# Smart Agriculture:
# ICT Technology Improves Agricultural Productivity


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**China Agricultural University**


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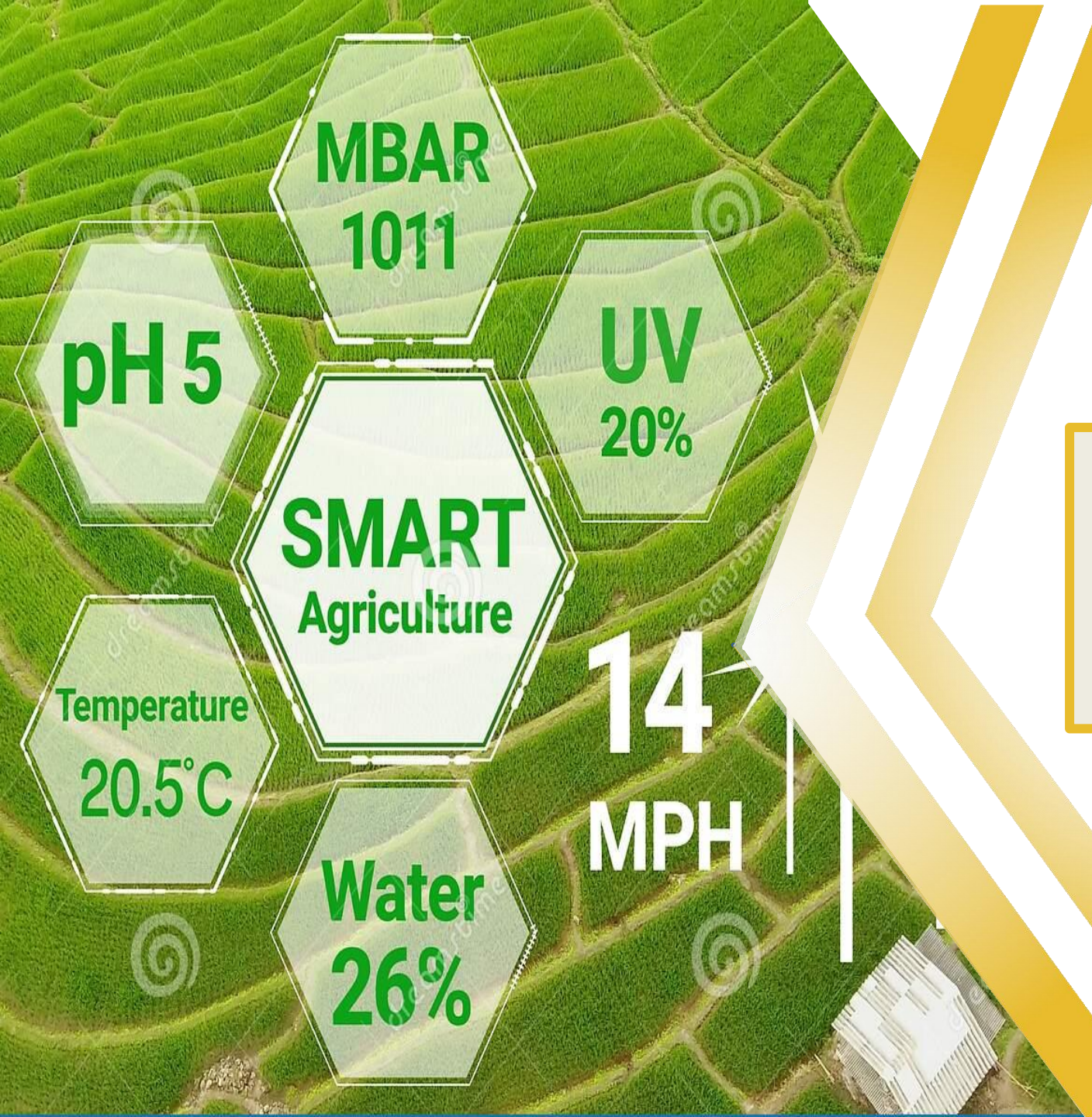
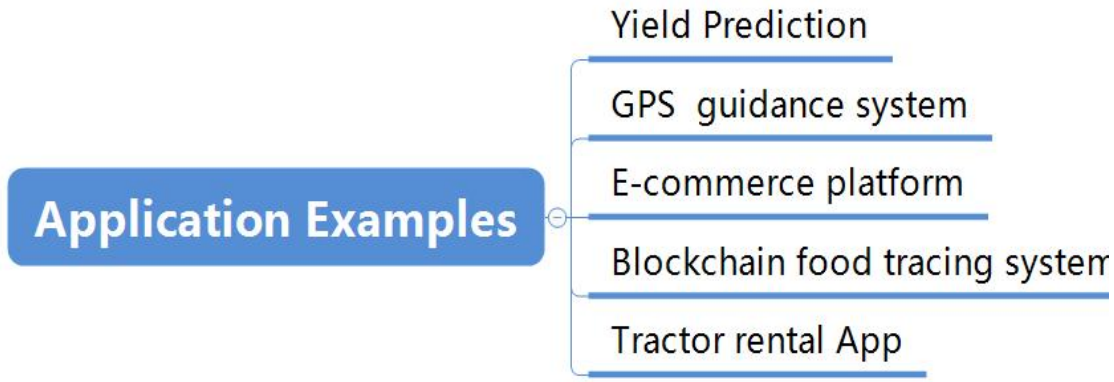


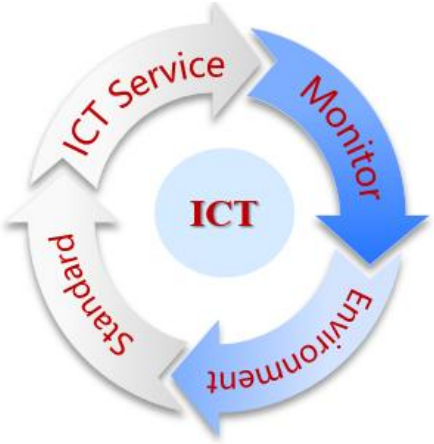

# PART 1

What is smart agriculture

# 1.1 The Definition of Smart Agriculture

**Smart agriculture** refers to the **usage of technologies** like Internet of Things, sensors, location systems, robots and artificial intelligence **on the farm**. The ultimate goal is increasing the **quality and quantity** of the crops while **optimizing the human labor** used.




- **Leading Technology**: ICT (Information and Communications Technology)
- **Core Element**: Environmental monitoring
- **Field of Application**: Production process monitoring
- **Key process**: Standardization and assurance

# 1.2 The History of Development

# 1.3 Challenges of traditional Agriculture

- Decreasing arable land
- Lack of technological advancements
- Aging farming population and labor shortages









# 1.4 Smart Ag Helps Smart Village Construction

1. Quality traceability & electronic sales system

2. Promote the upgrading of rural **tertiary industry**

3. Improve **living standard** of rural residents

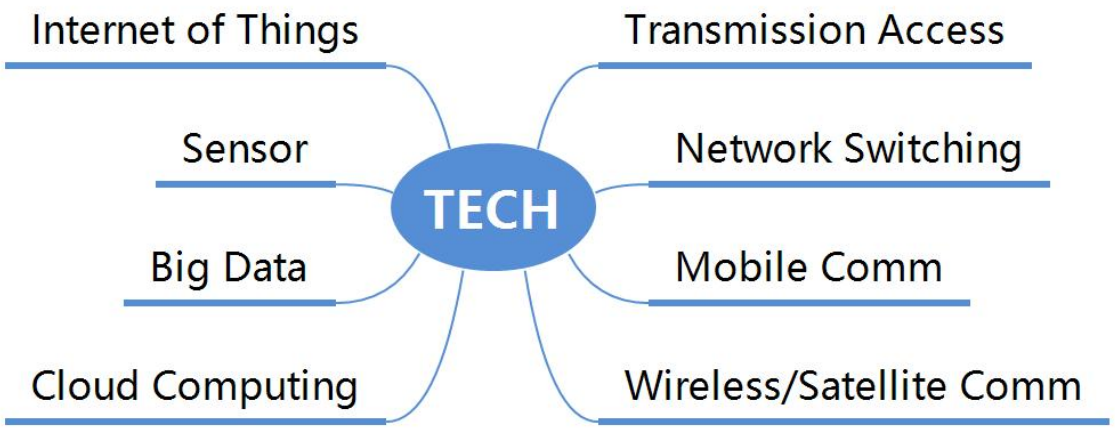
4. Facilitate the **sale** through livestream and ICT


IoT&Database: the **yield** increases by 20%, with 1500 yuan more **income** per acre. The **sales** of jujube in one hour surpasses 20,000 kilograms.

