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# 农业人工智能与无人农场

## Agricultural AI and Unmanned Farms

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# 提 纲 Outline

## 1.背景意义

Background and significance

## 2.农业人工智能技术

Agricultural AI technology

## 3.无人农场的探索与实践

Exploration and Practice of Unmanned Farms



華南農業大學  
South China Agricultural University



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01

背景意义

Background and significance



**人工智能**是新一轮科技革命和产业变革的重要驱动力量，加快发展新一代人工智能是事关我国能否抓住新一轮科技革命和产业变革机遇的战略问题。

——习近平总书记2018年10月31日在中共中央政治局第九次集体学习上的讲话

**AI** is an important driving force of the new round of scientific and technological revolution and industrial change, and accelerating the development of the new generation of human intelligence is a strategic issue concerning whether China can seize the opportunity of the new round of scientific and technological revolution and industrial change.

--Speech by General Secretary Xi Jinping at the Ninth Collective Study Session of the Political Bureau of the CPC Central Committee, October 31, 2018



## 1. 背景与意义

### Background and significance



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**智慧农业是现代农业的发展方向**

**Smart agricultural is the development direction of modern agriculture**

**人工智能是智慧农业的重要支撑技术**

**AI is an important technological support for smart agriculture**

**无人农场是实现智慧农业的重要途径**

**Unmanned farms are an important path to achieve smart agriculture**

## 采用农业人工智能的智能农机：

Smart agriculture is the development direction of modern agriculture

◆ 提高劳动生产率，应对劳动力短缺，促进工业化和城镇化发展

Improve labor productivity, address labor shortages, and promote industrialization and urbanization development

◆ 提高土地产出率，提高作物单产，保障粮食安全

Improve land productivity, increase unit crop yields, and ensure food security

◆ 提高农业资源利用率，保护生态环境，促进农业可持续生态发展

Improve the utilization rate of agricultural resources, protect the ecological environment, and promote sustainable ecological development of agriculture

# 1. 背景与意义

## Background and significance



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### 1.1 提高劳动生产率-水田耕整

#### Improve labor productivity - paddy field ploughing



**1个人1头牛1天最多只能犁2亩地**

**One person and one cow can only plow a maximum of 2 mu ( $\approx 1,333.33 \text{ m}^2$ ) of land per day**



**1台无人驾驶旋耕机1小时能耕20亩地**

**One unmanned rotary tiller can plough 20 mu ( $\approx 13,333.33 \text{ m}^2$ ) of land in one hour**



# 1. 背景与意义

## Background and significance



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### 1.1 提高劳动生产率-水稻种植

#### Improve labor productivity - Rice Planting



人工插秧1人1天最多只能插1亩地

Rice seedlings planting by human can only reach up to 1 mu ( $\approx 666.66\text{m}^2$ ) of land per person per day



1台无人驾驶插秧机1小时能插5亩地

One unmanned rice transplanter can plant 5 mu ( $\approx 3333.33\text{m}^2$ ) of land in 1 hour



# 1. 背景与意义

## Background and significance



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### 1.1 提高劳动生产率-水田管理

Improve labor productivity - Management of paddy fields



**人工喷雾1人1天最多只能喷3亩地**  
Manual spray can only be applied to 3 mu  
( $\approx 2000\text{m}^2$ ) of land per person per day



**无人机喷雾1小时能喷200亩地**  
UAV spray can finish 200 mu ( $\approx 133,333.33\text{m}^2$ )  
of land in one hour



# 1. 背景与意义

## Background and significance



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### 1.1提高劳动生产率-水稻收获

#### Improve labor productivity - Rice harvest



人工收获1人1天最多只能收半亩地  
One person can only harvest up to 1/2 mu  
( $\approx 333.33\text{m}^2$ ) of land per day



1台无人驾驶收获机1小时能收5-6亩地  
One unmanned harvester can harvest 5-6 mu  
( $\approx 3333.33\text{-}4000\text{ m}^2$ ) of land in one hour

# 1. 背景与意义

## Background and significance



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## 1.2 提高土地产出率

### Improve land productivity



由于采用基于北斗的精准导航技术，直线行驶横向误差小于2.5cm，能提高土地利用效率 **0.5—1.0%**  
Due to the use of precise navigation technology based on Beidou, the lateral error of straight-line driving is less than 2.5cm, which can improve land use efficiency by 0.5-1.0%



# 1. 背景与意义

## Background and significance



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### 1.3提高资源利用率

#### Improve utilization rate of agricultural resources



以农田精准平整为例：农田精准平整后能

Taking precise leveling of farmland as an example:  
precise leveling of farmland can

- 节水 20~30%,  
● Save water by 20-30%,
- 节水 20~30%,  
● Save fertilizer by 5-10%,
- 增产 5~10%,  
● Increase production by 5-10%,
- 比传统平地方法提高效率 30%  
● Improve efficiency by 30% compared to that uses traditional leveling methods.



