II Simposio Nacional de Ingeniería Hortícola
Automatización y TICs en agricultura
Almería, 10-12 de febrero de 2016

Ponencia la aplicación de las TICs en la agricultura China

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1 Introduction

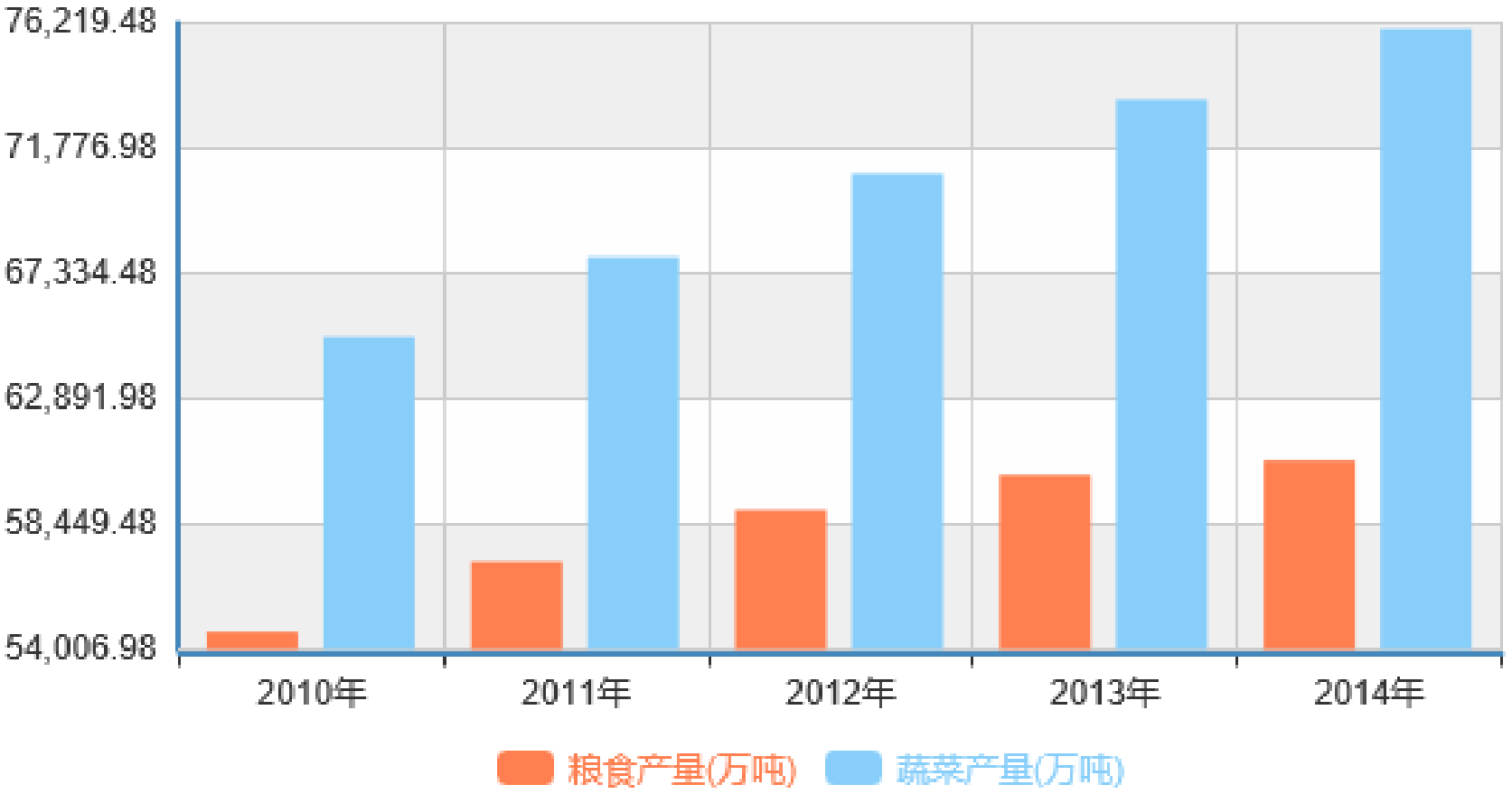
Agenda

- 1 Introduction
- 2. Breeding
- 3. Production
- 4. Logistics and traceability
- 5. Application
- 6. Cooperation with Spain

Horticulture: rapid development

- The rapid rise of the middle class and rising per capita income in emerging economies are leading to increasing demand for healthy, safe and sustainably produced horticultural products. (China has about 300 million population with middle class level)

