SMART INDIA HACKATHON 2025

Problem Statement ID – SIH25263

Problem Statement Title- Farm level yield estimation using very-high spatial resolution data and robust crop models

Theme- Agriculture, FoodTech & Rural Development

PS Category- Software

Team ID- 52275

Team Name- Graviton

प्रधानमंत्री फसल बीमा योजना

सत्यमेव जयते

कृषि एवं किसान कल्याण मंत्रालय
MINISTRY OF AGRICULTURE AND FARMERS WELFARE

YES-TECH

IN COLLABORATION WITH

KrishiSens
A SMART FARM YIELD PREDICTION SYSTEM

GRAVITON

KrishiSens

SMART INDIA HACKATHON 2025

KrishiSense upgrades YES-TECH to farm-level precision using high-resolution satellite/drone imagery (<1m-5m) with a hybrid AI engine (deep learning + crop simulation models) for accurate yield prediction ($R^2 \geq 0.85$).

- **Multi-Resolution Monitoring:** 3m PlanetScope + UAV + Sentinel-1 SAR imagery
- **Localized Stress Detection**: Identifies within-field crop damage zones for targeted interventions
- **Multi-Scale Monitoring:** Micro (farm) to macro (state) level data for PMFBY stakeholders
- **Role-Based Visulization Dashboards:** Farmer/Officer/Admin specific interfaces

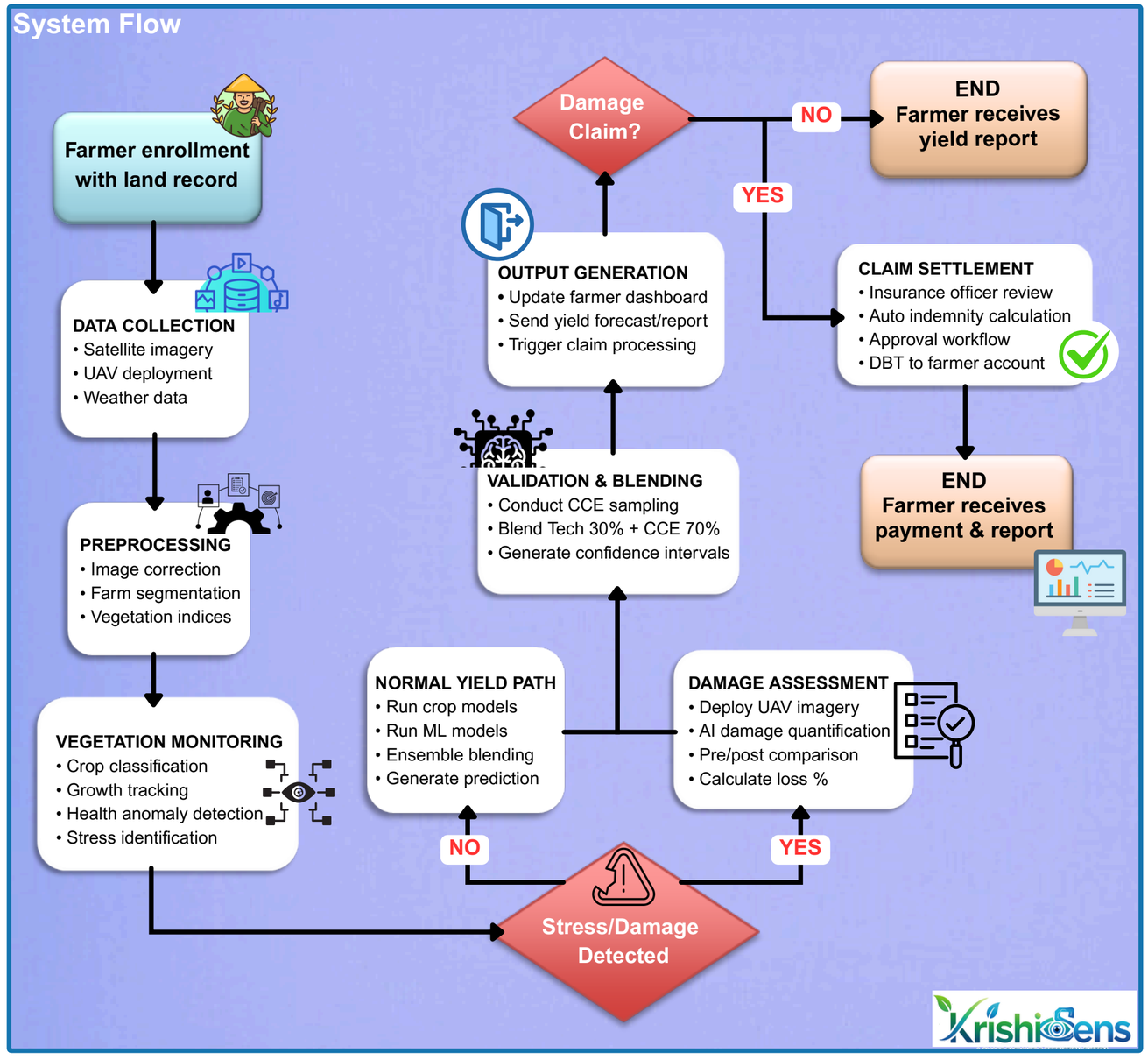
How it addresses the problem:

- **Upgrades YES-TECH:** Moves from village-level to farm-level precision using **VHR imagery (1-5m)** for fair individual payouts
- Eliminates Manual Errors: **80% less CCE dependency**, $R^2 \geq 0.85$ accuracy
- **Faster Claims:** Settlement reduced from months to <7 days
- Prevents Loss: **Early warnings** enable 15-20% yield improvement
- Fraud-Proof: Satellite evidence with **95%+ detection accuracy**
- **Cost-Effective:** 60% cost reduction (₹500→₹200/ha)
- Data-Driven Decisions: **What-if simulator for strategy optimization**

Innovation and uniqueness:

- Farm-Level Granularity**: First system** to deliver individual farm yield estimation
- **What-If Simulator:** Test scenarios with ROI projections for proactive decisions
- **Hybrid AI + Physics**: Deep learning + crop models ensemble
- Automated Land Integration: **Real-time cadastral sync from 10+ state portals**
- Real-Time ML: **Sub-minute latency from data to alerts**

System Flow



Prototype Link: https://krishisense0.netlify.app/
GitHub Repo: https://github.com/didaco97/KrishiSense.git

TECHNICAL APPROACH

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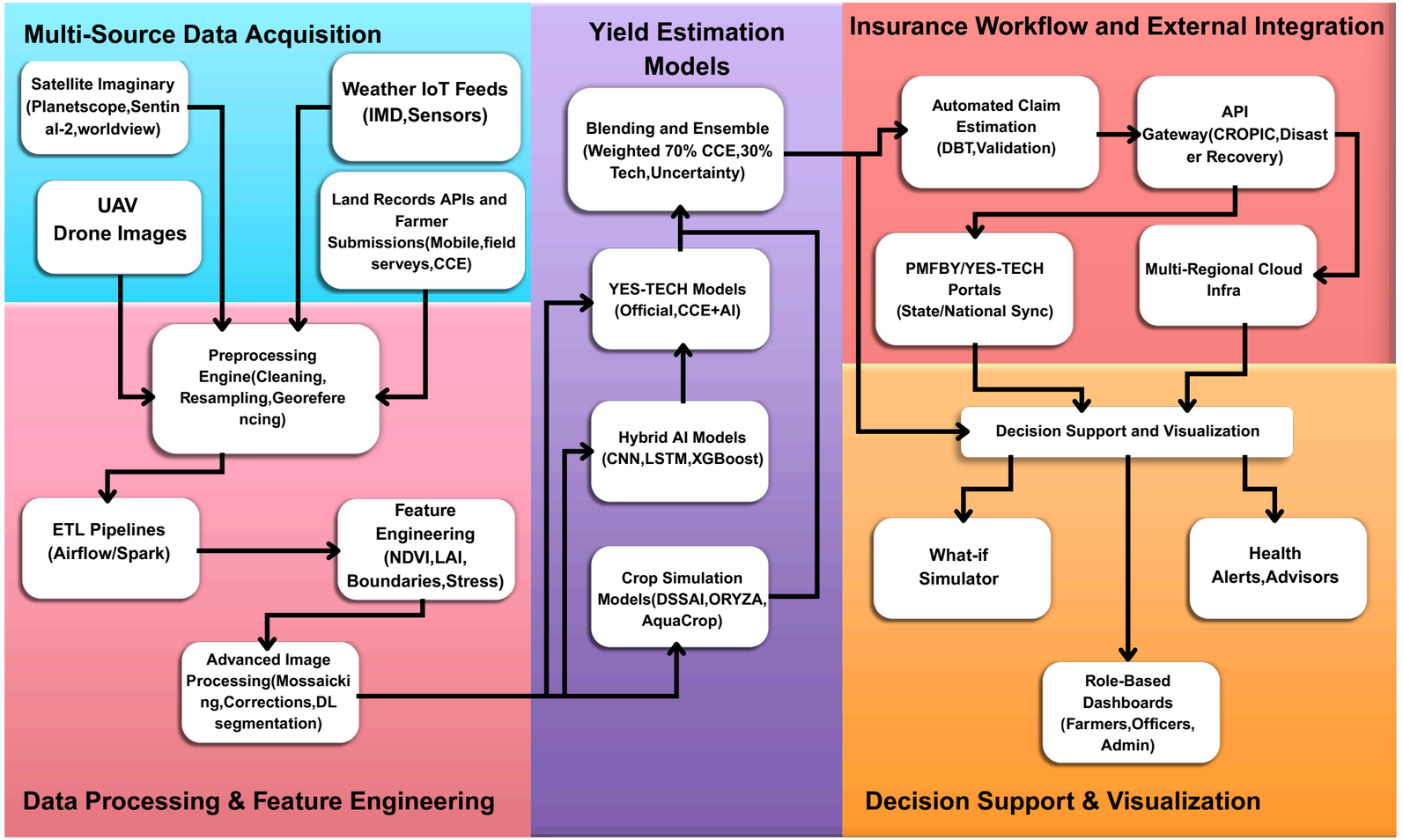
KrishiSense: Technical Methodology