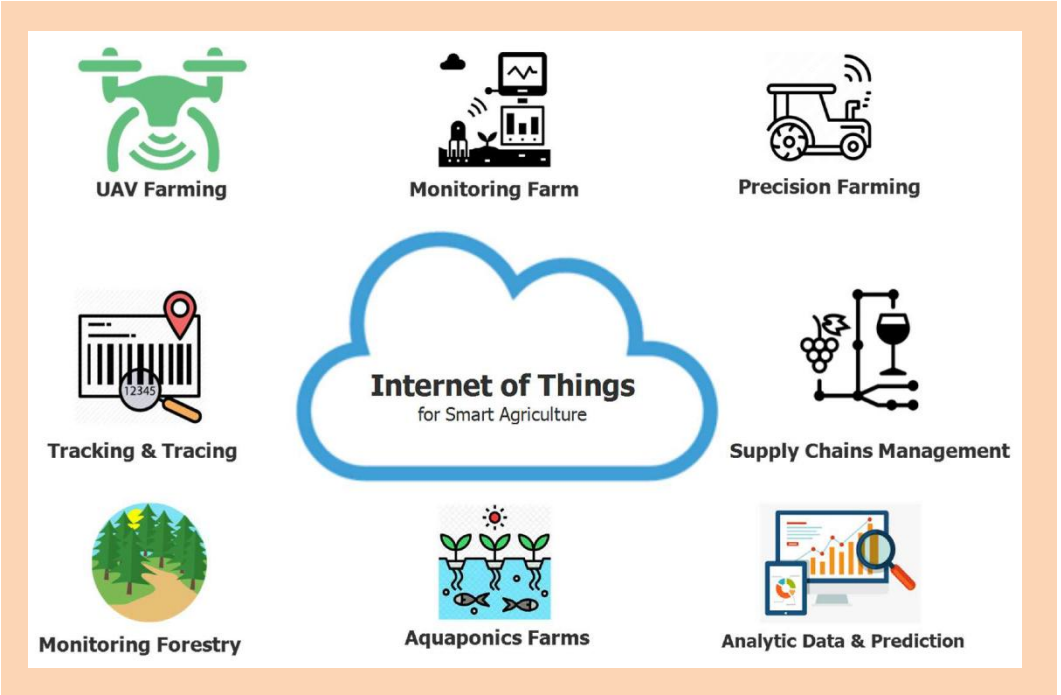
# 1.5 Characteristics of Modern Smart Agriculture

- Equipping the production process
  - Equipment instead of manpower
- Intensification and scale of operation
  - Optimal utilization of resources
- Digitization and automation of operations
  - Digitization & automation
- Logistics informatization
  - Real-time management

