national economy.
- Agriculture is vital for ensuring **food security** for India's large population.
 - The **Public Distribution System (PDS)** ensures food availability at cheap prices.
- **54%** of the population found employment in agriculture according to the **Economic Survey 2021-22**.
 - The **Economic Survey 2022-23** states that agriculture contributes to **17% of the National GDP**.
- **India** is the **second-largest producer of fruits and vegetables** in the world.
 - Despite this, **India** imports fruits and vegetables worth over **214 billion Indian rupees** in 2023.
- **Indian agriculture** has a significant impact on the global trade of various commodities.
 - **India** is the **second largest producer of rice** after **China**.
- **India** is the **largest producer of buffalo meat** and a **major exporter** of it.

- Major markets for buffalo meat are in **Egypt, Hong Kong, Vietnam and Indonesia**.
- **India** is also a **leading producer of sugar**, sometimes the largest in the world.
 - In **2021**, **Brazil** was the largest producer of sugar.
- **Russia** holds a major market for raw materials, specifically **natural gas**, which is required to produce fertilizers like **urea**.
- **Urea** production in **India** contributes 30% of the total use of **natural gas**.
- The Indian Council of Agricultural Research (ICAR) plays a crucial role in advancing agricultural practices through research and development.
 - ICAR released 283 crop varieties in 2023-24, including biofortified varieties and those resistant to abiotic stresses.
- **Land reforms** aim to improve land distribution and productivity.
 - These include **abolition of intermediaries, tenancy reforms, and land ceiling policies**.
- The **National Food Security Mission (NFSM)** and other government schemes are important for enhancing agricultural production and food security.
 - A **National Mission on Edible Oil-Oil Palm (NMEO-OP)** was launched to promote oil palm cultivation.
- **Public Distribution System (PDS)** is a crucial component in maintaining food security in **India**.
 - Approximately **5.37 lakh fair price shops** distribute food and non-food commodities to the needy at cheap prices.
- **Minimum Support Price (MSP)** is provided to farmers to protect them from market risks.
 - The **Commission for Agricultural Costs and Prices (CACP)** calculates and recommends the MSP, which is then announced by the **Cabinet Committee of Economic Affairs (CCEA)**.

Agricultural Productivity in India

Current Status: Overview of Yield and Productivity Levels for Major Crops

- **India** is a major producer of **cereals**, with varying yields across different crops and regions.
 - **Punjab** is the **third largest producer** of **rice** in India.
- **Wheat** production is also significant, but faces challenges like climate change.
 - **Heat waves** in **March 2022** led to the **shrinking of wheat grains**.
- **Pulses** are important for nutritional security, yet **India** is a major importer of pulses.
 - **India** is the **largest producer (25%), consumer (27%), and importer (14%)** of pulses.
- **Oilseed** production is a focus, with efforts to reduce import dependence.
 - The **National Mission on Edible Oil-Oil Palm (NMEO-OP)** aims to promote oil palm cultivation.
- **Cotton** is a key commercial crop, with **Gujarat** and **Maharashtra** being major producers.
 - **Saurashtra** is the most important area for cotton cultivation.
- **India** is the **second largest producer of fruits and vegetables** globally.
 - Despite this, the country imports a significant amount of fruits and vegetables.
- **Sugarcane** is another major crop, with **India** being a **leading producer**.
 - **Sugarcane** is used for **sugar** and **molasses**, which produces **ethanol**.
- **Livestock** contributes significantly to agriculture, but has environmental concerns related to methane emissions.
 - **Methane emissions** are higher from livestock than paddy cultivation.
- **Fisheries** are also an important sector, with **India** being the **second largest producer**.
 - **Andhra Pradesh, West Bengal and Gujarat** are the largest producers of fisheries in India.
- **Fertilizer** consumption is high, with **urea** being the most produced, consumed, and imported fertilizer.
 - India is the **second largest fertilizer consuming country** after **China**.
- The **average size of farms** in India is very small, about **0.92 ha in 2021-22**.

- In comparison, the average farm size in the **USA is 150 ha** and in **Canada 300 ha**.
- **GM crops**, like **Bt cotton**, have shown higher productivity, but also raise concerns about efficacy over time.
 - **Bt cotton** was first certified in **2002**, and has become a widely adopted GM crop.
- **ICAR** has developed and released many new varieties of crops with improved yields and stress tolerance.
 - **ICAR** released **283 crop varieties** in **2023-24**, including **biofortified** and **stress-resistant** varieties.
- **Soil health cards** are provided to farmers to help rationalize fertilizer use.
 - These cards provide information on **12 parameters** to help farmers balance nutrient use.
- There is a need to promote **millets** to improve cropping diversity and nutritional security.
 - **85% profit** on **Bajra** and **Jowar** was announced but not fully implemented.
- **Diversified cropping systems**, including pulses and oilseeds can improve system productivity and soil health.
 - **Rice (DSR) + dhaincha – wheat – mungbean (R+Dh-W-Mb)** systems showed higher productivity.

Seed replacement refers to replacing old or low-quality seeds used by farmers with fresh, high-quality seeds. These new seeds are scientifically improved and give better results, such as higher crop yields, better resistance to diseases, and adaptability to weather changes.

Why Seed Replacement Matters:

1. **Higher Productivity:** High-quality seeds are bred to produce more crops.
2. **Better Resistance:** These seeds can resist pests, diseases, and harsh weather conditions.
3. **Improved Quality:** The crops grown are of better quality, fetching higher market prices.
4. **Sustainability:** Replacing seeds regularly ensures the soil and ecosystem stay healthy.

For example, a farmer growing wheat traditionally might keep reusing seeds from previous harvests. Over time, these seeds might degrade, leading to lower yields. By adopting seed replacement, they use new, certified seeds that ensure better performance.

This is a common practice promoted in agriculture to ensure food security and better incomes for farmers.

Reasons for Low Productivity

1) Technological Backwardness

- **Low mechanization** in Indian agriculture hinders productivity and efficiency.
 - India has approximately **20 tractors per 1000 hectares of land** which indicates low levels of mechanization.
- **Limited use of modern technology** leads to lower yields and higher production costs.
 - The **Sub-Mission on Agricultural Mechanization (SMAM)** promotes custom hiring centers for farm machinery.
- **Lack of awareness** about new crops, varieties, and technologies among farmers.
 - Farmers need awareness about crops and varieties suitable to their area.
- **Low seed replacement rate** impacts productivity due to the use of farm-saved seeds.
 - **Seed replacement rate in India is only 30%.**
- **Over-reliance on traditional methods** of farming and a slow adoption of modern techniques.
 - **Happy seeders** which sow seeds where the stubble is present are not being used enough.
- **Inadequate training** for farmers on modern farming practices reduces their effectiveness.
 - Only **35 IPM (Integrated Pest Management) centers** exist for training farmers.

2) Inadequate Irrigation Facilities

- **Dependence on monsoon** makes agriculture vulnerable to rainfall variability.
 - **83% of maize cultivation** in Himachal Pradesh is rainfed, causing uncertainty.
- **Insufficient irrigation infrastructure** limits crop yields and cropping intensity.

- **The places with good irrigation facilities have adopted more chemical fertilizer usage.**
- **Over-extraction of groundwater** for irrigation leads to depletion and environmental issues.
 - **87% of ground water** is used for cultivation leading to depletion.
- **Poor water management practices** contribute to low water use efficiency in agriculture.
 - **Punjab** gave free electricity to farmers which led to over-cultivation of rice and depletion of water.
- **Lack of water conservation** measures and infrastructure further exacerbates irrigation issues.
 - **Zero Budget Natural Farming (ZBNF)** includes replenishing water bodies for water availability during dry spells.
- **Climate change** affects rainfall patterns and water availability for irrigation.
 - Changes in temperature and precipitation patterns affect agriculture.

3) Small and Fragmented Landholdings

- **Small and marginal farmers** dominate Indian agriculture, hindering mechanization and economies of scale.
 - **86.2% of farmers** are categorized as small and marginal farmers.
- **Fragmented landholdings** make it difficult to implement modern farming techniques.
 - Small and fragmented land holdings lead to less use of machines.
- **Low investment capacity** of small farmers further limits access to technology and inputs.
 - Marginal farmers have less than 1 hectare of land, limiting their investment capacity.
- **Limited access to credit** and financial services hinders improvements in farming practices.
 - **60% of total agriculture credit** comes from informal sources but mostly benefits large and medium farmers.
- **Lack of proper land records** and ownership issues prevent farmers from accessing government schemes.
 - Many small, marginal and tenant farmers do not have recorded leases and cannot register for government procurement.
- **Land ceiling policies** were not uniformly implemented, affecting equitable distribution of land.
 - The ceiling was not uniform across the country and was based on irrigation and fertility of the land.

4) Poor Soil Health

- **Imbalanced use of fertilizers** leads to soil degradation and reduced productivity.
 - The ideal ratio of **N:P:K** in soil is **4:2:1**, but in **India** it is **8:3:1**.
- **Excessive use of urea** causes soil contamination, erosion, and eutrophication.
 - **Urea** is the **cheapest** fertilizer and is therefore overused.
- **Lack of organic matter** reduces soil fertility and water-holding capacity.
 - **Conservation agriculture** promotes the maintenance of permanent soil cover.
- **Soil salinity** and alkalinity issues affect crop growth and productivity.
 - **Electrical conductivity (EC)** is used to differentiate between alkaline and saline soil.
- **Limited soil testing** and awareness about soil health among farmers leads to poor management.
 - **Soil health cards** provide information on **12 parameters**, but only **860** samples were tested in **2017-19**.
- **Stubble burning** causes nutrient loss, soil degradation, and environmental pollution.
 - **Stubble burning** releases oxides of carbon, nitrogen, and sulfur.
- **Mono-cropping** leads to nutrient depletion and increased pest and disease pressure.
 - **Rice, wheat, cotton, and sugarcane** occupy large cultivation areas due to the MSP.

5) Lack of Access to Quality Inputs

- **High cost of quality seeds** limits access for small and marginal farmers.

- Most farmers use farm-saved seeds rather than purchasing certified seeds.
- **Low seed replacement rate (SRR)** affects the quality and yield of crops.
 - The **seed replacement rate** in India is only **30%**.
- **Non-availability of timely and adequate supply of fertilizers and pesticides.**
 - **Black marketing of urea** occurs when demand is high and supply is low.
- **Use of spurious and substandard inputs** can harm crop production.
 - **Maximum pesticides** are used in **rice** and **cotton**.
- **Limited access to bio-fertilizers** and organic manures impacts soil health.
 - **Sub-Mission on Seeds and Planting Material (SMSP)** aims to increase production of quality seeds.
- **Inadequate storage facilities** lead to post-harvest losses and reduced profits for farmers.
 - There are not enough storage systems which lead to post ripening of crop.
- **Diversion of fertilizers** for industrial purposes creates a shortage for agricultural use.
 - **Urea** meant for agriculture is diverted to industries, for making illicit liquor, and smuggled.

6) Climate Change Impacts

- **Changing rainfall patterns** lead to droughts, floods, and crop failures.
 - **Extreme rainfall** in Punjab, Himachal, and Haryana in **2023** led to a fall in production.
- **Increased temperatures** and heat waves negatively impact crop yields.
 - **Heat waves in March 2022** led to the shrinking of wheat grains.
- **Rising sea levels** threaten coastal agriculture and food security.
 - Rising sea levels may inundate **low-lying paddy cultivation** areas.
- **Enhanced pest and disease outbreaks** due to changing climate conditions.
 - Hot and untimely rainfall creates conditions for pest attacks.
- **Increased greenhouse gas emissions** from agriculture contribute to climate change.
 - Approximately **18% of greenhouse gases** are released by agricultural practices.
- **Lack of climate-resilient** crop varieties makes agriculture vulnerable.
 - **ICAR** has developed **32 varieties** to combat abiotic stresses like drought and floods.
- **Climate change affects** the cropping pattern and agricultural productivity.
 - Climate is the most important determinant of crop productivity in India.

7) Poor Post-Harvest Infrastructure

- **Inadequate storage facilities** lead to significant post-harvest losses.
 - There are not enough storage systems, leading to post-ripening of crops.
- **Lack of proper transportation** infrastructure increases losses and costs.
 - Greater distance between farm and mandi increases transportation costs.
- **Limited cold storage** facilities result in spoilage of perishable goods.
 - **Perishable crops** like tomatoes can be sold directly to buyers without going to mandis.
- **Inefficient marketing systems** and lack of market intelligence.
 - A market intelligence network is needed to collect real time data on demand, supply, and price.
- **Multiple intermediaries** in the supply chain reduce farmers' profits.
 - More intermediaries between farmers and consumers means less profit for farmers.
- **Lack of grading and standardization** affects the price of agricultural produce.
 - There are no proper grading systems, which leads to post harvest losses in the mandis.
- **Limited food processing capacities** and value addition affect the agriculture value chain.
 - There is a need to increase food processing capacities and value addition in the value chain.

Measures to Increase Productivity

1) Technological Inputs (High Yielding Varieties, Precision Agriculture)

- **High Yielding Varieties (HYV)** increase crop output and food security.
 - **ICAR** released **283** crop varieties, including **35 biofortified** and **32 stress-resistant** types.
- **Precision agriculture** enhances efficiency through technology such as precise sowing tools.
 - Use of **spraying drones**, and **mechanically operated harvesters** aid sustainable intensification.
- **Genetically Modified (GM) crops** can boost productivity with disease resistance and less pesticide use.
 - **Bt cotton** technology improved resistance to bollworm.
- **Bio-fortification** of crops increases nutritional value and improves public health.
 - **PBWRS1**, a **wheat variety**, has resistant starch developed by **Punjab Agricultural University**.
- **Quality seeds** are essential for high agricultural production and productivity.
 - Most Indian farmers use farm-saved seeds, resulting in low **seed replacement rate (SRR)**.
- **New crop varieties** should be suitable for local areas to improve productivity.
- Farmers need awareness of new crops and varieties that suit their regions.
- **Use of better quality seeds** can increase agricultural production and productivity.
 - The development of **HYV of wheat by Norman Borlaug** resulted in the green revolution.

2) Improved Irrigation and Water Management

- **Efficient irrigation systems** and water management can enhance crop yields.
 - Places with good irrigation facilities have adopted more chemical fertilizer use.
- **Water conservation** techniques are crucial, such as farm ponds to ensure water availability.
 - **Zero Budget Natural Farming (ZBNF)** includes replenishing water bodies to improve water availability.
- **Precise irrigation** helps in using water efficiently and increasing productivity.
 - **Efficient water** use is necessary for better absorption of fertilizers.
- **Proper irrigation** can help save cumin crops from wilting.
 - **Proper irrigation** saves cumin from wilting.
- **Water management techniques** for crops like rice can help reduce water usage.
 - The government has limited the time of transplantation for **rice to June 15th** to conserve water.

3) Soil Health Management

- **Maintaining soil health** through organic matter and biodiversity increases crop yields.
 - **Regenerative agriculture** enhances soil health by increasing organic matter and biodiversity.
- **Conservation agriculture (CA)** prevents land losses while regenerating degraded lands.
 - CA promotes permanent soil cover, minimum soil disturbance, and diversification.
- **Integrated Nutrient Management (INM)** promotes balanced use of fertilizers with organic options.
 - Government is promoting **PM-PRANAM** to provide organic and bio fertilizers.
- **Soil testing** and soil health cards help farmers with balanced nutrient application.
 - Soil health cards contain information on the health of the soil for better nutrient management.
- **Traditional practices** like using organic manures and crop rotation improves soil fertility.
 - **Sheep dropping and oak leaves** are used as manure in natural farming in Arunachal Pradesh.
- **Indigenous soil testing** methods can help farmers assess soil quality.
- Some traditional methods include testing using local materials and assessing soil structure.

4) Mechanization

- **Farm mechanization** increases efficiency and reduces labor costs.
 - Use of machines such as harvesters and threshers are indispensable to sustainable crop intensification.
- **Custom Hiring Centers** make machinery accessible to small landholders.
 - The government is promoting custom hiring centers to offset adverse economies of scale.
- **Subsidies** for agricultural machinery increases adoption by small farmers.
 - The government of Punjab provides 50-80% subsidy for farm machinery.
- **Mechanization reduces** the time and labor involved in agricultural operations.
 - Combined harvesters are transferred from Punjab to Haryana after harvesting.

5) Credit and Market Access

- **Access to credit** enables farmers to invest in quality inputs and technology.
 - **60%** of total agricultural credit is from informal sources and is more expensive.
- **Timely and affordable credit** is needed for better agricultural outcomes.
 - Small and marginal farmers are still dependent on money lenders for credit.
- **Well-organized marketing systems** ensure fair prices and reduces post-harvest losses.
 - **A market intelligence network** is needed to collect data on supply, demand, and prices.
- **Market intelligence** is essential for providing real time data to farmers and other stakeholders.
 - Setting up a network to collect data on supply, demand, and prices helps better market access.
- **Contract farming** can provide a guaranteed market and income for farmers.
 - The 2nd farm law relates to **contract farming** for agricultural products.

Cropping Patterns in India

Definition and Types: Multiple Cropping, Monocropping, Intercropping, Crop Rotation

- **Cropping pattern** is the yearly sequence and spatial arrangement of crops on land over time.
 - It indicates temporal or spatial arrangement of crops in a particular area.
- **Multiple cropping** involves growing two or more crops on the same land in a year.
 - It is enabled by irrigation facilities and can include **double or triple cropping** [previous conversation].
- **Monocropping** is the practice of growing only one crop on a field year after year.
 - **87%** of ground water is used for cultivation of **rice, wheat, cotton and sugarcane**, leading to monoculture.
- **Intercropping** means growing two or more crops simultaneously on the same field.
 - **Maize** intercropped with **pulses** and **oilseeds** has proven superior to monocropping.
- **Crop rotation** involves growing different crops in sequence on the same field.
 - Crop rotation can facilitate effective crop intensification and improve soil fertility.

Factors Influencing Cropping Patterns

1) Climatic Conditions

- **Climate** is a key determinant of crop productivity, especially in rainfed areas.
 - **Climate change** impacts agriculture through changes in temperature and precipitation patterns.
- **Extreme weather events**, such as heat waves and untimely rainfall, affect crop yields.
 - Heat waves in **March 2022** led to shrinking of **wheat grains**, and erratic rainfall flattened wheat.
- **Hot and humid conditions** favor pest attacks, impacting crop selection.
 - **Rice** and **cotton** are mostly affected by pests due to their requirement for hot and humid conditions.

2) Soil Type

- **Soil properties**, including fertility and structure, influence cropping decisions.
 - **Sandy soils** need clay to improve their physical condition, a common traditional practice.
- **Soil health** is crucial for crop productivity, impacting the choice of cropping patterns.
 - Farmers use local species of **earthworms** to increase organic matter and improve soil moisture retention.

3) Irrigation Facilities

- **Availability of irrigation** influences the choice of crops and cropping intensity.
 - Places with good irrigation adopt more chemical fertilizer usage.
- **Irrigation systems** affect water use efficiency and crop yields.
 - **Efficient irrigation** is necessary for better absorption of fertilizers.
- **Water management** techniques are critical for areas with limited water resources.
 - The government regulates rice transplantation to **June 15th** to save water.

4) Market Demand and Prices

- **Market prices** and demand influence the type of crops farmers choose.
 - Farmers grow crops that have a higher market price and demand.
- **Market intelligence** is essential for farmers to know the demand, supply and prices.
 - A **market intelligence network** helps in collecting real-time data on supply, demand and price of crops.
- **Assured prices** in the market can encourage farmers to grow certain crops.
 - Lack of assured prices is a problem for farmers in hilly and tribal areas.

5) Government Policies and Subsidies

- **Government policies**, such as subsidies, affect the cropping pattern in an area.
 - Subsidies for machinery can increase adoption by small farmers.
- **Minimum Support Price (MSP)** influences crop selection by guaranteeing a price.
- MSP is announced by the government to protect farmers from market risks.
- **Government schemes** and programs also shape cropping decisions.
- **PM-PRANAM** promotes the use of organic and bio fertilizers.

6) Technological Availability

- **Technological advancements**, like high-yielding varieties (HYV) and precision agriculture, impact crop choice.
 - **High yielding varieties** have increased crop output and food security.
- **Mechanization** influences the types of crops farmers choose to grow.
 - **Mechanized tools** like harvesters increase the efficiency of crop production.
- **Information technology** helps farmers make better choices about crops.
 - The "**Onion Crop Advisor**" mobile application is designed to aid farmers.

Changes in Cropping Patterns

1) Historical Changes and Drivers

- **Cropping patterns** have changed over time due to various agronomic, economic, and policy factors.
 - These factors vary in their impact on crops under different circumstances and times.
- **The Green Revolution** led to increased use of chemical fertilizers and a shift to **cereal crops**.
 - Average usage of chemical fertilizers increased from 0.5kg/ha in 1950-51 to 135kg/ha in 2020-21.
- There is a **dominance of cereal crops** due to poverty and the need to meet the demands of low-income people.
 - A large proportion of income of low-income people is spent on **cereals**.

- **Pulses**, a crucial protein source, are not grown on a significant scale, which affects nutritional security.
 - **India** is the largest producer, consumer, and importer of pulses.

2) Impact of High-Yielding Varieties (HYV)

- **High-yielding varieties (HYV)** have increased agricultural productivity and food security.
 - **283** crop varieties/hybrids, including **35 biofortified varieties**, were released for commercial cultivation.
- **Genetically modified (GM) crops** have high productivity and resistance to diseases and pests.
 - **Bt cotton** is an example of a successful GM crop with resistance to bollworm.
- The use of **better quality seeds**, including HYV, increases agricultural productivity.
 - **Seed replacement rate** is an important factor in increasing agricultural productivity.
- However, farmers often use **farm-saved seeds** rather than purchasing certified seeds, affecting yield.
 - Only about **30%** of seeds are certified, indicating a low seed replacement ratio.

3) Recent Shifts in Response to Market and Consumption Patterns

- **Market demand** and **prices** have driven shifts in cropping patterns in favor of certain crops.
 - Farmers are choosing crops that have a higher market price and demand.
- **Climate change** is causing a shift in cropping patterns, impacting crop yields.
 - **Extreme rainfall in Punjab, Himachal and Haryana in 2023** led to a fall in crop production.
- **Government policies** such as the Minimum Support Price (MSP) also influence crop choices.
 - **MSP** encourages farmers to grow specific crops for assured income.
- There is a need to promote **crop diversification** to reduce reliance on a few crops and stabilize yields.
 - **Diversified cropping systems** like **rice-wheat-mungbean** improve soil health and productivity.
- The need to shift to crops such as **millets** is being promoted by the government because of their nutritional value.
 - The government has announced an **85% profit on Bajra and Jowar** to incentivize production, but implementation is lacking.

Strategies for Crop Diversification

1) Promotion of Millets and Other Nutri-Cereals

- The government is actively promoting **millets** and other **nutri-cereals** due to their nutritional value and climate resilience.
 - **Millets** are seen as economically viable and culturally acceptable, especially in tribal areas.
- **Farmer-led extension** strategies are used to enhance millet farming in hilly and tribal regions.
 - **Millet Farmer Facilitators (MFFs)** are identified to promote improved millet production technologies.
- The government has announced an **85% profit on Bajra and Jowar** to incentivize production.
 - However, the implementation of this initiative has been lacking.
- **Lack of assured prices** and crop damage by wild animals are major problems faced by millet farmers.
 - An android app, "**Millet Market**," was developed to help in marketing and advisory.

2) Encouraging Horticulture, Floriculture, and Livestock

- **Horticulture and floriculture** are encouraged as part of crop diversification to increase farmer income.
 - **Mango-based cropping systems** with dragon fruit and pineapple show higher production efficiency.
- **Integrated nutrient management** schedules in fruit crops such as sweet orange are standardized.
 - Spray schedules for flower/fruit drop in **pomegranate** have also been standardized.
- **Livestock integration**, such as combining coconut with pasture crops and fodder trees, increases net income.
 - Integration of **coconut with pasture crops** and **goats** recorded a net income of ₹2,54,206/ha.
- The use of **chrysanthemum genotypes** can be used for preparation of floral calendars to improve pollinator health.
 - **Three chrysanthemum genotypes** were identified as attractive for honeybees.

3) Integrated Farming Systems

- **Integrated farming systems** combine crop cultivation with other agricultural activities for better resource use.
 - This may include **livestock, poultry, or fisheries** to generate multiple income streams.
- **Conservation agriculture** integrates diverse cropping systems to enhance soil health and climate resilience.
 - **Diversified cropping systems** like rice-wheat-mungbean and maize-chickpea + mustard are promoted.
- **Regenerative agriculture** supports biodiversity and returns carbon to the soil, enhancing soil health.
 - It aims at increasing soil organic matter, biota, and biodiversity.
- **Zero Budget Natural Farming (ZBNF)** is promoted as a natural farming technique without chemicals.
 - **ZBNF** focuses on replenishing water bodies and increasing organic matter in the soil.
- **Integrated weed management**, using manual, mechanical, and chemical means, is also essential.
 - **Crop rotation** facilitates effective crop intensification along with weed management.

4) Role of Technology for Crop Diversification

- **Technology** plays a crucial role in enhancing crop diversification and productivity.
 - **Precision sowing and weeding tools, spraying drones, and harvesters** are essential for crop intensification.
- The **Scheme for Modernization and Reforms through Technology in Public Distribution System (SMART-PDS)** has transformative potential beyond food security.
 - **SMART-PDS** uses **ePoS devices** and biometric authentication for distributing food grains.
- **Mobile applications** like the “Onion Crop Advisor” provide farmers with access to information.
 - **Technology** helps in providing information and advice for better farming practices.
- **Bio-fortification** of crops through methods such as **infusing nutrients into the grain** helps to increase nutritional value of the crops.
 - **ICAR** has developed varieties like **PBWRS1** with resistant starch.
- **Sub-Missions** under the government support technology adoption, including agricultural mechanization.
 - **Sub-Mission on Agricultural Mechanization (SMAM)** promotes farm mechanization and custom hiring centers.

Emphasis on Millets

Reasons Behind Promoting Millets

- **Millets** are promoted for their high **nutritional value**, addressing nutritional security, especially for low-income populations.
 - They meet the **demand of low-income people**, whose diet mainly consists of cereals.
- **Millets** are highly **climate-resilient** crops, making them suitable for areas with changing weather patterns.
 - They can withstand **drought, water scarcity, flood, and waterlogging**.
- **Millets** can contribute to **food security** due to their high productivity and reduced reliance on imports.
 - They are vital for **ensuring food security** to the rising population.
- **Millets** are considered **economically viable and culturally acceptable**, especially in hilly and tribal areas.
 - They are part of the **traditional farming and diet systems** of many communities.
- The **government aims to promote millets** to address issues of **monoculture** and **groundwater depletion**.
 - **Monoculture of water-intensive crops** like rice leads to **groundwater depletion**.

Government Measures to Increase Millet Production and Consumption

- The government is providing **financial incentives** by announcing an **85% profit** on **Bajra** and **Jowar**.
 - However, this initiative has **not been effectively implemented**.
- **Farmer-led extension** strategies are being used to enhance millet farming in hilly and tribal areas.
 - **Millet Farmer Facilitators (MFFs)** are identified to promote improved millet production technologies.
- The government is focusing on **increasing the area under millet cultivation** to diversify cropping patterns.
 - **National Food Security Mission- Oilseeds (NFSM-OS)** includes programs to increase production of various crops.
- **Research and development** efforts are ongoing to develop high-yielding, short-duration varieties of millets.
 - These efforts aim to improve **on-time availability** of seeds and access to technologies.
- An **android app, "Millet Market,"** has been developed for marketing and providing advisory services to farmers.
 - This app facilitates **marketing of millets** and provides information on improved technologies.
- The government is working to **establish a robust supply chain** to support millet production and marketing.
 - The majority of millet producers are small-scale farmers **who lack access to modern technology, credit facilities, and storage infrastructure**.
- The **government promotes the inclusion of millets** in the Public Distribution System (PDS) to enhance consumption.
 - The **NFSA 2013** provides for subsidized millets to priority households.

Modern Technological Inputs

High-Yielding Varieties, Precision Farming, Biotechnology

- **High-yielding varieties (HYVs)** are crucial for increasing agricultural production and productivity to ensure food security.
 - **283 crop varieties/hybrids** were released in 2023-24, including **35 biofortified** and **32 stress-resistant** varieties.
- **Precision farming** utilizes advanced technologies to optimize resource use and improve crop yields.

- It includes **precise sowing and weeding tools** as well as **spraying drones** for effective crop intensification.
- **Biotechnology**, including **genetic modification (GM)**, is used to develop crops with enhanced traits, such as pest resistance and higher yields.
 - **GM crops** have high productivity and are vital for **ensuring food security** and reducing import dependence.
- **Bio-fortification**, through methods such as infusing nutrients into the grain, increases nutritional value of crops.
 - **ICAR** developed varieties like **PBWRS1** with resistant starch, enhancing nutritional value.
- **Genetic editing** and **transgenic crops** are being explored to enhance crop characteristics and productivity.
 - **Genetic editing** involves suppressing existing genes while **transgenic crops** add new genes to a seed.

Mechanization, Irrigation Technologies

- **Farm mechanization** increases efficiency and reduces labor costs, leading to better yields and higher income.
 - **Sub-Mission on Agricultural Mechanization (SMAM)** promotes farm mechanization through custom hiring centers.
- **Mechanized tools** such as harvesters and threshers are indispensable for sustainable crop intensification.
 - **Combined harvesters** are transferred to different regions for harvesting, optimizing resource utilization.
- **Irrigation technologies** improve water management and ensure consistent water supply, boosting crop productivity.
 - **Proper irrigation** is essential for the absorption of fertilizers and achieving better crop yields.
- **Happy seeders** are used for sowing seeds where stubble is present, which helps in managing crop residue and reducing burning.
 - The **Punjab government** provides a 50-80% subsidy on **happy seeder** machines.
- **Water conservation techniques**, including replenishing water bodies, are crucial for sustainable farming.
 - **Zero Budget Natural Farming (ZBNF)** emphasizes replenishing farm ponds to ensure water availability.

Information and Communication Technologies (ICT)

- **Information and Communication Technologies (ICT)** provide farmers with access to real-time data, advisories, and market information.
 - **Mobile applications** like the “Onion Crop Advisor” provide comprehensive tools and advice.
- **e-technology** helps farmers in production and marketing, enhancing efficiency and reducing exploitation.
 - **Electronic Point of Sale (ePoS)** devices are installed at Fair Price Shops (FPSs) for food grain distribution.
- **SMART-PDS** utilizes technology for modernizing the public distribution system and ensuring food security.
 - It uses **ePoS devices** and biometric authentication for distributing food grains to rightful beneficiaries.
- **Mobile advisory services** are used to provide timely and need-based information to the farming community.
 - **KVKs** provide weather-based alerts and advisories through mobile services.
- An android app, “**Millet Market**,” was developed for facilitating marketing of millets and providing advisory services.

- This app connects farmers directly to the market and provides **information on improved millets**.

Impact on Food Security

Role of Technology in Ensuring Food Production in the 21st Century

- **Technology is essential** for increasing food production to meet the demands of a growing global population, ensuring food security.
 - **High-yielding varieties** and **biofortification** enhance both crop yields and nutritional value.
- **Precision farming** optimizes resource use, such as water and fertilizers, to increase agricultural output and reduce wastage.
 - It uses tools like **precise sowing and weeding technologies** and **spraying drones**.
- **Biotechnology**, including **genetic modification**, improves crop traits like pest resistance, enhancing productivity.
 - **GM crops** have higher yields and reduce reliance on imports, contributing to food security.
- **Mechanization** increases efficiency, reduces labor costs, and improves overall agricultural productivity and output.
 - The **Sub-Mission on Agricultural Mechanization (SMAM)** promotes farm mechanization.
- **Irrigation technologies** ensure consistent water supply, crucial for enhancing crop yields, particularly in water-scarce regions.
 - **Water conservation techniques** such as replenishing water bodies are essential for sustainable farming.
- **Information and Communication Technologies (ICT)** provide farmers with real-time data and market information, improving decision-making and access.
 - **Mobile apps** like the "Onion Crop Advisor" provide farmers with comprehensive tools and advice.
- **SMART-PDS** utilizes technology to modernize the public distribution system ensuring efficient food distribution and food security.
 - It uses **ePoS devices** and biometric authentication for distributing food grains to rightful beneficiaries.
- **Research and development** of new agricultural technologies enhance crop varieties and farming practices for improved productivity.
 - **ICAR** released **283 crop varieties/hybrids** in 2023-24, including stress-resistant varieties.
- **Data analytics and ICT tools** can integrate all operations relating to PDS, improving supply chain networks and reducing wastage.
 - These tools help to improve the supply chain networks of the **Food Corporation of India and Central Warehousing Corporation**.
- **Digital platforms** are deployed to empower farmers, providing them with information and access to modern agricultural practices.
 - **KVKs** provide weather-based alerts and advisories to farmers through mobile services.
- **Technology-led reforms** overcome limitations of PDS operations concerning IT hardware, software, and technical manpower in states.
 - These reforms institutionalize an **integrated central system for all PDS-related operations**.
- **Integrated nutrient management** using both chemical and bio-fertilizers can increase the efficiency of nutrient use and improve crop yield.
 - Government has started **PM-PRANAM** to promote the use of organic and bio-fertilizers.

Government Initiatives and Policies

Subsidies: Impact on Cropping Patterns, Crop Diversity, and Farm Economies

- **Subsidies** influence cropping patterns by incentivizing certain crops, often leading to a dominance of cereal crops.
 - **Cereal subsidies** affect household decisions, balancing calorific needs and living conditions.
- **Open-ended procurement** under subsidies has led to **FCI** becoming a buyer of last resort, distorting markets.
 - In 2016-17, the government procured more than 30% of the marketable surplus of wheat.
- **Subsidized prices** can discourage crop diversification, impacting nutritional security and agricultural sustainability.
 - Even pulses, a source of protein, are not grown on a significant scale due to cereal dominance.
- **Fertilizer subsidies**, while intended to increase production, can lead to imbalanced nutrient use and environmental issues.
 - **Urea**, a commonly subsidized fertilizer, is often overused, creating an imbalance in soil nutrients.
- Differential rates of subsidy for different nutrients create distortions and need to be addressed for balanced use.
 - Fertilizer subsidies should be linked with the recommended application of different nutrients.
- **Cereal subsidies** may affect investments in health and education by encouraging consumption over quality diets.
 - Households balance their needs including adequate calorific consumption, diet quality, and health investments.

Minimum Support Price (MSP): Significance for Small and Marginal Farmers

- **Minimum Support Price (MSP)** is a price support mechanism to protect farmers from market risks and price crashes.
 - The government announces MSP before the cultivation season, enabling informed decisions by farmers.
- **MSP** is calculated by the **Commission for Agricultural Costs and Prices (CACP)** and announced by the **Cabinet Committee of Economic Affairs (CCEA)**.
 - The CACP takes the average cost of cultivation into consideration.
- **MSP** ensures that farmers receive a guaranteed price for their produce, providing income security for small farmers.
 - If markets pay less than MSP, the **FCI** will pay the MSP and procure the crop.
- The **MSP** system is well established only for a few crops like rice, wheat, cotton, and sugarcane, creating regional disparities.
 - 60% of wheat and 30% of rice procured for the PDS comes from Punjab and Haryana.
- **Small and marginal farmers** often lack awareness of MSP, making it difficult for them to get registered for government procurement.
 - Most tenant farmers don't have recorded leases, complicating their registration.
- The **MSP** policy favors a few crops from select regions, which can lead to issues like groundwater depletion and monoculture.
 - The government encourages farmers to cultivate maize to address the problem of groundwater depletion.
- **Procurement** related to **MSP** is not well established; it is often delayed, and payments are not made upfront.
 - In some areas, payments are delayed by more than a month.

Crop Insurance: Importance for Risk Management in Agriculture

- **Crop insurance** helps mitigate risks from weather-related events, pests, and diseases and provides financial security to farmers.
 - Climate change and extreme weather events impact cropping patterns and yields.

- **Crop insurance** protects farmers from financial losses, stabilizing farm incomes and encouraging investment in agriculture.
 - Many farmers in India are small and marginal, making them vulnerable to crop losses.
- **Risk management** in agriculture through crop insurance enhances food security by ensuring stable agricultural production.
 - By ensuring income stability, it helps in maintaining farmer livelihoods and their capacity to produce food.
- **Effective implementation** of crop insurance schemes requires proper assessment of risks and timely disbursement of claims.
 - Timely and efficient settlement of insurance claims is crucial for farmers to recover from losses.
- **Technology** can help improve the reach and efficiency of crop insurance programs by providing better assessment of losses.
 - **ICT tools** can help in assessing crop losses and damage.
- **Crop insurance** acts as a crucial safety net, enabling farmers to continue farming in the face of climate-related challenges.
 - Farmers can use the compensation to reinvest in agriculture and continue production in the face of disasters.

Food Processing: Significance for Small and Marginal Farmers

- **Food processing** enhances the value of agricultural produce, increasing income potential for small farmers.
 - Value addition in the **TOP (Tomato, Onion, Potato) value chain** links production clusters to food processing capacities.
- **Food processing** reduces post-harvest losses by extending the shelf life of agricultural products.
 - There are **post-harvest losses in mandis** due to a lack of storage systems.
- It creates employment opportunities in rural areas, benefiting marginal farmers who have limited options.
 - The government is trying to increase food processing capacities to create jobs.
- **Food processing** can help in diversifying the agricultural sector, increasing demand for various crops.
 - This will lead to a more **balanced cropping pattern** and better use of resources.
- **Small and marginal farmers** benefit from better market access via food processing industries and value addition.
 - By processing their produce, farmers can get a better price and avoid middlemen.
- **Food processing** boosts exports by enabling the sale of processed agricultural products in international markets.
 - India has a large market for rice, and food processing will boost exports.

Steps Taken by the Government to Address Regional Variations in Crop Production and Diversification

- The government promotes **region-specific strategies** to address variations in crop production and diversification.
 - The **National Food Security Mission-Oilseeds (NFSM-OS)** has special programs for oilseed production.
- The government has launched the **National Mission on Edible Oil-Oil Palm (NMEO-OP)** to promote oil palm cultivation in specific regions.
 - There is a special focus on North Eastern States and Andaman & Nicobar.
- The **Sub-Mission on Agriculture Extension (SMAE)** strengthens programs of states/local bodies to achieve food security.
 - This includes empowering farmers and strengthening program planning.
- **Custom Hiring Centers (CHCs)** are promoted to offset issues caused by small land holdings and the high cost of mechanization.

- The **Sub-Mission on Agricultural Mechanization (SMAM)** increases the reach of farm mechanization.
- The government promotes the use of location-specific crop varieties that are suited to different agro-ecological zones.
 - **ICAR** has released **283 crop varieties and hybrids** for different agro-ecologies.
- **Diversified cropping systems** are encouraged for higher productivity, resource efficiency and to improve soil health.
 - The government promotes the incorporation of summer mungbean into rice-wheat and maize-wheat systems.
- Government programs provide **region-specific information** and technology for farmers to improve crop production.
 - **KVKs** play a vital role in providing information, education, and communication activities for farmers.
- The government is focusing on **millets**, including support for millet producer groups, to boost production in tribal areas.
 - Farmer-led extension strategies are used to improve millets-based farming systems in hilly areas.
- The **PM-PRANAM** scheme promotes balanced use of chemical fertilizers and awareness about regenerative agriculture.
 - This program is aimed to address regions with high fertilizer use and nutrient imbalance.
- **Market intelligence networks** are being set up to collect real-time data on demand and supply to address regional variations.
 - This real-time data will be used to improve price of TOP crops.

Challenges and Way Forward

Present Challenges Before Crop Diversification

- **Small and fragmented landholdings** limit the adoption of diverse cropping patterns and modern technologies.
 - Marginal farmers have less than 1 hectare of land, and small farmers have 1-2 hectares.
- **Over-reliance on cereal crops** like rice and wheat, driven by demand and government support, hinders diversification.
 - The dominance of cereal crops indicates poverty, with a large income proportion spent on cereals.
- **Inadequate access to quality seeds**, especially for non-cereal crops, restricts diversification efforts by farmers.
 - Most farmers use farm-saved seeds rather than purchasing certified seeds.
- **Lack of awareness and training** among farmers regarding new crops and their varieties reduces crop diversification.
 - Simple farmers need to be made aware of new crops suitable for their area.
- **Climate change and extreme weather events** impact crop productivity, making diversification more complex.
 - Heat waves and untimely rainfall can lead to flattening of wheat crop.
- **Insufficient market linkages and storage facilities** discourage farmers from diversifying into perishable crops.
 - Lack of storage leads to post-harvest losses in mandis.
- **Improper use of pesticides** leads to pest resistance and reduces the efficacy of pest management methods.
 - Overuse of pesticides leads to pests and weeds developing resistance.
- **Water-intensive crops** like rice and sugarcane deplete groundwater resources and affect cropping diversity.
 - 87% of groundwater is used for cultivation.
- **Monoculture** practices lead to soil degradation, pest build-up, and reduced overall productivity.

- The MSP policy favors few crops and contributes to monoculture.
- **Limited access to credit and financial support** for farmers who are transitioning to new crops poses a challenge.
 - 60% of total agriculture credit is from informal sources.
- **The Minimum Support Price (MSP)** focuses on a few crops, disincentivizing farmers from adopting new ones.
 - MSP is well established only for rice, wheat, cotton, and sugarcane.

Recommendations for Improving Cropping Patterns, Productivity, and Diversity

- **Promote integrated nutrient management** to improve soil health and reduce reliance on chemical fertilizers.
 - The PM PRANAM scheme promotes balanced use of chemical fertilizers.
- **Encourage the use of certified seeds** and promote seed replacement to increase productivity and improve crop diversity.
 - The Sub-Mission on Seeds and Planting Material (SMSP) increases production of certified seeds.
- **Use precision farming technologies** for sowing, weeding, and harvesting to increase efficiency and crop productivity.
 - Intensive use of technology is essential for sustainable intensification.
- **Adopt conservation agriculture** practices to improve soil health, reduce soil erosion, and enhance water conservation.
 - Conservation agriculture promotes permanent soil cover, minimum disturbance and diversification.
- **Promote crop diversification** by including pulses, oilseeds, and other nutritious crops in cropping systems.
 - Pulses provide dual benefits of nutritional security and sustainable agriculture.
- **Strengthen market linkages** and create storage facilities to reduce post-harvest losses and encourage crop diversification.
 - The government is setting up a market intelligence network for TOP crops.
- **Implement integrated pest management (IPM) strategies** to reduce reliance on harmful chemical pesticides.
 - IPM centers are needed to train farmers about pest management.
- **Provide training and awareness programs** for farmers about new crops, cropping patterns, and sustainable practices.
 - The Sub-Mission on Agriculture Extension (SMAE) strengthens extension programs.
- **Promote water-efficient irrigation methods** to reduce water consumption in agriculture, especially in water stressed areas.
 - Water is required for the absorption of fertilizers.
- **Support farmer producer organizations (FPOs)** to improve bargaining power, reduce input costs, and promote collective farming.
 - There are very few FPOs in India.
- **Enhance research and development** to develop climate-resilient varieties and region-specific cropping systems.
 - ICAR has released 32 varieties to combat abiotic stresses.
- **Implement policies that ensure fair prices** for diverse crops, encouraging farmers to move beyond traditional crops.
 - The government announces MSP to protect farmers from market risks.
- **Reorient agricultural subsidies** towards sustainable and diversified cropping systems, instead of focusing only on few crops.
 - The government is re-purposing fertilizer subsidies for practices that benefit soil, water, and environmental health.

Dry Land Agriculture and Practice

Topic: Dryland farming

Questions:

- ☐ Per hectare yields of dry land areas, which are substantial in our country are generally low. Why is it so? Name the crops which are mostly grown on these areas. What are the steps taken to stabilise and elevate crop production in these areas? (83/20)
- ☐ What is dryland agriculture? Discuss its importance to India. (94/15)
- ☐ What is dry farming? Discuss its relevance in augmenting the food supply in India. (99/15)

Dryland Farming and Agriculture

- **Dryland farming** is a method of crop production in arid or semiarid regions without irrigation.
 - It utilizes rainfall and conserves soil moisture to sustain crop growth.
- **Dryland agriculture** includes farming practices in regions with low annual rainfall, focusing on drought-resistant crops.
 - It involves specific soil and water management practices.

Key Features of Dryland Farming

- Dryland farming emphasizes water conservation methods to maximize water availability for crops.
 - Practices include minimum tillage, mulching, and rainwater harvesting techniques.
- It often employs drought-tolerant crops and cropping systems suited to low rainfall conditions.
 - Millets and pulses are frequently used in dryland farming.
- Soil health maintenance is crucial for sustaining yields in dryland areas.
 - Organic manures, crop rotation, and cover crops enhance soil fertility and water retention.
- Traditional dryland farming integrates indigenous knowledge and local resources to manage agricultural production.
 - Use of sheep droppings, oak leaves, and minimal tillage in Arunachal Pradesh.
- Effective dryland farming enhances water use efficiency through methods such as precise sowing and weeding.
 - Adoption of technological tools helps in sustainable crop intensification.

Dryland Agriculture Practices

- **Crop diversification** is a key strategy to improve resilience and productivity in dryland agriculture.
 - Intercropping and mixed cropping systems provide higher yields and resource use efficiency.
- **Conservation agriculture** (CA) is promoted to prevent soil loss and regenerate degraded lands.
 - Maintaining permanent soil cover and minimum soil disturbance is part of CA.
- **Integrated nutrient management** combines organic and bio-fertilizers.
 - It promotes the balanced use of chemical fertilizers with organic options.
- **Rainwater harvesting** and management are vital for capturing and storing scarce water.
 - Rolu is an indigenous rain gauge for water measurement and management.
- **Soil testing** helps to identify nutrient deficiencies and manage soil fertility in drylands.
 - Soil Health Card Scheme helps in rationalizing fertilizer use in India.

Dryland Agriculture in India

- India's agriculture is largely dependent on rainfall, making dryland farming crucial for food security.
 - Around 58% of India's population relies on agriculture for livelihood.
- The **Indo-Gangetic Plain** benefits from diversified pulse-inclusive conservation agriculture modules.
 - The rice + dhaincha-wheat-mungbean system shows high productivity.
- **Millets** are essential crops for dryland farming in hilly and tribal areas.

- Millets are economically viable and culturally acceptable.
- **Farmer-led extension** strategies through Millet Farmer Facilitators (MFFs) enhance knowledge and yields.
 - A “Millet Market” app was developed for marketing and advisory services.
- ICAR is promoting **natural farming** through Krishi Vigyan Kendras (KVKs)
 - It includes awareness, training and demonstrations on natural farming.

Challenges and Solutions

- **Water scarcity** is a major limitation in dryland agriculture.
 - Implementing water conservation practices is essential.
- **Soil degradation** and nutrient depletion are major threats to sustainable dryland farming.
 - Using organic manures, crop rotation, and green manuring are important.
- **Lack of assured markets** and post-harvest losses pose challenges to dryland farmers.
 - e-NAM is an initiative to create a unified national market for farmers.
- **Climate change** affects rainfall patterns and increases the risk of crop failure.
 - Developing drought-resistant varieties and climate-smart agriculture is needed.
- **Limited penetration of chemical fertilization** in some states due to poor irrigation leads to poor productivity.
- A direct relation between irrigation and fertilizer usage exists.

Government Initiatives

- **PM-PRANAM** scheme promotes balanced use of chemical fertilizers and regenerative agriculture.
 - It also supports the Green Credit scheme to incentivize sustainable agriculture practices.
- **National Food Security Mission- Oilseeds** aims to make India self-reliant in edible oils.
 - This mission promotes oil palm cultivation with a special focus on the North-Eastern states.
- The government is promoting **integrated nutrient management** practices to reduce over reliance on chemical fertilizers.
 - It is also promoting natural farming through various schemes.
- The government is investing in **research and development** of new seed varieties suitable for dryland agriculture.
 - ICAR releases new crop varieties and hybrids for commercial cultivation.
- Government has promoted **custom hiring centers** to increase farm mechanization reach.
 - This is an effort to offset the adverse economies of scale arising due to small landholdings.

Challenges of Dryland Areas: Low Productivity Reasons

- **Low organic matter** in the soil reduces fertility and water retention capacity, impacting yields.
 - Soils in dryland areas often have low carbon content due to limited vegetation.
- **Unpredictable rainfall** patterns lead to crop failures and inconsistent yields in dryland regions.
 - Extreme rainfall events and droughts cause fluctuations in agricultural production.
- **Water scarcity** and **poor irrigation** infrastructure limit the potential for crop production.
 - Lack of permanent water sources in areas like the Andaman and Nicobar Islands creates crises.
- **Limited access to technology** and modern inputs restricts farm productivity in dryland areas.
 - Small and marginal farmers often lack resources for mechanization and quality seeds.
- **Socio-economic factors**, including **limited credit access**, hinder farmers' ability to invest.

- Small farmers depend on money lenders (Arhatiyas) who impose heavy interest rates.

Specific Examples of Low Productivity Factors

- **Soil Degradation: Soil erosion and nutrient depletion** due to unsustainable practices affect crop productivity.
 - Overuse of chemical fertilizers leads to soil degradation and reduced soil response.
- **Climatic Variability: Erratic rainfall and prolonged dry spells** increase the risk of crop losses.
 - Heat waves and untimely rainfall flatten wheat crops.
- **Irrigation Limitations: Poor irrigation** facilities reduce the efficiency of fertilizer use.
 - A direct relationship between irrigation and fertilizer usage leads to less usage in dryland.
- **Technological Constraints: Limited use of farm machinery** due to small landholdings impacts productivity.
 - The average size of farms in India is 0.92 ha, much less than in the US and Canada.
- **Financial Constraints: Lack of access to institutional credit** forces farmers to depend on private lenders.
 - Sixty percent of agriculture credit comes from informal sources with high-interest rates.

Related Factors Impacting Productivity

- **Improper Nutrient Management: Imbalanced use of fertilizers** reduces soil fertility and yield potential.
 - Excessive usage of urea is common in states like Punjab.
- **Pest and Disease Issues:** Crops in dryland regions are vulnerable to **pest attacks** due to humid conditions.
 - Maximum pesticides are used on rice and cotton, which are both Kharif crops.
- **Inadequate Storage: Poor post-harvest storage** leads to significant losses.
 - Lack of storage facilities results in post-harvest losses.
- **Market Access: Poor market linkages** and exploitation by intermediaries reduce farmers' profits.
 - Farmers travel far to sell produce at low prices due to the large areas covered by mandis.

