Extended Problem Statements

Theme I: Crop Improvement, Seed technology and Biotechnology

1. **Crop diversification in moth bean and rice bean**

Background

- Pulses are an important group of food crops that serve as a vital source of protein for both human and animal nutrition, playing a crucial role in national food and nutritional security.
- Moth bean is nutritionally rich, containing 22 - 24% protein along with essential vitamins, carbohydrates, and minerals.
- Similarly, rice bean is a drought-tolerant crop well suited for rainfed and dryland agriculture. It is a valuable source of nutrition, providing 20 - 25% protein, high dietary fiber, and essential minerals such as iron, zinc, and potassium.

Expected outcome

1. Pulses area and production will be increased through crop diversification.
2. Diversifying new pulse crops can enhance India's food security, promote sustainable agriculture, and improve farmer livelihoods.

Possible approaches

1. **Research and Development**: Undertake targeted research to enhance yield potential, disease and pest resistance, and adaptability of moth bean and rice bean to diverse agro-climatic conditions.
2. **Pilot Projects:** Implement pilot initiatives in selected regions to assess the feasibility of cultivation, identify production constraints, and formulate region-specific best management practices.
3. **Seed Production and Distribution**: Develop a robust seed production and distribution system to ensure the timely availability of high-quality seeds to farmers and promote wider adoption of these crops.
4. **Farmer Training Programs**: Organize capacity-building programs to educate farmers on the benefits, cultivation techniques, and efficient management practices for moth bean and rice bean.
5. **Demonstration Plots:** Establish demonstration plots to showcase improved production technologies and highlight the advantages of cultivating moth bean and rice bean to farmers, extension workers, policymakers, and other stakeholders.

2. **Crop diversification in safflower and mustard**

Background

- Need of the hour to achieve self-sufficiency in oilseed production in India to cut down the import bills on edible oil.
- Despite high production, demand outstrips supply and substantially increase the imports particularly on palm oil, soybean and sunflower
- Oilseed production growth lagged behind the food grain production; this creates a persistent gap.

Expected outcome

1. Oilseed area and production will be significantly increased through crop diversification
2. Self-reliance on oilseeds can be achieved by reducing the imports on edible oil
3. Due to increased production, consumers can avail edible oil at nominal rates

Possible approaches

1. Diversification of oilseed crops by introduction of new oilseed crops such as safflower, and mustard
2. Promising varieties of safflower and mustard can be tested in non-traditional and potential areas

3. **Crop diversification in Brown top millet, Fonio, Teff, Amaranth and Quinoa**

Background

- World food security has become largely dependent only on a handful of crops like wheat, rice, and corn which are the major cereals that support more than 50% of the global calorie demand.
- While these grains are an essential part of various diets, however they are devoid of essential micronutrients. As a result, it is estimated that micronutrient deficiency affects an estimated 2 billion people worldwide (FAOSTAT, 2018) raising health concerns over our high dependence on cereal crops.
- Introduction of new crops can significantly contribute to improving nutrition and health, enhance food basket and livelihoods, assures future food security and sustainable development.

Expected outcome

1. It is a strategic move to enhance nutritional security, and climate resilience due to their hardiness and high nutrient content. Cultivation of the following new crops offer significant nutritional advantages and environmental adaptability, making them valuable additions to existing agricultural systems.
2. Brown top Millet: Highly drought-resistant, short duration (70-75 days), grows in poor or rocky soils, can be a cover crop or intercrop. It is a gluten free, rich in fibre, iron, zinc, and magnesium content.
3. Fonio: Famine food, adaptable to poor soils and low rainfall, can withstand waterlogging to an extent. It has high protein and iron content. It is also a gluten free crop.
4. Teff: Drought tolerant, adaptable to various soils, altitudes, and temperatures, known for excellent recovery after stress. High in iron, calcium, and thiamine; low glycemic index, gluten-free crop.
5. Amaranth: Adaptable in hot and drought conditions, can be cultivated in poor soils, responsive to input management. Good source of protein (with balanced essential amino acids), fibre, and various micronutrients.
6. Quinoa: Highly resilient to climate change, tolerates frost, drought, and salinity, grown across a wide altitude range. Complete protein (ideal balance of amino acids), gluten-free, high in fibre and minerals.

Possible approaches

1. Introduction of new crops viz., Brown top millet, Fonio, Teff, Amaranth and Quinoa in the millet growing areas
2. Evaluation of above crops under inter-cropping systems to enrich soil nutrient content and earn additional income in the farming community
3. Awareness campaigns on the cultivation of new crops in farmers holdings to get maximum market price.
4. Demonstrations on the cultivation aspects, post-harvest processing and value addition technologies

4. **Identifying low GI food crops/varieties.**

Background

- India often referred as “Diabetes capital of the world” faces a massive diabetes epidemic. Low GI rice – A healthier diet for countering diabetic epidemic.
- According to ICMR-INDIAB study estimates that over 101 million Indians live with diabetes, with an additional 136 million in the pre-diabetes stage especially in urban areas.
- Staple food like rice with a low GI are likely to improve blood glucose and lipid control as well as promote insulin sensitivity and thus are beneficial dietary treatments for diabetic patients.

Expected outcome

Low GI rice with high resistant starch, dietary fibre; α-amylase and α-glucosidase inhibitors

Possible approaches

1. Biochemical profiling and genetic improvement of traditional landraces
2. Evaluation of rice varieties for low GI content

5. **Arresting pre harvest sprouting (PHS) in rice through small molecules**

Background

- Sprouted rice grains lose starch integrity due to activation of α-amylase.
- Leads to chalking, poor grain filling, and reduced head rice recovery during milling.
- Sprouted grains fetch lower market price.
- Export-quality rice is rejected due to poor cooking quality and appearance.
- Loss of seed viability and storability.
- Serious agronomic and economic problem directly affecting the profitability of farmers.

Expected outcome

1. Reduced yield loss and grain wastage.
2. Improved grain quality and market value.
3. Extended harvest window.

Possible approaches

1. Application of growth regulators and desiccants.
2. Chemical regulators of seed dormancy.
3. Enzyme inhibitors targeting germination pathways.
4. Reactive oxygen species (ROS) modulators.
5. Protective nano formulation coatings for controlled delivery of small-molecules.

6. **Arresting of pre harvest sprouting (PHS) in groundnut through small molecules**

Background

- Germination of seeds within pods while still in the soil before harvest, usually triggered by untimely rainfall, excess soil moisture, or delayed harvesting when the crop has reached physiological maturity. This problem is particularly serious in rainfed and monsoon-season groundnut cultivation.
- Sprouted kernels lose market value and are often rejected for seed, table, and processing purposes**.**
- Oil content and oil quality decline due to enzymatic breakdown of lipids during germination.
- Increases the risk of aflatoxin contamination.
- Seeds become shrivelled, discoloured, and unfit for export or premium markets.
- Directly affect the profitability of farmers.

Expected outcome

1. Reduced yield loss and improved harvest efficiency.
2. Improved seed quality and market value.
3. Extended harvest window.

Possible approaches

1. Application of dormancy-promoting chemicals.
2. Enzyme inhibitors targeting germination.
3. Seed/pod surface treatments.
4. ROS (Reactive Oxygen Species) modulators.
5. Nano-encapsulated delivery systems.

7. **Reducing hard seed coat formation in pulses**

Background

- Hard seed coat formation in pulses is a serious problem because it leads to poor and delayed germination, resulting in uneven crop establishment in the field.
- Such seeds require longer soaking and cooking time, reducing consumer acceptability and market value.
- Hard-seeded pulses show low water absorption, affecting processing efficiency in dhal and flour industries.
- The problem also causes losses in seed certification and storage, as hard seeds often remain dormant and fail to germinate uniformly.

Expected outcome

1. Improved germination and field establishment.
2. Enhanced seed quality and consumer acceptability.
3. Better seed viability and utilization efficiency.

Possible approaches

1. Screening for soft-seeded genotypes using marker-assisted selection to reduce seed coat thickness and impermeability.
2. Seed priming techniques (hydro-priming, osmo-priming, or hormonal priming with GA_3) to improve seed coat permeability and uniform germination.
3. Pre-harvest foliar sprays of calcium and micronutrients (boron, zinc) to ensure balanced seed coat development.
4. Controlled moisture management during seed maturation, avoiding terminal drought that induces hard-seededness.
5. Seed coating with biodegradable polymers or enzymes that enhance water imbibition at sowing.
6. Post-harvest physical treatments such as mild abrasion, laser scarification, or ultrasound treatment to break seed coat dormancy.
7. Biotechnological approaches targeting genes involved in lignin and phenolic deposition in the seed coat.

8. **Reducing shattering losses in green gram and black gram**

Background

- Splitting of mature pods before or during harvest is a vital natural seed dispersal mechanism in wild plants, but it is a highly undesirable trait in commercial agriculture.
- Often resulting in significant yield reductions of 10 - 20%. These losses directly translate to loss of income and reduced profitability to farmers
- Minimizing these losses can substantially enhance pulse availability, contributing to food and nutritional security and increase the profitability of farmers.