# 1.6 ICT technologies for Ag Production

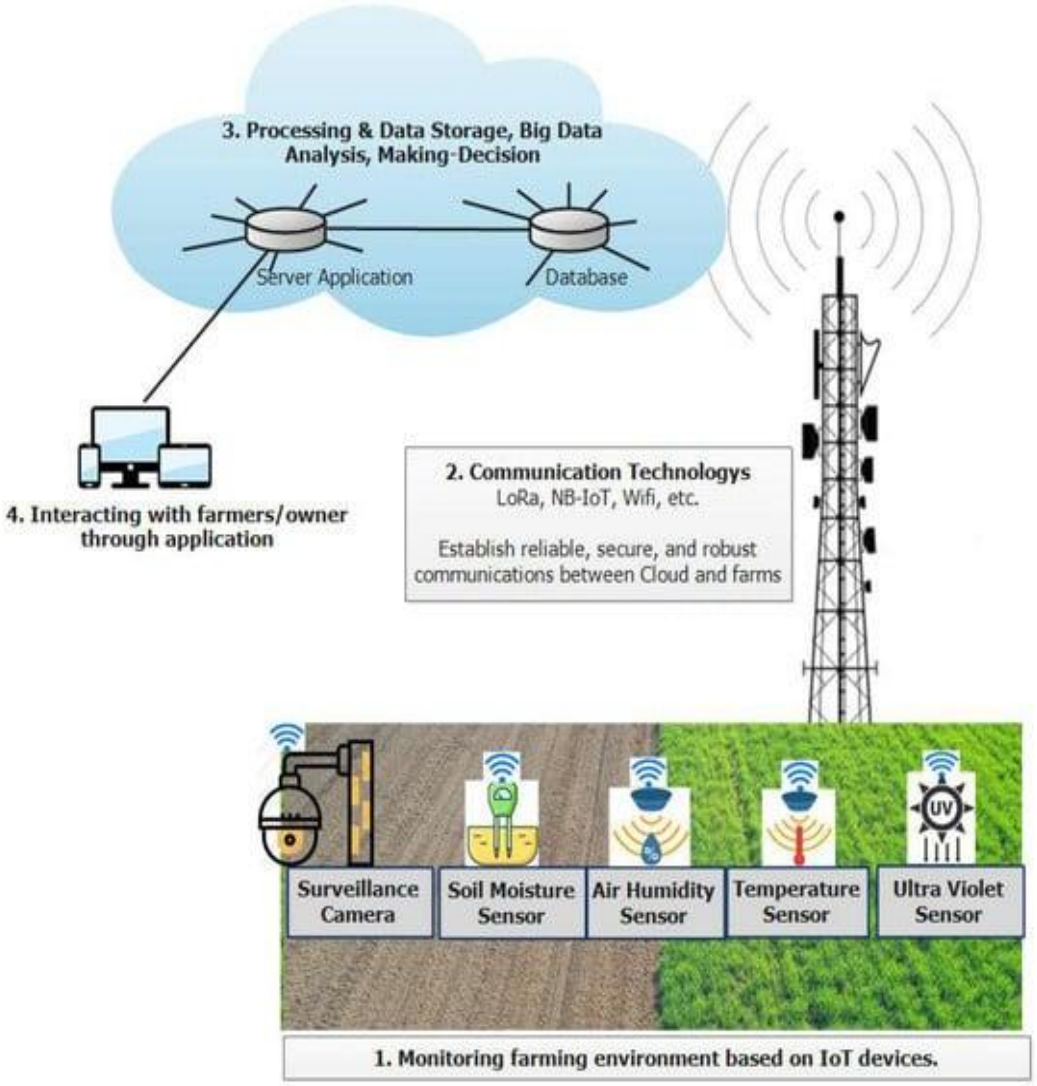


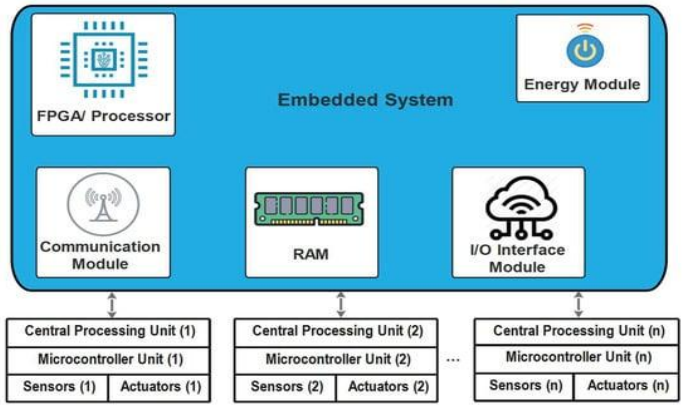

**The integration of technology**

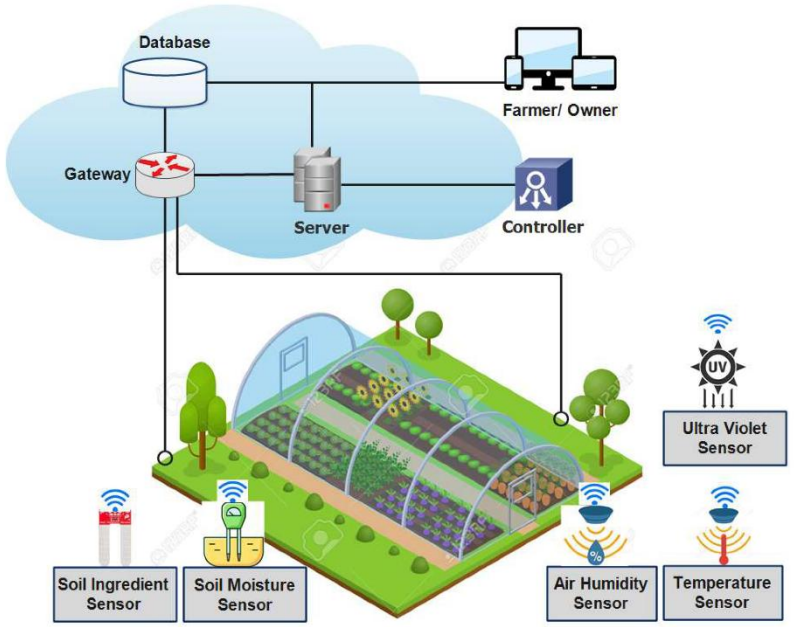



Right Picture: Quy, Vu Khanh, et al. "IoT-enabled smart agriculture: architecture, applications, and challenges." *Applied Sciences* 12.7 (2022): 3396.

# 1.6 ICT technologies for Ag production



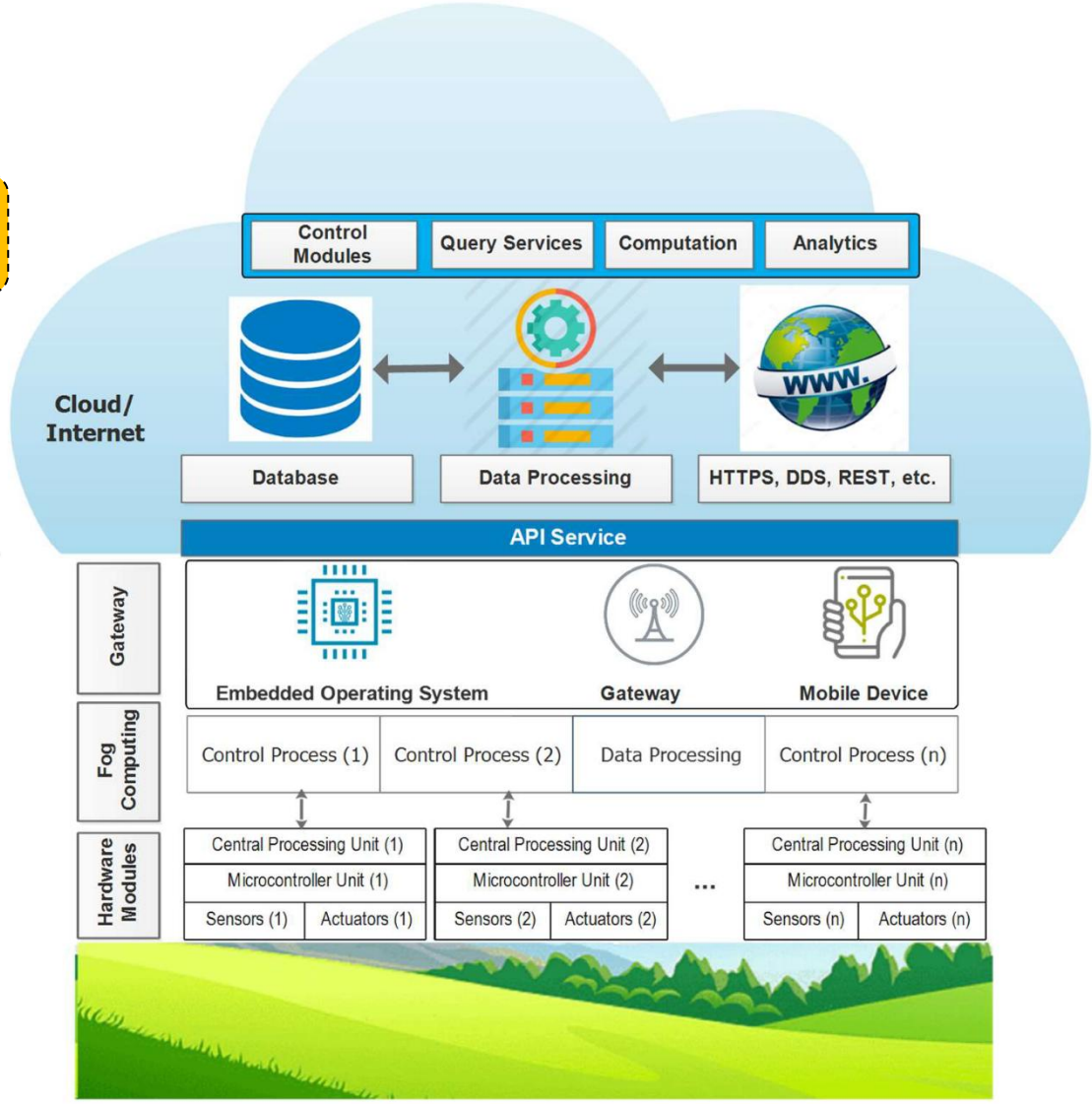



Pictures: Quy, Vu Khanh, et al. "IoT-enabled smart agriculture: architecture, applications, and challenges." *Applied Sciences* 12.7 (2022): 3396.