- **Data Acquisition:** Collects satellite, drone, weather, land records, and farmer-submitted data.
- **Processing:** Cleans and analyzes the data (NDVI, crop health, boundaries, anomalies).
- **Hybrid AI Modeling:** Combines deep learning and simulation models, blends with manual samples for yield prediction.
- **Decision Support:** Provides dashboards, scenario simulators, and actionable insights for all users.
- **Insurance Workflow:** Automates claims using AI damage detection and syncs with government portals.
- **Cloud & Integration:** Uses secure, scalable cloud and APIs for data sharing, compliance, and reliability.
- **Continuous Improvement:** Regularly updates models, supports new data sources, and scales across regions.

Technical Terms:

- **Preprocessing Engine:** Cleans and standardizes all incoming data for quality.
- **ETL Pipelines (Airflow/Spark):** Automated workflows to collect, process, and move data.
- **Blending and Ensemble:** Combines results from different models and manual samples for higher accuracy.
- **Hybrid AI Models (CNN, LSTM, XGBoost):** Machine learning algorithms for crop prediction using images and trends.
- **PMFBY/YES-TECH Portals (State/National Sync):** Integrates with official government schemes for reporting and settlements.



Tech-Stack

M E R N

Python TesnsorFlow PyTorch AWS BedRock XGBoost

GitHub Repo: https://github.com/didaco97/KrishiSense

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FEASIBILITY AND VIABILITY

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Feasibility:

- **Technical:** Farm-level yield prediction using hybrid AI (CNN, XGBoost) and crop models (DSSAT, APSIM) achievable with existing open-source frameworks
- **Resource:** Cloud platforms, GPUs, and UAV data sources enable scalable ML deployment and real-time inference.
- **Operational:** Automated data pipelines and integrated dashboards ensure smooth functioning with minimal manual effort.

Potential challenges and risks:

- **Data Quality:** Ensuring consistency across multi-source datasets (satellite, UAV, land records) and minimizing cloud or sensor noise.
- **Model Drift:** Prediction reliability may decline over time due to regional crop variations or climatic changes.
- **Scalability:** Processing high-frequency, high-resolution imagery across multiple states may affect system performance.

Strategies:

- **Data Quality:** Implement multi-source fusion (SAR + optical + drone) with automated anomaly detection and temporal validation.
- **Model Drift:** Use continuous retraining, ensemble calibration, and season-wise benchmarking to sustain accuracy.
- **Scalability:** Adopt distributed cloud processing, microservice-based design, and efficient data compression for smooth expansion.