Expected outcome

1. Reduced field losses and improved harvest efficiency.
2. Higher yield realization.
3. Enhanced farmer income.

Possible approaches

1. Interdisciplinary approaches involving crop physiology and seed technology researchers developing a suitable chemical formulation.
2. PCR based diagnostics for screening non-shattering cultures/varieties.
3. Evaluation of genotypes for shattering resistance - assessing advanced breeding lines and existing varieties for improved pod retention and reduced shattering.
4. Determination of optimum harvest time - identifying ideal harvest time to minimize shattering losses ensuring maximum yield recovery.
5. Standardization of safe chemicals - developing and standardizing safe, effective chemical or botanic formulations that can help to arrest or delay pod shattering, thereby reducing field losses before harvesting.

9. **Reducing shattering losses in sesame**

Background

- Sesame capsule shattering at the time of harvest is a major problem, causing up to 50% yield loss and turns out to be unsuitable for mechanized harvesting.
- Seed loss from sesame capsules before harvest is also a major economic problem for mechanized production.
- Non-availability of sufficient farm labours and increased cost for manual harvesting.

Expected outcome

1. Increased harvestable yield.
2. Facilitates timely and mechanized harvesting.
3. Higher seed quality and farmer profitability.

Possible approaches

Sesame varieties can be screened/ evaluated for capsule traits such as thick carpel membrane, strong placenta attachment and narrow splitting. Since, these traits are strongly associated with non-shattering type of sesame.

10. **Novel seed coating for faster germination, vigour, disease resistance and mitigating nutrient deficiency**

Background

- Increasing seed deterioration and nutrient-deficient soils demand novel seed coatings to ensure faster germination and stronger early seedling vigour.
- Changing climate and intensive cultivation increase pathogen pressure, creates a need for protective seed coatings to enhance early disease resistance.
- Conventional fertilization often fails to supply nutrients at germination, necessitating seed coatings that deliver essential nutrients directly to seedlings.
- Erratic rainfall and abiotic stresses require innovative seed coating technologies to improve crop establishment while reducing chemical inputs.

Expected outcome

1. Rapid and uniform germination with enhanced seedling vigour.
2. Improved protection against seed- and soil-borne diseases.
3. Efficient nutrient delivery and improved input use efficiency.

Possible approaches

1. Nano-encapsulation of bioactive compounds.
2. Bio-based coatings with beneficial microbes.
3. Smart polymer coatings.
4. Micronutrient-enriched coatings.
5. Seed priming with biostimulants.
6. Multi-layered protective coatings.
7. Eco-friendly, slow-release nutrient matrices.

11. **New plant architecture for yield and mechanization in black gram and green gram**

Background

- Developing plant architectures suited for mechanization
- Manual harvesting of black gram and green gram is highly labor-intensive and costly, accounting for about 25 - 28% of the total production cost, and the growing scarcity of farm labor further intensifies the problem.

Expected outcome

1. The development of erect and compact plant architecture, shatter-resistant pods, pods positioned above the canopy base, robust stem strength, reduced branching, and a determinate growth habit can significantly support the mechanization of green gram and black gram cultivation.
2. These traits collectively help address multiple challenges faced by farmers and improve overall production efficiency.

Possible approaches

1. Evaluation of various for their suitability for mechanization and carryout demonstration in a larger scale.
2. Physiological interventions for modifying the indeterminate genotypes into determinate genotypes synchronising flowering, enabling mechanised harvesting.

12. **New plant architecture for yield and mechanization in finger millet and kodo millet**

Background

- Non lodging millets suitable for mechanical harvest.
- Non-lodging millets are crucial for mechanical harvesting, because lodging causes significant yield loss, grain damage, and makes machine harvesting inefficient or impossible, hindering millet mechanization and adoption.
- Sturdy, non-lodging varieties with strong stems (culms) and good recovery angles ensure machines can efficiently harvest.

Expected outcome

1. Development of non-lodging types in finger millet and kodo millet will reduce labour intensity and costs, offer increased efficiency and productivity and enhance farmer income.
2. Improved grain quality and reduced post-harvest losses with optimized mechanical harvesting methods.

Possible approaches

1. Identification of genotypes having sturdiness, non-lodging with short to medium height, strong stems (culms), and uniform maturity.
2. Selection of genotypes having high lignin and silica content. These are the vital for mechanical harvesting because it provides the structural rigidity and stem strength.
3. Development of varieties with strong stems (culms), better root systems, and compact panicles amenable for machine harvest.

13. **Novel carrier molecules for gene-editing system**

Background

- A direct *Cas9* gene delivery mechanism enables transgene free editing thus overcoming the stable integration of *Cas9* in vegetatively propagated crops such as banana and sugarcane.

Expected outcome

1. Efficient and ease of gene delivery.
2. Broader applicability across crops and tissues
3. Transgene free gene editing.

Possible approaches

1. Bombardment mediated gRNA and *Cas9* delivery into immature embryos.
2. *Agroinfiltration* of gRNA delivery.
3. Micromanipulation/ microinjection of intact cell (immature embryos)/cell suspension
4. Nanoparticle mediated sgRNA/*Cas9* delivery on floral meristem.
5. Phytoene desaturase/ herbicide tolerance genes for validation of the process.

14. **Novel botanicals/biologicals for grain/seed treatment to control storage pests in ware house**

Background

- For reducing reliance on chemical fungicides and insecticides to provide protection against storage pests and pathogens using novel botanicals/biologicals.

Expected outcome

1. Eco-friendly and safe pest management.
2. Reduced post-harvest losses and quality deterioration.
3. Lower risk of resistance and improved sustainability.

Possible approaches

1. Nano-formulations of botanicals.
2. Bio-priming with plant growth-promoting microbes (PGPM).
3. Exopolysaccharide or biofilm-based coatings.
4. Incorporation of allelopathic plant extracts.
5. Smart multi-functional coatings.
6. Use of endophytic fungi or bacteria.
7. Microbial consortia with biopolymer carriers (chitosan, alginate, etc.)
8. RNAi or biocontrol-based coatings.

15. **Designing 'superbag' for seed storage/preventive rancidity**

Background

- Superbags create a low-oxygen and low-moisture environment, slowing seed deterioration and preserving germination capacity.
- By limiting oxygen entry, superbags reduce oxidation of seed oils, which is a major cause of rancidity in oilseeds.
- Airtight storage prevents insect infestation and reduces fungal growth without the need for chemical preservatives.

Expected outcome

1. Extended seed shelf life and maintained viability by preventing oxygen and moisture ingress.
2. Prevention of rancidity and quality deterioration.
3. Reduced storage losses and improved economic returns.

Possible approaches

1. Enhanced multi-layer barrier materials - using advanced plastic laminates with very low oxygen and moisture permeability to slow oxidation and rancidity.
2. Incorporation of oxygen absorbers - adding oxygen-scavenging sachets inside the Superbag helps maintain a low-oxygen environment, preserving seed quality.
3. Moisture-control features - integrating desiccants or humidity-regulating liners to keep seed moisture at safe levels and prevent fungal growth.
4. Improved sealing mechanisms - developing stronger, airtight zip locks or heat-seal options to prevent air leakage during long-term storage.
5. Use of food-grade, UV-resistant materials - UV protection reduces heat and light damage, while food-grade materials prevent chemical reactions that may cause rancidity.

Theme II: Crop and Natural Resource Management

16. **Organic approaches for weed management**

Background

- Weeds compete with crops for sunlight, water, and nutrients, reducing crop growth and yield and also harbor insects, fungi, and viruses, increasing the risk of crop damage and disease spread.
- Prolonged exposure to chemical herbicides can cause acute or chronic health issues in humans and long-term diseases.
- Synthetic herbicides can contaminate soil, water, and air, harming non-target organisms and ecosystems.
- Repeated use of synthetic herbicides leads to the development of herbicide-resistant weed species.

Expected outcome

1. Improved soil health and ecosystem balance.
2. Reduced chemical residues and environmental pollution.
3. Sustainable weed control.

Possible approaches

1. Mulching with organic materials.
2. Cover cropping/green manuring.
3. Allelopathic crops or extracts.
4. Biological control using microbes or insects.
5. Mechanical and manual innovation such as flame weeding, push hoes, or automated small-scale robotic weeders to reduce dependence on chemicals.
6. Soil solarization - covering soil with transparent plastic sheets to harness solar heat, killing weed seeds and soil-borne pathogens organically.
7. Crop rotation and intercropping strategies that disrupt weed life cycles and reduce their proliferation naturally.

17. **Improvement of crop recovery after drought/flood**

Background

- Drought and flood can severely impact crop health and yield by impairing photosynthesis, reproductive growth and development.
- Stress conditions weaken plant immunity, making crops more prone to infections and infestations.
- Both drought and flooding can lead to yield loss and quality deterioration by reducing overall biomass and nutritional quality, directly affecting productivity and market value.

Expected outcome

1. Stabilized yields, production sustainability and reduced crop failure risk.
2. Improved farmer income and livelihood security.
3. Strengthens crop tolerance to climatic extremes under increasing climate variability.

