



KGID
2026
SEJONG

Image Data-Driven AX Transformation in Open-Field Agriculture

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Contents

- I** Current Challenges / How we overcome?
- II** Case Study 1 – Digitalized Current Knowledge
- III** Case Study 2 – Discover New Knowledge
- IV** Transformation into *AX* in Open-Field Agriculture



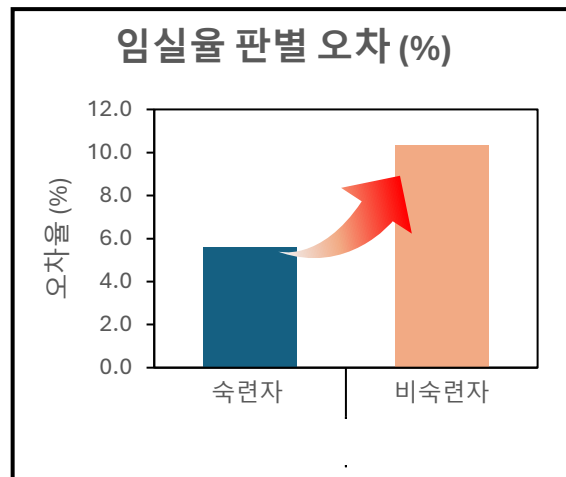
I . Current Challenges

Climate

Knowledge

Digitalized

Labor shortage at agriculture sector in R.O.K



Outdoor

Productivities ↓

Urbanization

Lack of experience

Untrained eyes

Not reliable data

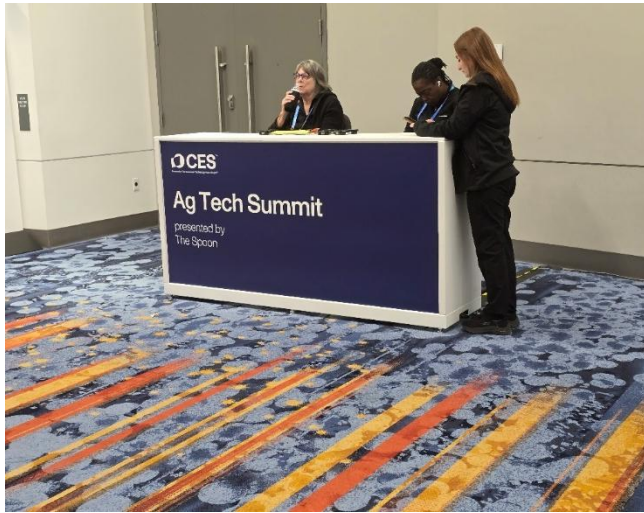
Extreme weather - heatwaves

Productivities ↓



Apply cutting-edge image analysis methods and A.I. for diagnostics of crop health

Labor shortage at agriculture sector is global phenomenon



Apply A.I. and image analysis method to solve the problem




How we overcome? (Field Phenotyping Data)







Image derived, non-destructive way is required for future agriculture

Digitalized Field Phenotyping Data

 
G x E

  
G x T x e

   
G x T x E x M

Conventional Data

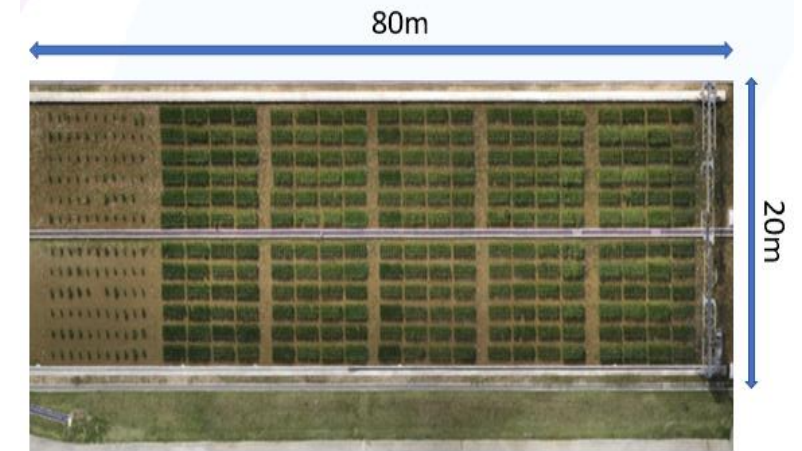


Indoor Phenotyping Data



Wageningen Research (WR, NL)
National Plant Eco-Phenotyping (NPEC) Center

Field Phenotyping Data



Field Phenotyping Data Acquisition at NICS



Real-time

- Sensor Network
- R G B images
- Known Knowledge

Precision Measurement

- Field Scanning Platform
- 3D & multiple spectral images
- Discover New Knowledge

Big Areas

- Autonomous Flying Drones
- R G B and multiple spectral
- New and Known Knowledge



II. Case Study 1 – Digitalized Known knowledge



Case Study 1 : Known Knowledge Measurement Methods



Manual Labor

Vs

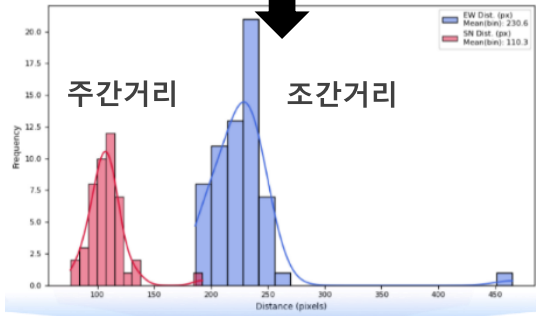


Portable Devices

There were known **yield associated traits** in rice. We selected few traits from the known traits and digitalized traits with deep learning models (ex., Yolo v.12 and etc)

