

India-Japan Joint Research Laboratory Programme  
2015 SICORP Collaborative Hub for International Research Program between  
Japan and India

# Data Science-based Farming Support System for Sustainable Crop Production under Climatic Change

PI

The University of Tokyo

Seishi Ninomiya

Indian Institute of Technology Hyderabad

Uday Desai



# Background and Objectives of the Project

- Drastic increase of food demand by growing population and increase of middle class people in India
- 80% of Indian arable land is in semi-arid area
  - Total arable land is the 2<sup>nd</sup> largest in the world
  - Vulnerable under climatic change and risk for stable productivity is increasing
  - 50 million tons of grain yield reduction took place in India by drought. The amount is equivalent to 20% of total annual grain trade in the world
  - Chronic water shortage and pests/diseases
  - 50% of the population are farmers and improvement of their benefits is an urgent and critical issue

# Current issues in semi-arid farming

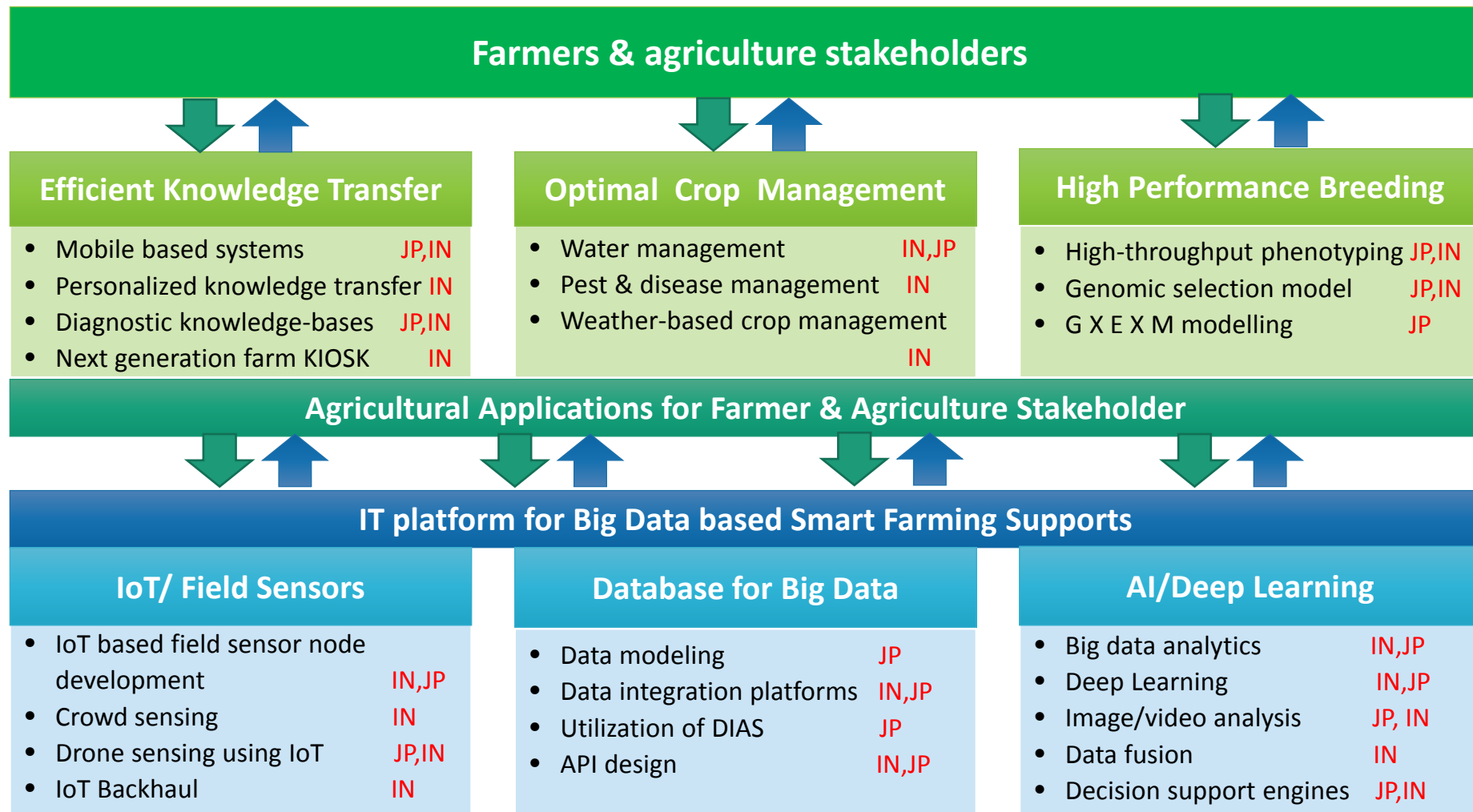
- Decision support information for optimal and effective crop managements is very poor
  - chemical applications and water usage
- Breeding for climatic change is delayed
  - Drought tolerance, pest tolerance, high yield, high quality
- Knowledge transfer to each farmer is rather poor
  - Personalized information is needed
  - Monitoring each farmer is necessary