# 02

## 农业人工智能技术 Agricultural AI technology



### 2.1 农情信息感知及精准管控

- ◆ Perception and precise control of agricultural information

### 2.2 农业大数据及云平台

- ◆ Agricultural big data and cloud platform

### 2.3 农业机械智能作业

- ◆ Intelligent operation of agricultural machinery



## 2.1 农情信息感知与精准管控

### Perception and precise control of agricultural information



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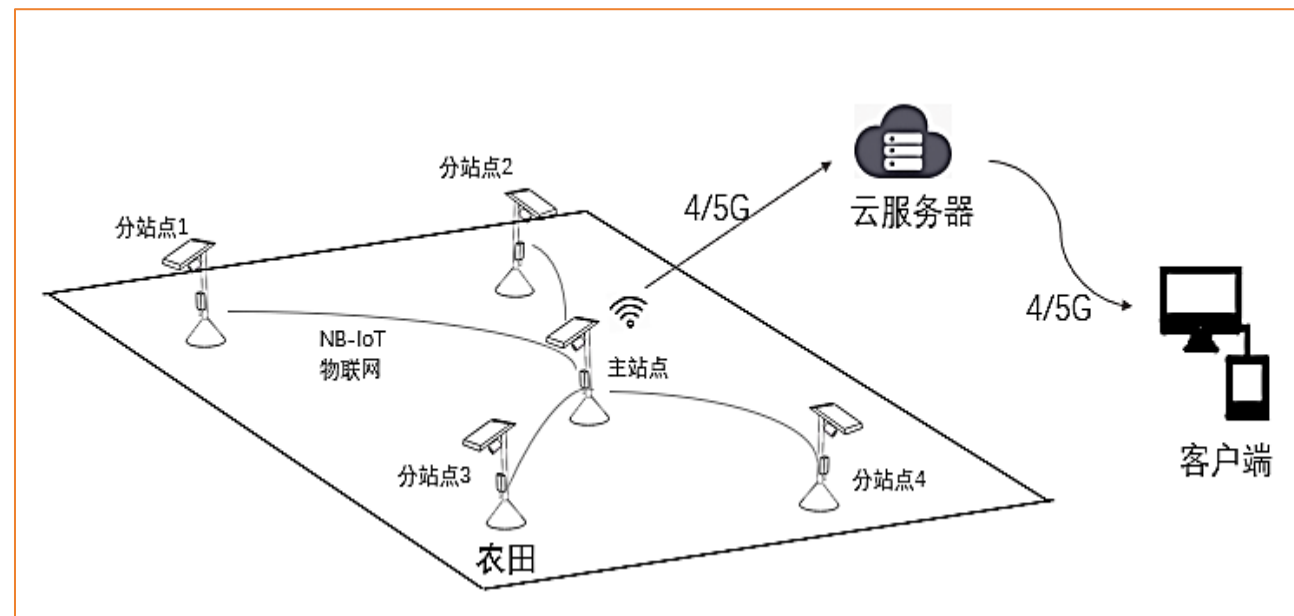
### (1) 作物的病虫害信息快速获取与识别

Rapid acquisition and identification of crop pest and disease information

- ❖ 地面多光谱监测传感器
- ❖ Ground multispectral monitoring sensor



同时获取作物长势、病虫害等多种农情信息  
Simultaneously obtaining various agricultural  
information such as crop growth, pests and  
diseases



冠层多光谱信息长时序原位监测传感器网络  
Long term in-situ monitoring sensor network for canopy  
multispectral information

# (1) 作物的病虫害信息快速获取与识别

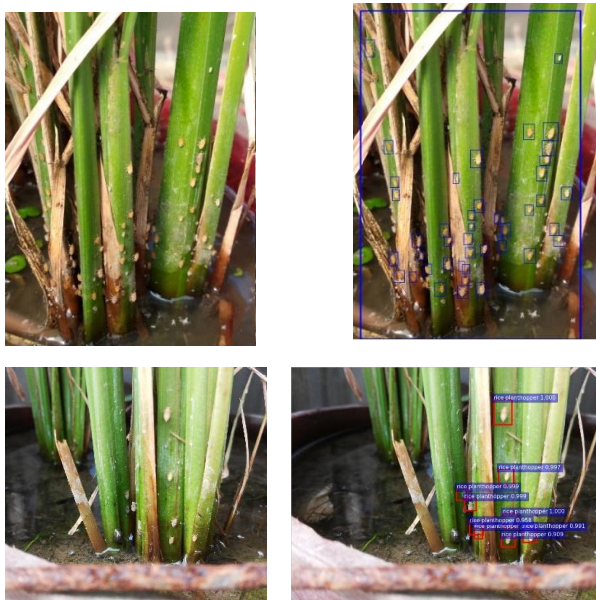
## Rapid acquisition and identification of crop pest and disease information



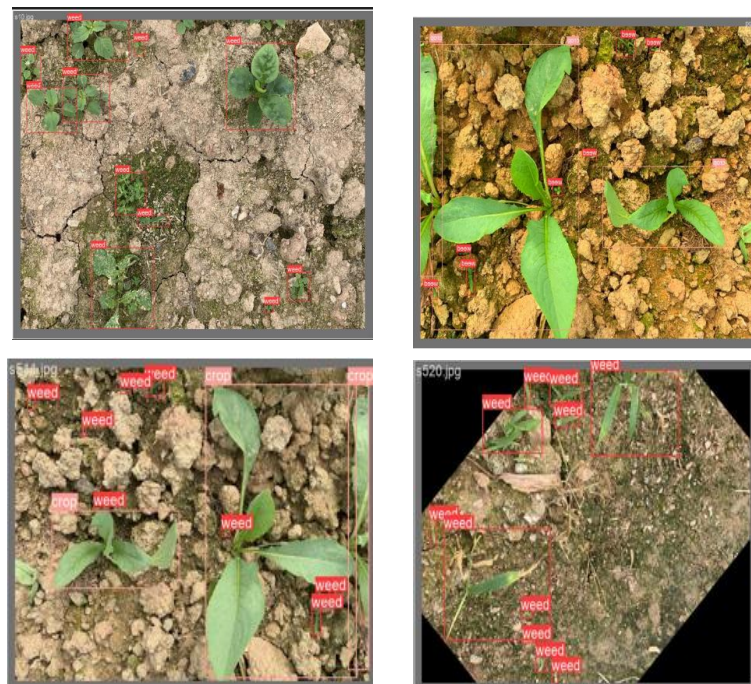
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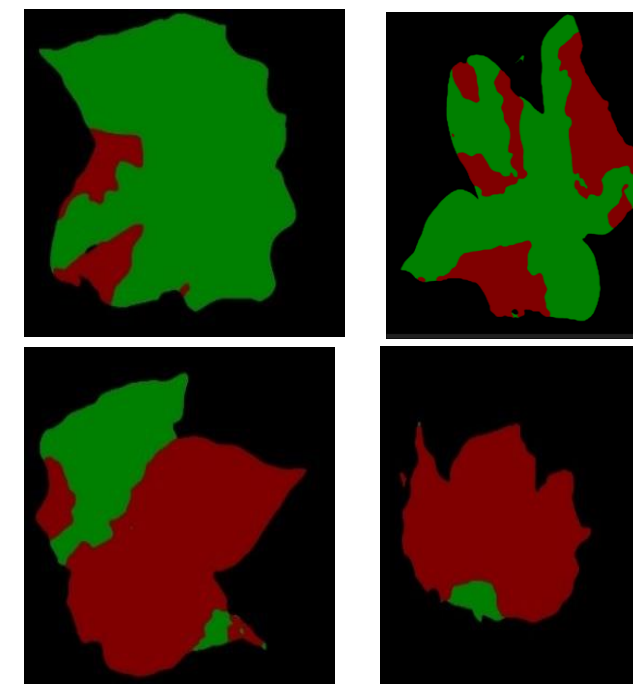
- ❖ 基于深度学习的作业病虫害识别算法
- ❖ Deep learning-based algorithm for identifying crop pests and diseases