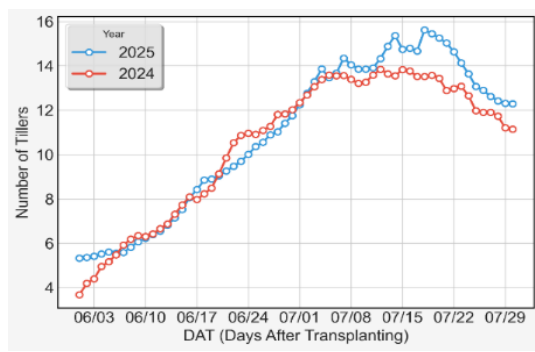
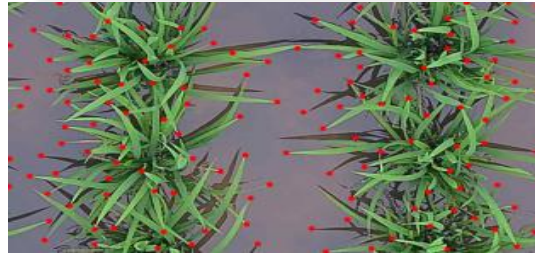
Case Study 1 : Developing A.I. models for measurement

Density



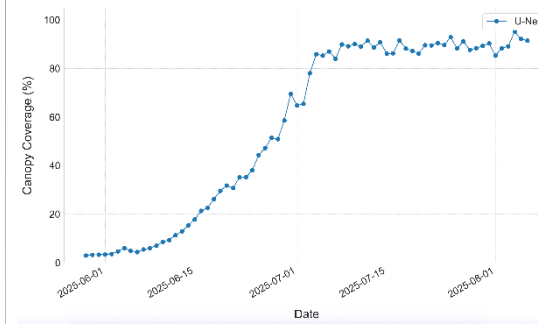
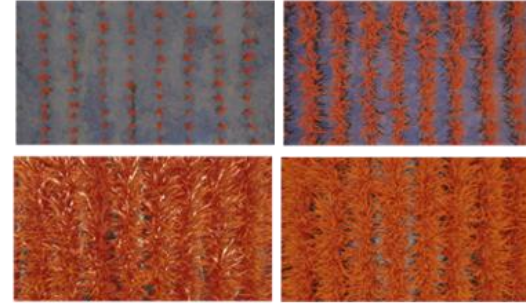
- Object detection modes(YOLOv8)
- Layout : 30 x 14.4 cm
- Density : 26.03 plants/m²
- Uniformity : 0.92 (1,uniform)

Number of Leaves



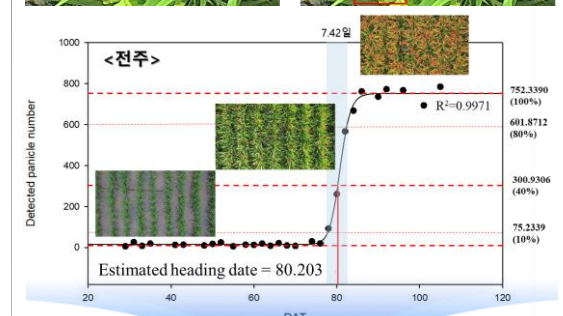
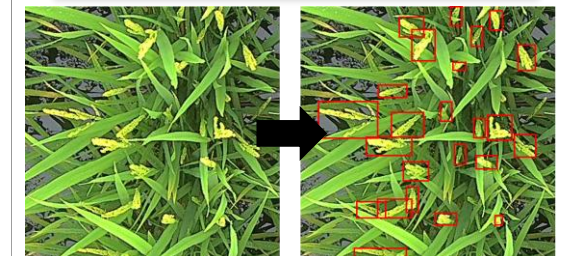
- Detection of leaf-tip
- * Object detection models (YOLOv8)
- Estimate number of leaves from models
- * Only monocot applicable models

Canopy Coverage Areas



- Segmentation* models (U-Net)
- Result were accurate
- * Segmentation : remove object from a background

Flowering Dates



- Object detection modes(YOLOv8)
- 출수시: 8월 17일
- 출수기: 8월 20일
- 출수전: 8월 24일
- Errors : 7.42일 (+/- 1 day)