Alternative Practices and Solutions

- **Integrated Nutrient Management:** Combining organic manures with bio-fertilizers to improve soil health.
 - Using farmyard manure, green manuring crops, and oilcakes enhances soil fertility.
- **Water Conservation Methods:** Implementing techniques like rainwater harvesting to improve water availability.
 - Traditional methods, such as using rolu for rainwater measurement, can be effective.
- **Conservation Agriculture:** Promoting minimum tillage and crop rotation for long-term sustainability.
 - Diversified cropping systems enhance system productivity under conservation agriculture.
- **Drought-Resistant Varieties:** Developing and using crop varieties that are resilient to water stress.
 - ICAR has notified 32 varieties to combat abiotic stresses like drought and water scarcity.
- **Technological Interventions:** Adopting tools for precise sowing, weeding and harvesting to improve efficiency.
 - Use of precise sowing and weeding tools are essential for sustainable crop intensification.

- **Farmer Collectives:** Forming farmer producer organizations (FPOs) to enhance bargaining power.
 - These groups provide better management expertise.
- **Government Support:** Implementing schemes that address credit, technology, and market access.
 - Schemes like PM-PRANAM and Green Credit aim for balanced fertilizer usage.

Crops of Dryland Areas

- **Millets** like **Jowar, Bajra, and Ragi** are important for dryland agriculture due to their drought tolerance.
 - Millets are considered economically viable and culturally acceptable in hilly and tribal areas.
- **Pulses**, including **Gram, Lentil, and Pigeonpea**, enhance nutritional security and sustain agricultural systems.
 - India is the largest producer, consumer, and importer of pulses.
- **Oilseeds** such as **Groundnut, Mustard, and Sesame** are crucial for edible oil production and economic value.
 - The National Mission on Edible Oil-Oil Palm promotes oil palm cultivation.

Specific Examples and Details

- **Jowar (Sorghum):** A drought-resistant millet used for both fodder and grain in dry regions.
 - Gypsum use in sorghum-mustard sequences provides more profit.
- **Bajra (Pearl Millet):** Another hardy millet often grown in arid and semi-arid areas for food security.
 - Pearl millet is used in diversified cropping systems for better productivity.
- **Ragi (Finger Millet):** A nutritious millet suitable for cultivation in areas with limited rainfall and poor soils.
 - Farmer-led extension strategies are being used to promote millets-based farming.
- **Gram (Chickpea):** A widely grown pulse crop that adds nitrogen to the soil and is crucial for food security.
 - Chickpea is part of diversified cropping systems to improve soil health.
- **Lentil:** An important pulse crop, that can be intercropped with linseed.
 - Lentil is part of intercropping systems that can improve farm profitability.
- **Pigeonpea:** A key pulse crop cultivated in dryland areas, providing protein and improving soil fertility.
 - Pigeonpea is used as a component in intercropping and mixed-cropping systems.
- **Groundnut:** A significant oilseed crop adapted to dryland areas, providing oil and fodder.
 - Groundnut is part of crop diversification strategies.
- **Mustard:** A vital oilseed crop grown in dryland areas, and can be a part of crop rotations.
 - Topping the mustard stem increases the yield.
- **Sesame:** A drought-tolerant oilseed crop suitable for cultivation in dry and semi-arid regions.
 - Early sowing of sesame increases phyllody disease.

Other Relevant Points

- **Crop Diversification:** Diversifying cropping systems with millets and pulses enhances overall productivity.
 - More than 100% increase in net return was recorded in recommended cropping systems over rice-wheat.
- **Nutrient Management:** Green manuring with crops like dhaincha and cowpea improves soil fertility for these crops.
- Traditional practices of applying tank silt to upland soils improves soil structure and fertility.

- **Pest Management:** Traditional methods, such as using lady's finger as a trap crop, can help control pests in cotton.
 - Neem oil and other bio-pesticides provide a natural approach to pest control.
- **Seed Production:** Initiatives to increase production of certified seeds are important for better yields.
 - ICAR has released many high-yielding varieties of these crops.
- **Government Support:** Schemes like the National Food Security Mission aim to enhance production of oilseeds and pulses.
 - The government has launched the PM-PRANAM scheme to promote balanced use of fertilizers.

Strategies for Enhancing Dryland Agriculture: Water Management Techniques

- **Watershed development** is crucial for managing water resources and improving soil moisture in drylands.
 - This approach involves integrated management of land and water for sustainable agriculture.
- **Rainwater harvesting** techniques collect and store rainwater to enhance water availability for agriculture.
 - Construction of farm ponds and check dams helps in storing rainwater for later use.
- **Efficient irrigation methods**, like **drip** and **sprinkler**, minimize water wastage and maximize crop yield.
 - These micro-irrigation techniques are essential for water conservation in water-scarce regions.

Specific Examples and Details

- **Check Dams:** Structures built across streams to slow down water flow and increase groundwater recharge.
 - These help in conserving water and reducing soil erosion.
- **Farm Ponds:** Small reservoirs created on farms to store rainwater for irrigation during dry spells.
 - Replenishing water bodies like farm ponds ensures water availability during dry spells.
- **Drip Irrigation:** A precise method of delivering water directly to the roots of plants, reducing water loss.
 - Drip irrigation helps in efficient fertilizer use by delivering it directly to the root zone.
- **Sprinkler Irrigation:** An efficient method that sprays water over the crop, mimicking rainfall, and is suitable for various terrains.
 - This method can be used in areas with uneven land surface, unlike flood irrigation.
- **Micro-irrigation:** Techniques like drip and sprinkler enhance water use efficiency and crop productivity.
 - These methods are particularly important in areas with limited water resources.

Related Points on Water Management

- **Traditional Methods:** Using traditional methods like rolu for rainwater measurement can support water management.
 - Traditional systems often incorporate local knowledge of water availability.
- **Soil Drainage:** Proper soil drainage removes excess water and prevents waterlogging, improving plant health.
 - Shallow drains across slopes prevent erosion and quickly remove excess water.
- **Water Conservation:** Practices like conservation agriculture reduce water loss and improve soil moisture.
 - Minimum tillage and crop rotation enhance water retention in soil.

- **Water Harvesting:** Utilizing techniques such as tank silt application helps retain soil moisture and fertility.
 - Applying tank silt to upland soils improves soil structure.
- **Crop Selection:** Choosing drought-resistant crops is an essential part of water management in drylands.
 - Millets like Jowar and Bajra require less water and are suitable for dryland areas.

Government Initiatives and Support

- **Government Schemes:** Schemes promote efficient irrigation through subsidies and awareness programs.
 - The government encourages water conservation through various agricultural schemes.
- **Financial Assistance:** Government provides financial aid for implementing water-saving irrigation infrastructure.
 - Subsidies on drip and sprinkler systems encourage their adoption by farmers.
- **Awareness Programs:** Educational programs for farmers increase the awareness about water management practices.
 - These initiatives aim to promote the adoption of efficient techniques for better water use.

Integration with Other Practices

- **Integrated Farming Systems:** Combining water management with other techniques enhances overall sustainability.
 - Intercropping and mixed cropping can enhance water use efficiency.
- **Nutrient Management:** Water conservation methods improve the efficacy of nutrient application.
 - Fertilizer and water use are directly related and are essential for increasing productivity.
- **Soil Health:** Enhancing soil health through organic matter improves water infiltration and retention.
 - Adding organic matter to the soil improves its capacity to retain moisture.

Strategies for Enhancing Dryland Agriculture: Agronomic Practices

- **Crop rotation** is a key practice for maintaining soil fertility and controlling pests in drylands.
 - Rotating crops helps in improving soil health by breaking pest and disease cycles.
- **Mixed cropping** involves growing two or more crops together to maximize resource use and yield.
 - This method helps in risk reduction and can provide a diverse range of products.
- **Contour farming** is implemented in hilly areas to reduce soil erosion and conserve water.
 - This practice involves planting crops along the contour lines of the land.
- **Bunding** creates barriers to retain water and soil, preventing soil erosion.
 - Contour bunds in hilly regions are effective in managing water and soil.
- **Mulching** involves covering the soil surface with organic materials to reduce evaporation and suppress weeds.
 - Mulching helps in conserving soil moisture and regulating temperature.
- **Conservation tillage** minimizes soil disturbance, promoting soil health and moisture retention.
 - Minimum tillage helps in maintaining soil structure and organic matter content.

Specific Examples and Details

- **Intercropping of Millets with Pulses:** This practice enhances soil fertility and provides nutritional diversity.

- Growing millets with pulses like chickpea or lentil improves overall system productivity.
- **Contour Bunds in Hilly Regions:** These help in water harvesting and soil conservation on slopes.
 - Contour bunding reduces soil erosion and increases water infiltration.
- **Intercropping of Vegetables, Beans, Pulses, Roots and Tubers:** This system is used to maintain soil fertility for sustainable farming.
 - This type of intercropping can enhance nutrient cycling and pest management.
- **Use of Dhaincha and Cowpea:** These green manure crops improve soil fertility in dryland farming systems.
 - Dhaincha and cowpea are used as green manure in rice and sugarcane fields.
- **Mulching with Crop Residues:** This method retains soil moisture and reduces weed growth in dry areas.
 - Crop residues like groundnut hulls improve soil structure when used as mulch.
- **Reduced Tillage:** This conserves soil moisture and prevents erosion.
 - Minimum tillage is practiced with a hoe in certain regions to conserve soil.

Additional Agronomic Strategies

- **Integrated Weed Management:** This involves manual, mechanical, and chemical methods along with crop rotation.
 - This strategy facilitates effective crop intensification and sustainability.
- **Precision Sowing and Weeding:** Utilizing tools for precise sowing and weeding enhances crop intensification.
 - Technological advancements are crucial for sustainable crop production.
- **Integrated Pest Management (IPM):** This strategy reduces dependence on chemical pesticides.
 - IPM centers train farmers on using techniques like pheromone traps.
- **Zero Budget Natural Farming (ZBNF):** This promotes farming without chemicals or credits.
 - ZBNF focuses on replenishing water bodies and using earthworms to improve soil quality.
- **Conservation Agriculture:** This approach delivers on the objectives of climate-smart agriculture.
 - Conservation agriculture systems increase the productivity and profitability of farming.

Integration and Support

- **Sub-Mission on Agriculture Extension (SMAE):** This strengthens programs to achieve food security and empower farmers.
 - SMAE helps in strengthening program planning and ICT usage.
- **Sub-Mission on Seeds and Planting Material (SMSP):** SMSP is aimed at increasing the availability of quality seeds.
 - SMSP helps in increasing seed replacement rates to improve farm productivity.
- **Farmer Training:** Educating farmers on sustainable practices is essential for effective implementation.
 - Farmers need training on contract farming to avoid exploitation.
- **Government Initiatives:** Various government schemes promote sustainable agriculture practices and conservation of resources.
 - The government is implementing PM-PRANAM to promote balanced fertilizer use.

Strategies for Enhancing Dryland Agriculture: Soil Management Methods

- **Organic manure application** is essential for improving soil health and fertility in drylands.
 - Farmyard manure (FYM) is a readily available, traditional organic manure.
- **Biofertilizers** enhance nutrient availability and promote sustainable agriculture in dryland conditions.

- Biofertilizers can be used as an alternative to chemical fertilizers.
- **Soil testing** is crucial for understanding nutrient deficiencies and guiding fertilizer use in drylands.
 - Soil health cards provide farmers with data on soil parameters and fertilizer needs.

Specific Examples and Details

- **Use of Compost:** City compost is promoted to scale up production and consumption in agriculture.
 - The government provides Market Development Assistance for city compost.
- **Application of Vermicompost:** This improves soil organic matter and nutrient availability.
 - Earthworms are used in Zero Budget Natural Farming to increase soil organic matter.
- **Use of Sheep and Goat Droppings:** This practice provides essential nutrients for crops.
 - Penning is a common method of using sheep and goat droppings in the fields.
- **Green Manuring:** Crops like dhaincha and cowpea are used to enhance soil fertility in drylands.
 - Green manure crops are commonly used in rice and sugarcane fields.
- **Application of Tank Silt:** This practice improves soil structure and fertility by adding finer soil particles.
 - Tank silt is applied to upland soils to enhance soil fertility.

Additional Soil Management Strategies

- **Neem-coated urea** enhances nutrient use efficiency and reduces nitrogen loss.
 - All domestic urea producers are required to produce neem-coated urea.
- **Nutrient-based subsidy** was introduced to rationalize fertilizer use and subsidies.
 - This scheme was introduced to address the issue of overuse of urea.
- **Integrated Nutrient Management:** This approach combines organic and bio-fertilizers.
 - The government encourages supplementing chemical fertilizers with organic and bio-fertilizers.
- **PM-PRANAM Scheme:** This program promotes balanced use of chemical fertilizers and regenerative agriculture.
 - The scheme aims at creating awareness about regenerative agriculture.
- **Soil Health Card Scheme:** This provides farmers with soil analysis and recommendations for fertilizer use.
 - The soil health cards contain information on 12 soil parameters.
- **Liquid Nano Urea:** This is an alternative to granular urea, enhancing nutrient use efficiency.
 - Liquid Nano Urea is sprayed on leaves to improve nutrient uptake and reduce wastage.

Traditional Knowledge and Practices

- **Traditional Nutrient Management Practices:** These methods use local resources to improve soil health.
 - Farmers in Andhra Pradesh use various organic resources for manuring.
- **Use of Indigenous materials:** Traditional methods such as using oak leaves as manure in Kharif season.
 - In Arunachal Pradesh, sheep droppings and oak leaves serve as manure in the Kharif season.
- **Mixing of Clay in Sandy Soils:** This improves the physical condition and water retention of sandy soils.
 - Clay is mixed with sandy soils to restore soil fertility.
- **Use of Plant Residues:** Residues like groundnut hulls and tamarind fruit are used to improve soil structure.
 - Groundnut hulls are applied to paddy fields to improve soil structure.

Integration and Support

- **Sub-Mission on Agricultural Mechanization (SMAM):** This promotes custom hiring centers for farm machinery.
 - SMAM increases the reach of farm mechanization through custom hiring centers.
- **Sub-Mission on Plant Protection and Plant Quarantine:** This minimizes losses in crop yield and quality.
 - The sub-mission facilitates exports and promotes good agricultural practices.
- **Training Programs:** Educating farmers on soil management techniques is essential for effective implementation of best practices.
 - The ICAR is developing syllabi for natural farming for UG and PG level studies.
- **Government Initiatives:** Various government schemes encourage sustainable soil management practices.
 - The Green Credit scheme incentivizes farmers to adopt sustainable agriculture practices.

Strategies for Enhancing Dryland Agriculture: Technological Interventions

- **Drought-resistant seed varieties** are crucial for ensuring crop productivity in water-scarce drylands.
 - **32 varieties to combat abiotic stresses** like drought were released.
- **Precision agriculture** optimizes resource use, increasing efficiency and productivity in dryland farming.
 - Precision sowing and weeding tools are indispensable for sustainable intensification.

Specific Examples and Details

- **Improved varieties of millets** are vital for food security in dryland areas.
 - Several high-yielding millet varieties, including **pearl, finger, and foxtail millet**, have been released.
- **Use of soil moisture sensors** aids in precise irrigation management in dryland regions.
 - This helps conserve water and ensures crops receive adequate moisture.
- **Use of GPS-enabled tractors** enhances efficiency in planting and other field operations.
 - This leads to better resource utilization and improved productivity.
- **Happy Seeders** enable sowing where stubble is present, cutting stubble and sowing simultaneously.
 - Punjab provides a **50-80% subsidy** for this machine.

Additional Technological Strategies

- **GM crops** offer higher productivity and resistance to diseases in dryland areas.
 - **Bt cotton** is an example of a GM crop used in India.
- **Bio-fortification** infuses nutrients into grains, improving their nutritional value.
 - **PBWS1, a resistant starch wheat variety**, is developed by Punjab Agricultural University.
- **Maleic enzyme (ME)-transgenic lines** show enhanced photosynthesis under water deficit.
 - These lines have reduced leaf malate content and are effective in drylands.
- **Salt-tolerant Indian Mustard** variety CS 64 was released for salt-affected areas.
 - This variety is suitable for Haryana, Punjab, Rajasthan, and other regions.
- **Nano formulations** reduce the incidence of red rot, smut, and wilt in sugarcane.
 - These were found to significantly reduce disease incidence in field experiments.
- **“Onion Crop Advisor” mobile application** is a tool designed for crop management.
 - This provides valuable information to farmers.

Indigenous Technological Knowledge

- **Traditional water management** includes rainwater harvesting for crop use.
 - Rainwater management for teak, mango and neem in arid regions is practiced.

- **Natural farming methods** avoid the use of chemical inputs and maintain soil health.
 - The Buddhist Manpas of Arunachal Pradesh practice natural farming on hill slopes.
- **Indigenous soil testing methods** provide simple ways to assess soil fertility.
 - Farmers in Rajasthan and Arunachal Pradesh use indigenous soil testing methods.

Integration and Support

- **Sub-Mission on Seeds and Planting Material (SMSP)** aims to increase the production of certified seeds.
 - This increases seed replacement rate (SRR) and upgrades the quality of farm-saved seeds.
- **Farmer-led extension strategies** through Millet Farmer Facilitators enhance knowledge of millet farming.
 - This approach is used in hilly and tribal areas of Odisha and Tamil Nadu.
- **"Millet Market" android app** facilitates millet marketing and provides advisory on improved millets.
 - This helps farmers with the sale and management of their millet produce.
- **Training Programs:** Educating farmers on new technologies is essential for effective implementation.
 - The ICAR is actively involved in this area.
- **Government Initiatives:** Various government schemes encourage the adoption of modern technologies.
 - Government initiatives include subsidies for farm mechanization.

Importance of Dryland Farming: Contribution to Food Security, Livelihoods, and Rural Economy

- **Dryland farming** is vital for **food security**, especially with the rising population and climate change.
 - **GM crops** with high productivity can ensure food security by reducing import dependence.
- Dryland agriculture contributes significantly to **nutritional security**, addressing malnutrition through diverse crops.
 - **Pulses**, a category of superfoods, provide dual benefits of nutrition and sustainable production.
- Dryland farming is a key source of **livelihoods**, offering employment and income for rural communities.
 - **54%** of the workforce finds employment in agriculture.
- Dryland areas play a crucial role in the **rural economy** through agriculture and allied activities.
 - **Integrated farming systems** combine crops, livestock, and other activities to maximize income.

Specific Examples and Details

- **Millet**s are crucial for dryland regions, providing both food and nutritional value.
 - **Millet**s are economically viable and culturally acceptable for farmers in hilly and tribal areas.
- **Livestock rearing**, an integral part of dryland farming, supports rural economies.
 - **Buffalo meat** production is a major source of income and export for India.
- **Regenerative agriculture** improves soil health, enhancing the long-term productivity of drylands.
 - **Soil organic carbon** and soil organic matter are vital for plant growth.
- **The Public Distribution System (PDS)** ensures food access to needy sections of society at cheap prices.
 - Approximately **5.37 lakh fair price shops (FPSs)** distribute basic food and non-food items.

Additional Economic and Social Contributions

- **Food processing** increases the value of agricultural products, creating more income.
 - **Value addition** in the TOP (Tomato, Onion, Potato) value chain creates linkages with production clusters.
- **Contract farming** can provide farmers with better prices and access to goods and services.
 - Farmers are **protected** from price fluctuations in the APMC market through contract farming.
- **Sub-Mission on Agriculture Extension (SMAE)** empowers farmers to strengthen their livelihood and food security.
 - The SMAE supports local bodies to achieve food security and empower farmers.

Challenges and Strategies

- **Climate change** is a major challenge, causing issues like heatwaves, untimely rainfall, and crop damage.
 - **Climate-smart agriculture** practices promote sustainable and climate-resilient farming.
- **Malnutrition** remains a concern despite increased production and availability of food.
 - **The Integrated Child Development Services (ICDS)** program suffers from misuse and has limited impact.
- **Market access** is crucial, as many farmers face exploitation through intermediaries.
 - **e-National Agriculture Market (e-NAM)** aims to create a unified national market for farm produce.
- **Minimum Support Price (MSP)** is designed to protect farmers from market risks.
 - MSP is calculated by the **Commission for Agricultural Costs and Prices (CACP)**.
- **Lack of awareness and access** to new technologies is another impediment for farmers.
 - **Training Programs** are essential to educate farmers on new technologies, as demonstrated by ICAR.

Government Schemes & Policies for Dryland Agriculture

- **National Mission for Sustainable Agriculture (NMSA)** aims to promote sustainable agricultural practices for food security.
 - The NMSA focuses on **climate-smart agriculture** that enhances resource-use efficiency and climate resilience.
- **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)** focuses on improving irrigation efficiency and water management.
 - This scheme is important for **dryland regions** where water scarcity is a major challenge.
- **National Food Security Mission (NFSM)** seeks to increase the production of food crops, including oilseeds.
 - The **NFSM-Oilseeds** sub-mission promotes oilseed cultivation to make India self-reliant in edible oils.
- **Watershed Development Programs** aim to conserve soil and water resources in rain-fed areas.
 - These programs are crucial for improving the **long-term productivity** of drylands.

Specific Objectives and Relevance to Dryland Farming

- **NMSA promotes integrated farming systems**, combining crops, livestock, and other activities.
 - This is particularly relevant in drylands where diversified income sources are needed.
- **PMKSY** helps in efficient water use, crucial for **dryland crops** that rely heavily on rainfall.
 - The scheme supports **precision irrigation methods** to ensure crops receive adequate moisture.
- **NFSM-Oilseeds** includes special programs for **rapeseed, mustard, and sunflower**, suitable for drylands.

- It aims to increase the availability of **high-yielding varieties** and production technologies.
- **Watershed development** increases water availability and improves soil fertility in dryland areas.
 - It focuses on **soil and water conservation** to improve crop yields.

Integration and Support

- **Out-scaling of Natural Farming** through Krishi Vigyan Kendras (KVKs) aims to promote natural farming methods.
 - The KVKs conduct awareness, training, and demonstrations on natural farming for farmers.

Dryland Farming: Sustainability and Climate Change

- **Climate change** significantly impacts agriculture through altered temperature and precipitation patterns.
 - **Heat waves**, untimely rainfall, and hailstones can cause severe crop losses and reduce yields.
- **Dryland farming** is highly vulnerable to these changes, requiring adaptive strategies for sustainability.
 - The majority of cultivated areas in India are **rain-fed**, making them particularly sensitive to climate shifts.
- **Greenhouse gas emissions** from agricultural practices contribute to global warming and climate change.
 - Paddy cultivation, livestock rearing, and stubble burning release significant amounts of methane.

Climate Change Mitigation Strategies

- **Climate-smart agriculture (CSA)** practices are crucial for reducing emissions and building resilience.
 - **Conservation agriculture**, such as minimum tillage and crop diversification, enhances climate resilience.
- **Integrated weed management** that combines manual, mechanical, and chemical methods can facilitate crop intensification.
 - **Crop rotation** is an effective practice for managing weeds and enhancing soil health.
- **Zero Budget Natural Farming (ZBNF)** promotes farming without chemical inputs, enhancing sustainability.
 - ZBNF focuses on replenishing water bodies and using local earthworms to improve soil health.
- **Reducing fertilizer use** and promoting organic and bio-fertilizers can minimize emissions.
 - **Neem-coated urea** improves nutrient use efficiency, reducing the need for excessive fertilizer.
- **Liquid Nano Urea**, developed by IFFCO, can reduce dependence on imports and improve nitrogen use efficiency.
 - This alternative fertilizer is cheaper and can be sprayed on leaves, reducing wastage.
- **Diversified cropping systems** can improve overall productivity and soil health.
 - Incorporating **mungbean** into rice-wheat and maize-wheat systems significantly improves productivity.

Role of Dryland Farming in Adapting to Climate Change

- **Drought-tolerant crops** like millets are suitable for dryland regions, providing food security in harsh conditions.
 - Millets are economically viable and culturally acceptable for farmers in hilly and tribal areas.

- **Water conservation techniques** are crucial for adapting to water scarcity in drylands.
 - **Farm ponds** and other water-harvesting methods ensure water availability during dry spells.
- **Traditional knowledge** and indigenous practices offer valuable solutions for climate resilience.
 - The **Buddhist Manpas** in Arunachal Pradesh use natural slopes for farming with minimum tillage and organic inputs.
- **Integrated farming systems** combining crops and livestock are key for diversified income and resilience.
 - **Mixed farming**, as adopted by a farmer in the Andaman and Nicobar Islands, enhances resource use and productivity.
- **Regenerative agriculture** practices improve soil health, increasing carbon sequestration and water retention.
 - Enhancing **soil organic matter** and biodiversity are crucial for plant growth and carbon storage.
- **Crop diversification** and crop rotation help stabilize yields and minimize risk.
 - In a trial in the Indo-Gangetic Plain, **mungbean** was incorporated into the rice-wheat cropping system.

Additional Strategies

- **Developing drought-tolerant varieties** through precision breeding is essential for dryland farming.
 - ICAR has released 32 varieties that combat abiotic stresses like drought, water scarcity and salinity.
- **Promoting farmer awareness** and access to information on climate-resilient practices is necessary.
 - **Farmer-led extension** programs and the use of apps can enhance technology adoption.
- **Government initiatives** like NMSA and NICRA support sustainable and climate-resilient agriculture.
 - The **National Innovations in Climate Resilient Agriculture (NICRA)** is an example of government initiatives.
- **Strengthening market access** and value addition for dryland crops is crucial for economic stability.
 - **Food processing capacities** and linkages with production clusters will increase farmer income.

Dryland Farming: Essential Data Points

- **Rain-fed areas** constitute a significant portion of India's cultivated land, making dryland farming crucial [previous conversation].
 - The majority of cultivated land in India is **rain-fed**, highlighting its importance [previous conversation].
- **Dryland agriculture** contributes substantially to India's overall food production [previous conversation].
 - Dryland areas are vital for crops like **millets** which are important for food security.
- A large percentage of India's population depends on dryland farming for their livelihoods.
 - **58% of India's population** relies on agriculture as the primary source of income.
- There are significant **yield gaps** in dryland regions compared to irrigated areas [previous conversation].
 - **Crop diversification** and improved technologies are essential to address the gap.
- **54% of the workforce** finds employment in agriculture, indicating dependency on dryland systems.
 - Most of the agricultural workforce is **female**.

- 2021-22 Annual Periodic Labour Force Survey (PLFS) Report, 62.9% of workers in the agriculture sector are female. This is the highest percentage of female workers in any industry.
- **Marginal and small farmers** with less than 2 hectares of land dominate Indian agriculture.
 - **56.2% of farmers** are marginal or small.
- The **average size of farm** in India is very small compared to the USA and Canada.
 - In India, the average farm size is **0.92 ha**, while it is **150 ha** in the USA.
- **Rice and wheat** are the most commonly procured crops but are water intensive.
 - 60% of wheat and 30% of rice under PDS is procured from **Punjab and Haryana**.
- **Pulses** provide nutritional security, yet India is not self-sufficient in their production.
 - India is the **largest producer (25%), consumer (27%), and importer (14%)** of pulses globally.
- **Edible oil** is the most important imported good.
 - The **National Mission on Edible Oil-Oil Palm (NMEO-OP)** aims to promote oil palm cultivation.

Dryland Farming: Case Studies

- **Watershed development projects** have shown success in improving water availability in dryland regions.
 - **Diggi** and **khati** structures in Himachal Pradesh collect roof and surface water, aiding water management.
- **Self-Help Groups (SHGs)** can play a role in providing credit and supporting collective farming practices.
 - SHGs of **4-5 farmers** can apply for loans, fostering collective farming and economic empowerment.
- **Farmer Producer Organizations (FPOs)** also foster collective farming and improve market linkages.
 - FPOs allow farmers to collectively manage production, processing, and marketing.
- **Government schemes** like the Sub-Mission on Agriculture Extension (SMAE) empower farmers and strengthen planning.
 - SMAE aims to achieve **food security** through extension programs.
- The **National Food Security Mission- Oilseeds (NFSM-OS)** promotes oilseed production through special programs.
 - It includes initiatives for rapeseed, mustard, soybean, and sunflower cultivation.
- Government initiatives promote **custom hiring centers** to offset the adverse effect of small landholdings.
 - The government provides subsidies to establish these centers for farm mechanization.
- **Farmer-led extension strategies** enhance farmer income through millets-based farming systems.
 - **Millet Farmer Facilitators (MFFs)** in Odisha and Tamil Nadu promote millets and form producer groups.
- **Integrated farming systems** with crops, livestock, and other activities increase farmers' income and resilience.
 - **Coconut with pasture and fodder trees**, along with goat rearing, showed higher net income.
- **Traditional practices** like using sheep droppings and oak leaves as manure enhance sustainability.
 - The **Buddhist Manpas** in Arunachal Pradesh use such practices in their farming.
- **Organic farming** is being promoted through government schemes such as PM-PRANAM.
 - This program aims at promoting balanced use of fertilizers and regenerative agriculture.
- **Soil Health Cards** help farmers optimize fertilizer use and improve soil health and sustainability.
 - The cards provide results after testing soil samples for 12 parameters.

- **Integrated nutrient management** encourages the use of organic and bio-fertilizers.
 - The PM-PRANAM scheme promotes organic and bio-fertilizers, but there is no separate budget allocated.
- **Liquid Nano Urea** is a technology that reduces the dependence on imports and increases Nitrogen use efficiency.
 - It can replace granular urea and can be sprayed on leaves reducing wastage.
- **Precision breeding tools** aid in developing stress-tolerant crop varieties for dryland areas.
 - ICAR has released 32 crop varieties to combat drought, water scarcity, and salinity.
- **Mobile applications**, such as the “Onion Crop Advisor”, disseminate information to farmers.
 - These apps provide farmers with a comprehensive tool to enhance their productivity and knowledge.
- **Pheromone traps** and biological methods are being used for pest control.
 - **Pheromone traps** use the smell of female pests to trap male pests.

Shifting / Jhum Agriculture Question

- ☐ What is shifting cultivation? Where in India has this been resorted to? Consider its consequences and examine the steps taken by Government to prevent this practice. (81/20)
- ☐ What is shifting cultivation, and where is it carried? (88/3)
- ☐ Mention the states where shifting cultivation is still practiced in India. (90/3)
- ☐ What is shifting cultivation? Describe its salient characteristics with reference to India? (96/15)
- ☐ Write short notes on Jhum cultivation - process and consequences. (02/2)
- ☐ Write note on Negative impacts of shifting cultivation. (05/2)

Shifting / Jhum Agriculture

Shifting and Jhum Cultivation

I. Introduction:

- **Definition:** Shifting cultivation, also known as Jhum cultivation or swidden agriculture, is a farming method involving land clearing for temporary cultivation. It's characterized by cyclical land use: clearing, farming, and fallow periods.

II. Main Points:

- **Environmental Impact:** Jhum cultivation, while traditionally sustainable with long fallow periods, causes deforestation and soil erosion when practiced intensively or with short fallow cycles. Soil nutrient depletion is another significant concern.
 - Example: Unsustainable Jhum in Northeast India leads to land degradation and biodiversity loss. Government initiatives promote alternative farming practices.
- **Socio-economic Aspects:** Jhum cultivation supports communities in resource-scarce regions, offering subsistence livelihoods. However, its low productivity and dependence on natural resources limit economic development.
 - Example: Buddhist Manpas of Arunachal Pradesh utilize natural slopes for Jhum, relying on organic matter and minimal tillage.
- **Government Initiatives:** India implements various schemes to promote sustainable agriculture and reduce reliance on Jhum cultivation. This includes promoting alternative farming systems like conservation agriculture, and the PM-PRANAM scheme for balanced fertilizer use.
 - Example: The National Mission on Edible Oil-Oil Palm (NMEO-OP) aims to increase oil palm cultivation.
- **Indigenous Knowledge:** Traditional techniques and practices embedded in Jhum cultivation showcase local communities' understanding of their environment. This knowledge, when integrated with modern techniques, can support sustainable practices.

- Example: Indigenous soil testing methods are part of the traditional Jhum farming knowledge. ICAR has collected and documented such practices.
- **Modernization and Alternatives:** Several sustainable alternatives exist, including conservation agriculture that prevents arable land loss and regenerates degraded areas. Regenerative agriculture improves soil health and biodiversity.
 - Example: ICAR developed diversified pulse-inclusive conservation agriculture modules for northern Indo-Gangetic Plains, showing higher yields.

I. Process of Shifting Cultivation:

- **Land Clearing:** Jhum cultivation begins with clearing land, typically involving felling trees and removing vegetation. This prepares the land for farming.
 - Example: Buddhist Manpas in Arunachal Pradesh use the entire natural hillslope for both Kharif and Rabi crops without terracing.
- **Burning Vegetation:** Cleared vegetation is often burned to clear the land and add nutrients to the soil through ash. This is a characteristic feature of "slash-and-burn" agriculture.
 - Example: Stubble burning in Punjab, Haryana, and Western UP is a common practice, though it contributes to air pollution.
- **Cultivation:** The cleared and burned land is cultivated for a few years. Crops are grown until soil fertility declines.
 - Example: Maize and finger millet are commonly grown in Arunachal Pradesh's Jhum system.
- **Land Abandonment:** After several years, the land is abandoned and allowed to lie fallow for a significant period to recover its fertility. The cycle then repeats.
 - Example: The length of fallow period significantly impacts the sustainability of Jhum cultivation. Shorter cycles lead to land degradation.

II. Methods Used:

- **Traditional Tools:** Traditional tools and methods are often used in Jhum cultivation, which are labor-intensive. This includes manual clearing, burning, and minimal tillage.
 - Example: The Buddhist Manpas of Arunachal Pradesh use only hoes for minimal tillage.
- **Crop Selection:** Crop selection is often guided by traditional knowledge and local conditions. Farmers choose crops suitable to the environment and soil fertility.
 - Example: Diversified cropping systems including pulses are used in some Jhum farming, such as in the Indo-Gangetic Plains.
- **Integration with Other Practices:** Jhum farming may be integrated with livestock raising, where livestock provide manure and other benefits.
 - Example: Sheep droppings and oak leaves serve as manure in Arunachal Pradesh's Jhum system.
- **Sustainable Practices:** Some communities use sustainable practices to minimize environmental impact. Long fallow periods and careful resource management are key.
 - Example: Conservation agriculture is one such sustainable method to prevent loss of arable land.
- **Government Interventions:** Government initiatives aim to promote sustainable alternatives to Jhum farming, such as conservation agriculture.
 - Example: Sub-Mission on Agriculture Extension (SMAE) aims to achieve food security and empower farmers.

III. Cycle of the Process:

The cycle of Jhum cultivation involves a repeated sequence of clearing, burning, cultivation, and fallow. The length of the fallow period is critical for soil recovery. The frequency of cycles is a major factor influencing sustainability. Intensive Jhum leads to environmental degradation.

Geographical Distribution and Major States

- **Geographical Distribution:** Predominantly in Northeast India, with some presence in Odisha, parts of Andhra Pradesh, and Jharkhand.
- **Northeast India: Major states** include Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura.
 - **Arunachal Pradesh:** Buddhist Manpas practice settled subsistence hoe farming on natural slopes, without terracing. They use sheep droppings and oak leaves as manure (*kharif*), and human waste and litter (*rabi*). Maize and finger millet are grown for soil health. Mixed cropping systems are also used, adapting to diverse soil types and slopes.
 - **Nagaland:** The Zabo system uses irrigation water passing through animal yards for field fertilization. Farmers add tree branches and leaves for soil enrichment. Alder (*Alnus nepalensis*) land use systems are also practiced.
- **Other States (Limited Information):** Indigenous knowledge and practices exists.

Salient Characteristics

- **Simple Tools and Techniques:** Shifting cultivation relies heavily on simple tools and manual labor.
 - In Arunachal Pradesh, Buddhist Manpas utilize hoes for minimal tillage.
 - The Zabo system in Nagaland involves simple irrigation methods and the addition of organic matter.
 - Describes the use of a spade (*fawda*) for furrow preparation in sugarcane cultivation, avoiding plowing.
- **Monsoon Dependence:** Rainfall patterns significantly influence crop yields and the timing of cultivation.
 - Highlight the importance of monsoon rains for successful harvests in various regions.
 - Farmers adapt planting schedules and crop selection to suit the monsoon season and its variability.
- **Low Yield and Short Fallow Periods:** The practice typically results in relatively low yields, and fallow periods are often short.
 - Short fallow periods, often dictated by land availability and population pressure, contribute to soil nutrient depletion.
- **Field Rotation and Multi-cropping:** Farmers rotate fields and practice intercropping or mixed cropping systems.
 - In Arunachal Pradesh, *kharif* and *rabi* crops are grown on the same slopes in a sequence.
 - The example of intercropping maize with oilseeds and pulses in Himachal Pradesh to mitigate weather risks.
 - Relay cropping of groundnut and sesame is mentioned as another example.
- **Environmental Impact:** The practice can have environmental consequences, such as deforestation and soil erosion.
 - Potential for soil nutrient depletion and the need for sustainable practices.
 - The use of techniques like minimum tillage aims at mitigating environmental impacts.

Consequences (Negative Impacts)

- **Deforestation and Environmental Implications:** Shifting cultivation, involving clearing forests for temporary cultivation, leads to deforestation. This impacts biodiversity and ecosystem services, affecting local communities dependent on forest resources.
 - Loss of forest cover increases soil erosion and reduces water retention, impacting local water resources and potentially leading to desertification.
 - The practice can disrupt watersheds, affecting the hydrological balance and potentially causing downstream flooding or water scarcity.

- **Soil Erosion and Fertility Loss:** The clearing of land and lack of sustainable practices can lead to substantial soil erosion and depletion of soil fertility.
 - Short fallow periods do not allow sufficient time for soil regeneration, resulting in nutrient depletion over time.
 - This reduces crop yields and forces farmers to clear new areas of forest, perpetuating a cycle of deforestation.
- **Loss of Biodiversity:** Deforestation and habitat destruction associated with shifting cultivation lead to a loss of biodiversity in affected ecosystems.
 - This reduction in biodiversity can have cascading effects on ecosystem health and resilience.
 - The loss affects both plant and animal species, impacting the ecosystem's ability to provide essential services.
- **Greenhouse Gas Emissions:** Land clearing for agriculture releases significant greenhouse gases, contributing to climate change.
 - Burning of vegetation during land clearing releases carbon dioxide and other pollutants into the atmosphere.
 - The decomposition of organic matter in flooded rice paddies can lead to substantial methane emissions.
- **Socioeconomic Impacts:** The practice of shifting cultivation can negatively affect the socioeconomic well-being of local communities.
 - Reduced yields due to soil degradation and land scarcity can lead to poverty and food insecurity.
 - The unsustainable nature of the practice can lead to conflicts over land and resources, negatively affecting community relations.
- **Other Negative Impacts:** There can be additional negative impacts of shifting cultivation, including:
 - Increased vulnerability to pests and diseases due to monoculture and reduced biodiversity.
 - Potential for soil degradation and reduced water infiltration.
 - Impacts on the quality and sustainability of agricultural production.

Government Measures to Control/Prevent Shifting Cultivation

- Reforestation programs and afforestation projects implemented.
 - National Afforestation Programme (NAP) funds afforestation.
 - CAMPA funds utilized for compensatory afforestation.
- Alternative livelihoods promoted via schemes; reduce jhum.
 - National Horticulture Mission (NHM) supports fruit/veg.
 - Integrated Dairy Development Programme (IDDP) aids animal husbandry.
 - Mudra scheme helps small business including beekeeping.
 - TRIFED schemes promotes tribal crafts and products.
- Land reforms and initiatives secure land rights for tribals.
 - Forest Rights Act (FRA) 2006 grants land titles; reduces shifting.
 - Land Record Modernization Programme enhances land admin.
- Joint Forest Management (JFM) increases community involvement.
 - Approx. 8.49 million ha of forests under JFM.
 - Local Van Panchayats protect forests in some regions.
- Awareness campaigns educate on sustainable agriculture benefits.
 - Krishi Vigyan Kendras (KVKs) promote farming practices.
 - Soil Health Card scheme enhances soil fertility awareness.
- Promote organic farming, crop rotation for sustainable practices.
 - Paramparagat Krishi Vikas Yojana (PKVY) aids organic farming.
 - National Mission on Sustainable Agriculture (NMSA) promotes practices.
 - North-East Region: Jhum has led to about 17% of forest cover loss.

Alternative Livelihood Options

- **Horticulture:** Promoting fruit and vegetable cultivation offers a viable alternative to shifting cultivation.
 - **Example:** Arunachal Pradesh's Aadi tribes successfully integrated horticulture (pineapple, litchi, plum, etc.) with silviculture in a horti-silvicultural system. This system helps conserve resources and provides diverse income streams.
- **Animal Husbandry:** Raising livestock provides a sustainable alternative to slash-and-burn agriculture.
 - **Example:** Integrating coconut cultivation with pasture crops, fodder trees, and goat rearing in a multi-cropping system shows higher economic efficiency.
- **Agroforestry:** Combining trees and crops increases land productivity and provides diverse income sources.
 - The horti-silvicultural system in Arunachal Pradesh exemplifies the successful integration of timber trees and fruit trees with crops and other plants.
- **Fisheries:** In coastal areas or near water bodies, fisheries can provide sustainable livelihoods.
 - **Example:** ICAR-CMFRI identified potential sites for seaweed farming in various coastal states and Union Territories, promoting sustainable farming practices.
- **Ecotourism:** Developing eco-tourism in areas with unique biodiversity can create income opportunities while protecting the environment.

Sustainability and Community-based Solutions

- **Traditional Knowledge and Indigenous Practices:** Many indigenous communities have practiced sustainable variations of shifting cultivation for generations.
 - **Example:** In Arunachal Pradesh, the Buddhist Manpas practice settled subsistence hoe farming on natural hillslopes, utilizing sheep droppings and oak leaves as manure. They use intercropping and minimum tillage to maintain soil health.
 - **Debate:** Balancing the preservation of indigenous knowledge and practices with the need for environmental sustainability is crucial.
- **Community-Based Natural Resource Management:** Involving local communities in managing natural resources is key to sustainability.
 - **Example:** Joint Forest Management (JFM) programs a general approach to sustainable forest management.
 - **Success depends on factors:** Effective community participation requires securing land rights, providing alternative livelihoods, and fostering community consensus.
- **Sustainable Agricultural Practices:** Adopting sustainable practices on existing farmland reduces the need for new land clearing.
 - **Methods:** This includes techniques like integrated nutrient management (INM), conservation agriculture (CA), and zero-budget natural farming (ZBNF). These improve soil health, water retention, and biodiversity.
 - **Government support:** Some government schemes aim to promote these sustainable practices, for instance, the PM-PRANAM scheme promotes balanced fertilizer use and regenerative agriculture.
- **Improved Agricultural Technology:** Technological advancements can enhance productivity on existing land.
 - **Example:** The use of improved seeds and appropriate agricultural technologies are highlighted as ways to increase yields and promote sustainability.
 - **Access:** Ensuring access to appropriate technology and inputs for farmers (especially marginal and small farmers) is important for widespread adoption.
- **Economic Incentives and Support Systems:** Providing economic incentives and support systems can encourage sustainable land use practices.
 - **Example:** The importance of alternative livelihood options such as animal husbandry, horticulture, and agroforestry, along with government-backed initiatives such as MSP (Minimum Support Price) schemes.

- **Limitations:** Highlight challenges such as uneven distribution of benefits from support programs and market risks that can undermine the viability of sustainable farming.

Debates on Shifting Cultivation

Argument: Shifting cultivation is environmentally harmful.

- **Evidence:** Mention the environmental damage caused by shifting cultivation. Jhuming, a type of shifting cultivation, leads to deforestation, soil erosion, and ecological imbalance. Burning forest shrubs and organic residues to induce germination is another harmful practice.

Counter-argument: Traditional practice integral to tribal livelihoods and culture.

- **Evidence:** Acknowledge that shifting cultivation is a traditional practice deeply ingrained in the culture and livelihoods of many tribal communities. For example, the traditional cultivation of red sorghum in Jhadol, Rajasthan, is described as a practice passed down from forefathers. Indigenous knowledge systems, such as those documented by ICAR, have long incorporated sustainable aspects within this practice. There is an implicit acknowledgment that these practices have been sustainable for centuries in certain contexts.

Argument: Government should enforce laws to stop it.

- **Evidence:** The significant environmental damage caused by shifting cultivation justifies government intervention. Strict enforcement of laws against deforestation and land encroachment would be one approach.

Counter-argument: Need for alternatives & community-based approaches are important.

- **Evidence:** **Simply banning shifting cultivation without providing viable alternatives is likely to be ineffective and socially unjust.** Promoting alternative livelihood options (horticulture, animal husbandry, agroforestry, fisheries, ecotourism), along with community-based natural resource management, is a better approach. **Joint Forest Management (JFM)** is mentioned as a strategy promoting sustainable practices but details of implementation within the context of shifting cultivation are missing. ICAR has been working on documenting and validating Indigenous Technical Knowledge (ITK) to help support a more sustainable approach. The integration of ITK with modern sustainable agricultural practices may offer an effective solution. The need for economic incentives and support systems is also stressed.

Case Studies and International Examples

Case Studies:

- **Watershed Management:** Examples such as Dhara Vikas (Sikkim), Hiware Bazar (Maharashtra), and artificial glaciers in Ladakh demonstrate successful water conservation efforts, indirectly contributing to land restoration. These initiatives improve water security and may indirectly support reforestation efforts.
- **Andaman and Nicobar Cooperative Supply and Marketing Federation (ANKOFED):** This cooperative helped resettle villages and replant coconut trees post-tsunami, illustrating successful community-based restoration. This is a localized example of reforestation, following a natural disaster.
- **Tribal Communities Adopting Alternative Livelihoods:**
 - **Himachal Pradesh:** A case study highlights a farmer, Shri Lal Singh, who transitioned from low-yield traditional farming to diversified high-value exotic vegetable cultivation, integrating dairy, fodder crops, vermicomposting, and trout fish farming, boosting productivity and income. This demonstrates the feasibility and potential success of alternative livelihoods.
 - **Arunachal Pradesh:** The Aadi tribe's horti-silvicultural system successfully integrates horticulture (pineapple, litchi, etc.) with silviculture, proving a sustainable alternative. This shows a diversified approach to sustainable farming.
 - **Tamil Nadu:** Thirumalapadi village successfully avoided sugarcane stubble burning, increasing productivity by 15.5% and improving soil health. While not a full shift

away from traditional cropping, this demonstrates an effective alternative practice within the existing system.

Shifting cultivation affects substantial forest cover; need mitigation.

1. Approx. 3-5% of total forest cover lost annually (estimated).

Significant population depends on shifting cultivation; need support.

1. ~ 1 million families rely on jhum cultivation (estimated).

Deforestation/soil erosion cause significant economic loss/degradation.

1. Deforestation costs India ~2.5% of GDP (World Bank est).
2. Soil erosion reduces crop yields by ~ 10-15%.

International Examples:

- **Brazil (Cerrado region):** A crop rotation system (soybeans, maize, cotton, and pasture) helps reduce soil erosion, increase soil organic matter, and reduce fertilizer/pesticide use while maintaining high yields. This illustrates successful sustainable farming practices in another country but does not directly address shifting cultivation.

Sustainable Agriculture Questions:

- ☐ "Some of the modern agricultural practices being used at present in India are leading to undesirable consequences." Do you agree with this view? (87/15)
- ☐ Write about Organic Farming in 20 words. (08/2)
- ☐ Sikkim is the first 'Organic State' in India. What are the ecological and economical benefits of Organic State? (18/10)
- ☐ How far is Integrated Farming System (IFS) helpful in sustaining agricultural production. (19/10)
- ☐ What is Integrated Farming System? How is it helpful to small and marginal farmers in India? (22/15)

Sustainable Agriculture

Modern Agriculture & Sustainable Practices

- **Modern Agriculture:** Increased productivity; high yields; chemical inputs.
 - High-yielding varieties; GM crops.
 - Intensive technology; mechanization.
 - Chemical fertilizers; pesticides.
- **Sustainable Agriculture:** Environmentally sound; resource-conserving; socially supportive.
 - Soil & water conservation; integrated nutrient management.
 - Crop rotation; efficient irrigation.
 - Integrated pest management (IPM).
 - **Zero Budget Natural Farming (ZBNF):** Chemical-free; no credit inputs.
 - Water conservation; soil improvement.
 - **Organic farming:** No chemicals; natural processes.
 - Regenerative agriculture; soil health.
 - Climate-smart agriculture.
 - Conservation agriculture.
 - Maintains soil cover; minimizes soil disturbance.
 - Government schemes: SMART-PDS; PM-PRANAM.
 - Technology; balanced fertilizer use.

Consequences of Modern Agricultural Practices

- **Soil Degradation:** Intensive farming depletes soil nutrients.
 - Overuse of chemical fertilizers reduces soil organic matter.
 - Unsustainable practices lead to erosion and degradation.
 - **Conservation agriculture** methods aim to mitigate these issues by maintaining soil cover and minimizing disturbance.
- **Water Depletion:** Modern agriculture is highly water-intensive.
 - Irrigation practices, especially for water-intensive crops like rice, can deplete groundwater resources.
 - Climate change exacerbates water scarcity, impacting cropping patterns.
 - Waterlogging due to rice cultivation also poses an issue.
- **Chemical Pollution:** Excessive use of pesticides and fertilizers contaminates soil and water.
 - Pesticide residues pose health risks to humans and the environment.
 - Fertilizer runoff pollutes water bodies, impacting aquatic ecosystems.
 - **Integrated Nutrient Management (INM)** and **Zero Budget Natural Farming (ZBNF)** are sustainable alternatives.
- **Biodiversity Loss:** Monoculture reduces biodiversity, making crops vulnerable to pests and diseases.
 - GM crops can lead to the extinction of indigenous varieties through cross-pollination.
 - High pesticide use can harm beneficial insects and other organisms.
 - **Diversified cropping systems** promote biodiversity.
- **Health Hazards:** Chemical pesticides and fertilizers pose significant health risks.
 - Pesticide residues in food can cause various health issues.
 - The long-term effects of GM crops on human health are still being studied.
- **Social Inequalities:** Modern agricultural practices often exacerbate social inequalities.
 - Small and marginal farmers are disproportionately affected by economic hardship.
 - Access to technology, credit, and markets are unequal.
 - **Government schemes**, such as **SMART-PDS**, aim to address this.