褐飞虱危害情况田间检测和计数算法  
Field detection and counting  
algorithm for brown planthopper  
hazards



蔬菜田间杂草分类识别  
Classification and identification  
of weeds in vegetable fields



棉花黄萎病等级分类识别  
Classification and  
recognition of cotton wilt  
disease grades



# (1) 作物的病虫害信息快速获取与识别

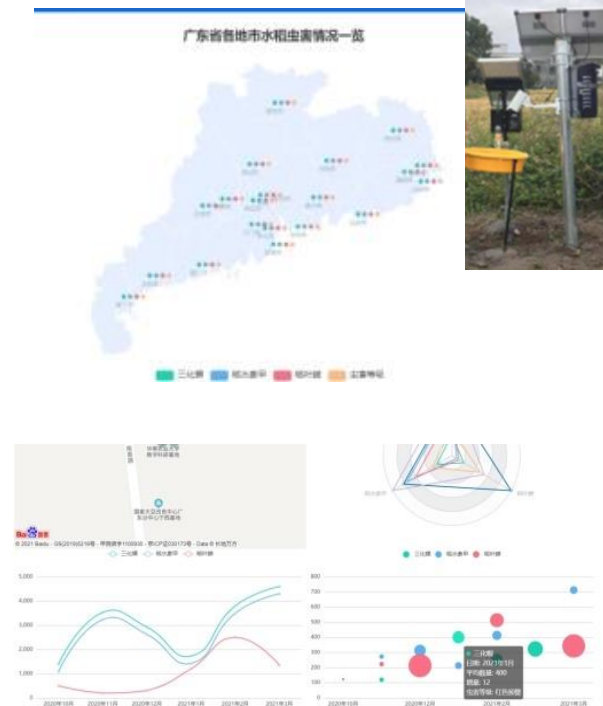
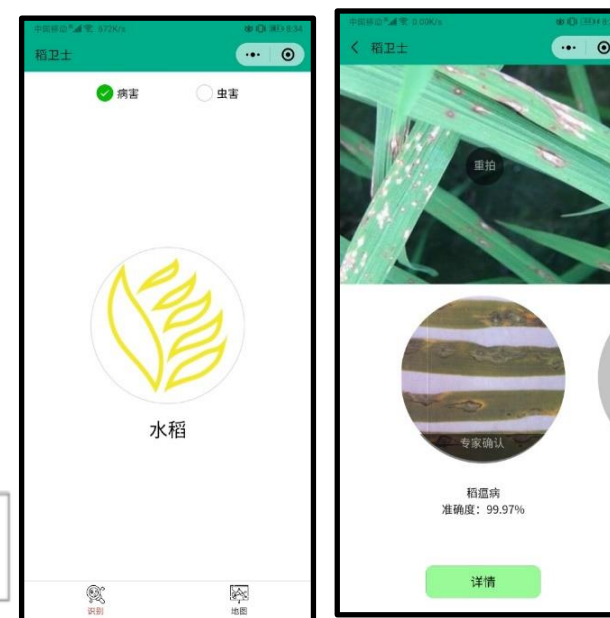
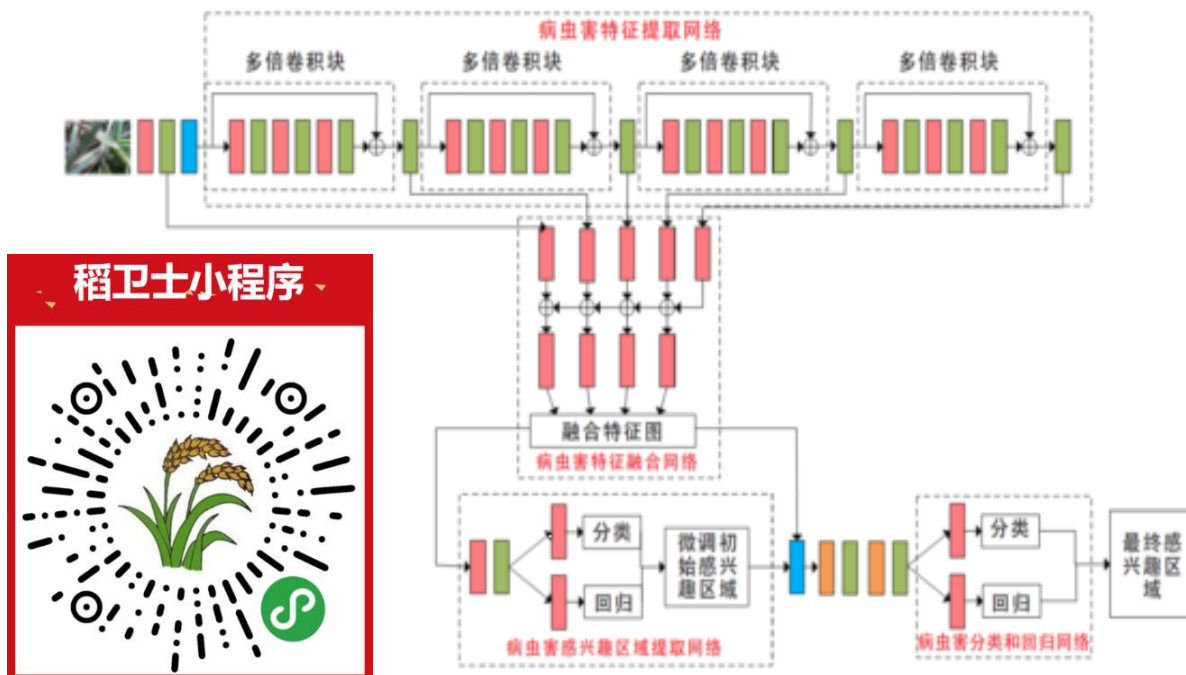
## Rapid acquisition and identification of crop pest and disease information



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- ❖ 基于深度学习的作业病虫害识别算法
- ❖ Deep learning-based algorithm for identifying crop pests and diseases



以水稻为例：识别的水稻病害23种、虫害19种，识别的准确率分别为：病害93.41%、虫害90.25%

Taking rice as an example: 23 types of rice diseases and 19 types of pests were identified, with accuracy rates of 93.41% for diseases and 90.25% for pests, respectively