⇒ Developing A.I. models of additional traits for yield

Case Study 1 : Known knowledge – Yield Forecast Pipeline

Image Acquisition

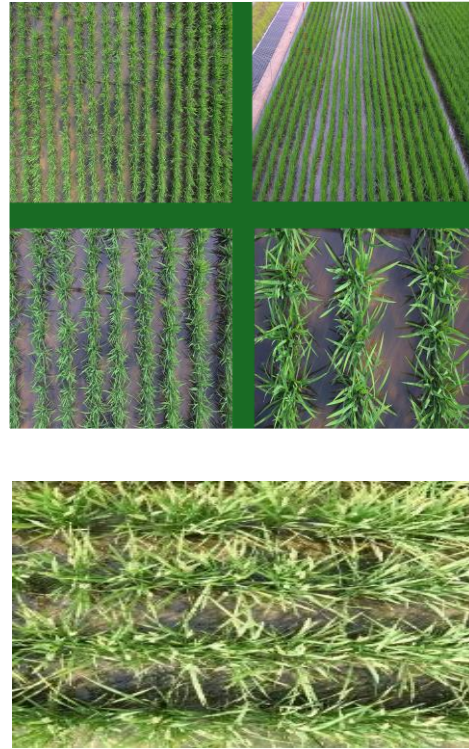
Fixed



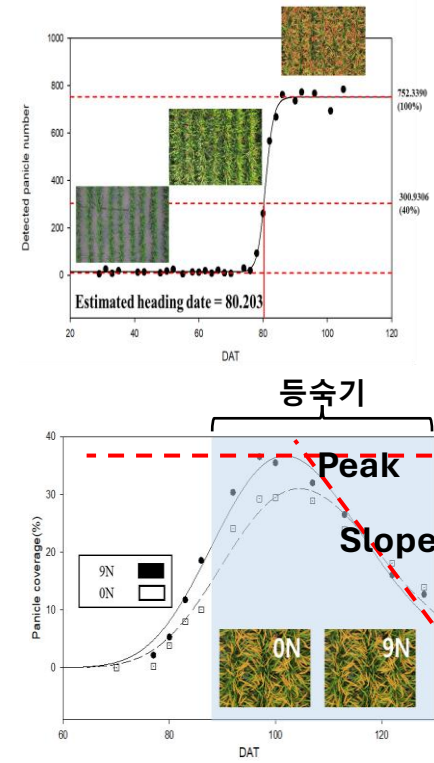
Portable



Data Analysis



A.I. models



Platforms



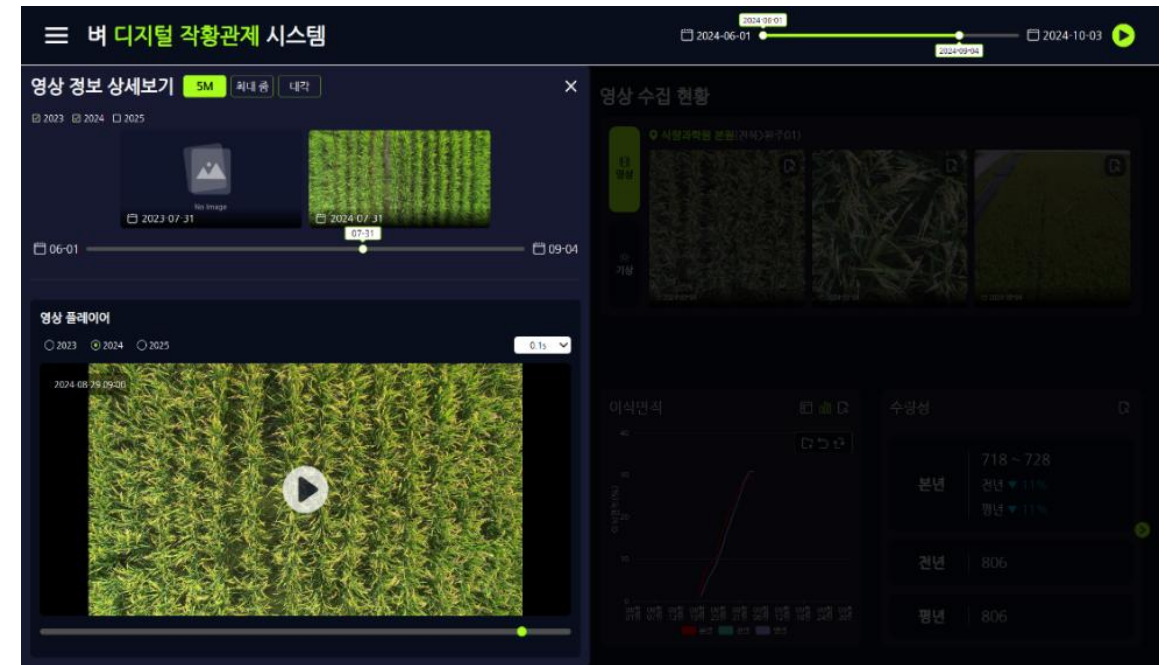
⇒ Additional images were collected from various regions of R.O.K

Case Study 1 : Known Knowledge – Platform Service

“Web-based traits measurement platform (Working Progress)”

‘Provide traits for yield prediction with A.I. and image analysis’

‘Diagnostics of grow habit of plants by regions & years’



“Update images and additional traits to yield prediction”



III. Case Study 2 – Discover Knew knowledge



Case Study 2 – New Knowledge with Field Scanning Platform (FSP)

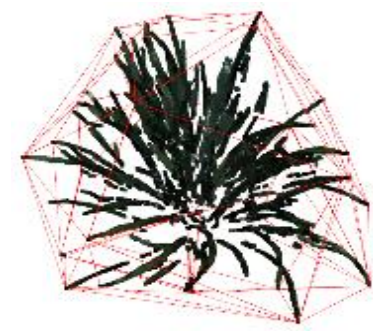
“Field Scanning Platform – Gathering 3D images of crop at rice paddy field”
= **Measuring traits not possible by manual labor** (ex., Volume, Leaf angles, and etc) =
Structural and spectral information of crop at Open-Field