# Research objectives

- Improvements of cropping in semiarid area accelerated by information sciences and technologies
  - To provide decision support systems particularly for better crop managements in semi-arid area such as efficient water use
  - To accelerate crop breeding based on data science for semi-arid area under climatic change
  - To provide a method for efficient and effective personalized knowledge transfer to agricultural stakeholders

# Data Science-based Farming Support System for Sustainable Crop Production under Climatic Change

Establishment of bilateral Joint Laboratory for research to support sufficient and environmentally friendly production of safe and quality crops under climatic change



# Research Group

- The University of Tokyo
  - Graduate School of Agriculture and Life Sciences
  - Graduate School of Information Science and Technology
  - Institute of Industrial Science
- Indian Institute of Technology Hyderabad
- Indian Institute of Technology Bombay (IITB)
- Professor Jayashankar Telangana State Agricultural University (PJTSAU)
- International Institute of Information Technology Hyderabad (IIITH)

# Bilateral research project Geo-ICT and Sensor Network based Decision Support Systems in Agriculture and Environment Assessment (2008~2011)

- Strategic Japanese-Indian Cooperative Programme on “Multidisciplinary Research Field, which combines Information and Communications Technology with Other Fields supported by JST and DST
- Team
  - National Agriculture and Food Research Organization (NARO) and UT
  - IITB and ANGRAU





# Test beds in Hyderabad

Acharya N G Ranga Agricultural University, Hyderabad





## Interaction with farmers



# Key factors in the project under synergy of information sciences and agricultural sciences

- **Element technologies**

- Development of field sensors usable under severe environmental condition in semi-arid India
- Monitoring of environments
- High throughput phenotyping
- Crowd sensing
- Big data and database technologies
- Models for prediction and optimization, artificial intelligence