## 2.1 农情信息感知与精准管控

### Perception and precise control of agricultural information



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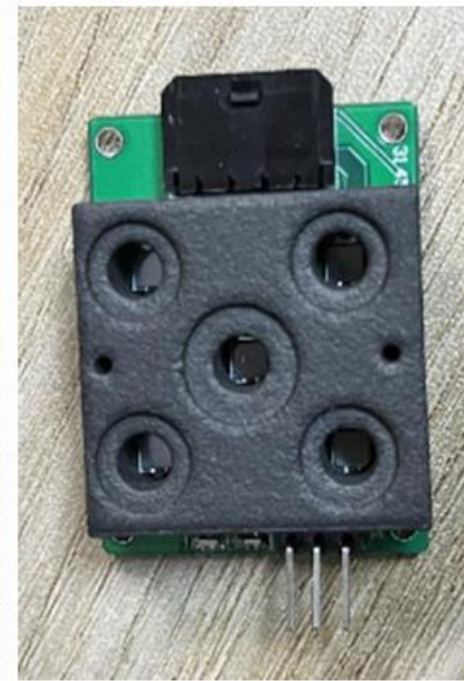
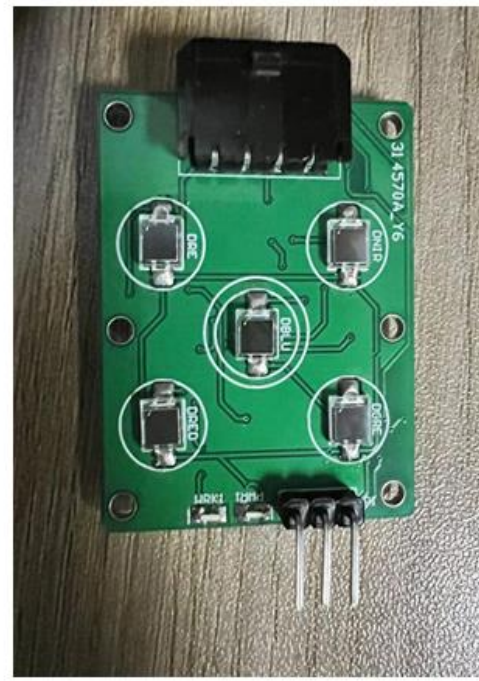
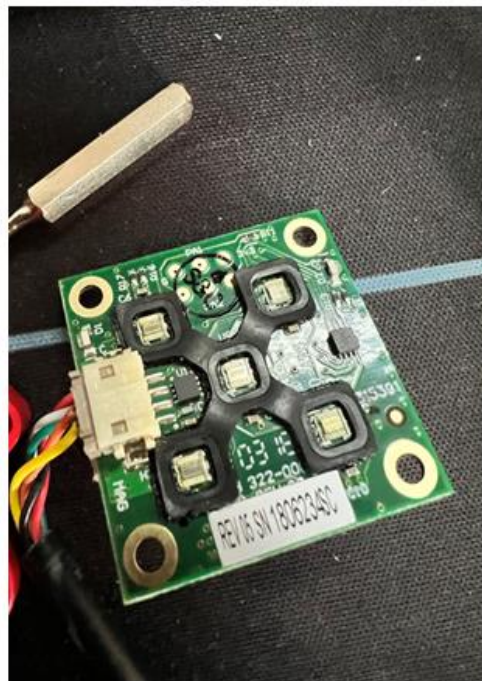
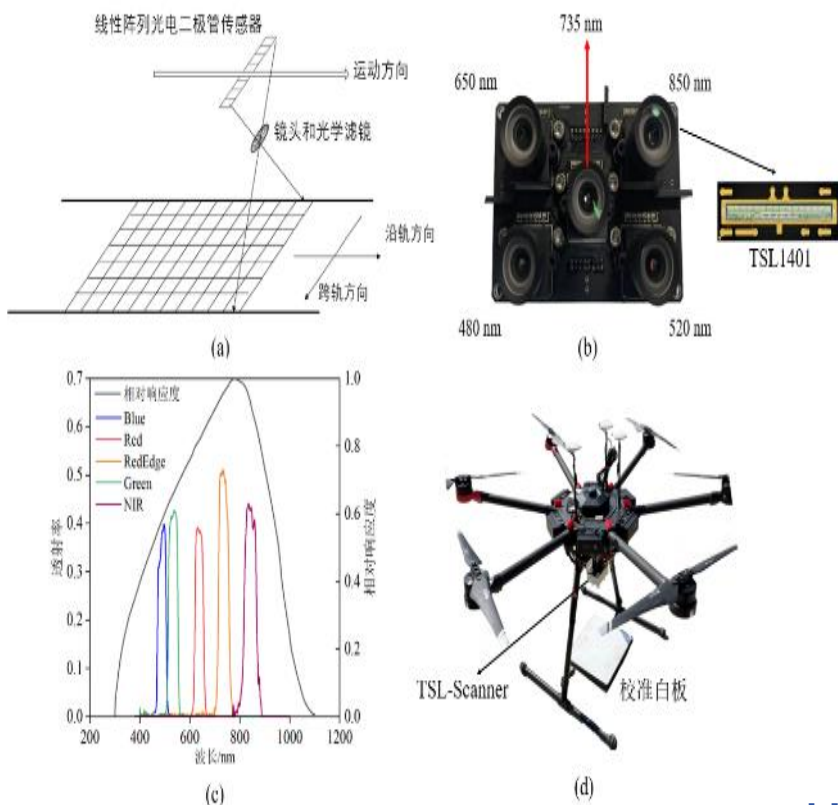


### (2) 作物长势信息感知与变量施肥决策

Sensing growth information of crops and making decision in variable fertilization

#### ❖ 低空遥感多光谱监测传感器

#### ❖ Low-altitude remote sensing multispectral monitoring sensor



精准高效的作物长势信息低空遥感监测

Accurate and efficient low altitude remote sensing monitoring of crop growth information



