Inception Report

on

Implementing YESTECH for Kharif rice in Andhra Pradesh.
2025-26

Submitted to

Department of Agriculture,
Government of Andhra Pradesh

By

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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14	Abstract (with keywords) :	The Department of Agriculture & Farmers Welfare (DA&FW), Government of India, has launched the YESTECH programme under the Pradhan Mantri Fasal Bima Yojana (PMFBY). As part of this initiative, the Agriculture Department of Andhra Pradesh has adopted a semi-physical model approach, as detailed in the YESTECH Manual (2023), for crop yield estimation. The department has decided to implement this technology-based approach in five districts: Eluru, East Godavari, West Godavari, Konaseema, and Nellore. The programme is scheduled for implementation during the Kharif season 2025–26. This inception report outlines the data sources and methodology used for rice crop classification and mapping, the approach for yield estimation of Kharif rice using the semi-physical model, the expected outcomes, and key references. Key words: YESTECH, PMFBY, kharif-rice, crop map, yield estimate, insurance unit, Satellite data, Semi-Physical model.		

1. Introduction

1.1 Crop yield estimates of the Insurance Units (IUs) for the current and past years form the basis for crop loss assessment and indemnity payout. Crop yield estimation is done by carrying out Crop Cutting Experiments (CCEs), the traditional system of manual yield measurements in randomly selected field plots for each crop in each IU. Major limitations of CCE-based crop yield estimation include the following gaps: (a) a limited number of measurements, (b) a time-consuming process, and (c) vulnerable to human errors.

1.2 The Department of Agriculture & Farmer Welfare (DA&FW), Government of India (GOI) has taken up many initiatives to improve crop yield estimation procedures ever since the launch of Pradhan Mantri Fasal Bheema Yojna (PMFBY). Technology development agencies of both the Government and Private sectors have been engaged in developing new yield estimation methods using various datasets and models such as 1. Semi-physical model, 2. Machine learning approach, 3. Crop simulation model, 4. Ensemble model, and 5. Parametric index of crop performance (CHF model) through pilot studies.

1.3 Towards enabling large-scale adoption of technology-based yield estimates in the PMFBY system for crop loss assessment, DA&FW has conceptualized a special initiative, the "Adoption of a Yield Estimation System based on Technology (YES-Tech)" under PMFBY. YES-TECH advocates the blended use of modelled and CCE yield estimates for insurance claim assessment from the 2023 season onward. An SOP (Standard Operating Procedure) has been developed by DA&FW, GOI to estimate yield at the Insurance Unit level.

1.4 In Andhra Pradesh state, the state Agriculture Department, Government of Andhra Pradesh is the implementing agency of the YES-Tech program. The program was initially piloted in Kakinada and Nandyal districts during the Kharif seasons of 2023–24 and 2024–25, with the Andhra Pradesh Space Applications Centre (APSAC) serving as the Technical Implementation Partner (TIP). Following the successful implementation and encouraging results, APSAC is continuing the implementation of the program in these two districts during Kharif 2025–26 as well.

During Kharif 2025-26, the Agriculture Department has decided to expand the YESTECH program to five additional districts: Eluru, East Godavari, West Godavari, Konaseema, and Nellore. For this expanded rollout, ICRISAT has been designated as the Technical Implementation Partner-2 (TIP-2). The Space Applications Centre (SAC-ISRO), Ahmedabad is acting as the Mentor Institute for Technology Rollout (MITR) for the YESTECH program in Andhra Pradesh, providing technical guidance and oversight.

1.5 The objectives of the project are:

a. To generate rice crop mask based on satellite remote sensing data.
b. To estimate yield of Kharif rice at insurance units (IU) level in Eluru, East Godavari, West Godavari, Konaseema, and Nellore districts of Andhra Pradesh using semi-physical model.

2. Review of Literature

2.1 Predicting food grain yields earlier can help farmers and policymakers plan accordingly. Accurate statistical data on yield production availability assists planners in making strategic decisions and regulating import and export activities. However, the traditional crop area and yield estimation approach, which requires a huge labour force, is time-consuming, inaccurate, and practically difficult to apply on a broad scale (Tripathy *et. al.*, 2014, Dwivedi *et. al.*, 2019, Ali *et. al.*, 2021, Pazhanivelan*et. al.*, 2022).