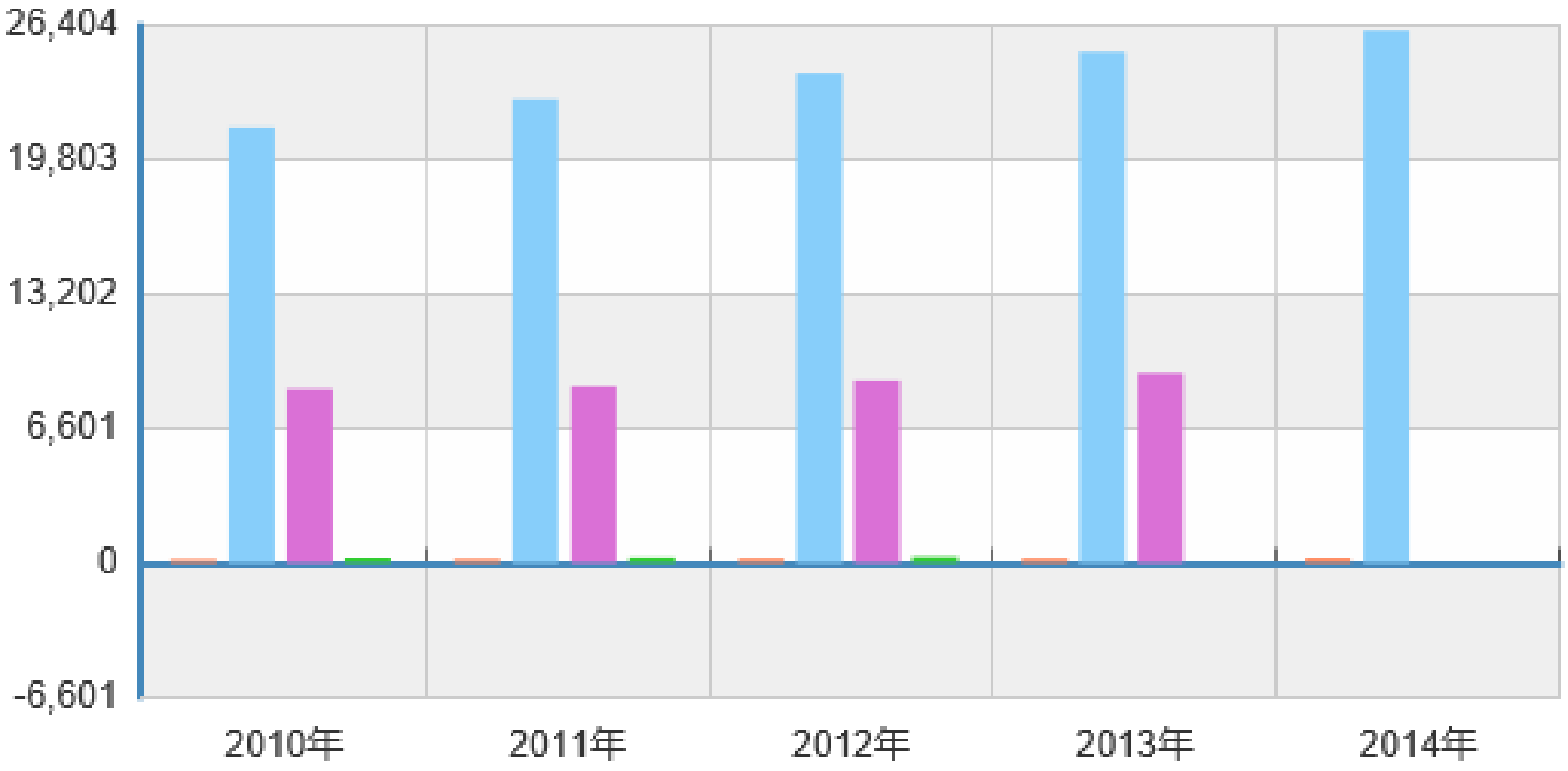
1.1 General view of China's horticulture



Grain yield (10000 tons)

Vegetable yield (10000 tons)

Horticultural yield in China



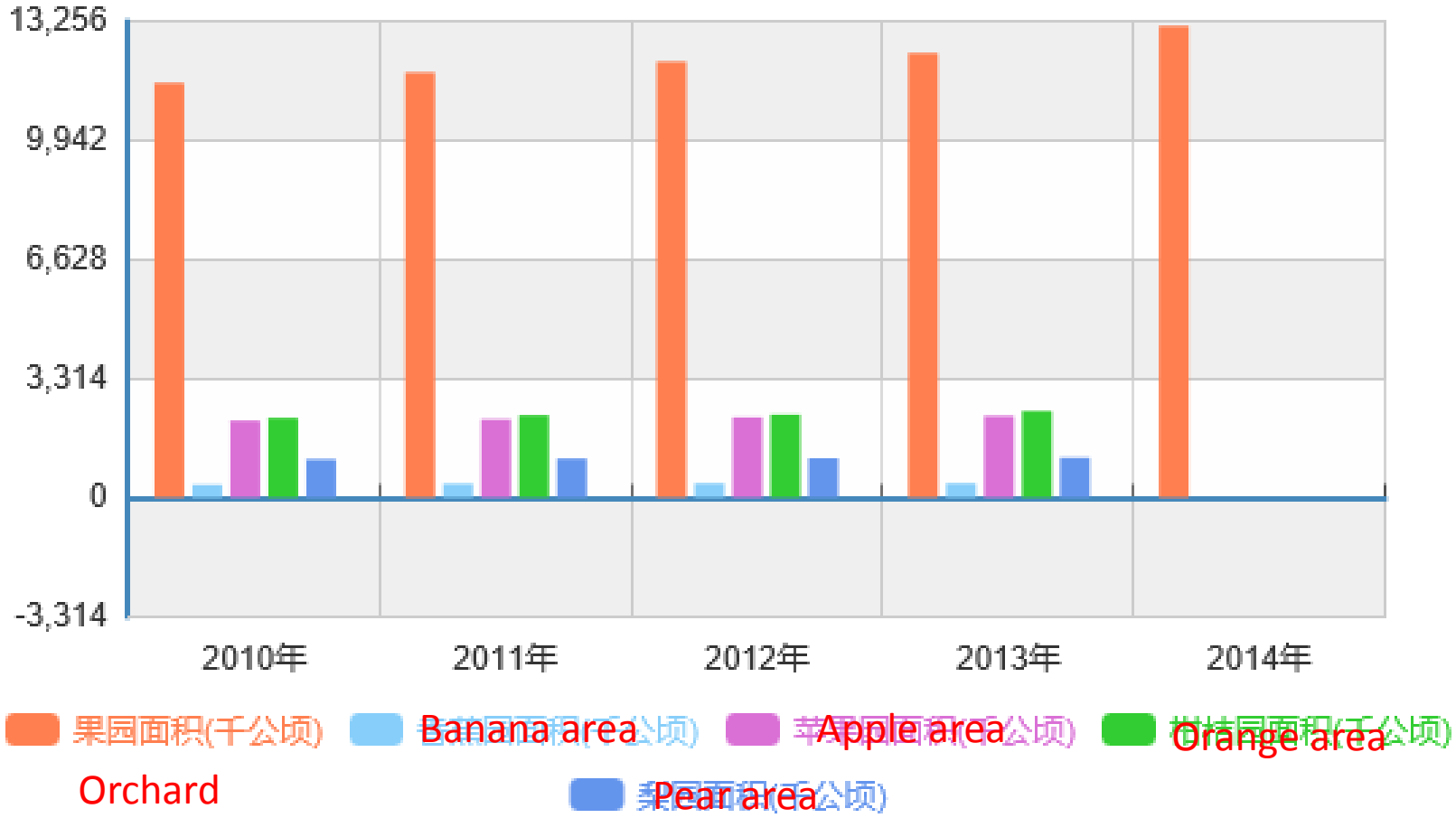
Tea yield (10000 tons)