Possible approaches

1. Use of stress-alleviating biostimulants to enhance recovery and metabolic activity.
2. Precision nutrient and foliar feeding to correct stress-induced deficiencies.
3. Soil rehabilitation using organic amendments.
4. Microbial inoculation and rhizosphere restoration to improve root regeneration and nutrient uptake.
5. Stress-responsive plant growth regulators (PGRs) to stimulate recovery and delay senescence.
6. Adaptive canopy and crop management to balance source - sink relationships and optimize regrowth after damage.
7. Climate-smart water management practices to prevent secondary stress and promote recovery.

18. **Rapid increase in Soil Organic Carbon (SOC) content**

Background

- Declining organic carbon content in the soils of Tamil Nadu.
- Lack of awareness on recycling/use of farm wastes for mitigating climate change extremities and improving soil health.

Expected outcome

1. Strategies for improving Soil Organic Carbon (SOC) and reducing Greenhouse gas emission.

Possible approaches

1. Integrated Nutrient Management strategies (INM, STCR-IPNS, MN mixtures and Bio inoculants).
2. Recycling/use of farm wastes/green/green leaf manures.
3. Use of industrial by-products and biochar.
4. Inclusion of legumes/pulses as intercrops/cover crops.
5. Conservation/natural farming practices.
6. No tillage/minimal tillage.
7. Bio-mineralisers/microbial consortia for effective conversion of organic wastes.
8. Adopting *insitu* decomposition and incorporation of crop residues.
9. Organic amendments for problem soils.
10. Promotion of multi-tier cropping systems and agroforestry.

19. **Easy-to-Use soil biological testing kits for rapid soil health assessment**

Background

- Soil biological tests are slow, lab-dependent, and costly.
- Farmers lack quick, field-ready tools for microbial and enzyme-based soil health assessments.

Expected outcome

1. Low-cost, portable kit for rapid biological soil testing.
2. Real-time indicators to guide nutrient management and soil health sustainability.

Possible approaches

1. Sensors - CO_2/microbial activity, enzyme color strips, fluorescence/chromogenic.
2. Microfluidics - Lab-on-chip extraction and reactions.
3. Electrochemical modules - amperometric /voltammetric sensors, impedance-based microbial activity detection.
4. Data and Machine learning - calibration models, result interpretation.
5. Device and App - hardware integration, mobile reporting.

20. **Real-time soil testing kit for quantitative soil health assessment (Electrochemistry/ Spectroscopy)**

Background

- Conventional wet chemistry is laborious, time-consuming and chemical-intensive.
- Delayed test results prevent timely and informed decision-making in the field.

Expected outcome

1. A new, low-cost soil testing kit will be developed.
2. Farmers will receive real-time soil health reports.
3. Soil test-based fertilizer management will save 20 - 30% of fertilizers and help sustain the soil health.

Possible approaches

1. Portable ion-selective electrode (ISE) array.
2. Voltammetric/amperometric sensor.
3. Electrochemical impedance spectroscopy (EIS).
4. Handheld NIR / MIR spectrometer.
5. Fluorescence & UV-Vis module.
6. Microfluidic lab-on-chip extraction (sensor fusion combined with edge ML).
7. Mobile app integrated with cloud analytics leading to recommendations.

21. **Precision biomolecule delivery for crop health management using nanocarriers**

Background

- Yellow mosaic disease causes heavy yield loss in major pulse crops.
- Managing both the virus and the vector remains a challenge under field conditions

Expected outcome

1. Targeted and efficient delivery of biomolecules.
2. Reduced chemical input and environmental impact.
3. Improved crop health, stress tolerance, and productivity.

Possible approaches

1. An effective antiviral biomolecule will be identified for managing yellow mosaic disease.
2. A nano-based biomolecule delivery system will be developed for targeted control of the virus.
3. Pulse crop yield and productivity will increase by 15 - 20% through improved disease management.
4. Screening biomolecules with proven antiviral properties against YMV.
5. Synthesizing suitable nanocarriers for targeted biomolecule delivery.
6. Formulating biomolecule nanocarrier for enhanced stability and uptake.
7. Conducting controlled laboratory and greenhouse assays.
8. Optimizing dosage and application methods for field conditions.
9. Evaluating the nano-formulation under multi-location field trials.
10. Assessing impacts on plant health, yield, and vector suppression.

22. **Assessing greenhouse gas emissions through remote sensing**

Background

- Greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) play a critical role in global climate change.
- Traditional ground-based GHG monitoring methods rely on meteorological towers, soil-atmosphere flux measurements, and surface observations, but these data sources are spatially limited and expensive for continuous monitoring.
- Remote sensing has emerged as a powerful tool to assess GHG emission at regional and global scales.
- Several satellite missions including NASA OCO-2, Sentinel-5P, GOSAT, Landsat and MODIS offer spectral bands that allow estimation of atmospheric GHG concentrations.
- Remote sensing-based algorithms, radiative transfer models, vegetation indices, land-use mapping and atmospheric retrieval models help quantify emission trends, detect sources, and evaluate the impact of land use/land cover changes.

Expected outcome

1. High-resolution maps of GHG concentrations (CH_4, CO_2, N_2O).
2. Identification of key emission sources (agriculture, industries, wetlands, transport).
3. Improved understanding of spatial-temporal variations.
4. Estimation of annual and seasonal emission trends.
5. GHG emission-hotspot mapping.
6. Contribution to carbon accounting and climate policy planning.
7. Decision support for low-carbon projects and mitigation strategies.

Possible approaches

1. Collection of satellite data from OCO-2, GOSAT, Sentinel-5P CO2 and Landsat/MODIS for land use and temperature coupled with in-situ emission inventory data and Climate data.
2. Pre-processing of data for atmospheric and radiometric correction and georeferencing.
3. Retrieval of GHG Concentration using spectral analysis; column density retrieval methods; radiative transfer models and / or machine-learning based inversion models Land cover and emission source mapping using LULC classification and hotspot analysis.
4. Integration with ground data like eddy covariance towers; soil flux measurements; IPCC emission factors and National GHG inventories.
5. Estimation of Emission through statistical regression models / atmospheric transport models / carbon flux estimation / machine learning prediction.
6. Validation with in-situ flux towers / observations.

23. **Crops/varietal identification using satellite data**

Background

- Conventional crop and varietal mapping rely on field surveys and administrative records, which are costly, infrequent, and often inconsistent across regions.
- High-resolution multispectral and hyperspectral satellites now provide detailed spectral–temporal signatures, but robust methods are needed to distinguish crops and even varieties with overlapping phenology and management.

Expected outcome

1. Operational classification schemes and maps that distinguish major crops and, where feasible, key varieties/hybrids at the field scale across seasons.
2. A library of temporal spectral signatures and separability metrics for dominant crops/varieties under local agro-climatic conditions.
3. Validated workflows combining satellite data and limited ground truth for scalable crop inventory, policy support, and input/seed supply planning.

Possible approaches

1. Collect ground truth on crop type and variety (plot boundaries, sowing dates, management) and link with dense time-series of Sentinel-2 and Sentinel-1 data for phenology-based classification.
2. Exploit hyperspectral missions such as PRISMA to extract fine spectral features and indices sensitive to biochemical differences among varieties (pigments, water, structure).
3. Perform multi-temporal feature engineering (e.g., phenological metrics, temporal NDVI) to enhance separability among crops and sowing windows.
4. Test advanced ML/AI methods (Random Forest, gradient boosting, CNNs, transformers) for pixel-wise and object-based crop mapping using fused optical–SAR–hyperspectral inputs.
5. Use transfer learning and domain adaptation to port models across years/regions while minimizing new field data requirements.
6. Evaluate classification accuracy at crop and varietal levels using stratified validation sampling and confusion matrices, and analyze factors that confuse.
7. Integrate topographic, soil, and management layers (e.g., irrigation command, typical rotations) as ancillary features to constrain classification.
8. Prototype decision-support applications for agencies (acreage estimation, procurement planning) and private actors (seed companies, insurers) based on the derived crop/variety maps.

24. **Crop health and yield assessment using satellite/drone data**

Background

- Traditional crop health monitoring and yield estimation rely on visual inspection and sample cuts, which are laborious, subjective, and challenging to scale in space and time.
- Satellite and UAV platforms now provide high-frequency, high-resolution observations. Still, there is a need for robust, transferable models that link these signals to stress, biomass, and final yield across varying environments.

Expected outcome

1. Near-real-time maps of crop vigour, stress (nutrient, water, pest/disease), and biomass to support precision management and risk monitoring.
2. Quantitative yield prediction models at field and regional scales, with uncertainty bounds, based on combined satellite/UAV, weather, and management data.
3. Decision rules or advisory products for variable-rate inputs, early warning of yield shortfalls, and inputs for insurance and food-security assessments.