2.2 In India, the Crop Cutting Experiments (CCE) is operational for the crop yield estimation at Insurance Unit level. The CCE is a traditional approach employed by governments and agricultural bodies to accurately estimate the yield of a crop where sample locations are selected based on random stratified sampling. The conventional CCE approach is not without flaws, the biggest drawback of this traditional method is that it is dependent on a number of variables such as administrative setup, type and size of the field staff, farmer cooperation, and harvest conditions. Especially in a scenario where there are nearly 2.5 lakh gram panchayats in India that are scattered, along with inadequate trained human labour for yield estimation within the short harvesting window (https://indiaai.gov.in/article/how-ai-is-used-to-streamline-pradhan-mantri-fasal-bima-yojana). The increasing number of CCEs for conducting a crop yield estimation, which results in time-consuming, redundancy, and rise data uncertainty issues. Since the harvest time is very short, carrying out a few CCEs is extremely difficult with limited manpower and time.

2.3 Using advanced technologies to bring optimize the solution for minimizing CCEs of the insurance unit level (village, village panchayat, block, revenue circle, Mandal, or taluk) is essential for overall crop management practices for yield prediction. Further, to optimize the CCEs, a technique for the CCE site selection using yield proxy derived from the remote sensing based Semi-Physical model was implemented during 2019-20(Source: Protocol of smart sampling for crop cutting experiments, 2019, Department of Agriculture, Coop. & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare, Government of India, New Delhi – 110001, September, 2019). The chosen semi-physical model was demonstrated at district and state level yield estimation (Tripathy *et. al.*, 2014) and further refined for its application in estimating yield of different crops including rice and wheat at gram panchayat scale (Tripathy *et. al.*, 2022, Dwivedi *et. al.*, 2019).

2.4 For the rice crop mapping, two primary methodologies are employed for mapping extensive paddy rice cultivation areas using satellite remote sensing data. The first approach relies on multi-temporal observation data, predominantly employing statistical models or index-based methods (Singha *et. al.* ,2020; Yang *et. al.*,2021). Given the distinctive phenological characteristics of paddy rice, such as flooding and transplanting, these features are widely utilized for precise paddy rice identification (Yin *et. al.*,2019).

2.5 The second approach utilizes single observation data in conjunction with machine learning classifiers (Onojeghuo *et. al.*, 2018; Zhang et. al., 2018b; Cai *et. al.*, 2019). Classifiers like Random Forest, Support Vector Machine, or Decision Trees are chosen to extract relevant features, followed by the classification process. While these methods are effective in identifying paddy rice from Landsat images, the feature extraction step heavily depends on domain knowledge and expertise, potentially missing intrinsic subtle features and lacking the desired flexibility (Xu *et. al.,*2021).

2.6 So, understanding the limitations of automation and manual way of identifying the crop, the study is utilising the semi-automatic classification procedure which include unsupervised classification followed by class labelling using spectral matching techniques.

3. Study Area

The agriculture department has selected "Semi-Physical" model (YESTECH manual) of yield estimation for Rice crop yield estimation at Insurance Unit level (Village level) in extended five districts namely, Eluru, East Godavari, West Godavari, Kona Seema, and SPS Nellore of Andhra Pradesh. The spatial map of study area is shown in Figure 1.

1.1 East Godavari

East Godavari experiences a tropical climate with moderate to high humidity during the Kharif season. Temperatures commonly range between 25°C and 32°C, with May–June peaks occasionally reaching 48°C. The district's normal annual rainfall is approximately 1,219 mm, most of which arrives during the southwest monsoon from June to September. Crops such as rice and cotton dominate, supported by fertile delta soils and extensive irrigation infrastructure. The district is also prone to drought and occasional cyclonic flooding during harvest time.

1.2 West Godavari

West Godavari has a tropical, deltaic climate with hot dry summers and moderately mild winters, typical of Coastal Andhra. Summer temperatures often exceed 40°C, while during Kharif, day-time highs usually fall between 30–32°C. Average annual rainfall ranges around 976–1,015 mm, with approximately 60% falling during the southwest monsoon (around 642 mm). Major Kharif crops include rice, cotton, and sugarcane, benefiting from a well-developed canal and reservoir-based irrigation system across the Godavari delta.