Fruit yield (10000 tons)

Melon yield (10000 tons)

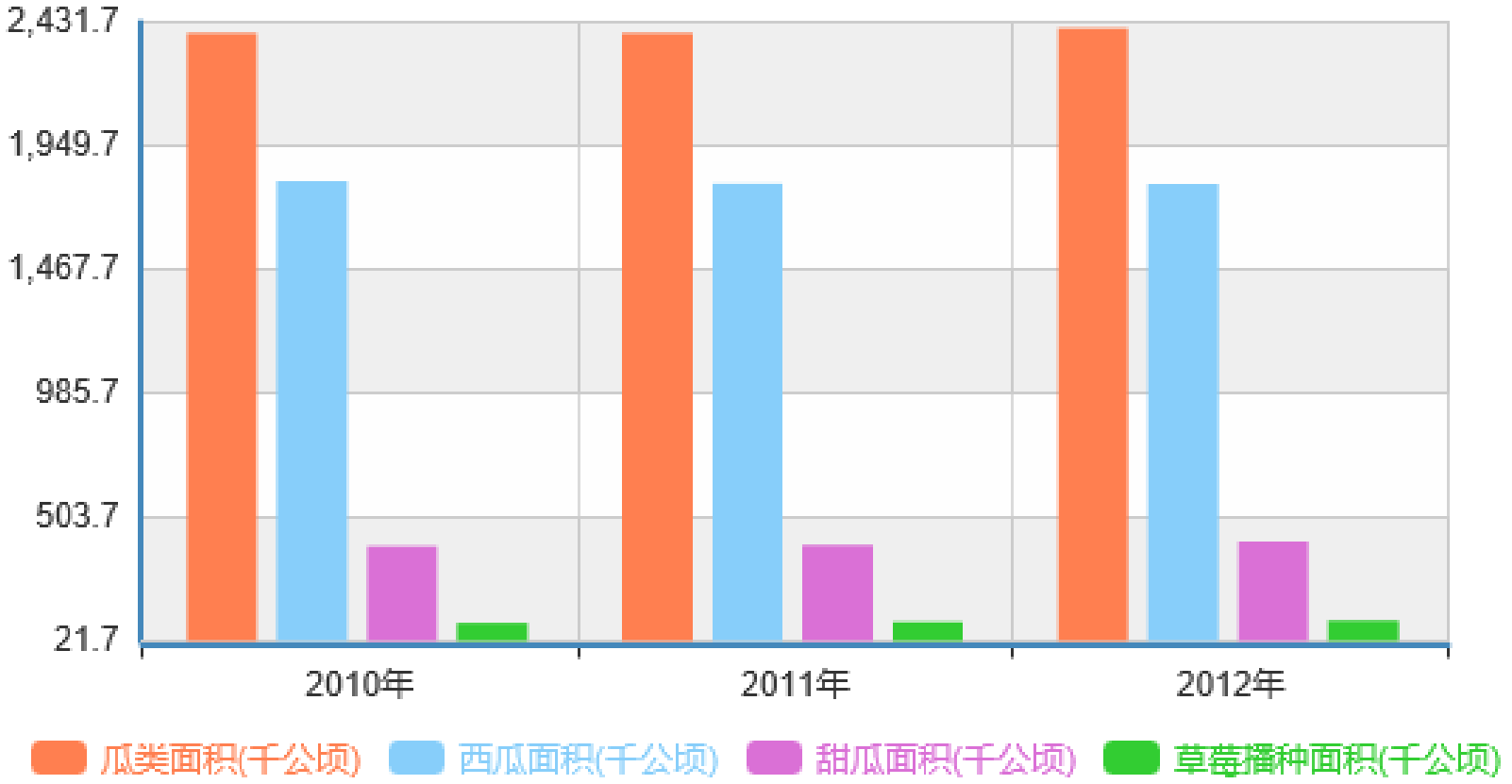
Strawberry yield (10000 tons)

Orchard area



Orchard area (1000 hectares)