Possible approaches

1. Acquire multi-temporal UAV imagery (RGB, multispectral, possibly thermal) over experimental plots and farmers' fields, and derive structural and spectral indicators (e.g., canopy height, NDVI, red-edge indices).
2. Use satellite time series (Sentinel-2, Sentinel-1, PRISMA) to track growth curves and key phenological stages relevant to yield formation.
3. Calibrate relationships between vegetation indices, canopy traits (LAI, chlorophyll, water status), and measured biomass/yield using regression and ML (RF, SVR, XGBoost, AutoML).
4. Integrate climatic and soil data (rainfall, temperature, Vapour-Pressure Deficit (VPD), soil texture, water holding capacity) with remote sensing features to improve stress and yield prediction.
5. Apply image-based disease and nutrient stress detection (e.g., CNNs on RGB/multispectral UAV data) to generate health maps feeding into yield-loss models.
6. Combine optical and SAR data to reduce cloud impacts and better capture canopy structure and moisture during critical stages.
7. Couple remote sensing-derived variables with crop growth models to simulate yields and conduct scenario analysis for management options.
8. Design operational workflows (data acquisition calendars, processing chains, validation protocols) and evaluate their cost–benefit and robustness for institutional or private-sector deployment.

25. **Defoliants for mechanical harvesting**

Background

- Excess foliage cause clogging and poor feeding of plants into harvesters, reducing operational efficiency.
- Leaves increase trash content and conceal produce, leading to incomplete harvesting and higher crop losses.

Expected outcome

1. Facilitates efficient and uniform mechanical harvesting.
2. Improved produce quality and harvest efficiency.

Possible approaches

1. Bio-defoliants from plant extracts that induce ethylene production and leaf abscission.
2. Microbial-based defoliants – Application of specific fungi or bacteria that selectively weaken leaf petioles without affecting yield or produce quality.
3. Nano-formulated defoliants – Nano-encapsulated ethylene releasers or PGRs for controlled, uniform, and low-dose defoliation.
4. RNA-based or gene-silencing triggers – Foliar sprays targeting genes involved in leaf retention and abscission for precise, crop-specific defoliation.
5. Stress-mimicking biostimulant blends – Formulations combining amino acids, hormones, and signaling molecules that safely accelerate natural senescence.

26. **Chemical interventions/treatments to reduce sucrose degradation associated with delayed harvest of sugarcane**

Background

- Sucrose degradation associated with delayed sugarcane harvest directly impacts sugar recovery and profitability.
- Delayed harvest enhances enzymatic activity (invertase), converting sucrose into glucose and fructose, reducing recoverable sugar.
- Standing cane becomes more susceptible to microbial invasion, accelerating sucrose breakdown and juice deterioration.
- Higher reducing sugars increase viscosity, slow crystallization, and reduce sugar quality during processing.

Expected outcome

1. Enhanced sugar recovery and quality.
2. Extended harvest window and flexibility.
3. Increased farm profitability.

Possible approaches

1. Application of specific enzyme (invertase) inhibitors (natural or synthetic) to suppress sucrose hydrolysis into reducing sugars.
2. Use of ethylene antagonists such as 1-MCP or anti-ethylene formulations to slow senescence and sucrose breakdown.
3. Targeted application of mild antimicrobial juice protectant sprays to limit microbial invasion and post-maturity deterioration in standing cane.
4. Controlled-release nano-encapsulation of ripeners or anti-degradation chemicals to prolong sucrose stability in cane stalks.
5. Use of oxidative stress suppressors (ascorbates, phenolics) to reduce stress-induced enzymatic activity responsible for sucrose degradation.
6. Application of safe pH stabilizing agents that maintain intracellular pH unfavorable for invertase activity.
7. Use of novel chemical signalling blockers that interfere with stress or senescence signaling pathways, delaying biochemical deterioration of sucrose.

27. **Growth-regulators/biostimulants to achieve rapid growth in sugarcane**

Background

- Sugarcane has a long juvenile phase. Delayed bud sprouting and weak initial tiller formation limit early biomass accumulation.
- Inadequate or poorly timed supply of N, P, K, and micronutrients limits cell division and elongation.
- Disruption of natural growth regulators reduces internode elongation and cane growth rate.
- Low organic matter and compacted soils restrict root proliferation and limit rapid vegetative growth.

Expected outcome

1. Accelerated vegetative growth and early canopy development.
2. Enhanced sucrose accumulation and yield potential.
3. Improved stress tolerance and input use efficiency.

Possible approaches

1. Seaweed-based biostimulants – rich in natural cytokinins, auxins, and betaines that enhance tillering, root growth, and photosynthesis.
2. Microbial biostimulants (PGPR consortia) – use of beneficial microbes to improve nutrient uptake, hormone synthesis, and early vigor.
3. Nano-formulated plant growth regulators – controlled-release nano-encapsulated gibberellic acid or auxins for sustained internode elongation and biomass accumulation.
4. Amino acid and peptide-based biostimulants – foliar or soil application to accelerate metabolic activity, stress recovery, and cell division.
5. Silicon and micronutrient-based stimulants – silicon with Zn/Fe enhances structural strength, photosynthetic efficiency, and rapid vegetative growth.

28. **Soil amendments for reducing Electrical Conductivity (EC)**

Background

- Elevated soil EC leads to osmotic stress and impaired nutrient uptake, ultimately reducing crop productivity.
- Leaching of excess salts is the only recommendation wherever the drainage and good quality water facilities are available.
- Hence, advanced, multifunctional, and recoverable materials are required to simultaneously adsorb salts, improve structure, and enhance nutrient delivery.

Expected outcome

1. Significant reduction in soil EC through enhanced salt adsorption and removal.
2. Improved soil structure, porosity, and microbiome activity, enabling better plant performance under salinity stress.
3. Development of reusable, eco-friendly, and cost-effective amendment systems tailored for long-term soil salinity mitigation.

Possible approaches

1. Alginate–Biochar composite prill development for salt adsorption and soil EC reduction.
2. Magnetically recoverable biochar sorbent design (Fe_3O_4-Biochar) for salt adsorption and soil EC reduction.

29. **pH stability challenges in liquid biofertilizers**

Problem statement

- Liquid biofertilizers often show pH drift - especially pH drop - during storage.
- This pH instability reduces microbial viability and causes many batches to fail QC requirements, leading to product rejection.

Expected outcome

1. Stable formulations that maintain optimal pH [6.0 - 7.5] for longer storage periods [~ 1 year].
2. Improved microbial viability and consistent field efficacy.

Key components/team roles

1. Formulation team - buffer systems, stabilizers, compatible additives.
2. Microbiology Team - suitable strains and culture conditions.
3. Electrochemical/monitoring team - pH micro-sensors for storage monitoring.
4. Process and packaging team - optimized fermentation, packaging, and sealing solutions.
5. Data and QA team - shelf-life modelling and quality validation.

30. **Next-Gen biofertilizer: Microbial consortium for multi-nutrient delivery**

Problem statement

- Single-strain biofertilizers cannot provide multiple nutrients or functions needed by crops.
- Using 3-5 complementary strains can broaden nutrient delivery, but compatibility issues may reduce stability or performance.
- If one strain loses viability, others should compensate - yet current formulations fail to maintain balanced, stable consortia over time.

Expected outcome

1. A stable, compatible three-strain consortium that consistently delivers multiple nutrients/functions to crops.
2. Improved shelf life with each strain maintaining viable populations during storage.
3. Reliable field performance even if one strain declines, ensuring functional redundancy and resilience.

Key components/team roles

1. Microbiology team - select compatible strains, test interactions, and ensure multi-nutrient functional traits.
2. Fermentation specialists - optimize co-culture growth, stabilize strain ratios, and improve shelf-life performance.
3. Product development team - formulate the consortium, develop additives/stabilizers, and design user-ready liquid products.
4. Quality control team - monitor viability, pH, nutrient functions, and ensure the product meets QC standards during storage.

31. **Farm scale desalinization of irrigation water**

Background

- High salinity in irrigation water increases soil osmotic pressure, making it harder for plants to absorb water, which stunts growth and lowers productivity.
- Continuous use of saline water can lead to soil salinization, reducing soil fertility, altering structure, and causing poor drainage.
- Saline water often contains high levels of sodium, chloride, or boron, which can be toxic to plants, causing leaf burn, nutrient imbalances, and reduced physiological activity.

Expected outcome

1. Improved soil and crop health.
2. Expanded use of marginal water resources.
3. increasing water availability for agriculture in water-scarce areas.
4. Minimises crop losses due to salinity.

Possible approaches

1. Solar-powered desalination units.
2. Membrane-based filtration (RO/NF) at micro-scale.
3. Electrodialysis with renewable energy integration.
4. Blending and cyclic desalination systems.
5. Bio-desalination and phyto-desalination approaches.

32. **Integrated mobile app linking '*Tamil Manvalam*' recommending crops suitable for specific soil types for a specific location**

Background

- Selecting crops suited to the soil's texture, fertility, pH, and water-holding capacity ensures better root development, nutrient uptake, and higher productivity.
- Soil-appropriate crops require less irrigation, fertilizers, and soil amendments, reducing input costs and improving sustainability.
- Suitable crop–soil matching prevents soil degradation problems like salinity, compaction, and nutrient depletion, maintaining soil productivity over time.

Expected outcome

1. Site-specific crop planning and higher productivity.
2. Efficient resource utilization.
3. Informed decision-making and reduced risk.