- **Optimal water usage in cropping**

- Crop status monitoring and crop modeling

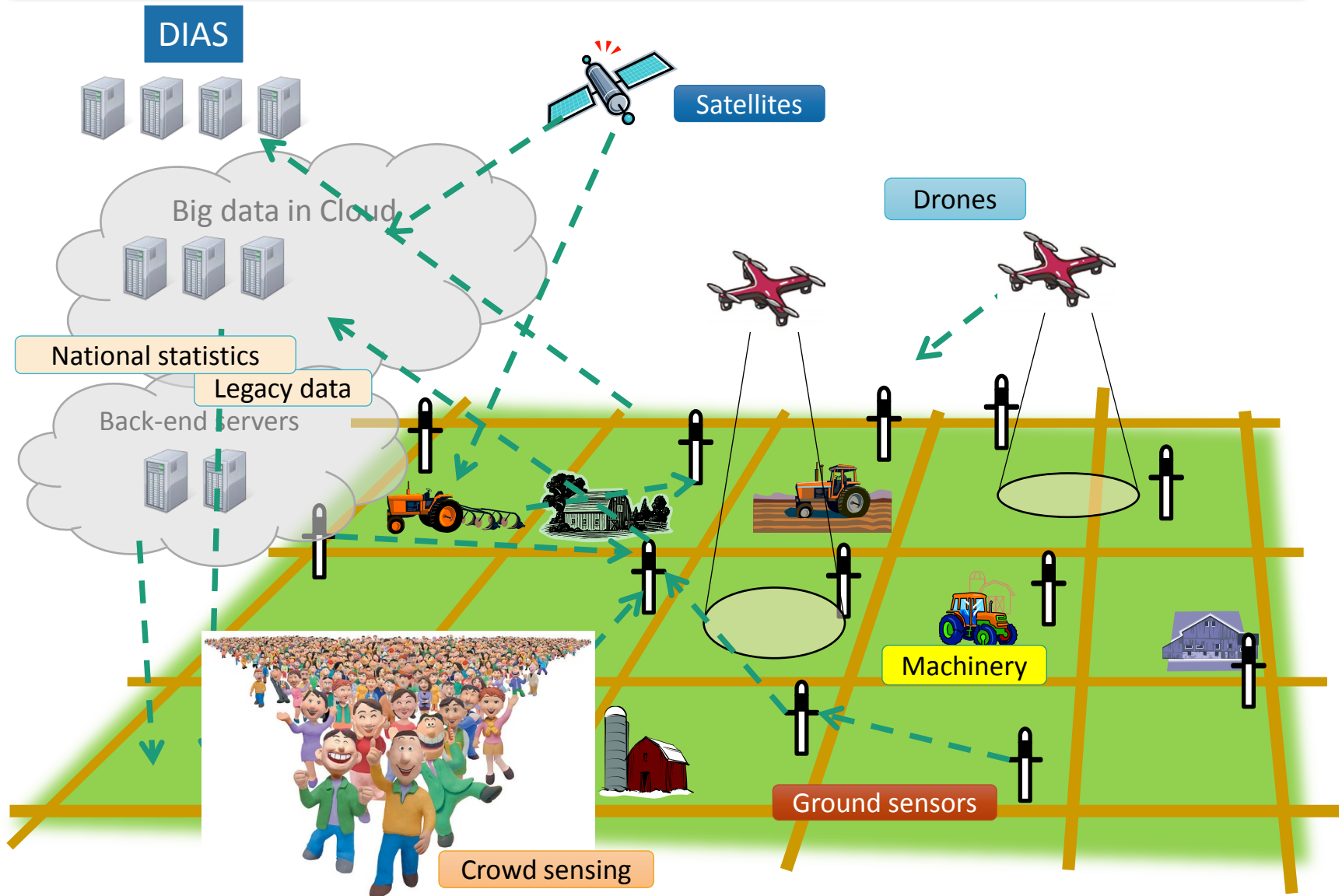
- **Acceleration of breeding**

- From empirical breeding to designed breeding
- Prediction of crop performance by G X E modeling

- **Identification of individual farmers' issues and efficient and appropriate knowledge transfer to each farmer**