Cucurbit crop area



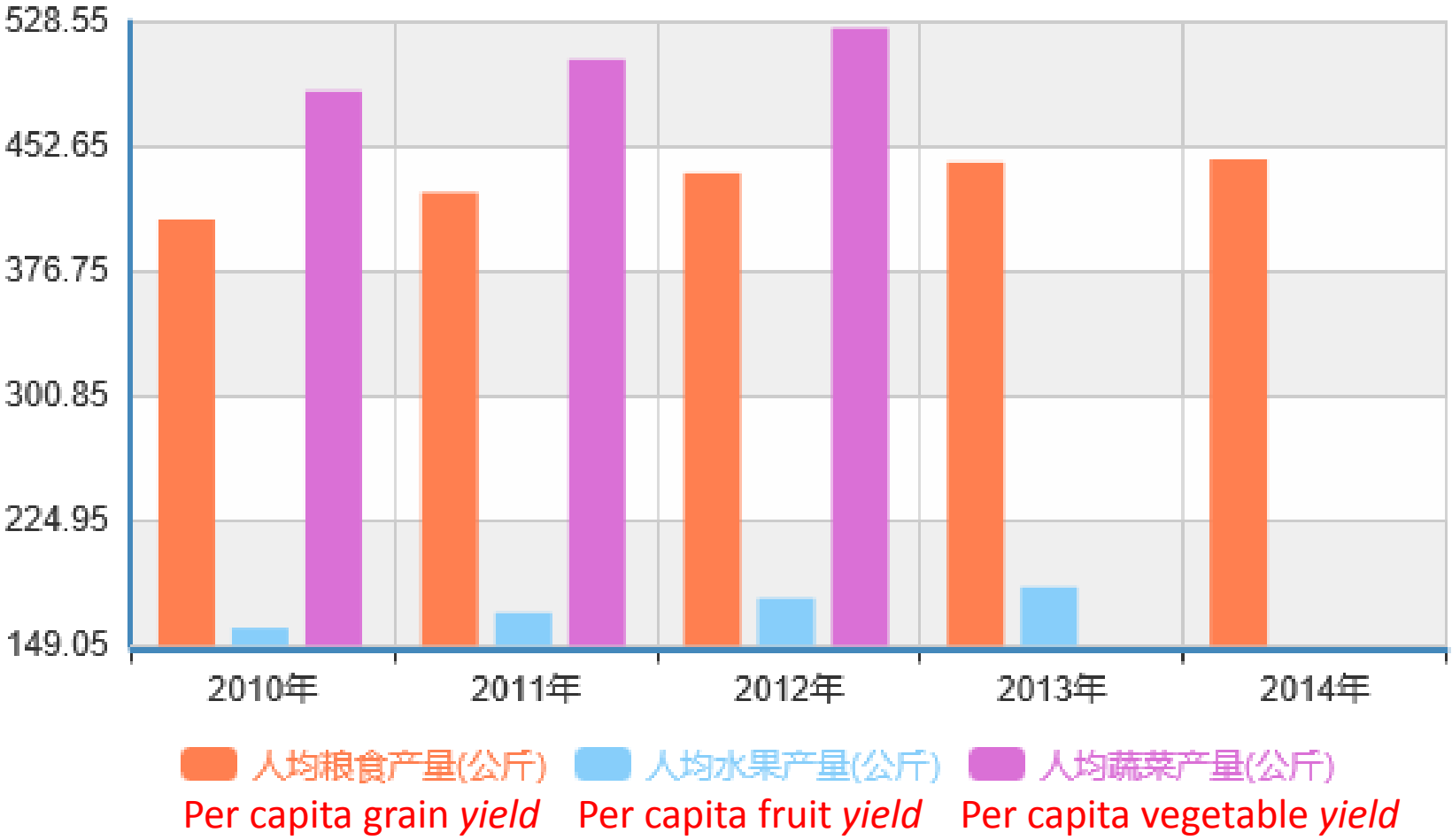
Cucurbit crops area (1000 hectares)

Watermelon area (1000 hectares)

Melon area (1000 hectares)

Strawberry area (1000 hectares)