Possible approaches

1. Soil database integration – linking the app with *Tamil Manvalam* soil health data (soil type, pH, nutrients) so recommendations are based on scientifically tested soil information.
2. GPS-based location mapping – using mobile GPS to automatically identify the user's location and fetch location-specific soil and agro-climatic data.
3. Crop recommendation engine – developing an algorithm that matches soil properties and local climate with suitable crops, varieties, and cropping seasons.
4. Farmer-friendly Tamil interface – providing recommendations, alerts, and guidance in simple Tamil with visuals to improve understanding and adoption by farmers.
5. Real-time updates and advisory support – integrating weather data, fertilizer advice, and expert alerts to give dynamic, location-specific crop guidance.

Theme III: Crop Protection

33. **Ways to increase pollination/fruit set in vegetable/fruit cultivation (sunflower, mango, gourds)**

Background

- Are we able to achieve yield maxima per drop of water used under a climate-smart agriculture approach?
- How to attain pollinator services under environmental and climate declines?

Expected outcome

1. Increased seed quality, seed yield, and oil content of sunflower.
2. Increased size and quality of mango fruits/gourds.
3. Increased honey and honey bee products.
4. Market and consumer preferential farm products fetch premium prices.
5. Increased consumer health and satisfaction.
6. Contract pollination service, migratory beekeeping.
7. Assured farm family labour engagement, entrepreneurial opportunities and farm income.

Possible approaches

1. Interdisciplinary approaches comprising enthusiastic researchers in the field of entomology, plant breeding and horticulture to design pollinator requirements and the design of farm apiary.
2. Hive management, floral requirements, biological and structural refinements, and increasing pollination.
3. Quality assessment and quantity gain studies in target crops.
4. Physiological and behavioural response monitoring in pollinator species.

34. **Repellents for mitigating wild boars**

Background

- Man-wild animal conflicts interfere with crop husbandry. Wild boars destroy agricultural crops, leading to severe economic losses and human life. Wild boars need to be effectively managed using eco-friendly, sustainable approaches, including repellents and other measures.

Expected outcome

1. Safer management of wild boars without direct contact with the animal.
2. Sustainable solution for long-lasting effects.
3. Reducing direct conflicts and safety of farmers.
4. Reduced the wild boar population breeding in cropping areas.
5. Avoiding major losses to farmers at a minimum investment.

Possible approaches

1. Multidisciplinary team approach involving enthusiastic researchers in the field of wild animals, agronomy, zoology and veterinary sciences.
2. Understanding the animal behaviour and cognitive effects.
3. Quality assessment and quantity gain studies in target crops.
4. Community-wide campaigning for the adoption of developed wild boar management.

35. **Scarer for birds swarming agricultural crops**

Background

- An accelerated phase of ecological destruction compels birds to flock to crop ecosystems, resulting in inevitable yield losses.
- Distraction of swarming birds during more susceptible crop stages.
- Are we able to build mechanical scarers that imitate their behaviour to keep them at bay from crops?

Expected outcome

1. Safer management of birds with limited drudgery.
2. Sustainable solution for long-lasting effects.
3. Reducing direct conflicts and ensuring the safety of farmers.
4. Reduced the wild boar population breeding in cropping areas.
5. Avoiding major losses to farmers with a minimum investment.

Possible approaches

1. Multidisciplinary team approach involving enthusiastic researchers in the fields of wildlife, agronomy, zoology, and veterinary sciences.
2. Integrating animal behaviour with physical forces using Sensors (IR), micro controller/ imaging- camera/ confirmation, switching on the device which emits light or sound or chemical mild irritant etc., sound (aversion sounds - buzzing of a bee when it crosses limits), light- flashing lights or lasers, SMS alerts.
3. Understanding the animal behaviour and cognitive effects.
4. Quality assessment and quantity gain studies in target crops.
5. Community-wide campaigning for the adoption of developed wild boar management.

36. **Developing eco-friendly pheromone lures to manage fruit flies in the horticultural ecosystem**

Background

- Why do fruits in the field and post-harvest (35 - 70%) rot? Are fruit flies the reason for such rot?
- What is the problem with the existing technology based on pheromone molecules for fruit fly attraction? Are pheromones rapidly dissipating by thermal oxidation and UV radiation?

Expected outcome

1. Slow-release nano systems for enhanced male fruit flies trap catches and extended field duration.
2. Cost-effective large-scale production of lures by involving young entrepreneurs and the student community
3. Increasing the production and reducing the losses through eco-friendly approaches

Possible approaches

1. Who can be involved in product development and testing - a multidisciplinary team of researchers *viz.,* entomologists, Horticulturists, nanotechnologists and extension functionaries?
2. How to test the efficacy? through student resources, efficacy can be tested and verified.
3. How production can be done in large scale? through training, production can be done by involving young entrepreneurs and the student community.
4. How to market the products? TNAU AgriCart (online) and Department (point of sale).
5. How to reach the farmers? the extension functionaries can facilitate the products to reach farmers.
6. How to assess the benefit of the products? through farmers' feed-back.

37. **Rapid detection of pesticide residues in fruits, vegetables, and spices**

Background

- Changing climatic conditions increase the incidence of pests and diseases in crops, compelling the use of synthetic pesticides to manage them and sustain yields. Pesticides deteriorate in food matrices over a designated waiting period. Before proceeding with the harvest.
- The presence of pesticides and their residues in food commodities poses a threat to human health. Food safety is therefore a mandate in the human food commodity chain, minimizing its impacts on human life.
- Pesticide residues need to be monitored using an accurate, faster method to ensure food safety for consumers.

Expected outcome

1. Rapid detection (within 5–15 min).
2. Field-ready design (lightweight, durable).
3. Low cost (consumer-affordable).
4. Multi-pesticide molecule detection capability.

Possible approaches

1. Involvement of a team of life science, chemistry, biology and engineering-based researchers.
2. Design a portable detection kit that identifies multiple pesticide residues.
3. within a shorter period of sample processing and detection.
4. Innovative sensor technologies (biosensors, nanomaterials, electrochemical sensors, etc.,).
5. Integrating the use of smartphone cameras or spectroscopy for residue detection.
6. Create a database of pesticide residue patterns for training AI models.
7. Empowering data from the developed kit to support government food safety policy and certification prospects.

38. **Early diagnosis of coconut root wilt**

Background

- Coconut root wilt remains undetected in its early, asymptomatic phase, causing gradual but irreversible decline in palm health, productivity, and lifespan. So, early diagnosis is critical.
- Timely detection helps to prevent the movement of infected planting material; disease spread and enable effective integrated management interventions.

Expected outcome

1. Implementation of timely management strategies.
2. Identifying disease free mother palms.
3. Improving over-all yield and productivity of the farm.

Possible approaches

1. e-nosing approach to identify volatile organic compounds (VOCs) as signature molecules to detect root wilt.
2. RPA (Recombinase Polymerase Amplification) lateral-flow strip assays.
3. CRISPR–based molecular detection (CRISPR-Cas12/Cas13 biosensing).
4. Disease-specific protein signature/peptides as molecular markers.
5. Microbial biomarkers as a tool to detect root wilt infection.
6. Exploring metabolome, proteome and metagenome profile to identify root wilt infection.

39. **Novel molecules for yellow mosaic disease (YMD) in black gram**

Background

- YMD causes severe yield loss in black gram, and the existing integrated management strategy is often ineffective. Novel molecules are needed for timely and targeted management.
- Developing new molecules reduces reliance on broad-spectrum pesticides, and supports sustainable integrated disease management.

Expected outcome

1. Prevention of crop loss and improving productivity.
2. Ensuring price stability through integrated value-chain development.

Possible approaches

1. Antiviral compounds that block virus replication or movement in the plant.
2. Whitefly-targeted molecules to reduce virus transmission.
3. Plant-derived bioactive compounds for foliar sprays or seed treatment.
4. Antiviral compounds from microbes inhibiting virus replication or interfering in virus–plant interactions.
5. Enzymes/peptides from beneficial microbes for degrading viral proteins or block viral movement.
6. Defense-inducing metabolites that trigger systemic resistance in black gram.
7. Vector-targeted biomolecules (bacterial or fungal metabolites) for reducing whitefly populations or feeding activity/fitness.
8. RNAi-based sprays to silence viral or vector genes.

40. **Novel approaches for effective control of sugarcane Pokkah boeng disease**

Background

- Pokkah Boeng disease reduces sugarcane yield and sugar quality, and existing control measures are often inadequate, limited applicability under field conditions and unsustainable.
- Current measures lack integration, and do not provide consistent, field-level efficacy; there is minimal use of biological control and limited resistant varieties making sustainable and reliable disease management challenging.

Expected outcome

1. Mitigating disease severity.
2. Higher yields, improved juice quality, reduced economic losses.
3. Healthier canes with normal internodes avoiding phenotypes like twisted tops, leaf tearing and rot.