- Mobile tools

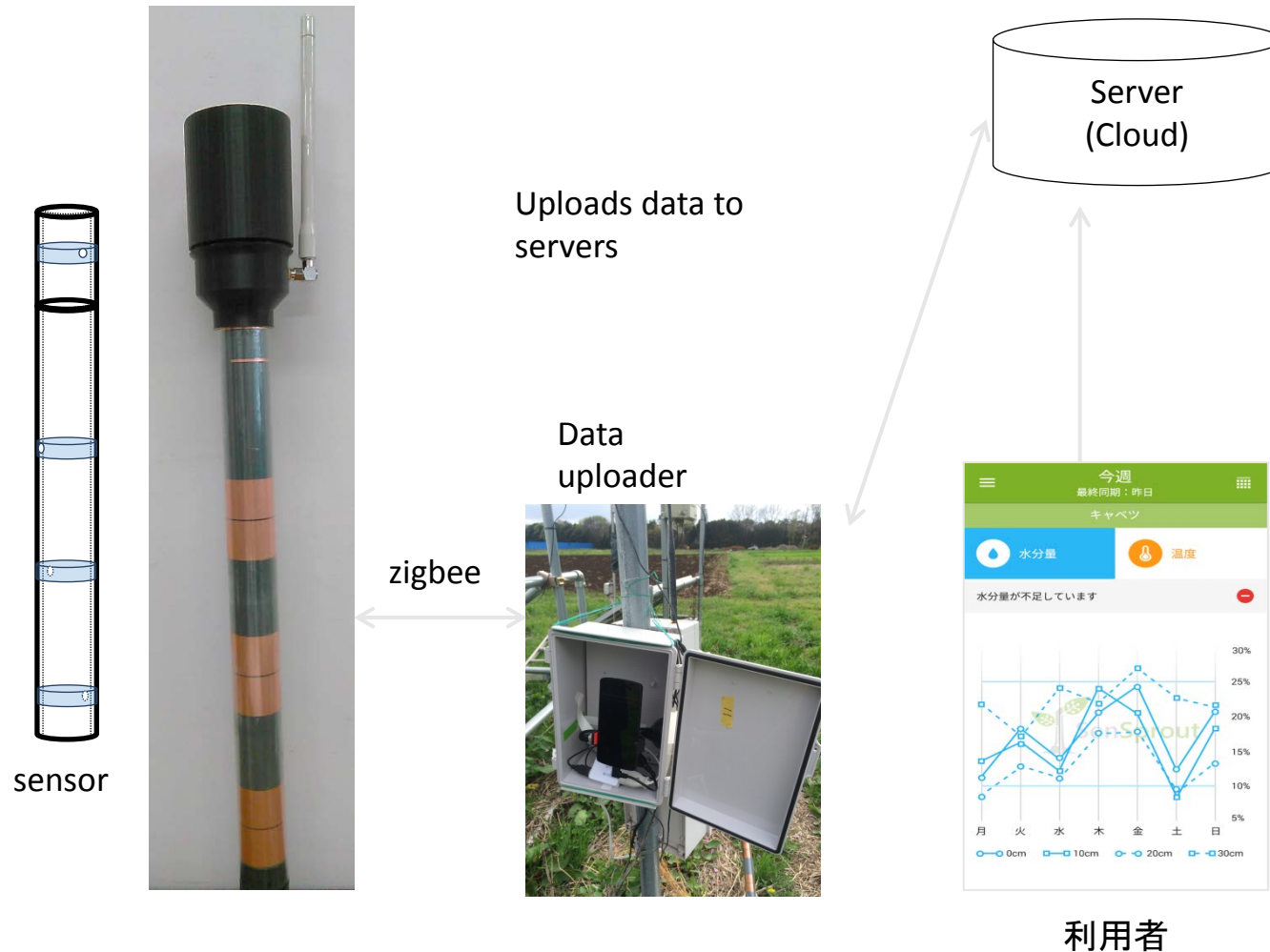
# Big Data collection & utilization for crop production by multi-layer IOT