Per capital yield

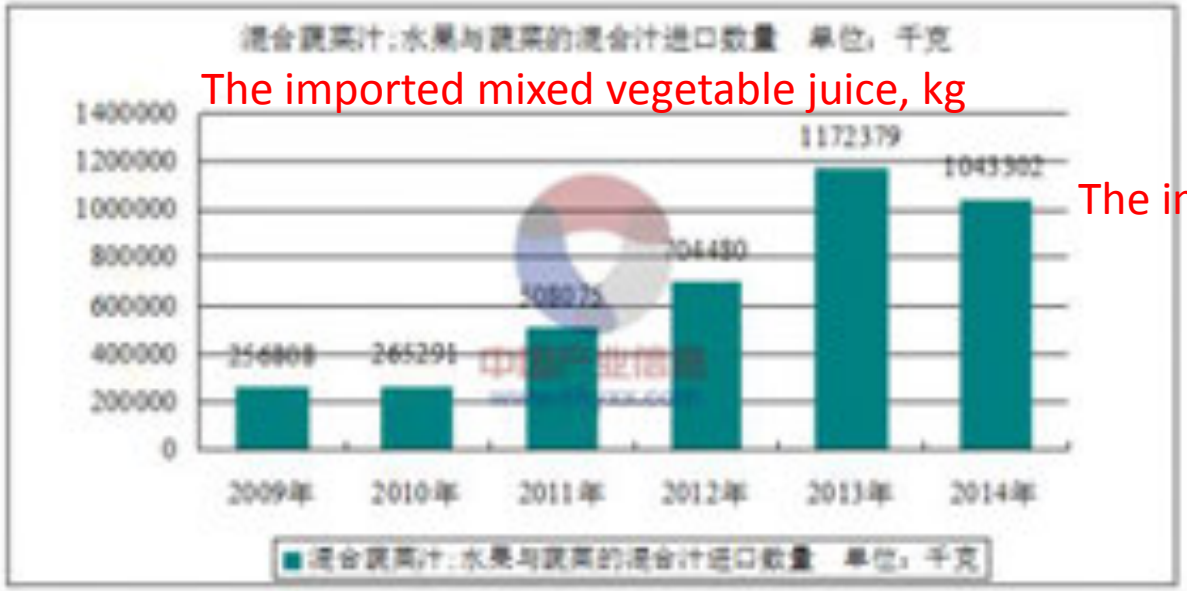


Per capita grain *yield* Per capita fruit *yield* Per capita vegetable *yield*

Higher demand for imported food

- 2015, China imported more than 4 million tons of fruits

The imported mixed vegetable juice, kg



The imported mixed vegetable juice, 1000$

Global importers

Variety	Total (Tons)	Variety	Total (Tons)
Longan	126,790.37	Kiwi	6,886.94
Banana	134,478.49	Citrus	6,758.78
Watermelon	72,423.74	Apple	2,813.74
Dragon Fruit	67,764.82	Pear	1,061.83
Grape	36,505.98	Mango	618.27
Durian	17,307.64	Papaya	107.09
Mangosteen	11,060.98	Leeche	0.68
Pineapple	6,922.40		