Organic Farming

Definition and Principles: Organic farming produces healthy, nutritious, and environmentally sustainable food, minimizing ecosystem impact and promoting long-term soil fertility and biodiversity. It excludes synthetic pesticides, fertilizers, and genetically modified organisms (GMOs). Practices include crop rotation, cover cropping, composting, and integrated pest management.

- **Ecological Benefits:**
 - **Soil Health:** Improves soil organic matter, biota, and biodiversity. Enhances water-holding capacity and carbon sequestration.
 - **Biodiversity:** Supports biodiversity, a key driver of soil carbon sequestration and ecosystem benefits.
 - **Water Conservation:** Conserves water through practices like replenishing water bodies (farm ponds).
 - **Reduced Pollution:** Minimizes pollution from chemical inputs (pesticides, fertilizers).
- **Economic Benefits:**
 - **Premium Pricing:** Organic produce often commands premium prices in the market.
 - **Eco-tourism:** Organic farms can attract eco-tourism, generating additional income.
 - **Lower Input Costs:** ZBNF, a type of organic farming, reduces input costs by eliminating purchased inputs.
- **Scope and Challenges in India:**
 - **Government Initiatives:** MOVCD-NER (Northeast organic production) and PKVY (cluster adoption, PGS certification) promote organic farming. PM-PRANAM promotes organic farming and balanced fertilizer use.

- **Challenges:** Limited awareness among farmers, lack of infrastructure and market access, and certification costs are key challenges in India. The transition to organic farming can also initially reduce yields.
- **Regional Variation:** Organic farming may be better suited for some agro-ecological regions than others. The Northeast region is a focus for organic development.

Integrated Farming System (IFS)

Definition and Principles: IFS is a farming approach that integrates various agricultural components (crops, livestock, aquaculture, forestry) on a single farm to optimize resource use and improve overall productivity and sustainability. It aims for synergistic interactions among components, minimizing external inputs and environmental impact.

- **Components of IFS:**
 - Crop cultivation (diverse cropping patterns).
 - Livestock rearing (dairy, poultry, goat).
 - Aquaculture (fish farming).
 - Agroforestry (integrating trees with crops).
 - Utilizing by-products (e.g., using animal manure as fertilizer, crop residues as animal feed).
- **Benefits of IFS:**
 - Improved soil health (enhanced organic matter, nutrient cycling).
 - Reduced input costs (reduced dependence on external inputs like fertilizers and pesticides).
 - Better water and waste management (recycling of water and organic wastes).
 - Enhanced climate change resilience (increased diversity and resource efficiency).
 - Increased income and profitability.
 - Improved nutritional security (diversified food production).
- **Relevance to Small and Marginal Farmers:**
 - **Income generation:** IFS provides multiple income streams, reducing reliance on single crops and enhancing income stability.
 - **Employment and risk diversification:** Provides multiple income-generating activities, increasing employment opportunities and reducing risks associated with crop failures.
 - **Nutritional security:** Improved access to a diversity of nutritious foods.
 - **Resource efficiency:** Optimized use of limited resources like land, water, and labor.
 - **Waste reduction:** Reduced waste generation through improved resource utilization.
 - **Improved sustainability:** Promotes sustainable and environmentally friendly farming practices. One example is the use of Mahua oil cake to clean a pond in an integrated farming system.

Green Revolution

1. History: Setting the Stage

The Green Revolution was not a singular event but a period of transformative agricultural development spanning roughly from the 1940s to the late 1970s. It was largely a response to the widespread food shortages and famines that plagued many developing nations in the mid-20th century.

- **Pre-Revolution Context:** Traditional farming practices were often inefficient, leading to low yields. Population growth was rapidly outpacing food production, creating a dire need for agricultural innovation.
- **Key Drivers:**
 - **Post-World War II:** Increased availability of scientific research and technologies.
 - **Cold War Politics:** Western nations saw agricultural development as a way to counter communist influence in developing countries.
 - **Philanthropic Efforts:** Organizations like the Rockefeller and Ford Foundations played a crucial role in funding agricultural research.
- **Early Pioneers:**

- **Norman Borlaug:** Often called the "Father of the Green Revolution," Borlaug's work on developing high-yielding, disease-resistant wheat varieties was instrumental in transforming agriculture, particularly in Mexico and India.
- **M.S. Swaminathan:** Known as the "Father of the Green Revolution in India," he played a pivotal role in adapting Borlaug's wheat varieties to Indian conditions.

2. First Green Revolution: Key Features

The initial phase of the Green Revolution focused on increasing agricultural output through a combination of technological and management practices:

- **High-Yielding Varieties (HYVs):** The cornerstone of the revolution was the introduction of genetically modified or crossbred crop varieties (wheat, rice, and maize primarily) capable of producing significantly higher yields compared to traditional varieties.
- **Fertilizers:** Increased use of chemical fertilizers, particularly nitrogen, phosphorus, and potassium, was crucial in supporting the growth of HYVs.
- **Pesticides and Herbicides:** Chemical pesticides and herbicides were adopted to control pests and weeds, protecting crops and reducing crop losses.
- **Irrigation:** Expansion of irrigation systems to ensure that HYVs received the necessary water supply for optimal growth, especially in arid and semi-arid regions.
- **Mechanization:** Increased use of farm machinery (tractors, harvesters, etc.) to improve the efficiency of planting, harvesting, and other farming operations.
- **Modern Agricultural Management Techniques:** Adoption of modern techniques such as proper spacing, time management, and cultivation methods.
- **Institutional Support:** Governments invested in agricultural research, extension services, and credit facilities to support farmers in adopting these new technologies.

3. Impact of the Green Revolution

The Green Revolution had profound and multifaceted impacts on global food systems, economies, and societies.

- **Positives:**
 - **Increased Food Production:** The most significant positive impact was a dramatic increase in food production, particularly in wheat and rice. This helped avert widespread famines and improved food security in many countries, most notably in India and Southeast Asia.
 - **Reduced Food Prices:** Increased supply led to a reduction in food prices, making it more affordable for consumers.
 - **Economic Growth:** The agricultural sector saw substantial growth, creating employment opportunities in farming and related industries. It also stimulated economic growth by generating surplus for trade.
 - **Poverty Reduction:** Higher agricultural incomes contributed to poverty reduction, particularly in rural areas. It allowed farmers to have more earnings.
 - **Scientific Advancement:** The revolution fostered further research and innovation in agriculture, leading to the development of new technologies and crop varieties.
 - **Self-Sufficiency:** Many countries previously dependent on imports achieved self-sufficiency in food production.
- **Negatives:**
 - **Environmental Degradation:**
 - **Overuse of Fertilizers:** Led to soil degradation, water pollution (eutrophication), and greenhouse gas emissions (nitrous oxide).
 - **Pesticide Resistance:** Over-reliance on chemical pesticides led to the emergence of resistant pest populations, requiring more toxic substances.
 - **Water Depletion:** Increased irrigation caused depletion of groundwater resources and contributed to water scarcity.
 - **Loss of Biodiversity:** The focus on HYVs led to the displacement of traditional crop varieties, resulting in a loss of genetic diversity.
 - **Deforestation:** Some regions experienced deforestation to create new farming areas.

- **Social and Economic Inequalities:**
 - **Marginalization of Small Farmers:** Smaller farmers often lacked access to the resources required to adopt new technologies, leading to increased inequality.
 - **Dependence on Inputs:** Farmers became reliant on expensive inputs (seeds, fertilizers, pesticides) from external sources, often accumulating debts.
 - **Shift in Land Ownership:** The increase in agricultural productivity increased the demand for land, leading to the concentration of land ownership in fewer hands.
- **Health Concerns:**
 - **Chemical Residues:** Increased consumption of food with pesticide residues led to potential health issues.
 - **Dietary Changes:** Increased consumption of HYVs, which were often refined grains, led to a decline in nutrient diversity.
- **Dependency:** Developing countries got dependent on corporations for technologies, seeds and fertilizer.

4. Suggestions by Experts

In the wake of the Green Revolution's successes and shortcomings, experts emphasize the need for a more sustainable and inclusive approach to agriculture:

- **Focus on Sustainable Agriculture:**
 - **Agroecology:** Promoting farming practices that work with natural ecosystems and reduce reliance on chemical inputs.
 - **Integrated Pest Management (IPM):** Employing biological and cultural controls for pest management to minimize pesticide use.
 - **Water Conservation:** Adopting efficient irrigation techniques and promoting water harvesting.
 - **Soil Health Management:** Focusing on building healthy soils through organic matter and reduced tillage.
- **Diversification of Agriculture:**
 - **Promoting Crop Diversity:** Encouraging the cultivation of a wider variety of crops to increase resilience and improve nutrition.
 - **Integrating Livestock:** Supporting integrated farming systems that combine crop and livestock production for improved soil fertility.
- **Empowering Small Farmers:**
 - **Access to Credit and Markets:** Providing financial and market support to smallholder farmers.
 - **Technology Transfer:** Facilitating the adoption of appropriate technologies that are affordable and suited to local conditions.
 - **Farmer Education:** Investing in extension services that empower farmers with knowledge and skills.
- **Strengthening Local Food Systems:**
 - **Reducing Food Miles:** Supporting local food production and consumption to reduce transportation emissions.
 - **Promoting Local Varieties:** Investing in the conservation and use of traditional crop varieties that are well-adapted to local environments.
- **Rethinking Consumption:**
 - **Reducing Food Waste:** Addressing food loss and waste across the supply chain.
 - **Promoting Plant-Based Diets:** Encouraging dietary patterns that are more sustainable.
- **Climate Smart Agriculture:**
 - **Adapting to Climate Change:** Adopting farming practices that are resilient to the impacts of climate change.
 - **Mitigating Climate Change:** Reducing greenhouse gas emissions from agriculture.

Conclusion

The Green Revolution has been a landmark achievement in the history of agriculture. It successfully addressed the immediate crisis of food shortages, but it also created new challenges, particularly in the realm of environmental sustainability and social equity.

The Green Revolution initially bypassed the eastern region due to a combination of factors:

- **Infrastructural limitations:** The Green Revolution's success in the north and west was significantly linked to the pre-existing irrigation infrastructure. The eastern region lacked adequate irrigation facilities, hindering the adoption of high-yielding varieties (HYVs) that required substantial water. Access to credit and other inputs was also limited.
- **Socio-economic factors:** The Green Revolution disproportionately benefited regions with better-off farmers who could afford the costs of HYVs, fertilizers, and irrigation. Eastern India often had a larger population of small and marginal farmers with less access to resources, making it challenging for them to participate fully.
- **Land tenure systems:** While land reforms aimed to address unequal land distribution, their effective implementation was hampered by various challenges, including political factors and resistance from large landowners. These issues were likely more pronounced in the eastern region, further hindering the adoption of new technologies and practices.
- **Lack of access to technology and inputs:** The initial focus on wheat and rice in irrigated areas meant that technology dissemination and input supplies were concentrated in these regions. The eastern region's diverse cropping systems and reliance on rainfed agriculture meant that it was not an immediate priority for the Green Revolution's initial efforts. This lack of access to HYVs and improved inputs further hindered agricultural growth.

1. Soil Degradation:

Data:

Extent: Approximately 120.40 million hectares (about 37% of India's total land area) are affected by various forms of land degradation, as of the latest estimates from the Indian Space Research Organisation (ISRO). (Source: ISRO - National Remote Sensing Centre (NRSC))

Types:

Water Erosion: Most common type, affecting around 57.7 million hectares.

Wind Erosion: Affecting about 10.2 million hectares, particularly in arid and semi-arid regions.

Chemical Degradation: Affecting around 14.4 million hectares due to salinity, sodicity, and soil acidity.

Physical Degradation: Including compaction and waterlogging, affecting about 16.1 million hectares.

Nutrient Depletion: Widespread across cultivated areas due to excessive fertilization and poor organic matter management.

Desertification/Land Degradation: A significant portion of India is undergoing desertification or land degradation which leads to loss of arable land.

2. Water Depletion:

Data:

Groundwater Depletion: India is one of the largest consumers of groundwater globally. About 256 of 700 districts reported 'critical' groundwater depletion.

Annual Groundwater Extraction: More than 250 cubic kilometers (km³) of groundwater are extracted annually, with agriculture accounting for ~85% of this use.

Overexploited Blocks: Over 30% of the groundwater blocks in India are categorized as overexploited, particularly in Punjab, Haryana, and Rajasthan.

Decline in Water Table: Water table declines in many regions, with some areas experiencing a drop of several meters per year.

3. Trends in Organic Farming:

Data:

Area Under Organic Farming: As of 2022, India had around 3.8 million hectares under certified organic cultivation. India ranks first in the number of organic farmers. (Source: Agricultural and Processed Food Products Export Development Authority (APEDA))

Growth Rate: The organic sector is growing at a rate of approximately 10-15% annually.

States: States like Madhya Pradesh, Rajasthan, Maharashtra, and Uttar Pradesh have a significant area under organic farming.

Exports: India exports a significant amount of organic products, with a large portion of it going to the USA and Europe.

4. Impact of Green Revolution on Crop Production:

Data:

Wheat Production: Increased from around 10 million tons in the 1960s to over 110 million tons in 2021-22.

Rice Production: Increased from around 30 million tons in the 1960s to over 130 million tons in 2021-22.

Overall Food Grain Production: From about 50 million tons in the 1950s to more than 300 million tons in recent years.

Yield per Hectare: Dramatic increase in yield per hectare of wheat, rice, and other crops.

Case Studies

- **Sikkim's Organic Journey: First fully organic state.**
 - **Successes:** Positive environmental impact, enhanced biodiversity, improved soil health. (Data specifics missing in sources).
- **Integrated Farming Systems Success: Higher production efficiency.**
 - **Mango-based System:** Dragon fruit, pineapple integration – higher production, economic efficiency, sustainable yields.
 - **Coconut-based System:** Pasture crops, fodder trees, goats integration – net income 2,54,206/ha, B:C ratio 3.16.
 - **Other examples:** Data specifics on other successful integrated farming systems are missing in sources.
- **Women Farmers & Collectives: Empowerment key for participation.**
 - **Millet Farmer Facilitators (MFFs):** Improved millet production technologies; dairy, beekeeping – profitable interventions.
 - **Millet Producer Groups (MPGs):** Enhanced yield, net returns, knowledge; Millet Market app for marketing.
 - **Additional cases:** Sources lack more examples of successful women farmers and collectives in sustainable agriculture. The sources provide information about the need for women's empowerment in agriculture, however.

Sikkim's Organic Journey: Challenges

1. Conversion Challenges:

- **Yield Drop in Transition:** Initial shift to organic methods led to a temporary drop in yields for some crops, affecting farmer incomes.
- **Pest and Disease Management:** Managing pests and diseases without chemical pesticides required new skills and knowledge; farmers needed to adopt traditional practices back.
- **Soil Fertility Management:** Building soil fertility organically took time and effort, with farmers needing to understand composting and other methods.

2. Certification and Market Access:

- **Certification Process:** Stringent organic certification processes were costly and time-consuming for small farmers.
- **Market Infrastructure:** Lack of adequate market infrastructure limited the access to good markets with premium prices for organic produce.

- **Supply Chain Issues:** Maintaining the organic integrity of produce throughout the supply chain was a challenge (i.e. contamination during transportation/storage.)

3. Economic and Social Challenges:

- **Input Costs:** Organic inputs (biofertilizers, biopesticides) sometimes had a higher initial cost than conventional inputs.
- **Training and Awareness:** Farmers required extensive training and support to adopt organic methods and build awareness.
- **Farmer Resistance:** Some farmers initially resisted the shift to organic farming due to fear of yield loss and unfamiliarity with new practices.
- **Lack of Local Processing Units:** Sikkim lacks the local processing units for agricultural goods which makes the logistics challenging.

4. Environmental and Climate Challenges:

- **Natural Disasters:** Frequent landslides and other natural disasters affected organic farms and supply chains, causing disruptions.
- **Changing Weather Patterns:** Increased variability in weather and rainfall created additional challenges for organic farming.

5. Policy and Implementation Challenges:

- **Enforcement:** Strict enforcement of organic standards and regulations was necessary but difficult in some areas.
- **Coordination:** Coordination among different government agencies and stakeholders was essential but not always smooth.
- **Data Collection:** Reliable and comprehensive data on organic farming practices and impact was needed but challenging to obtain.

6. Maintaining Organic Status:

- **Border Control:** Ensuring that organic practices are followed in all of the state and no input or produce from the outside is used is essential but difficult to enforce.
- **Sustainability:** Continuously improving and innovating to keep up the standards of organic practice requires investments.

Key Points on Sikkim's Experience:

- **Success Despite Challenges:** Despite these challenges, Sikkim's achievement as a fully organic state is commendable and provides valuable lessons for other regions.
- **Long-Term Commitment:** The transformation required long-term commitment, patience, and continuous learning and investment.
- **Community Involvement:** The success was attributed to the participation of the community in the decision-making process and in the implementation of organic practices.
- **Organic is not Easy:** Conversion to organic is not simple and requires careful planning and support to the farmers and the market.

Agricultural Inputs

Agricultural Inputs Questions:

- ☐ What are the limitations of mechanized farming in the Indian context? (87/3)
- ☐ What is Integrated Pest Control Management? Comment on its current status in the Country? (88/40)
- ☐ Comment on the relationship between credit availability and agricultural growth in India. (07/30)
- ☐ Bring out the main objectives of Rashtriya Krishi Bima Yojana. The scheme is being implemented by which agency? (07/7½)
- ☐ Given the vulnerability of Indian agriculture to vagaries of nature, discuss the need for crop insurance and bring out the salient features of the Pradhan Mantri Fasal Bima Yojana (PMFBY). (16/12.5)
- ☐ How do subsidies affect the cropping pattern, crop diversity and economy of farmers? What is the significance of crop insurance, minimum support price and food processing for small and marginal farmers? (250 Words) (17/15)

Introduction

- **Agricultural inputs are essential for enhancing crop production & food security.**
 - **Key inputs:** Seeds, fertilizers, pesticides, irrigation, machinery, labor, credit.
 - **Input stage:** First of three agricultural stages.
- **Seeds** crucial; **High Yielding Varieties (HYV)** boost productivity.
 - **Certified seeds** increase productivity; climate change necessitates adapted varieties.
 - **Low Seed Replacement Rate:** Farmers use saved seeds over certified.
- **Fertilizers** provide essential nutrients, supporting plant growth.
 - **Urea** most produced, consumed, and imported fertilizer in India.
 - **Chemical fertilizer usage** increased, but non-uniform across states.
 - **Integrated Nutrient Management (INM)** promotes balanced use of chemical and bio-fertilizers.
- **Pesticides** (chemical, bio) manage pests, diseases.
 - **Overuse** of pesticides creates resistance, harms environment.
 - **Pesticides Management Bill 2020** aims to regulate production, use.
- **Mechanization** increases efficiency, reduces labor needs.
 - **Custom Hiring Centers** promote access to machinery.
 - **Small landholdings** limit machine use.
- **Irrigation** crucial for absorption of fertilizers and plant growth.
 - **Regions with good irrigation** use more chemical fertilizers.
 - **Water depletion** is an issue due to water-intensive crops (previously discussed).
- **Access to credit** vital for farmers to purchase inputs.
- **60% of credit** is from informal sources, small farmers still depend on money lenders.
- **Formal loans are availed** by larger, medium farmers.
- **Government initiatives:** Subsidies, schemes, technology for sustainable inputs.
 - **PM-PRANAM** promotes balanced fertilizer use, regenerative agriculture.
 - **Sub-missions** for agriculture extension, seeds, mechanization, plant protection.
- **Traditional Knowledge (ITK)** can offer sustainable input management.
- **Organic resources:** Farmyard manure, green manure, oilcakes are used to improve soil fertility.
- **Indigenous methods** for pest control; crop rotation for soil health.
- **Input costs** a significant challenge for small, marginal farmers (previously discussed).
 - **Zero Budget Natural Farming (ZBNF)** a low-cost input method (previously discussed).

Limitations of mechanization in India

- **Small, fragmented landholdings** limit mechanization adoption.
 - **Dominance of marginal farmers** with < 1 hectare land.
 - **Average farm size is 0.92 ha** (2021-22), very small compared to USA (150 ha), Canada (300 ha).
- **High costs** of machinery is a barrier for most farmers.
 - **Adverse economies of scale** for small landholders, previously mentioned.
 - **Custom Hiring Centers (CHCs)** promoted, but limited reach.
 - **Subsidies for CHCs** exist; rent decided by village council.
- **Potential labor displacement** due to mechanization is a concern.
 - **India has large agricultural labor force;** machines may reduce incomes.
- **Need for strong manufacturing base;** skill training for agriculture.
- **Regional disparities** exist in mechanization adoption.
 - **Better developed regions** have more access to CHCs.
 - **Low machine penetration** overall, 20 tractors/1000 hectares.
- **Suitability of machinery** for all farms is an issue.
 - **Collective farming** had limited success; small plots impede machine use.
 - **Farm mechanization** is not a choice for US due to high labor costs.

- **Soil erosion** and other issues are not directly linked to mechanization in sources.
 - **Conservation Agriculture (CA)** helps prevent soil loss.
 - **Minimum soil disturbance** is a key feature of CA.
- **Need for a balanced approach:** mechanization plus other interventions.
 - **Strong manufacturing base;** skill training; renewable energy focus needed (mentioned before).
 - **Technological advancements** (satellite imagery, robotics, big data) offer new opportunities.
 - **Transition from production to income centric farming** using technology is key, previously discussed.
- **Indigenous technologies and ITK** can supplement mechanization.
 - **Mulubhai's multi-purpose contraption;** small engine for various tasks.
 - **Wooden markers** for sowing cotton; equal spacing of crops.
- **Low levels of mechanization** mark Indian agriculture (mentioned previously).
 - **Most farmers depend on human labour;** machine penetration is poor.

Integrated Pest Management (IPM)

IPM Definition and Principles: Sustainable pest control; minimizing economic, health, environmental damage.

- **Multiple strategies:** Biological control, cultural practices, chemical control used judiciously.
- **Economic threshold:** Pest control initiated only when pest population reaches a level causing significant economic damage.
- **Monitoring:** Regular pest monitoring crucial for effective management.
- **IPM Strategies: Diverse approaches for effective, sustainable pest management.**
 - **Biological Control:** Using natural predators (e.g., ladybugs, neem extract)
 - **Bio-pesticides:** Neem, chilli, clove, etc.
 - **Cultural Practices:** Crop rotation, trap crops (e.g., lady finger for bollworms), intercropping.
 - **Trap crops** attract pests away from main crops.
 - **Intercropping** creates diverse environment, impacting pest populations.
 - **Chemical Control:** Use of pesticides only as last resort, at recommended levels.
 - **Pesticide Management Bill 2020:** Aims to regulate pesticide production, import, distribution, sale, minimizing harmful effects.
- **IPM Status in India: Limited adoption; significant challenges; growing government support.**
 - **Low adoption rate:** Many farmers still rely heavily on chemical pesticides.
 - **Challenges:** Lack of awareness, access to technology, resources; training needed; resistance development
 - **Only 36 IPM centers** to train farmers in India.
 - **High cost of chemical alternatives** limits use in many contexts
 - **Government support:** Promotion of IPM through various schemes, research initiatives, training programs.
 - **PM-PRANAM** includes awareness about regenerative agriculture, part of broader effort toward sustainable farming practices.
 - **Indigenous Knowledge (ITK)** incorporated into IPM strategies, utilizing local resources and practices

Agricultural Credit

- **Credit Sources:** Formal (institutional) and informal (non-institutional) sources exist.
 - **Institutional:** Banks, cooperatives; provide formal loans.
 - **Non-institutional:** Money lenders, traders; often with high interest.
 - **60% of total credit** from informal sources
- **Credit and Agricultural Growth: Crucial for technology, investment, productivity.**

- **Access to credit enables:** Purchase of inputs, adoption of new tech, investment in farm improvements.
- **Institutional credit** promotes agricultural growth via input access.
- **Credit Access Challenges for Small/Marginal Farmers: Significant barriers limit access to formal credit.**
 - **Informal sources are dominant** for small, marginal farmers, previously discussed.
 - **Money lenders charge high interest**, adding to farmer debt.
 - **Lack of awareness:** Many unaware of formal schemes, procedures.
 - **Collateral requirements:** Small farmers often lack assets for loan security.
 - **Tenant farmers** lack recorded leases, hindering formal loan access.
 - **Lease issues** also limit access to government procurement programs.
 - **Formal loans mostly availed** by larger, medium farmers, previously mentioned.
 - **Delays in payments** from government procurement add to problems.
- **Government Initiatives: Efforts to improve credit access, formalize lending.**
 - **Subsidies and schemes** aim to increase institutional credit availability.
 - **NABARD** plays role in rural credit, as previously discussed.
 - **Focus on digitizing** credit access to improve efficiency and transparency.
- **Linkages to other issues:** Credit tied to issues such as **MSP, market access, input costs**, and **indebtedness**, as mentioned previously.
 - **Need for reforms** to make credit accessible for all farmers, as previously noted.
 - **Focus on technology** and shifting to income-centric approach needed, as mentioned before.

How subsidies affect cropping patterns, crop diversity, and economy of farmers.

- **Subsidies significantly influence cropping patterns**, often leading to monoculture.
 - **Emphasis on certain crops** via subsidies changes cropping patterns.
 - **MSP linked procurement** favors rice and wheat, impacting diversification.
 - **Water intensive crops** are cultivated in drought areas due to subsidies.
 - **Cereal subsidies** may affect household decisions beyond food.
 - They can affect dietary choices, living conditions, health, education investments.
- **Subsidies can reduce crop diversity** by incentivizing specific crops.
 - **MSP** for limited crops leads to mono-cropping, neglecting other options.
 - **Over-reliance on subsidized crops** may hinder cultivation of pulses and millets.
 - Pulses are beneficial for nutrition, soil, and production.
- **Impact on Farmer Economy:** Subsidies have mixed effects, often benefiting larger farmers more.
 - **Subsidies on inputs** like fertilizers can lower production costs, and increase productivity for some.
 - **Urea subsidies** lead to high usage, as previously mentioned.
 - **Distortions in nutrient prices** due to differential subsidies cause imbalances.
 - **Large and medium farmers** take max advantage of formal credit, and subsidies.
 - **Small/marginal farmers** face challenges in accessing benefits, as previously mentioned.
 - **Input subsidies** can influence farmer decisions, sometimes not related to yield.
- **Subsidies impact trade**, creating global disparities.
 - **Developed nations' subsidies** contrast with developing nations, causing trade imbalances.
 - **Need for reforms** in trading to create fair and equitable system.
- **Need for Re-evaluation:** Subsidies must be re-evaluated for better outcomes.
 - **Existing fertilizer subsidies** should be repurposed for environmental health and sustainability.
 - **Crop insurance and MSP** are crucial for small/marginal farmer's economy, as previously mentioned.

- **Balanced use of fertilizers**, and awareness about regenerative agriculture is important.
- **Link subsidies with recommended nutrients** application, and also incentivize sustainable agriculture practices.

Positive and negative impacts of different types of subsidies.

- **Input Subsidies:** Positively impact production, but also have negative consequences.
 - **Fertilizer subsidies** lower costs, boosting yields for some, as previously mentioned.
 - However, they cause **imbalanced nutrient use**, with overuse of urea due to lower prices, as previously discussed.
 - They can also lead to **groundwater contamination, soil erosion, and eutrophication**, previously mentioned.
 - **Power subsidies** for agriculture are provided by government, as previously mentioned.
 - Companies recover costs through **commercial electricity**, as mentioned before.
 - **Subsidized seeds** can enhance productivity via better quality seeds.
 - **Mechanization subsidies** help increase the reach of farm mechanization.
 - Promote 'Custom Hiring Centers', to offset small landholding issues.
- **Output Subsidies (MSP):** Intended to support farmers, but with downsides.
 - **MSP aims to protect farmers** from market risks and price crashes.
 - However, it is **limited to a few crops** like rice, wheat, and sugarcane, as previously noted.
 - **Leads to regional disparities**, with some states benefiting more.
 - **Promotes mono-cropping** by incentivizing water-intensive crops, such as rice, in certain areas.
 - **MSP linked procurement** contributes to groundwater depletion, as discussed earlier.
 - **Procurement is not uniform** across the country, and small farmers are often left out, as previously noted.
 - **Delayed payments** under MSP can affect farmers, previously mentioned.
- **Trade Subsidies:** Creates disparities in global agriculture.
 - **Developed nation subsidies** create unequal competition for developing nations, mentioned before.
 - **Distort global markets**, and need reforms for fair trade, as previously noted.
- **Direct Benefit Transfer (DBT):** Aims to reduce leakages in subsidies.
 - **DBT is intended to minimize the diversion of subsidized fertilizers** in the market, and to the industries.
- **Overall Impacts:** Subsidies need careful consideration for better outcomes, as previously mentioned.
 - **Overuse of fertilizers**, due to subsidies, affects soil health and the environment, as previously mentioned.
 - Promoting integrated nutrient management and use of bio-fertilizers is needed.
 - **Need to reduce reliance on chemical fertilizers**, as discussed earlier, and re-purpose subsidies.
 - **Subsidies affect farmer decisions**, not always related to yield, as previously mentioned.
 - **Need for awareness among farmers** for the success of any scheme.
 - **Balanced subsidies, crop diversification, and technology** adoption are crucial for long term sustainability.

Pradhan Mantri Fasal Bima Yojana (PMFBY)

- About:

- A scheme of the Ministry of Agriculture & Farmers Welfare, PMFBY is an insurance service for farmers for their yields, launched in 2016.
- The new Crop Insurance Scheme is in line with the One Nation One Scheme theme.
- The PMFBY replaced the previous two schemes: the National Agricultural Insurance Scheme (NAIS) and the Modified NAIS.
- Objectives:
 - To provide insurance coverage and financial support to the farmers in the event of failure of any of the notified crops as a result of natural calamities, pests and diseases.
 - To stabilise the income of farmers to ensure their continuance in farming.
 - To encourage farmers to adopt innovative and modern agricultural practices.
 - To ensure flow of credit to the agriculture sector.

Key features of the PMFBY

- Premium rates
 - There will be a uniform premium of only 2% to be paid by farmers for all Kharif crops and 1.5% for all Rabi crops (winter sown).
 - In case of annual commercial and horticultural crops, the premium to be paid by farmers will be only 5%.
 - The balance premium will be paid by the Government (to be shared equally by central and state government).
 - The idea is to provide a fully insured amount to the farmers against crop loss on account of natural calamities.
- Area based approach
 - The Scheme will be implemented on an 'Area Approach basis,' i.e., Defined Areas for each notified crop for widespread calamities,
 - The unit of insurance shall be Village/Village Panchayat level for major crops and for other crops it may be a unit of size above the level of Village/Village Panchayat.
 - It is assumed that all insured farmers in a unit of insurance, to be defined as a "Notified Area" for a crop, face similar risk exposures.
- No upper limit to subsidy
 - There is no upper limit on Government subsidy. This means, even if the balance premium is 90%, it will be borne by the Government.
- Use of technology
 - Crop Insurance App: Provides for easy enrollment of farmers. It facilitates easier reporting of crop loss within 72 hours of occurrence of any event.
 - Latest Technological Tools: To assess crop losses, satellite imagery, remote-sensing technology, drones, artificial intelligence and machine learning are used.
 - PMFBY Portal: For integration of land records.
- Exemptions from tax liabilities
 - There will be exemption from Service Tax liability of all the services involved in the implementation of the scheme.
- Beneficiaries to be covered
 - All farmers growing notified crops in a notified area during the season who have insurable interest in the crop are eligible.
 - To address the demand of farmers, the scheme has been made voluntary for all farmers from Kharif 2020.
 - Earlier, the enrolment was compulsory for farmers who possess a Crop Loan account or Kisan Credit Card (KCC) account, etc).
- Risks covered under the scheme:
 - Comprehensive risk insurance is provided to cover yield losses due to non-preventable risks, such as Natural Fire and Lightning, Storm, Hailstorm, Cyclone, Typhoon, Tempest, Hurricane, Tornado.
 - Risks due to Flood, Inundation and Landslide, Drought, Dry spells, Pests and Diseases will also be covered.

- In cases where the majority of insured farmers in a notified area have intent to sow or plant and have incurred expenditure for the purpose, but are prevented from sowing or planting the insured crop due to adverse weather conditions, indemnity claims up to a maximum of 25% of the sum-insured may be made.
- In post-harvest losses, coverage will be available up to a maximum period of 14 days from harvesting for those crops which are kept in “cut & spread” condition to dry in the field.
- Loss and damage resulting from occurrence of identified localised risks like hailstorm, landslide and inundation affecting isolated farms in the notified area would also be covered.

Significance of MSP for small and marginal farmers

- **MSP aims to provide income support**, safeguarding farmers from market risks, as previously mentioned.
 - It is a **price support** offered by government, intended to **protect against price crashes**.
 - **MSP is announced before cultivation**, so farmers can make informed decisions.
- **MSP's role in income stability for small and marginal farmers** is limited by several factors.
 - **Many small, marginal, and tenant farmers are unaware** of MSP and procurement processes.
 - **Tenant farmers often lack recorded leases**, hindering their registration for procurement.
 - **MSP benefits are not uniformly available** across the country, and procurement is often delayed.
 - **Procurement systems are well established for few crops**, primarily rice and wheat, in limited states.
 - This creates **regional disparities**; as previously mentioned, and **favors few crops** from select regions.
 - Small farmers often rely on **money lenders** who impose high interest rates.
 - **Farmers are exploited** in markets by buyers who offer lower prices.
- **MSP's effect on food security** is also nuanced, as previously mentioned.
 - **MSP-linked procurement focuses on rice and wheat**, leading to mono-cropping.
 - This **neglects pulses and millets**, impacting nutritional security.
 - **MSP encourages cultivation of water-intensive crops** in water-scarce areas, leading to drought.
 - The current focus on a few crops may **affect overall food security** by reducing diversity.
- **MSP seeks to reduce risks** associated with cultivation for farmers, but does not fully address all issues.
 - **MSP is announced before sowing season**, reducing price-related uncertainties.
 - **However, farmers face risks like crop failures** due to weather, pests, and diseases.
 - Climate change and extreme weather events impact cropping patterns.
 - Pest and disease management is important.
 - **Need for climate-resilient agriculture** is essential.
 - **Farmers may still be exploited by private traders** even with MSP in place.
- **Reforms in MSP policy are needed**, to address its limitations.
 - The current policy favors a **few crops and regions** creating several problems.
 - **Need to diversify** the crops covered under MSP to include more millets and pulses.
 - **Need to improve procurement process**, so it reaches small and marginal farmers.
 - **Address the issue of delayed payments**, to ensure that farmers receive timely benefits.
 - **MSP needs to be calculated** with cost of cultivation, demand and supply and buffer stocks in mind.

Food Processing

- **Food processing links agriculture and industry**, transforming raw produce into value-added products.
 - It plays a significant role in connecting these two pillars of the economy, as mentioned earlier.
 - It **enhances the shelf life** of food, reducing wastage.
 - It also **incentivizes diversification** and commercialization of agriculture.
- **Food processing enhances farmer income.**
 - It provides **better prices** for processed goods, increasing returns for farmers.
 - **Value addition** increases the economic value of agricultural produce.
 - **It reduces dependence on imports.**
 - Food processing supports **market-led production.**
- **Food processing generates employment**, especially in rural areas.
 - It creates opportunities in **processing, packaging, and distribution.**
 - **Small-scale processing units** can uplift the socio-economic status of poor farmers.
- **Food processing minimizes post-harvest losses**, as previously noted.
 - A significant percentage of cereals, pulses, oilseeds, fruits, and vegetables are lost post-harvest.
 - **Proper storage facilities** are crucial to reduce wastage and for the efficient supply chain.
- **Food processing plays a crucial role in supply chain management.**
 - It serves as a vital link between production and consumption.
 - It **reduces the number of intermediaries**, enhancing efficiency.
 - **Supermarkets** play a role in this efficient supply chain.
 - **Integrated supply chain infrastructure minimizes wastage.**
 - It is important to **strengthen institutions** operating in the food processing segment.
- **Food processing is impacted by upstream and downstream constraints.**
- **Upstream constraints** include raw material accessibility, storage, and farmer linkages.
 - Good linkages with farmers are important.
- **Downstream constraints** include market access and transportation.
 - **Market intelligence** is needed to promote market-led production.
- **Initiatives for the food processing industry** are essential for growth and include:
 - Promotion of a cluster approach, and **creating integrated supply chain infrastructure.**
 - **Incentivizing capacity expansion and tech upgrades**, especially for perishables.
 - **Increasing access to institutional credit**, promoting R&D and strengthening institutions.
- **Government policies** should promote technology upgrades in the food processing sector.
 - This includes **modern extraction techniques** and R&D.
 - **Upgrading processing and preservation technologies** is essential.
 - **Promoting the use of ICT** can add efficiency to input management.

India: Essential Agricultural Data - Crisp

1. Credit Access:

- **Coverage:** 45-50% farmers (institutional).

2. Crop Insurance:

- **Penetration:** 30-35% of cultivated area.

3. Input Costs:

- **Fertilizer Subsidy:** ₹1.5-2 lakh crore annually (approx.)
- **Pesticide Costs:** High, fluctuating.
- **Machinery Costs:** High for small farmers.

4. Crop Production/Area:

- **Rice:** >130 million tons; ~43 million hectares
- **Wheat:** >110 million tons; ~31 million hectares
- **Pulses:** 25-30 million tons; ~29 million hectares
- **Oilseeds:** Varies; ~27 million hectares
- **Coarse Grains:** ~30 million tons; ~20 million hectares.

5. Subsidy Expenditure:

- **Fertilizer:** ₹1.5-2 lakh crore annually (approx.)
- **Power:** Significant, state-specific.
- **Interest Subvention:** On agricultural loans.

No explanations. Just data.

Agricultural Inputs: Case Studies

- **Successful Cases of Integrated Pest Management (IPM)**
 - **Bio-intensive IPM in groundnut:** Combining border crops, resistant varieties, seed treatment with *Trichoderma asperellum*, and foliar applications of neem and other biopesticides reduced disease and pest incidence, increasing pod yield by 9-37% and the benefit-cost ratio by 1.4-2.1.
 - **Pheromone traps for bollworms:** Traps using pheromones to attract and trap male bollworms reduce the population of the pest. However, the limited number (35) of IPM centers to train farmers is a constraint in India.
 - **Integrated pest and disease management in cumin:** A standardized schedule using kresoxym methyl and thiamethoxam resulted in higher cumin yield (677 kg/ha) and a better benefit-cost ratio (1.98) while reducing disease and aphid incidence.
- **Examples of Farmer Cooperatives Accessing Credit**
 - **Farmers' Producer Organizations (FPOs):** FPOs as a mechanism for collective farming and accessing credit.
- **Cases of Farmers Facing Challenges Due to Lack of Access to Agricultural Inputs**
 - **Access to credit:** Small and marginal farmers are heavily reliant on money lenders who charge high interest rates, placing them at a disadvantage.
 - **Access to fertilizers:** The uneven distribution of subsidies and distorted nutrient prices cause imbalances in nutrient use. **Black marketing of urea** occurs due to high demand and low supply.
 - **Access to seeds:** Most farmers use farm-saved seeds (low seed replacement ratio), limiting the use of high-yielding, improved varieties.
 - **Access to technology:** The lack of mechanization, especially for small and marginal farmers, hinders productivity. Only a limited number of custom hiring centers are available, mostly in better developed areas.
 - **Access to markets:** Inefficient marketing systems, grading systems, and post-harvest losses cause exploitation of farmers. The shift towards private markets may lead to the shutting down of *mandis* (wholesale markets), potentially depriving farmers of MSP benefits.
 - **Access to information:** Farmers are often unaware of important information such as Maximum Residue Limits (MRL) of pesticides and MSP-related procurement processes. The need for improved extension services is highlighted.

India has a 40% farm mechanization rate, compared to the US (95%), Brazil (75%), and China (57%). Tractors dominate the farm equipment market in India, while other equipment like sowers, tillers, and harvesters make up only 15-20% of the market share. Conservation Stewardship Program (CSP) in the United States which provides financial assistance to farmers who adopt practices such as cover cropping, crop rotations, and intercropping. Organic Agriculture Promotion Program in the Philippines is also mentioned as a program to promote organic agricultural practices, including crop diversification.

Fertilizers

Fertilizers Question

- ☐ Write short notes on the following: Thal-Vaishet Project. (81/5)
- ☐ What is meant by bio fertiliser? (84/3)
- ☐ What are biofertilizers? What advantages do they have over chemical fertilizers? (92/20)
- ☐ Briefly explain the use of various chemical fertilizers in Indian agriculture. (92/15)
- ☐ What is vermicomposting? Discuss its importance in the Indian context. (01/15)

Fertilizers provide essential nutrients for plant growth, supplementing what soil lacks. India consumes **55 million metric tons annually**, with imports covering nearly 30%. Urea dominates consumption (74%), causing a **nutrient imbalance** and soil degradation.

Types of chemical fertilizers and their uses.

- **Nitrogenous Fertilizers:** Primarily provide Nitrogen (N), crucial for plant growth.
 - **Urea:** Most produced (86%), consumed (74%), and imported (52%) fertilizer in India. Contains 46% N, subsidized, leading to overuse and black marketing. Neem coating slows release, improving efficiency.
 - **Other Sources:** Organic options like biofertilizers (e.g., Jeevamrutha) and vermi compost exist, supplementing chemical use.
- **Phosphatic Fertilizers:** Provide Phosphorus (P), vital for root development and flowering.
 - **Diammonium Phosphate (DAP):** Contains 46% P and 18% N. Higher cost than urea, recommended for rice and wheat primarily. Imports affected by geopolitical events (e.g., Russia-Ukraine conflict) impacting price.
- **Potassic Fertilizers:** Supply Potassium (K), improving crop quality and disease resistance.
 - **Muriate of Potash (MOP):** Provides K, enhancing crop lustre. Lower cost than DAP.
- **Nutrient Imbalance:** Overuse of nitrogenous fertilizers, especially urea, creates imbalances. Ideal N:P:K ratio is 4:2:1, but India's usage deviates significantly.
- **Government Initiatives:** Promote balanced nutrient management:
 - **Neem-coated urea:** Slows nitrogen release, improving efficiency.
 - **Soil Health Cards:** Guide farmers on appropriate fertilizer use.
 - **PM-PRANAM:** Promotes balanced fertilizer use and awareness about regenerative agriculture.
 - **Nano Urea:** Liquid formulation aiming to reduce subsidy burden and improve nitrogen use efficiency. However, its effectiveness is debated. Application to leaves, rather than soil, aims to reduce wastage.
- **Organic Alternatives:** Indigenous knowledge emphasizes organic options like green manure (e.g., *Calotropis gigantea*, *Tephrosia purpurea*), FYM, and oil cakes. Zero Budget Natural Farming (ZBNF) and other approaches are promoted.

Advantages: Increased productivity, quick growth

- **Increased Productivity:** Chemical fertilizers significantly boost crop yields.
 - **Green Revolution:** Increased fertilizer use was a key factor in the Green Revolution, leading to substantial increases in wheat and rice production.
 - **Higher Yields:** Specific examples include improved yields in cumin (677 kg/ha) with integrated pest management and increased yields in groundnut with bio-intensive IPM [see previous conversation].
 - **GM Crops:** Genetically modified crops, often designed for higher yields and pest resistance, rely heavily on chemical fertilizers.
- **Quick Growth:** Fertilizers accelerate plant growth and maturity.
 - **Faster Maturation:** Early maturation of crops leads to earlier harvests.
 - **Improved Agronomic Practices:** Use of fertilizers enables farmers to improve agronomic practices like timing and rates of nutrient applications.

- **Higher Nutrient Uptake:** With fertilizers, nutrient uptake improves, which leads to faster development and overall improvement in plant structure.

Chemical Fertilizers :Disadvantages

- **Soil Degradation:** Excessive fertilizer use harms soil health.
 - **Nutrient Imbalance:** Overuse of nitrogenous fertilizers (especially urea) creates imbalances, impacting soil structure and microbial activity.
 - **Soil Erosion:** Excessive fertilizer use can contribute to soil erosion.
 - **Reduced Soil Response:** Long-term overuse leads to decreased soil response to fertilizers.
 - **Loss of Soil Organic Matter:** Indiscriminate use depletes soil organic matter and biodiversity.
- **Water Pollution:** Fertilizer runoff contaminates water bodies.
 - **Eutrophication:** Excess nutrients cause algal blooms and oxygen depletion, harming aquatic life.
 - **Groundwater Contamination:** Fertilizer chemicals can leach into groundwater, affecting human and animal health.
- **Environmental Damage:** Fertilizer use contributes to environmental problems.
 - **Greenhouse Gas Emissions:** Certain agricultural practices release greenhouse gases contributing to global warming and climate change. Paddy straw burning also releases pollutants.
 - **Bioaccumulation:** Harmful chemicals accumulate in the soil and water, entering the food chain.
- **Health Hazards:** Excessive fertilizer use poses health risks.
 - **Bioaccumulation (repeated):** Harmful chemicals accumulating in food affect human and animal health.
 - **Pesticide Residues:** Excessive pesticide use leaves residues on crops, potentially harming consumers.
 - **Micronutrient Deficiency:** Focus on macronutrients neglects micronutrients like Zinc.
- **Unbalanced Nutrient Usage:** Imbalances between N, P, and K create problems.
 - **Nitrogen Overuse:** Heavy subsidies on nitrogenous fertilizers lead to overuse.
 - **Regional Disparities:** Fertilizer use varies significantly across regions, with some areas exhibiting excessive and imbalanced usage.
 - **Subsidy Distortions:** Differential subsidy rates for different nutrients artificially distort prices, promoting overuse of some nutrients.
 - **Economic Imbalance:** High cost of certain fertilizers (e.g., MOP) affects farmer affordability and causes underutilization of certain nutrients.

Different types of biofertilizers and their roles.

- **Biofertilizers: Definition:** Biofertilizers are living microorganisms that enhance nutrient availability to plants, promoting growth and improving soil health. They offer a sustainable alternative to chemical fertilizers.
- **Types and Roles of Biofertilizers:** Several types of biofertilizers play distinct roles in plant nutrition and soil improvement.
 - **Nitrogen-fixing Bacteria:** These bacteria convert atmospheric nitrogen into forms usable by plants, reducing the need for nitrogen-based fertilizers. Examples include those used in Jeevamrita/Jivamrutha preparation, a ZBNF input, and those used in Bijamrita seed treatment.
 - **Phosphate Solubilizing Microorganisms (PSM):** PSMs convert insoluble phosphates in the soil into soluble forms, making phosphorus more accessible to plants.
 - **Mycorrhizae:** These are symbiotic fungi that form associations with plant roots, enhancing nutrient uptake (particularly phosphorus and other micronutrients) and improving water absorption. They also boost plant resistance to diseases and abiotic stresses.

- **Other examples of biofertilizers:** Vermicompost, a type of organic fertilizer, is created by the action of earthworms. Several indigenous preparations are used. These include preparations of cow dung and urine, often combined with other ingredients. Some are used for seed treatment, while others are soil applications. The use of green leaf manure from species like *Calotropis gigantea* and *Tephrosia purpurea* is also practiced.
- **Government Initiatives:** Government initiatives promote biofertilizers as part of integrated nutrient management, and natural farming including ZBNF. The PM-PRANAM scheme aims to promote their use along with balanced chemical fertilizer applications. The development and distribution of bio-formulations have also been undertaken.

Advantages over chemical fertilizers

- **Advantages over Chemical Fertilizers:** Biofertilizers offer several benefits compared to their chemical counterparts.
 - **Environmentally Friendly:** Biofertilizers are **environmentally benign**, unlike chemical fertilizers, which contribute to soil degradation, water pollution, and greenhouse gas emissions.
 - **Sustainable:** They promote **sustainable agriculture** by improving soil health, reducing reliance on synthetic inputs, and fostering biodiversity.
 - **Improved Soil Health:** Biofertilizers enhance soil structure, nutrient availability, and microbial activity. This improves water retention, boosts soil organic matter, and increases overall fertility. Specific examples include Jeevamrita/Jivamrutha's role in boosting soil microbes and nutrient content, and the use of green leaf manure which maintains soil health.
 - **Cost-Effective:** In the long run, biofertilizers can be **more cost-effective** than chemical fertilizers, although initial investment in preparation or procurement might be needed. The use of locally produced inputs further reduces the cost. Zero Budget Natural Farming (ZBNF) emphasizes cost-effectiveness.
- **Scope and Challenges in India:** While biofertilizers hold immense potential, their widespread adoption in India faces challenges.
 - **Awareness and Adoption:** **Limited awareness** among farmers about the benefits and application methods of biofertilizers is a major hurdle.
 - **Production and Distribution:** **Inadequate production capacity and inefficient distribution networks** hinder the availability of diverse biofertilizers to farmers.
 - **Research and Development:** **Further research is needed** to develop region-specific biofertilizers tailored to the diverse agro-ecological conditions of India. Research is also needed on how best to integrate biofertilizers into established farming practices.
 - **Lack of Standardization:** Standardization and quality control measures for biofertilizers remain a challenge.
 - **Integration with Existing Systems:** Farmers need guidance on how to effectively **integrate biofertilizers with existing farming systems** and inputs, especially chemical fertilizers. Simply substituting chemical fertilizers without careful consideration can lead to suboptimal results.
 - **Behavioral Change:** Shifting farmers from reliance on chemical based inputs to cow based locally produced inputs, and adoption of the techniques needed for successful use of biofertilizers requires continuous creation of awareness and training.

Vermicomposting

- **Vermicomposting: Definition:** Vermicomposting is a natural process where earthworms decompose organic waste, creating nutrient-rich vermicompost. This is a form of organic fertilizer.
- **Vermicomposting: Process:** The process involves several key steps:
 - **Organic Waste Collection:** Organic materials like farm waste, kitchen waste, cow dung, and other biodegradable materials are collected.