<Field Scanning Platform – Operating at NICS since 2023>



Replace manual measurement with automated platform



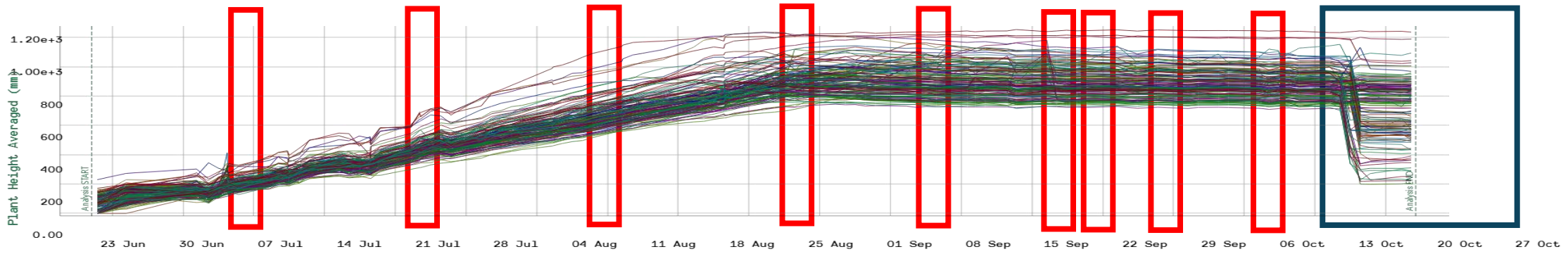
Volume



Leaf Angles

“Measuring various traits at crop level for yield prediction”

➤ Build yield prediction Random Forest (RF) models at various time points



7월5일 (0.7818)

- (측정) 3차원 분광 카메라
- (분석) 60개 지표 사용

Confusion Matrix and Statistics

	Reference		
Prediction	low	Medium	high
low	17	8	0
Medium	11	62	5
high	0	0	7

Overall Statistics

Accuracy : 0.7818
 95% CI : (0.693, 0.8549)
 No Information Rate : 0.6364
 P-Value [Acc > NIR] : 0.0007385

8월20일 (0.8455)

- (측정) 3차원 분광 카메라
- (분석) 60개 지표 사용

Confusion Matrix and Statistics

	Reference		
Prediction	low	Medium	high
low	16	1	0
Medium	12	67	2
high	0	2	10

Overall Statistics

Accuracy : 0.8455
 95% CI : (0.7641, 0.9073)
 No Information Rate : 0.6364
 P-Value [Acc > NIR] : 1.052e-06

9월16일 (0.8273)

- (측정) 3차원 분광 카메라
- (분석) 60개 지표 사용

Confusion Matrix and Statistics

	Reference		
Prediction	low	Medium	high
low	17	1	0
Medium	11	69	7
high	0	0	5

Overall Statistics

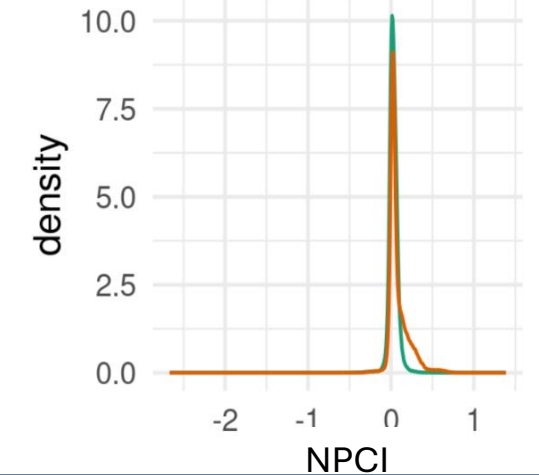
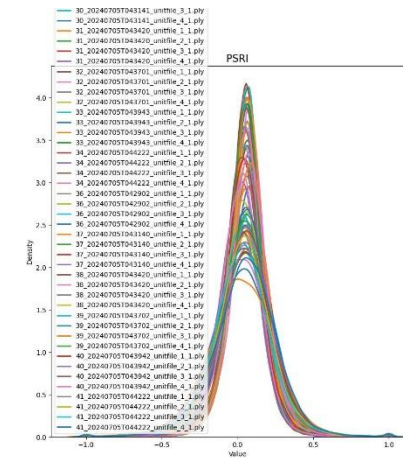
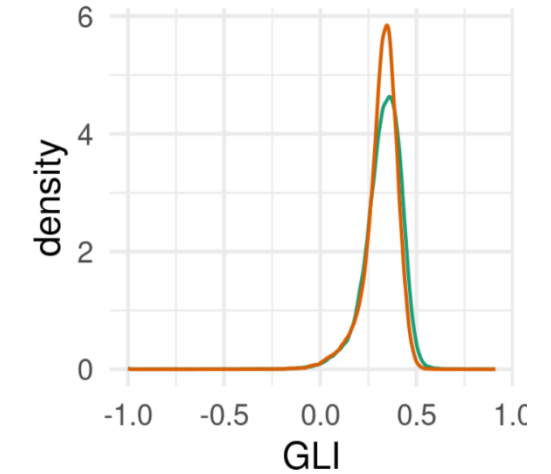
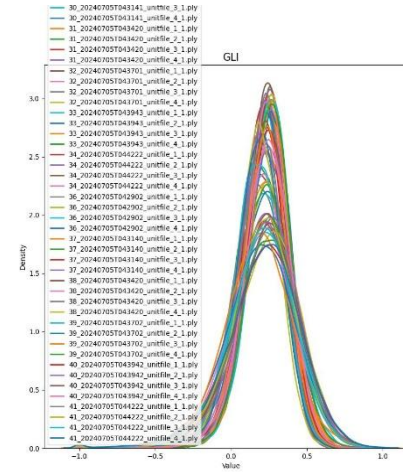
Accuracy : 0.8273
 95% CI : (0.7435, 0.8927)
 No Information Rate : 0.6364
 P-Value [Acc > NIR] : 9.156e-06