Data from China World Fruit & Vegetable Trade Fair,2015

S&T demand for horticulture

Fresh, Frozen & Dehydrated Produce Products

Nuts & Processed Produce Products

Juice, Drinks & Winery

Herbs & Spices

Organic & Healthy Food

Produce Packaging Machinery & Technology

After Harvest Machinery & Technology

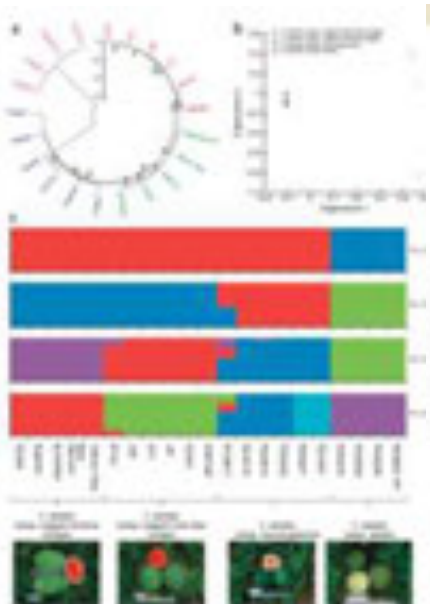
Logistics & Cold Chain

Breeding & Seedling Technology

Marketing, Research, Consulting & Financial Solutions

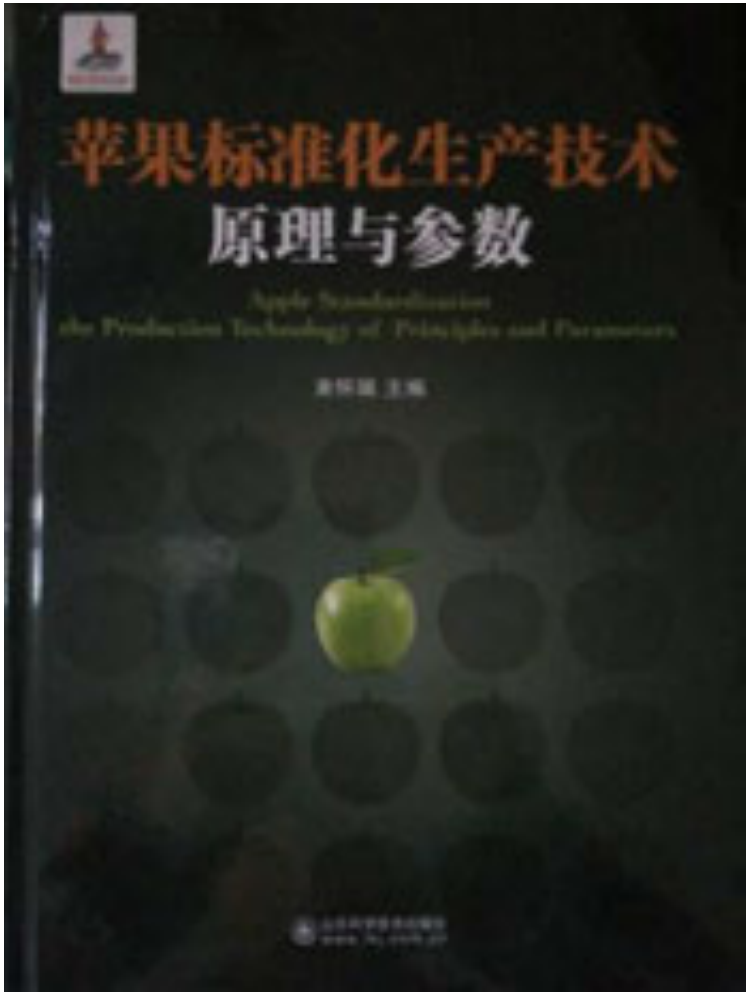
2. Breeding

- Mining the variety resources



2. Breeding

- Establish the variety resource standard



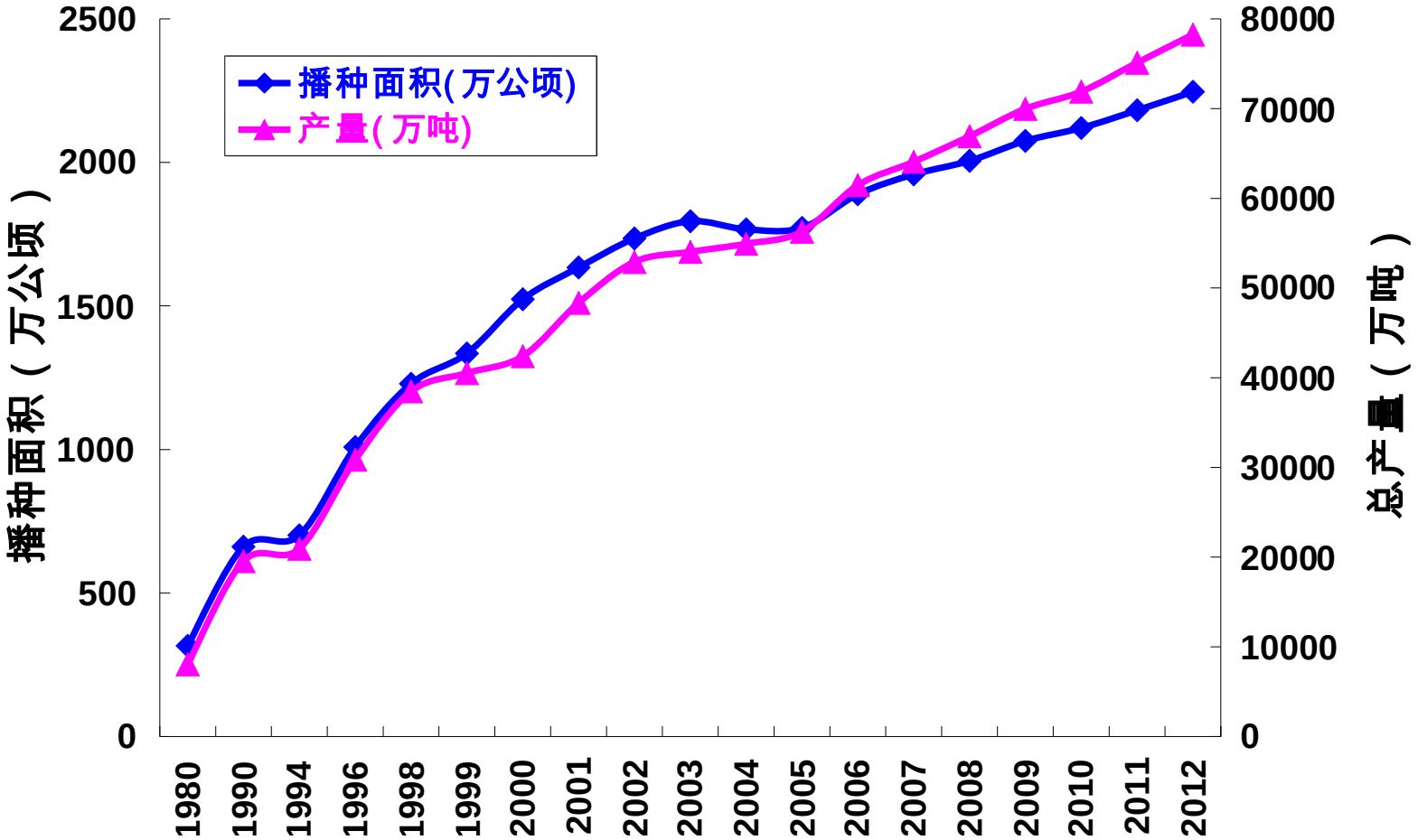
2. Breeding

- Golden seed breeding platform