- **Earthworm Introduction:** Earthworms are added to the collected organic matter. The type of earthworm used can influence the efficiency of vermicomposting.
- **Decomposition:** Earthworms ingest organic waste and excrete it as vermicompost. This process typically takes several weeks or months.
- **Moisture and Aeration:** Maintaining adequate moisture and aeration levels is crucial for optimal decomposition. The appropriate moisture content depends on the organic material and earthworms used.
- **Harvesting:** Once the decomposition is complete, the finished vermicompost is harvested. Vermicompost is rich in nutrients, enhancing soil health and fertility.
- **Specific Examples:** A vermicomposting unit was developed for use in the North-East hill region, using farm waste. A design using a plastic polyhouse with HDPE vermi-beds was described. Another example involves using cow dung, cow urine, and other household wastes in a compost pit.
- **Benefits of Vermicomposting:** Vermicompost improves soil structure, enhances nutrient availability, and improves water retention. It also provides a sustainable method for waste management. Specifically, it enhances soil organic matter and helps in retaining moisture, benefiting plant growth. Replenishing earthworms can also improve soil quality.

Importance of vermicomposting

- **Importance of Vermicomposting:** Vermicomposting offers multiple benefits across various sectors.
 - **Soil Improvement:** Vermicompost significantly enhances soil health, increasing nutrient availability, improving water retention, and boosting microbial activity. It also improves soil structure and increases organic matter.
 - **Sustainable Agriculture:** It promotes sustainable agriculture by recycling organic waste and reducing dependence on chemical fertilizers. **This aligns with government initiatives promoting natural farming** and integrated nutrient management.
 - **Waste Management:** Vermicomposting provides an effective and eco-friendly way to manage organic waste, including farm waste, kitchen waste, and other biodegradable materials. It reduces environmental pollution associated with other waste disposal methods.
 - **Rural Livelihoods:** By offering a source of income from creating and selling vermicompost, it can empower rural communities and improve livelihoods. This is particularly important in areas with high unemployment.
- **Application for Small and Marginal Farmers:** Vermicomposting is particularly relevant for small and marginal farmers in India.
 - **Resource Accessibility:** It utilizes readily available resources like farm waste, kitchen waste, and cow dung, which small farmers usually have readily at hand.
 - **Low-Cost Technology:** It requires minimal capital investment, unlike industrial composting methods.
 - **Skill Development:** The process is relatively simple to learn and implement, requiring minimal specialized training.
 - **Empowerment:** By transforming waste into valuable fertilizer, it can add value to agricultural practices and increase income potential. Government schemes could be leveraged to support small farmers in this area.

Agriculture Data

1. Chemical Fertilizer Consumption:

- **Total Consumption (Annual):** Approximately 50-60 million tonnes (all nutrients combined – Nitrogen (N), Phosphorus (P), Potassium (K)).
 - *Note: Varies by year and crop season.*
- **Dominant Nutrient:** Nitrogen (N) consumption is highest, followed by Phosphorus (P) and then Potassium (K).
 - *Note: Imbalance in NPK use is a concern.*
- **Per Hectare Consumption:** Average consumption is about 150-160 kg/hectare .

- *Note: Highly variable across states.*

2. Soil Degradation & Nutrient Deficiency:

- **Total Degraded Land:** ~ 120.40 million hectares (approx. 37% of total land)
 - *Note: Includes water erosion, wind erosion, chemical degradation, and physical degradation.*
- **Nutrient Deficiency:**
 - **Nitrogen (N):** Widespread deficiency across most soils.
 - **Phosphorus (P):** Significant deficiency in many regions.
 - **Potassium (K):** Deficiency is becoming increasingly prevalent.
 - *Note: Multi-nutrient deficiencies are common and increasing.*
 - *Note: Micronutrient deficiencies also are widespread.*
- **Specific Soil Degradation:**
 - **Water Erosion:** Affects ~57.7 million hectares.
 - **Chemical Degradation:** Affects ~14.4 million hectares.
 - *Note: This results in a loss of agricultural productivity.*

3. Organic Farming Area:

- **Total Certified Area:** ~3.8 million hectares (as of 2022).
 - *Note: Includes both cultivated land and wild harvest areas.*
- **Key States:** Madhya Pradesh, Rajasthan, Maharashtra are leading states.
- *Note: Organic farming area is increasing but still a small portion of total cultivated land.*
- **Growth Rate:** Organic sector growing at ~10-15% annually.

4. Government Spending:

- **Fertilizer Subsidy (Annual):** ₹1.5 - ₹2 Lakh crore (approx.)
 - *Note: Includes urea, DAP, and other fertilizers.*
- **Total Agriculture Subsidies:** Varies annually, including fertilizer, power, and other subsidies.
 - *Note: Subsidies form a significant portion of agricultural spending.*
- **Budget Allocation:** Increase in budget for schemes promoting natural and organic farming.

Successful cases of promoting biofertilizers and vermicomposting among farmers. And Even Ill effects

- **Successful Biofertilizer/Vermicomposting Promotion:** Several examples illustrate successful adoption of these practices:
 - **Bhartiya Prakritik Krishi Paddati (BPKP):** This scheme promotes natural farming, including biofertilizers, across 8 Indian states, covering 4.09 lakh hectares. It focuses on training and demonstration by champion farmers. The scheme is being upgraded to the National Mission on Natural Farming (NMNF).
 - **Zero Budget Natural Farming (ZBNF):** This method, developed by Subhash Palekar, eliminates chemical fertilizers and purchased inputs. It involves techniques like Bijamrita (seed treatment) and Jeevamrita (soil amendment using cow dung and urine). The scheme includes water conservation and soil quality improvement practices such as replenishing farm ponds and earthworms.
 - **Indigenous Technical Knowledge (ITK):** Various ITKs demonstrate successful community adoption of biofertilizers and vermicomposting. These include using green leaf manure, compost from waste materials, and specific methods for vermicomposting and seed treatment. Examples across different states are documented.
 - **Specific Cases:** Punjab shows a heavy usage of Nitrogen, highlighting the issue of over-fertilization.

Agricultural Policies

Agricultural Policies Question

- ☐ What are the basic objectives of agricultural price policy of the Government of India and how is it implemented? (250 words) (89/40)
- ☐ What do you mean by providing industry status to agriculture in India? (01/2)
- ☐ What has been the policy of agricultural development during last two decades in India? (04/2)
- ☐ Elaborate the steps taken by the Government for regionally differentiated approach to increase crop production and diversification in the country. (09/15)
- ☐ There is also a point of view that Agricultural Produce Market Committees (APMCs) set up under the State Acts have not only impeded the development of agriculture but also have been the cause of food inflation in India. Critically examine. (14/12.5)
- ☐ How can the 'Digital India' programme help farmers to improve farm productivity and income? What steps has the Government taken in this regard? (15/12½)
- ☐ Assess the role of National Horticulture Mission (NHM) in boosting the production, productivity and income of horticulture farms. How far has it succeeded in increasing the income of farmers? (18/15)

Agricultural policies are crucial for ensuring **food security**, supporting **farmer livelihoods**, and promoting **sustainable practices**. They address issues such as **pricing**, market access, and technology adoption. Effective policies also foster growth and equity in the sector.

Agricultural Price Policy

- **Objectives of Agricultural Price Policy:** The main objectives of agricultural price policy are to ensure fair prices for farmers, stabilize market prices, and promote food security.
 - **Fair Returns for Farmers:** Policies aim to provide farmers with remunerative prices for their produce to incentivize production and ensure their livelihoods.
 - **Price Stability:** Policies are designed to reduce price volatility and protect consumers from price spikes.
 - **Food Security:** By ensuring stable prices, these policies encourage continuous agricultural production and contribute to overall food security for the population.
 - **Market Regulation:** Policies help regulate agricultural markets and prevent exploitation of farmers by private traders.
- **Implementation Mechanisms:** Several mechanisms are used to implement agricultural price policy.
 - **Minimum Support Price (MSP):** The MSP is a price support mechanism to protect farmers from market risks. The MSP is announced by the government before the sowing season based on recommendations by the Commission for Agricultural Costs and Prices (CACP).
 - **MSP Calculation:** The CACP considers cost of cultivation, demand-supply, and international prices when recommending MSP. However, cost of cultivation is not uniform across the country.
 - **MSP Coverage:** MSP is announced for 14 Kharif crops, 6 Rabi crops, and 2 commercial crops, and the government also announces fair and remunerative price for sugarcane.
 - **Procurement:** Government agencies like the Food Corporation of India (FCI) procure crops at MSP.
 - If market prices are higher than MSP, farmers can sell to private traders. If the mandi does not pay the MSP, then the FCI will procure the crop.
 - **Procurement Issues:** Procurement is not uniform and is well-established only for certain crops like rice and wheat.
 - **Buffer Stock:** The government maintains buffer stocks of food grains to manage price fluctuations and address food shortages.
 - If demand and supply are equal there is no need for buffer stock. The government will increase MSP if they want farmers to produce more.
 - **Public Distribution System (PDS):** The PDS is a food security system for distributing food grains at affordable prices to needy sections of society.

- It involves a government-sponsored chain of fair price shops distributing essential commodities.
- PDS supply chain includes procurement, storage, and distribution.
- **Objectives** of PDS are to manage scarcity, provide affordable food grains, and ensure food security.
- The Targeted Public Distribution System (TPDS) is a modification that aims to reach the most vulnerable.
- **e-NAM:** The e-National Agriculture Market is an online platform for market between farmers and consumers to create a single unified market throughout the country.
 - It is aimed to address concerns regarding price dispersion, where the same variety of rice is sold at different prices in different states.
- **Market Intervention:** The government may take measures like export bans and stock limits to control prices.

Impact on farmers and consumers.

- **Impact on Farmers:** Agricultural price policies, particularly **MSP**, aim to protect farmers from market volatility but have varied impacts.
 - **Income Support:** MSP provides income support, safeguarding farmers from price crashes. However, benefits are not uniform; small and marginal farmers are often unaware or unable to access government procurement.
 - **Assured Markets:** MSP ensures a market for crops through government procurement, reducing dependence on private traders. FCI procures crops if the mandi doesn't pay MSP. However, procurement systems are not well established for all crops.
 - **Distortions:** The MSP policy can lead to cropping pattern distortions, favoring water-intensive crops like rice and wheat. This results in **groundwater depletion** and regional disparities.
 - **Limited Coverage:** MSP focuses on a few crops and regions, neglecting other crops like millets. This can lead to **monoculture** and imbalanced production.
 - **Dependence on Arhatiyas:** Small farmers often depend on Arhatiyas for credit and sell their produce at lower prices.
- **Impact on Consumers:** Agricultural price policies also impact consumers through the Public Distribution System (PDS).
 - **Food Security:** PDS ensures access to affordable food grains for needy sections of society. The **National Food Security Act (NFSA) 2013** provides subsidized food to priority households.
 - **Price Stability:** Policies aim to stabilize market prices and protect consumers from price fluctuations. However, this is not always achieved and price dispersion can still exist between states.
 - **Trade-offs:** Policies sometimes lead to higher domestic prices to incentivize local production and maintain food security, which may affect consumers. For example, if international prices are more than the MSP, domestic prices may increase and lead to inflation.
 - **PDS Challenges:** PDS faces challenges related to efficiency, targeting, and leakages, affecting its effectiveness in reaching all consumers.
- **Overall Impact:** Price policies affect both farmers and consumers and must balance these interests.
 - **Inter-crop parity** can also be impacted by MSP, where a high MSP for one crop can decrease production of other crops.
 - **Need for Reforms:** There is an urgent need for reforms in the MSP policy to address distortions, improve coverage, and promote diversified cropping patterns.
 - **Market reforms** were initiated in most states in the 1960s and 70s with the establishment of Agriculture Produce and Market Regulation Act (APMC), and designated markets known as APMC Mandis. However, these Mandis also have

concerns such as dependency of farmers on arhatiyas and a lack of transparency in auctions.

- **e-NAM** seeks to create a unified market, but other acts such as the Farmer's Produce Trade and Commerce Act of 2020 aimed to bypass the APMC mandis, but this act faced opposition from farmers.

Industry Status to Agriculture:

- **Meaning of Industry Status:** Granting industry status to agriculture means recognizing it as a formal economic sector, similar to manufacturing or services.
 - This recognition can enable agriculture to access benefits and resources available to industries.
 - It allows for formalizing and modernizing various agricultural activities.
- **Implications for Investment:** Industry status can significantly impact investment in agriculture by attracting more capital.
 - **Increased Credit Access:** Formal industry status can facilitate easier access to institutional credit from banks and other financial institutions. This is important, since currently, 60% of total agricultural credit comes from informal sources.
 - **Private Sector Participation:** It encourages private sector investments in agricultural infrastructure, technology, and value chain development.
 - **Infrastructure Development:** More investments can flow into developing storage, transport, and processing facilities which would reduce post-harvest losses and improve market efficiency. (PDS, MSP - prev.)
 - **Technology Adoption:** Attracts investments in advanced technologies such as precision farming, biotechnology, and mechanization which are vital for sustainable crop intensification.
 - Use of technology can also improve areas like seed development, fertilizer use, pest control and post-harvest management.
- **Potential Benefits:** This approach could lead to many positive outcomes for the agricultural sector.
 - **Enhanced Productivity:** Increased investment in technology and infrastructure can lead to higher agricultural productivity, improving yields and quality.
 - **Value Addition:** Industry status could enable greater value addition through food processing, packaging, and branding, creating new income streams.
 - **Employment Generation:** Formalization of agriculture can generate more jobs in rural areas in the form of forward and backward linkages.
 - **Reduced Import Dependence:** Increased production due to increased investments can reduce dependence on imports, especially in areas like edible oils.
 - **Improved Farmer Income:** Increased productivity and access to better markets would lead to higher farmer incomes. (MSP - prev.)
- **Challenges and Concerns:** Granting industry status also presents several challenges and concerns.
 - **Small Land Holdings:** The dominance of small and marginal farmers with fragmented land holdings can limit the adoption of technology. India has a large number of marginal farmers, with 56.2% of farmers contributing to marginal and small farms.
 - **Informal Sector:** Much of the agricultural sector operates informally and may not easily adapt to industry-specific regulations and procedures.
 - **Market Volatility:** Agricultural markets are prone to price fluctuations that may impact investment decisions. (MSP - prev.)
 - **Environmental Concerns:** Increased industrialization may lead to unsustainable practices, such as over-extraction of groundwater, and increased pollution if not managed well. (Cropping patterns - prev.)
 - **Subsidy Dependence:** Farmers are also dependent on government subsidies for inputs like power and fertilizers which would need to be streamlined.

- **Implementation Difficulties:** Proper implementation of industry status will require significant policy changes and infrastructure development.
- **Conclusion:** Granting industry status to agriculture holds potential for increased investment, modernization and growth.
 - However, potential drawbacks must be addressed with targeted policies.
 - A balanced approach that supports small farmers and promotes sustainability is important.
 - Support for farmer producer organizations (FPOs) can aid in enabling small farmers to avail benefits of this approach.

Agricultural Development Policies of the last two decades

- **Technology-Focused Policies:** Government policies have emphasized technology adoption to enhance productivity and sustainability.
 - **Mechanization:** The Sub-Mission on Agricultural Mechanization (SMAM) increases access to farm machinery. Custom Hiring Centers promote mechanization for small landholders.
 - Subsidies provided for machinery purchase, promotes custom hiring.
 - **Precision Farming:** Focus on technologies like precise sowing, weeding tools, spraying drones, and harvesters.
 - **Biotechnology:** Investment in developing **GM crops** for food security and pest resistance.
 - Bt cotton is one example of GM crop used in India.
 - **Digital Agriculture:** Use of e-technology for farmers' aid, including mobile apps for information and advisory services.
 - "Onion Crop Advisor" mobile app is one example.
 - **Seed Technology:** Sub-Mission on Seeds and Planting Material (SMSP) aims to increase production of certified seeds.
 - Emphasis on high-yielding, climate-resilient seed varieties.
 - **Integrated Nutrient Management (INM):** Promotion of balanced fertilizer use through schemes like PM-PRANAM.
 - Neem-coated urea, soil health cards, and liquid nano urea are promoted.
- **Infrastructure Development:** Policies aim to improve agricultural infrastructure for better storage, transport, and market access.
 - **Cold Storage and Warehousing:** Focus on increasing storage capacities to reduce post-harvest losses.
 - **Market Intelligence:** Setting up market intelligence networks to collect data on demand, supply, and prices.
 - **e-NAM:** Promotion of electronic National Agriculture Market (e-NAM) for a unified market.
 - **Irrigation:** Focus on different types of irrigation and irrigation systems.
- **Farmer Welfare Policies:** Several initiatives focus on improving farmer incomes, reducing risks and ensuring social security.
 - **Minimum Support Price (MSP):** Government announces MSP for various crops before the sowing season. (MSP - prev.).
 - **Public Distribution System (PDS):** Provides subsidized food grains to needy sections of the society. (PDS - prev.)
 - **National Food Security Act (NFSA):** Aims to eliminate hunger and malnutrition.
 - **Natural Farming:** Promotion of chemical-free farming via the National Mission on Natural Farming (NMNF).
 - Bhartiya Prakritik Krishi Paddati (BPKP) promotes natural farming using cow-based inputs.
 - **Farmer Producer Organizations (FPOs):** Encouraging the formation and promotion of FPOs to enhance market access and bargaining power.
 - **Crop Insurance:** Schemes to reduce risk from crop failure due to various factors.

- **Land Reforms:** Land reforms aim at equitable distribution of land and prevention of wealth concentration.
 - Reforms include abolition of intermediaries, tenancy reforms and land ceiling.
- **Key Initiatives and Programs:** Numerous programs have been launched to support agricultural development.
 - **National Innovations in Climate Resilient Agriculture (NICRA):** Focuses on climate-resilient technologies and practices.
 - **Sub-Mission on Agriculture Extension (SMAE):** Strengthens extension programs to empower farmers.
 - **Mera Gaon Mera Gaurav:** Connects scientists with farmers to provide technology and information.
 - **Attracting and Retaining Youth in Agriculture (ARYA):** Initiatives to engage youth in agriculture.
 - **Technology Demonstration Component (TDC):** Implements NICRA through KVKs to enhance resilience.
 - Krishi Vigyan Kendras (KVKs) play a key role in technology dissemination.
 - KVKs also conduct demonstrations, training and awareness programs on natural farming.
 - **Outscaling of Natural Farming:** A project by the Department of Agriculture and Farmers' Welfare, implemented by KVKs.
 - **Promotion of Agricultural Mechanization for in situ management of crop residue:** Scheme to promote use of technology for crop residue management through KVKs.
 - **Pulses Seed Hubs:** Initiatives for increasing pulses production.
 - India is the largest producer, consumer and importer of pulses.
 - **Cereal Systems Initiatives for South Asia (CSISA):** Program to improve cereal production systems.
- **Research and Development:** Government has supported agricultural research and development through the Indian Council of Agricultural Research (ICAR).
 - ICAR is the apex body for agricultural research and education in India.
 - ICAR releases new crop varieties and hybrids for commercial cultivation.
 - ICAR also supports research on livestock, fisheries and natural resource management.
 - ICAR promotes research, education and extension through agricultural universities and Krishi Vigyan Kendras (KVKs).
 - ICAR also documents traditional knowledge practices.

Regionally Differentiated Approach

- **Region-Specific Crop Promotion:** Government initiatives focus on boosting production of crops suitable for different agro-ecological zones.
 - **Oilseeds:** National Mission on Edible Oil-Oil Palm (NMEO-OP) targets oil palm cultivation in Northeast and Andaman & Nicobar Islands.
 - Aims to increase oil palm area from 3.70 lakh hectares to 10.00 lakh hectares by 2025-26.
 - **Pulses:** Government plans for area expansion and productivity enhancement for Tur, Moong, and Urad.
 - Focus on high-yielding, short-duration varieties and access to production technologies.
 - **Millet:** Initiatives to promote millet cultivation despite low adoption by farmers.
 - Addressing challenges to increase millet production.
 - **Rice:** Jaladhi variety of rice, developed by ICAR, is suited to waterlogged conditions.
 - Regionally specific rice varieties address challenges of climate change.
 - **Wheat:** Focus on reducing losses due to untimely rainfall and hailstorms.
 - Promoting climate-resilient wheat varieties adapted to regional conditions.

- **Addressing Regional Challenges:** Schemes consider regional variations in climate, soil, and water resources.
 - **Conservation Agriculture (CA):** Promotes practices like maintaining soil cover, minimum soil disturbance, and crop diversification, adapting to diverse climates.
 - CA is implemented through various sub-missions, including SMAE and SMSP.
 - **Natural Farming:** Bhartiya Prakritik Krishi Paddati (BPKP) promotes natural farming techniques adapted to different regions.
 - Implemented in eight states, aiming for behavioral changes in farming practices.
 - **Integrated Nutrient Management (INM):** Addresses nutrient imbalances and promotes efficient fertilizer use, considering regional nutrient deficiencies.
 - Focuses on balanced use of chemical fertilizers and alternatives.
- **Role of Schemes Like NMSA:** National Missions and Sub-Missions play a vital role in regionally differentiated agricultural development.
 - **National Food Security Mission (NFSM):** Special programs under NFSM support specific crops like rapeseed & mustard, soybeans, and sunflowers.
 - Focuses on distributing high-yielding varieties and improving cultivation techniques.
 - **National Mission on Natural Farming (NMNF):** Aims to upscaling chemical-free farming, emphasizing regional adaptation.
 - **Sub-Missions within the National Agriculture Development Programme (NADP):** Focus on addressing various challenges related to agriculture development.
 - This includes sub-missions for agricultural mechanization, seed production, plant protection, and agriculture census.

Agricultural Produce Market Committees (APMCs)

- **Role of APMCs in Agricultural Marketing:** APMCs were established to provide a regulated marketplace for agricultural produce.
 - APMCs are regulated markets, with some elected and some nominated members.
 - **Farmers take their produce to APMC mandis**, where sales occur through auction.
 - The stated objective of mandis was the welfare of farmers.
- **Impact of APMCs:** APMCs have had a mixed impact on agricultural development and food inflation.
 - **Challenges:** APMCs have not always functioned as intended and are facing various issues.
 - **Dependence on Arhatiyas:** Small, marginal, and tenant farmers are often dependent on commission agents (Arhatiyas) for credit.
 - Farmers often have to sell produce to Arhatiyas at low prices.
 - **Lack of Transparency:** Auction processes in APMCs often lack transparency, with prices controlled by cartels.
 - **Exploitation of Farmers:** Farmers are often exploited on the basis of crop quality and other charges.
 - **Large Mandi Coverage:** Large areas covered by a single mandi lead to increased transportation costs for farmers.
 - **High Commission:** Commission charges in APMCs can be very high.
 - **Post-Harvest Losses:** Lack of storage and grading systems can lead to post-harvest losses in mandis.
 - **Limited Reach:** More than 40% of agricultural trade occurs outside the APMC mandis.
 - **Taxation:** Mandis levy taxes, which are used to maintain infrastructure.
 - **Regional Disparities:** Mandi coverage is uneven; for example, Punjab has much better coverage than Meghalaya.
 - **Ineffective in Controlling Inflation:** Studies indicate APMC policies have had a negligible effect in controlling domestic inflation.

- **Need for APMC Reforms and Alternatives:** There is a need for APMC reforms, and new alternatives are required to address issues in agricultural marketing.
 - **Model APMC Act:** The central government circulated the Model APMC Act in 2003, but not all states have implemented it.
 - Some states have abolished APMCs while others have framed laws late.
 - **e-NAM:** e-National Agriculture Market is an online platform for a unified market across the country. (e-NAM - prev.)
 - Aims to create a single, unified market throughout the country to reduce price dispersion.
 - **Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020:** This act promotes intra- and inter-state trade of agricultural commodities outside APMC mandis.
 - Allows online trading, but has met with protests from farmers.
 - It also prohibits state governments from levying taxes on trade outside APMC mandis.
 - **Contract Farming:** Contract farming may divert land from food crops to exotic fruits and vegetables.
 - The second farm law relates to contract farming and includes dispute resolution mechanisms.
 - **Private Markets:** Private markets can also lead to exploitation of farmers due to lack of regulation.
 - Private markets may initially attract farmers with incentives and then lead to exploitation.
 - **Direct Purchase:** Direct purchase from farmers by large retailers could save commissions.
 - **APMC Bypass:** Farmers should sell non-perishable crops through mandis, while perishable crops can be sold directly.
 - **MSP and APMC:** 90% of rice produced in Punjab is non-basmati which is procured by FCI largely through mandis.
 - **Storage and Grading:** There is a need for improved storage and grading systems.
 - **Mandi Tax:** Niti Aayog says that a mandi tax of 1% is enough to maintain the mandis.
- **Alternative Marketing Channels:** There are alternative marketing channels that can reduce the number of intermediaries.
 - **Forward Linkages:** Forward linkages include needs after harvesting like transportation, warehouses, and value addition.
 - Value addition would increase the value of farmer's produce.
 - **Backward Linkages:** Backward linkages include all inputs for cultivation like seeds, fertilizers, and credit.
 - **Need to Organize Farmers:** There is a need to organize farmers into groups for collective farming and better bargaining.

Digital India and Agriculture

- **Digital India's Role in Improving Farm Productivity and Income:** Digital technologies are transforming Indian agriculture from traditional methods to precision agriculture.
 - **Precision Agriculture:** Digital tools such as sensors, drones, robotics, IoT, AI, and geo-informatics aid in precise input application.
 - **Input Application:** Drones can spray nutrients, fertilizers, and chemicals, increasing efficiency and reducing waste.
 - Also reduces human exposure to harmful chemicals.
 - **Real-time Data:** Market intelligence networks can collect real-time data on demand, supply, and prices of crops. (APMC-prev)
 - **Information Access:** Digital platforms provide farmers with crucial information on weather, market trends, and best practices.

- **Government Initiatives:** The government is promoting various digital platforms and apps to support farmers.
 - **Kisan Suvidha App:** Provides information on fertilizer dealers, stock, prices, machinery, seeds, soil health, crop insurance, and organic farming.
 - Helps farmers calculate subsidies and locate custom hiring centers.
 - **UMANG App:** Enables farmers to check beneficiary and payment status under PM-KISAN, and edit Aadhaar details.
 - **AGRISNET:** Provides informational services in Tamil Nadu.
 - **e-NAM:** e-National Agriculture Market is an online platform for market access (e-NAM - prev.).
 - Facilitates trade between farmers and consumers.
 - **KisanSarathi Platform:** Connects farmers with agricultural scientists through IVR, SMS, and mobile apps.
 - Offers services in 13 languages, reaching over 1.5 crore farmers.
 - **Millet Market App:** Facilitates marketing of millets and provides advisory services.
 - **Onion Crop Advisor App:** A tool to manage onion production effectively.
- **Digital Extension Services:** Government initiatives enhance extension services through digital tools.
 - **Sub-Mission on Agriculture Extension (SMAE):** Strengthens programs for food security, farmer empowerment, and ICT usage.
 - **Krishikosh:** A digital repository of agricultural documents with over 50 million digitized pages.
 - **ICAR SPARROW:** A digital platform for performance appraisal and recording.
 - **ATARI:** Provides zone-wise call and SMS services to farmers.
- **Improved Access and Transparency:** Digitalization promotes transparency and better access to services and information.
 - **e-PoS Devices:** Electronic Point of Sale (ePoS) devices are installed at Fair Price Shops (FPSs) for authentication of beneficiaries.
 - Biometric/Aadhaar authentication ensures accurate distribution of food grains.
 - **Reduced Intermediaries:** Digital platforms can help reduce the number of intermediaries in the supply chain.
 - **Unified Market:** The objective of e-NAM is to create a unified national market. (APMC-prev)
- **Specific Technologies:** Various technologies are being used to enhance productivity and efficiency.
 - **Agri-Drone Project:** Promotes the use of drones for input application in agriculture.
 - Aims to create awareness and demonstrate drone use in farmers' fields.
 - **Geo-informatics:** Used for precision agriculture by mapping soil properties and site suitability.
 - **Cloud-Based Irrigation:** Cloud-based networks enable real-time irrigation.

National Horticulture Mission (NHM):

- **Role of NHM in Promoting Horticulture:** The National Horticulture Mission (NHM) plays a crucial role in boosting India's horticulture sector.
 - **Holistic Growth: MIDH (Mission for Integrated Development of Horticulture)** aims to promote the holistic growth of the horticulture sector.
 - **Production Increase:** NHM focuses on increasing production of fruits, vegetables, and ornamental plants.
 - **High-Density Plantations:** NHM promotes high-density plantations, protected cultivation, micro-irrigation, and quality planting material.
 - **Improved Practices:** The mission supports improved horticultural practices, including precision farming, enhanced water-use efficiency, and horticulture-based cropping systems.

- **Technology Adoption:** NHM encourages adoption of latest technologies like ICT for efficient input management and knowledge transfer.
- **Post-Harvest Management:** The mission emphasizes post-harvest management and marketing to reduce losses and increase profitability.
- **Rejuvenation of Orchards:** NHM includes rejuvenation of senile orchards and improved cultivars.
- **Specific Sub-schemes:** NHM comprises sub-schemes like National Horticulture Mission (being implemented in selected districts) and Horticulture Mission for North East & Himalayan States (HMNEH).
- **Focus on specific crops:** NHM includes programs such as Special Programme on Rapeseed & Mustard and a special project to increase sunflower cultivation.
- **Success of NHM in Raising Farmer Income:** The success of NHM in raising farmer income is evident through various factors.
 - **Increased Production:** Increased production due to improved practices leads directly to higher income for farmers.
 - **Improved Efficiency:** Enhanced water-use efficiency and reduced post-harvest losses contribute to greater profitability.
 - **High-Value Crops:** Focus on high-value horticultural crops enables farmers to earn higher returns.
 - **Diversification:** Horticulture-based cropping systems offer diversification opportunities, reducing reliance on a single crop and increasing income stability.
 - **Value Addition:** Post-harvest management and marketing initiatives facilitate value addition, leading to better prices for farmers.
 - **Integrated Farming Systems:** Integration of coconut with other crops and livestock can significantly boost net income. For example, an integrated system using coconut, pasture crops, fodder trees, and goats achieved a net income of 2,54,206/ha.
 - **Improved Technologies:** Adoption of improved varieties and precision technologies directly enhance productivity and farmer profitability.

India: Essential Agricultural Data - Data Only

1. Chemical Fertilizer Consumption:

- 50-60 million tonnes/year
- Nitrogen (N) dominant
- 150-160 kg/hectare (avg)

2. Soil Degradation & Nutrient Deficiency:

- 120.40 million hectares (degraded)
- Nitrogen (N), Phosphorus (P), Potassium (K) deficiency
- Water Erosion: ~57.7 million hectares
- Chemical Degradation: ~14.4 million hectares

3. Organic Farming Area:

- 3.8 million hectares (certified)
- Madhya Pradesh, Rajasthan, Maharashtra (leading states)
- 10-15% annual growth

4. Government Spending:

- Fertilizer Subsidy: ₹1.5 - ₹2 Lakh crore (annual)

Case Studies:

- **Success Stories of Farmers Benefiting from Price Policy and Government Schemes:** Farmers have benefited from various government initiatives aimed at improving prices and providing support.

- **MSP Procurement: Farmers in Punjab and Haryana** benefit from Minimum Support Price (MSP) through Food Corporation of India (FCI) procurement for rice and wheat.
- **MSP + Bonus:** Government may announce a bonus over MSP to encourage FCI procurement if private traders offer higher prices. (MSP - prev.)
- **Integrated Farming Systems:** Shri M M Joydhar in Andaman and Nicobar Islands, increased income using integrated farming with pond, ducks, fish, fruits, and vegetables, after tsunami damage.
- **Natural Farming:** Farmers in Andhra Pradesh are using organic resources such as cow dung, sheep/goat droppings, and green manure to improve soil fertility.
- **Integrated Nutrient Management:** Farmers are utilizing organic and bio-fertilizers, along with chemical ones, for better soil health, supported by PM PRANAM scheme. (Fertilizers-prev.)
- **Custom Hiring Centers (CHCs):** Government promotes CHCs, enabling access to farm machinery, offsetting high costs for small landholders. (Mechanization-prev.)
- **Cases of Negative Impacts of APMCs and Need for Reforms:** The Agricultural Produce Market Committees (APMCs) have exhibited several issues.
 - **Exploitation:** Farmers are often exploited in APMC mandis through lack of transparency and bidding at lower prices.
 - **Commission and Charges:** Farmers incur high commissions and other charges in mandis, reducing their income.
 - **Delayed Payments:** Payments to farmers are not always upfront, causing delays of over a month in some areas.
 - **Limited Awareness:** Small, marginal, and tenant farmers are often unaware of MSP benefits and registration processes for government procurement. (MSP-prev.)
 - **Monopolies:** Private markets may initially offer incentives, but may lead to farmer exploitation by single buyers once APMCs are shut down.
 - **Regional Disparities:** MSP linked procurement is well-established only for few crops like rice, wheat, cotton and sugarcane in select regions, which leads to regional disparities.
 - **State Subject:** Agriculture being a state subject, the center is limited in its ability to intervene in APMC matters.

Storage, Transport and Marketing of Agricultural Produce and Issues and Related Constraints

Storage, Transport and Marketing of Agricultural Produce and Issues and Related Constraints Questions

- ☐ Analyse the functioning of dual pricing of sugar in India. Offer your comments. (82/20)
- ☐ Discuss the desirability of removing all controls in India on the import and export of agricultural commodities. (94/20)
- ☐ What is Agri-Trade? (06/2)
- ☐ What are the main constraints in transport and marketing of agricultural produce in India? (2020/10)
- ☐ What are the main bottlenecks in upstream and downstream process of marketing of agricultural products in India ? (22/15)
- ☐ From being net food importer in 1960s, India emerged as a net food exporter to the world. Provide reasons. (2023/15 marks)

Efficient storage, transport, and marketing are critical to minimize the 20-25% **post-harvest losses** in fruits and vegetables, improve farmer income by reducing intermediaries, and ensure better access to quality food for consumers.

Objectives of dual pricing.

- Dual pricing system: **levy sugar** (govt controlled) and **free sale sugar** (market-driven)
- Levy sugar: Govt. buys at lower price, distributes via PDS; **ensures affordability for poor**
 - PDS - Public Distribution System provides food grains at affordable prices

- Free sale sugar: Sold in open market, prices determined by demand and supply
- Dual pricing objectives:
 - Manage **scarcity** of food grains with affordable distribution
 - Ensure availability for needy via PDS
- Minimum Support Price (MSP) is announced for **sugarcane**
 - MSP intended to protect farmers from market risks
 - **Fair and remunerative price** for sugarcane also announced
- Sugar production: India is a **large producer of sugar**, sometimes largest
 - In 2021, Brazil was the largest producer of sugar
- Sugarcane: Wet lands in UP, Nepal border good for sugarcane
 - Requires a lot of water; Southern Karnataka also cultivates
- Sugarcane is sent to produce Ethanol
 - During Russia-Ukraine war, countries diverted sugarcane to produce ethanol
 - Price of crude oil is related to the price of sugar
- Molasses, a byproduct of sugarcane, is also used to produce ethanol

Critical analysis (impact on sugar industry, farmers, consumers).

- Dual pricing impacts: Sugar industry faces govt. control; market prices vary [prev.]
 - Levy sugar purchase at lower rates impacts industry profits
 - Free sale sugar subject to market volatility
- Farmers' income: FRP for sugarcane aims to protect from market risks [prev.]
 - Fair price sought, but payment delays sometimes occur
 - MSP is announced before the cultivation season
- Consumer impact: Dual pricing intends to make sugar affordable for poor [prev.]
 - PDS provides subsidized levy sugar
 - Free sale sugar prices vary based on market demand
- Public Distribution System (PDS): Government-sponsored chain of fair price shops
 - Distributes food and non-food items at low prices to the needy
 - 5.37 lakh fair price shops (FPSs) are entrusted with the work of distribution
- Food security system: PDS is a food security system under Ministry of Consumer Affairs
 - National Food Security Act (NFSA), 2013, aims to combat hunger
 - NFSA provides 5 kg of subsidized grains per person monthly
- Cereal subsidies have two kinds of effects
 - Households balance needs like calorific intake, diet quality, health, education
- Trade: India is a large exporter of rice, including basmati
- West Asia, North America, Western Europe are major markets for basmati rice
- African nations and Bangladesh are major markets for non-basmati rice
- Food security issues: Under-nutrition linked to food security and distribution
 - Rising food prices, poor implementation of schemes, and leakages contribute
 - The focus is on food distribution rather than only production
- Climate change and food security: Affects agriculture and food production
 - Extreme weather events and changing precipitation patterns cause crop losses
 - Heat waves can decrease production in tropical areas
- Global trade issues: India's foodgrain policies link to global trade
 - Disparities in subsidy practices between developed and developing countries
 - Need for reforms to create fair and equitable trading system
- Technology in PDS: Scheme for Modernization and Reforms through Technology (SMART-PDS)
 - Electronic Point of Sale (ePoS) devices installed in most FPSs
 - ePoS devices use biometric/Aadhaar authentication for beneficiary ID
 - SMART-PDS has the potential to bring transformative change
- Challenges in food security include climate change, rising prices, and population growth
 - Poor agricultural growth rate and environmental stress also factors

Agricultural Trade Policies:

- **Arguments for removing import and export controls:**
 - **Increased market efficiency:** Removing controls can lead to a more efficient allocation of resources, as prices will reflect true supply and demand.
 - **Enhanced competitiveness:** Domestic producers would be forced to improve efficiency and compete internationally.
 - **Greater access to global markets:** Removal of barriers would allow domestic producers to reach more consumers globally, potentially leading to higher profits and economies of scale.
 - **Lower consumer prices:** Increased competition from imports could lead to lower prices for consumers.
 - **Improved food security:** In theory, increased trade could improve food security by ensuring a more stable and diverse supply of food. GM crops, with higher yields, could reduce import dependence.
- **Arguments against removing import and export controls:**
 - **Protection of domestic producers:** Removal of controls could harm inefficient domestic producers who lack the competitiveness to survive in a global market.
 - **Food security concerns:** Removing controls could make the country vulnerable to price shocks and supply disruptions from the global market, particularly for essential crops. This is exacerbated in tropical countries due to climate change impacts.
 - **Unfair competition:** Developed countries might have unfair advantages, such as more subsidies, making it difficult for developing countries to compete.
 - **Potential for exploitation:** Removing controls could lead to exploitation of farmers, as they might be forced to sell their produce at low prices due to a lack of bargaining power.
 - **Price instability:** Removing controls could lead to price volatility, harming both producers and consumers.
 - **Loss of domestic industries:** Import liberalization may lead to the closure of domestic industries.
 - **Trade deficits:** Increased imports without commensurate export growth could lead to trade deficits.
 - **Market failures:** Agricultural markets often face inefficiencies. Complete liberalization without addressing these inefficiencies could lead to worse outcomes. There is a need for better infrastructure (warehousing, cold storage) to enable liberalization.

Impact of liberalization on agricultural trade.

- **Liberalization in India:** Increased competition, improved quality of production [prev]
 - Indigenous companies improved quality due to competition.
 - India has a large middle class with disposable income.
 - India is a good market to establish MNCs (Multinational Corporations).
- **Impact on farmers:** Could lead to exploitation, price volatility [prev]
 - Small farmers may lack bargaining power, be forced to sell low.
 - Contract farming may divert land from food crops to exotic fruits/vegetables
 - Need laws to protect farmers' interests in contract farming
- **APMC Mandis:** face competition from private markets post liberalization
 - Private markets have fewer regulations, but no guarantee against exploitation.
 - APMC mandis offer MSP, but also face exploitation.
 - Shift to private markets may shut down APMCs.
- **MSP:** Limited benefit to small, marginal, tenant farmers [prev]
 - Many unaware of MSP, lack land records to register for procurement.
 - Procurement often late and payments are delayed in many areas.
- **Infrastructure** needed for liberalization: Warehouses, cold storage, processing units [prev]
 - Lack of infrastructure leads to post-harvest losses and affects consumers.
 - Strict laws hinder investment in infrastructure

- Trade policies: India uses **export duties to curb inflation** [prev]
 - This may affect farmers who cultivate crops exclusively for export.
 - Holding curbs on produce affect processing units, which require stable policies
- **Food processing units:** Help reduce food wastage, generate employment [prev]
 - Correct rural-urban market imbalances.
 - Strict agricultural laws deter investment in food processing.
- **Agri-export:** India has low share (3%) in global trade despite large arable land
 - Agri-exports mainly comprise raw items, with a short shelf life.
 - Need to develop infrastructure to enhance trade.
- **Essential Commodities Act (1955):** Used to tame domestic inflation
 - Recent studies show a negligible effect in bringing down inflation.
 - This may spoil image as a credible trade partner.
- **Need for stable policies** to promote exports and attract investments [prev]
 - Present agri-export policy is ad hoc.
- **Farmers Produce Trade and Commerce Act, 2020:** Promotes trade outside APMC mandis
 - Permits online trading.
 - Prohibits state taxes on trades outside APMC mandis.
 - Farmers protested against these laws due to concerns
- **Concerns of farmers:** Lack of regulation in private markets [prev]
 - Auctions under officials in APMCs still lead to exploitation.
 - Private markets could exploit farmers without government intervention.
 - 90% of rice production in Punjab is non-basmati, procured by FCI through mandis.
- **Contract farming:** Sponsors prefer large farmers [prev]
 - Small farmers not trained, contracts framed to benefit sponsors.
 - May divert land from food crops to exotic crops.
 - Need laws to protect farmers and for collective farming.
 - Farmers Agreement on Price Assurance Act 2020, provides contract parameters.
- **Mandi taxes:** Punjab has 3% mandi tax and 3% rural development tax
 - If trade is outside the mandi, rural development taxes could be unbalanced.
- **No sustainable canal systems,** lead to reliance on ground water [prev]
- Ground water depletion is a problem.
- No capital for cold storage or processing units.
- **Need to liberalize agriculture markets:** To attract investment [prev]
- Agricultural markets are regulated by the states.
- APMC Mandis enjoy near monopoly status.
- India has a shortage of warehouses, cold storages, etc.
- Liberalization may help in preventing distress yield.

Agri-Trade

Agri-trade involves the activities, agencies, and policies in the procurement of farm inputs and the movement of agricultural produce from farms to consumers. This includes assembling, processing, and distribution. It also encompasses exports and imports of agricultural commodities.

- Agriculture is the primary source of livelihood for about 58% of India's population.
 - India ranks first in the world with highest net cropped area, followed by US and China.
- Share of agriculture and allied sectors in GDP of India at current prices was 19.9 % in 2020-2021.
- **India is the largest producer (25%), largest consumer (27%) and largest importer (14%) of pulses** in the world.
- The value of fruit and vegetable imports in the country amounted to over 214 billion Indian rupees in fiscal year 2023.
 - More than 16 percent of total imports of fruits and vegetables in the country came from China in 2017.

- **India has the largest area under rice cultivation** and is the second largest producer of rice after China.
 - India is a major exporter of both basmati and non-basmati rice.
 - Major markets for Indian basmati rice include West Asia, North America, and Western Europe.
 - African nations and Bangladesh are major markets for non-basmati rice.
- India is the second largest producer of fisheries.
 - Andhra Pradesh, West Bengal, and Gujarat are the largest producers of fisheries in India.
 - North America, Europe, East Asia and South East Asia are large markets for fish from India.
- **India is the largest producer of buffalo meat and sugar.**
 - Major markets for Indian buffalo meat are Egypt, Hong Kong, Vietnam, and Indonesia.
 - In 2021, Brazil was the largest producer of sugar.
- Gujarat followed by Maharashtra and Telangana are the largest producers of cotton.
 - Saurashtra is a most important area for cotton cultivation.
- **Edible oil is the most important imported good.**
 - Maximum imports are of palm oil, mostly from Malaysia and Indonesia.
- Until 1991, India was self-sufficient in edible oils.
 - In the last 3 decades there has been an increase in imports of edible oil.
- India's agricultural export comprises mainly raw items, which have a short shelf life and low-profit margin.
- India has the second largest arable land in the world, but its share in global trade of agri-commodities is just 3%.
- The Public distribution system (PDS) is a food security system established under the Ministry of Consumer Affairs, Food, and Public Distribution.
- The PDS includes a government-sponsored chain of approximately 5.37 lakh fair price shops.
- The Scheme for Modernization and Reforms through Technology in Public Distribution System (SMART-PDS) has transformative potential for India.
- The National Food Security Act (NFSA) of 2013 provides five kilograms of wheat, rice, and millets per person per month to priority households at subsidized prices.
- The government of India uses an agri-export policy for curbing inflation.
 - Export duties are imposed on crops to encourage farmers to sell in the domestic market.
- The objective of e-NAM is to create a single unified market throughout the country.
- The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020 promotes intra- and inter-state trade of agricultural commodities outside APMC Mandis.

Constraints in Transport and Marketing

1) Main constraints in transportation.

- **Inadequate infrastructure** such as warehouses, cold storage, pack houses, and ripening chambers, **hampers effective transportation.**
- **Transportation services are crucial for connecting production to markets**, but face various logistical challenges.
- **Poor road conditions** and a lack of efficient transport networks increase the time and cost of moving produce.
- **Lack of specialized transport facilities** for perishable goods contributes to post-harvest losses.
- **The absence of a well-organized supply chain** leads to delays and increased costs.

2) Main constraints in marketing of agricultural produce in India

- **Insufficient storage systems and grading practices** in *mandis* lead to significant post-harvest losses.

- **A lack of market information** prevents farmers from making informed decisions, resulting in price dispersion.
 - For instance, prices for the same rice variety can vary greatly between states.
- **Intermediaries in the supply chain** often increase costs for consumers while reducing farmer profits.
 - The longer the supply chain, the more the mediation charges.
- **Price fluctuations** make agricultural markets unpredictable, which harms both farmers and consumers.
- **Small and marginal farmers** are often dependent on local money lenders, leading to their exploitation.
- **Auctions in *mandis* often lack transparency**, which often causes farmers to receive low prices.
- **Farmers must pay numerous charges**, like weighing and commission fees, reducing their earnings.
- **APMC *mandis* have a near-monopoly** in agricultural markets regulated by states, which can limit farmers' options.
 - This affects both farmers and consumers.
- **The government procurement system is not well established**, with most PDS procurement from just Punjab and Haryana.
 - For example, 60% of wheat and 30% of paddy for the PDS is procured from Punjab and Haryana.
- **India's agricultural export mainly comprises of raw items**, which have short shelf life and low-profit margins.

3) Role of technology and effective management

- **Technology** plays a key role in providing market information to farmers and in streamlining operations.
- **e-NAM** provides an online platform to connect farmers directly with consumers.
- **The Scheme for Modernization and Reforms through Technology in Public Distribution System (SMART-PDS)** has transformative potential.
- **Electronic Point of Sale (ePoS) devices** are used in Fair Price Shops (FPSs) for authentication and electronic record-keeping.
 - Around 95% of FPSs now use ePoS devices with biometric/Aadhaar verification.
- **Online allocation orders of food grains** for all FPSs are now implemented in most States and UTs.
- **Computerization of the supply chain** manages stocks in godowns and their movement in 31 States/UTs.
- **Toll-free helplines and online grievance registration** are available in all States/UTs.
- **ICAR's Krishikosh** is a digital repository with 50 million digitized pages of agricultural documents.
- The **"Millet Market" app** helps in marketing millets and providing advisory services.
- **Effective management** is crucial for coordinating the various elements of the agricultural supply chain and marketing process.

Bottlenecks in Upstream and Downstream Processes

Bottlenecks in upstream processes (procurement, sorting, grading).

- **Procurement** faces issues due to a lack of **well-established systems and transparency**.
 - For example, **60% of wheat and 30% of paddy** for the Public Distribution System (PDS) is procured from Punjab and Haryana.
- **Auctions in *mandis* are often not transparent**, leading to lower prices for farmers.
 - **Buyers bid low** to procure crops at lower prices.
- **Farmers lack proper awareness** about government procurement processes.
- **Sorting and grading systems are inadequate** in many *mandis*, affecting the quality and price of produce.
 - **This leads to post-harvest losses.**

- **The quality of seeds affects agricultural productivity**, but many farmers use farm-saved seeds.
 - This leads to a **low seed replacement rate**.
- There are **delays in payments** to farmers by procurement agencies.
- **Farmers have to pay multiple charges** such as weighing and commission in mandis.
- **Small and marginal farmers** often struggle with access to credit, affecting their ability to procure inputs.
- **Fragmented land holdings** also lead to less use of machines, and affect overall productivity.
- **The high cost of certified seeds** limits their usage, despite their higher productivity.
- **Usage of chemical fertilizers in India has increased**, however, the usage is **non-uniform** across states.
 - Some states have very high usage while some have very low usage.

Bottlenecks in downstream processes (storage, distribution, processing).

- **India faces a shortage of warehouses, cold storage, pack houses, and ripening chambers**, affecting storage.
 - This leads to post-harvest losses and affects consumers and farmers.
- **Poor storage facilities** lead to post-harvest losses and affect the quality of agricultural products.
- There is a **lack of an efficient transportation system**, resulting in delays and spoilage of perishable goods.
 - **Poor road conditions** and a lack of specialized transport facilities increases transport time and cost.
- **Processing facilities are limited**, restricting value addition and shelf life of products.
- **Distribution systems** also face challenges in reaching remote areas and timely delivery.
- **Intermediaries** in the supply chain increase costs for consumers and reduce farmer profits.
 - The more intermediaries in a supply chain, the more are the mediation charges.
- **Price fluctuations** in agricultural produce are a significant issue in downstream processes.
- **The government procurement system is not well established** and faces many constraints.
- **Agri-markets** in the country are regulated by the states, where **APMC Mandis enjoy a near monopoly status**, which has affected both farmers and consumers.
- **There is a lack of a unified market** because the taxes levied are different in different states.
- **The agriculture sector** in India needs a lot of public and private investment, but strict regulations prevent this.

Transition from Net Importer to Exporter

Reasons for India's transition

- The **Green Revolution** significantly boosted agricultural productivity through high-yield varieties and improved techniques.
 - **Punjab and Haryana** are examples of regions that saw significant growth in wheat production.
- **Technology** has played a key role in improving agricultural practices, including better seeds and techniques.
 - **High Yielding Variety (HYV)** seeds increase agricultural productivity.
 - The **use of better quality seeds** increases agricultural productivity.
 - **ICAR** develops new varieties of seeds.
 - The **"Millet Market" app** facilitates marketing of millets and provides advisory services.
- **Government policies** have supported agricultural growth, including subsidies and various schemes.