Case Study 2 – New Knowledge with FSP (Yield Prediction)

“Selected traits at crop level for yield prediction”

Collaboration work with **WR/NPEC**

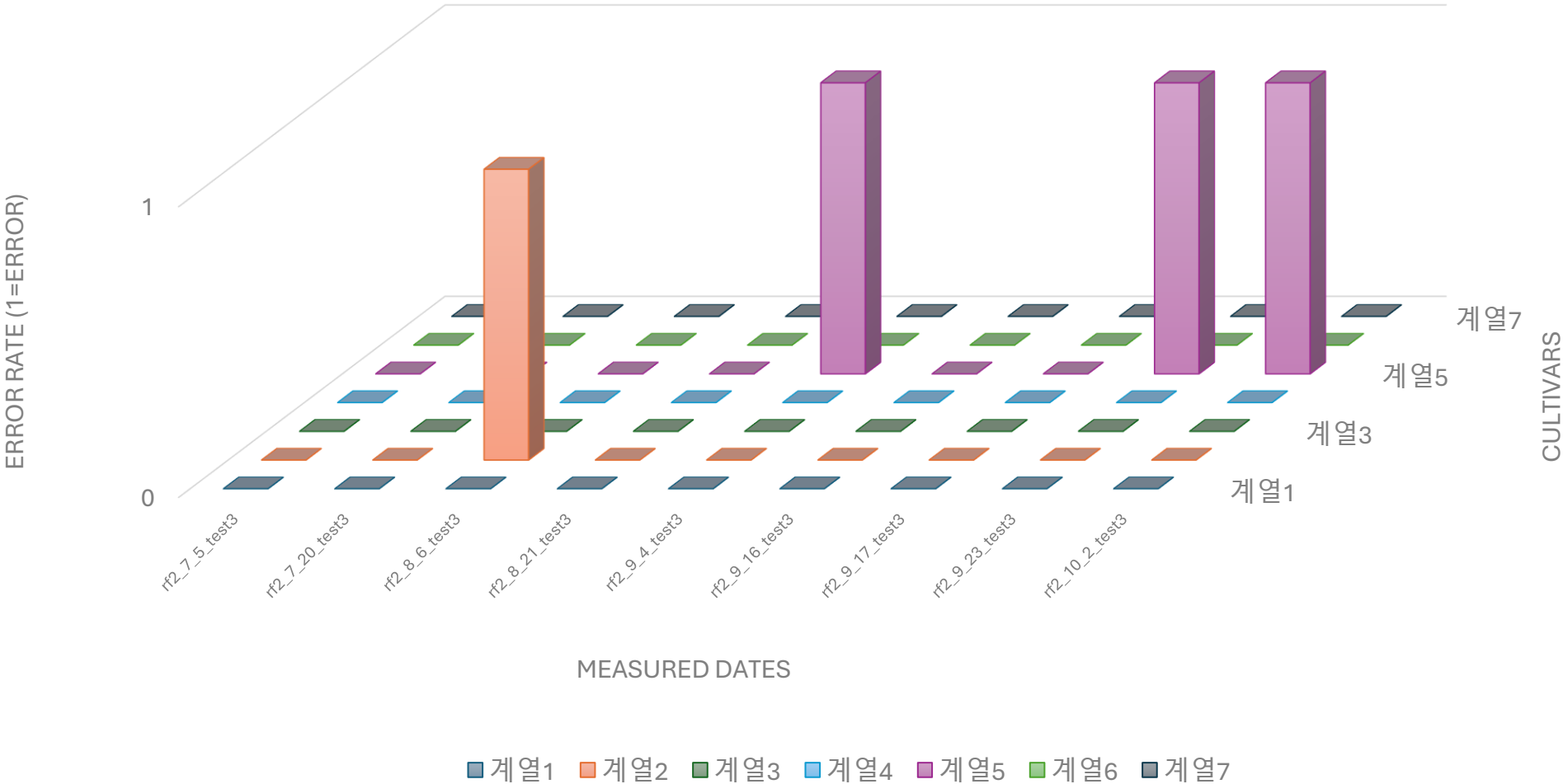
Class	Features	Grouping
Structural	Convex.Hull.Area.mm	1
	Convex.Hull.Circumference.mm	2
	Digital.Biomass.mm	3
	Plant.Height.Averaged.mm	4
	Plant.Height.Max.mm	5
	Surface.Angle.Average	6
Spectral	GLI..0.15.0.3...	1-1
	GLI..0.3.0.6...	1-2
	NDVI..0.3.0.45...	2
	NPCI...4..0.8...	3-1
	NPCI...0.8..0.4...	3-2
	NPCI...0.2.0...	3-3
Color-based	NPCI..0.0.2...	3-4
	Saturation..100.100...	1
	Hue..75.100...	2
	Lightness..50.75...	3-1
Lightness..75.100...	3-2	



Case Study 2 – New Knowledge with FSP (Yield Prediction)

“New Knowledge from FSP useful for rice yield prediction”

Comparison model prediction results cultivars and measured dates



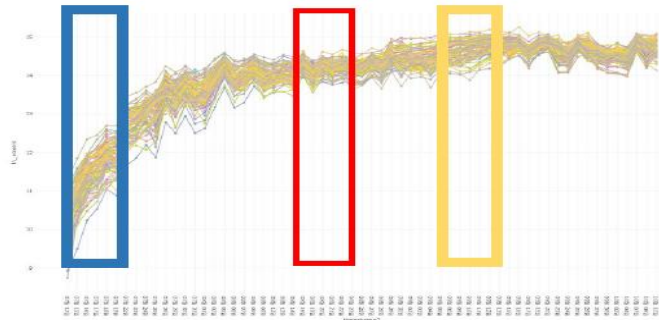
“Measuring various traits at crop level–preparing for Physical A.I.”