# 1.6.1 Agricultural IoT

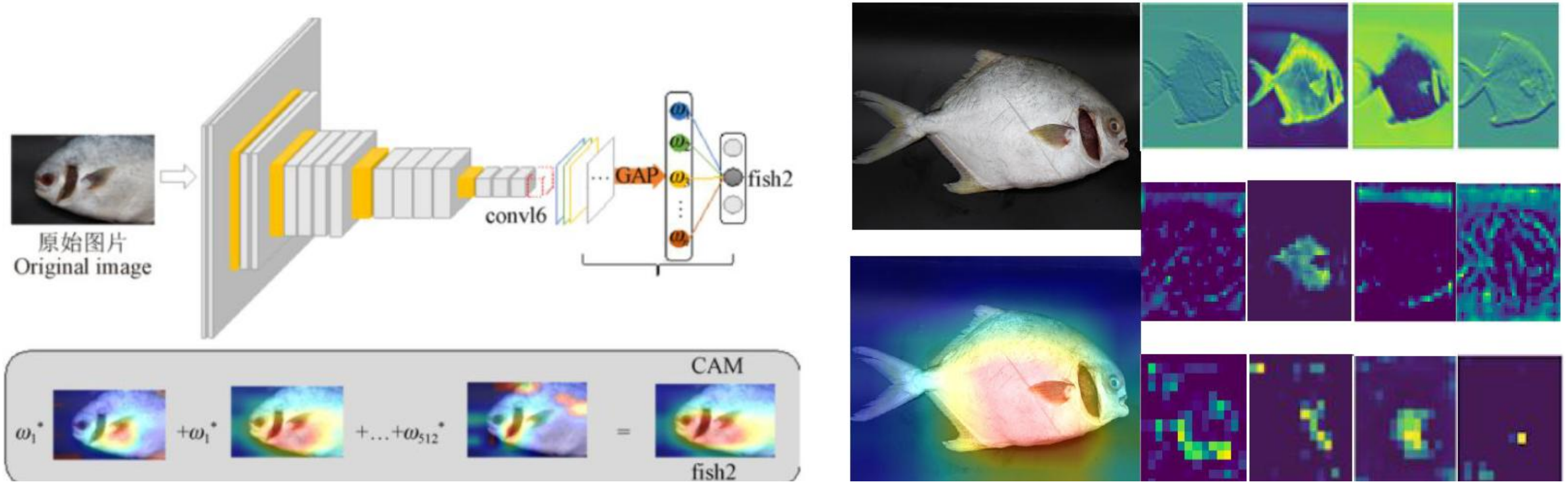
The synergy of sensors in Ag. IoT

- Comprehensive perception
- Reliable transmission
- Intelligent processing




Right Picture: Quy, Vu Khanh, et al. "IoT-enabled smart agriculture: architecture, applications, and challenges." *Applied Sciences* 12.7 (2022): 3396.

# 1.6.2 Big Data

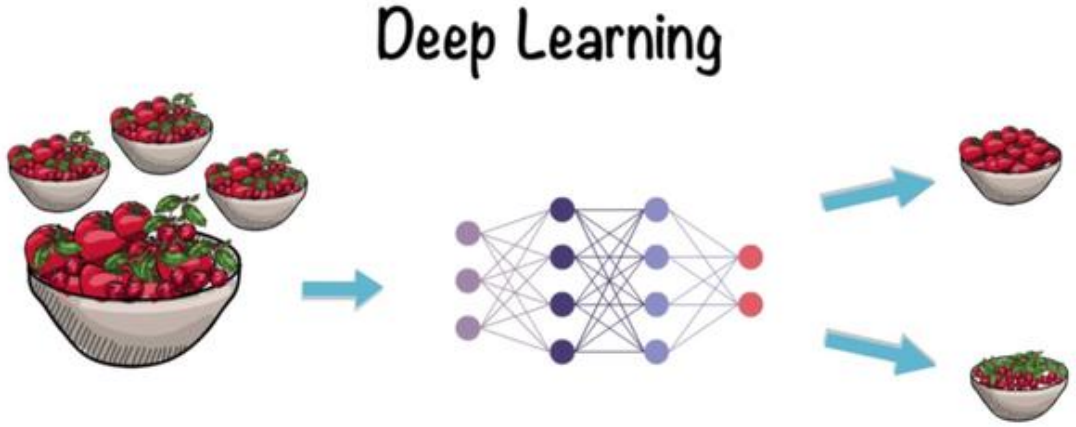


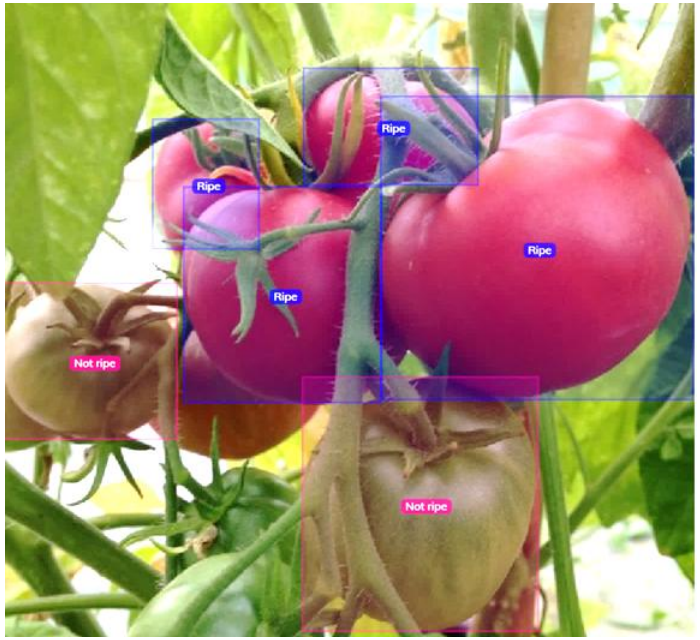

**Paper**: Li, Z. et al. An improved VGG-19 convolutional neural network-based freshness assessment method for chilled pomfret. Transactions of the Chinese Society of Agricultural Engineering 37.22 (2021).

Data from deep learning models' prediction

# 1.6.3 Artificial Intelligence

- Classification, recognition, pest identification and behavior monitoring
- UAVs for crop monitoring
- Models for ripeness detection
- A novel tool of the new era



# 1.6.4 Smart Equipment & Robotics

Characteristics of Intelligent equipment robot market:
Large scale, fast growth, high threshold, urgent demand

weeding

fertilization

phenotypic

sow

transplanting

milking

disinfection

feeding

inspection

Farmland management

A million agricultural robots
& 200 billion market in 2030

Animal husbandry

Perception targets:

- 3D structure
- Thermal imaging
- Spectrum imaging
- GPS / INS
- Laser radar ranging


University of Sydney

# 1.7.1 Related Policies——China

| Time | Unit | Policy | Highlight |
|---|---|---|---|
| 2022.10 | Ministry of Agriculture and Rural Affairs | Digital construction guidelines for agricultural modernization **demonstration** areas | Take 3-5 years to build a number of intelligent agriculture first demonstration areas |
| 2022.3 | Ministry of Agriculture and Rural Affairs | The **14th Five-Year Plan** for National Agricultural and Rural Informatization Development | By 2025, significantly improve the level of **information technology** |
| 2022.2 | The State Council | Opinions of the State Council of the Central Committee of the Communist Party of China on the Key Work of Comprehensively Promoting Rural **Revitalization** in 2022 | Training of **farmers' digital skills**, promoting Internet+, and strengthening digital **infrastructure** construction |
| 2022.2 | The State Council | The 14th Five-Year Plan for Promoting Agricultural and Rural **Modernization** | Promoting the deep **integration of Internet of Things, artificial intelligence and blockchain** |
| 2021.10 | The State Council | Opinions on **Accelerating** Agricultural and Rural Modernization by Comprehensively Promoting Rural Revitalization | Establish agricultural and rural **big data system** |

# 1.7.2 Related Policies——UK

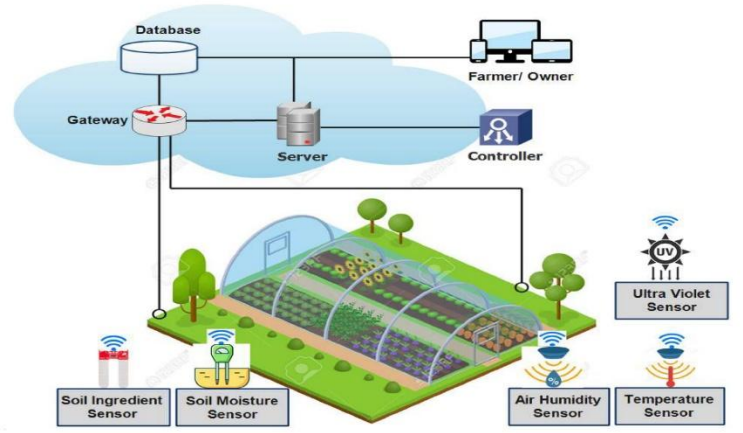
**Agricultural Technology Strategy**

- Initiated from 2013
- Big data → the key to improve agricultural crop yields and livestock production
- Data for modelling and visualization
- Open data policy for supply chain & marketing


# 1.7.3 Related Policies——America

**Agricultural information system**

- Investment pattern: combining government input and capital market operation
- Construction of agricultural informatization network infrastructure
- Modern agricultural intelligent equipment technology


Bottom right Picture: Quy, Vu Khanh, et al. "IoT-enabled smart agriculture: architecture, applications, and challenges." *Applied Sciences* 12.7 (2022): 3396.