## (2) 作物长势信息感知与变量施肥决策

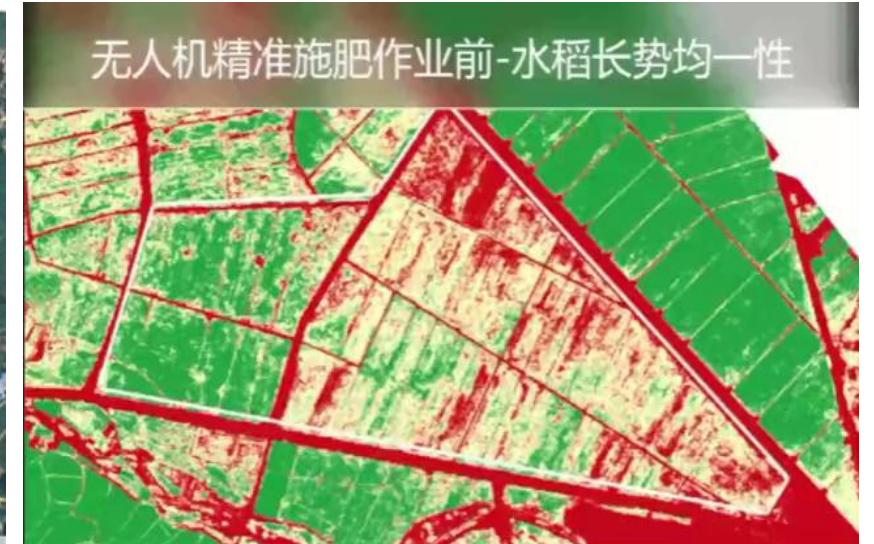
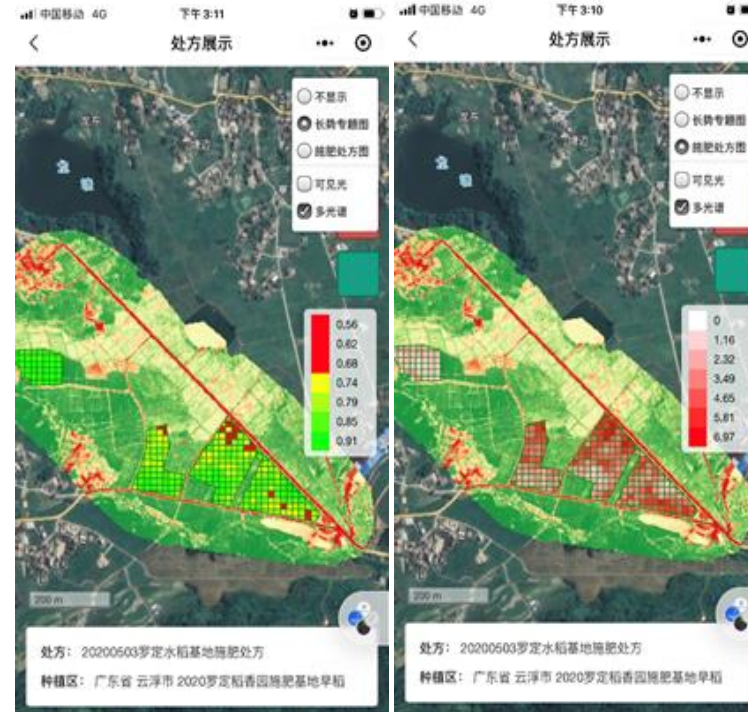
Sensing growth information of crops and making decision in variable fertilization



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- ❖ 微小型无人机水稻氮素遥感信息获取与施肥管理技术
- ❖ Remote sensing information acquisition of nitrogen in rice and fertilization management technology by using micro UAVs



2019年罗定示范结果: 150亩连片示范, 平均减少氮肥28%

Field test resulted reduction of 28% in nitrogen fertilizer and 22.5% in nitrogen fertilizer



## 2.2 农业大数据及云平台

### Agricultural big data and cloud platform



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农业大数据标准、大数据挖掘算法模型、软件云平台、安全生产监管四大关键技术

Four key technologies: agricultural big data standards, big data mining algorithm models, software cloud platforms, and safety production supervision

#### 农业大数据标准研究

包括水稻、牛、生猪、鸡、鸭和鹅养殖等不同场景下的信息化数据采集标准、智能种养标准

#### 大数据挖掘算法模型

动植物相应种养环境下的大数据挖掘算法、生产过程远程监管及智能决策管控模型



#### 农业大数据云平台研发

涵盖水稻种植，生猪、家禽养殖等多维度信息的物联网采集平台、算法平台和大数据平台

#### 农产品安全生产监管体系

为水稻、生猪、鸡、鸭和鹅的安全生产提供品质管控标准，建立品质控制点，提供标准化生产管理监管平台

# 2.2 农业大数据及云平台

## Agricultural big data and cloud platform

构建了农业大数据三大支撑平台

Constructed three major supporting platforms for agricultural big data





# 2.2 农业大数据及云平台

## Agricultural big data and cloud platform

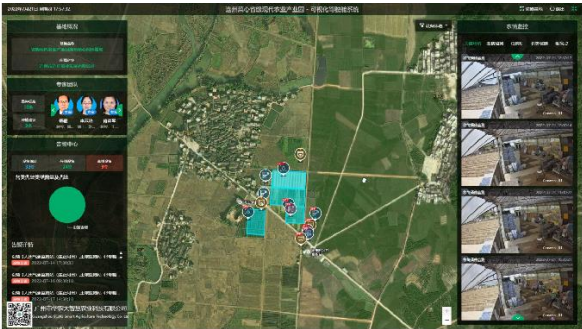


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### 智慧种植应用平台

### Smart Planting Application Platform



### 智慧养殖应用平台

### Smart Breeding Application Platform





## 2.2 农业大数据及云平台 Agricultural big data and cloud platform



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### 增城丝苗米产业园智慧农业大数据平台 Zengcheng Simiao Rice Industry Park Smart Agricultural Big Data Platform



园区、企业、第三方检测机构、监督机构、  
平台运营企业，共同管理和发放溯源码



单品示意图



建立了农产品安全生产监管体系

Established a safety production regulatory system for agricultural product



## 2.3 农业机械智能作业 Smart operation of agricultural machinery



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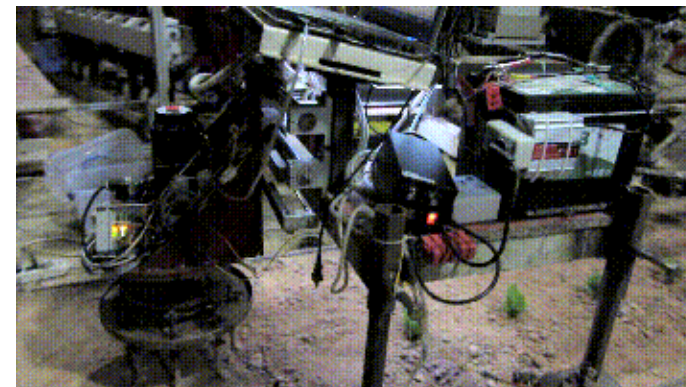
### 农业机器人 Agricultural robots