Possible approaches

1. Exploring endophytic microbes from disease free/resistant germplasm planting material.
2. Bio-hardening of chip bud with antagonistic microbiome using vacuum infiltration.
3. Bio-hardening with microbiome at different stages of hardening of sugarcane TC plants.
4. Exploring synergistic interaction of fungicides and bacterial microbiome.
5. Nanoparticle based fungicides or delivery systems.

41. **Innovative and holistic approaches for pest/disease forecast of major crops**

Background

- Most of the plant disease epidemics has developed due to air borne plant pathogens.
- Curative and blanket management practices require several rounds of fungicidal spray.
- Irregular outbreak of plant diseases due to adaptation of pathogens under changing climatic conditions and lack of knowledge on the weather-based forewarning under changing climatic conditions warrants innovative and holistic.

Expected outcome

1. Improved decision making leading to proactive management and prevention.
2. Optimal timing of interventions.
3. Economic savings by reducing input costs.
4. Enhancing crop yield and food security.
5. Rendering safe environment by reducing excessive chemical usages.

Possible approaches

1. Forewarning of plant diseases through spore trapping technology - rice and grapevine.
2. Weather based forewarning models for potato and groundnut.
3. Holistic approach as an advisory measure by linking with other forewarning data bases.

42. **Reduction of aflatoxin levels in groundnut**

Background

- Reducing aflatoxin levels in groundnut is a One Health priority, safeguarding human and animal health while enhancing food safety, marketability, and economic returns for farmers and the industry.

Expected outcome

1. Lowering the risk of health issues such as liver cancer, immunity, improved child growth and organ health.
2. Ensuring fair pricing and export access.

Possible approaches

1. Exploring yeast for mitigating aflatoxin in groundnut.
2. Application of Atoxigenic strains of *Aspergillus* to competitively suppress toxin-producing strains.
3. Application of biomolecules from yeast for detoxification of aflatoxin.
4. Characterization and application of plant derived aflatoxin detoxifiers.
5. Controlled atmospheric storage to prevent aflatoxin contamination.

Theme IV: Agricultural Engineering

43. **Farm level, low cost, solar-powered low temperature storage systems for short term as fruits, vegetables and flowers, Improvisation of existing IARI storage models.**

Background

- Farmers, especially smallholders lack affordable cold storage, leading to 20 - 30% post-harvest losses in fruits, vegetables, and flowers.
- Grid electricity is unavailable in many rural regions.

Expected outcome

1. A low-cost, energy-efficient, solar-powered storage prototype that reduces spoilage, maintains produce quality for 5-7 days, and can be easily adopted at the farm level.

Possible approaches

1. Design modular, lightweight structures using bamboo/FRP panels
2. Integrate solar PV and DC compressor/thermoelectric cooling modules for stable temperature.
3. Modify IARI-zero energy models with better insulation materials, PCM (phase change materials), or evaporative cooling enhancements.

44. **Cost effective pulp/juice extractor for tomato and water melon at farm level**

Background

- Farmers face distress sales during peak tomato/watermelon seasons.
- Lack of basic processing tools prevents value addition at source.

Expected outcome of the Problem statement

1. A low-cost extractor suitable for farm-level use, enabling farmers to convert fresh produce into pulp or juice.

Possible approaches

1. Design a manually operated or low-power motorized extractor.
2. Develop interchangeable sieves for different fruits.

45. **Combine harvester for pulses**

Background

- Manual harvesting in pulses is highly labor intensive and costly.
- Slow harvesting causes delays, leading to pod shattering, weather damage, and reduced grain yield.
- Pulses differ widely in plant height, pod position, maturity pattern, and susceptibility to shattering, making it challenging to design a single harvester suitable for all pulse crops.

Expected outcome

1. Significant reduction of labour - reduction of physical strain.
2. Minimizing labour cost and time saving.
3. Enhances productivity and quality - minimizing crop loss and grain damage.

Possible approaches

1. Adjustable cutting and threshing mechanisms – designing adaptable cutters and threshers to handle varying plant heights, pod positions, and shattering-prone varieties.
2. Lightweight, low-damage pickup system - developing gentle crop handling to minimize pod shattering and grain loss during harvesting.
3. Smart sensors and automation – integrating IoT or AI-based sensors for crop maturity detection, yield monitoring, and automated operation for efficiency.

46. **Groundnut digger cum stripper**

Background

- Manual digging of groundnut is highly labour intensive, time-consuming and costly.
- Involves strenuous bending, lifting, and pulling, leading to fatigue and musculoskeletal problems to the labourers involved.
- Manual handling often causes broken pods, incomplete harvesting, and reduced yield.

Expected outcome

1. Minimizes the drudgery of manual labor.
2. Significantly reduces field loss in the digging and stripping process.
3. Increases profitability to farmers.

Possible approaches

1. Adjustable digging mechanism: Design soil-lifting blades or tines that adapt to different soil types and crop conditions to minimize pod damage.
2. Integrated stripping and cleaning system: Incorporate gentle shaking, brushing, or conveyor-based stripping to separate pods efficiently without loss.
3. Automation and sensor integration: Use smart sensors for depth control, pod detection, and automated operation to improve efficiency and reduce labour dependence.

47. **Small scale sugarcane harvester**

Background

- Manual harvesting of sugarcanes requires many workers and takes a long time, which can delay harvesting and reduce efficiency.
- Workers face injuries from sharp tools, cuts from cane leaves, snake bites, and long hours of physically demanding work.
- Although tools are simple, paying large numbers of labourers over time can be expensive, especially when labour is scarce.

Expected outcome

1. Reduced labour dependency and harvesting cost
2. Suitability for small and fragmented landholdings
3. Improved harvesting efficiency and cane quality

Possible approaches

1. Innovations like mini sugarcane harvesters, which can be self-propelled or mounted on tractors, offer greater flexibility and adaptability to different field conditions and terrains. These systems could include adjustable hydraulic controls and lighter weight designs for easier handling in narrow or uneven fields.

2. Cost-effective designs making mechanization more accessible to smallholder farmers.

48. **Sensors for food spoilage/storage pests**

Background

- Food spoilage during storage is a major cause of loss in grains, fruits, and processed foods.
- Farmers and warehouse operators lack real-time monitoring systems.

Expected outcome

1. Affordable sensors capable of detecting changes in gas composition, temperature, humidity, VOCs, or movement indicative of pest infestation or spoilage.
2. A user-friendly monitoring system for early warning and quality assurance.

Possible approaches

1. Develop smart packaging with colour-changing indicators.
2. Use ML models to predict spoilage trends from sensor data.
3. Deploy IoT-based nodes for remote monitoring and notifications.

49. **Food formulations to address health issues**

Background of the problem

- Rising lifestyle diseases such as diabetes, hypertension, anemia, obesity, and micronutrient deficiencies
- Consumers demand functional foods made from natural, local ingredients.

Expected outcome

1. Novel, nutrient-rich food products aimed at specific health concerns (diabetes-friendly foods, iron-rich snacks, low-sodium formulations, probiotic foods).
2. Improved nutritional value, sensory acceptability, and shelf stability

Possible approaches

1. Formulate low-GI snacks, gluten-free products, or fortified beverages.
2. Use millets, legumes, fiber-rich materials, and natural bioactive compounds.
3. Include plant-based proteins and prebiotics/probiotics.

50. **Value addition in fruits and vegetables**

Background

- A large percentage of fruits and vegetables are lost due to inadequate processing and poor supply chain management.
- Farmers earn low income due to market instability and perishability.

Expected outcome

1. Development of shelf-stable, high-value products such as fruit powders, dehydrated snacks, purees, pickles, RTS beverages, etc.
2. Reduction of wastage at the farm and processing levels.

Possible approaches

1. Development of ready-to-eat products.
2. Waste valorisation using peels and seed and development of packaging film or extraction of bioactive compounds

51. **Innovative technologies for reducing post-harvest losses**

Background

- Post-harvest losses in India range from 10 - 40% due to poor handling, inadequate storage, outdated equipment, and inconsistent processing techniques.
- Losses affect both farmer income and national food security.

Expected outcome

Creation or improvement of technologies that can rapidly cool, preserve, package, or transport produce more efficiently, thereby reducing damage, microbial growth, and waste.

Possible approaches

1. Controlled atmosphere/modified atmosphere technologies.
2. Mobile pre-cooling units (hydro cooling, vacuum cooling).
3. Novel packaging materials - biodegradable films, anti-microbial coatings

52. **Bio-colorants from fruits and vegetables for food industry**

Background

- Synthetic dyes pose health and environmental risks. The food industry needs natural, safe, and stable colorants.
- Many fruit and vegetable by-products (peels, seeds, pomace) are rich in pigments like anthocyanins, carotenoids, and betalains, yet are discarded.

Expected outcome

1. Extraction of stable natural colorants that can be used in beverages, confectionery, dairy, and bakery products.
2. Conversion of agro-waste into valuable food ingredients.

Possible approaches

1. Microencapsulation for colour stability (spray or freeze drying).
2. Use ultrasound, microwave, or enzyme-assisted extraction.
3. Develop a small-scale extraction module for rural use.