# 1.8 ICT technologies in Chinese Agriculture

**Status quo**

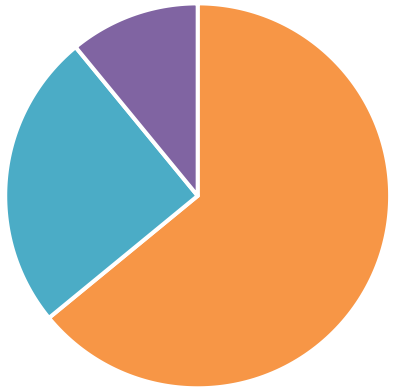
1. **Development background**: During the development of the smart economy, agricultural informatization is strongly supported by the state

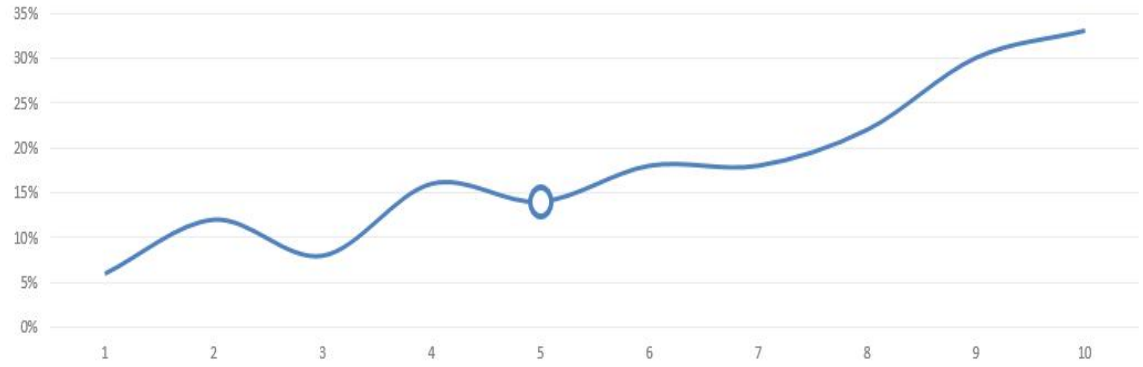
# 1.8 ICT technologies in Chinese Agriculture

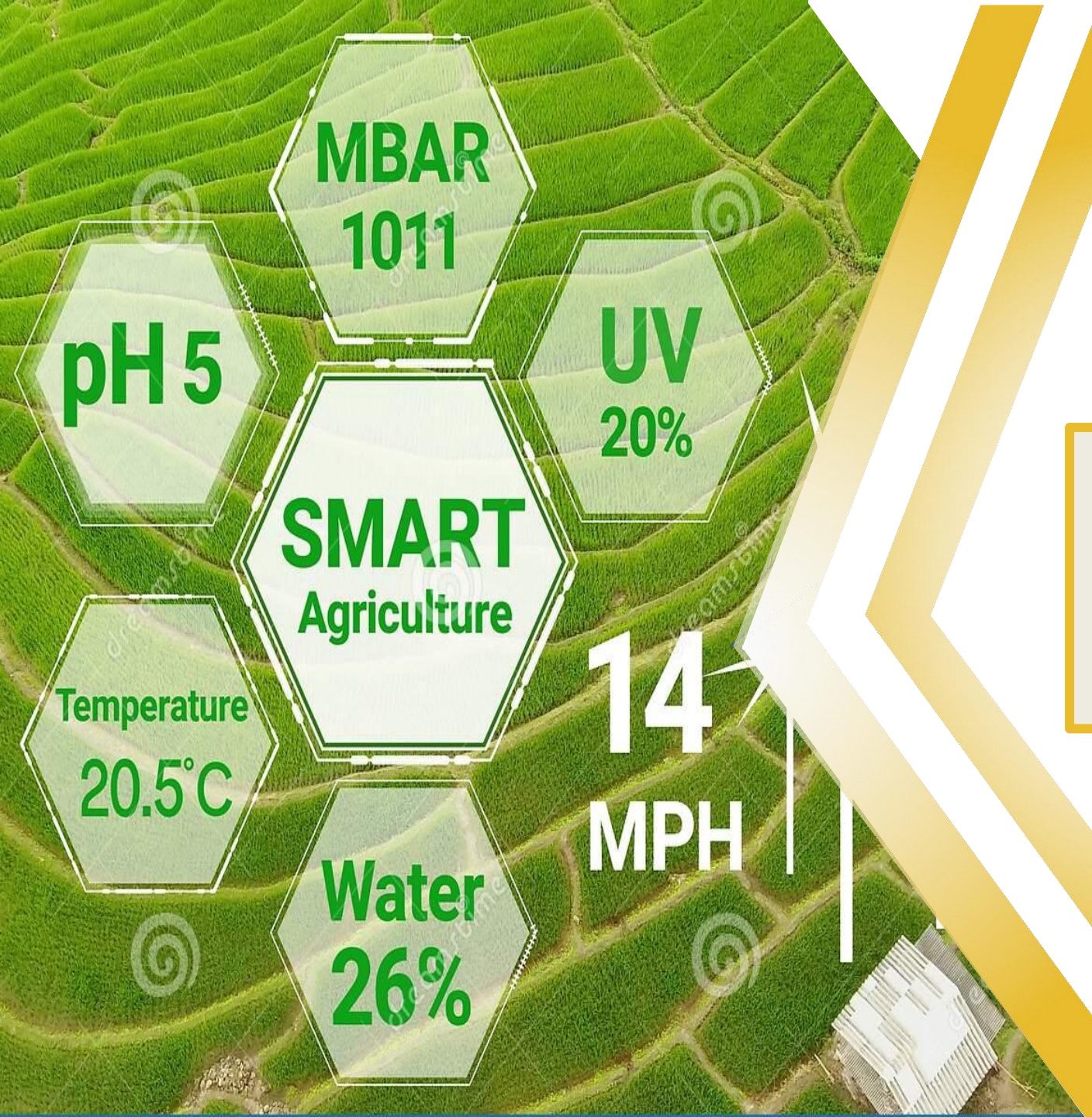
**Status quo**

2. Economically developed regions enjoys a higher level of agricultural informatization, higher in the eastern coastal regions