3. Production

- 3.1 Problem
- 3.2 Monitor
- 3.3 Model
- 3.4 Decision and conduction

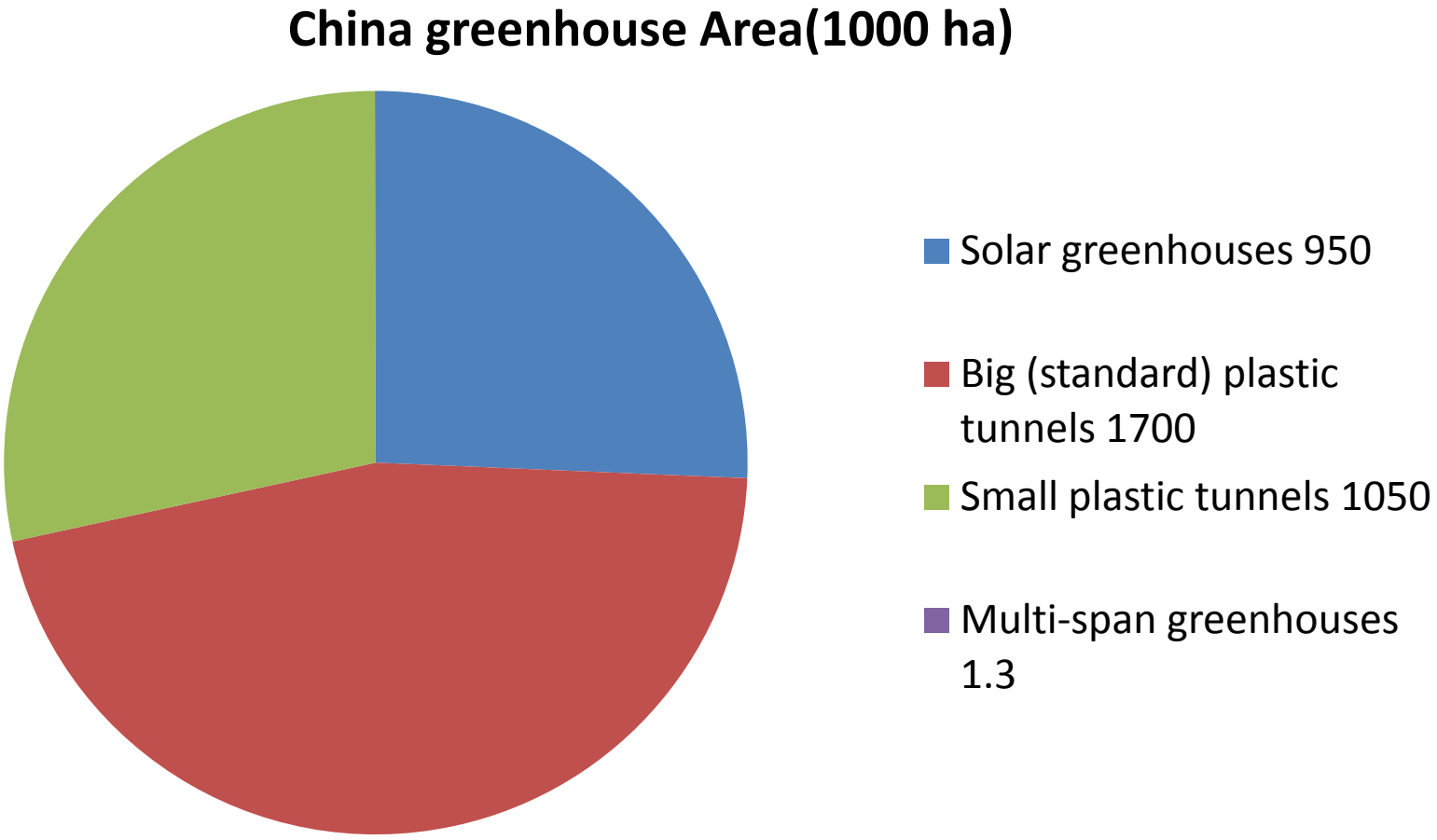
Fast increase of horticultural production in China



Annual planting area and yield for vegetables in China

Li Baoju, 2013

3.1 Problem

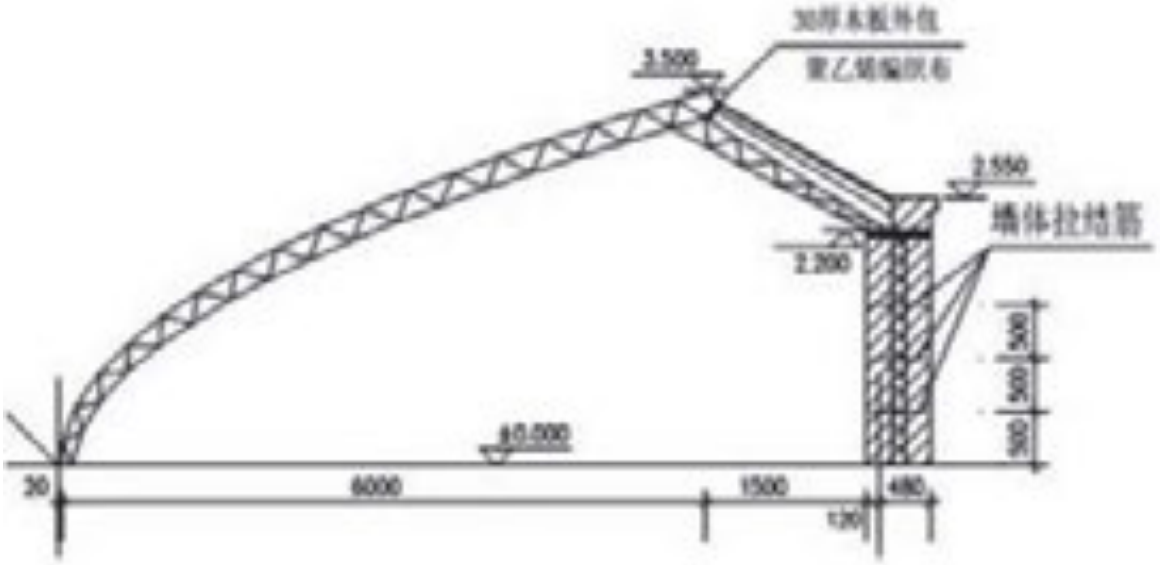

China greenhouse Area(1000 ha)
Solar greenhouses 950
Big (standard) plastic tunnels 1700
Small plastic tunnels 1050
Multi-span greenhouses 1.3

Low cost, simple facilities in agriculture

Zhang Zhenhe， 2009

Solar greenhouse creation

- 1985, Farmers in Haicheng and Wafangdian, Liaoning province, China invented solar greenhouses to produce fruit vegetables, in the external weather of -20℃.