# Low cost fully autonomous soil moisture sensors

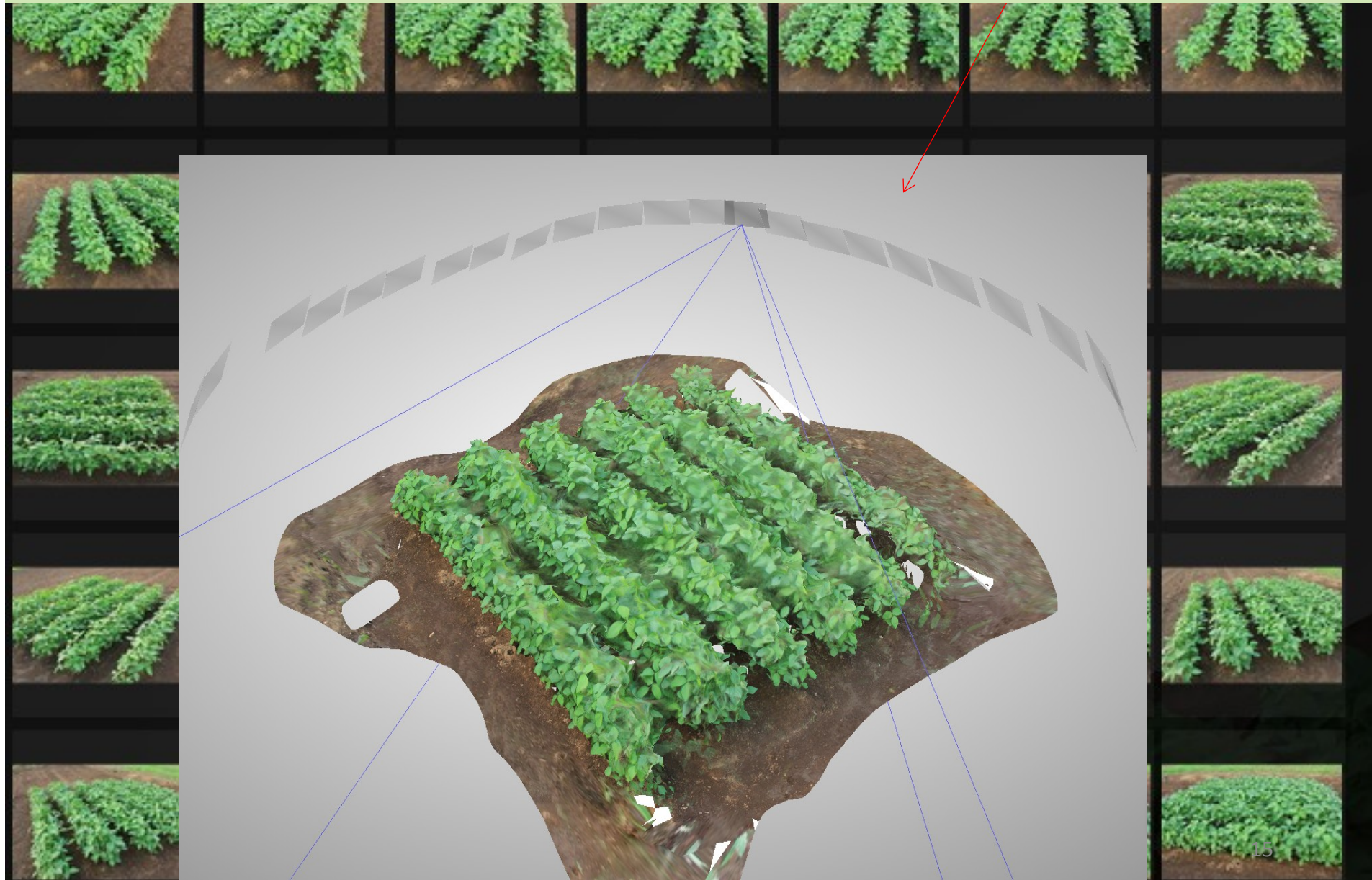
- Data taken by SenSprout pro is uploaded to cloud server



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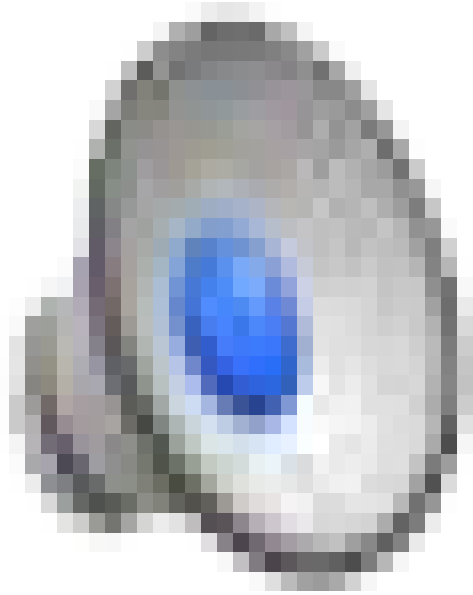