53. **Low-cost waste/polluted water treatment for agriculture (EcoClean Irrigation Water)**

Background

- Farmers lack affordable and simple systems to treat polluted or wastewater for safe irrigation.
- Current treatment methods are too costly and complex, creating a need for low-cost, easy-to-maintain solutions.

Expected outcome

1. Affordable, easy-to-use, and scalable water treatment solutions that provide safe irrigation water and improve crop productivity.

Possible approaches

1. Low-cost filtration technologies.
2. Microbial fuel cells for wastewater cleanup.
3. Chemical-free disinfection.
4. Portable water treatment devices.

54. **Newer methods and technologies in micro irrigation systems (Next-Gen Micro Irrigation Systems)**

Background

- Existing micro irrigation systems are costly, prone to clogging and lack effective automation for small and resource-limited farmers.
- There is a need for smarter, affordable and durable technologies that improve water efficiency and make micro irrigation easier to use and manage.

Expected outcome

Smart, cost-effective and durable micro irrigation systems that optimize water use, reduce wastage and enhance crop yield.

Possible approaches

- Clog-free drip emitters.
- Self-cleaning emitters.
- Low-cost smart irrigation controllers.
- Nanostructured or hydrogel-integrated drip lines.
- AI-driven drip systems.

55. **Solar powered low temperature storage systems for short-term preservation of perishable produces (Green refrigerator)**

Background

- Most of the post-harvest losses of perishable farm produces is due to the lack of proper storage facilities in the rural areas.
- The keeping quality and shelf-life perishable produces requires farmer friendly affordable low-cost storage systems.

Expected outcome

1. Simple, easy to operate, solar powered low temperature storage unit.

Possible approaches

1. Evaporative cooling storage unit.
2. Solar assisted low temperature storage structure.
3. AI based low-cost cooling storage structure.

56. **Artificial intelligence driven approaches for weed control**

Background

- Manual weeding is labor-intensive, time-consuming, and increasingly expensive due to labor scarcity.
- Weeding efficiency is highly dependent on soil moisture and field conditions, limiting timely operations.
- Manual and mechanical methods are impractical for large holdings and high-density planting systems.

Expected outcome

1. Precise and targeted weed management.
2. Reduced chemical usage and environmental impact.
3. Lower labour requirement and improved farm efficiency.

Possible approaches

1. AI-based weed detection using computer vision – Deep learning models (CNNs) analyse real-time field images to distinguish crops from weeds with high accuracy.
2. Precision spot-spraying systems – AI-guided sprayers apply herbicides only on detected weeds, drastically reducing chemical usage and cost.
3. Autonomous robotic weeders – Self-driving robots equipped with AI sensors perform mechanical or laser-based weed removal without harming crops.
4. Drone-based weed mapping and forecasting – AI processes multispectral drone imagery to identify weed hotspots and predict weed emergence patterns.
5. Decision-support systems (AI + IoT) – Integration of soil, weather, and crop data to recommend optimal timing and method for weed control.

57. **Innovative grain moisture/ chalkiness assessing digital device affordable to farmers**

Background

- Chalkiness affects grain market value but is visually judged, leading to inconsistent quality grading.
- Need for rapid detection of grain moisture and quality monitoring in procurement canters.

Expected outcome

1. A low cost, portable digital device that accurately measures grain moisture and chalkiness within seconds, enabling correct harvest timing, drying decisions, and fair pricing during procurement.

Possible approaches

1. Develop image-processing algorithms to quantify chalkiness.
2. Integrate sensors with a mobile app for data interpretation.
3. Build a low-cost microcontroller-based system

Theme V: Horticulture

58. **Extending shelf life of flowers and fruits**

Background

- India is one of the world's largest producers of fruits and flowers, but 20–40% of fruits and flowers are lost after harvest due to improper handling, lack of cold storage, and rapid spoilage.
- Longer shelf life allows farmers to sell produce over a longer period rather than distress-selling immediately after harvest. This helps them obtain better prices and reduces market glut during peak seasons.
- India supplies fruits and cut flowers to distant domestic markets and international destinations. Extended shelf life is essential to maintain freshness, appearance, and quality during transportation and export, thereby improving India's competitiveness in global markets.
- By reducing spoilage, more produce reaches consumers, contributing to food and nutritional security.

Expected outcome

1. Reduced post-harvest losses.
2. Improved marketability and quality.
3. Increased farmer income and supply chain efficiency.
4. Exploring new export market opportunities.

Possible solutions

1. Shelf life of flowers and fruits can be enhanced by combining pre-harvest, harvest, and post-harvest technologies.
2. Selection of suitable varieties or cultivars with longer shelf-life thicker cuticle, and slower respiration rate.
3. Management of irrigation practices.
4. Adequate balanced nutrition to improve cell wall strength and delays senescence.
5. Physical and chemical post-harvest and appropriate packaging procedures.
6. An integrated approach involving good pre-harvest management, careful harvesting, effective post-harvest treatments, cold chain infrastructure, and packaging interventions could reduce the losses, improve quality, and increase profitability for farmers and marketers.

59. **Low-cost structures for protected cultivation**

Background

- Protected cultivation is increasingly important in India, but high investment costs limit its adoption.
- Over 85% of Indian farmers are small and marginal.
- Low-cost protected cultivation structures are vital for India to increase productivity, reduce climate risk, conserve resources, improve farm incomes, and ensure sustainable horticultural growth.

Expected outcome

1. Affordable and accessible technology for small farmers.
2. Enhanced crop growth and yield.
3. Reduced crop losses.
4. Cultivation irrespective of seasons.

Possible approaches

1. Novel low-cost protected cultivation structures suitable for changing harsh climatic conditions made from locally available materials in an energy efficient way could make protected cultivation suitable for small and marginal farmers in India.
2. Bamboo-based modular polyhouse.
3. Naturally ventilated smart net house.
4. Solar-assisted low-cost polyhouse.
5. Retractable roof net house.
6. Underground/trench greenhouse.
7. Movable mini-polyhouse/portable greenhouse.
8. Bio-climatic greenhouse.
9. Green house made up of recycled plastic materials.

60. **Off season production in jasmine, tomato and moringa**

Background

- Seasonal glut leads to price crashes, while shortages cause price spikes. Off-season production helps balance supply, stabilizing prices and benefiting both farmers and consumers.
- Off-season cultivation allows better use of land, labor, irrigation systems, and protected structures during periods when fields would otherwise remain idle.
- Unpredictable weather affects normal cropping seasons. Off-season production using protected cultivation reduces dependency on monsoon and minimizes climate-related risks.
- Off-season production of jasmine, tomato, and moringa is essential in India to increase farmers' income, ensure year-round supply, stabilize markets, reduce climate risk, support agro-industries, and improve resource use efficiency, making horticulture more profitable and sustainable.

Expected outcome

1. Higher market value and profitability.
2. Continuous supply and consumer demand fulfilment.
3. Optimized resource use and production scheduling.

Possible approaches

1. Adopting protected cultivation.
2. Selection of early maturing and climate resilient varieties/hybrids with wider adaptability and continuous bearing traits.
3. Standardization of staggered planting practices.
4. Use of appropriate, crop specific growth regulators.
5. Pruning and canopy management.

61. **Universal nutrient solution for vegetable cultivation**

Background

- Vegetable crops require precise nutrient supply, but crop-specific nutrient schedules are complex and difficult for farmers to follow.
- A universal nutrient solution simplifies fertilization, reducing confusion and errors.
- The need for a universal nutrient solution for vegetable cultivation in India arises from the demand for simple, efficient, uniform, and sustainable nutrient management, especially under protected and soilless cultivation systems.
- It empowers farmers, improves productivity and quality, reduces costs and environmental impact, and supports modern intensive vegetable farming.

Expected outcome

1. Simplified and balanced nutrition management.
2. Enhanced crop growth, yield, and quality.
3. Resource efficiency and reduced input costs.

Possible solutions

1. Develop nutrient solutions based on crop groups (leafy, fruiting, root crops) with adjustable EC and pH ranges, making one base solution adaptable to many crops.
2. Sensor-based real-time nutrient adjustment – using IoT sensors to monitor EC, pH, and key ions continuously and automatically fine-tune nutrient concentrations, helping create a near-universal solution that adapts to crop demand.
3. Machine Learning and AI Models - Analyse large datasets (crop type, growth stage, climate, yield response) using AI/ML to predict optimal nutrient ratios and derive a generalized nutrient solution with stage-wise modifications.
4. Use of balanced chelated micronutrient blends - developing stable, chelated micronutrient mixes (Fe, Zn, Mn, Cu, B, Mo) that remain available across a wide pH range, reducing crop-specific deficiencies.
5. Modular nutrient solution concept – creating a universal base solution (N-P-K-Ca-Mg-S) and add small modular boosters (e.g., flowering, fruiting, stress tolerance) depending on crop and growth stage.

62. **Low-cost biodegradable inputs for kitchen garden**

Background

- Many urban and peri-urban families cannot afford expensive commercial inputs (fertilizers, pots, growth media).
- Low-cost inputs make gardening accessible to middle and low-income households.
- Low-cost alternatives reduce production cost.