采摘机器人  
Harvesting robot



移栽机器人  
Grafting robot



除草机器人  
Weeding robot





# 03

## 无人农场探索与实践 Exploration and Practice of Unmanned Farms





### 3. 无人农场的探索与实践

#### Exploration and Practice of Unmanned Farms



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- ◆ 无人农场的概念
- ◆ The concept of unmanned farms
- ◆ 无人农场的关键技术
- ◆ Key technologies for unmanned farms
- ◆ 华南农业大学水稻无人农场
- ◆ Unmanned Rice Farm in SCAU

### 3.1 无人农场的概念

#### The concept of unmanned farms



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**无人农场是智慧农业的一种生产方式，是实现智慧农业的一种途径。无人农场有五个功能：** Unmanned farms are one of the production method of smart agriculture and an important way to realize the concept of smart agriculture. Unmanned farm featuring the following 5 functions:

- (1)耕种管收生产环节全覆盖； All the production links, including tillage, planting, management and harvesting are unmanned;
- (2)机库田间转移作业全自动； The unmanned machines can automatically transfer between garage and field;
- (3)自动避障异况停车保安全； The machines can automatically avoid obstacles and have emergency stop triggers;
- (4)作物生产过程实时全监控； The whole production process is monitored in real time;
- (5)智能决策精准作业全无人。 Decision-making and precision operations are all intelligence-based and unmanned.





**数字化感知**

**Digital Perception**

**智能化决策**

**Intelligent Decision-making**

**精准化作业**

**Precision Operation**

**智慧化管理**

**Intelligent Management**

## 3.2 无人农场的关键技术

### Key technologies for unmanned farms



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#### (1) 数字化感知—以植物生产为例

Digital Perception - Taking Plant Production as an Example

##### ❖ 数字化感知的内容 Content of Digital Perception

##### ① 土壤信息 Soil information

土壤耕作阻力 Soil tillage resistance

土壤养分 Soil nutrient

土壤水分 Soil moisture

##### ② 作物长势信息 Crop growth information

##### ③ 作物病虫草害信息 Information on diseases, pests, and weeds of crop



## 3.2 无人农场的关键技术

### Key technologies for unmanned farms



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#### (1) 数字化感知—以植物生产为例

#### Digital Perception - Taking Plant Production as an Example

##### ❖ 数字化感知的内容 Content of Digital Perception

**“星”**：根据卫星影像分析农作物长势和病虫草害情况

"Satellite": Analyzes crop growth and assesses pest and weed infestations using satellite imagery.

**“机”**：根据飞机或无人机获取的影像分析农作物长势和病虫草害情况

"Aerial": Evaluates crop growth, along with pest, disease, and weed conditions based on imagery captured by aircraft or drones.

**“地”**：在地面用仪器直接获取农作物长势和病虫草害情况

"Ground-based": Directly collects data on crop growth and monitors pest, disease, and weed status using ground-based instruments.



## 3.2 无人农场的关键技术 Key technologies for unmanned farms



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### (1) 数字化感知—以植物生产为例

#### Digital Perception - Taking Plant Production as an Example

##### ❖ 数字化感知的内容 Content of Digital Perception

###### 卫星遥感: 全球尺度

Satellite Remote Sensing: Global Scale

###### 航空遥感: 区域尺度

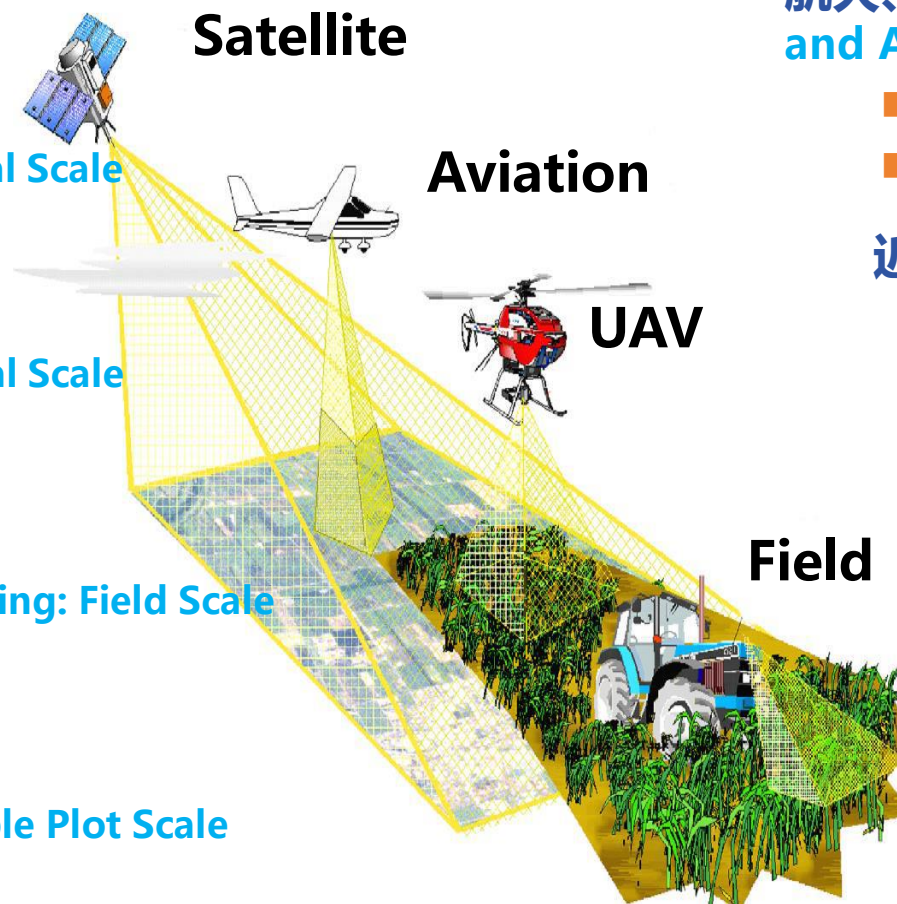
Aerial Remote Sensing: Regional Scale

###### 升降平台: 田块尺度

Elevated Platform Remote Sensing: Field Scale

###### 实验室光谱: 样地尺度

Laboratory Spectroscopy: Sample Plot Scale



#### 航天、航空遥感: Aerospace and Aerial Remote Sensing:

- 时效性问题 Timeliness Challenges
- 气象窗口问题 Weather Dependency Issues

#### 近地遥感: Near-Earth Remote Sensing:

- 运行成本低 Low Operating Costs
- 灵活性高 High Flexibility
- 时效性高 Enhanced Timeliness
- 数据精度高 High Data Accuracy