ML Model Training Architecture

Data Source Layer

- Satellite: Sentinel-1/2, Landsat-8 (optical & SAR)
- Weather: Temp, rainfall, sunlight, PAR (IMD, INSAT-3D, Terra MODIS)
- Ground Truth: CCEs, GPS-tagged photos, farmer surveys
- 7/12 Land Records: Map farms to satellite images

Data Processing & Feature Extraction

- Clean images: remove clouds/shadows
- Extract vegetation indices: NDVI, LSWI, fAPAR
- District crop maps, cloud-checked
- Multi-data satellite monitoring

Model Layer

- Semi-Physical: Biomass = fAPAR × RUE × water/temp factors
- Crop Simulation: Growth modeled on soil, weather, management
- AI/ML: Deep learning + stats on historical yield & satellite data
- Ensemble: Combined outputs
- CHF: Health metrics for supplemental yield

Yield Estimation & Blending

- Tech-Based Yield: AI + models
- Manual CCE Yield: Field experiments at IU level
- Blended Yield: 70% CCE + 30% model → reduces errors, ensures reliability

Evaluation & Deployment

- Metrics: RMSE, MAE, R^2
- State-level customization, feeds PMFBY portal
- Customization by State

KrishiSens

IMPACT AND BENEFITS

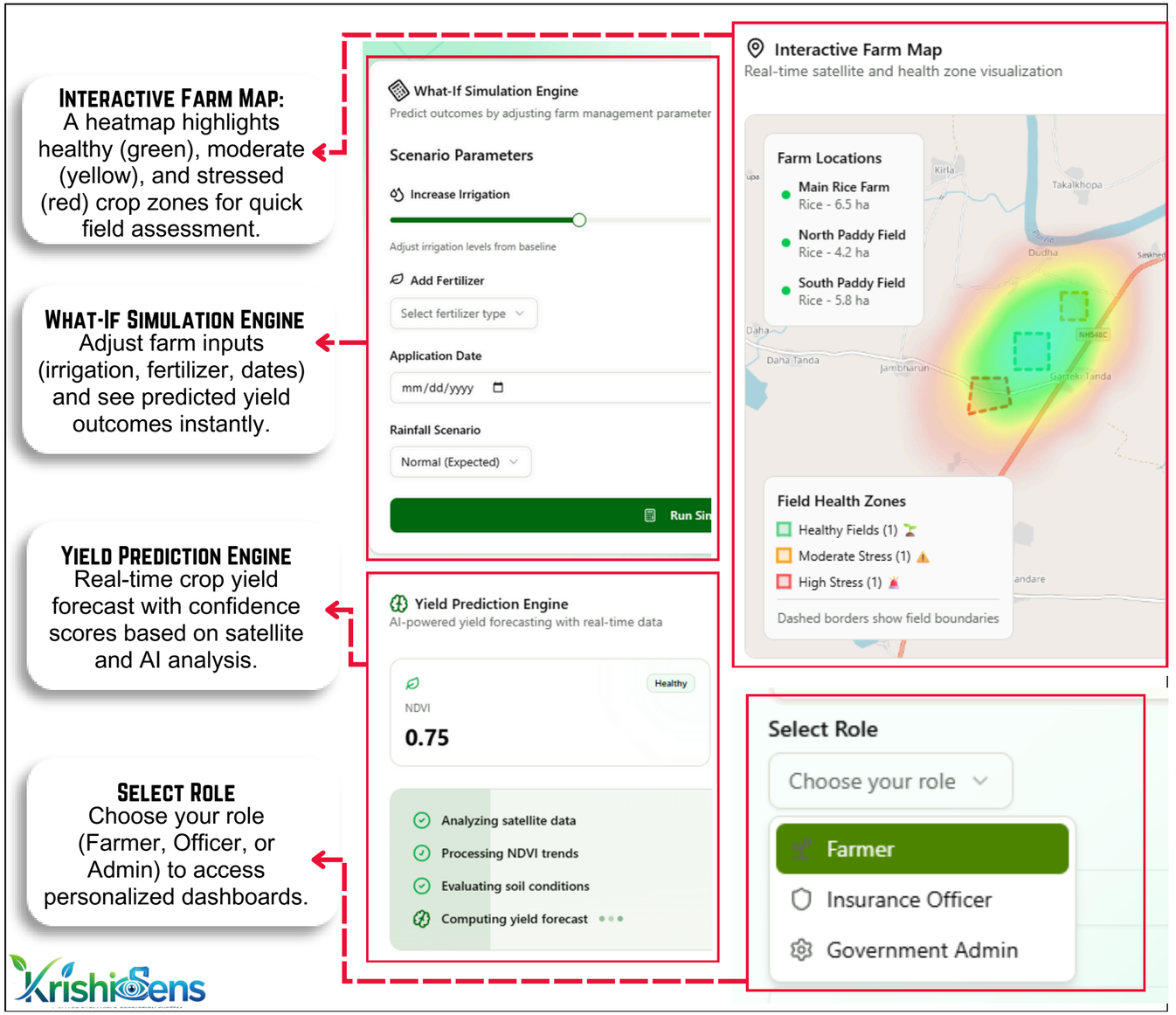
Potential Impact on the Target Audience

- Empowers farmers with near **real-time, farm-level yield and stress insights.**
- Reduces crop i**nsurance claim settlement time from months to days.**
- Enables data-driven, transparent **decision-making for government policies.**
- Dramatically **increases efficiency and accuracy in insurance** loss assessment.
- **Equips all PMFBY stakeholders with timely, granular data** for precise monitoring and effective decision-making at both local and national levels.

Benefits of the Solution:

- **Maximizes farmer income** by optimizing crop management and claims.
- Minimizes manual errors and **fraud for insurance companies.**
- **Improves government agility** in disaster relief and subsidy allocation.
- **What-If Simulator**: Instantly test scenarios and receive ROI projections for more proactive farm decisions.
- Automated Land Integration: Real-time **cadastral syncing across 10+ state land portals** for fraud prevention and boundary precision
- **PMFBY beneficiaries gain faster, fairer, and more transparent claim settlements** through direct, real-time yield and damage verification at the individual farm level.

Check the Prototype : https://krishisense0.netlify.app/