# 3D reconstruction of fields by drone images



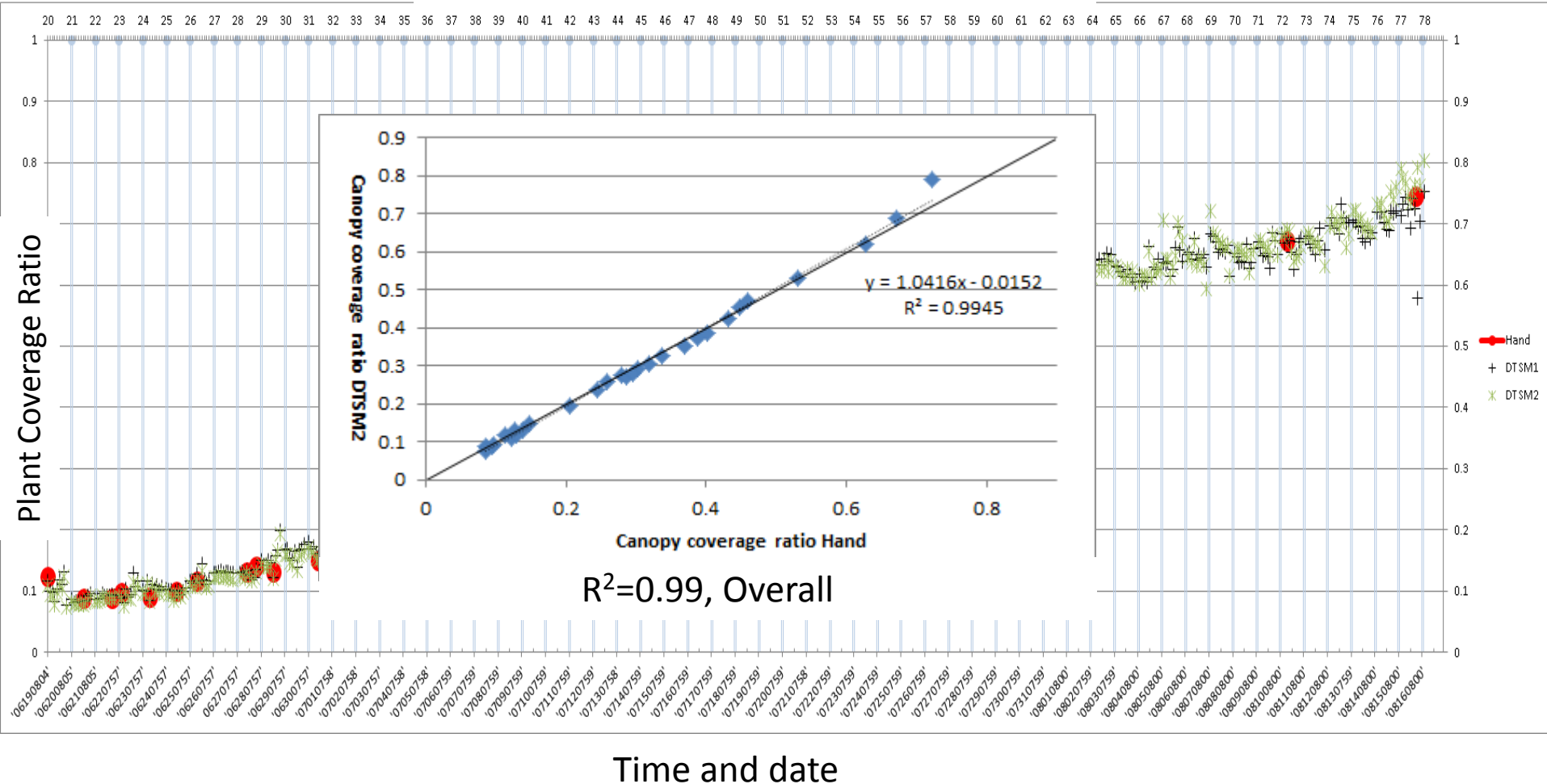


# 3D reconstruction of fields by drone images

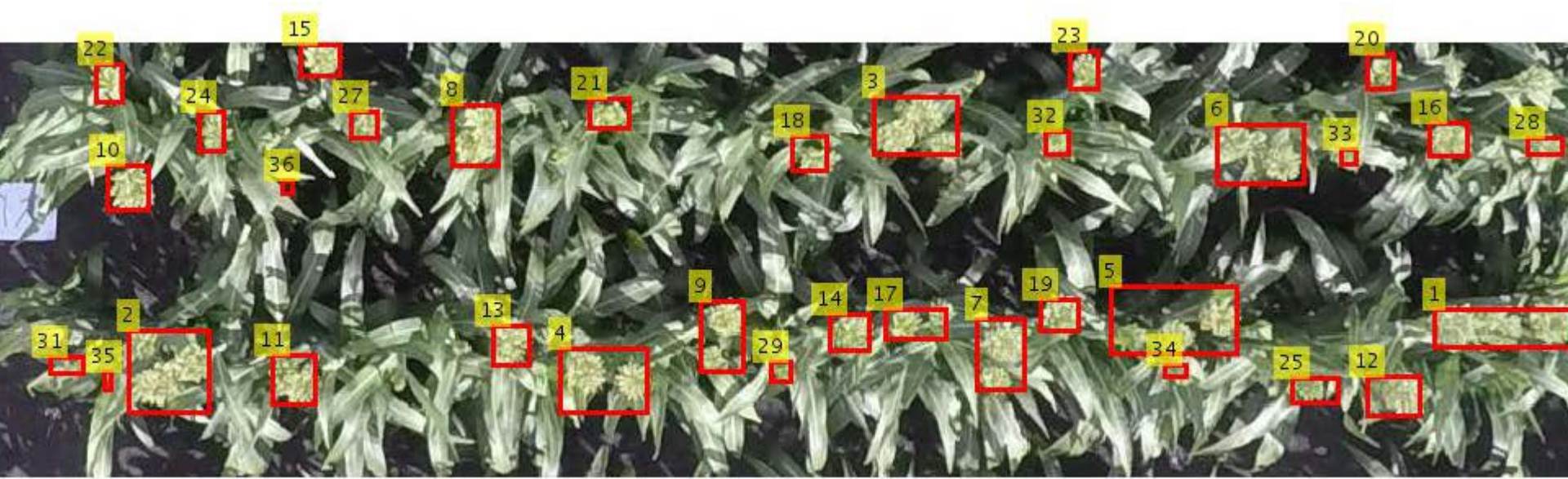