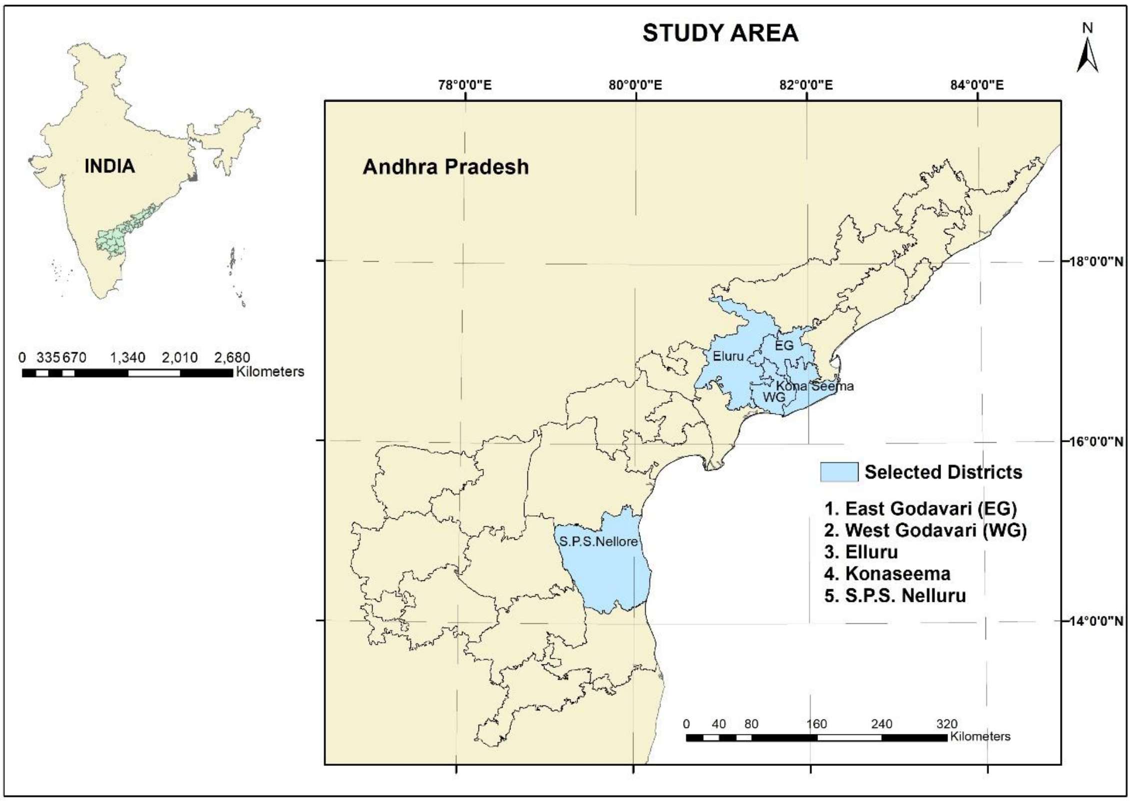

Figure 1: Study Area

1.3 Eluru

Eluru lies inland within the Coastal Andhra plains and shares a hot, humid tropical climate like its neighbours. Summers can exceed 40°C, with an average annual temperature of about 28.2°C. The district receives around 992 mm of rainfall annually, with maximum precipitation in July–August, coinciding with monsoon onset. Rice is the dominant Kharif crop, supported by proximity to Kolleru Lake and the Eluru Canal system used for irrigation; cotton is also grown on parts of the plain.

1.4 Konaseema

Konaseema, formed from Southeastern parts of East and West Godavari, has a tropical deltaic climate like adjacent districts, with hot and humid conditions during Kharif. Average rainfall aligns with East Godavari norms (~1,200 mm), concentrated in the southwest monsoon. Fertile soils along the Godavari delta support rice cultivation predominantly, with coconut, banana, and other plantations thriving under irrigation canals. Occasional cyclonic rainfall during monsoon withdrawal affects late crops and harvesting.