- The government promotes **integrated nutrient management** through the PM-PRANAM scheme for organic farming.
 - There are also **subsidies on power used for agriculture**.
- **Farmer's hard work** and adoption of new practices have been crucial to the increase in production.
- **Subsidies and incentives** have encouraged farmers to invest in better inputs and technologies.
 - The government provides subsidies to open **custom hiring centers** for farm equipment.
 - The government provides subsidies on **fertilizers**.
- **Global demand** for agricultural commodities has also increased opportunities for Indian exports.
 - India is the **2nd largest producer of rice** in the world and is a major exporter of rice.
 - **West Asia, North America, and Western Europe** are major markets for Indian Basmati Rice.
 - **African nations and Bangladesh** are major markets for non-Basmati rice.
- **Policy framework** such as export policies that are used for curbing inflation have influenced the transition.
 - By imposing **export duties** on crops, the government encourages farmers to sell domestically.
- **India is the largest producer of sugar**, and the **largest producer of buffalo meat**, and a major exporter of both.
- **India ranks second in the production of fruits and vegetables** in the world, but the value of imports is still high.
- **India has the largest area under rice cultivation**, and is the second largest producer of rice after China.
- **India was self sufficient for edible oil till 1991**, but now imports 13-14 mmt of edible oil.
- **Natural gas** is a major raw material for urea production.
- **Russia** is a major supplier of natural gas in the world.

Essential Agricultural Data: India, US, China (Data Only)

1. Post-Harvest Losses:

- **India:**
 - Food Grains: 4-10%
 - Fruits & Vegetables: 15-25%
- **US:**
 - Food Grains: 2-5%
 - Fruits & Vegetables: 10-20%
- **China:**
 - Food Grains: 8-12%
 - Fruits & Vegetables: 20-30%

2. Agricultural Infrastructure Expenditure (Annual):

- **India:**
 - 10-15% of Agricultural Budget
- **US:**
 - Highly variable; No specific percentage of overall budget, but high investment
- **China:**
 - Significant investment, a mix of government and private expenditure.

3. Agricultural Trade Volume & Value:

- **India:**
 - Export Value: ~\$50-60 billion
 - Import Value: ~\$30-40 billion
- **US:**
 - Export Value: ~\$200-250 billion

- Import Value: ~\$150-200 billion
- **China:**
 - Export Value: ~\$70-80 billion
 - Import Value: ~\$200-250 billion

4. Agricultural Exports & Imports Trends:

- **India:**
 - Exports: Increasing (rice, spices, seafood, cotton)
 - Imports: Increasing (edible oils, pulses)
- **US:**
 - Exports: High (grains, soybeans, meat, processed foods)
 - Imports: High (fruits, vegetables, seafood)
- **China:**
 - Exports: Increasing (processed foods, fruits and vegetables, aquaculture)
 - Imports: High (soybeans, grains, meat, edible oils)

5. Government Spending & Schemes (Annual):

- **India:**
 - Total Agriculture Budget: ~3-4% of total budget
 - Fertilizer Subsidy: ₹1.5 - ₹2 lakh crore
 - *Note: Spending varies on schemes and budgets*
- **US:**
 - Agricultural Budget: ~\$150-200 billion
 - Subsidies & Support: High, for farmers and insurance
- **China:**
 - Agricultural Budget: High, specifics vary
 - Subsidies & Support: High, for inputs and production

Case Studies

Successful cases of improving agricultural supply chains.

- The **"Millet Market" app** was developed to facilitate marketing of millets and provide advisory services.
- **Electronic Point of Sale (ePoS) devices** are installed at Fair Price Shops (FPSs) to distribute food grains through authentication and electronic record-keeping.
 - About **95% of FPSs** have ePoS devices that confirm identification through biometric/Aadhaar authentication.
- The **Scheme for Modernization and Reforms through Technology in Public Distribution System (SMART-PDS)** has transformative potential.
 - Smart cards are used for data storage and check on counterfeiting.
- **Custom hiring centers** for farm machinery are being promoted by the government.
- The **e-National Agriculture Market (e-NAM)** is an online platform for markets between farmers and consumers.
 - The objective of e-NAM is to create a single unified market throughout the country.
- **Contract farming** is another way to improve the agricultural supply chain.

Examples of farmer cooperatives involved in marketing and storage.

- **Primary Agriculture Credit Society (PACS)** in Bihar is an example of a farmer cooperative that facilitates payment to farmers.
- **10 millet producer groups (MPGs)** were formed under the leadership of Millet Farmer Facilitators (MFFs) for millets promotion.
- The **National Agricultural Cooperative Marketing Federation of India (NAFED)** is involved in the procurement of crops.
 - NAFED is involved in the procurement of cotton.

Cases of challenges related to agricultural trade and exports.

- **European countries** rejected Indian basmati rice due to high pesticide residue.
- **Maximum Residue Limit (MRL)** for pesticides varies among countries.

- The **government imposed a ban on basmati exports** in August 2023.
- The **Essential Commodities Act, 1955** is used as a tool to tame domestic inflation.
- **India's share in world trade** of agricultural commodities is just **3%**.
 - Agricultural exports are mainly raw items with a short shelf life and low profit margins.
- There is a **lack of a unified market** because the taxes levied are different in different states.
- **Agri-markets in the country are regulated by the states**, where **APMC Mandis enjoy a near monopoly status**, which has affected both farmers and consumers.
- **India faces acute shortage of warehouses, cold storage, pack houses, ripening chambers, processing units**, etc.
- **90% of rice production in Punjab is non-basmati**, which is procured by FCI largely through *mandis*.
 - If farmers shift to private markets, it may lead to the shutting down of APMC *mandis*.
- **Private markets** have no regulations, and no direct intervention of the government.
 - There is no guarantee for farmers that they will not be exploited.
- **Monoculture** and **Groundwater depletion** are problems associated with **MSP**.
- **MSP** is provided for a few crops, so farmers are cultivating **water-intensive crops**, even in drought areas.
- **Small, marginal, and tenant farmers are not aware of MSP** and therefore find it difficult to get registered for government procurement.
- There are **delays in payment** under the government procurement system.
- **The government imposes a ceiling** on the maximum quantity that can be procured.

How does e-Technology help farmers in production and marketing of agricultural produce

☐ How does e-Technology help farmers in production and marketing of agricultural produce? Explain it. (150 words) (UPSC GS 3 2023/10 marks)

- **e-Technology aids farmers** in production through various applications and digital platforms.
 - The **"Onion Crop Advisor" mobile app** is a comprehensive tool designed for onion cultivation.
 - **ICAR Technologies Mobile App** provides information and resources to farmers.
- **e-LISS portal** and app provides an end to end solution of estimating production for livestock.
 - The e-LISS system has shifted from paper based surveys to a **digital platform**.
 - The system has 22,000 enumerators, 8,000+ supervisors and 730 district nodal officers.
- **KisanSarathi** connects farmers directly to agricultural scientists for issue resolution.
 - KisanSarathi is an **IVR based calling system** available in 13 languages.
 - More than **4,000 agricultural scientists and subject matter experts** are registered with this system.
- **e-NAM (National Agriculture Market)** is an online platform that connects farmers and consumers.
 - e-NAM aims to create a **single unified market** throughout the country.
- **Krishikosh** is a digital repository of valuable documents in the field of agriculture.
 - Krishikosh has **50 million digitized pages** in more than 3 lakh digital items.
- **Digital platforms** facilitate data collection and analysis for better decision-making.
 - A tool was developed to extract keywords along with frequency in different years from the metadata of thesis titles in Krishikosh.
- **SMS advisories** are sent to registered farmers by scientists using the KisanSarathi platform.

- The **"Millet Market" app** was developed for facilitating marketing of millets.
- **Electronic Point of Sale (ePoS) devices** are being installed at Fair Price Shops (FPSs) for distribution of food grains.
 - ePoS devices confirm identification through biometric/Aadhaar authentication and keep electronic records of sales.
- The **SMART-PDS** scheme uses technology for modernization and reforms in the public distribution system.
- **Soil health cards** are provided to farmers after testing soil samples to help in rationalizing fertilizer use.
- **The government promotes custom hiring centers** for farm mechanization, to make machinery available for farmers.
- **e-technology** can also provide farmers with information about **pesticides, risks associated, and alternatives**.

Subsidies and MSP: Issues related to Direct and Indirect Farm Subsidies and Minimum Support Prices

Subsidies and MSP: Issues related to Direct and Indirect Farm Subsidies and Minimum Support Prices Questions:

- ☐ What are 'Minimum Support Prices' in agricultural products? What are their objectives? (02/15)
- ☐ What are the different types of agriculture subsidies given to farmers at the national and at state levels? Critically analyse the agricultural subsidy regime with reference to the distortions created by it. [200 words] (13/10)
- ☐ Electronic cash transfer system for the welfare schemes is an ambitious project to minimize corruption, eliminate wastage and facilitate reforms. Comment. (GS 2, 13/10)
- ☐ In what way could replacement of price subsidy with Direct Benefit Transfer (DBT) change the scenario of subsidies in India? Discuss. (15/12.5)
- ☐ How do subsidies affect the cropping pattern, crop diversity and economy of farmers? What is the significance of crop insurance, minimum support price and food processing for small and marginal farmers? (250 Words) (17/15)
- ☐ What do you mean by Minimum Support Price (MSP)? How will MSP rescue the farmers from the low income trap? (18/10)
- ☐ Reforming the government delivery system through the Direct Benefit Transfer Scheme is a progressive step, but it has its limitations too. Comment. (GS 2, 22/10)
- ☐ What are the direct and indirect subsidies provided to farm sector in India? Discuss the issues raised by the World Trade Organization (WTO) in relation to agricultural subsidies. (250 words) (UPSC GS 3 2023/15 marks)

Subsidies in agriculture are financial aids for inputs, while **Minimum Support Price (MSP)** is a government-set price to protect farmers from market risks. **MSP** is often set at 1.5 times the cost of production.

Minimum Support Price (MSP)

Definition of MSP

- **MSP** is a **price support** offered by the government to **protect farmers** from market-related risks.
- It is the **minimum price** at which the government **purchases crops** from farmers.
- MSP is **calculated** by the **Commission for Agricultural Costs and Prices (CACP)**.
 - CACP recommends MSP to the government, and it is announced by the **Cabinet Committee of Economic Affairs (CCEA)**.
- **MSP is announced before the cultivation season**, enabling farmers to make informed decisions.
- **Fair and Remunerative Price (FRP)** is paid by traders where the price is set by the government.

As of now, CACP recommends MSPs of 23 commodities, which comprise 7 cereals (paddy, wheat, maize, sorghum, pearl millet, barley and ragi), 5 pulses (gram, tur, moong, urad, lentil), 7 oilseeds (groundnut, rapeseed-mustard, soyabean, seasmum, sunflower, safflower, nigerseed), and 4 commercial crops (copra, sugarcane, cotton and raw jute).

Objectives of MSP

- The primary objective of MSP is to **provide income support** to farmers and **protect them from price crashes**.
- It aims to **ensure a stable income** for farmers and **encourage** them to **produce essential crops**.
- MSP seeks to **safeguard farmers from exploitation** by private traders.
- The MSP also aims to **stabilize the market and ensure food security** by setting a benchmark price for crops.
- MSP is intended to **influence production** and guide farmers on what crops to cultivate.

Impact of MSP on farmer incomes and food security

- MSP provides **assured income** to farmers, particularly those growing crops that are procured under the scheme.
- The **Food Corporation of India (FCI)** procures crops at MSP when *mandis* do not.
- If private traders offer a better price than MSP, farmers can choose to sell to them, otherwise the FCI will procure at MSP.
- The **MSP system** is well-established only in **a few states**, mostly for crops like **rice, wheat, cotton and sugarcane**.
 - **60% of wheat** and **30% of rice** sold under the Public Distribution System (PDS) is procured from Punjab and Haryana.
- **MSP has led to regional disparities**, as it mainly benefits farmers in select regions.
- **Monoculture** has resulted from MSP as farmers tend to grow crops with assured procurement, leading to **groundwater depletion**.
- The MSP has **encouraged cultivation of water-intensive crops**, even in drought-prone areas.
- **Small, marginal and tenant farmers are often not aware of MSP** and find it difficult to register for government procurement.
- **Delays in payments** are also common in government procurement systems.
- **Procurement systems** are not well established across the country.
- The government imposes a **ceiling on the maximum quantity** that can be procured under MSP.
- The MSP policy has **avored few crops from select regions** which is considered a major reason for **groundwater depletion and monoculture**.
- If there is a **price crash**, the government is responsible for procuring the crops.
- To incentivize farmers to sell to the government, the government may announce a **bonus over and above MSP**.

How MSP Calculated

The Minimum Support Price (MSP) is calculated by the Commission for Agricultural Costs and Prices (CACP), which then makes recommendations to the government. The Cabinet Committee on Economic Affairs (CCEA) takes the final decision on the level of MSPs. The MSP is typically set at a level that is 1.5 times the cost of production.

Here's how the cost of production is calculated:

- **Cost A1** includes the value of hired human labor and hired bullock labor, along with other input costs such as seeds, fertilizers, and pesticides.
- **Cost A2** includes Cost A1, plus the rent paid for leased-in land.
- **Cost A2+FL** adds an imputed value of family labor to Cost A2.
- **Cost C2** includes Cost A2+FL, plus the imputed rent for owned land and interest on fixed capital.

The CACP takes into account the **average cost of cultivation** across different regions, as this cost is not uniform across the country. For example, costs of cultivation in Punjab include fertilizers,

machinery, and *mandis*, while in West Bengal, rainfall is also considered. The CACP also considers the **demand and supply** of a crop to calculate the MSP.

The states may also recommend prices to the CACP, although the CACP is not bound to accept these recommendations. The CACP will take the average cost of cultivation and calculate a weighted average cost based on the percentage of the crop produced in the state.

The **Swaminathan Committee** recommended that MSP should be set at 50% above Cost C2.

Currently, the government has accepted the recommendation to set MSP with a minimum 50% margin over A2 cost plus imputed cost of family labor.

The MSP is announced before the cultivation season so that farmers can make informed decisions about what crops to grow. However, despite the recommendation for 50% margin over cost, the CACP still considers demand-side factors when setting the MSP, in order to avoid market distortions.

It is also important to note that the MSP is not the final sale price for crops. The MSP is the price the government is willing to pay if the market price falls below that level. Farmers can sell their produce to private traders if they offer a higher price. The Food Corporation of India (FCI) procures crops at the MSP when private *mandis* do not. The government may also announce a bonus above the MSP to incentivize farmers to sell their produce to the government.

Example

If the Cost A2+FL is ₹10 per kg, then a 50% margin over that cost will make the MSP ₹15. If market prices do not support this price, the marketing system could collapse and the government may have to bear the losses.

Direct Benefit Transfer (DBT)

Concept of DBT

- **DBT** is a mechanism to **directly transfer subsidies** or benefits to **beneficiaries' bank accounts**.
- The aim is to **bypass intermediaries** and ensure that funds reach the intended recipients directly.
- This method is used for both **food and non-food** items.
- **Electronic Point of Sale (ePoS) devices** at Fair Price Shops (FPSs) aid in DBT through authentication and record-keeping.
 - About **95% of FPSs** use ePoS devices for **biometric/Aadhaar authentication**.
- The **One Nation One Ration Card (ONORC) scheme** also facilitates DBT and food security.
- The **Scheme for Modernization and Reforms through Technology in Public Distribution System (SMART-PDS)** has a transformative potential beyond food security for India.

Potential benefits (reduced corruption, efficiency)

- DBT aims to **reduce corruption and leakages** in the distribution system.
- It helps in **identifying the rightful beneficiaries** of government schemes.
- DBT can **improve the efficiency** of subsidy delivery by eliminating intermediaries.
- It promotes **transparency and accountability** in fund disbursement.
- **Data storage** and **check on counterfeiting** are other features of DBT cards.
- DBT enables **better tracking and monitoring** of funds usage.
- The **SMART-PDS** is expected to transform the Public Distribution System beyond just food security.
- Through the use of **ePoS devices**, **electronic record-keeping** of sales transactions are maintained.
- The **One Nation One Ration Card (ONORC) scheme** ensures that beneficiaries can access food from any ration shop in the country.

Limitations and Challenges of DBT

1. Limited Financial Literacy and Access

- Many beneficiaries lack awareness about DBT mechanisms and access to bank accounts or mobile banking services.

- *Example:* Studies show that rural women often face difficulty understanding account usage or tracking payments.
- 2. Inadequate Infrastructure in Rural Areas**
 - Poor banking penetration, lack of ATMs, and unreliable internet connectivity hinder smooth DBT implementation.
 - *Example:* Aspirational districts like Mewat (Haryana) face severe banking infrastructure gaps.
- 3. Delay in Transfers**
 - Administrative bottlenecks or technical glitches often lead to delayed transfers, causing hardship to beneficiaries.
 - *Example:* Farmers under the PM-Kisan Yojana have reported delays in receiving installments.
- 4. Exclusion Errors**
 - Eligible beneficiaries might be excluded due to lack of proper documentation or issues in database linking like Aadhaar.
 - *Example:* Migrant laborers were excluded during COVID-19 relief measures due to incomplete Aadhaar linkage.
- 5. Misuse of Aadhaar Data**
 - Concerns over data privacy and security have emerged due to dependence on Aadhaar-based authentication.
 - *Example:* The Aadhaar data breach controversy raised alarms about the vulnerability of sensitive beneficiary information.
- 6. Leakages Persist Through Middlemen**
 - In some cases, middlemen still play a role in withdrawing DBT amounts or coercing beneficiaries to share funds.
 - *Example:* Studies show instances in the Public Distribution System (PDS) where intermediaries exploited beneficiaries.
- 7. Behavioral Resistance**
 - Beneficiaries accustomed to the traditional subsidy model resist DBT, perceiving it as a reduction in benefits.
 - *Example:* Farmers in states like Tamil Nadu expressed dissatisfaction with DBT for fertilizers, citing trust issues with cash transfers.

How DBT Can Change the Subsidy Landscape in India

- 1. Minimizing Leakages**
 - DBT ensures direct cash transfers to beneficiaries, bypassing intermediaries, reducing pilferage.
 - *Example:* LPG subsidies under the PAHAL scheme eliminated over 4 crore ghost beneficiaries, saving ₹12,700 crores annually.
- 2. Enhancing Targeted Delivery**
 - By linking Aadhaar and bank accounts, DBT ensures subsidies reach only intended beneficiaries.
 - *Example:* PM-Kisan Yojana provides direct support to registered farmers, ensuring better-targeted assistance.
- 3. Boosting Financial Inclusion**
 - DBT encourages opening of bank accounts under schemes like Jan Dhan Yojana, promoting financial inclusion.
 - *Example:* Over 50 crore accounts have been opened under PMJDY, ensuring easier DBT transfer mechanisms.
- 4. Empowering Beneficiaries**
 - Beneficiaries receive funds directly, empowering them to decide how to use subsidies.
 - *Example:* Cash transfers in place of subsidized food enable tribal populations to buy preferred grains.
- 5. Administrative Efficiency**

- Digitization of records and automated transfers reduce administrative costs and processing time.
- *Example:* Implementation of DBT for scholarships under the NSP portal streamlined disbursements.
- 6. **Promoting Transparency and Accountability**
 - Digital tracking systems and public dashboards make subsidy delivery transparent.
 - *Example:* The DBT Bharat Portal tracks real-time transfer data across welfare schemes.
- 7. **Stimulating Behavioral Change**
 - Linking cash subsidies with specific outcomes encourages beneficiaries to adopt progressive practices.
 - *Example:* Linking fertilizer subsidies to soil health card recommendations fosters sustainable agriculture.

WTO and Agricultural Subsidies

Issues Raised by WTO

1. **Subsidy Inequities:** Disparities between developed nations' high subsidies and developing nations' minimal support raise fairness concerns.
 - *Example:* US and EU subsidies often outcompete Indian exports on global platforms.
2. **Amber Box Violations:** India's MSP for staple crops often breaches WTO's subsidy caps, leading to disputes.
 - *Example:* India faced challenges over its wheat and rice subsidy levels.
3. **Export Restrictions:** Ad hoc bans and duties on agricultural exports disrupt global trade norms.
 - *Example:* The 2023 basmati rice export ban affected food security in importing nations.
4. **Non-Tariff Barriers:** Importing nations impose strict standards like pesticide residue limits, challenging India's exports.
 - *Example:* EU's rejection of Indian rice due to Tricyclazole residue.
5. **Stockholding Policies:** India's public stockpiling of grains exceeds WTO limits, citing food security needs.
 - *Example:* WTO criticized India's buffer stock policies under the Food Security Act.
6. **Lack of Harmonized Standards:** Indian products face rejection for failing to meet global quality benchmarks.
 - *Example:* European nations rejecting fruits due to pest contamination concerns.
7. **Market Access Barriers:** Tariff and non-tariff measures in developed countries limit access for Indian agricultural goods.
 - *Example:* Tariff escalations on processed food items reduce India's competitiveness.
8. **Inflation-Driven Policy Shifts:** Frequent changes in export policies affect international market stability.
 - *Example:* Export curbs on onions during price hikes destabilize trade.
9. **Compliance with Subsidy Norms:** WTO's stringent monitoring mechanisms pose challenges for India's farm support programs.
 - *Example:* WTO's Trade Policy Review flagged India's subsidy declarations.
10. **Climate Change Implications:** WTO's push for eco-friendly farming challenges India's reliance on traditional methods.
 - *Example:* Subsidies for chemical fertilizers conflict with global sustainability goals.

Impact of Subsidies on International Trade

1. **Distortion of Domestic Markets:** Export restrictions shift surplus to domestic markets, depressing local prices.
 - *Example:* Farmers faced losses when wheat exports were restricted despite surplus production.
2. **Hindrance to Export Competitiveness:** High subsidy dependency reduces competitiveness in global markets.

- *Example:* Non-Basmati rice competes poorly against Thailand and Vietnam.
- 3. **Inflation Control vs. Trade Dynamics:** Subsidy-driven policies prioritize domestic inflation over stable exports.
 - *Example:* Pulses export bans during inflationary periods disrupted global supply.
- 4. **Infrastructure Deficiencies:** Limited cold storage, logistics, and processing facilities hinder quality exports.
 - *Example:* Fruits and vegetables lose value due to inadequate post-harvest storage.
- 5. **Export Dependency for Certain Crops:** Farmers cultivating export-specific crops face risks from sudden policy changes.
 - *Example:* Basmati growers in Punjab suffer from fluctuating export restrictions.
- 6. **Promoting Import Substitution:** Focus on self-sufficiency through GM crops and oil palm expansion reduces import dependence.
 - *Example:* National Mission on Edible Oil targets reduced palm oil imports from Malaysia.
- 7. **Adverse Trade Balances:** High imports of edible oils and pulses widen the trade deficit.
 - *Example:* India remains the largest importer of palm oil globally.
- 8. **Potential Growth in Niche Exports:** Expansion in sectors like fisheries, buffalo meat, and sugar enhances global trade prospects.
 - *Example:* Buffalo meat exports to Egypt and Indonesia are increasing.
- 9. **Digital Transformation in Trade:** Initiatives like e-NAM promote price discovery and market transparency.
 - *Example:* Farmers accessing better prices through unified digital platforms.
- 10. **Regulatory Reforms for Sustainability:** Upcoming policies like the Pesticides Management Bill aim to align exports with global standards.
 - *Example:* Streamlining pesticide use to meet international residue norms and boost export acceptability.

Role and significance of each element.

- **Minimum Support Price (MSP)** is an income support provided by the government to protect farmers from market risks.
 - It is calculated by the **Commission for Agricultural Costs and Prices (CACP)** and is recommended to the government.
 - MSP is announced before the **cultivation season** so farmers can make informed decisions.
 - The **Food Corporation of India (FCI)** procures crops if mandis do not pay MSP.
 - If private traders pay more than MSP, farmers will sell to them.
 - The government may announce a **bonus** to procure crops if private traders pay higher than the MSP.
- **Factors in calculating MSP** include the cost of cultivation, demand, and supply.
 - The cost of cultivation is not uniform across the country and is based on the average cost of cultivation.
 - States may recommend prices to CACP, but it is not bound to accept them.
 - The government increases MSP to encourage farmers to produce more of a crop.
- MSP-related procurement is well-established for rice, wheat, cotton, and sugarcane.
- 60% of wheat and 30% of rice sold under the Public Distribution System (PDS) are procured from Punjab and Haryana.
- The government imposes a ceiling on the maximum quantity that can be procured.
- **Procurement systems** are not well-established, and the government may not procure all crops or enough quantity.
 - This is a concern because the MSP policy favors a few crops in select regions.
- The MSP policy can lead to issues like **groundwater depletion** and monoculture of certain crops.

- Farmers should grow crops based on **agro-climatic conditions** to solve some of the issues with the MSP.
- Small, marginal, and tenant farmers are often unaware of the MSP and have difficulty registering for government procurement.
 - Payments are not made upfront in some areas and there are delays in payments.
- The government is promoting **millets** by announcing a profit for bajra and jowar, but it is not implemented.
- The **Public Distribution System (PDS)** is a food security system under the Ministry of Consumer Affairs, Food, and Public Distribution.
 - It is a government-sponsored chain of fair price shops distributing food and non-food commodities at cheap prices.
 - There are approximately **5.37 lakh fair price shops (FPSs)** in the country.
- The **National Food Security Act (NFSA) of 2013** is considered a revolutionary step towards fighting hunger.
 - It provides 5 kgs of wheat, rice, and millets per person per month at subsidized prices.
- The **Scheme for Modernization and Reforms through Technology in Public Distribution System (SMART-PDS)** has transformative potential.
 - Electronic Point of Sale (ePoS) devices at Fair Price Shops (FPSs) are used for distribution of food grains.
 - About 5.07 lakh (95%) of FPSs have ePoS devices that confirm identification through biometric/Aadhaar authentication.
- **Food processing** can increase the value of farmers' produce.
 - The government is working to increase food processing capacities.
 - Better development of infrastructure can increase Indian agricultural exports and increase farmers' incomes.
- The government has been working to improve **market infrastructure** with a market intelligence network to collect real time data on demand and supply and price of TOP crops.
- **e-NAM** (electronic National Agriculture Market) was created to establish a single unified market, and address concerns regarding price dispersion.
 - It is an online platform for markets between farmers and consumers.
 - There are concerns regarding price dispersion as the same variety of rice may be sold at 100 Rs/kg in Maharashtra and 200 Rs/kg in Arunachal Pradesh.
 - A farmer in a remote area may not have information on the price of a crop in different parts of the country, while the buyers have this information.
 - The goal of e-NAM is to create a unified market.

Case Studies: Successful Implementation of DBT

1. **PAHAL (Pratyaksh Hanstantrit Labh):** Direct transfer of LPG subsidy into beneficiaries' bank accounts curbed leakages and saved ₹75,000 crore by reducing ghost connections.
 - *Example:* Over 23 crore beneficiaries transitioned to DBT in the LPG scheme.
2. **PM-KISAN:** Farmers receive ₹6,000 annually in three installments, improving smallholder farmers' cash flow.
 - *Example:* Over ₹2.2 lakh crore disbursed to 11 crore farmers since its launch.
3. **Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA):** Wages transferred directly to workers' bank accounts, reducing corruption in fund disbursement.
 - *Example:* Wage payment delays reduced significantly in rural areas.
4. **Scholarship Schemes for Students:** DBT implementation in post-matric scholarships ensured timely delivery to beneficiaries without intermediaries.
 - *Example:* Over 1 crore students benefited from the scheme.
5. **Janani Suraksha Yojana (JSY):** DBT in maternity benefits promoted institutional deliveries, especially in rural and tribal areas.
 - *Example:* Over 10 crore women availed benefits since inception.

6. **COVID-19 Relief Packages:** Cash transfers under PMGKY during the pandemic ensured financial support to vulnerable sections swiftly.
 - *Example:* ₹500 per month transferred to over 20 crore Jan Dhan accounts.

Case Studies: Negative Impacts of Subsidies on the Environment and Market

1. **Fertilizer Subsidy and Soil Degradation:** Excessive use of subsidized urea led to nutrient imbalance in soils, reducing long-term fertility.
 - *Example:* Punjab and Haryana's overuse of nitrogenous fertilizers deteriorated soil quality.
2. **Electricity Subsidy and Groundwater Depletion:** Free electricity for agricultural pumps encouraged over-extraction of groundwater.
 - *Example:* Critical groundwater levels in northwestern states like Punjab.
3. **MSP for Water-Intensive Crops:** MSP on rice incentivized paddy cultivation in unsuitable regions, worsening water stress.
 - *Example:* Paddy cultivation in semi-arid Maharashtra.
4. **Distorted Crop Markets:** Overproduction of MSP-supported crops led to price crashes in non-MSP crops, hurting crop diversification.
 - *Example:* Farmers shifted away from pulses and oilseeds in favor of rice and wheat.
5. **Fisheries Subsidy and Overfishing:** Fuel subsidies for fishing boats contributed to overfishing, disrupting marine ecosystems.
 - *Example:* Coastal overfishing in Tamil Nadu and Kerala.
6. **Livelihood Challenges from Export Restrictions:** Subsidy-linked bans on agricultural exports disrupted global supply chains and farmer incomes.
 - *Example:* Export bans on onions during domestic shortages hurt exporters in Maharashtra.

Case Studies: Success Stories of Farmers Benefiting from MSP and Crop Insurance

1. **MSP for Wheat in Punjab:** Stable procurement through MSP enabled farmers to secure reliable incomes despite fluctuating market prices.
 - *Example:* Wheat growers in Amritsar earned 20% higher returns than non-MSP crops.
2. **Paddy MSP in Andhra Pradesh:** Farmers shifted to paddy cultivation due to guaranteed procurement under MSP, ensuring financial stability.
 - *Example:* Increased farmer incomes in Krishna and Guntur districts.
3. **Crop Insurance under PMFBY:** Timely compensation for crop losses due to floods in Bihar reduced farmer distress.
 - *Example:* ₹1,200 crore disbursed to affected farmers during the 2020 floods.
4. **Cotton MSP in Gujarat:** Guaranteed prices under MSP encouraged farmers to increase cotton cultivation, boosting rural livelihoods.
 - *Example:* Cotton farmers in Saurashtra benefited from assured minimum returns.
5. **Drought Mitigation through Insurance:** Farmers in Maharashtra's Vidarbha region survived drought-induced crop failures using PMFBY payouts.
 - *Example:* ₹3,500 crore provided to drought-affected farmers in 2021.
6. **Encouraging Oilseed Cultivation:** MSP for oilseeds like mustard in Rajasthan incentivized farmers to adopt crop diversification.
 - *Example:* Mustard farmers in Jaipur and Bharatpur districts reported improved incomes.

1. Data on Minimum Support Price (MSP) Procurement

- **Wheat Procurement:** In the 2022-23 marketing season, the government procured approximately 18.8 million metric tonnes of wheat.
- **Rice Procurement:** For the 2022-23 marketing season, rice procurement stood at around 60.2 million metric tonnes.
- **Oilseeds and Pulses:** Under the Pradhan Mantri Annadata Aay Sanrakshhan Abhiyan (PM-AASHA), year-wise procurement details are available, indicating significant

procurement to support farmers.

2. Statistics on Subsidy Expenditure

- **Agriculture Budget Allocation:** In the Union Budget for 2024-25, the central government allocated ₹6.2 trillion for the agriculture sector, constituting 13% of the overall budget of ₹48.2 trillion.
- **Food Subsidy:** The food subsidy allocation accounts for 30% of the entire agrarian budget, amounting to ₹2.05 trillion.
- **Fertilizer Subsidy:** The fertilizer subsidy accounts for 24% of the agriculture budget, with an allocation of ₹1.64 trillion.

3. Data on Farmers' Income and Indebtedness

- **Farmers' Debt:** Based on the NSS survey conducted in 2019, over half of agricultural households were in debt across India. Estimates put farmer debt at around ₹170 million as of 2021.
- **Non-Institutional Borrowing:** Marginal farmers account for about 71% of all non-institutional borrowers, followed by 16.9% for small farmers, indicating a reliance on informal credit sources.

4. Data on Digital Penetration and Accessibility in Rural Areas

- **Internet Users:** In 2023, India had 821 million internet users, with rural areas accounting for 442 million users, surpassing urban areas which had 378 million users.
- **Internet Penetration:** Internet penetration grew across the nation at a modest 8% year-on-year. Rural India is a clear majority, accounting for over 53% of the total user base.
- **Digital Adoption:** The growing internet penetration in India surpassed a new milestone of 800 million active internet users in 2023, meaning more than 55% of Indians used the internet last year.

Public Distribution System (PDS)

Public Distribution System (PDS) Question

- ☐ Examine the working of the Public Distribution System in India, with particular reference to its objectives and constraints. Suggest a set of measures towards an improvement in the present system. (250 words) (87/40)
- ☐ What are the factors that ensure the success of the Public Distribution System? (91/20)
- ☐ What is (Revised) Targeted Public Distribution System? What are its main features? (00/15)
- ☐ Comment on the recommendations of the Wadhwa Commission on the Public Distribution System. (10/5)
- ☐ What are the reformative steps taken by the Government to make food grain distribution system more effective? (2019/15)
- ☐ What are the major challenges of Public Distribution System (PDS) in India? How can it be made effective and transparent ? (22/10)

The **Public Distribution System (PDS)** is a **food security system** under the Ministry of Consumer Affairs, Food, and Public Distribution. It manages scarcity by distributing **food and non-food items** at affordable prices via a network of **fair price shops**. The PDS ensures access to essential commodities and has become an important part of the government's policy for managing the food economy in the country.

Functioning of PDS

Procurement of food grains.

- Foodgrains are procured at the **Minimum Support Price (MSP)** fixed by the Government of India.
 - For the Kharif Marketing Season (KMS) 2023-24, the MSP for common paddy was ₹2183 per quintal.

- The MSP for wheat for the Rabi Marketing Season (RMS) 2023-24 was fixed at ₹2125 per quintal.
- The government procures **coarse grains** under the Central Pool, and guidelines have been revised to facilitate this.
- The **Food Corporation of India (FCI)** and state agencies are involved in the procurement process.
 - **90% of rice production in Punjab is non-basmati** and is procured by FCI through Mandis.
- **Procurement of rice** varies by state.
 - In 2023-24, Chhattisgarh procured 83.00 lakh MT of rice, while Punjab procured 124.14 lakh MT.
 - Andhra Pradesh's rice procurement was 13.44 lakh MT in 2023-24.
 - Telangana procured 31.72 lakh MT of rice in 2023-24.
- The total **procurement targets** for the Central Pool are decided based on estimates given by State Food Secretaries.
- **Primary Agricultural Credit Societies (PACS)** in some states are involved in the procurement process, creating delays in payment.
- In some states, farmers sell to Arhatiyas who then sell to the FCI.
- In the past the MSP was announced by the government, now, **subsidies are fixed on the nutrients**, with the **Maximum Retail Price (MRP)** being variable.

Storage and distribution.

- The **Public Distribution System (PDS)** distributes food and non-food commodities through a network of **fair price shops (FPSs)**.
 - There are approximately **5.37 lakh fair price shops** in India.
- System-generated **online allocation orders** of foodgrains for all FPSs are implemented in most States/UTs.
- The **supply chain management of foodgrains** is computerized in many States/UTs for online stock management.
- **Toll-free helpline numbers** and transparency portals with online grievance registration are set up in all States/UTs.
- The **National Food Security Act (NFSA) of 2013** provides food entitlements to priority households at subsidized prices.
 - Priority households are entitled to 5 kgs of wheat, rice, or millets per person per month.
 - These are available at subsidized prices of ₹3/kg for rice, ₹2/kg for wheat, and ₹1/kg for millets.
- The **total offtake of foodgrains** from the Central Pool during the financial year 2023-24 was 555.32 lakh MT under NFSA.
- This includes 383.43 lakh MT of rice and 171.89 lakh MT of wheat.
- Additionally, 118.08 lakh MT of foodgrains were distributed under the **Open Market Sale Scheme (OMSS)**.
- The government maintains **buffer stocks of foodgrains** in the central pool.
 - As of April 1, 2024, the total central pool stock of rice in the East Zone was 25.70 lakh MT, and wheat was 6.00 lakh MT.
- The **Pradhan Mantri Garib Kalyan Ann Yojana (PMGKAY)** is a food security scheme launched in 2023.
- The **One Nation One Ration Card (ONORC)** scheme is being implemented across the country, which allows beneficiaries to access PDS benefits from any location.
- **Electronic Point of Sale (ePoS)** devices are used at Fair Price Shops for distribution and authentication.

Fair Price Shops (FPS)

- The Public Distribution System (PDS) operates through a network of approximately **5.37 lakh Fair Price Shops (FPSs)**.
- FPSs are responsible for distributing **basic food and non-food commodities** to needy sections of society.
- These shops provide commodities at very **cheap prices**, ensuring food security for vulnerable populations.
- FPSs are entrusted with distributing items through a **government-sponsored chain**.
- **Online allocation orders** are generated for all FPSs in many States/UTs, streamlining the distribution process [previous turn].
- Many States/UTs have computerized the supply chain for **online stock management** at FPSs [previous turn].
- **Electronic Point of Sale (ePoS) devices** are installed at FPSs for distribution of food grains.
 - As of now, **5.07 lakh (95.0%) of FPSs** have ePoS devices.
- ePoS devices confirm identification through **biometric/Aadhaar authentication**.
- **Toll-free helpline numbers** and **transparency portals** with online grievance registration are available in all States/UTs [previous turn].

Identification of beneficiaries.

- The **National Food Security Act (NFSA) 2013** provides food entitlements to priority households.
- State governments identify **priority households** as per guidelines from the Government of India.
- Priority households are entitled to **5 kilograms of foodgrains** per person per month at subsidized prices.
 - Subsidized prices are **₹3/kg for rice, ₹2/kg for wheat, and ₹1/kg for millets**.
- **Ration cards with data storage features** and counterfeit checks are being implemented in some states.
 - Such cards are used in **Haryana, Andhra Pradesh, and Odisha**.
- **ePoS devices at FPSs** help in identifying rightful beneficiaries through biometric authentication.
- The **One Nation One Ration Card (ONORC)** scheme enables beneficiaries to access PDS from any location [previous turn].
 - This helps **migrant workers** access food grains from any FPS across India [previous turn].
- The government aims to ensure that PDS benefits reach the **most vulnerable and marginalized** sections of society.

Objectives of PDS

Food security.

- The Public Distribution System (PDS) aims to ensure **food security** for the vulnerable sections of society.
 - It does this by providing access to essential food items at **subsidized prices**.
- The **National Food Security Act (NFSA) 2013** is a significant step towards fighting hunger.
 - It provides **food entitlements to priority households**.
- The PDS aims to maintain **buffer stocks of foodgrains** to ensure a continuous supply.
 - This helps to prevent **food shortages** and stabilize the market.
- Schemes like the **Pradhan Mantri Garib Kalyan Ann Yojana (PMGKAY)** further support food security.
 - It was launched in 2023 to ensure **availability of foodgrains**.
- The PDS distributes food grains, including **rice, wheat, and millets**.
 - The total offtake of foodgrains from the Central Pool during the financial year 2023-24 was 555.32 lakh MT under NFSA.

- The system works through a network of **5.37 lakh Fair Price Shops (FPSs)** across the country.

Price stabilization.

- The PDS helps in **stabilizing prices** of essential commodities by maintaining buffer stocks.
 - This is particularly important during periods of **scarcity or high demand**.
- The government fixes **Minimum Support Prices (MSP)** for various crops.
 - This ensures a minimum income for farmers and encourages production.
- In the past, the government fixed MSP for crops, but now **subsidies are fixed on the nutrients** instead with **variable MRP**.
- The PDS aims to provide foodgrains at **affordable rates** through FPSs.
 - This protects consumers from price fluctuations and profiteering.
- The **Open Market Sale Scheme (OMSS)** is also used to release foodgrains into the market to control prices.
 - In 2023-24, 118.08 lakh MT of foodgrains were distributed under OMSS.

Poverty alleviation.

- The PDS is designed to support **poor and vulnerable sections** of society.
 - It helps reduce poverty by ensuring access to food.
- Subsidized food grains provided through the PDS help **lower living expenses** for the poor.
 - **Priority households** under NFSA are entitled to food at subsidized prices.
- The PDS targets **needy sections** through a government-sponsored chain of fair price shops.
 - These shops provide essential items at **cheap prices**.
- The **One Nation One Ration Card (ONORC)** scheme allows beneficiaries to access PDS benefits from any location.
 - This helps the **migrant population** gain food security and reduces poverty.

Social welfare.

- The PDS contributes to **social welfare** by ensuring food security.
 - It provides a **safety net** for the vulnerable and marginalized.
- The system works through a network of **Fair Price Shops (FPSs)**, making food accessible.
 - There are 5.37 lakh FPSs that ensure that essential items are available to the needy.
- **Electronic Point of Sale (ePoS)** devices and **Aadhaar authentication** enhance transparency and accountability in distribution.
 - This makes sure the benefits reach the targeted population.
- The PDS also provides **non-food commodities** at subsidized prices.
- The system has **toll-free helplines** and **transparency portals** for grievance registration.
 - This promotes **accountability and responsiveness** within the system.
- The PDS enhances **social inclusion** by providing essential goods to all regardless of location.

Limitations/Constraints of PDS

Leakage and corruption.

- **Leakage and corruption** are significant issues affecting the PDS.
 - This results in **diversion of food grains** meant for beneficiaries.
- **Black marketing** of subsidized food items is a common problem.
 - This reduces availability for the **intended beneficiaries**.
- **Diversion of subsidized fertilizers** for industrial uses is an issue.
 - **Urea** meant for agricultural use is diverted to produce synthetic milk.
- **Ghost beneficiaries** exist on the ration card lists, leading to pilferage of food grains.
- **Intermediaries** exploit the system through malpractices at various levels.
 - These intermediaries can **manipulate supply chains** to their benefit.

- The **absence of proper monitoring** and enforcement mechanisms enable these issues.

Inclusion and exclusion errors.

- **Inclusion errors** occur when ineligible people are included as beneficiaries.
- This results in **undue benefits** to the non-poor.
- **Exclusion errors** happen when eligible people are left out of the system.
 - This means that **the most vulnerable** are denied access to food.
- **Lack of proper identification** mechanisms can lead to these errors.
 - Most **tenant farmers** do not have a record of lease and are not registered for government procurement.
- **Aadhar seeding** of ration cards is not complete, leading to errors.
- **Migrant workers** and people without permanent addresses are often excluded.
 - This hinders their access to benefits under the PDS.
- **Awareness** about the system is low among the marginalized population leading to exclusion.
- A number of small, marginal, and tenant farmers are not aware of MSP and government procurement.

Poor infrastructure and storage.

- **Inadequate storage capacity** leads to food grain wastage.
 - This can be because of **improper storage facilities**.
- **Lack of proper transportation** infrastructure affects timely distribution of food grains.
 - Poor logistics result in **spoilage** and quality reduction.
- **Insufficient number of Fair Price Shops (FPS)** in some areas creates access issues.
 - The locations of many FPSs are not convenient for all beneficiaries.
- **Poor condition of FPSs** and lack of amenities are common issues.
- This deters people from accessing food grains.
- **Lack of grading systems** in mandis can lead to post-harvest losses and reduced value.
- **Lack of cold storage** especially for perishable crops is a concern.

Lack of transparency and accountability.

- **Lack of transparency** in the PDS makes it difficult to monitor and detect irregularities.
 - This also prevents beneficiaries from understanding their entitlements.
- **Poor grievance redressal** mechanisms result in lack of accountability.
 - Beneficiaries struggle to file complaints and seek justice.
- **Limited use of technology** and lack of online tracking mechanisms hinder accountability.
 - This makes it challenging to monitor the movement of food grains.
- **Absence of social audits** and public participation enables corruption.
- **Irregular inspections** and weak enforcement leads to malpractices.
- **Delays in payments** to farmers by agencies adds to lack of accountability in the system.

Regional disparities.

- **Uneven distribution** of FPSs leads to regional disparities in access to food grains.
 - Some states have better infrastructure and distribution systems.
- **Procurement** is often concentrated in a few states like Punjab and Haryana, creating disparities.
 - 60% of wheat and 30% of rice for the PDS are procured from these two states.
- **Varying levels of awareness** among beneficiaries cause regional disparities in usage of PDS.
- **Different implementation models** in states affect efficiency of distribution of goods.
- **Regional preferences for certain crops** and dietary habits are not always addressed.
- This can cause less demand for some food grains in certain areas.
- **Groundwater depletion** due to excess cultivation of rice is a problem in some regions.

- This further exacerbates regional agricultural disparities.

Targeted Public Distribution System (TPDS)

Rationale for TPDS

- The **primary rationale** for TPDS is to provide **subsidized food grains** to the poor.
 - This is done to ensure food security for vulnerable populations.
- TPDS aims to **target specific groups** based on their socio-economic status.
 - This ensures that benefits reach those who are **most in need**.
 - Beneficiaries of the TPDS fall into one of two categories: "Households Below the Poverty Line" (BPL) and "Households Above the Poverty Line" (APL).
- It seeks to **reduce inclusion and exclusion errors** compared to a universal PDS.
 - By focusing on specific groups, it tries to minimize errors in targeting.
- TPDS is designed to **address the issue of food affordability**.
 - It provides food grains at **lower prices** than the open market.
- It aims to **reduce the financial burden** on the government by limiting coverage to the poor.
 - By targeting the poor, the overall subsidy burden is expected to decrease.
- TPDS **incorporates data storage** and checks on counterfeiting.
 - This intends to improve transparency and reduce leakages.

Key features of TPDS

- TPDS involves **identifying priority households** by the state governments.
 - These households are determined as per the **guidelines from the Government of India**.
- It provides **food entitlements** of 5 kg of wheat, rice, and millets per person per month.
 - These are given at subsidized prices of Rs. 3/kg, Rs. 2/kg, and Rs. 1/kg, respectively.
- TPDS utilizes a **network of Fair Price Shops (FPSs)** for distribution.
 - These shops are entrusted with the work of distributing basic food items to the needy.
- **Electronic Point of Sale (ePoS) devices** are used at FPSs to authenticate sales.
- This involves **biometric/Aadhaar authentication**.
- It incorporates **smart ration cards** with features of data storage and check on counterfeiting.
- **One Nation One Ration Card (ONORC)** scheme enables beneficiaries to access benefits anywhere in the country.
 - This enhances the portability of ration cards.

Advantages and disadvantages of TPDS

- **Advantages** of TPDS include:
 - It **targets the poor** and reduces inclusion errors.
 - It provides **subsidized food** at affordable prices.
- It enhances food security among vulnerable populations.
- It can reduce **overall financial burden** on the government.
- **Disadvantages** of TPDS include:
 - **Exclusion errors** persist despite targeting, leaving some poor out.
 - **Migrant workers** and people without permanent addresses are often excluded.
 - It is susceptible to **leakage and corruption** at various levels.
 - This includes **black marketing** and diversion of resources.
 - **Poor infrastructure** and lack of storage lead to wastage of food grains.
 - **Lack of transparency** and accountability continue to be issues in the system.
 - **Grievance redressal mechanisms** are often weak.
 - **Regional disparities** persist in access to and implementation of the system.
 - Distribution of FPSs is not even.
- **Technology** is not fully integrated leading to problems in delivery.

- There is **limited use of technology** and lack of online tracking mechanisms hinder accountability.

PDS Reforms

Government Initiatives

- The government has launched the **Scheme for Modernization and Reforms through Technology in Public Distribution System (SMART-PDS)**.
 - This aims to **transform** the PDS beyond just food security.
- **End-to-end computerization** of PDS operations has been implemented to improve efficiency.
 - This involves **digitizing data**, supply chain, and record-keeping processes.
- **Aadhaar linkage** has been made mandatory for beneficiaries to ensure authentic identification.
 - This is used for authentication during food grain distribution.
- The **One Nation One Ration Card (ONORC) scheme** allows portability of ration cards.
 - Beneficiaries can access their entitlements anywhere in the country.
- **Electronic Point of Sale (ePoS) devices** have been installed at Fair Price Shops (FPSs).
 - These devices confirm identification through biometric/Aadhaar authentication.
- The government has introduced **smart ration cards** with data storage and counterfeiting checks.
 - These cards improve the security and transparency of the PDS.

Role of Direct Benefit Transfer (DBT)

- **Direct Benefit Transfer (DBT)** is an alternative to the physical distribution of food grains.
 - It involves **transferring cash** directly to the beneficiary's account.
- DBT aims to **reduce leakages and corruption** in the PDS system.
 - It removes the need for physical handling and transportation of food grains.
- It provides beneficiaries with the **choice to purchase** food items based on their preferences.
 - This provides flexibility in buying their choice of food.
- However, DBT raises concerns about **food security** for beneficiaries if cash is used for other purposes.
- There is no guarantee that cash transfers will be spent on food.
- DBT has been considered **as an alternative** to the Targeted Public Distribution System.
 - **Universal PDS** has been considered as another alternative.

Impact of Technology in PDS

- **Technology** is being used for better identification of beneficiaries at the FPS.
- Electronic Point of Sale (ePoS) devices are used for authentication.
- **ePoS devices** confirm identification through biometric/Aadhaar authentication.
- This minimizes identification errors.
- Technology is being used for **electronic record-keeping** of sales transactions.
 - This improves the **transparency and efficiency** of the system.
- **Data storage** on smart cards reduces the risk of counterfeiting and fraud.
 - This helps in better **tracking and monitoring** of distribution.
- Technology can **enable real-time monitoring** of stock availability.
 - This helps in preventing shortages and diversion of food grains.
- Technology is used for **modernization and reforms** in the PDS through schemes like SMART-PDS.
 - This aims to create a transformative effect beyond just food security.

Measures for Improvement

Improvement of infrastructure and storage capacity

- There is a need to **improve infrastructure** for efficient distribution of food grains.

- This includes building more Fair Price Shops (FPSs) and ensuring their **even distribution** across regions.
- **Storage capacity** needs to be enhanced to reduce wastage of food grains due to spoilage.
- Proper storage facilities can prevent **post-harvest losses** in the PDS.
- Investments in transportation infrastructure can ensure **timely delivery** of food grains.
 - **Efficient logistics** can minimize delays and reduce transportation costs.
- It is essential to **modernize existing infrastructure** to prevent losses during storage.
- This includes building new warehouses and updating existing ones.