   → Towards a more **balanced national** comprehensive development



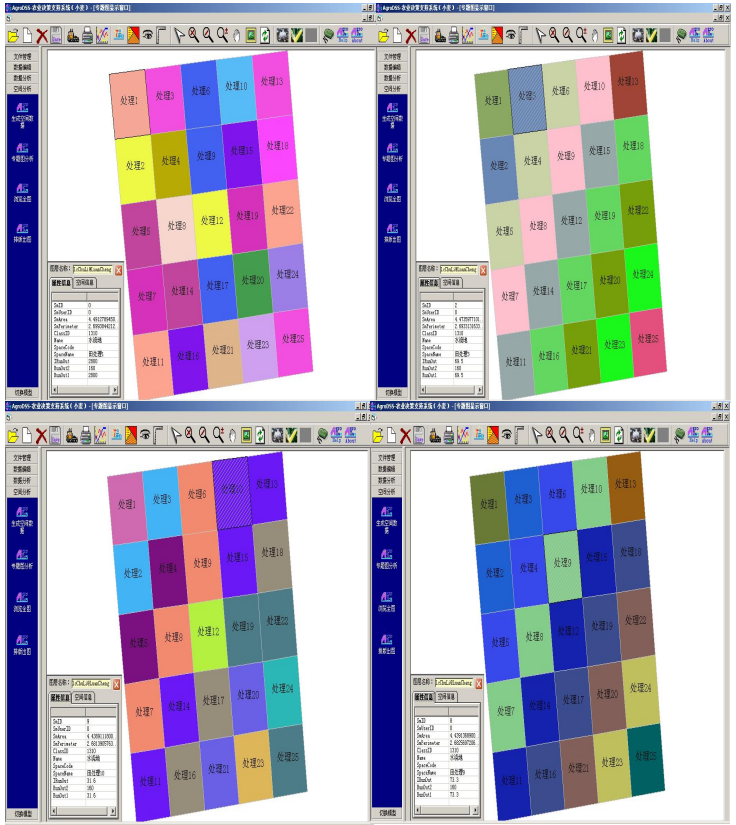


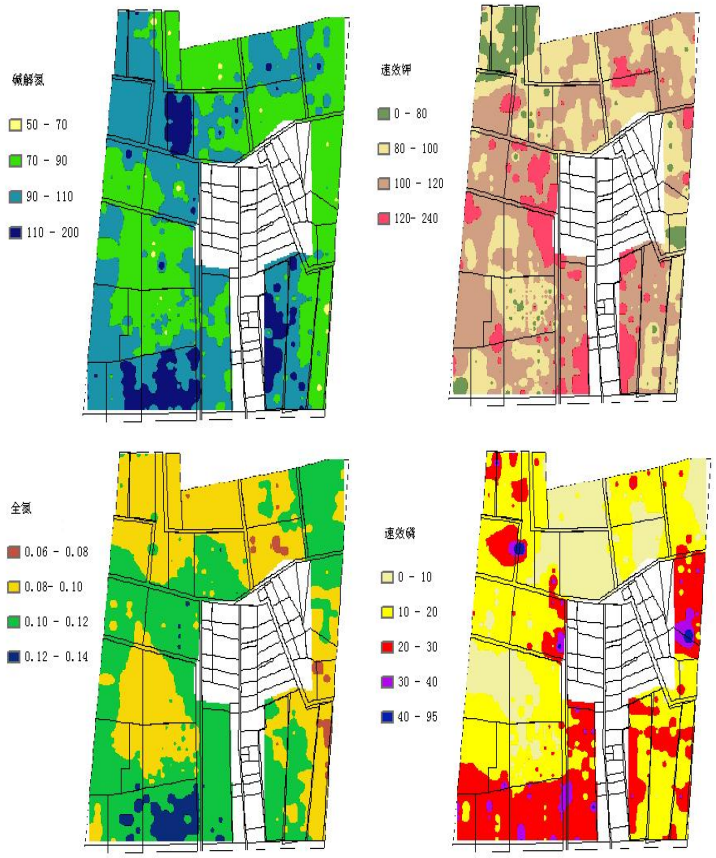



# PART 2

ICT technology improves agricultural productivity

# 2.1 Smart Field Planting






Fine management at the field level

# 2.2 Smart Greenhouse

**6 workers, 80,000 square meters, 35－40kg/m²**

# 2.2 Smart Greenhouse——Automatic seedling detection

To find abnormal seedlings in time, an automatic detection method for **hydroponic lettuce** seedlings was proposed based on **improved Faster RCNN**, with an average accuracy of 86.2%, taking the **death and double-plant** state of hydroponic lettuce seedlings as the research objects, which provided **technical support** for intelligent seedling cultivation.

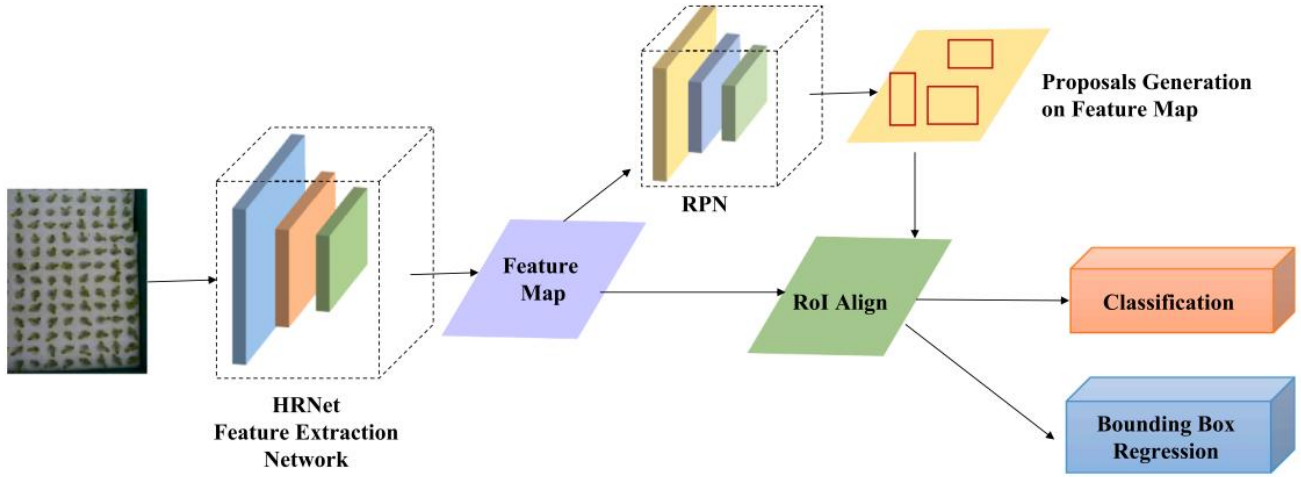
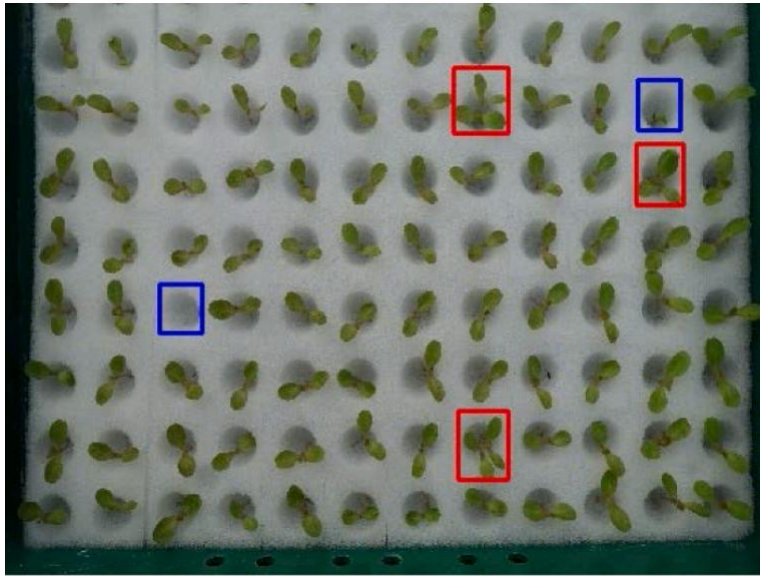



Fig. 3. The network architecture of hydroponic lettuce seedlings status model.



**Paper:** Li Z, Li Y, Yang Y, et al. A high-precision detection method of hydroponic lettuce seedlings status based on improved Faster RCNN[J]. Computers and Electronics in Agriculture, 2021, 182: 106054.