Volume (Voxel)

Measuring volumes of individual cultivar with 3D images


* Hortcontrol

Comparison of rice volumes



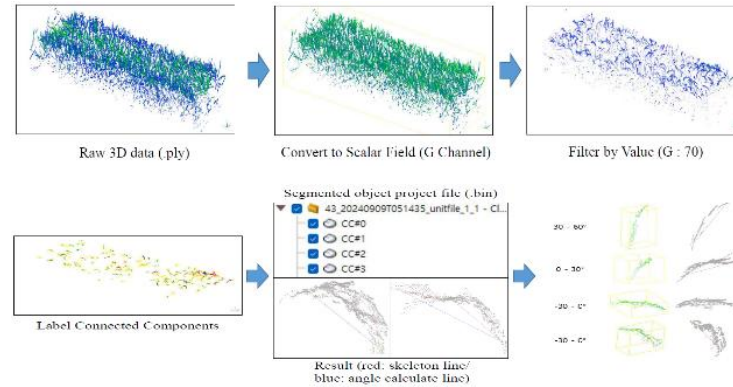
Analyze with genetic markers

ID	Time	Chr	Pos	Lod
5	T4	5	5611	7.955273
6	T7	5	5611	9.543731
7	T8	5	5611	8.465575
9	T1	5	5611	6.700465
13	T5	1	0	5.025717
14	T5	0	0	6.81596
15	T5	1	0	5.802192
16	T5	0	0	5.124043

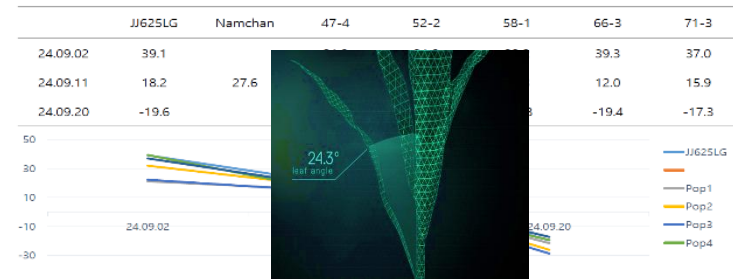


Panicle Detection and Angles

Panicle detection and angle measurement



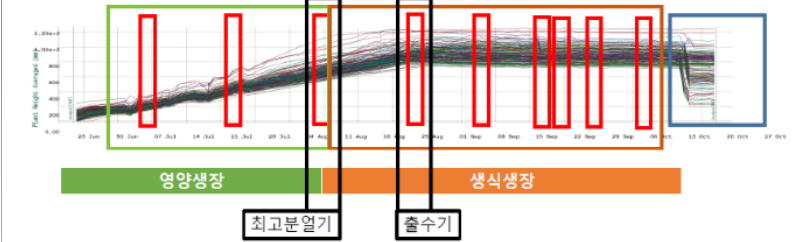
Comparison of rice panicle angles



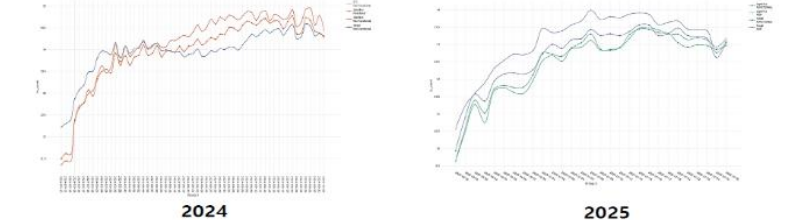
- Apply the information in Physical A.I. in future

Flowering Date Prediction

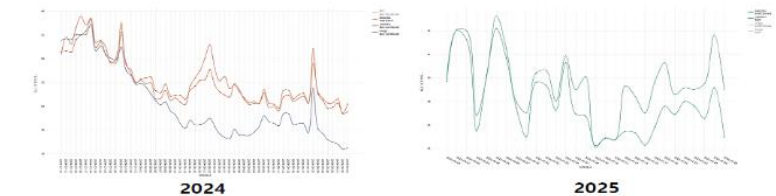
Analysis flowering date by genomic information of rice



Comparison of rice cultivars with structural data



Comparison of rice cultivars with spectral data



Measured crop with 3D data and then validate new knowledge with crop genomic data