Reducing leakages and corruption

- Effective **monitoring and surveillance** mechanisms are required to prevent diversion of resources.
 - Regular audits and inspections of FPSs can reduce instances of corruption.
- **Stringent punishment** for those found guilty of malpractices can deter corruption.
- Implementing strong **legal frameworks** for penalties is needed.
- The use of **technology** can help in tracking and minimizing leakages in the system.
 - **Online tracking** can be used to monitor movement of food grains.
- **Direct Benefit Transfer (DBT)** can be implemented to bypass the physical distribution system.
 - It reduces the opportunity for leakages at various stages.

Improving transparency and accountability

- The PDS should be **made more transparent** by publishing relevant data online.
 - This includes **availability of stocks** and distribution details.
- **Grievance redressal mechanisms** should be made more robust and accessible.
 - Beneficiaries should have a clear avenue for registering complaints.
- Regular **social audits** of FPSs can ensure accountability and public oversight.
 - Community members can monitor the functioning of these shops.
- Implementing **online tracking** mechanisms can improve the accountability of the system.
 - This makes the distribution chain more visible.
- **Public awareness campaigns** can help ensure that the beneficiaries know about their rights.
- This also increases the accountability of those involved in distribution.

Community participation and monitoring

- **Local communities** should be involved in the monitoring and management of the PDS.
 - This fosters **ownership** and increases local accountability.
- **Community-based organizations (CBOs)** can help in raising awareness and ensuring proper implementation.
 - CBOs can bridge the gap between beneficiaries and the government.
- **Self-help groups (SHGs)** can be engaged to manage and monitor FPSs.
- SHGs can be more accountable to the community they serve.
- **Involving community** in social audits makes the PDS more transparent and accountable.
- This also enables a bottom up approach in implementing the PDS.

Use of technology for better targeting and delivery

- **Geographic Information System (GIS)** can help in mapping the beneficiaries and FPSs.
- GIS can help optimize delivery routes and identify gaps in coverage.
- **Data analytics** can be used to improve targeting of beneficiaries.
 - This also helps in identifying and rectifying any inclusion or exclusion errors.
- **Mobile applications** can be used by beneficiaries for information on entitlements and availability.
 - This provides more empowerment and control to them.

- **Electronic Point of Sale (ePoS) devices** can ensure secure and transparent delivery of food grains.
 - This makes transactions more traceable and accurate.

Role of Self-help groups

- **Self-help groups (SHGs)** can play a crucial role in managing fair price shops.
 - SHGs can also be a platform for local women to participate in community management.
- SHGs can ensure better last mile delivery and distribution of food grains.
 - This reduces the burden of local authorities to handle last mile delivery.
- They can be better positioned to maintain transparency and accountability.
 - This is because they are often from the same community.

Promoting awareness and community participation

- **Awareness campaigns** should be conducted to inform beneficiaries about their entitlements.
 - This also creates awareness about their rights under the PDS.
- The government should **utilize media** and local channels to spread information.
- This also ensures that information reaches the remotest of areas.
- **Community meetings and workshops** should be conducted to build awareness.
 - This enables the community to discuss, participate, and give feedback about the PDS.
- **Involving local leaders** and influencers can improve the effectiveness of awareness campaigns.
 - This can enhance community participation and reduce cases of exclusion.

1. Data on Public Distribution System (PDS) Beneficiaries

- **Coverage under the National Food Security Act (NFSA):** As of 2023, the NFSA aims to provide subsidized food grains to approximately 75% of the rural population and 50% of the urban population, covering about 800 million individuals across India.

2. Data on Food Grain Off-take and Stocks

- **Food Grain Off-take:** Between August 2022 and July 2023, the total off-take of rice and wheat under the PDS was approximately 71 million metric tonnes (MMT).
- **Food Corporation of India (FCI) Stocks:** As of December 2023, the FCI reported buffer stocks of food grains at 60 million tonnes, which is above the buffer norm of 30.7 million tonnes for this period.

3. Statistics on PDS Leakages

- **Leakage Estimates:** Recent studies estimate that PDS leakages amount to approximately 20 MMT of rice and wheat annually, translating to a financial loss of around ₹69,108 crore (US\$8.42 billion) in the fiscal year 2022-23.

Case Studies: Successful Cases of PDS Implementation in Different States

1. Tamil Nadu:

- **Success Story:** Known for its universal PDS model, Tamil Nadu provides subsidized rice, wheat, sugar, and kerosene to all residents.
- **Outcome:** Minimal exclusion errors and high levels of beneficiary satisfaction due to universal coverage.
- **Technology:** Early adoption of automation in Fair Price Shops (FPS) improved efficiency.

2. Chhattisgarh:

- **Success Story:** Pioneered reforms with its Chhattisgarh Food Security Act (2012) by enhancing transparency and accountability.

- **Outcome:** Leakage reduced from 40% to less than 10%.
- **Technology:** GPS-enabled tracking of food grain movement and SMS alerts for beneficiaries.
- 3. **Odisha:**
 - **Success Story:** Implemented targeted reforms like digitization of ration cards and e-PDS systems.
 - **Outcome:** Ensured food grains reached 96% of identified beneficiaries.
 - **Recognition:** Received the "Scotch Award" for innovation in PDS management.
- 4. **Kerala:**
 - **Success Story:** Offers a diversified basket including pulses and millets under PDS.
 - **Outcome:** High nutritional outcomes and low food insecurity.
 - **Community Involvement:** Strong monitoring through local governance.
- 5. **Andhra Pradesh:**
 - **Success Story:** Introduced biometric authentication for ration distribution.
 - **Outcome:** Significantly reduced duplicate and ghost beneficiaries.
 - **Technology:** Integration of Aadhaar with PDS.
- 6. **Haryana:**
 - **Success Story:** Migrated to DBT in place of in-kind food grain distribution in select areas.
 - **Outcome:** Beneficiaries received timely cash transfers, ensuring market freedom.
 - **Learnings:** Highlighted challenges of cash adequacy and price volatility.

Examples of Government Initiatives for Improving PDS

1. **One Nation One Ration Card (ONORC):**
 - **Objective:** Nationwide portability of ration cards to aid migrant workers.
 - **Outcome:** Implemented in all states, benefiting 80 million migrant workers.
2. **End-to-End Computerization of PDS:**
 - **Objective:** Ensure transparency through digitization.
 - **Outcome:** 100% ration cards digitized, and real-time monitoring enabled.
3. **Smart Cards for PDS:**
 - **State Example:** Introduced in Punjab, enabling faster and more transparent transactions.
4. **Fortification of Food Grains:**
 - **Objective:** Address malnutrition by distributing fortified rice.
 - **Outcome:** Implemented in aspirational districts and scaling nationwide.
5. **GPS Tracking of Supply Chains:**
 - **State Example:** Chhattisgarh and Rajasthan implemented GPS for tracking food grains to reduce diversions.
6. **Grievance Redressal Mechanisms:**
 - **Objective:** Set up call centers and District Grievance Redressal Officers under NFSA.
 - **Outcome:** Improved beneficiary complaint resolution rates.

Negative Impact of Corruption and Leakages and the Need for Reforms

1. **Leakages in Food Grain Distribution:**
 - **Example:** Studies indicate 40% food grain leakage in Bihar before reforms.
 - **Impact:** Reduced access for genuine beneficiaries and inflated costs.
2. **Diversion of Subsidized Food Grains:**
 - **Example:** Subsidized grains sold in the open market in Uttar Pradesh.
 - **Impact:** Adversely affects food security and government credibility.
3. **Ghost Beneficiaries:**
 - **Example:** Detection of 1.9 crore fake ration cards during digitization.
 - **Impact:** Wastage of subsidies meant for the poor.
4. **Operational Inefficiencies:**
 - **Example:** Delays in food grain supply due to outdated logistics in Assam.
 - **Impact:** Loss of food grains and increased storage costs.

5. Exclusion Errors:

- **Example:** Poor identification processes led to the exclusion of eligible families in Rajasthan.
- **Impact:** Widening inequality and loss of faith in government schemes.

6. Need for Comprehensive Reforms:

- **Measures Suggested:**
 - **Strengthen Monitoring:** Deploy AI and blockchain for tracking.
 - **Improve Identification:** Regular updates to beneficiary databases.
 - **Promote Decentralization:** Engage local bodies in PDS oversight.

Negative impact of corruption and leakages and the need for reforms

- Diversion of resources leads to less food grains reaching the intended beneficiaries.
 - This has implications on food security and causes malnutrition.
- Leakages in the PDS reduce the effectiveness of government spending on food subsidies.
 - This wastes public funds and distorts the intended goals of the program.
- Corruption at fair price shops results in beneficiaries not receiving their full entitlements.
 - This causes distress among vulnerable populations and leads to food insecurity.
- Lack of transparency and accountability enables corrupt practices to flourish.
 - This needs to be addressed to enhance public trust in the system.
- Post-harvest losses due to inadequate storage and handling also reduce overall food availability.
 - Improving storage facilities is important to minimize this wastage.
- Black marketing of urea occurs when the demand is high and supply is low leading to a shortage for farmers and increasing import costs.
 - This impacts productivity and profitability for farmers.
- Overuse of pesticides leads to the development of resistance in pests and creates an unhealthy environment.
 - This results in reduced effectiveness and causes more problems with food production.
- Non-uniform distribution of irrigation in regions leads to unequal access for farmers and creates disparities.
 - The lack of access to water can lead to crop failures

Food Security: Issues of Buffer Stocks and Food Security

Food Security: Issues of Buffer Stocks and Food Security Question

- ☐ What is 'procurement price' for food grains? What purpose does it serve? (81/3)
- ☐ A large quantity of food grains and fruits lost each year after harvesting and during marketing. Describe briefly the steps taken in recent years to prevent these losses. (82/20)
- ☐ Per Capital per day, availability of cereals in India has during the last two decades (i) remained constant (ii) gone up (iii) gone down. Give two major factors responsible for the situation. (84/3)
- ☐ India requires 225 million tonnes of food grains by the end of the twentieth century. Briefly discuss the elements of the strategy of agricultural growth that can ensure an increase in food grains output to meet this projected demand. (84/20)
- ☐ What do you mean by Government Buffer Stock Operations? (93/3)
- ☐ Why was the rationale for 'Mid-day Meal' Scheme? (97/3)
- ☐ Discuss the role of modern technological inputs on agricultural development in India. How would it be helpful for food security during 21st century? (250 words) (99/40)
- ☐ What is the rationale for 'Mid-day Meal' Scheme? (00/2)
- ☐ With what objectives was 'Annapurna' Scheme launched? (02/2)
- ☐ "Small-holder farms need to be strengthened to achieve national food security." Do you agree with this assessment? (10/24)
- ☐ Explain various types of revolutions, took place in Agriculture after independence of India. How these revolutions have helped in poverty alleviation and food security in India? (150 words) (17/10)
- ☐ What are the salient features of the National Food Security Act, 2013? How has the Food Security Bill helped in eliminating hunger and malnutrition in India? (21/15)

Food security exists when all people have physical, social, and economic access to sufficient, safe, and nutritious food. It's crucial for a healthy life and includes availability, access, utilization, and stability of food. **India's food security** programs aim to combat hunger and malnutrition.

Procurement Price

Definition and purpose of procurement price

- The **Minimum Support Price (MSP)** is a form of income support provided by the government to farmers to protect them from market risks.
 - **MSP** is calculated by the **Commission for Agricultural Costs and Prices (CACP)**, then recommended to the government and finally announced by the **Cabinet Committee of Economic Affairs (CCEA)**.
- The **MSP** is always announced before the cultivation season so that farmers can make informed decisions before sowing.
- **Procurement price** is used to procure food grains at the **Minimum Support Price (MSP)** fixed by the Government of India.
- Foodgrains are procured at the **MSP** for the Central Pool.
- If the market price falls below **MSP**, government agencies like the Food Corporation of India (**FCI**) purchase crops at the **MSP**.

How does it impact the supply and price

- **MSP** aims to ensure fair prices for farmers, influencing crop production and supply.
- If private traders offer better prices than **MSP**, farmers may sell to traders instead of government agencies, impacting public procurement.
- To encourage procurement, the government may announce a bonus over the **MSP**.
- When the government increases **MSP**, it encourages more farmers to produce that crop leading to an increase in supply.
- The government may limit the maximum quantity of crops procured at **MSP**.
- The **MSP** policy often favors select crops from specific regions, which can lead to problems like groundwater depletion and monoculture.
- If demand for a crop is high, but the supply is low, it can lead to black marketing of that crop.
- **Procurement** of crops through **APMC Mandis** is well-established only for some crops such as rice, wheat, cotton and sugarcane.
 - Rice and wheat are procured by **FCI** or State Food agencies, while cotton by the Cotton Corporation of India (**CCI**).
- **MSP** linked procurement is well established only in a few states with 60% of wheat and 30% rice procured for the Public Distribution System (**PDS**) coming from Punjab and Haryana.
- The **FCI** will decide to build a godown in a state like Punjab because of its large surplus.
- **Procurement** systems are not well established, and government may not procure crops in surplus.
- **MSP** is not a provision in private markets.

Post-Harvest Losses

Causes of post-harvest losses

- **Post-harvest losses** occur due to a lack of adequate **warehouses, cold storage, and processing units**.
- Inadequate **storage systems** and grading systems contribute to post-harvest losses in *mandis*.
- A lack of **ripening chambers** also leads to **post-harvest losses**.
- **Transportation and handling** issues cause losses of agricultural products.

Measures to prevent losses (infrastructure, cold storage, technology, farmer awareness)

- Developing infrastructure such as **warehouses, cold storage, pack houses, and processing units** can prevent losses and distress sales.
- **e-National Agriculture Market (e-NAM)** is an online platform to provide information on prices for farmers.
 - **e-NAM** aims to create a unified market throughout the country, thereby reducing exploitation.
- **Market intelligence networks** can collect real time data on demand, supply, and prices of crops, which can help to reduce losses due to price volatility.
- **Custom hiring centers** for farm machinery can help farmers with harvesting and processing, decreasing the time between harvest and sale, therefore decreasing post harvest losses.
- Providing farmers with better quality seeds increases agricultural productivity, further reducing losses.
- **Integrated nutrient management** strategies promote soil health and better crop yields.
- The government promotes **organic farming** to improve soil health and reduce the need for chemical fertilizers that degrade the soil.
- **Neem coating of urea** improves nitrogen efficiency, which leads to increased crop yield and reduces the need for high usage of fertilizers.
- Using **Pheromone traps** to control pests reduces crop loss by controlling bollworms in cotton.
- Government initiatives such as the **Sub-Mission on Agriculture Extension** aim to strengthen programs to achieve food security and empower farmers.
- **Sub-Mission on Seeds and Planting Material** increases production of quality seed and improves farm saved seeds.
- The use of technology like the **e-LISS app** provides data on livestock commodities.
- The **PM-PRANAM** scheme aims at promoting balanced use of chemical fertilizers while creating awareness about regenerative agriculture.
- The government promotes **Zero Budget Natural Farming (ZBNF)** techniques to reduce reliance on purchased inputs and improve soil health.
 - **ZBNF** also focuses on water conservation practices such as replenishing farm ponds and promoting earthworms to increase soil organic matter.

Per Capita Cereal Availability

Trends in Cereal Availability in India Over the Last Few Decades:

1. **Per Capita Availability of Cereals:**
 - **1970s to 1990s:** Steady increase due to the Green Revolution, higher agricultural productivity, and improved irrigation.
 - Example: Per capita cereal availability was around **400 grams/day** in the mid-1970s and rose to about **470 grams/day** in the 1990s.
 - **Post-1990s:** Decline in per capita cereal availability due to population growth outpacing production and dietary diversification.
 - Example: Dropped to approximately **440 grams/day** in the 2000s and further to around **430 grams/day** by 2015.
2. **Production Trends:**
 - **Increased overall production** due to improved farming practices and technology, but availability per capita did not grow proportionally due to high population growth.
 - Total cereal production rose from **100 million tons in 1970-71** to over **300 million tons in 2020-21**.
3. **Diversification of Diets:**

- Shift from cereal-based diets to diets including more fruits, vegetables, and animal-based products contributed to reduced per capita cereal consumption.
4. **Policy Interventions:**
- Government programs like the Public Distribution System (PDS) ensured cereal availability for vulnerable populations, but did not significantly affect overall per capita trends.

Factors affecting this trend (population growth, production levels, policies, consumption patterns)

- **Population growth** is a major factor influencing per capita availability, as higher populations increase demand on food resources.
- **Production levels** of cereals are affected by factors like **monsoon**, **soil health**, and the adoption of new technologies.
- **Government policies** such as the **Minimum Support Price (MSP)** can encourage the production of certain cereals.
 - If the government increases **MSP**, it encourages more farmers to produce that crop leading to an increase in supply.
 - The **MSP** policy often favors select crops from specific regions, which can lead to problems like groundwater depletion and monoculture.
- **Cropping patterns**, which are influenced by MSP, determine the type and amount of cereals produced.
- **Consumption patterns** are driven by income levels. Low-income populations spend a large proportion of their income on cereals.
- **Food security** is impacted by the availability and affordability of food.
- Changes in dietary habits and an increase in per-capita income lead to a demand for items other than cereals.
- The **Public Distribution System (PDS)** impacts cereal consumption and access by distributing subsidized food to vulnerable populations.
 - The **NFSA** entitles priority households to five kilograms of wheat, rice and millets per month at subsidized prices.
- The scheme for **Modernization and Reforms through Technology in Public Distribution System (SMART-PDS)** has the potential for transforming food security.
- **Cereal subsidies** influence household consumption and budget allocations, impacting the quality of diets and other needs.
- India's foodgrain policy reflects global agricultural trade issues, including disparities in subsidies between developed and developing countries.
- **Climate change** is a growing concern, and it affects agriculture through changes in temperatures and precipitation patterns.
 - If temperature increases in tropical areas, the agriculture will increase in temperature but in tropical regions, that increase will lead to heat waves which lead to a decrease in production.
- **Soil health** impacts long-term productivity. The government is promoting integrated nutrient management, organic farming, neem coating of urea, and Zero Budget Natural Farming to improve soil conditions and reduce reliance on chemical fertilizers.

Agricultural Growth Strategies

Measures to meet the food grain demand

- To meet food grain demand, it is important to increase **agricultural productivity** through **better quality seeds** and **high yielding varieties**.
 - Examples include the **Jaladhi variety of rice** which can survive waterlogging and **PBWS1** a wheat variety resistant to starch.
- The **Sub-Mission on Seeds and Planting Material (SMSP)** aims to increase production of certified seeds and improve farm saved seeds.

- The government promotes the use of **Genetically Modified (GM) crops** to increase productivity and reduce dependence on imports.
 - However, **GM crops** can develop resistance to pests and also lead to monopolies by the companies that create them.
- **Crop diversification** is important to stabilize yields and improve resilience to climate change.
- **Integrated nutrient management** improves soil health, contributing to better yields and reduced input costs.
- **Expanding irrigation infrastructure** can help increase production by reducing the dependence on monsoon rains, although the distribution of irrigation is not uniform.
- **Improving water management** through replenishing water bodies, like farm ponds, ensures water availability during dry spells.
- **Promoting agricultural mechanization** through custom hiring centers can help farmers with harvesting and processing.
 - However, this may displace agricultural labor, creating a need to evaluate the introduction of machines.
- The **Public Distribution System (PDS)** helps make food grains available to vulnerable populations at affordable prices.
 - The **National Food Security Act (NFSA)** ensures subsidized food grains for priority households.
- **Food processing capacities** and value addition can be enhanced with firm linkages with production clusters.
- Implementing a **market intelligence network** to collect data on demand, supply, and price of crops can improve market efficiency.
- **Zero Budget Natural Farming (ZBNF)** practices reduce reliance on purchased inputs and improve soil quality.

Technology driven approach (high-yielding seeds, precision farming, etc.)

- **High-yielding seeds** are essential for increasing agricultural productivity.
 - **ICAR** develops new varieties of seeds like **Pusa Basmati 1121** and the **Jaladhi variety of rice** that is resistant to water logging.
- **Precision farming** techniques include using technology like the **e-LISS app** for data collection on livestock.
- **Krishikosh** is a digital repository of valuable documents in the field of agriculture.
 - It has 50 million digitized pages in more than 3 lakh digital items including old books and journals.
- **e-National Agriculture Market (e-NAM)** is an online platform that provides market information and seeks to create a unified national market for agricultural produce.
- **DNA fingerprinting** of medicinal rice varieties, like 'Njavara', aids in preserving genetic resources.
- **Mobile apps** like "Millet Market" facilitate marketing of millets and provide advisory services.
- **Electronic Point of Sale (ePoS) devices** at Fair Price Shops (FPSs) enable the distribution of food grains through authentication and electronic record-keeping.

Sustainable agricultural practices

- **Conservation agriculture** improves soil health, enhances resource use efficiency, and increases climate resilience.
- **Regenerative agriculture** improves soil health, increases water-holding capacity and carbon sequestration and biodiversity.
- **Organic farming** is being promoted to improve soil health and reduce reliance on chemical fertilizers.
 - The government launched the **Paramparagat Krishi Vikas Yojana** in 2015-16 to promote organic farming through a cluster based approach.
- **Neem coating of urea** improves nutrient-use efficiency.

- **Zero Budget Natural Farming (ZBNF)** is a natural farming technique that avoids the use of chemicals and purchased inputs.
- **Water conservation** is important in ZBNF, which includes replenishing water bodies like farm ponds.
- **Crop rotation** and intercropping can enhance soil fertility and reduce pest infestations.
- Using **Pheromone traps** for pest control in cotton fields is an environmentally friendly practice.
- **Integrated Pest Management (IPM)** centers help farmers implement practices to reduce pest damage.
- The government is promoting the **PM-PRANAM** scheme to encourage the balanced use of chemical fertilizers and create awareness about regenerative agriculture.
- Adopting **climate-smart agriculture** practices is important for long-term food security, as it delivers on climate-related objectives.
- Diversified cropping systems, such as incorporating summer mungbean into rice-wheat and maize-wheat systems, improve productivity.
- The government is promoting the use of **bio-fertilizers** and **vermi compost** instead of chemical fertilizers.

Buffer Stock Operations

Definition and objectives of government buffer stock operations

- Buffer stock norms for foodgrains aim to meet food security needs and maintain supply.
 - This helps with monthly releases through the TPDS and other welfare schemes.
- Buffer stocks also address emergencies like crop failure and natural disasters.
- Operational stocks fulfill distribution needs under public schemes.
- **Strategic reserves** are surplus stocks held by the Food Corporation of India.
 - These stocks stabilize food prices and address urgent grain demands.
- The government procures grains at Minimum Support Prices (MSP) to build stocks.
 - **MSP** is announced before cultivation, helping farmers make informed decisions.
- Buffer stock operations maintain foodgrain supply and price stability in the market.
- Food Corporation of India (FCI) is the main agency for these operations.
 - FCI procures grains and maintains the buffer stock.
- Open-ended procurement means the FCI buys large quantities, becoming a last resort buyer.
 - Procurement prices can effectively become the price for all sales.
- Buffer stocks are utilized during times of contingency or when demand and supply are uneven.
- The government aims to encourage farmers to produce more by increasing MSP.

Mid-day Meal Scheme

Rationale behind the scheme (improved nutrition and education)

- The Mid-Day Meal scheme, also known as PM Poshan, aims to **improve nutritional levels** of school children.
 - It provides hot cooked meals in government and government-aided schools.
- The scheme also has the objective of **enhancing enrollment, retention, and attendance** in schools.
 - Regular meals can incentivize students to attend school more consistently.
- PM Poshan helps address classroom hunger and aims to **improve educational outcomes**.
- The program is designed to particularly benefit children from disadvantaged backgrounds.
- By providing a regular meal, the scheme aims to reduce nutritional deficiencies among students.
- The scheme provides nutritional support to children along with educational support.
- The Mid-Day meal scheme provides a way to improve nutritional indicators and educational access.

- The program ensures children have a **nutritious meal**, which is crucial for their development.
 - This can lead to better physical and cognitive development.
- By improving nutrition and education, the scheme contributes to the overall development of children.

Annapurna Scheme

Objectives of the scheme (food security for senior citizens)

- The Annapurna Scheme aims to provide **food security** to indigent senior citizens who are not covered under the National Old Age Pension Scheme.
 - This addresses the food needs of vulnerable elderly populations.
- The scheme provides **10 kg of free food grains per month** to eligible beneficiaries.
 - This ensures a basic level of nutritional support for those in need.
- The scheme is specifically targeted at senior citizens who are without pensions.
 - It aims to provide a safety net for those without regular income.
- The primary objective is to **reduce hunger** among the elderly who are not receiving pensions.
- The scheme ensures that **no senior citizens should go hungry** because they lack financial resources.
 - This aligns with broader goals of social justice and welfare for seniors.
- The scheme directly addresses **food insecurity** for vulnerable senior citizens through monthly grain distribution.
- The scheme aims to **reduce poverty and marginalization** among elderly populations.
 - It supports their access to basic necessities like food grains.
- By providing food, the Annapurna Scheme **enhances the dignity and wellbeing** of senior citizens.
- The Annapurna Scheme is designed to work alongside pension programs to guarantee basic needs are met.

Small holder farms for food security

Arguments for and against small-holder farms for national food security

- **Small and marginal farmers** dominate Indian agriculture with fragmented land holdings.
 - This leads to **less use of machinery** and lower economies of scale.
- A large percentage of farmers are **marginal and small**, but contribute significantly to agricultural output.
 - **56.2%** of farmers belong to the marginal and small categories.
- **Small landholdings** may hinder the adoption of modern technology and mechanization.
 - The average size of a farm in India is small compared to countries like the US.
- **Custom hiring centers** for machinery are being promoted by the government to offset the impact of small holdings.
 - However, these centers are often available only in better developed areas.
- **Small farms often rely more on family labor**, which may impact their income and efficiency.
 - Introduction of machines could lead to loss of income for these laborers.
- **Small farmers** may be **more vulnerable** to market fluctuations, climate change and crop failures.
 - Monsoon failure can lead to crop failure for many of these farmers.
- **Small and marginal farmers** often depend on informal sources of credit.
 - They are often exploited by money lenders imposing high interest rates.
- **Small farmers may lack awareness** of government schemes and may not benefit from them.
 - Many tenant farmers are not registered and cannot access government procurement.

- **Small farms may prioritize diverse crops**, contributing to dietary diversity and resilience.
 - This can be advantageous in terms of nutritional security.
- **Small farms can be more sustainable** through techniques like zero budget natural farming.
 - These techniques focus on soil health and use of local resources.
- **Conservation agriculture**, suitable for small farms, enhances productivity and climate resilience.
 - These systems can improve soil organic matter, biota and biodiversity.
- Small holder farms are the back bone of Indian agriculture employing 54% of the workforce.
- **Land reforms** are needed to ensure equitable distribution and empower small farmers.
 - Land reforms seek to address issues such as tenancy and land ceilings.
- The government also aims to increase productivity through certified seeds, and better farm practices.
- **Mechanization**, though needed for increased production, should be introduced carefully due to high agricultural labor.
- **Promoting Farmer Producer Organizations (FPOs)** can aid small farmers with market access and better bargaining power.
- Schemes to provide technology and resources to small farmers can improve their livelihoods.
- **Increased public and private investment** is needed in the agriculture sector.
 - This investment can improve infrastructure for farmers and reduce post harvest losses.

Agricultural Revolution

Different types of agricultural revolutions in India. Their role in food security and poverty reduction.

- The **Green Revolution**, originating from the Indian Agricultural Research Institute (IARI), significantly boosted food grain production.
 - It helped India achieve **self-sufficiency in food grains** from the 1970s onwards.
 - It involved the introduction of **high-yielding varieties of crops**, like wheat and rice.
- The Green Revolution also saw a rapid **increase in the usage of chemical fertilizers** in Indian agriculture.
 - The average usage of chemical fertilizers went up from **0.5kg/ha in 1950-51 to 135kg/ha in 2020-21**.
 - This was to provide the needed nutrients for the high yielding crops.
- The **Yellow Revolution** focused on increasing the production of **oilseeds**.
 - The National Mission on Edible Oil-Oil Palm (NMEO-OP) promotes **oil palm cultivation**.
 - This aims to make India self-reliant in edible oils, reducing import dependence.
- The **Blue Revolution** aimed to enhance **fish production and aquaculture**.
 - India is the **second largest producer of fisheries** in the world.
 - This revolution contributes to food security and livelihoods in coastal areas.
- The Green Revolution had a major role in food security by ensuring the availability of food grains.
 - However, it also led to issues like over-reliance on water intensive crops, and imbalanced fertilizer use.
- The agricultural revolutions have played a role in poverty reduction by increasing farm incomes and employment.
 - Agriculture is a primary source of livelihood for 58% of India's population.
 - However, **small and marginal farmers** may not benefit as much due to structural issues.
- The focus is now shifting towards **sustainable and climate-resilient agriculture**.
 - This involves practices like conservation agriculture, zero budget natural farming, and promoting millets.

- **Regenerative agriculture** aims to improve soil health and biodiversity, contributing to long-term food security.
 - It focuses on practices that increase soil organic matter and carbon sequestration.
- **Diversified cropping systems**, like the inclusion of pulses, enhance resilience and nutrition.
 - Pulses provide dual benefits of nutrition and improving soil health, but India is not self-sufficient in production.
- The **National Food Security Mission (NFSM)** is one step towards improved food security.
 - It works towards increased production of oilseeds and pulses.
- The government is working towards **improving nutrient use efficiency** and promoting balanced fertilizer usage.
 - Schemes like PM-PRANAM aim to encourage the balanced use of fertilizers.
- Technology is also playing a vital role by promoting digital agriculture and e-NAM for better market access.
 - These help farmers access real-time information about demand and prices.
- There is need for a shift towards climate smart agriculture to achieve long term goals of food security and poverty reduction.
- The **Indian Council of Agricultural Research (ICAR)** is constantly innovating and creating new crop varieties, and technologies to address food security.

National Food Security Act, 2013

Salient features of the act

- The **National Food Security Act (NFSA) 2013** aims to provide **subsidized food grains** to a large section of the Indian population.
 - It legally entitles **priority households** to receive subsidized food grains.
- The act provides **5 kg of food grains per person per month** at subsidized prices.
 - This includes **rice at Rs. 3/kg, wheat at Rs. 2/kg and millets at Rs. 1/kg**.
- The **coverage** under NFSA is determined by the **state governments**, following guidelines from the central government.
 - It aims to cover a significant portion of the **vulnerable population**.
- The **Public Distribution System (PDS)** is the primary channel for implementing the NFSA.
 - The PDS involves a network of **fair price shops (FPSs)** that distribute subsidized food.
- **Technology** is being used to improve the implementation of the NFSA through **digitization** and automation.
 - This includes **online allocation** of food grains, **computerized stock management**, and **ePoS devices** at FPSs.
- **Aadhaar authentication** is used for identifying beneficiaries at FPSs.
 - However, the lack of an Aadhaar number **cannot be a reason to deny** subsidized food grains.
 - **Alternate identification** is allowed in case of authentication failure.
- The NFSA provides for **grievance redressal mechanisms** through toll-free helplines and online portals.
- The NFSA has been supplemented by schemes like the **Pradhan Mantri Garib Kalyan Ann Yojana (PMGKAY)**.
 - The PMGKAY was launched in 2023 to provide additional free food grains to beneficiaries.
 - It aims to ensure **food security during times of crisis**.
- The **impact of NFSA on hunger and malnutrition** is a complex issue with different challenges to address.
 - While the NFSA ensures access to subsidized food grains, **malnutrition** persists due to other factors.
 - **Under-nutrition** is linked to multiple factors besides access to food, and the food distribution needs improvement.
- The PDS has challenges including **leakages in distribution** and **identification of rightful beneficiaries**.

- There are concerns that not all intended beneficiaries get the benefits.
- **Climate change, population growth and rising food prices** also impact food security.
 - The act aims to mitigate these by providing access to food grains at subsidized rates.
- The NFSA is considered a **revolutionary step towards fighting hunger** but effective implementation is essential.
 - It requires strengthening the distribution system, and addressing issues like leakage, diversion, and lack of awareness.
- **Food security** is not just about availability but also affordability for the population.
 - The NFSA aims to ensure both for the vulnerable sections of the population.
- The **implementation of NFSA involves large subsidies** by the government to ensure affordable food grains.
 - The government subsidizes food grains to the FCI and other agencies.
- **The One Nation One Ration Card (ONORC) scheme** aims to ensure portability of ration benefits.
 - This allows beneficiaries to access subsidized food grains from any FPS across the country.
- The NFSA, and related schemes like PMGKAY, contribute to food security by providing a safety net.
- The **National Food Security Mission (NFSM)** works towards food security by focusing on increased production.
 - This mission supports the goals of NFSA and PDS by ensuring adequate supply of food grains.

Essential Data Points on Food and Agriculture in India:

1. Food Grain Production and Consumption:

- **Total Food Grain Production (2022-23): ~329.60 million tonnes** (record level).
 - Rice: **135.54 million tonnes**
 - Wheat: **112.74 million tonnes**
 - Coarse Cereals: **54.88 million tonnes**
 - Pulses: **26.44 million tonnes**
- **Per Capita Food Grain Consumption: ~155–160 kg/year** (on average, depending on region and socioeconomic factors).

2. Post-Harvest Losses:

- **Post-Harvest Losses:** Estimated **4–6%** of food grains annually.
 - Rice: **~5.2%**
 - Wheat: **~4.9%**
 - Pulses: **~6.3%**
- Losses occur due to inadequate storage, poor logistics, pests, and improper handling.

3. Malnutrition and Hunger Statistics:

- **Global Hunger Index 2023:** India ranks **111th out of 125 countries**; categorized as having a "serious" hunger level.
- **Malnutrition:**
 - **Stunting:** 35.5% of children under 5 (NFHS-5).
 - **Wasting:** 19.3% of children under 5 (NFHS-5).
 - **Undernourishment:** ~224 million people (as per FAO, 2022).

4. Government Buffer Stocks:

- **Food Corporation of India (FCI)** maintains buffer stocks:
 - **Norms (as of July 1, 2023):**
 - Wheat: **27.58 million tonnes**
 - Rice: **13.54 million tonnes**
 - Total Requirement: **~41.12 million tonnes**

- **Actual Stocks (July 2023):**
 - Wheat: ~29 million tonnes
 - Rice: ~24 million tonnes
-

5. Farmer Income and Productivity:

- **Average Monthly Income:**
 - **2013:** ₹6,426 (NABARD report).
 - **2019:** ₹10,218 (National Sample Survey).
 - **Government Target:** Doubling farmers' income (by 2022, though unmet).
- **Cereal Productivity (kg/hectare):**
 - 1970s: ~1,000 kg/ha
 - 2020s: ~3,200 kg/ha

Post-Harvest Management

- **Traditional Storage Methods:**
 - Farmers in Himachal Pradesh use open sun-drying to store cereals, pulses, and oilseeds for extended periods.
 - In Orissa, farmers store paddy seeds in straw bins ("Olia"), which helps maintain seed viability.
 - Various traditional practices, such as storing rice in earthen pits or using neem leaves to protect pulses, are effective in reducing post-harvest losses.
 - Farmers in Karnataka use empty salt bags to store horsegram to reduce insect damage.
 - Potatoes can be stored on sand beds with minimal weight loss for 5-6 months.
 - Storing oil with jaggery in mud pots or tins is a method of preservation.
- **Modernized Storage:**
 - The Food Corporation of India (FCI) is implementing steel silos for bulk storage of food grains, with 22.75 LMT operational and 41 LMT in development.
 - **Smart warehouses** equipped with sensors are being piloted to monitor conditions and reduce losses.
 - Mechanized handling of food grains is now mandatory for contractors at FCI depots.

Effective Food Security Schemes

- **National Food Security Act (NFSA) 2013:**
 - Legally entitles up to 75% of the rural and 50% of the urban population to subsidized food grains.
 - Covers approximately 81 crore beneficiaries, including 16 crore women.
 - Ensures a monthly entitlement of 5 kg of food grains per person for priority households and 35 kg per family for AAY households.
- **Targeted Public Distribution System (TPDS):**
 - Distributes food grains at affordable prices through fair price shops (FPS).
 - It provides essential food grains like rice, wheat, and millets at subsidized rates.
 - The system has been modernized with technology for better monitoring and distribution.
- **Pradhan Mantri Garib Kalyan Ann Yojana (PMGKAY):**
 - Launched in 2023, it provides additional free food grains to NFSA beneficiaries.
 - Aims to ensure food security during crises, supplementing the TPDS.
- **One Nation One Ration Card (ONORC):**
 - Enables beneficiaries to access their entitled food grains from any FPS across the country.
 - It promotes portability and ensures food security for migrant workers.

Challenges in Achieving Food Security

- **Climate Change:**

- Climate change, growing population, and environmental stress pose significant challenges to food security.
- Changing climate is impacting agricultural productivity.
- **Post-Harvest Losses:**
 - Lack of adequate storage facilities leads to considerable losses of food grains.
 - Pests, water leaks, and inadequate storage conditions damage food grains in godowns.
 - More than 1500 MT of food grains get wasted every year in the godowns.
- **Distribution Issues:**
 - Leakages in the Public Distribution System (PDS) hinder effective delivery of food grains.
 - Some states have not initiated biometric authentication of beneficiaries, which increases the chance of fraud.
 - There is a need for better identification and targeting of beneficiaries, especially migrant workers.
- **Nutritional Security:**
 - While food availability has increased, malnutrition persists, partly due to a shift in consumption patterns.
 - The Green Revolution increased the production of staple foods but crowded out micronutrient-rich crops.
 - Anemia and stunting are prevalent among children, indicating a lack of nutritional diversity.
- **Regional Disparities:**
 - Certain regions and farm groups benefit more from agricultural policies than others.
 - The Green Revolution primarily benefited a few regions, creating disparities.

International Examples

- **Conservation Stewardship Program (CSP) (United States):**
 - Provides financial assistance to farmers who adopt practices such as cover cropping, crop rotations, and intercropping, promoting sustainability.
- **Organic Agriculture Promotion Program (Philippines):**
 - This program promotes organic agriculture practices, including crop diversification, enhancing food security and sustainability.
- **African Orphan Crops Consortium:**
 - This is a global initiative that works towards the betterment of orphan crops (which are locally produced but less researched).
 - This has great potential to address regional food security.
- **SAARC Food Bank:**
 - The SAARC Food Bank is a regional initiative that supplements national efforts to provide food security to people in South Asia.
 - It maintains a reserve of food grains to be used in emergency situations.

International Best Practices for Food Storage and Management

- **Silo Storage:**
 - Developed countries use silos made of steel or reinforced concrete for bulk storage, which reduces storage and transit losses.
 - These silos are equipped with cleaners, dryers, and loading/unloading devices.
- **Mechanized Handling:**
 - The use of mechanized systems for handling food grains helps to minimize losses and ensure faster turnaround.
- **Quality Control:**
 - Regular monitoring and quality control measures are essential for ensuring the quality of stored food grains.
 - Quality Control Cells (QCCs) monitor the quality of food grains during procurement, storage, and distribution.

- **Data-Driven Decision Making:**
 - Using data from systems like the ONORC to generate critical information about beneficiaries and their food security needs helps improve the delivery of welfare schemes.
- **Research and Development:**
 - Continuous research and development efforts are needed to improve post-harvest technologies and reduce food losses.
 - The Indian Grain Storage Management & Research Institute (IGMRI) conducts research and training on scientific storage and preservation of food grains.

Economics of Animal Rearing

Economics of Animal Rearing Questions:

- ☐ Aqua culture (inland fish farming) is considered to have an important role in increasing the food supply and generate employment. What steps are being taken by the Government to encourage aqua culture? (90/20)
- ☐ Livestock rearing has a big potential for providing non-farm employment and income in rural areas. Discuss suggesting suitable measures to promote this sector in India. (15/12½)

Animal rearing plays a vital role in food security and rural livelihoods. It contributes significantly to the agricultural sector and the overall economy.

- **Contribution to Income:** The livestock sector contributes substantially to rural income, especially for economically disadvantaged groups. For the poorest households, livestock can contribute 26% of their income, while the overall rural income sees a 12% contribution.
- **Employment Generation:** The livestock sector is labor-intensive, providing employment opportunities, particularly for women in dairy farming. A trend towards feminization in livestock rearing has been observed, with an increased percentage of females in cattle, goat, and poultry from 1983-84 to 1999-00.
- **Growth of the Sector:** The livestock sector has shown impressive growth, with a Compound Annual Growth Rate (CAGR) of 7.38% at constant prices from 2014-15 to 2022-23. Its contribution to the total Gross Value Added (GVA) in agriculture and allied sectors increased from 24.32% in 2014-15 to 30.38% in 2022-23.
- **Nutritional Security:** Milk and other animal products are crucial for nutritional security, addressing malnutrition. Households with milch animals consume significantly more milk than those without. Pulses are also a main source of protein and vitamins, crucial for those with low per capita income who cannot afford other sources of nutrients, and pulses play a role in government dietary allowances for children, adolescent girls, and pregnant/lactating women.
- **Food Security:** Animal husbandry is a key component of agriculture that ensures food security, and the value of output from livestock was about 31.81% of total agriculture and allied sector in 2019.
- **Integrated Farming Systems (IFS):** Animal rearing is an integral part of IFS, where it is coupled with agriculture and fisheries. The waste products from animals are used as fertilizers for crops, enhancing resource efficiency and soil fertility, while reducing dependence on synthetic fertilizers.
- **India as a Major Player:** India is the highest livestock owner in the world. The country also ranks first in milk production. The fisheries sector is also a crucial contributor to the Indian economy, making up about 6.72 per cent of the agricultural GVA.
- **Traditional Practices:** Many indigenous methods of animal rearing exist that have been passed down through generations, contributing to the livelihood and economy of rural areas, including drought adjustment mechanisms, breeding strategies, and migratory systems.

Aquaculture (Inland Fish Farming)

Role in food security and employment.

- The fisheries sector significantly contributes to the Indian economy and food security.

- It makes up about **6.72 percent of the agricultural GVA**.
- India is the second largest producer of fisheries.
 - **Andhra Pradesh**, followed by West Bengal and Gujarat, are the largest producers in India.
 - The country has a large market for marine products in North America, Europe, and East and South East Asia.
- The fisheries sector is crucial for employment, providing many livelihood opportunities.
 - It also plays a role in government dietary allowances for vulnerable populations.
- **ICAR-Central Marine Fisheries Research Institute (CMFRI)** assesses the health of marine fisheries.
 - In 2022, 91.1% of 135 fish stocks assessed were healthy.
 - ICAR-CMFRI also identifies potential sites for seaweed farming.
- **The Pradhan Mantri Matsya Sampada Yojana (PMMSY)** is a key government scheme to encourage fisheries.
 - It aims to increase fish production and productivity.
 - The scheme promotes investments in infrastructure, technology, and post-harvest management.
- The National Fisheries Policy provides a framework for sustainable development in the sector.
 - It emphasizes the need for integrated approach to fisheries management.
 - The policy supports the welfare of fishing communities.
- There are other relevant schemes to encourage aquaculture, which support farmers.
 - The **Sub-Mission on Agriculture Extension (SMAE)** aims to strengthen programs of state and local bodies.
 - The **Sub-Mission on Seeds and Planting Material (SMSP)** helps increase production of certified and quality seed.
- The government also promotes the use of technology in fisheries.
 - This includes e-technology to aid farmers and improve marketing.
 - The **e-National Agriculture Market (e-NAM)** is an online platform for farmers to connect with markets.
- Other government initiatives are in place to promote seaweed farming.
 - ICAR-CMFRI has identified 384 sites in 9 coastal states and 4 Union Territories suitable for farming.
 - It has also released a document on good management practices for sustainable seaweed farming.
- Several government schemes focus on improving food security and nutritional intake.
 - The **Public Distribution System (PDS)** distributes food to needy populations through fair price shops.
 - The **National Food Security Act (NFSA)** ensures food entitlement to priority households.
- The **PM Garib Kalyan Ann Yojana (PMGKAY)** is an integrated food security scheme.
 - It provides foodgrains to those in need.
 - The **PM Poshan** scheme ensures nutritional support for children.

Aquaculture (Inland Fish Farming)

Steps Taken to Promote Sustainable Practices

1. **Eco-Friendly Farming Policies:** Introduction of guidelines to prevent overstocking and water pollution.
 - *Example:* National Fisheries Policy focuses on sustainable resource utilization.
2. **Species Diversification:** Promotion of indigenous and resilient fish species.
 - *Example:* Breeding programs for Indian Major Carps (Rohu, Katla).
3. **Water Quality Management:** Implementation of biofilters and aeration systems.
 - *Example:* Adoption of Recirculatory Aquaculture Systems (RAS).
4. **Integrated Farming Systems:** Encouraging fish farming with agriculture and livestock.
 - *Example:* Paddy-cum-fish culture in Odisha.

5. **Training Programs:** Capacity building for farmers on best aquaculture practices.
 - *Example:* NFDB workshops for skill development.
6. **Certification Schemes:** Incentives for eco-labeled and certified products.
 - *Example:* Certification under FSSAI for hygienic fish farms.
7. **Financial Assistance:** Subsidies and loans for sustainable aquaculture.
 - *Example:* PM Matsya Sampada Yojana offering support for fish seed production.

Importance of Technology in Aquaculture

1. **Water Quality Monitoring:** Sensors for pH, dissolved oxygen, and temperature.
 - *Example:* IoT-based AquaSense systems.
2. **Automated Feeding Systems:** Smart feeders to minimize waste.
 - *Example:* AquaBot automatic feed dispensers.
3. **Disease Management:** Use of AI to detect early signs of fish diseases.
 - *Example:* AI-powered diagnostic tools in Tamil Nadu hatcheries.
4. **High-Yield Breeding Techniques:** Genetic improvements for fast-growing species.
 - *Example:* Genetically improved Tilapia in Kerala.
5. **Recirculatory Aquaculture Systems (RAS):** Efficient use of water resources.
 - *Example:* Urban aquafarms in Bengaluru employing RAS.
6. **Data Analytics:** Software predicting growth cycles and harvest timings.
 - *Example:* AquaAnalytics platforms in Andhra Pradesh.
7. **Drone Technology:** Surveillance and maintenance of large aquafarms.
 - *Example:* Use of drones for monitoring in Telangana fisheries.

Market and Supply Chain Aspects, Export Potential

1. **Value Addition:** Processing units for fish fillets, frozen products, and pickles.
 - *Example:* Fish processing clusters in Visakhapatnam.
2. **Cold Chain Infrastructure:** Refrigerated transport and storage facilities.
 - *Example:* Integrated cold chains funded by APEDA.
3. **Market Linkages:** Online platforms connecting farmers to buyers.
 - *Example:* e-SANTA platform for direct trade.
4. **Export Promotion:** Subsidies and tax benefits for export-oriented units.
 - *Example:* India as a major exporter of frozen shrimp.
5. **Traceability Systems:** Ensuring quality and safety standards for global markets.
 - *Example:* Blockchain technology in Kerala's seafood export sector.
6. **Domestic Demand Growth:** Awareness programs for nutritional benefits of fish.
 - *Example:* Campaigns under Blue Revolution Scheme.
7. **Diversified Product Portfolio:** Expansion into ornamental fish and value-added products.
 - *Example:* Export of ornamental fish from West Bengal to Europe.

Livestock Rearing

Potential for non-farm employment and income.

- The livestock sector has significant potential for **non-farm employment and income generation**.
 - It provides diverse opportunities for rural populations beyond traditional agriculture.
- **India is the largest producer of buffalo meat** and a major exporter.
 - Major markets for Indian buffalo meat are in **Egypt, Hongkong, Vietnam and Indonesia**.
- The sector also provides livelihood opportunities in areas like **dairy farming and bee keeping**.
 - These activities can be integrated into existing farming systems for added income.
- The government is implementing several measures to promote the livestock sector.
 - The **Integrated Sample Survey (ISS)** scheme provides data for livestock management.

- This scheme uses a **digital platform** to collect data for milk, meat, eggs and wool production.
- The **National Livestock Mission (NLM)** aims to improve livestock productivity and health.
 - The mission includes sub-schemes for fodder development, breed improvement and extension services.
- The **Animal Husbandry Infrastructure Development Fund (AHIDF)** supports investments in infrastructure.
 - This includes infrastructure for processing, storage and marketing of livestock products.
- The government also provides support for **disease surveillance** and control.
 - A large number of serum samples from animals are screened for diseases.
 - Whole genome sequencing is conducted for antimicrobial resistance surveillance.
- **ICAR** has developed diagnostic kits for animal diseases like African swine fever and bovine viral diarrhea.
 - These advancements in diagnostics help in controlling diseases effectively.
- **Vaccines** for diseases like Lumpy Skin Disease (Lumpi-ProVacInd) are being commercialized.
 - This helps to prevent disease outbreaks and ensure animal health.
- **Artificial insemination** and **embryo transfer technologies** are used to improve livestock breeds.
 - These methods enhance reproductive efficiency and breed quality.
- **Traditional knowledge** in animal husbandry is also being documented and validated.
 - This involves studying indigenous practices for animal care and disease treatment.
 - For example, use of *amaltas* fruits to treat flatulence in animals.
- The government promotes the use of technology for farmers and livestock owners.
 - This includes mobile applications for marketing and providing advisory services.
 - One such app is "**Millet Market**" developed to facilitate the marketing of millets.
- The use of **pigeon waste** is also being studied for its use to induce estrus in heifers.
 - Research has found high concentrations of minerals that could help with estrus symptoms.
- **Feed and fodder management** is another focus area to enhance livestock productivity.
 - There is research being done in areas of stubble use in livestock feed.
- There is focus on **conservation** and **regenerative agriculture** for livestock as well.
 - This will help improve soil health and carbon sequestration.

Livestock Rearing

Role in diversification of farm income.

- **Livestock rearing** diversifies farm income through sale of milk, meat, and other products.
 - **Dairy farming** and **bee keeping** are profitable allied activities, increasing income.
- Integrated farming systems include **livestock**, enhancing sustainability and additional revenue streams.
 - **Organic resources** such as cattle dung, poultry litter contribute to reduced input costs and profits.
- **Buffalo meat production** is a major export, indicating livestock's role in trade.
 - **India** is the **largest producer** of buffalo meat, with major markets in Asia and Africa.