1.5 SPS Nellore

Nellore experiences a tropical savanna climate (Köppen As/Aw) with hot, humid summers and moderate winters. Maximum summer temperatures reach 36–40°C, while minimum winter—Kharif—temperatures stay between 23–25°C. The district's average annual rainfall is around 1,080 mm, of which nearly 60% falls during the northeast monsoon (October to December); southwest monsoon contributes less. Rice is the major Kharif crop, along with cotton and pulses; the district also faces both droughts and floods, especially during cyclonic events associated with northeast monsoon showers.

4. Data set to be used

For the Rice crop yield estimation during Kharif 2025-26, the basic input indicators for Semi-Physical model are the Fraction of absorbed photo synthetically active radiation (fAPAR), Photo synthetically active radiation (PAR), Radiation use efficiency (RUE), Water scalar, Temperature Scalar and Harvest Index (HI) data, which will be used for yield estimation. The rice crop map, representing the area of interest, will be generated using cloud-free Sentinel-2 (MSR) data. In the absence of suitable optical data, Sentinel-1 SAR data will be utilized for crop classification. To generate these input indicators the following data sets are required. The details of data product, satellite/sensor, and source are given in the Table 1.

Table 1: Details of input data and source

Data /Product	Purpose	Satellite/ Ground	Sensor	Resolution	Source
Surface Reflectance data	Rice Crop Mapping	Sentinel-2/ Sentinel-1	MSI/SAR	10m/ 20m	**ESA** (European Space Agency) https://dataspace.copernicus.eu/
Daily integrated Insolation	PAR	INSAT 3DR	Imager	4km	**MOSDAC-ISRO**. https://mosdac.gov.in/

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FAPAR	FAPAR	Terra	MODIS	0.5km	**NASA-** EARTHDATA. https://earthexplorer.usgs.gov/
Surface Reflectance data	LSWI, Water Scalar, Planting Date.	Terra/ Sentinel-2	MODIS/MSI	0.5km./ 20m./ 10m.	**NASA-** EARTHDATA. https://earthexplorer.usgs.gov/ **ESA** (Europian Space Agency) https://dataspace.copernicus.eu/
Past year/current CCE data	Harvest index	Calibration with past year data		District Level	Agriculture dept. (GoAP)/ICRISAT
RUE_{max} (Maximum Radiance Use Efficiency)	The RUE_{max} for the major cultivar will be taken from literature in consultation with SAC.				

5. Methodology

The SOP (Standard Operating Procedure) is mentioned in the YES-TECH manual for semi-physical model.