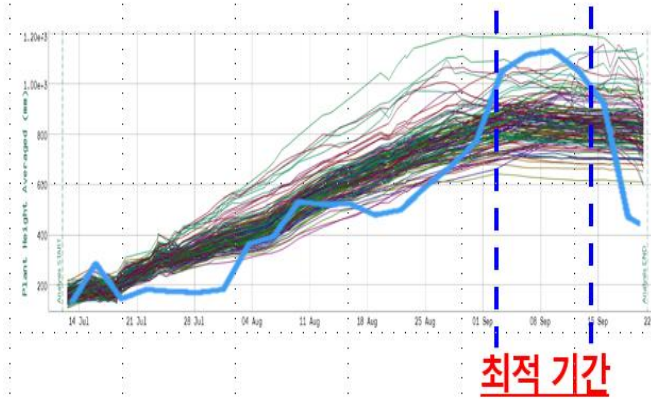


IV. AX Transformation In Open-Field Agriculture



AX Transformation: Transfer New and Digitalized Knowledge

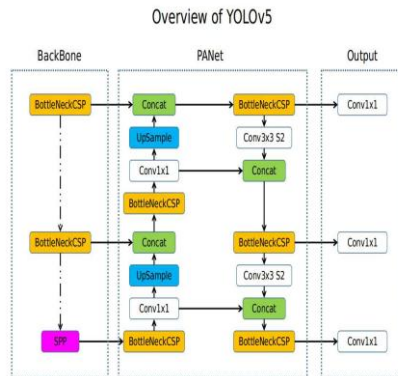
New knowledge transfer with FSP



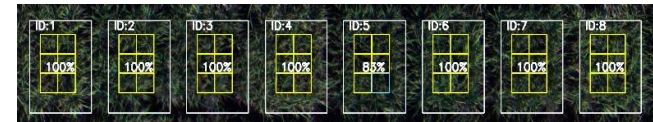
AX transformation (Drone)



Digitalized knowledge transfer with sensor network



Flowering Date




Canopy Heights



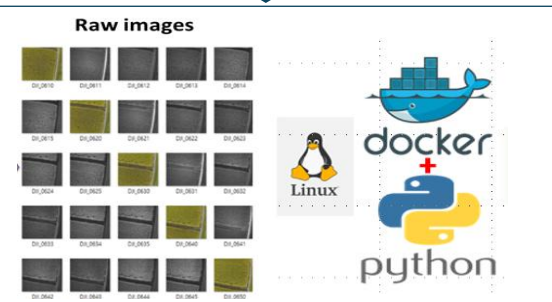
AX Transformation: Developed Drone Image Analysis

<Image Acquisition for Drone >




Scheduling for Drone

Raw images



Automated image transfer Methods



<Drone Image Analysis Tool (DIAT.exe)>

Image stitched together with open drone map (ODM)

* Automation at local servers




Image analysis by cultivars and lines for field crop

* 동일 위치 포장 시계열 데이터 추출에 특화 (Window에서 구동)

전처리

분할 주석 작업

분할 저장 초기화

분할 목록 맵 목록

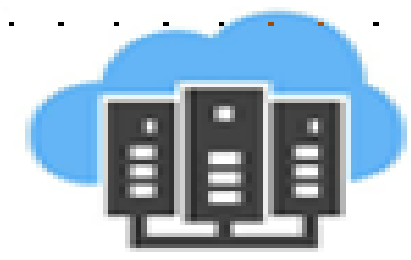
sd01.tif grid_001.csv
 sd03.tif m_sd.csv
 sd03_dsm.tif m_sv.csv
 sv01.tif sd_part1.csv
 sv02.tif sd_part2.csv
 sv_part1.csv

<Connected with NICS server>

ID	Heading(%)	NDVI	TGI	NDRE	SR	EVI	GNDVI	CIGREEN	SAVI	ARVI	GRVI	NGRDI	IPCA	DSM
1	0	0.6543	0.05	0.143	6.21	2.43	0.5175	2.49755	0.98	0.653	3.5	0.2334	41.35	87.55
2	50	0.6895	0.04	0.176	8.22	2.07	0.5555	3.42333	1.03	0.687	4.42	0.2477	39.08	87.49
3	50	0.7294	0.09	0.202	9.08	2.78	0.6068	3.76393	1.09	0.729	4.76	0.2526	35.6	87.35
4	0	0.7251	0.07	0.183	8.93	2.41	0.5877	3.54693	1.08	0.724	4.55	0.2713	38.6	87.53
5	25	0.7214	0.08	0.178	8.06	2.31	0.5868	3.41565	1.08	0.721	4.42	0.2545	40.68	87.73
6	0	0.677	0.05	0.169	6.79	2.35	0.5554	2.91212	1.01	0.676	3.91	0.221	45.96	87.57
7	0	0.6795	0.08	0.181	6.93	2.37	0.5576	3.0143	1.02	0.679	4.01	0.2215	43.39	87.67
8	75	0.7	0.07	0.176	7.55	2.41	0.5585	3.05764	1.05	0.699	4.06	0.2558	54.59	87.65
9	25	0.7733	0.06	0.199	11.1	2.88	0.6094	4.0114	1.16	0.773	5.01	0.334	50.78	87.68
10	0	0.7518	0.05	0.204	9.7	2.87	0.598	3.72132	1.13	0.751	4.72	0.3036	52.29	87.76

CRIS 와 연동 및 활용 (진행중)