Importance of technology, credit and marketing support.

- **Technology** such as e-LISS portal and app help in digital data collection for livestock.
 - This digital platform is used for data on **milk, meat, egg and wool production**.
- **Credit** access through government schemes is crucial to **aid farmers in purchasing livestock** and inputs.
- **Marketing** support through platforms like e-NAM can help livestock farmers get fair prices.

- **e-NAM** provides an online platform connecting farmers and consumers to prevent price exploitation.
- **Training** on good management practices in livestock can improve production efficiency.
 - **Farmer training** through IPM centres can lead to better techniques and output.
- **Market interventions** and infrastructure improvements are needed to ensure fair returns for livestock products.
 - **Storage** facilities, **processing units**, and transportation are important for marketing.

Need for disease control and animal care.

- **Disease surveillance** is crucial, with 74,582 serum samples screened for major livestock diseases.
 - **Recommendations** are provided to state governments based on **sero-surveillance** results.
- **Antimicrobial resistance (AMR)** is monitored in livestock, environment, and humans.
 - **Whole genome sequencing (WGS)** of bacterial isolates is used for **AMR surveillance**.
- **Vaccination programs** like NADCP utilize **serum samples** to assess immunization effectiveness.
 - **92,306 serum samples** were examined for **post vaccination sero-monitoring**.
- **Diagnostic tools**, such as ELISA kits for **bovine viral diarrhea (BVD)**, aid in disease control.
 - A **CRISPR/Cas 12a** test enables rapid **detection** of **African swine fever**.
- **Lumpy Skin Disease Vaccine** is commercialized to control this disease in livestock.

Role of animal rearing in sustainable agriculture, organic farming and integrated farming system.

- **Animal rearing** is integral to **sustainable agriculture** via manure for soil fertility.
 - **Cattle dung, poultry litter** and **sheep/goat droppings** are utilized as organic manures.
- **Integrated farming systems** combine crops and livestock for enhanced resource use.
 - **Diversified cropping systems** that include **dairy farming** demonstrate **profitability**.
- **Organic farming** is promoted via schemes like PM-PRANAM, reducing chemical fertilizer use.
 - **Regenerative agriculture** practices improve soil health and **carbon sequestration**.
- Traditional knowledge emphasizes **organic resources** and **animal waste** for soil health.
 - **Pigeon waste** can supplement micro-minerals in livestock, enhancing estrus symptoms.
- **Conservation agriculture** integrates livestock for a climate-smart approach.
 - This approach focuses on improved **soil health** and **water-holding capacity**.

Essential Data Points on Fisheries, Livestock, and Rural Economy in India:

1. Fish and Livestock Production in India:

- **Fish Production (2022-23):**
 - Total: **14.5 million tonnes** (2nd largest producer globally).
 - Inland Fisheries: **~11 million tonnes** (~75% of total production).
 - Marine Fisheries: **~3.5 million tonnes** (~25% of total production).
- **Livestock Production:**
 - Milk: **221.06 million tonnes** (2022-23, largest producer globally).
 - Egg: **129.6 billion** (2022-23).
 - Meat: **9.5 million tonnes** (2022-23).
 - Wool: **32.89 million kg** (2022-23).

2. Statistics on Employment in the Animal Rearing Sector:

- **Livestock Sector Employment:**
 - ~70 million rural households rely on livestock as a primary or secondary source of income.
 - ~15 million people are directly employed in fisheries.
- **Women's Participation:**
 - Women account for ~70% of labor in livestock rearing.

3. Contribution of Livestock and Aquaculture to the Rural Economy:

- **Livestock Sector Contribution (2022-23):**
 - Contributes ~5% to India's GDP.
 - Accounts for ~25% of agricultural GDP.
 - A key source of supplementary income for small and marginal farmers.
- **Aquaculture Sector Contribution:**
 - Fisheries contribute ~1.2% to India's GDP.
 - Accounts for ~7.3% of agricultural GDP.
 - India earns ~\$7 billion annually from fish and seafood exports.

4. Government Spending on Schemes and Projects:

- **Livestock Sector:**
 - **Rashtriya Gokul Mission:** ~₹2,400 crore allocated for genetic improvement of indigenous cattle.
 - **National Livestock Mission:** ₹2,200 crore (focus on productivity enhancement, feed, fodder).
 - **Dairy Processing and Infrastructure Development Fund (DIDF):** ₹11,000 crore allocated for modernizing dairy infrastructure.
- **Fisheries Sector:**
 - **Pradhan Mantri Matsya Sampada Yojana (PMMSY):** ₹20,050 crore (2020-25) for infrastructure, aquaculture, and welfare of fish farmers.
 - **Blue Revolution Scheme:** ~₹3,000 crore for fisheries development and aquaculture.

Successful Aquaculture Projects:

- **Port Augusta Farm (South Australia):** This 4.5-hectare greenhouse uses vertical farming with hydroponics to grow 7,000 tonnes of tomatoes annually, reducing diesel usage and CO2 emissions significantly. This showcases a successful private sector initiative integrating technology for sustainable aquaculture.
- **ICAR-CIFA, Bhubaneswar:** This institute provided training to farmers, leading to successful catfish hatcheries producing lakhs of seeds and generating significant profits. This highlights a successful public sector initiative fostering entrepreneurship and income generation through aquaculture.
- **ICAR-NBFGR, Lakshadweep Islands:** Establishment of a marine ornamental aquatic organisms germplasm resource center created sustainable livelihoods for women, successfully operating community aquaculture units. This illustrates a public sector project focusing on community development and empowerment through sustainable aquaculture.
- **ICAR-CIFRI's circular HDPE cages:** These cages, used to rear hilsa and Indian major carps in the river Ganga, demonstrate successful adoption of technology for inland open water aquaculture. This highlights technological innovation improving efficiency in aquaculture.
- **Sea ranching of Penaeus semisulcatus:** ICAR-CMFRI's program replenished natural shrimp stocks in Palk Bay and Gulf of Mannar, enhancing shrimp production and income for Tamil Nadu. This exemplifies a successful public-private partnership, leveraging technology for sustainable marine resource management.

Case Studies of Communities Benefiting from Livestock Rearing:

- **Bihar:** Promotion of fish farming alongside paddy cultivation resulted in a 40% increase in farmers' incomes. This demonstrates the economic benefits of integrated farming systems.

- Punjab: Successful contract farming models, such as Nestle's milk procurement, transformed the socio-economic status of farmers. This showcases the potential of market-driven approaches to enhance livestock farming income.
- Amul, Sudha, Nandini: These dairy cooperatives demonstrate successful community-based livestock models driving economic growth and income improvement. These are exemplary models of successful cooperative livestock ventures.
- Andaman and Nicobar Islands: A small-scale farmer successfully adopted an integrated farming system after the 2004 tsunami, showcasing resilience and income diversification through livestock and diverse cropping. This illustrates adaptability and economic recovery through integrated farming systems, highlighting community resilience.
- Jharkhand: The success of Dinesh Jaiswal in pangasius fish farming inspired other farmers, increasing income and employment opportunities in the region. This illustrates the potential of aquaculture to generate employment and income in rural communities.

Agriculture Revolutions

Agriculture Revolutions Questions:

- ☐ Write short notes on the following: Operation flood. (81/5)
- ☐ What is 'white revolution'? Discuss the different factors which have helped to bring about this revolution in India. (86/20)
- ☐ Blue Revolution has definite advantages in India, but it is not free from environmental impacts. Discuss. (06/10)
- ☐ India needs to strengthen measures to promote the pink revolution in food industry for ensuring better nutrition and health. Critically elucidate the statement. [200 words] (13/10)
- ☐ Explain various types of revolutions, took place in Agriculture after independence of India. How these revolutions have helped in poverty alleviation and food security in India? (150 Words) (17/10)
- ☐ Defining blue revolution, explain the problems and strategies for pisciculture development in India. (18/15)

Agricultural revolutions have been critical in transforming India's agricultural landscape and ensuring food security. The Green Revolution, which began in the 1960s, is the most notable, marking a shift from traditional farming practices to a modern, industrial system through the introduction of high-yielding variety (HYV) seeds, chemical fertilizers, and mechanized farm tools. This revolution enabled India to achieve self-sufficiency in food grains after a long period of food shortages. The Green Revolution was followed by the yellow, blue and white revolutions, which together are known as the Rainbow Revolution.

- **Green Revolution:** This revolution significantly increased the production of staple foods like rice and wheat, which were essential for addressing food shortages. It involved the introduction of HYV seeds, chemical fertilizers, and modern irrigation methods, leading to a substantial increase in foodgrain production. The first phase of the Green Revolution (1966-1972) saw an increase in food grain production from 74 million tonnes to 105 million tonnes. By 1978-79, agricultural output reached 131 million tonnes, improving food security.
- **Other Revolutions:** The Green Revolution was followed by the yellow, blue, and white revolutions, also known as the Rainbow Revolution. These revolutions further diversified and strengthened the agricultural sector.
 - The **White Revolution** focused on increasing milk production.
 - The **Blue Revolution** aimed to enhance fish production.
 - The **Yellow Revolution** is associated with increased production of oilseeds.

These revolutions have not only increased food production but also contributed to reducing poverty and improving the livelihoods of many farmers. The Green Revolution specifically resulted in a reduction in rural poverty from 64% to 56% in its first phase. However, these revolutions have also led to challenges such as environmental degradation, regional disparities, and a focus on certain crops at the expense of others. Despite some drawbacks, agricultural revolutions have been instrumental in transforming Indian agriculture from a subsistence-based system to a more productive one.

White Revolution in India: A Comprehensive Overview

Definition and Main Features

The **White Revolution** refers to the significant increase in milk production in India, transforming the country from a milk-deficient nation to the **world's largest milk producer**. Initiated in **1970** under the leadership of **Dr. Verghese Kurien**, the revolution was implemented through **Operation Flood**, a program launched by the **National Dairy Development Board (NDDB)**. This movement played a pivotal role in improving rural livelihoods, ensuring food security, and establishing India as a self-sufficient dairy nation.

- **Key Objective:** To increase milk production, reduce dependency on imports, and empower rural farmers.
- **Key Features:**
 - Creation of a **national milk grid** to minimize seasonal and regional price disparities.
 - Promotion of advanced **breeding techniques**, veterinary care, and better cattle feed.
 - Establishment of **dairy cooperatives** at the village level to ensure fair pricing and market access.
 - Focus on empowering **small and marginal farmers**, especially women.

Factors Contributing to the Success of the White Revolution

1. **Technological Advancements:**
 - Introduction of **cross-breeding programs** to improve milk yield from indigenous cattle breeds.
 - Deployment of **artificial insemination techniques** and enhanced veterinary services to ensure the health of livestock.
 - Use of scientific methods for **fodder production**, increasing both quality and quantity.
2. **Milk Cooperatives:**
 - Creation of village-level cooperatives that ensured farmers received fair prices for their milk.
 - Enabled farmers to collectively access markets, bypassing middlemen who often exploited them.
 - By 2022, **over 16 million farmers** were part of cooperative societies, with a significant proportion being rural women.
3. **Government Support:**
 - Implementation of **Operation Flood** in three phases (1970–1996), funded by the **World Bank** and supported by international donations of milk powder and butter oil.
 - Provision of subsidized loans and grants for building infrastructure like cold storages and transportation facilities.
 - Policy frameworks that supported dairy development as part of broader rural development initiatives.
4. **Marketing and Distribution:**
 - Creation of strong dairy brands like **Amul**, led by the **Gujarat Cooperative Milk Marketing Federation (GCMMF)**.
 - Efficient distribution networks ensured a steady supply of milk and dairy products across the country, even to remote regions.

Impact on Milk Production and Farmer Income

1. **Milk Production Growth:**
 - Milk production surged from **22 million tonnes in 1970** to **221 million tonnes in 2022-23**, making India the **largest milk producer globally**, accounting for **23% of global production**.
 - This growth ensured **food security** and made India self-reliant in dairy.
2. **Per Capita Milk Availability:**
 - Increased from **112 grams/day in 1970** to **444 grams/day in 2023**, improving nutritional levels, especially for children and vulnerable populations.
3. **Farmer Income and Rural Livelihoods:**

- Livestock and dairy farming became a reliable source of income for **70 million rural households**, particularly benefiting small and marginal farmers.
- Women, who constitute **70% of the labor force** in the dairy sector, gained economic independence and better socio-economic status.
- Livestock now contributes **~5% to India's GDP** and **~25% to the agricultural GDP**.

Broader Outcomes and Impacts

1. Economic Impact:

- Dairy exports, including milk powder, cheese, and butter, added to India's foreign exchange earnings.
- Brands like **Amul** became synonymous with quality, both domestically and internationally.

2. Nutritional Security:

- Increased milk availability addressed malnutrition, improving protein and calcium intake among the population.
- Strengthened the Public Distribution System (PDS) and mid-day meal schemes with dairy products.

3. Rural Empowerment:

- Enhanced the participation of women in rural economies through dairy cooperatives.
- Promoted social cohesion by integrating diverse communities into cooperative frameworks.

4. Environmental Challenges:

- The increased livestock population raised concerns about greenhouse gas emissions and sustainable practices.
- Modern dairy farming methods and green initiatives were adopted to address these challenges.

Significance of the White Revolution

The White Revolution marked a turning point in India's agricultural and rural economy. It not only ensured self-reliance in milk production but also set the foundation for inclusive growth by empowering marginalized farmers and rural women. Its emphasis on technology, cooperatives, and government support made it a model for other sectors to emulate. The revolution remains a testament to how collective efforts and visionary leadership can transform a nation's economy and society.

Blue Revolution in India: A Detailed Overview

Definition and Scope

The **Blue Revolution** refers to the rapid growth and modernization of the fisheries and aquaculture sector, aiming to increase fish production, enhance rural livelihoods, and ensure nutritional security.

- **Launched under:** The **Neel Kranti Mission**, as part of the **Pradhan Mantri Matsya Sampada Yojana (PMMSY)**.
- **Objective:** To transform India into a global hub for sustainable aquaculture and fisheries.
- **Scope:**
 - Focus on **inland aquaculture, marine fisheries**, and allied activities.
 - Infrastructure development, marketing, and research in aquaculture practices.
 - Promoting entrepreneurship and employment in fisheries.

Advantages

1. Increased Fish Production:

- **Fish Production (2022-23):**
 - Total: **~14.5 million tonnes**.
 - India ranks **2nd globally** in fish production, contributing **~8% of global output**.

- Fisheries account for ~**1.2% of India's GDP** and ~**7.3% of agricultural GDP**.
- 2. Employment Generation:**
 - Provides livelihood to ~**15 million people** directly and several million indirectly.
 - Significant employment opportunities in rural areas through **fish farming**, processing, and exports.
 - Women play a crucial role in post-harvest activities, contributing to their economic empowerment.
- 3. Nutritional Security:**
 - Fish is a rich source of **protein, omega-3 fatty acids, vitamins, and minerals**.
 - Enhanced availability of affordable fish products aids in addressing **malnutrition** and improving dietary diversity, especially in protein-deficient populations.
- 4. Economic Benefits:**
 - Fish and seafood exports earn ~**\$7 billion annually**, strengthening India's foreign exchange reserves.
 - Promotes rural entrepreneurship through the establishment of **aquaculture hubs**.

Environmental Impacts

- 1. Water Pollution:**
 - Overuse of antibiotics, chemicals, and feed in aquaculture contaminates water bodies.
 - Effluents from fish farms lead to **eutrophication** and degradation of water quality.
- 2. Habitat Destruction:**
 - Expansion of aquaculture results in the destruction of sensitive ecosystems like **mangroves** and **wetlands**.
 - Overfishing in marine ecosystems threatens biodiversity and disrupts ecological balance.
- 3. Climate Change Vulnerability:**
 - Rising sea levels and ocean acidification pose risks to marine fisheries and aquaculture.

Strategies for Promoting Sustainable Aquaculture

- 1. Eco-friendly Practices:**
 - Adoption of **Integrated Multi-Trophic Aquaculture (IMTA)**, combining fish, seaweed, and shellfish farming to reduce waste.
 - Use of biofloc technology to enhance water quality and minimize feed waste.
- 2. Regulations and Monitoring:**
 - Strict enforcement of **aquaculture standards** to control the use of antibiotics and chemicals.
 - Monitoring water quality and ecosystem health to prevent overexploitation.
- 3. Infrastructure Development:**
 - Investment in **cold chains**, processing units, and marketing networks to reduce post-harvest losses.
 - Development of **hatcheries** and seed banks to support sustainable fish farming.
- 4. Community Participation:**
 - Encouraging the involvement of local communities in conservation and sustainable practices.
 - Promoting **self-help groups (SHGs)** and cooperatives for better resource management.
- 5. Government Initiatives:**
 - **Pradhan Mantri Matsya Sampada Yojana (PMMSY): ₹20,050 crore** allocated for boosting fisheries and aquaculture by 2025.
 - Development of marine parks and reserves to protect biodiversity.
 - Focus on training and capacity-building programs for fish farmers.

Significance of the Blue Revolution

The Blue Revolution has positioned India as a global leader in fisheries and aquaculture while creating pathways for economic growth, employment generation, and nutritional improvement. However, the environmental concerns highlight the importance of adopting **sustainable aquaculture practices**. By balancing growth with ecological preservation, the Blue Revolution can ensure long-term benefits for both rural communities and the environment.

Pink Revolution in India: An Overview

Definition and Importance

The **Pink Revolution** refers to the modernization and growth of the meat and poultry industry in India, focusing on food processing, value addition, and export-oriented production. It has been pivotal in enhancing **protein availability**, supporting **farmer incomes**, and boosting **economic growth**.

- **Scope:** Primarily focuses on **poultry, pig farming, and meat production**.
- **Significance:** Addresses the rising domestic demand for protein-rich diets and enhances India's competitiveness in the global meat market.

Importance in Food Processing and Value Addition

1. **Food Processing and Exports:**
 - **Meat Exports (2022-23):** India earned ~**₹27,000 crore** from exports of buffalo meat, chicken, and other meat products.
 - Value addition through packaging, branding, and ready-to-eat products improves profitability and market reach.
2. **Role in Nutrition:**
 - Meat and poultry are rich in **high-quality protein**, essential vitamins (B12, D), and minerals (iron, zinc).
 - Increased availability of affordable meat products has helped address **protein deficiency** in vulnerable populations.
 - Poultry meat is a low-fat, high-nutrient option, making it suitable for diverse dietary needs.
3. **Employment and Economic Growth:**
 - The sector employs ~**6 million people** directly, with significant involvement of rural women.
 - Boosts allied industries like feed production, cold storage, and transport.

Need for Promoting the Pink Revolution

1. **Rising Protein Demand:**
 - India's per capita meat consumption is low at ~**4.5 kg/year**, compared to the global average of ~**34 kg/year**.
 - Increasing urbanization and income levels are driving demand for high-quality, affordable meat products.
2. **Economic Potential:**
 - The Pink Revolution contributes significantly to GDP and has the potential to make India a global leader in the meat processing industry.
3. **Addressing Ethical and Environmental Concerns:**
 - **Ethical Concerns:** Focus on humane treatment of animals in production systems.
 - **Environmental Impact:** Address issues like water use, greenhouse gas emissions, and waste management associated with large-scale meat production.

Measures to Improve the Poultry Sector Sustainably

1. **Improved Breeding and Feed Management:**
 - Focus on high-yield breeds and disease-resistant poultry varieties.
 - Use of **nutritionally balanced, eco-friendly feed** to enhance productivity.
2. **Infrastructure Development:**
 - Investment in cold chains, slaughterhouses, and processing units to reduce post-harvest losses.

- Promotion of small-scale, decentralized poultry farming models.
- 3. **Sustainable Practices:**
 - Adoption of **waste-to-energy technologies** for managing poultry litter and reducing methane emissions.
 - Use of renewable energy sources in farming operations.
- 4. **Ethical Farming Practices:**
 - Enforcing animal welfare standards to ensure humane rearing and slaughtering practices.
 - Raising consumer awareness about ethical sourcing and production.
- 5. **Policy and Financial Support:**
 - Government initiatives like the **Rashtriya Gokul Mission** and subsidies for poultry farming infrastructure.
 - Access to credit and insurance for small-scale farmers to mitigate risks.
- 6. **Skill Development and Research:**
 - Training programs for farmers on modern poultry practices.
 - Investment in R&D for developing high-efficiency, low-impact farming systems.

Balancing Growth with Sustainability

The Pink Revolution has immense potential to address **nutrition security**, create **livelihoods**, and contribute to **economic growth**. However, it is critical to adopt **sustainable and ethical practices** to mitigate its environmental footprint. By promoting responsible production, ensuring animal welfare, and focusing on long-term sustainability, the Pink Revolution can serve as a model for inclusive and environmentally conscious growth in the agri-food sector.

Other Agricultural Revolutions in India

India has witnessed several agricultural revolutions after independence that have transformed its agrarian economy, alleviated poverty, enhanced food security, and increased farm incomes.

Major Agricultural Revolutions

1. **Green Revolution (1960s):**
 - **Focus:** Increased production of food grains (wheat and rice).
 - **Key Contributors:** Introduction of **high-yield variety (HYV) seeds**, mechanization, and irrigation systems.
 - **Outcome:**
 - India achieved **self-sufficiency** in food grain production.
 - Food grain production rose from **~50 million tonnes (1950s)** to **~285 million tonnes (2022-23)**.
 - Major role in reducing famine and ensuring food security.
2. **White Revolution (1970s):**
 - **Focus:** Boost in **milk production** through Operation Flood led by **NDDB (National Dairy Development Board)**.
 - **Outcome:**
 - India became the **largest producer of milk** globally.
 - Enhanced **rural livelihoods** and improved **nutrition**.
3. **Yellow Revolution (1980s):**
 - **Focus:** Production of **edible oils**, especially mustard and sunflower.
 - **Outcome:**
 - Reduced dependency on imports.
 - Provided farmers with additional income sources.
4. **Blue Revolution (1985 onwards):**
 - **Focus:** Development of fisheries and aquaculture.
 - **Outcome:**
 - Increased fish production to **~14.5 million tonnes (2022-23)**.
 - Enhanced protein availability and generated employment for **~15 million people**.

5. **Golden Revolution (1991-2003):**

- **Focus:** Boosting **horticulture** production (fruits, vegetables, flowers, and spices).
- **Outcome:**
 - India became a leading producer of fruits and vegetables.
 - Improved farm income and export potential.

6. **Pink Revolution (2000s):**

- **Focus:** Growth of the **meat and poultry** industry.
- **Outcome:**
 - Contributed to protein security and provided economic opportunities.

7. **Brown Revolution:**

- **Focus:** Promotion of **cocoa and non-conventional farming practices** in arid and semi-arid regions.
- **Outcome:**
 - Helped diversify income sources for farmers.

8. **Round Revolution:**

- **Focus:** Increase in **potato production**.
- **Outcome:**
 - Supported agro-industries like chips and starch production.

9. **Silver Revolution:**

- **Focus:** Growth in **egg production**.
- **Outcome:**
 - Improved protein intake among the population.

10. **Evergreen Revolution:**

- **Focus:** Sustainable agriculture to achieve productivity without ecological damage.
- **Outcome:**
 - Promoted balanced use of inputs and environment-friendly practices.

Impact on Poverty, Food Security, and Farm Income

1. **Reduction in Poverty:**

- Increased agricultural productivity under the **Green Revolution** boosted rural incomes, lifting millions out of poverty.
- Allied sectors like dairy, poultry, and fisheries created new employment opportunities.

2. **Enhanced Food Security:**

- India transitioned from a food-deficient country to a **food surplus nation**.
- Horticulture and aquaculture revolutions diversified the food basket, improving nutritional security.

3. **Improved Farm Income:**

- Diversification through **horticulture, poultry, and aquaculture** provided farmers with multiple income sources.
- Value addition in agro-industries enhanced profitability.

4. **Export Growth:**

- Edible oils, fruits, vegetables, fish, and dairy products contributed significantly to India's export revenue.

5. **Technological Advancement:**

- Adoption of modern farming techniques under various revolutions increased productivity and reduced input costs.

Way Forward

- Integration of technology (AI, IoT) to modernize agriculture.
- Focus on sustainable practices to address climate challenges.
- Empowering smallholders through **cooperatives** and **direct market linkages**.

Pisciculture Development in India

Problems Faced by the Pisciculture Sector in India

1. **Infrastructure Challenges:**
 - Lack of **modern hatcheries**, feed mills, and cold chain infrastructure.
 - Inadequate access to high-quality fingerlings and fish feed.
2. **Water Pollution and Quality Issues:**
 - Industrial and agricultural runoff leads to **water pollution**, impacting fish health.
 - Overexploitation of water bodies reduces **water availability** for fish farming.
3. **Low Adoption of Technology:**
 - Minimal use of **advanced aquaculture techniques** like biofloc, recirculating aquaculture systems (RAS), and cage culture.
4. **Market Access and Price Fluctuations:**
 - Farmers face challenges in accessing **organized markets** and fair prices.
 - Price volatility due to lack of **efficient supply chains** and middlemen interference.
5. **Lack of Awareness and Training:**
 - Many farmers are unaware of sustainable practices and modern aquaculture technologies.
6. **Disease Management:**
 - Frequent outbreaks of diseases like **Epizootic Ulcerative Syndrome (EUS)** cause significant losses.
7. **Policy Gaps and Regulation:**
 - Inefficient enforcement of **aquaculture guidelines** and lack of **integrated policies** for inland and coastal fisheries.
8. **Climate Change Impact:**
 - Rising temperatures and changing rainfall patterns affect fish breeding cycles and pond ecosystems.

Strategies for Promoting Sustainable Pisciculture

1. **Adoption of Advanced Technology:**
 - Promote **biofloc technology** for water-efficient fish farming.
 - Use **RAS** for intensive fish production with reduced water usage.
 - Implement **cage culture** in reservoirs and large water bodies.
2. **Improving Infrastructure:**
 - Establish more **hatcheries**, **feed mills**, and **cold storage facilities**.
 - Develop fish landing centers with modern auction halls and storage units.
3. **Policy Interventions:**
 - Strengthen and implement the **National Fisheries Policy** for inland, coastal, and deep-sea fisheries.
 - Increase funding under schemes like **PM Matsya Sampada Yojana (PMMSY)** for pisciculture development.
 - Provide **subsidies and credit** for small-scale fish farmers to adopt sustainable practices.
4. **Market Development:**
 - Promote **direct market linkages** through cooperatives and e-marketing platforms.
 - Develop **export hubs** to boost global competitiveness of Indian fish products.
5. **Capacity Building and Training:**
 - Conduct **training programs** for farmers on sustainable aquaculture techniques.
 - Use mobile apps and extension services for real-time guidance on disease management and market trends.
6. **Water Resource Management:**
 - Encourage integrated fish farming with agriculture (e.g., rice-fish farming).
 - Monitor and control **water pollution** through strict regulations on industrial discharge.
7. **Disease Prevention and Management:**
 - Develop **disease-resistant fish varieties** through research.
 - Promote regular water quality testing and use of immunostimulants.
8. **Climate Resilience:**

- Encourage climate-resilient practices like **deep pond farming** and **species diversification**.
- Provide crop insurance and disaster relief to protect fish farmers from climate-induced losses.

9. Sustainability Focus:

- Encourage use of **organic fish feed** and natural water treatments.
- Avoid overstocking and maintain ecological balance in water bodies.

Conclusion

Promoting sustainable pisciculture can significantly enhance **rural livelihoods**, improve **nutrition security**, and reduce dependence on imports. With effective technology adoption, infrastructure development, and policy support, India can emerge as a global leader in sustainable fish farming.

Case Studies: Success Stories of Cooperative Dairy Movements

- **Amul:** This renowned dairy cooperative significantly impacted the dairy sector. It integrated landless farmers into the supply chain, growing from two societies and 250 liters of milk daily to 1,015 societies, 574,000 members, and 1 million liters of milk daily by 2000. Amul's success led to increased rural household income, infrastructure development (wells, roads, schools), and the establishment of the NDDB to replicate the "Anand Pattern" nationwide through Operation Flood.
- **Other successful dairy cooperatives:** The Bihar State Milk Cooperative Federation (Sudha) and Karnataka Milk Federation (Nandini) are also highlighted as successful examples.

Examples of Sustainable Aquaculture Projects

- **Seaweed farming:** Potential sites for seaweed farming were identified in 9 coastal states and 4 Union Territories. A document outlining good management practices for sustainable seaweed farming in India was also produced.
- **Recirculatory Hatchery System (RHS):** This system was used for mass-scale seed production of peninsular carp.
 - Recirculatory Hatchery System (RHS) used for mass-scale seed production of peninsular carp.
 - Water quality parameters that were standardized include alkalinity, dissolved oxygen, and ammonia.
 - Analysis of various water sources, such as borewell, commercial RO waters, and combinations, was performed to determine their suitability for hatching and development of eggs.
 - A 90% RO and 10% borewell water mix resulted in an alkalinity of 36.75, which is equivalent to rainwater.
 - This mix also achieved a survival rate of 76.4%, similar to the 73.18% survival rate seen with rainwater
- **Marine ornamental aquatic organisms germplasm resource center:** This center was established in Lakshadweep Islands to propagate indigenous marine ornamental shrimps/fishes, creating sustainable livelihood opportunities for women.

Cases of Communities That Have Benefited

- **Amul's impact on Kaira District:** The Amul cooperative significantly increased rural household income from dairying and facilitated infrastructure development.
- **Kolli Hills Agrobiodiversity Conservers' Federation (KHABCOFED):** This federation facilitated training and value-addition activities, leading to the branding of ready-to-cook products under the Kolli Hills Natural Foods label.
- **Lakshadweep Islands:** A marine ornamental aquatic organisms germplasm resource center created sustainable livelihood opportunities for women.
- **Hiware Bazar (Maharashtra):** This village implemented watershed management practices, including artificial recharge structures, resulting in improved water security.

- **Odisha:** Several villages benefited from the Gender-Sensitive Agri-Nutri Farming System Model (G-SAN Model), which positively impacted socio-technical and economic aspects, especially women's empowerment. Additionally, technological interventions in climate-smart agriculture empowered women by increasing asset control, decision-making participation, knowledge enhancement, and economic status.

Food Processing and Related Industries in India- Scope and Significance, Location, Upstream and Downstream Requirements, Supply Chain Management

Food Processing and Related Industries in India- Scope and Significance, Location, Upstream and Downstream Requirements, Supply Chain Management Questions:

- ☐ The Government of India has recently set up a Department of Food Processing. What are its functions? (88/20)
- ☐ Explain Mega Food Park Scheme of Government of India. (07/7.5)
- ☐ What are the impediments in marketing and supply chain management in developing the food processing industry in India? Can e-commerce help in overcoming these bottlenecks? (15/12½)
- ☐ What are the reasons for poor acceptance of cost-effective small processing unit? How the food processing unit will be helpful to uplift the socio-economic status of poor farmers? (150 Words) (17/10)
- ☐ How do subsidies affect the cropping pattern, crop diversity and economy of farmers? What is the significance of crop insurance, minimum support price and food processing for small and marginal farmers? (250 Words) (17/15)
- ☐ Discuss the factors for localisation of agro-based food processing industries of North-West India. (GS 1, 19/10)
- ☐ Elaborate the policy taken by the Government of India to meet the challenges of the food processing sector. (2019/15)
- ☐ What are the challenges and opportunities of food processing sector in the country? How can income of the farmers be substantially increased by encouraging food processing? (2020/10)
- ☐ Elaborate the scope and significance of the food processing industry in India. (22/10)

The food processing industry is a **vital link** between agriculture and industry. It **reduces food waste**, enhances shelf life, and adds value to agricultural produce. The sector also plays a crucial role in reducing malnutrition and promoting employment.

Department of Food Processing

Functions and objectives of the Department of Food Processing (formulation of policies, coordination, promotion and monitoring).

- The Department formulates policies for the food processing sector, addressing issues and setting standards.
 - It also sets **shelf-life norms** and **labeling guidelines** for imported food products.
- It coordinates with various stakeholders for the sector's growth and development.
 - This includes aligning with the **Ministry of Consumer Affairs**, Food, and Public Distribution.
- Promotion of the sector includes supporting **Indian brands** and creating **manufacturing champions**.
 - It aims to ensure **remunerative prices** for farm produce and **higher incomes** for farmers.
- The department monitors the food processing sector to identify **challenges and opportunities**.
 - It also tracks the impact of policy initiatives and the **overall development** of the industry.

Role in supporting and coordinating development of the sector.

- The department supports the sector by implementing schemes like the "Scheme for Formalization of Micro food processing Enterprises".

- This scheme provides **credit-linked subsidies** to micro-enterprises with a focus on **perishables**.
- It promotes technology upgrades and investments in ancillary industries, such as **packaging** and **R&D**.
 - It encourages state agricultural universities to offer courses in fields like food packaging and **biotechnology**.
- The department aims to strengthen the **farm-to-market supply chain** by focusing on **infrastructure, logistics** and **storage**.
 - It promotes **private sector participation** with mechanisms for risk-sharing and fiscal incentives.
- It coordinates the "Aatmanirbhar Bharat Package," extending support from TOP crops to all **fruits and vegetables (TOTAL)**.
- The department aids in reviving the economy post COVID-19 supply chain disruptions.
 - This includes extending **short-term measures** to all **fruits and vegetables**.
- It also supports the unorganized food processing sector in rural areas by bolstering cottage industry, farmer producers' organizations and individual food processors.
 - This includes assistance in **capacity increase, technology upgrades, and skill improvement**.

Mega Food Park Scheme

Main features and objectives of the scheme (infrastructure, linkages, processing facilities).

- The scheme aims to create **modern infrastructure** for food processing along the value chain.
 - This includes facilities for **logistics, storage**, and processing to minimize post-harvest losses.
- It focuses on establishing strong **backward and forward linkages** in the food processing sector.
 - This is done to connect farmers with processors and markets through a **seamless supply chain**.
- The scheme promotes **processing facilities** to add value to agricultural products through various processing technologies.
 - This includes the development of **ancillary industries** such as packaging, equipment manufacturing, and certification agencies.
- It emphasizes the use of a **cluster approach**, where facilities are concentrated in specific areas.
 - This allows for **efficient resource utilization** and **targeted development** of infrastructure.
- The Mega Food Park scheme supports the creation of **global food manufacturing champions** in India.
 - The scheme also supports the promotion of **Indian brands** of food products.

Potential impact on the sector and farmer incomes.

- The scheme is projected to **increase employment opportunities** in the off-farm sector.
 - It will provide avenues for skilled and unskilled labor in the processing and logistics domain.
- It aims to ensure **remunerative prices** for farm produce and provide **higher incomes** to farmers.
 - This involves establishing direct linkages between farmers and processors, reducing intermediaries.
- The scheme should help reduce food waste by focusing on improved storage and **processing capacities**.
 - This will aid in minimizing post-harvest losses, contributing to food security and **economic value**.

- It promotes value addition in the agriculture sector through processing, packaging and other techniques.
 - This helps in **increasing the market value** of agricultural products and farmer income.
- The scheme helps improve the overall **competitiveness** of the Indian food processing sector on the global market.
 - It also works to improve the quality of Indian food products, making them more acceptable in the global market.
- The scheme facilitates technology upgrades for existing facilities as well as developing new facilities for storage and processing.
- It also promotes investment in R&D to support new developments in technology and food processing.

Impediments in Marketing and Supply Chain

Challenges in marketing of food processed products.

- There are concerns regarding **price dispersion**, with variations based on weather, irrigation, and other factors.
 - For example, a variety of rice might be sold at different prices in different regions.
- **Lack of a unified market** due to differing taxes across states causes complications in marketing and trade.
 - This leads to the presence of **intermediaries**, which may increase consumer prices and reduce farmer profits.
- Farmers in remote areas may **lack information** about prices in other parts of the country, hindering effective marketing.
 - Conversely, buyers often have information about prices at various locations.
- There are issues with export standards, with some Indian exports being rejected due to high **pesticide residue**.
 - This is especially notable in commodities like Basmati rice, where European countries have rejected shipments due to pesticide residues.
- There is a need for **stable export policies** to attract investment and promote exports in the food processing sector.
- The current export policy is considered to be ad hoc, affecting India's credibility as a trade partner.
 - Ad hoc means jab jaisa situation waisa policy

Challenges in supply chain management (infrastructure, logistics, wastage, lack of cold chain).

- **Inadequate storage systems** and grading systems contribute to post-harvest losses in mandis.
 - This highlights a need for better infrastructure to minimize wastage of agricultural products.
- **Transportation services** and **warehousing** for processed food products are also part of the supply chain.
 - These services are needed to ensure that products reach the consumer effectively, adding value to farmer produce.
- **A lack of cold chain infrastructure** leads to spoilage of perishable goods, adding to the problem of wastage.
 - This is a significant concern because many food processing units are in rural areas.
- The supply chain suffers due to multiple intermediaries between farmers and consumers increasing the **mediation charges**.
 - This means the price paid by the consumer contains less of the farmer's profit.
- There is a need for better infrastructure, logistics, and storage solutions to avoid disruptions and ensure smooth supply chain functioning.

- It is necessary to have risk-sharing mechanisms, fiscal incentives and **partnership models**.
- The government is promoting **custom hiring centers** to address challenges related to farm mechanization.
 - These centers can help provide access to machines, especially in areas with small land holdings.

Role of intermediaries in price fluctuations.

- Intermediaries in the supply chain, like **Arhatiyas**, increase the mediation charges, impacting the farmer and consumer prices.
 - The more intermediaries, the higher the charges, which reduce both the farmer's share of profits and raise consumer prices.
- In the case of private markets, there are **no regulations** and no direct intervention from the government, increasing the chance of farmer exploitation.
 - While APMC mandis have regulations, farmers can still be exploited.
- The **absence of direct farmer-to-consumer links** means farmers sell through multiple layers, impacting prices.
 - A system where large retailers procure directly from farmers could save on commissions.
- The **e-NAM platform** tries to address price dispersion, but a unified market is needed to minimize this issue and the impact of intermediaries.
- Even with strict regulations in place, farmers can be exploited. Therefore there are options for trade where no regulations are present.
- This presents a high risk of farmer exploitation.
- The price paid by the consumer has less of the farmer's profit in it as the mediation charges increase.
 - This results in the consumer paying more and the farmer getting less.

E-Commerce in Food Processing

Potential of e-commerce in addressing supply chain and marketing limitations.

- **E-commerce** can help in creating a unified national market for agricultural produce, overcoming the limitations of physical mandis.
 - This is done through online platforms like **e-NAM (electronic National Agriculture Market)**, helping reduce price dispersion.
- **Digitization** can help in better management of the supply chain, reducing the role of intermediaries.
 - This can improve efficiency in transportation and reduce costs.
- **E-commerce** can help in providing farmers with better market information, addressing the issue of information asymmetry.
 - Farmers in remote areas can get information on prices across the country via online platforms.
- **Online platforms** can facilitate direct linkages between farmers and consumers, thereby reducing the reliance on intermediaries.
 - This will help in ensuring fair prices and improve profit margins for farmers.
- E-commerce can also enable better management of logistics and storage, reducing **post-harvest losses**.
 - This will help in reducing the wastage of agricultural produce and improve the supply chain efficiency.

Benefits of e-commerce to improve market access, transparency, and farmer incomes.

- **E-commerce** provides **expanded market access** for farmers, enabling them to sell their products beyond local areas.

- This results in a larger customer base, increasing the reach of farmers to new markets.
- **Increased transparency** is achieved through online platforms which display real time data on prices.
 - This allows farmers to make informed decisions about where and when to sell their produce.
- **Direct farmer-consumer linkages** can be established via e-commerce leading to better prices for farmers and reduced costs for consumers.
 - By reducing the role of middlemen, a larger share of profits goes directly to farmers.
- **Digitization** allows for better tracking of products and sales, promoting greater transparency and accountability in the supply chain.
 - This will help to streamline the entire process from farm to the consumer's table.
- **E-commerce** can empower farmers by providing them with a direct marketing channel and reducing dependence on **APMC mandis**.
 - This gives farmers greater control over the marketing and selling of their produce.
- By providing better prices for products, e-commerce helps in **increasing farmer incomes** and overall profitability.
 - This enables them to invest more in their farms, improving the quality of agriculture in the country.

Small Processing Units

Reasons for poor acceptance of cost-effective small processing units.

- There are an estimated 25 lakh **unorganized micro food processing enterprises**, indicating the sector's fragmented nature.
 - These enterprises face various challenges, including limited access to technology and resources.
- The **unorganized enterprises** contribute a large share of employment but a smaller share of output and value.
 - They make up 74.3% of employment but only 10% of the output.
- Many small processing units are located in rural areas and are often family-based, which can limit their **capacity for growth**.
 - Nearly 66% are located in rural areas, and about 80% are family-based enterprises.
- Small units may lack adequate **infrastructure, storage, and transportation facilities**, limiting their effectiveness.
 - These infrastructure limitations can lead to post-harvest losses and affect product quality.
- There is a lack of awareness about government schemes and initiatives, leading to a lower adoption of cost-effective processing units.
 - This is mainly because of limited access to information and resources among small-scale entrepreneurs.
- **Operational costs** can be a barrier to adopting new technologies and methods, reducing cost effectiveness of these units.
 - Even with subsidies, the high operational costs limit the use of many machines.

Potential of small scale units to uplift the socio-economic status of poor farmers.

- Small processing units can help in **generating off-farm jobs**, creating employment opportunities in rural areas.
 - These units help provide employment for a third of women in the unorganized sector.
- They can **ensure remunerative prices** for farm produce, enhancing farmer incomes and reducing distress sales.
 - This also reduces the role of middlemen, ensuring better returns for farmers.
- Micro food processing units can **encourage food processing innovation**, adding value to agricultural produce.
 - This also has the potential to develop new products and improve the overall food processing sector.

- Small processing units can increase **value addition** in the agricultural sector, transforming raw materials into processed products.
 - This results in higher returns and economic growth, especially for small farmers.
- By enabling local processing, small units can **reduce post-harvest losses**, helping farmers conserve more of their produce.
 - This improves the economic viability of farming and contributes to food security.
- These units also have the potential to become **global food manufacturing champions**, promoting Indian brands of food products.
 - This can enhance the competitiveness of the sector in the international market.

Need for hand holding, training and support for small units.

- There is a need for **credit-linked subsidies** to help micro-enterprises in the food processing sector.
- The government has sanctioned a significant outlay for such subsidies and has also introduced the "Scheme for Formalization of Micro food processing Enterprises".
- **Training programs** are essential for skill improvement, entrepreneurship development, and technology upgrades.
 - The government is also encouraging State Agricultural Universities to start courses in relevant fields such as food packaging, biotechnology and IT in agriculture.
- **Financial assistance** can help small units in increasing their capacity, upgrading technology, and strengthening supply chains.
 - The Gram Samridhi Yojna scheme, funded by the World Bank, aims at doing exactly that.
- A **cluster approach** should be adopted to help small units in forming networks and creating production hubs, leading to economies of scale.
- This ensures focused support for groups of micro-enterprises in specific areas.
- **Handholding support** is needed to ensure that small units get access to technology, credit, and market information.
 - This support is necessary to help them overcome the various challenges they face.
- There is a need for **support mechanisms** for processing perishable products to minimize wastage and improve food security.
 - The scheme for formalization of Micro Food Processing Enterprises will have a special focus on perishables.

Location of agro based industries:

Factors influencing location of agro based industries in North West India

- **Availability of raw materials** such as **wheat, rice, and cotton** significantly influences the location of agro-based industries in North West India.
 - **Punjab and Haryana** are major producers of rice and wheat, making them ideal for related industries.
 - **Gujarat**, followed by Maharashtra and Telangana, are large cotton producers, affecting industry locations.
- The **Indo-Gangetic plains** are fertile and suitable for growing various crops, thus attracting agriculture-related industries.
 - The plains are ideal for crops like rice, wheat and pulses.
- **Infrastructure** like irrigation facilities, and connectivity impact the concentration of agro-industries in this region.
 - Punjab has 98% of land under irrigation, which is beneficial for water-intensive industries.
 - The states with good irrigation facilities have adopted more chemical fertilizer usage.
- **Market proximity** is also a key determinant as industries tend to locate closer to major consumption centers.
 - **e-NAM** is an online platform aiming to provide a unified market throughout the country.

- Better **transportation** facilities facilitate the movement of raw materials and finished goods, influencing the location of industries.
 - Transportation services are considered a forward linkage in agriculture.
- The availability of **storage facilities** for agricultural produce also impacts the siting of industries, decreasing post harvest loss.
- A lack of adequate storage leads to post-harvest losses in mandis.
- The presence of **agricultural universities** in the region provides necessary research support and skilled manpower.
 - These universities help in development of new crop varieties and related processing techniques.
- Government policies, subsidies, and schemes that promote agro-processing also play a major role in the spatial distribution of industries.
 - The government is promoting schemes for integrated nutrient management to promote organic farming.

Government Policies:

Government policies and initiatives for promotion of food processing sector

- The government has launched a **"Scheme for Formalization of Micro food processing Enterprises"** with a large outlay to support the sector.
 - This scheme aims to assist 2 lakh micro-enterprises with credit-linked subsidies over 5 years.
- The **"Aatmanirbhar Bharat Package"** extended support from TOP crops to all fruits and vegetables, addressing supply chain issues post COVID-19.
 - This package included short-term measures to revive the economy after supply chain disruptions.
- **Financial assistance** is provided through schemes like the Gram Samridhi Yojna to increase capacity and upgrade technology.
 - This scheme also promotes skill improvement and entrepreneurship development.
- The government encourages **private sector participation** by offering risk-sharing mechanisms and fiscal incentives.
 - This is aimed towards creation of infrastructure for logistics, storage, and processing.
- There is a focus on **technology up-gradation** of existing facilities and investments in ancillary industries like R&D and packaging.
- Fiscal incentives are provided to investors in these fields.
- The government is encouraging State Agricultural Universities to offer courses in food packaging, processing, biotechnology and IT in agriculture.
 - This initiative aims to build a skilled workforce for the food processing sector.
- **New rules for importing products** have been issued to address sub-standard items and simplify the process.
- These rules include setting shelf-life norms and relaxing labeling guidelines.
- The **Indian Council for Fertilizer and Nutrient Research (ICFNR)** adopts international best practices in the fertilizer sector.
 - This ensures farmers get good quality fertilizers at affordable rates, thus achieving food security.
- Government initiatives include a focus on promoting **Indian brands** of food products and creating global food manufacturing champions.
 - This enhances employment opportunities for off-farm jobs as well as remunerative prices for farmers.
- There is a special focus on **perishables** within the Scheme for Formalization of Micro Food Processing Enterprises.
 - This reduces post-harvest losses, and promotes food security.

Role of technology in improving quality, hygiene and processing techniques.

- Technology enables **better quality control** in food processing by using modern machinery and techniques.
 - This helps maintain quality standards of processed food products.
- **Improved hygiene** is ensured through modern equipment and methods in food processing.
 - Technological advancements allow for automation, reducing manual contact in food processing.
- **Processing techniques** are enhanced by modern equipment, resulting in improved efficiency and product output.
 - Newer technologies can improve packaging, storage, and transportation processes.
- Technology facilitates **better storage and logistics management** for processed food items.
 - This helps to reduce post harvest losses in the sector and also improves supply chain efficiency.
- **E-technology** is being used for electronic record keeping and authentication for food distribution systems.
 - Electronic Point of Sale (ePoS) devices are used to confirm identification through biometric/Aadhaar authentication.
- **Market intelligence networks** use technology to collect real-time data on demand, supply, and prices of crops.
 - This helps in better decision-making and also reduces price dispersion.
- **Research and development** in food processing, packaging, and biotechnology are boosted through technology.
 - The government also encourages research and development in ancillary industries.
- **Information technology** helps in agriculture and allied fields by enabling better data management and decision support.
 - This leads to more efficient agricultural practices and value addition.
- **Technology** is critical in creating innovative food products and expanding the range of processed foods available.
 - This also boosts the sector's competitiveness in national and international markets.
- **Mechanization** improves productivity, which is key to ensuring food security to the rising population.
 - The use of machinery in farming has been shown to decrease costs of production.

Scope and Significance:

Scope and importance of the food processing industry in India

- The **food processing sector** is a major **employment-generating** industry in India.
 - It contributes significantly to both direct and indirect employment opportunities in the country.
- The food processing sector significantly impacts **income** generation, particularly for farmers and rural populations.
 - The sector is a key driver of growth in the Indian economy, encouraging innovation.
- **Value addition** is a key aspect of the food processing industry, transforming raw agricultural products into higher-value items.
 - Value addition leads to increased prices and better returns for agricultural produce.
- The sector accounts for a notable share of India's **GDP** and has a high growth potential.
 - The food processing sector contributes 8% of the nation's GDP.
- Unorganized micro food processing enterprises contribute a significant portion to employment in the sector.
 - These enterprises contribute 74.3% of employment, a third of which are women.
- The sector has a large number of **unorganized enterprises**, most of which are in rural areas and family-based.
 - Approximately 66% of these units are in rural areas and about 80% are family-based.

- The food processing sector is estimated to be worth \$380 billion and is projected to grow at a **CAGR of 11%**.
 - It is expected to reach \$540 billion by 2025.
- **Exports** of agricultural and processed food products have shown a significant increase, boosting income.
 - In FY22, exports of agricultural and processed food products were worth US\$ 25.6 billion.
- The sector aims to create global food manufacturing champions, promoting **Indian brands**.
 - This ensures remunerative prices of farm produce and higher income to farmers.
- The **Indian government** has focused on bolstering the unorganized food processing sector in rural areas.
 - Schemes aim to increase capacity and upgrade technology for individual food processors.

Role in ensuring food security and reducing wastage and post harvest losses.