#### 微小型无人机遥感: Remote Sensing Using Micro-UAVs (MUAVs):

- 操控性好, 高机动性
- 单次遥感图像覆盖面积优于地面机械
- Excellent Maneuverability and High Mobility
- Coverage Area of a Single Remote Sensing Image Exceeds That of Ground Machinery

## 3.2 无人农场的关键技术

### Key technologies for unmanned farms



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#### (2) 数字化感知技术 Intelligent Decision-making

- ◆ **智能决策土地整治方案**，包括地块大小、机耕道和灌排渠道等。

Intelligent decision-making for land improvement programs, including considerations for plot size, access paths for machinery, and irrigation and drainage channels.

- ◆ **智能决策耕整方案**，包括犁耕，耙耕，旋耕及激光平整等

Intelligent decision-making for cultivation strategies, including practices such as plowing, harrowing, rotary tilling, and laser leveling.

- ◆ **智能决策种植方案**，包括一熟制或多熟制、种植品种等

Intelligent decision-making for planting programs, including determining single or multiple cropping systems and selecting appropriate plant varieties.

- ◆ **智能决策播种方案**，包括播种时间、行距、穴(株)距和播种量。

Intelligent decision-making for seeding plans, including optimization of seeding times, row spacing, plant spacing, and seeding quantities.

- ◆ **智能决策田间管理方案**，包括灌排，施肥，打药等。

Intelligent decision-making for field management strategies, including the management of irrigation and drainage, fertilization, and pesticide application.

- ◆ **智能决策收获方案**，包括收获时间和收获方式。

Intelligent decision-making for harvesting strategies, including decisions related to the timing and methods of harvesting.



## 3.2 无人农场的关键技术 Key technologies for unmanned farms



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### (3) 精准化作业 Precise Operation

#### ❖ 自动导航 Automatic Navigation

3机  
同田  
直播



Simultaneous Operation of Three  
Machines in the Same Field

无人  
驾驶  
高地  
隙喷  
雾机



Autonomous Upland Sprayer



Autonomous Rotary Tiller

无人  
驾驶  
旋耕  
机



Master-Slave Navigation System for Rotary Tilling

主从  
导航  
旋耕



#### ❖ 精准作业 Precise Operation

- ① 耕整 Tilling
- ② 种植 Planting
- ③ 田间管理 Field Management
- ④ 收获 Harvesting
- ⑤ 干燥 Drying



❖ 精准作业 Precise Operation

① 耕整-激光/卫星平地 Tilling- Leveling farmland by using laser/satellite technologies

水田激光平地机



Paddy field laser grader



Dryland laser grader

旱地激光平地机

水田平地机  
卫星信号



Satellite signal water field grader



Unmanned satellite signal paddy field grader

水田平地机  
无人驾驶卫星信号



### (3) 精准化作业 Precise Operation

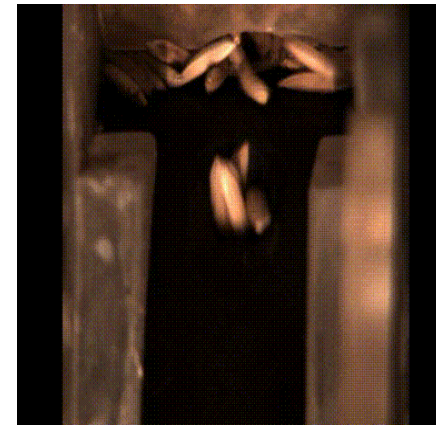
#### ❖ 精准作业 Precise Operation



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#### ② 种植-水稻精量播种 Planting - Precision sowing of seeds





## ② 种植-杂交稻制种同步插秧穴直播机 Planting Hybrid Rice Seedling Transplanter with Synchronized Hole Seeding





### ③ 田间管理-喷雾 Field Management - Spraying





③ 田间管理-无人直升机用于杂交稻制种辅助授粉 Field Management - Unmanned helicopter assists pollination in hybrid rice seed





### (3) 精准化作业 Precise Operation

#### ❖ 精准作业 Precise Operation



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### ③ 田间管理-施肥 Field Management - Fertilization





#### ④ 收获-主从导航水稻收获系统 Harvesting- Master-slave Navigation System for Rice Harvesting



跟车卸粮模式 Unloading while Following the Vehicle



#### ④ 收获-主从导航收获系统 Harvesting- Master-slave Navigation System Corn Harvesting



跟车卸粮模式 Unloading while Following the Vehicle

⑤ 干燥Drying



- 稻谷含水率由**28.4%**降到**13.6%**时的小时处理量**14.134吨/小时**
- The moisture content of rice decreases from 28.4% to 13.6%, the hourly processing capacity is 14.134 tons/hour
- 处理总成本**15.16元/吨** (煤价: 600元/吨, 电价: 0.8元/度)
- The total processing cost is 15.16 RMB/ton (coal price: 600 RMB/ton, electricity price: 0.8 RMB/kWh)



## 3.2 无人农场的关键技术

### Key technologies for unmanned farms



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#### (4) 智慧化管理 Intelligent Management

##### ①农作物生长管理 Crop growth management

##### ②农机管理 Agricultural machinery management

远程监控农机作业位置、进度、质量 Remote monitoring of agricultural machinery operations, including location, progress, and quality assessments

故障预警和指导维修 Early warning systems for equipment malfunctions, coupled with guidance for maintenance and repairs

农机远程调度 Remote scheduling of agricultural machinery

##### ③农场管理 Farm management

农事管理：产前、产中和产后全程管理 Comprehensive agricultural management: Overseeing all stages of production, from pre-production planning and mid-production activities to post-production processes