# 2.3 Smart Livestock and Poultry Farming

Automated Precise Perception of Information

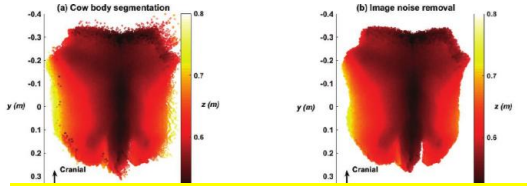
Smart Livestock Farming

Body condition | Behaviour | Animal comm | Environment

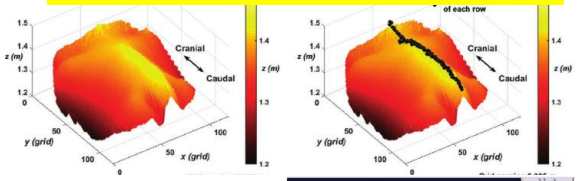
Contact-based perception

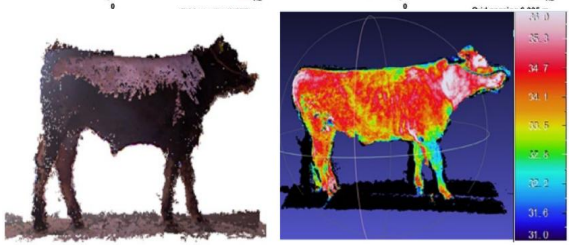
Perception based on vision & auditory

**Weight, breathing state, activity level, body temperature…**




**Weight Estimation**



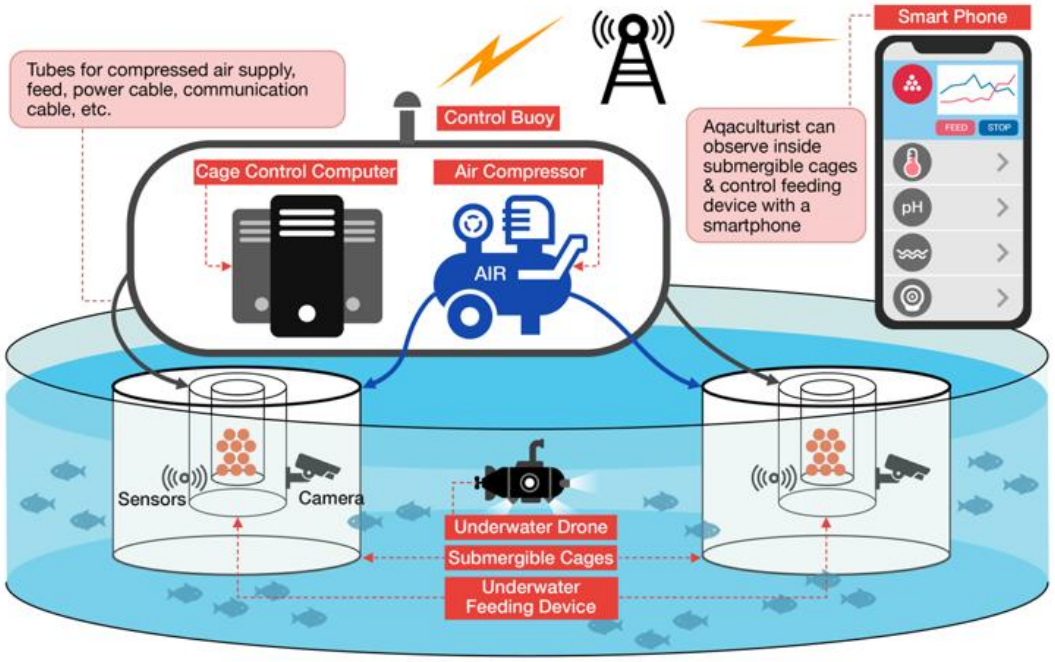
**a** Point cloud data **b** thermal image

**Temperature monitoring**

- 15% increase in meat and milk production and 25%-30% increase in net profit

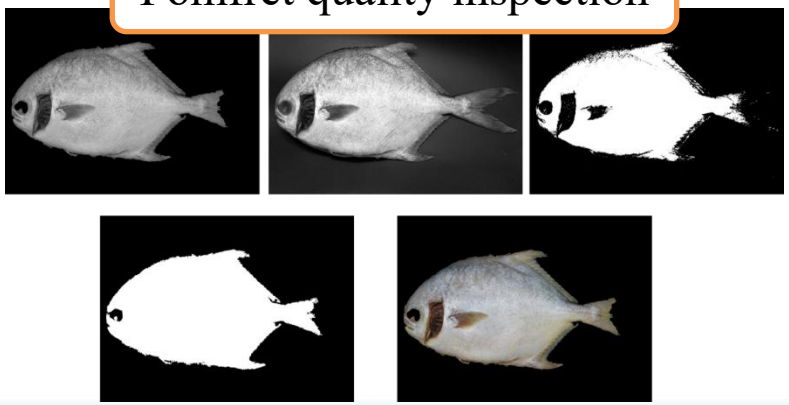
# 2.4 Smart Fishery

Digital aquaculture




Auto shellfish classification

Pomfret quality inspection



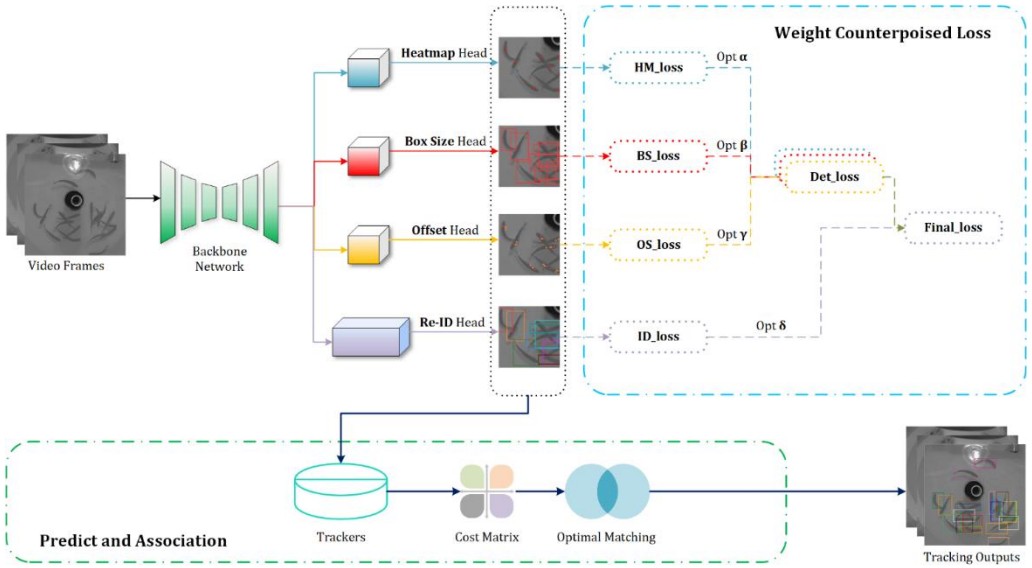
- Promoting **real-time monitoring** and precise fishing & low-carbon and **high-efficiency** fisheries
- Improve the level of **industrialization** and ability of **management** in fisheries

Upper left fig: Vo, Thi Thu Em, et al. "Overview of smart aquaculture system: Focusing on applications of machine learning and computer vision." *Electronics* 10.22 (2021): 2882.

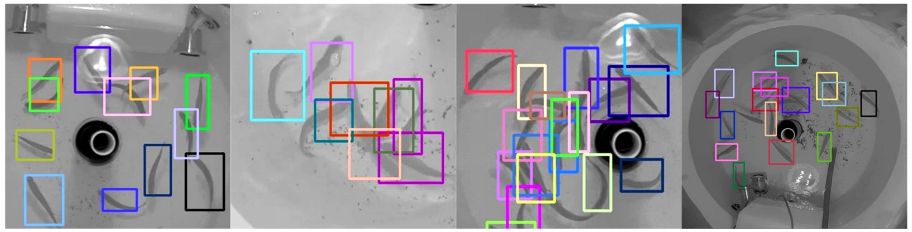
# 2.4 Smart Fishery——Fish target tracking

## ◆Fish multi-target tracking based on balanced joint network

To provide accurate data for **fish behavior analysis**, the end-to-end, efficient and accurate fish multi-target tracking method is studied. A multi-target tracking model of fish based on joint balance network was proposed, which reduced the training time cost and realized real-time and stable multi-target tracking of fish



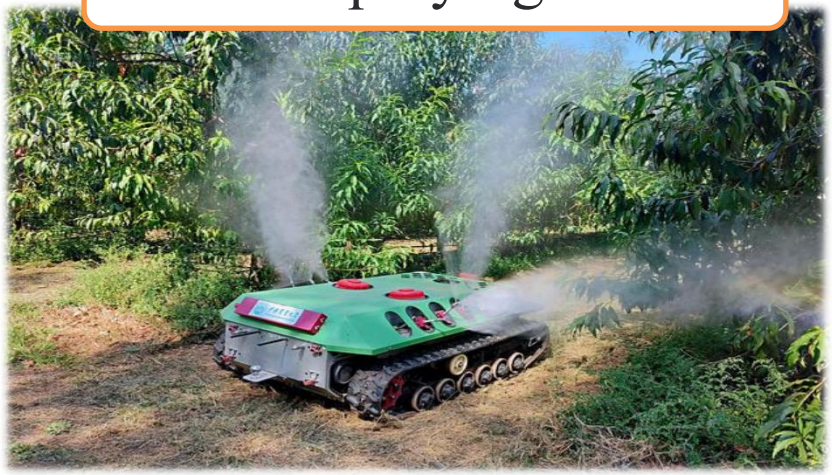

- ResNet - 101 - DCN as Backbone, four sub branch for child tasks
- Balance weight loss is used for subtask fusion
- Lower feature dimension.