Expected outcome

1. Environmentally friendly and sustainable gardening.
2. Improved plant growth and yield.
3. Increasing the affordability and accessibility for home gardeners.

Possible approaches

1. Effective utilization of household waste.
2. On-site composting and vermicomposting.
3. Homemade organic manures.
4. Use of locally available materials.
5. Recycle and reuse of containers.
6. Effective utilization of crop residues.

63. **Efficient and timely processing of coir-pith for use in kitchen garden**

Background

- Methods currently adopted for coir pith processing takes more time and highly water consuming.
- The treatment process generates brown-colored effluents rich in organic matter polluting soil and nearby water bodies.
- Inconsistence in quality reduces its acceptance in export and horticulture markets.

Expected outcome

1. Improved soil structure and water holding capacity.
2. Reduced phytotoxicity and faster usability.
3. Enhanced plant growth and productivity.

Possible approaches

1. Development of rapid lignin degrading microbial inoculants.
2. Development of organic additive mixtures to speed up the degradation process.
3. Standardizing energy and time efficient coir pith processing protocol.

64. **Affordable canopy management in high density planting (HDP)**

Background

- Closely spaced plants create intense competition for light, air, water, and nutrients.
- Proper canopy management ensures optimum growth, yield, and quality.
- Helps in farm mechanization.

Expected outcome

1. Optimized light interception and photosynthesis.
2. Improved yield and fruit/produce quality.
3. Reduced labour and input costs.

Possible approaches

1. Use of dwarfing rootstocks.
2. Precision pruning techniques.
3. Canopy architecture modelling.
4. Reflective mulches.
5. Sensor-based canopy monitoring.
6. Integrated canopy management (ICM).
7. Climate-responsive canopy management.

65. **Innovative plant propagation techniques such as precision grafting**

Background

- Innovative plant propagation techniques, especially precision grafting, are increasingly essential in modern agriculture and horticulture due to changing production systems, climate stress, and the demand for high-quality planting material.

Expected outcome

1. Faster and uniform crop establishment.
2. Enhanced disease resistance and stress tolerance.
3. Improved yield and quality of produce.

Possible approaches

1. Rootstock - scion optimization.
2. Standardization of precision grafting protocols.
3. Use of artificial intelligence and image analysis to assess stem diameter, compatibility, and cut precision and monitor graft union healing and success rates using sensors.
4. Creation of decision-support systems for selecting optimal graft combinations.
5. Development and adoption of advanced materials such as tissue-friendly cutting materials, biodegradable grafting clips, tapes, and sealants, anti-microbial and bio-stimulant coatings.
6. Integration of micro-grafting and in vitro grafting for rapid multiplication.
7. Use of molecular markers to predict graft compatibility and exploration of graft-transmissible signals (RNAs, hormones, proteins).

66. **Identifying new flower or fruit crops enabling diversity and meeting export market**

Background

- Current traditional crops may not fully meet the growing consumer preference for exotic or high-value flowers and fruits. Introducing new crops reduces reliance on a few species, and increases biodiversity and farm sustainability.

Expected outcome

1. Improves agricultural biodiversity.
2. Novel flowers or fruits with unique traits cater to international demand, fetching premium prices and expanding trade opportunities.
3. Year-round supply through staggered flowering or fruiting periods.
4. Enhanced export potential and market opportunities.
5. Improving foreign exchange earnings and farmer income.

Possible approaches

1. Germplasm exploration and importation.
2. Adaptive field trials and performance evaluation.
3. Breeding and selection for desirable traits.
4. Market and value-chain analysis.
5. Promotion and farmer training programs.

Theme VI: Agricultural Marketing

67. **Innovative tools to address market glut in tomato, onion, etc.**

Background

- Perishable horticultural crops like tomato and onion frequently suffer from seasonal overproduction, leading to sharp price crashes and significant post-harvest losses.
- Lack of real-time market intelligence, storage gaps, and weak value chain linkages result in farmers receiving poor returns despite high consumer demand variability.

Expected outcome

1. Solutions that stabilize farmer prices and reduce post-harvest losses during market glut situations.
2. Digital/technology-based platforms enabling better market prediction, supply-demand balance, and efficient product movement.
3. Scalable and affordable innovations adoptable by farmers, FPOs, traders, and processors.

Possible approaches

1. AI/ML models for demand prediction, weather linkage, and glut forecasting.
2. Mobile apps or dashboards providing real-time market advisories, price comparisons, and decision support for farmers.
3. Aggregation and logistics optimization through digital platforms connecting farmers - FPOs – buyers - processors.
4. Smart e-auction or dynamic pricing tools integrated with APMC/online market places.
5. Consumer-direct marketing channels: subscription models, farmer retail kiosks, last-mile delivery apps.
6. Low-cost, modular storage solutions such as solar cold rooms, dehydration units, or controlled-environment packaging.
7. Decentralized processing/value-addition technologies (e.g., puree, paste, flakes, dehydrated rings).
8. Waste-to-value solutions for unsold produce (compost, natural colours, bio-products).

68. **Price forecasting information system for agricultural crops**

Background

- Farmers often lack reliable, real-time price information, leading to distress sales and poor decision-making regarding when and where to sell produce.
- Price volatility due to seasonality, market arrivals, climate shocks, and demand - supply mismatch highlights the need for predictive tools to guide market planning.

Expected outcome

1. A user-friendly price forecasting platform enabling farmers to plan harvest, storage, and market choice to maximize returns.
2. Improved decision-making for stakeholders through short-term and long-term price forecasting, alerts, and advisories.
3. Enhanced market transparency and reduced-price uncertainty, benefiting farmers, traders, FPOs, and policymakers.

Possible approaches

1. Use of AI/ML models to forecast prices based on historical market arrival and price datasets.
2. Integration with FPO networks, e-NAM, and logistics providers for seamless farm-to-market linkage.
3. Forecasting wholesale prices and Retail prices and transmitting through Specific Digital Apps
4. Integration of climate, production trends, sowing area reports, and transportation cost data for more accurate predictions.
5. Real-time price from markets/APMCs/online platforms with alerts for price surges or crashes.
6. Mobile app/dashboard interface with multilingual support and voice-based access for farmers.
7. Geo-tagged forecasts for district-wise or market-wise price variations.
8. Recommendation engine suggesting optimal sale time, nearby better-priced markets, storage advice, and crop diversification.
9. Visual analytics: trend graphs, heat maps, seasonal price patterns.

69. **Innovative Supply Chain Models for Vegetables and Fruits**

Background

- Fresh vegetables and fruits face very high post-harvest losses due to poor storage, fragmented supply chains, and weak market linkages. Farmers earn less, consumers get inconsistent quality, and much produce is wasted. Innovative, efficient supply-chain models are needed to reduce losses, improve freshness, and increase farmer incomes.
- There is an urgent need for disruptive, integrated supply-chain models leveraging modern logistics, cold-chain infrastructure, digital tools, real-time data, and direct farmer-market linkages to reduce waste, improve profitability for farmers, ensure freshness and quality for consumers, and stabilize the produce supply and pricing.

Expected outcome

1. Reduced post-harvest losses and wastage through better storage and logistics.
2. Higher farmer incomes via direct market linkages and transparent pricing.
3. Faster, more efficient farm-to-market movement of produce.
4. Real-time data, tracking, and traceability to improve decision-making.
5. Fresher, higher-quality fruits and vegetables for consumers.
6. Scalable, sustainable supply-chain models suitable for small farmers.

Possible approaches

1. Create farm-level aggregation and collection centres for quick sorting and dispatch.
2. Use low-cost cold-chain solutions like solar cold rooms and smart crates.
3. Build digital platforms for direct farmer-to-retailer or consumer linkages.
4. Enable real-time logistics coordination and transport booking via mobile apps.
5. Use data tools for demand forecasting, price insights, and supply planning.
6. Implement simple traceability systems using QR codes or digital logs.
7. Improve packaging and handling to reduce damage and maintain quality.

70. **Traceability Tools for Niche Products**

Background

- As global and domestic buyers increasingly demand transparency, food safety compliance, and sustainability documentation, the absence of reliable traceability systems becomes a major barrier for niche products.
- Niche agricultural products need strong traceability to prove authenticity, prevent adulteration, and meet market standards. Today's supply chains lack transparency, causing loss of value and trust.
- Small farmers often cannot prove how or where their products were grown, leading to loss of market trust and reduced income.
- There is an urgent need for simple, affordable, and digital traceability tools that can track products from farm to consumer, ensure authenticity, and help farmers access premium markets.

Expected outcome

1. Verify authenticity and origin of niche products for market trust.
2. Enable transparent tracking from farm to consumer, reducing adulteration.
3. Help farmers access premium markets and improve income.
4. Provide simple, low-cost digital traceability tools for smallholders.
5. Support compliance with certifications and faster issue identification.

Possible approaches

1. Use mobile apps or digital logs for farm-level data recording.
2. Apply QR codes or RFID tags for batch tracking.
3. Implement blockchain or secure digital ledgers for authenticity.
4. Build integrated platforms connecting farmers, processors, and retailers.
5. Provide consumer-facing tools to verify product origin and quality.