农资管理 Management of agricultural inputs

经营管理 Operational management

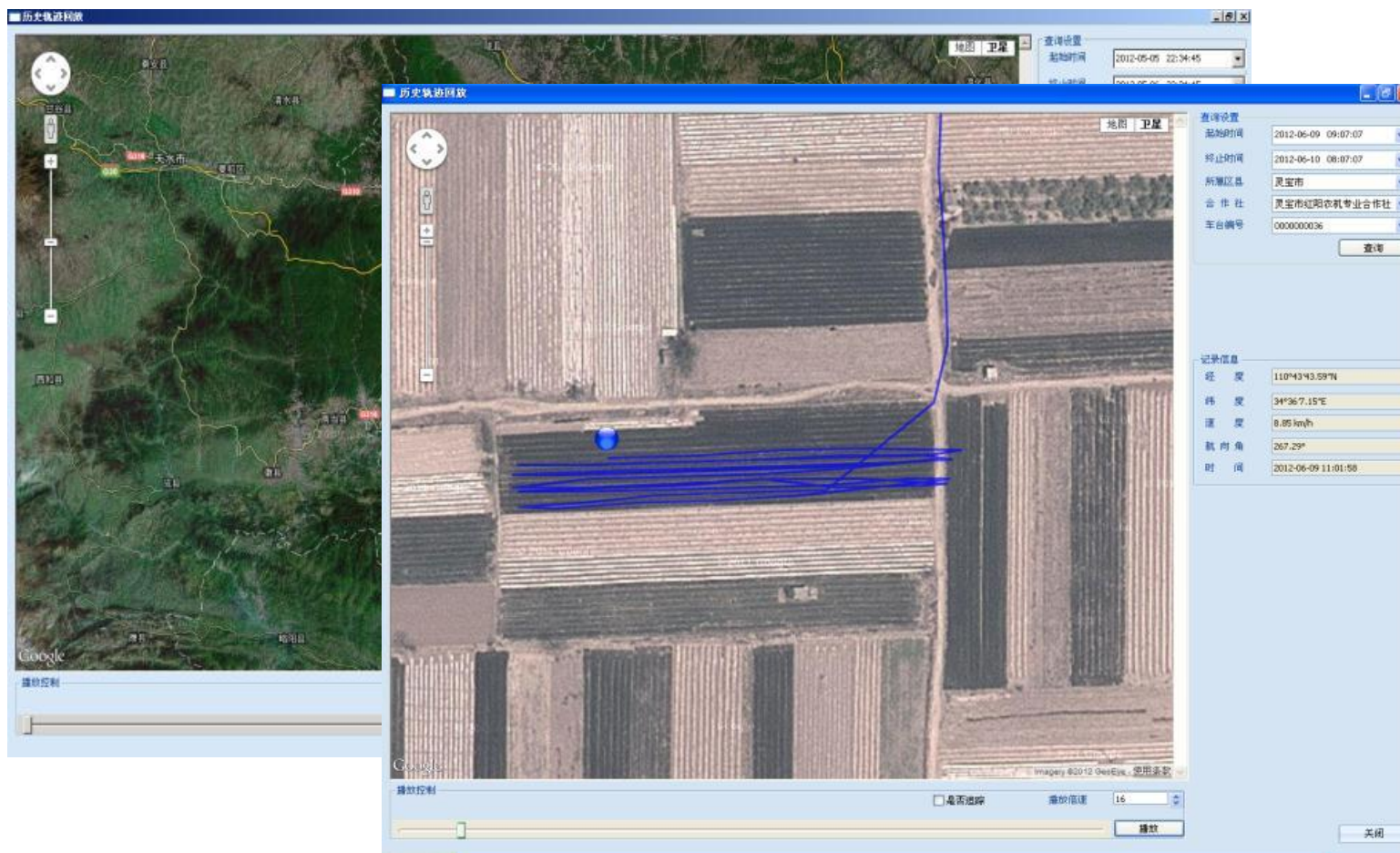
## (4) 智慧化管理 Intelligent Management



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- ❖ 远程监控农机作业状况并进行故障预警和指导维修
- ❖ Remote monitoring of agricultural machinery operation status, and conducting fault warning and maintenance guidance



■ 支持**农机作业历史数据记录与轨迹回放**功能：能够检索指定农机在指定时间段的历史行走轨迹，包括**经纬度、速度、航向角、日期信息**，并**回放历史作业轨迹**功能



- ❖ 远程监控农机作业状况并进行故障预警和指导维修
- ❖ Remote monitoring of agricultural machinery operation status, and conducting fault warning and maintenance guidance
- 收获机：脱粒滚筒转速、清选风扇转速、净粮升运转速、谷物流量、GPS位置、作业速度、割台高度、实际割幅、发动机参数 ..... **Harvesters**
- 拖拉机：发动机参数、PTO、行驶速度、GPS位置、动力换挡参数 ..... **Tractors**
- 播种机：播种堵塞状态、播种量、播种深度 ..... **Seeders**
- 施肥机：施肥量、排肥转速、堵塞状态..... **Fertilizer spreader**
- 喷雾机：药液流量、压力、喷头区段状态..... **Sprayers**

### 3.3 华南农业大学水稻无人农场 Unmanned Farm in SCAU



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#### 旋耕 Rotary tillage





### 3.3 华南农业大学水稻无人农场 Unmanned Farm in SCAU



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## 播种 Sowing



## 施肥 Pesticide distribution



## 喷雾 Fertilizer application





### 3.3 华南农业大学水稻无人农场 Unmanned Farm in SCAU



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## 喷雾 Pesticide distribution



收获—等待卸粮模式  
Harvesting — waiting to unload mode





## 2台收割机1台运粮车协同收获

Two harvesters and one grain transporter operating together



### 3.3 华南农业大学水稻无人农场 Unmanned Farm in SCAU



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**2021年早稻，优质丝苗米19香，662.29公斤/亩**

In 2021, the unmanned farm yield for early season Fragrant Rice 19Xiang in Zengcheng District of Guangdong Province was 662.29 kg/mu.





### 3.3 华南农业大学水稻无人农场 Unmanned Farm in SCAU



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**2023年益阳千山红镇再生稻无人农场，两季最高亩产达1290.1公斤**

In 2023, the highest yield (two season) of ratoon rice unmanned farm in Qianshanhong Town, Yiyang City was 1290.1 kg/mu.







## 未来农场 The Future Farming



—Simon Blackmore





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谢谢  
THANK YOU