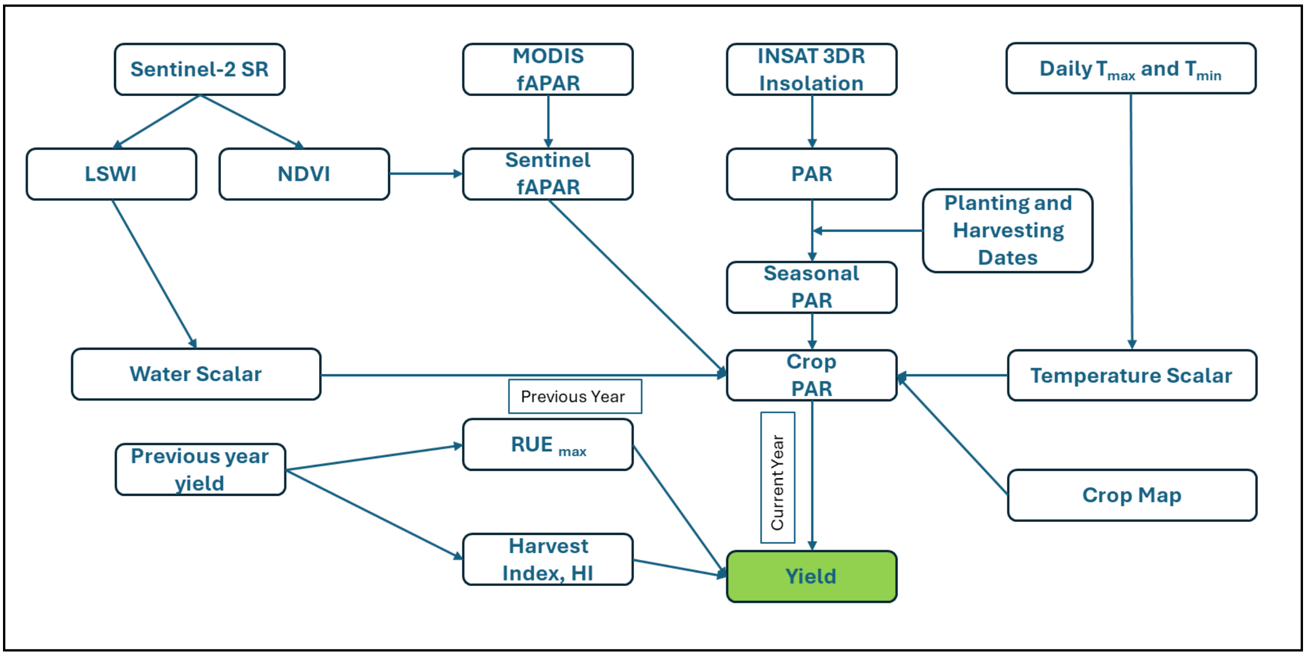

Figure 2: Semi-physical model framework

The semi-physical model is based on the concept that the biomass produced by a crop is a function of the amount of photo synthetically active radiation (PAR) absorbed, which in turn depends on incoming radiation and the crop's PAR interception capacity. Biomass (BM) is a function of the total photo synthetically active radiation (PAR) and the ability of the plant to absorb (fAPAR) this radiation and to convert this radiation to dry matter (RUE) and yield is a function of net dry matter and the harvest index (HI) of the crop. Water Scalar derived from satellite images is used as a limiting factor of crop yield. Model framework (flow chart) is furnished in figure 3.

6. Rice map generation

Crop-type classification will be carried out using a semi-automatic workflow that combines satellite data processing, spectral analysis, and ground-truth integration. This approach balances automation with expert intervention to ensure both scalability and accuracy.

a. Satellite Data Pre-Processing

The classification process begins with the acquisition and preprocessing of multi-temporal satellite imagery, typically from sensors like Sentinel-2 or Landsat. Key preprocessing steps include:

- Cloud masking and atmospheric correction
- Stacking multi-spectral bands over the crop growing season
- Generating maximum NDVI composites at monthly or fortnightly intervals to capture crop phenological patterns

This processed dataset forms the basis for further analysis and classification.

b. Unsupervised Classification and Pre-Clustering

An initial unsupervised classification is applied to group pixels with similar spectral behaviour. This helps identify broad land cover categories and guides the selection of representative training samples. These pre-clusters also help isolate noise and identify spectral confusion zones that may need further ground validation.