# Estimation of canopy coverage of paddy rice

Days after transplanting



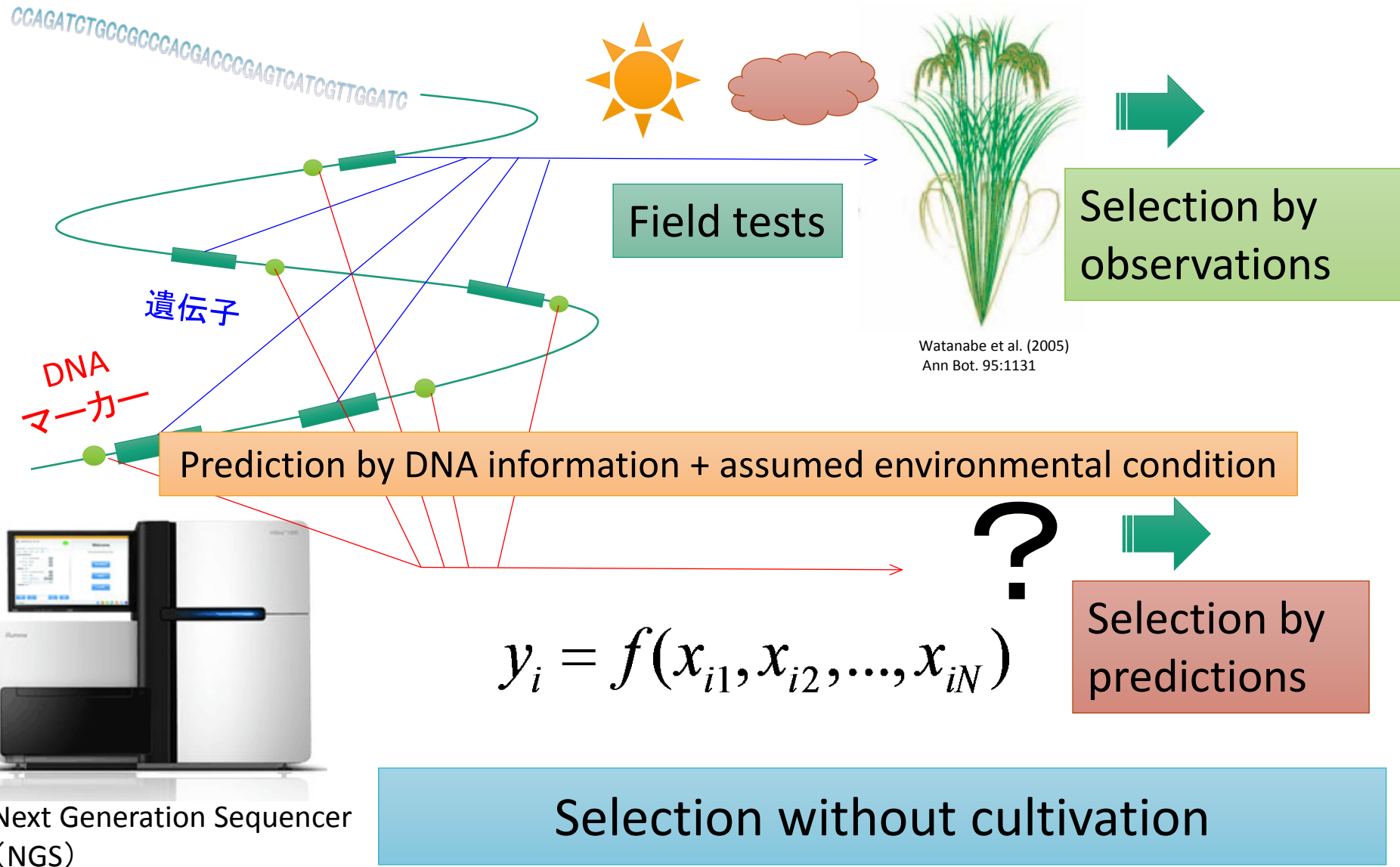
# Detection of heading of sorghum by drone images