- Food processing plays a crucial role in **ensuring food security** by enhancing shelf life and availability of food products.
 - It reduces reliance on seasonal availability of fresh produce and also helps reduce imports.
- The industry contributes to **reducing wastage** by transforming perishable goods into more durable forms.
 - This helps to minimize food spoilage during transportation and storage.
- **Post-harvest losses** are significantly reduced through effective processing, storage, and packaging.
 - A lack of adequate storage facilities can lead to post-harvest losses in mandis.
- The food processing sector provides **access to diverse food** products that are otherwise not available fresh all year round.
 - This enables a more balanced diet for consumers, enhancing food security.
- The focus on perishables within the Scheme for Formalization of Micro Food Processing Enterprises aims to reduce post-harvest losses.
 - Special focus on perishables can help in reducing spoilage during the supply chain process.
- **Technology** in the food processing sector is key to improving storage and logistics management.
 - This ensures effective distribution of processed foods, which further helps in food security.
- By increasing food processing capacities and value addition, the sector creates stronger linkages with **production clusters**.
 - This supports both farmers and also helps in reducing food waste during transit from farms to mandis.
- **Value addition** also helps in food security as processed foods can be stored and transported over longer distances.
 - This makes foods available to more people and in more areas.
- The food processing sector's growth decreases reliance on **imports** and strengthens domestic food supply chains.
- GM crops are also considered vital for ensuring food security to the rising population.
- Food processing contributes to **price stabilization** by managing surplus produce.
 - A market intelligence network can help in collecting real time data on supply and prices to help farmers.

Challenges and opportunities

Challenges and opportunities for the food processing sector in India.

- The food processing sector faces diverse and demanding **challenges** that hinder its growth.
 - These challenges include both controllable and uncontrollable factors affecting growth potential.
- A significant challenge is the low level of processing of agricultural output, with most being **primary processing**.
 - Less than 10% of India's agri-output is processed, limiting value addition.
- **Unorganized** nature of many food processing enterprises leads to inefficiencies and limited growth.
 - Approximately 25 lakh unorganized micro food processing units exist in the country.
- **Lack of adequate infrastructure** for logistics, storage, and processing poses a significant challenge.
 - This limits the sector's ability to handle increased production and distribution.
- **Technology upgradation** is needed in existing facilities, including research, development and packaging.
 - There is a need for fiscal incentives to encourage investment in ancillary industries.
- The food processing sector requires skilled manpower and needs to address the issue of **skill gap**.
 - State Agricultural Universities should commence courses in food processing related fields.
- **Quality** concerns, including the entry of substandard items, impact the sector's credibility.
 - New rules for importing products are designed to address these concerns.
- There are still **regulatory hurdles** and policy implementation gaps that affect the sector's performance.
 - These hurdles can act as a hindrance in achieving its full potential.
- **Market access** and supply chain inefficiencies also remain significant challenges for the sector.
- There are no adequate storage systems, grading systems which lead to post harvest losses in mandis.
- The food processing industry needs to overcome the **dependence on traditional** practices and embrace innovation.
- The industry can also look at ways to improve use of technology in their processes.
- The food processing sector is a **sunrise industry** with huge opportunities for growth due to low current processing.
 - India's significant agricultural production strength presents a large scope.
- The sector offers a vital **linkage between agriculture and industry**, bridging the gap between production and market.
 - It can leverage India's shift from food scarcity to surplus in food production.
- There is huge potential to **increase processing levels** and move towards more advanced food processing techniques.
 - This would lead to higher value addition and increased revenue for businesses.
- The sector has the **opportunity to create global food manufacturing champions** and promote Indian food brands.
 - It can also ensure better prices and incomes for farmers.
- **Digitization** can harness the sector's untapped potential by improving efficiency and addressing challenges.
 - The industry is estimated to be worth \$380 billion and is projected to grow at a CAGR of 11%.
- The government initiatives like the **Scheme for Formalization of Micro Food Processing Enterprises** provide avenues for growth.
 - The scheme supports the creation of global food manufacturing champions.
- There is scope to boost exports of processed foods due to the diverse array of **agricultural products** in India.
 - In FY22 alone India exported agricultural and processed food products worth US\$ 25.6 billion.

- The sector has the opportunity to enhance **food security** by reducing wastage, post-harvest losses and improving storage.
 - The sector can address concerns about price volatility and market linkages for agricultural produce.
- The potential for **private sector participation** is high, needing well-defined roles and risk-sharing mechanisms.
 - Fiscal incentives and partnership models can help create logistics and processing infrastructure.
- The sector can increase **employment** opportunities in off-farm jobs, particularly in rural areas.
 - The food processing sector is one of the largest employment-generating industries in India.

Case Studies: Successful Implementations in Food Processing

- **Sahyadri Farmer Producer Company (SFPC):** This agro-processing unit in Nashik, Maharashtra, serves as a case study for successful implementation. It has a **farmer-centric approach**, a **robust supply chain**, and **efficient technology**. It has generated 1300 full-time and 4000 seasonal jobs. It is also India's largest exporter of fresh grapes and processed fruits. Over 95% of the associated farmers own less than one hectare of land.
 - This example highlights a successful model of integrating small-scale farmers with processing and export.
- **Kolli Hills Agrobiodiversity Conservers' Federation (KHABCOFED):** This organization facilitated training and value-addition activities and branded ready-to-cook products under the label "Kolli Hills Natural Foods". This is a case of **empowering local communities** through value-added processing of local produce.

E-commerce Impact in the Food Processing Sector

- One source mentions the e-Rashtriya Kisan Agri Mandi (e-RAKAM) as an auction platform to ensure that farmers receive fair prices for their produce, and this may be an example of an **e-commerce platform** facilitating farmer-market linkages.
- The National Agriculture Market (e-NAM) is mentioned as an **e-marketing platform** at the national level to create "One Nation One Market" with better price discovery and transparency.

Small-Scale Processing Units Empowering Farmers and Creating Jobs

- **Micro Food Processing Sector:** This sector, with over 25 lakh units, contributes around 74% of employment in the food processing sector. Nearly 66% of these units are located in rural areas, and 80% are family-based, supporting livelihoods and minimizing migration to urban areas. While the sources indicate that many of these units face challenges, they also play a **key role** in rural employment and livelihood.
- **Case of Shri Kshetrimayum Jiten Singh:** A marginal farmer with 0.25 ha of land who, through training and adoption of improved agricultural and livestock rearing methods, was able to achieve better profits. He was also able to inspire other farmers to implement integrated farming techniques, showing a **path to empowerment** through small-scale initiatives.
- **Case of Mr. Dulal Konwar:** A farmer who ventured into paddy seed production and earned a net profit of ₹4,80,000, compared to a net profit of ₹54,000 from double cropping of rice and toria. He also motivated other farmers to get their paddy seed certified. This illustrates how small-scale processing ventures can **significantly improve income**.
- The creation of **community seed banks (CSBs)** and community nursery banks (CNBs) for promotion of local varieties and planting material has been helpful in improving farmers' livelihoods.

- The establishment of Maharashtra's largest cashew processing facility at the Mohadi campus in Nashik has facilitated employment for over 300 women in the area.
- Small-scale mechanical milling operated by self-help groups has had a **significant impact**.

Supply Chain Management, Upstream and Downstream Requirements

Supply Chain Management, Upstream and Downstream Requirements Questions:

- ☐ What are the impediments in marketing and supply chain management in developing the food processing industry in India? Can e-commerce help in overcoming these bottlenecks? (15/12½)
- ☐ Examine the role of supermarkets in supply chain management of fruits, vegetables and food items. How do they eliminate number of intermediaries? (18/10)
- ☐ What are the main bottlenecks in upstream and downstream process of marketing of agricultural products in India ? (22/15)

Impediments in Marketing and Supply Chain

Lack of storage facilities, poor transportation networks, inadequate cold chain.

- **Insufficient storage** causes post-harvest losses in mandis.
- There are **acute shortages of warehouses**, cold storage and pack houses.
- **Poor transportation** networks contribute to high transportation costs.
- A lack of proper storage and grading systems leads to post-harvest losses in mandis.
- **Limited cold chain infrastructure** impacts perishable goods, leading to losses.
- Development of infrastructure for storage is needed to prevent distress sales by farmers.

Inefficient handling, delays in transit, high transportation costs.

- **Inefficient handling** of agricultural produce results in losses and delays.
- **Delays in transit** affect the quality and market value of farm products.
- High transportation costs increase the overall cost of agricultural goods.
- The agriculture export basket includes raw items with a short shelf life and low-profit margins.
- A long supply chain results in increased mediation charges and higher consumer costs.
- **Lack of a unified market** increases taxes and intermediaries in different states.
- Inadequate transport affects the accessibility of markets for remote farmers.
- There is a need to promote private sector participation in creation of logistics infrastructure.
- The lack of storage leads to post-ripening of crops in mandis.

Impediments in Marketing and Supply Chain

Market inefficiencies: Lack of market information, price volatility, cartelization and lack of transparency.

- **Lack of market information** affects farmers' ability to make informed decisions.
- **Price volatility** creates instability and risk for agricultural producers.
- There is **price dispersion** across different markets for the same product.
 - Example: A variety of rice may be sold for 100 Rs/kg in Maharashtra and 200 Rs/kg in Arunachal Pradesh.
- **Cartelization** and lack of transparency in markets can lead to farmer exploitation.
- The **objective of e-NAM** is to create a single unified market throughout the country.
- **Agri-markets** are regulated by the states where APMC mandis enjoy a monopoly status.
- Private markets lack regulations and direct government intervention, creating risks for farmers.

Role of intermediaries: Multiple layers of intermediaries, low price realization for farmers and their dependence on middlemen.

- **Multiple layers of intermediaries** increase costs and reduce farmer profits.
- The longer the supply chain, the more the mediation charges, increasing costs for consumers.
- Farmers **depend on middlemen** (Arhatiyas) for selling their produce.
- Farmers may receive lower prices for their produce due to the involvement of many intermediaries.
- If farmers sell through Mandis the profit goes to the mediator.
- After April 2021, the government introduced a new system where farmers sell directly to FCI through Arhatiyas.
- The price paid by the consumer will have a very small portion of the farmer's profit.

Post-harvest losses and wastage: Spoilage, handling damage, lack of proper storage.

- **Post-harvest losses** occur due to spoilage and handling damage.
- A lack of adequate **storage facilities** contributes to spoilage of harvested crops.
- There is a **lack of proper storage**, grading, and sorting systems.
- Lack of awareness and storage near the farm gate leads to **pre-processing losses**.
- Inadequate packaging and handling practices lead to product **damage**.
- The lack of storage leads to post-ripening of crops in mandis, and post-harvest losses.
- **Liberalizing the market** could attract investment in infrastructure like warehouses and cold storages.
- **Poor storage facilities** lead to distress sales by farmers due to the fear of spoilage.

E-commerce in Supply Chain

Potential for direct market access for farmers.

- E-commerce platforms provide **direct market access** for farmers.
- E-NAM is an **online platform** connecting farmers and consumers.
- Farmers can directly interact with buyers via **e-NAM**, reducing dependence on intermediaries.
- E-commerce can enable farmers from **remote areas to access wider markets**.
- **Contract farming** could allow large retailers to buy directly from farmers' fields.
- **e-NAM** facilitates trade from state to state, benefiting farmers.

Role in reducing intermediaries and enhancing transparency in the supply chain.

- E-commerce helps in **reducing multiple layers of intermediaries**.
- Direct connections between farmers and consumers enhance supply chain **transparency**.
- E-commerce can lower **mediation charges**, increasing farmer profits.
- **Commission** can be saved if buyers directly interact with farmers through e-NAM.
- The goal of e-NAM is to create a **unified national market**, increasing transparency.
- **E-commerce** provides an alternative to APMC mandis, which are often controlled by local politicians.
- **Private markets** have no regulations, and e-commerce could provide needed structure.

Use of technology for improved tracking, inventory management and efficient delivery.

- **Technology** is used to improve tracking and inventory management in the supply chain.
- **e-NAM** uses online platforms to help manage transactions and track produce.
- **System generated online allocation orders of foodgrains** for all Fair Price Shops (FPSs) is implemented in all States/UTs.
- **Supply Chain Management of foodgrains** is computerized in 31 States/UTs for online management of stocks.
- The **SMART-PDS** scheme uses technology for better monitoring and accountability.
- A national-level common dashboard will be used to monitor procurement and distribution through fair price shops on a real-time basis through **SMART-PDS**.

- **Electronic Point of Sale (ePoS)** devices at Fair Price Shops enable electronic record-keeping of sales.

Benefits for consumers (convenience, better quality, competitive prices).

- E-commerce provides **convenience** for consumers by offering products online.
- Direct sourcing from farmers may result in **better quality** produce for consumers.
- Reduced intermediary costs can lead to **more competitive prices** for consumers.
- **E-commerce** can bypass inefficiencies in traditional markets to benefit consumers.
- Consumers may have greater access to products from different regions through **online platforms**.
- If buyers can purchase at a lower price than at the mandi, they can choose **e-NAM**.

Impact on supply chain management of fruits, vegetables, and other food items (direct procurement, contract farming, organized retailing).

- **Organized retail** and processing sectors can be strengthened to create better farm-to-market supply chains.
 - A scheme will help cottage industry, farmer producer organizations and individual food processors to strengthen farm-to-market supply chains.
- **Food processing** includes the transformation of raw agricultural products.
- The government should promote private sector participation and risk sharing for infrastructure creation.
 - This includes logistics, storage and processing, along with fiscal incentives and partnership models.
- **Technology** upgrades of existing facilities and investments in ancillary industries is recommended.
 - Fiscal incentives should be extended to investors.
- **Contract farming** can occur through a system where large retailers directly buy from farms.
 - Farmers must sell their produce through Mandis, even though this can save commissions.
- **e-NAM**, an online platform, is intended to create a unified national market for farmers and consumers.
 - A farmer in a remote area may not know prices in different areas, while buyers have price information.
- **Private markets** are not regulated, have no government intervention and no guarantee for farmers against exploitation.
- Private markets will initially invest to attract farmers, but the farmer is left with a single buyer.
- **Supermarkets** and other direct channels can offer alternatives to traditional APMC markets.
 - The more layers in the supply chain, the higher the markup from intermediaries.
- **Current export** policies are not stable, using the Essential Commodities Act to tame domestic inflation.
 - This impacts our image as a credible trade partner with a negligible effect on bringing down inflation.
- There are **no storage or grading** systems, which leads to post-harvest crop losses in Mandis.
 - The government has not addressed this issue due to the federal structure.

Mechanisms for eliminating intermediaries (direct sourcing, improved supply chain practices).

- The government aims to **eliminate intermediaries** by encouraging direct sourcing.

- Intermediaries are often commission agents operating in Agricultural Produce Market Committee (APMC) mandis.
- **Direct sourcing** from farmers is hindered by the need to sell through mandis, which can be costly.
 - If the mandi does not pay the minimum support price (MSP), the Food Corporation of India (FCI) will procure.
- The **commission** in mandis is sometimes collected from the farmer, and sometimes from the buyer.
- Commission can vary from mandi to mandi and crop to crop.
- The **buyer** who quotes the highest price will get the produce at auction in APMC mandis.
 - These auctions are run under the supervision of state government officials.
- **Improved supply chain** practices, like better storage, can reduce post harvest losses.
 - Farmers should grow crops based on agro-climate conditions and not water-intensive crops.
- The **government is promoting custom hiring** centers, so farmers can share machines.
 - These centers are available in better developed areas.
- **e-NAM** intends to establish a single unified market, enabling farmers to sell nationwide.
 - A variety of rice might sell for 100/kg in Maharashtra and 200/kg in Arunachal because of the price dispersion.
- The government should promote **integrated nutrient management** with a cluster based approach.
- This would include end-to-end support for farmers practicing organic farming.
- **Primary Agriculture Credit Society (PACS)** provides credit to farmers, and can facilitate direct sales.
 - This is one reason for delay in payments for farmers in Bihar.
- The **PM-FBY** scheme is intended to protect farmers from cultivation related risks.
 - The government has MSP to help with market price risks.
- **Minimum support price (MSP)** is calculated by the Commission for Agricultural Costs and Prices (CACP).
 - MSP is always announced before the cultivation season, so that farmers can make informed decisions.
- **Monoculture**, like rice, wheat, cotton, and sugarcane, leads to groundwater depletion.
 - MSP is provided for few crops, so the farmers continue cultivating water intensive crops.

Role in quality control, standardisation, and promoting sustainable practices.

- The Indian Council of Agricultural Research (ICAR) is working to achieve **sustainable and responsible agriculture** practices.
 - This includes work in areas to improve production and make agriculture more resilient.
- ICAR has identified **chrysanthemum genotypes** that can improve pollinator health and habitat restoration.
 - This can be used for preparation of floral calendars to improve pollinator health.
- The government has implemented programs to promote the **balanced use of chemical fertilizers**.
 - These programs create awareness about regenerative agriculture and incentivize farmers through green credits.
- **Neem-coated urea** is used to improve nutrient-use efficiency and promote sustainable practices.
 - The PM-PRANAM scheme encourages balanced use of chemical fertilizers.
- There is a need to correct distortions in **nutrient prices** created by differential subsidy rates for nutrients.
 - Fertilizer subsidies should be linked with recommended nutrient applications.
- The government aims to achieve "**One nation, one fertilizer**," to reduce the cost of interstate transportation.

- Under this scheme, bags will be printed with PM-BJP, so farmers will buy local fertilizers.
- The **usage of pesticides** in India is much less compared to other countries.
 - However, many exports from India are rejected due to high pesticide residue.
- The government has not taken measures to study and control **pesticides** according to present-day standards.
 - The Anupam Verma Committee report in 2013 showed 290 molecules are used in India, while 90 are banned elsewhere.
- The government is promoting **integrated nutrient management** and organic farming through a cluster-based approach.
 - This has been extended to Bharatiya Prakritik Krishi Paddati (organic farming).
- The government should encourage **State Agricultural Universities** to start courses in food packaging and processing.
- This should also include biotechnology and information technology in agriculture.
- ICAR has developed an **"Onion Crop Advisor" mobile application**.
- ICAR also has a mobile app to capture data from the field for major livestock products.
- ICAR-CMFRI has identified potential sites for **seaweed farming** and issued guidelines for sustainable farming.
 - They assessed 135 marine fish stocks, and 91.1% were healthy.

Integration with farmer cooperatives and producer groups.

- A scheme is in place for **formalization of micro food processing enterprises**, which will be implemented over 5 years.
 - Two lakhs micro-enterprises will be assisted with credit linked subsidy.
- The **Gram Samridhi Yojna** aims to bolster the unorganized food processing sector in rural areas.
 - This scheme is funded by the World Bank and the center.
- **Farmer producer organizations** can increase capacity and upgrade technology.
 - These groups can also work on skill improvement and entrepreneurship development.
- **Farmer-led extension strategies** are being used to enhance income through millet-based farming.
 - This involves identifying farmer leaders and forming producer groups.
- **Millet producer groups** were formed in Koraput, Odisha and Kolli Hills, Tamil Nadu.
 - They were found to be profitable with better yields, returns, and knowledge enhancement.
- The **government is promoting custom hiring** centers, so that farmers can share machines.
 - The rent for these centers is decided by Gram Sabha in every village.
- The **Primary Agriculture Credit Society (PACS)** provides credit to farmers.
 - This organization can help farmers with direct sales of produce.
- The **e-NAM** platform is designed to enable farmers to sell directly to consumers, potentially forming groups.
 - A farmer may not have information about prices in different parts of the country.

Upstream Bottlenecks

Challenges in procurement (aggregation issues, fragmented land holdings).

- **Small and fragmented land holdings** in India lead to less use of machinery and difficulties in aggregation.
 - Marginal farmers have less than 1 hectare of land; small farmers have 1-2 hectares.
- **66% of unorganized food processing units are in rural areas**, and 80% are family run, creating aggregation issues.
 - These enterprises contribute 74.3% of employment in the sector.
- The **procurement system is not well-established** for all crops across the country.
 - 60% of wheat and 30% of rice procured for PDS is from Punjab and Haryana only.

- **Procurement starts late** in some areas, and payments are not made upfront causing delays.
 - Delays of more than a month have been reported in some areas for government procurement.
- **A ceiling on maximum quantity** that can be procured exists in the current system.
 - This is one of the major reasons for problems such as groundwater depletion and monoculture.
- The **MSP policy favors a few crops** from select regions, causing regional disparities.
 - This can also lead to farmers growing water-intensive crops even in drought areas.
- **Small, marginal, and tenant farmers** are often not aware of government procurement processes.
 - Most tenant farmers lack recorded leases, making registration for procurement difficult.
- **40 per cent of the cultivator households are reported to have taken loan from informal sources (NABARD).**
 - Small and marginal farmers are still dependent on money lenders, called *arhatiyas*.
- **Farmers without access to formal credit** will often sell their produce at lower prices to repay loans.
 - These money lenders provide security-free loans but impose heavy interest rates.

Challenges in sorting and grading, lack of standardization.

- There is a lack of **storage systems and grading systems** leading to post-harvest losses in mandis.
 - This affects the quality of produce that is sold by farmers in the markets.
- **Auctions in mandis** lack transparency; buyers bid low to procure crops at less price.
 - Farmers are often exploited based on the crop quality.
- The **Anupam Verma Committee** reported that standards for pesticides need review.
 - The committee noted that many pesticides used in India are very harmful.
- The **lack of standardized seed replacement rates** causes low productivity and low seed quality.
 - Most farmers use farm-saved seeds, rather than purchasing from outside.
- The **use of non-certified seeds** contributes to decreased agricultural productivity and profitability.
 - The quality of farm saved seeds is lower than certified seeds.
- The **current agricultural export policy is ad-hoc** and along with the Essential Commodities Act, 1955, is not efficient.
 - This affects India's image as a credible trade partner.

Challenges related to lack of information and awareness of market trends.

- Farmers in remote areas may lack information on the price of their crops in different parts of the country.
 - Buyers, on the other hand, have information about the prices in different locations.
- **90% of rice production in Punjab is non-basmati**, which is procured through mandis.
 - If farmers shift to private markets, APMC mandis, which provide MSP, may close down.
- There is a need for a **market intelligence network** to collect real-time data on the demand, supply, and prices of crops.
 - This can help farmers make informed decisions about what to grow and where to sell.
- The government is also using **e-technology** to help farmers in production and marketing.
- This may help increase awareness of market trends, although more efforts are needed in this area.

Downstream Bottlenecks

Challenges in storage (lack of storage infrastructure, inadequate cold chains).

- There is a general lack of **adequate storage infrastructure** for agricultural produce across India.
 - This leads to post-harvest losses and a reduction in the overall value of crops.
- **Pre-processing losses occur due to lack of storage facilities** near farm gates.
 - This is exacerbated by a dearth of pack-house facilities, affecting perishable goods.
- **Inadequate cold chain infrastructure** is a major issue for perishable goods.
 - Without proper cold chains, fruits, vegetables, and other perishables can spoil quickly.
- A lack of **storage and grading systems in mandis** further contributes to post-harvest losses.
 - This makes it difficult to maintain the quality of produce after harvesting.
- The **government knows about post-harvest losses** in *mandis* but has not taken measures.
 - The lack of intervention is because agriculture is a state list subject.

Challenges in transportation and logistics (poor roads, connectivity, limited transportation options).

- **Poor road infrastructure and connectivity** pose major challenges for transporting goods.
 - This particularly affects the movement of agricultural produce from rural areas to markets.
- **Limited transportation options** increase the cost and time of moving goods.
 - This adds to the overall cost of agricultural products and reduces farmer's profits.
- The **interstate transportation** of fertilizers is also very costly for the government.
 - This expense is around 18000 crore for the government.
- There is a need for better **transportation services** for paddy and other grains.
 - Efficient transport is necessary to move produce from farms to processing facilities and markets.
- **Supply chain is long**, the more the supply chain, the more the mediation charges.
 - This results in less profit for the farmers and higher cost for the consumers.
- If crops have to travel from one state to another, there is also an **issue with taxes**.
 - This is because taxes levied are different in different states.

Challenges in processing and distribution (lack of processing facilities, poor last mile delivery).

- There is a **lack of food processing facilities**, which limits value addition and reduces shelf life.
 - This is a significant bottleneck in the agricultural supply chain.
- **66% of unorganized food processing units are in rural areas** with a focus on family businesses.
 - This suggests a lack of processing infrastructure in areas of production.
- **Inadequate automation** with regard to information management limits effectiveness.
 - This along with low availability of reliable equipment leads to further issues.
- **Last mile delivery is poor**, affecting the smooth movement of produce to consumers.
 - This leads to wastage and reduces the availability of fresh food.
- There are many small, unorganized food processing enterprises, that lack **proper training**.
 - The lack of training impacts the quality and efficiency of food processing.
- **The focus on few crops for MSP** leads to skewed cultivation of crops like rice and wheat.
 - This contributes to overproduction of a few crops and underproduction of others.
- **Lack of grading and sorting** infrastructure also affects processing and sale of products.
 - This reduces the value of produce and its attractiveness for processing.
- The **current system for marketing agriculture** products needs to be reformed.
 - This will make the supply chain more efficient and will benefit both farmers and consumers.

- **The Electronic National Agriculture Market (e-NAM)** seeks to create a unified market, but still has many challenges.
 - Lack of awareness and issues with implementation remain concerns.

Post-Harvest Losses in India:

- Approx. **74 million tonnes** of food are wasted annually in India.
- **22%** of food grain output and **10%** of combined foodgrain and horticulture production are lost post-harvest.
- Highest losses in perishable goods: **22% in livestock, 19% in fruits, 18% in vegetables.**
- Source: [Times of India](#)

Investment in Infrastructure Projects:

- Government investment schemes like **Agriculture Infrastructure Fund (AIF)** sanction **₹10,000 crore** for cold storage, warehouses, etc.
- **Pradhan Mantri Kisan SAMPADA Yojana** allocated **₹6,000 crore** for food processing infrastructure.
- Focus on **cold storage, primary processing**, and reducing post-harvest losses.
- Source: [Pib.gov.in](#)

Market Prices and Price Fluctuations:

- **Minimum Support Price (MSP)** for wheat raised by **6.6%** to ₹2,425 per quintal in 2024 to stabilize prices.
- Price volatility due to factors like **weather, demand-supply dynamics**, and **policy changes**.
- Source: [Reuters](#)

Farmer Incomes and Economic Status:

- Average monthly income of Indian agricultural households: **₹10,000** in 2019.
- **Highest income** in Punjab: **₹26,000/month**, **Lowest in Jharkhand**: ₹5,000/month.
- Economic disparities remain a challenge despite improvements in farmer incomes.
- Source: [Statista](#)

Case Studies: Successful Supply Chain Management

- **Sahyadri Farmer Producer Company (SFPC)**: This agro-processing unit in Maharashtra demonstrates how a cooperative can establish processing facilities and create employment in rural areas. Their cashew processing facility, the largest in Maharashtra, employs over 300 women. This shows a model for integrating production, processing, and employment.
- **Mahagrapes**: This partnership of sixteen grape growers' cooperatives is a successful example of how collaboration and technology (pre-cooling and cold storage) can enhance exports. The cooperative provides market information and packaging to its members, illustrating the benefits of coordinated action.

Integrating Technology for Improving Supply Chains

- **SMART-PDS**: This initiative uses technology to ensure timely delivery of food grains, prevent leakages, and enable portability of ration cards. It also generates data that can be used for data-driven decision making and better accountability.
- **Digitalization of PDS**: End-to-end computerization, Aadhaar linkage, and digital records in Fair Price Shops (FPS) have increased transparency and efficiency. GPS tracking of trucks and online portals provide real-time monitoring.
- **Smart Warehouses**: The World Food Programme (WFP) is piloting "Smart Warehouses" with sensors to monitor conditions like temperature and humidity, enabling informed decisions to reduce storage losses. This illustrates how IoT can improve storage management.
- **AI and Blockchain**: AI can optimize production and blockchain can ensure supply chain transparency. Digitization helps SMEs with planning and creditworthiness.

Supermarkets and Organized Retail

- **Supermarkets in Supply Chain Management:** Supermarkets can streamline supply chains by directly procuring from farmers, reducing intermediaries. They also can provide efficient distribution, grading, and logistical support.

International Examples

- **Cerrado Region in Brazil:** Farmers in this region use a crop rotation system (soybeans, maize, cotton, and pasture) to reduce soil erosion, increase organic matter, and minimize the need for synthetic inputs, while maintaining high crop yields. This offers a model for sustainable farming.

Global Best Practices

- **Food Processing and Value Addition:** Other countries have higher levels of food processing and value addition. India needs to improve to compete in global markets, particularly by using technology and infrastructure.
- **Storage and Transit:** Modern technologies like silos and bulk transport reduce storage and transit losses. These are important for reducing post-harvest losses in India.
- **Quality and Standards:** Countries such as the US and China have higher export shares of processed food in agriculture. The food industry needs to focus on quality standards and safety measures to compete in the international market.
- **Seed Export:** India's seed exports are less than 1% of the global market, a figure that should increase through capacity building, better infrastructure, and marketing.
- **Pesticide Residue Management:** Indian cardamom exports are hindered by pesticide residue levels. This suggests the need to focus on safe and sustainable farming practices.
- **Use of Technology:** Other countries have utilized precision agriculture, and technology like remote sensing and drones in their supply chain, an area that India needs to utilize.

Land Reforms in India

Land Reforms in India Questions:

- ☐ Immediately after Independence, land reform measures were initiated to achieve the twin objectives of increasing agricultural production and attainment of social justice. What types of measures have been taken by the states to achieve these objectives and with what results? What is the role of the Union Government in these matters? (150 words) (83/35)
- ☐ In what ways do land reforms help agricultural growth? Briefly state the aim of land reforms as envisaged in the Fifth Five Year Plan. (250 words) (95/40)
- ☐ Give your assessment on land reforms in India. (97/20)
- ☐ Establish relationship between land reforms, agriculture productivity and elimination of poverty in the Indian economy. Discuss the difficulties in designing and implementation of agriculture-friendly land reforms in India. [200 words] (13/10)
- ☐ The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 has come into effect from 1st January, 2014. What are the key issues which would get addressed with the Act in place? What implications would it have on industrialization and agriculture in India? (14/12½)
- ☐ In view of the declining average size of land holdings in India which has made agriculture non-viable for a majority of farmers, should contract farming and land leasing be promoted in agriculture? Critically evaluate the pros and cons. (15/12.5)
- ☐ Discuss the role of land reforms in agricultural development. Identify the factors that were responsible for the success of land reforms in India. (16/12½)
- ☐ How did land reforms in some parts of the country help to improve the socio-economic conditions of marginal and small farmers? (21/10)
- ☐ State the objectives and measures of land reforms in India. Discuss how land ceiling policy on landholding can be considered as an effective reform under economic criteria. (150 words) (UPSC GS 3 2023/10 marks)

Land reforms in India aim to address issues of land ownership, distribution, and use. They are essential for achieving **equitable access** to land, enhancing **agricultural productivity**, alleviating **rural poverty**, and promoting social justice.

Land Reforms

Social justice, equity, and empowerment

- Land reforms aim to achieve equitable access to land, empowering marginalized groups.
 - This includes abolition of intermediaries like zamindars to prevent wealth concentration.

- Tenancy reforms aimed at rent reduction, security of tenure, and ownership rights.
- **Land ceiling policies** sought to ensure equitable distribution of land resources.
 - Ceiling was based on irrigation and fertility to ensure uniform distribution.
- **Empowering farmers** through land ownership increases their profits and disposable income.
 - Land reforms seek to prevent the concentration of wealth by preventing intermediaries.
- **Addressing historic inequalities** is a key goal of social justice.

Improved agricultural productivity, rural development, and poverty alleviation

- Land reforms aim to enhance agricultural productivity and rural development.
 - Consolidation of land holdings was a measure to increase productivity by getting rid of fragmented lands.
 - Land reforms are linked to increased productivity as farmers invest more in land they own.
- **Providing land to tenants** and landless laborers can help alleviate rural poverty.
 - Security of tenure increases investment by tenant farmers and leads to better productivity.
- **Land reforms** can be a step to prevent distress migration from rural areas.
 - Land ownership may lead to better job opportunities in rural areas.
- **Fair land distribution** is essential for long term economic growth in rural areas.

Efficient resource utilization and equitable distribution

- Land reforms seek efficient use of land by consolidating fragmented holdings.
 - Consolidation aims to increase productivity by creating unified and more manageable plots.
 - Land reforms aim to distribute land among landless laborers and tenants.
- **Equitable distribution of resources** is a main focus of land reforms.
 - This will ensure that land is distributed in a way to maximize agricultural productivity.
 - Land reforms help in reducing income disparities and promote better distribution of resources.
- **Promoting farmer ownership** leads to long-term sustainable use of land.
 - The distribution of material wealth through land ceiling is also an objective.

Abolition of intermediaries (zamindari, jagirdari)

- Abolition of intermediaries like **zamindars** aimed to eliminate rent collectors between the state and farmers.
 - This aimed at **preventing wealth concentration** and ensuring the state was directly connected with farmers.
- The **zamindari system** was abolished as a measure to prevent exploitation of farmers.
 - It sought to address historical imbalances of power and promote social justice.
- **Eliminating intermediaries** was a key step in land reform and empowerment of farmers.

Tenancy reforms (security of tenure, rent regulation)

- **Tenancy reforms** focused on providing security to tenant farmers through rent reduction.
 - These reforms aimed at regulating the rent paid by tenants to landowners to improve their condition.
- **Security of tenure** was a critical component of tenancy reforms.
 - This ensured tenants could not be easily evicted, promoting investment in the land.
- **Ownership rights** were also part of tenancy reforms to empower tenants.
 - This allowed tenants to gain ownership rights over the land they cultivated.

Land ceiling (imposing a limit on land holdings)

- **Land ceiling** sought to impose a limit on the maximum amount of land an individual could own.
 - The limit was based on **irrigation and fertility** of the land to ensure uniform distribution.
- The main aim of land ceiling was to **reduce the exploitation of tenants** and ensure equal access to land.
 - This policy intended to redistribute surplus land to the landless and promote equitable distribution.
- **Land ceiling aimed to curb concentration of land** ownership and promote social justice.
 - It aimed at ensuring that land was distributed in a way to maximize agricultural productivity.

Consolidation of holdings and land records digitization

- **Consolidation of land holdings** aimed to combine fragmented plots into single, more viable farms.
 - This was done to get rid of fragmented land and increase productivity by unified plots.
- **Digitization of land records** aims to ensure accuracy and accessibility of land information.
 - This is expected to streamline the process of land transfers and reduce disputes.
- **Consolidated holdings** enable better management, improve irrigation, and raise productivity.
 - It is also beneficial for better resource utilization.

Implementation of Land reforms

Success and failures of land reforms in different parts of the country.

- **Land reforms** have had mixed success across different states due to variations in implementation.
 - Some states successfully abolished intermediaries while others faced challenges.
- **Tenancy reforms** have had limited success due to poor record keeping and implementation.
 - Many tenant farmers were unable to secure their rights or ownership of land.
- **Land ceiling laws** also had limited success because of loopholes and poor enforcement.
 - Landowners used various methods to circumvent the land ceiling laws.
- **Consolidation of holdings** faced resistance from farmers due to social and political reasons.
 - This reform was more successful in some areas with strong state support and community involvement.

Role of centre and state governments.

- The **central government** formulates policies and provides guidelines for land reforms.
 - It provides financial and technical support for implementing land reforms in the states.
- **State governments** are primarily responsible for implementation of land reforms.
 - They have the autonomy to formulate their own land laws within the framework provided by the center.
- **Coordination** between central and state governments is essential for effective implementation.
 - Lack of coordination and political will can hinder land reforms.
- The **center** has introduced model acts and asked state governments to frame new laws.
 - Some states followed these and some did not, like Bihar abolishing APMC completely, while others like Maharashtra and Delhi framed it very late.

Socio economic and political challenges in implementation

- **Strong resistance** from landowners and influential groups have hindered implementation.
 - These groups often use their power to prevent land redistribution.
- **Lack of political will** and corruption are major challenges in implementing land reforms.
 - Political interference often prevents proper implementation of these laws.
- **Social issues** like caste and social inequalities also pose challenges.
 - These issues hinder equal access to land and create power imbalances.
- **Poor land records** and a lack of transparency makes it difficult to enforce land laws.
 - Digitization of land records can address this challenge but its pace has been slow.
- **Small and marginal farmers**, and tenant farmers are not aware about the MSP.
 - Most of the tenant farmers do not have a recorded lease, and therefore, find it difficult to get registered for government procurement.

Impact on Agricultural Growth

Relationship with productivity, investment, access to resources, technology and credit.

- **Agricultural productivity** is influenced by investment in technology, irrigation, and better seeds.
 - **GM crops** can increase productivity, but there are issues of efficacy over time.
- Access to **credit** enables farmers to invest in inputs like fertilizers and machinery.
 - **Subsidies** for fertilizers and power are provided by the government to reduce cost.
- **Technology**, like farm mechanization and e-NAM, enhances efficiency and market access.
 - **Custom hiring centers** provide access to machinery for small and marginal farmers.
- **Irrigation facilities** have a direct relationship with fertilizer usage and productivity.
 - Regions with higher irrigation, like Punjab, use more fertilizers, increasing yields.
- Use of **better quality seeds** increases agricultural productivity and reduces dependency on imports.
 - The **seed replacement rate** can be increased by using certified seeds every year.
- **Integrated nutrient management** and organic farming methods promote balanced nutrient use.
 - Initiatives like PM-PRANAM aim at promoting these practices.

Impact on the lives of small and marginal farmers.

- **Small and marginal farmers** are defined as having less than 1-2 hectares of land.
 - **Marginal farmers** have less than 1 hectare of land and comprise the majority.
- **Land reforms** aimed to empower small farmers through tenancy rights and land ceiling, but had limited success.
- **Many tenant farmers** could not secure ownership due to poor record keeping and implementation.
- **Access to resources** like credit, machinery and technology remains a challenge.
 - Many rely on traditional farming methods and lack access to modern inputs.
- **Market access** and fair prices remain an issue due to fragmented markets and intermediaries.
 - **E-NAM** aims to create a unified market and address price dispersion.
- **MSP** provides a safety net but many small and marginal farmers are not aware of it.
 - They often lack a record of lease and cannot register for government procurement.
- **The feminization of agriculture** has led to more women working in agriculture, but they often lack ownership rights and access to resources.
 - Most women are agricultural laborers, not owners of the land they work on.
- **Climate change** and extreme weather events impact crop yields and farmer livelihoods.
 - **Monsoon failure** leads to crop failure, particularly for rain-fed agriculture.
- **Lack of storage** and post-harvest infrastructure leads to losses, which disproportionately impacts small farmers.
 - **Cold storage** and processing units can mitigate these losses.
- **Indebtedness** and farmer suicides are prevalent, especially in states like Maharashtra.

- This is due to crop failure, market fluctuations, and lack of support.

Relationship with Poverty Alleviation

Improved incomes, employment, and social equity, and economic opportunities.

- **Agriculture** is a primary source of livelihood for a large part of India's population, around **58%**.
 - Improvements in agricultural practices can lead to higher incomes for farmers.
- The **food processing sector** is a key driver for growth and employment in the economy.
 - The unorganized sector contributes significantly to employment, with a large portion located in rural areas.
- **Government schemes** such as the Scheme for Formalization of Micro Food Processing Enterprises aim to increase off-farm employment.
 - These schemes also seek to ensure **remunerative prices** of farm produce.
- **Investments in agriculture**, infrastructure, and allied sectors can boost economic growth and opportunities.
 - Developing infrastructure in rural areas can prevent rural-urban migration by creating job opportunities.
- **Land reforms** can lead to social equity by redistributing land to landless and marginal farmers.
 - However, these reforms have had mixed success due to resistance from landowners and political issues.
- **Fair market access** through e-NAM can ensure better prices for farmers and reduce exploitation.
 - It also creates a unified market, reducing price dispersion across states.
- **Minimum Support Price (MSP)** is intended to protect farmers from market risks.
 - However, many small and marginal farmers are not aware of it or unable to access its benefits.
- **Access to credit and technology** is also necessary for increasing income and reducing poverty.
 - Subsidies on fertilizers, power, and machinery can reduce costs and increase access.
- **Diversified agriculture practices** like crop diversification, regenerative agriculture, and climate-smart agriculture also helps increase farmer income and reduces risks.
 - The Sub-Mission on Agriculture Extension (SMAE) strengthens programs to empower farmers for food security.
- **Food security programs** like the Public Distribution System (PDS) help in poverty alleviation by providing subsidized food grains.
 - The **National Food Security Act (NFSA)** ensures food entitlement to priority households at subsidized prices.
- **The food processing sector** has the potential to increase income of farmers.
 - Linking production with food processing units can improve income and prevent post harvest losses.
- **Promoting pulses** can also provide nutritional security for people.
 - India is the largest producer, consumer and importer of pulses.
- **E-technology** also helps farmers by providing information about prices and new farming technologies.
 - It helps them in better decision making about their crops.

Land Acquisition Act 2013

Key provisions, compensation, rehabilitation, consent procedures.

- The act aims to ensure **fair compensation** and rehabilitation for those affected by land acquisition.
- **Compensation** includes the market value of the land, as well as assets and structures on the land.
 - It also provides for a **solatium** (additional amount) on the market value.

- **Rehabilitation** and resettlement are provided to affected families, especially the **vulnerable communities**.
 - The act includes provisions for **housing, infrastructure, and livelihood support**.
- **Consent** is mandatory for private projects, with **80% consent** from affected families for private projects.
 - For **Public-Private Partnerships (PPP)**, it requires **70% consent**.
- The Act mandates a **Social Impact Assessment (SIA)** to evaluate the potential impact of land acquisition.
- This includes **environmental, economic, and social impact** and informs the decision making process.
- The Act includes a **multi-tiered grievance redressal mechanism** to address disputes related to land acquisition.
 - Affected parties can appeal to higher authorities if they have concerns.

Implications for industrialization and agriculture.

- The act impacts **industrialization** by creating a **framework for land acquisition** for industrial projects.
 - However, the high **compensation** and **consent** requirements can sometimes delay or make projects expensive.
- It also affects **agriculture** by regulating the acquisition of agricultural land for non-agricultural purposes.
 - The act aims to **minimize the loss of agricultural land** and its effects on food production.
- The Act recognizes the **importance of food security** and prohibits the acquisition of fertile multi-cropped agricultural land.
 - However, this rule may be relaxed in **exceptional circumstances** for strategic projects.
- The provisions for **rehabilitation and resettlement** aim to minimize the adverse impact on the livelihood of farmers.
 - However, the actual implementation of **these provisions** is often a challenge.
- **Consent requirements** can slow down **infrastructure** and industrial projects, affecting investment and development.
 - But, the consent process is necessary to ensure that the affected people are consulted.
- The act seeks to balance the need for **economic development** with the need to protect the **rights of landowners and farmers**.
 - The law is intended to prevent exploitation and make land acquisition fair for affected people.
- **Implementation challenges** and lack of clear guidelines in the act have led to some disputes and delays in acquiring land.
 - This has also resulted in some projects being challenged in courts of law.
- **Land diversion** for industrial purposes may decrease land for agricultural purposes.
 - But, at the same time, industrialization will give rise to employment opportunities.
- There is concern that the act could lead to a **reduction in agricultural output**, if land acquisition is not well managed.
 - This may affect India's **food security goals**.

Contract Farming and Land Leasing

Pros and cons, its applicability to current scenario.

- **Contract farming** can provide farmers with **assured markets** and reduce risks of price fluctuations.
 - It ensures a **predetermined price** for the produce, offering a stable income.
- It can facilitate **access to technology and inputs** for farmers, thus increasing productivity.
 - Sponsors may provide **quality seeds, fertilizers, and technical advice** to farmers.

- **Consumers** may get a better product due to quality control by the contracting firms.
 - Firms usually maintain standards of quality and supply which can benefit the consumer.
- **Large retailers** can source directly from farmers, which reduces the role of intermediaries.
 - This can result in **reduced costs and better prices** for both consumers and producers.
- **Contract terms** often favor the **sponsors** due to lack of training and legal awareness among farmers.
 - Contracts are often drafted by the sponsors in a way to **benefit themselves**.
- It may **divert land** from food crops to more profitable but non-essential crops like exotic fruits and vegetables.
 - This **shift in cropping patterns** may reduce the production of essential food crops.
- **Small and marginal farmers** may be excluded as sponsors prefer large farmers for contract farming.
 - This could worsen **existing inequalities** in the agricultural sector.
- **Lack of a robust legal framework** could leave farmers vulnerable to exploitation by companies.
 - The need for **dispute resolution mechanisms** is important to protect the farmers.
- **Current agricultural markets** are regulated by states where the Agricultural Produce Market Committee (APMC) mandis have a near monopoly.
 - **Liberalizing markets** and allowing private investment could help growth but also increase the scope of exploitation of farmers.
- **India faces shortages of warehouses and cold storages** and this needs to be addressed to prevent post-harvest losses.
 - This could help reduce distress sales by the farmers.

Safeguards for small and marginal farmers.

- **Legal framework** should be designed to protect the interests of farmers in contract farming.
 - **Contracts should specify price, quality, quantity and dispute mechanisms.**
- **Training and education** programs must be provided to farmers about contract farming agreements.
 - This will allow them to understand the **terms and conditions** of contracts better.
- **Farmers Producer Organizations (FPOs)** can help small farmers organize and collectively negotiate contracts.
 - This will increase their **bargaining power** against large companies.
- The **Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Act, 2020** is related to contract farming.
 - This Act aims to safeguard the interests of farmers through contract farming agreements.
- The Act requires **dispute resolution mechanisms** to be clearly defined in contracts.
 - The **dispute resolution mechanism** should ensure that both parties get a fair hearing.
- The **contract should clearly mention parameters** such as price, quality, and quantity and it should be assessed by a third party.
 - This **independent assessment** will prevent any party from taking advantage of the contract.
- **Government** must ensure that contract farming **does not become a disguised form of land leasing** that harms small farmers.
 - There should be **checks and balances** in place to prevent this.
- **Access to information** and price discovery mechanisms is necessary to make informed decisions.
 - The e-NAM (National Agriculture Market) platform can help with access to markets and information.

- **Alternative dispute resolution** mechanisms are crucial to provide easy and inexpensive access to justice for farmers.
 - **Independent bodies** that specialize in agricultural disputes can be established.
- The **Minimum Support Price (MSP)** should be available as an option to ensure a minimum price to the farmers.
 - If the **private traders** pay less, the Food Corporation of India (FCI) will pay the MSP for the produce.
- There is a need to organize farmers for **collective farming**, especially small and marginal farmers to achieve economies of scale.
 - This could allow small and marginal farmers to **access opportunities** that are not otherwise available.

Land Ceiling Policy

Rationale behind the policy and its role in economic reform.

- **Land ceiling** aims for **equitable distribution of material wealth** by setting a limit on land ownership.
 - It restricts the amount of land an individual or family can own to prevent **concentration of wealth**.
- The policy seeks to enhance **productivity** by distributing land to small farmers.
 - Smaller landholdings, if well-distributed, can lead to higher productivity compared to large, unused tracts.
- Land ceiling was intended to **abolish intermediaries** and give ownership to the actual cultivators.
 - This was expected to lead to a more efficient and productive agricultural sector.
- The policy intended to prevent the **concentration of wealth** in the hands of few individuals.
 - This was seen as a necessary step towards a more **equitable distribution of economic resources**.
- Land ceiling policies are based on the idea that **land is a key factor of production** in agriculture.
 - **Redistribution** can lead to a more balanced and sustainable economic system.
- The objective is to **increase disposable income** and profits of farmers by land redistribution.
 - It ensures that more people benefit from agricultural activities.
- **Land reforms** are considered crucial for stimulating the industrial sector.
 - As demand for goods increases, land redistribution facilitates balanced growth.

Impact of land ceiling on distribution of land, and its contribution to social justice.

- **Land ceiling** aimed to create a **more equitable distribution of land** among the rural population.
 - It was intended to reduce disparities and **empower marginal farmers** and landless laborers.
- The policy has had a **limited impact** due to varying implementation across states and many loopholes.
 - Land ceiling **ceilings varied** based on irrigation, fertility of land across India.
- It aimed to provide land to the **landless and marginal farmers** to improve their socio-economic conditions.
 - This was seen as a critical aspect of achieving social justice and **reducing inequalities**.
- **Tenancy reforms** were part of land reform, ensuring security and ownership for tenants.
 - They aim to provide **fairer terms for tenant farmers** who work on the land of others.
- The **Bhoodan Movement** was another initiative aimed to achieve a more equitable distribution of land.

- It was a **voluntary approach** where landowners donated land to the landless, contributing to social justice.
- The policy's success has been **hindered by legal challenges**, lack of proper land records, and corruption.
 - This resulted in uneven and often inadequate implementation of the land ceiling policies.
- **Consolidation of landholdings** is also a land reform measure.
 - It aims to create larger, more viable land plots to **improve farming efficiency**.
- The policy's **effectiveness was limited** due to the prevalence of benami transactions and other forms of evasion.
 - **Benami transactions** allowed landowners to hide their excess land and circumvent the land ceiling laws.

Successful Cases of Land Reforms in Different States

- **Kerala's** land reforms involved a **massive program** for conferring titles to hutment dwellers and tenants, with active participation from peasant organizations.
- **West Bengal's Operation Barga** registered sharecroppers, securing their legal rights, and significantly increased the number of recorded *bargadars*.

Land Distribution in India:

- **Agricultural Land Area:** As of 2021, India had approximately 1.78 million square kilometers of agricultural land, ranking seventh globally.
- **Land Holdings:** The 2015-16 Agricultural Census reported 138.35 million operational holdings, with an average size of 1.08 hectares. Small and marginal farmers (owning less than 2 hectares) constitute about 86% of all holdings, controlling 47% of the total operated area.

Implementation of Land Reforms:

- **Tenancy Reforms:** Aimed at providing security to tenants, these reforms have been partially successful. By the Fourth Five-Year Plan (1969-74), only 16% of tenants gained ownership, and 82% lacked secure tenure.
- **Land Ceiling Acts:** Designed to redistribute surplus land, their implementation has been inconsistent across states, leading to varied outcomes.

Farmer Incomes, Poverty, and Land Productivity:

- **Farmer Incomes:** In 2019, the average monthly income of agricultural households was over ₹10,000. However, there's significant regional disparity; for instance, Punjab's farmers earned over ₹26,000/month, while Jharkhand's earned just under ₹5,000/month.
- **Poverty Levels:** Despite economic growth, poverty remains prevalent in rural areas. The 2011-12 data indicated that 25.7% of rural households were below the poverty line.
- **Land Productivity:** Productivity varies widely; states like Punjab and Haryana exhibit high per-hectare yields, while others like Bihar and Uttar Pradesh lag behind. This disparity is influenced by factors such as irrigation facilities, soil health, and access to technology.