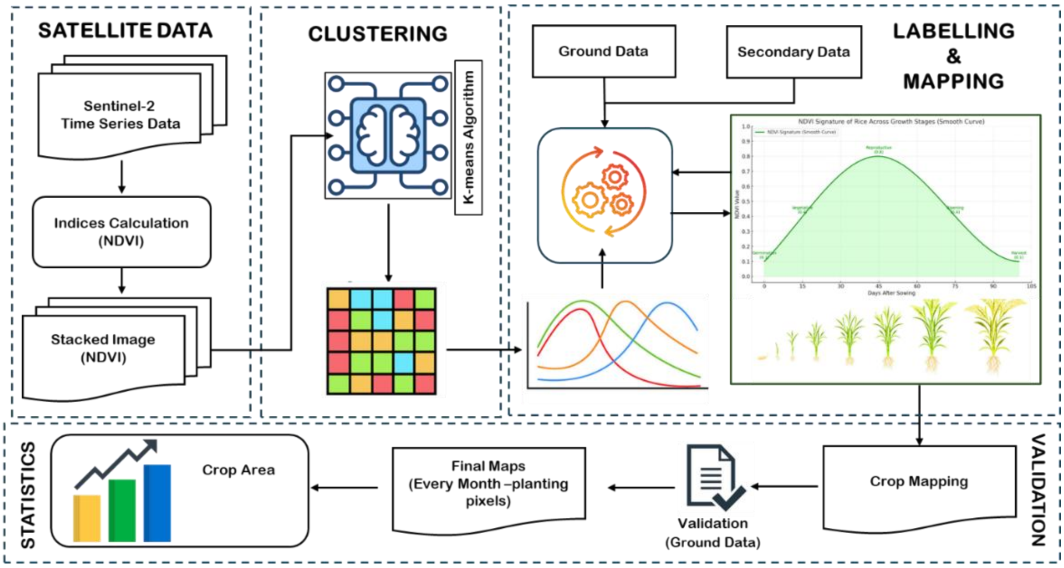

Figure 3: Methodology for crop classification

c. Development of Spectral Signatures

With support from field data collected using the ICROPS mobile application, spectral signatures are developed for each crop type (e.g., rice, maize) and for other land use/land cover (LULC) classes (e.g., water bodies, fallow, settlements). The process involves:

- Extracting pixel values for ground-verified locations
- Analysing NDVI and other spectral indices over time
- Generating class-wise temporal spectral profiles

This step ensures that each class has a distinct and biologically meaningful spectral identity.

d. Spectral Matching Techniques

Using the developed signatures, spectral matching techniques are employed to identify and classify each pixel into its most likely crop or LULC class. This step is refined using:

- Field-collected training data
- Secondary datasets such as crop calendars, administrative records, and historical land cover maps
- Expert knowledge to adjust thresholds or resolve class confusion (e.g., rice vs. wetlands)

e. Accuracy Assessment

To ensure the reliability of classification outputs, an accuracy assessment is conducted using an independent set of ground-truth points that were not used in the training phase. This involves:

- Generating a confusion matrix
- Calculating key accuracy metrics: Overall Accuracy, User's Accuracy, Producer's Accuracy, and Kappa Coefficient

This validation step is crucial for reporting confidence levels and for integrating outputs into decision-support systems.

7. CCE Collection

ICRISAT with the help of Agriculture Department will collect Crop Cutting Experiment (CCE) data based on smart sampling techniques following the standard protocol prescribed for yield estimation. The collected data will be utilized for the evaluation and validation of the YESTECH yield estimates.

8. Ground truth data for rice crop mapping and accuracy assessment of rice map

ICRISAT team will collect ground truth observations from study districts; Eluru, East Godavari, West Godavari, Konaseema, and SPS Nellore of Andhra Pradesh, with a minimum of 150 points from each district covering rice fields as well as other LULC. The ground data will be collected based on the spectral variations generated using sentinel-2 NDVI imagery till date. Polygon-based samples will be collected using *KrishiMapper*, a geospatial mobile and web application developed by the Ministry of Agriculture and Farmers Welfare, Government of India. Along with ICRISAT will use our field data collection application, ICROPS, which has developed by the RS-GIS Team of ICRISAT. The idea for ICROPS emerged from the need for a simple and reliable tool to capture ground-truth data which was designed with user requirements in mind: lightweight, intuitive, and able to function offline in areas with limited connectivity. Its core features include geo-tagged data entry, drop-down menus to minimise manual errors, and real-time syncing when internet access is available.

The sample locations will be carefully selected considering the variability of different crops as observed on optical satellite data. These samples will be used as reference data for unsupervised classification labelling and accuracy assessment of the rice map.

9. Deliverables

The expected results of the study during Kharif 2025-26 are

(i) Rice crop map of selected districts (pixel wise) and acreage.

(ii) Planting date map.

(ii) Village wise Rice grain yield. (IU wise)

10.Schedule

The project schedule is outlined in Table 2.

Table 2: Project schedule

Activity	1FN-June	2FN-June	1FN-July	2FN-July	1FN-Aug	2FN-Aug	1FN-Sep	2FN-Sep	1FN-Oct	2FN-Oct	1FN-Nov	2FN-Nov	1FN-Dec	2FN-Dec
Ground Truth data Collection						☑	☑							
Rice crop map generation								☑	☑					
Crop Condition Assessment			☑	☑	☑	☑	☑	☑	☑	☑	☑	☑		
Planting date map generation									☑	☑				
Input data preparation for SPM		☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑		
CCE data Collection												☑	☑	
Yield estimation and Validation													☑	☑
Mid Season Report										☑	☑			
End Season Report													☑	☑

11. Related Papers

[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16]

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