Unpublished, Collaborated with CSIRO, Australia



# Acceleration of breeding by genomic selection



# 1<sup>st</sup> stage to 2<sup>nd</sup> stage

## 1<sup>st</sup> Stage (2016-2021) JL

Research & development  
Practical test beds  
Training and education

### Japan Side/JST

- University of Tokyo
- ✓ Grad. Schl. Agric. Life Sci.
- ✓ Grad. Schl. Engineering
- ✓ Grad. Schl. Info. Sci. Tech.
- ✓ Inst. Industrial Sci.

### India Side/DST

- IIT Hyderabad
- IIT Bombay
- IIIT Hyderabad
- PJTSAU

### Social Impacts

- Stable crop supply
- Higher productivity
- Efficient water usage
- Low environmental impact
- Safety food
- Farmers' benefits

## 2<sup>nd</sup> Stage (2021-2026) JL

Research & development  
Societal implementation  
Training and education

Tight collaboration among academia,  
governments and private sectors

### Japan Side/JST

- University of Tokyo, NARO,  
Nagoya U., Chubu U., Kyoto U.,  
Hokkaido U., AIST, NII, etc

### India Side/DST

- IITH, IITB, IIITH, PJTSAU,  
ICRISAT, ICAR,

### Societal Implementations

- DOA/MAFF, Extension services
- TCS, INFOSYS, WIPRO, ITC,
- Fujitsu, Kubota, NEC, NTT, KDDI, Soft  
Bank, etc.

### Scientific Impacts

- Acceleration of bilateral  
multi-disciplinary research  
and education
- IOT technology for farming
- Analytics on crop related  
data
- Designed cultivation
- Designed breeding
- Efficient use and  
enrichment of DIAS

### Social Impacts

- Stable food supply
- Higher productivity
- Better water usage  
efficiency
- Quality and safety
- Low environmental impact
- Higher income of farmers



# Expected impacts of the project

- **Exchange of young students/scientist of two countries**
  - To understand each end and to promote the next generation international collaboration
- **Scientific Impacts**
  - Acceleration of bilateral multi-disciplinary research and education
  - IOT technology for farming
  - Analytics on crop related data
  - Designed cultivation and cultivation control
  - Designed breeding
  - Efficient use and enrichment of DIAS
- **Social Impacts**
  - Stable food supply
  - Higher productivity
  - Better water usage efficiency
  - Quality and safety
  - Low environmental impact
  - Higher income of farmers

# Kick-off Meeting at IITH in December 2016





Thank you very much

For a fruitful project