RESEARCH AND REFERENCES

1. Farm-Level Yield Estimation & Crop Monitoring

- Multi-resolution imagery for real-time crop monitoring; Sentinel-1/2, PlanetScope, WorldView, Cartosat; UAVs for ultra-high resolution field validation

2. Hybrid AI & Crop Simulation Models

- CNN for crop classification (92% accuracy), LSTM for growth tracking, XGBoost for yield prediction ($R^2 \geq 0.85$); ensemble blending for robust forecasts

3. Process-Based Crop Simulation Models

- DSSAT, APSIM, AquaCrop, ORYZA for multi-crop growth modeling; integrates environmental & management variables for farm-level yield estimation

4. What-If Decision Simulator

- Scenario analysis for sowing dates, irrigation, fertilizer, market/price variations; Monte Carlo & multi-objective optimization for ROI and risk assessment

5. Automated Land Record Integration:

- Automates the integration of cadastral data from over 10 state portals.
- Ensures accurate farm boundary mapping and ownership verification to prevent fraud.

6. Cloud & MLOps

- Deploys multi-region cloud infrastructure (AWS/Azure/GCP) with auto-scaling capabilities.
- Utilizes MLflow for model versioning and retraining, ensuring robust MLOps practices.

GitHub Repo:
https://github.com/didaco97/KrishiSense

Prototype:
https://krishisense0.netlify.app/

YouTube:
https://youtu.be/lgbmo4XwsXs

- **KrushiSense Technical document**
- **PPT and Other Documentation**

YES_TECH_Manual_2023.pdf

Data Source	Link
Satellite imagery - PlanetScope	https://www.planet.com/products/planet-imagery/
Satellite imagery - Sentinel-2	https://sentinel.esa.int/web/sentinel/missions/sentinel-2
Satellite imagery - WorldView	https://www.maxar.com/products/worldview-satellite-imagery
UAV Drone Images (RGB, Multispectral)	https://dronesurvey.in/
Weather data - IMD	https://mausam.imd.gov.in/
IoT field sensors (soil, rain)	https://www.cropin.com/solutions/smart-sensing/
Land Records APIs (Bhulekh, State portals)	https://bhulekh.up.nic.in/
Farmer submissions (CCE/mobile)	https://pmfby.gov.in/cce-dashboard
DSSAT crop simulation model	https://dssat.net/
ORYZA rice growth model	https://www.ricehub.org/resources/oryza/
AquaCrop model	https://www.fao.org/aquacrop/en/
PMFBY crop insurance portal	https://pmfby.gov.in/
YES-TECH program portal	https://www.sih.gov.in/
Agmarket mandi price API	https://agmarknet.gov.in/