**Paper:** Li, W., Li, F., & Li, Z. (2022). CMFTNet: Multiple fish tracking based on counterpoised JointNet. Computers and Electronics in Agriculture, 198, 107018.

# 2.5 Smart Orchard

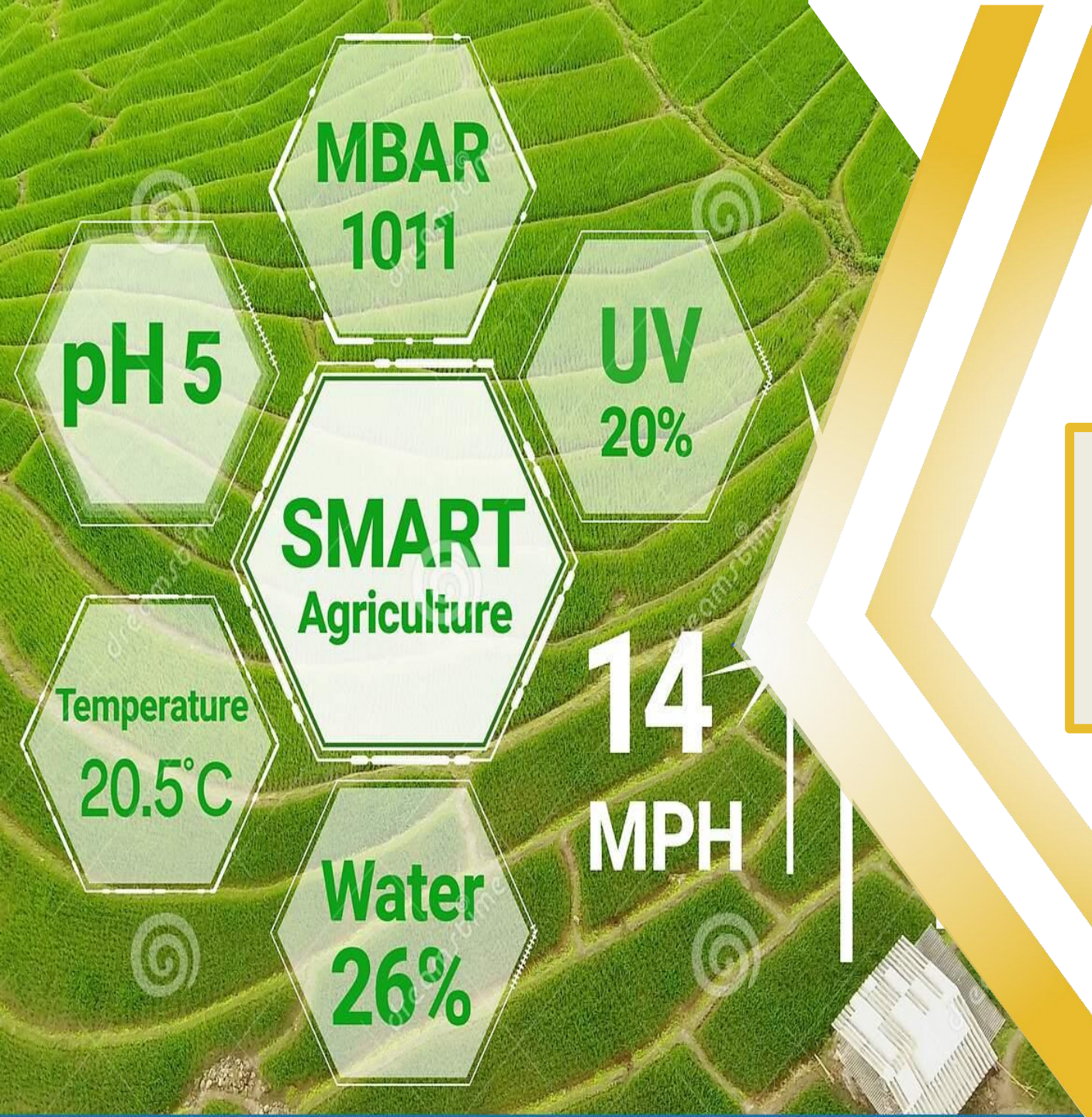
Auto-spraying robot



Picking robot

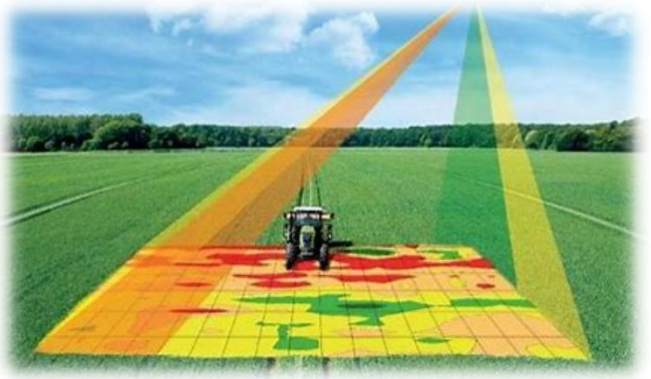
Weeding robot

1. Precisely spray water and fertilizer
2. Auto-picking fruits
3. Increase comprehensive economic benefit by 32.5%




# PART 3

Future prospect



# 3.1 Future Prospect

**Future trends: Digitization of the whole industry chain**

- With the **guidance of the policy**, vigorously promote the development of agricultural and rural informatization
- **Informatization, refinement and intelligence** of the whole chain; improving the **efficiency of all factors** of agricultural production and the **standardization** of agricultural products

**Weeding by Laser**

**Precision Harvesting**

**Crop Fertilizing**

# 3.1 Future Prospect

**Future trends: Digitization of the whole industry chain**

- ☐ Build a data resource system
- ☐ Explore application scenarios
- ☐ Key technology development
- ☐ Carry out trials and demonstrations
- ☐ Combination of equipment and method

# 3.2 Unmanned Farm

- Without human in the scene
- Internet of things, big data, artificial intelligence, 5G, robotics
- Independent decision-making of farm facilities, equipment, machinery
- Unmanned operation mode

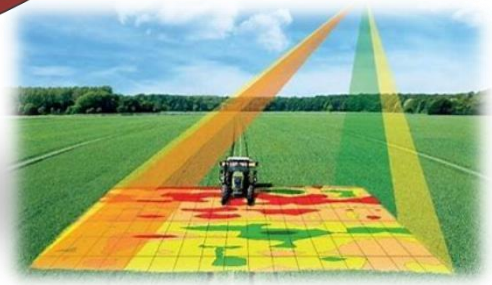
Essence

Accomplish

Machines help people

# 3.2 Unmanned Farm

Future Agricultural Vision

Smart Agriculture

# Thank you for your attention!


**Professor Zhenbo Li**

**China Agricultural University**


May 26, 2023