* 육종가 에게 참고 자료로 제공



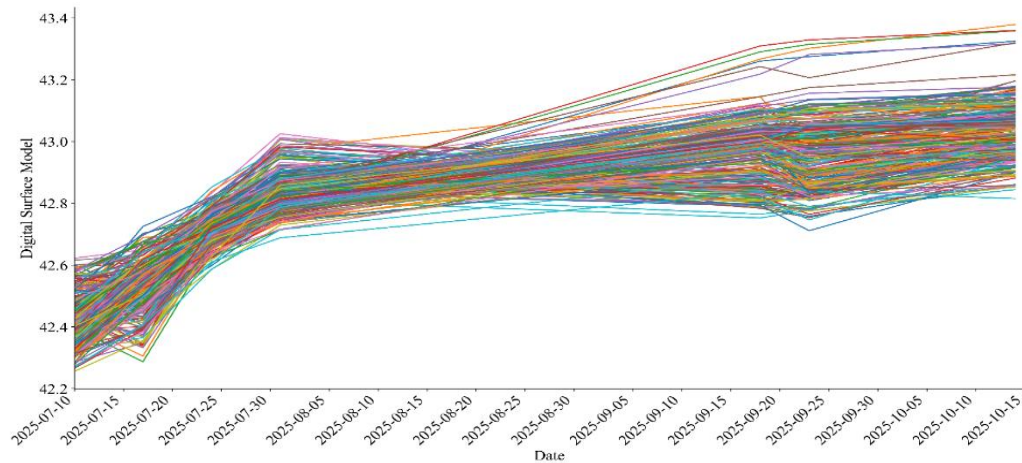
AX Transformation: Tested at testing plots at NICS

Comparison of rice growth patterns and heading dates by cultivars/dates

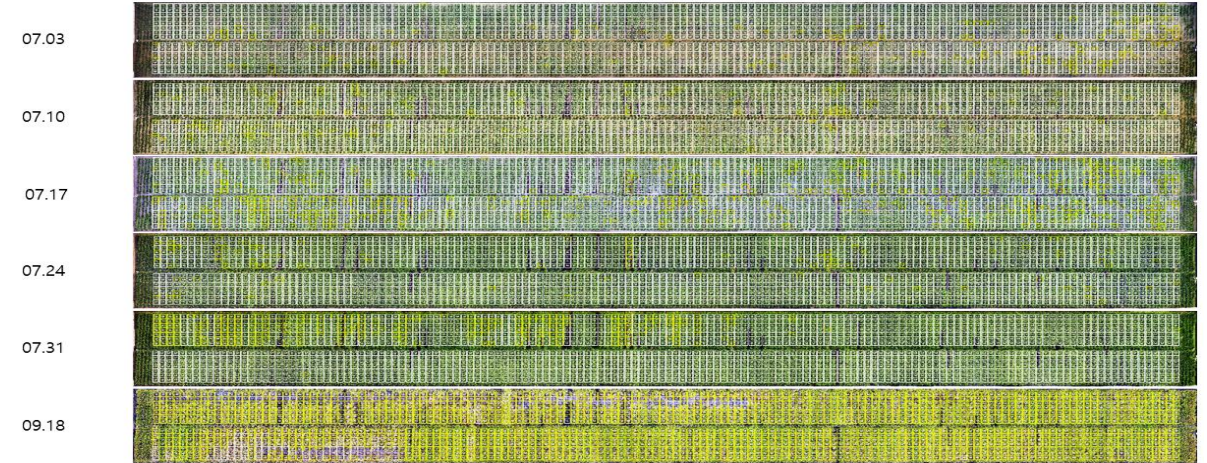
(Image) 300 rice cultivars were grown at NICS (2025.07.04)



(Canopy Heights) Comparison of growth patterns

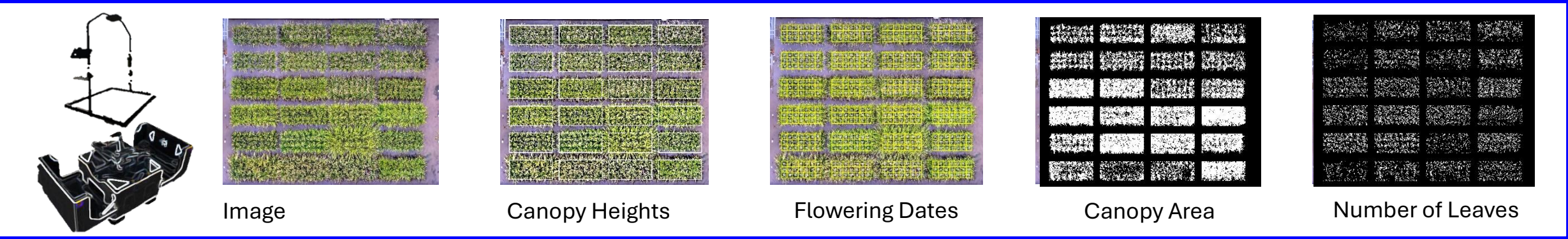
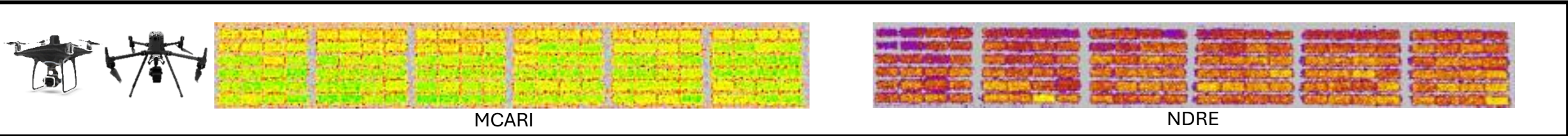


(Flowering Dates) Comparison of heading dates



AX Transformation and Beyond (Physical A.I.)

➤ Measuring traits related to crop health in un-manned and automated way and then apply for future agriculture



Case Study XXX : Future of Agriculture ??



Atlas in 2026

VS



Humanoids in 2034