辽沈Ⅰ型日光温室断面示意图

Solar greenhouse extension

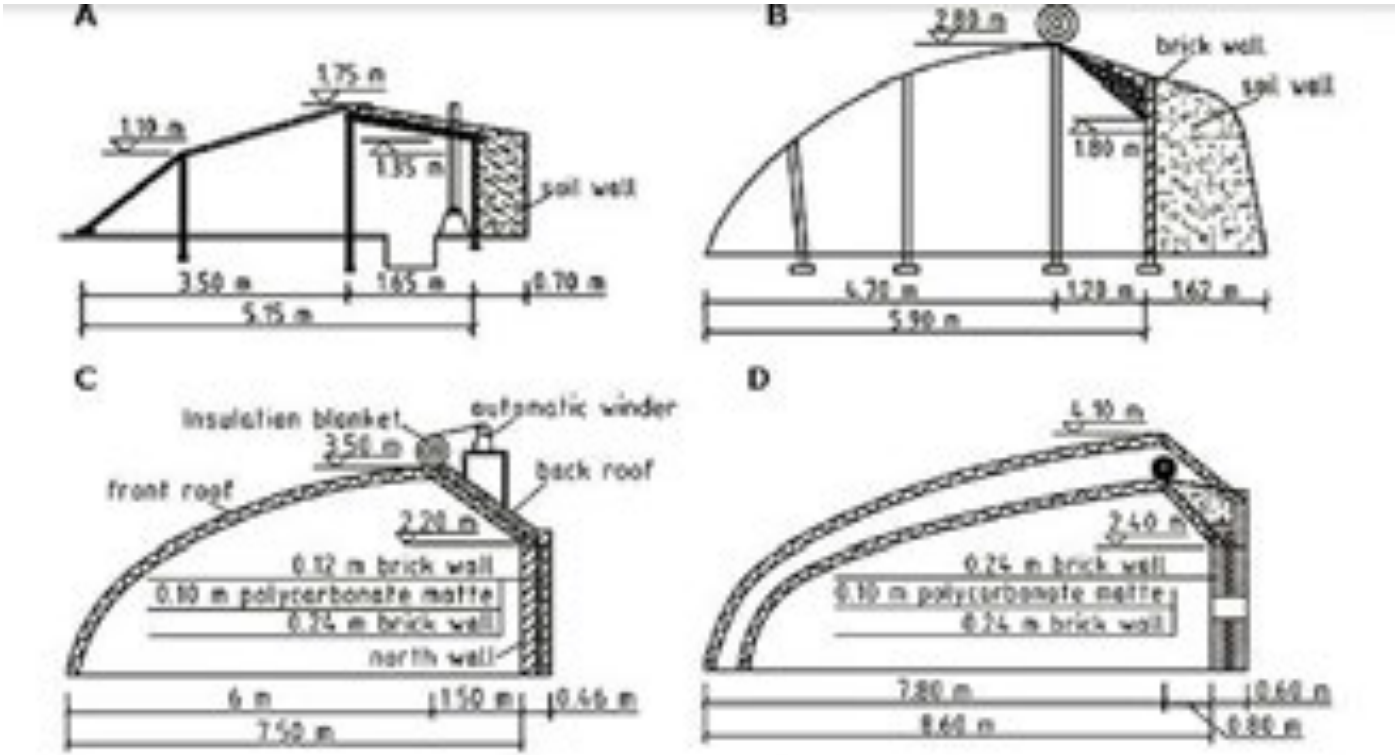


Fig. 1. Models, structure parameters, and evolution of solar greenhouse structure in China. (A) The primary solar greenhouse (before 1985): spans = 5.5 to 6.5 m, wall thickness = 0.5 to 0.7 m, arch height = 2.1 to 2.4 m; steel frames and two to three pillars inside the greenhouse, no insulating blanket, the roof is glass. (B) Modified solar greenhouse (1986–95): spans = 6.0 to 8.0 m, arch height = 3.0 to 4.0 m; frames are bamboo, steel, or a mixture of both, with two to three pillars inside; soil wall thickness = 0.8 to 1.1 m with heterogeneous double layer; transparent coverage materials polyethylene (PE) or polyvinyl chloride (PVC) with insulating blanket on it. (C) Modern solar greenhouse (1996-present): spans = 8.0 to 14.0 m, arch height = 3.8 to 5.5 m, walls of air-entrained brick, polystyrene slates, and perlite at 0.8 m; non-pillar, zinc-coated steel frame. The rolling up and down of the insulation blanket and ventilation vents are all automatic. The east and west walls have a wet curtain cooling system. (D) Double-arch solar greenhouse (2007–present): structure parameters are the same as (C) except the double-arch frames; 1 m = 3.2808 ft.

Gao, et al, 2010

Fig. 2. Photos of a single-slope solar greenhouse: (A) exterior, (B) interior, (C) upper side of the double-arch solar greenhouse, and (D) a group of solar greenhouses. (Photos A through C were provided by M. Qu and Z. Zhang, respectively; photo D is courtesy of Beijing Agricultural Bureau).

Greenhouses in different latitudes

Table 1. The main structural parameters of the solar greenhouse located at different degrees of latitude (Zhang, 2001).

Latitude	Greenhouse types[z]	Span (m)[y]	Ridge ht (m)	Back wall ht (m)	Back roof horizontal shadow length (m)
43°N	1	7.0	3.5–3.8	2.3–2.5	1.5–1.6
	2	6.5	3.3–3.6	2.2–2.3	1.4–1.5
	3	6.0	3.0–3.4	2.0–2.2	1.3–1.4
41°N–42°N	1	7.5	3.6–3.9	2.3–2.6	1.5–1.6
	2	7.0	3.4–3.7	2.1–2.4	1.4–1.5
	3	6.5	3.2–3.5	2.0–2.3	1.3–1.4
38°N–40°N	1	8.0	3.7–4.0	2.4–2.6	1.4–1.5
	2	7.5	3.5–3.7	2.2–2.5	1.3–1.4
	3	7.0	3.3–3.5	2.2–2.5	1.2–1.3

[z]Greenhouse types are divided by the span and the ridge height.
[y]1 m = 3.2808 ft.

Solar greenhouse cost and benefit

Table 2. Input and output of different styles of greenhouses for growing cucumber and tomato in Beijing, China.

Projects		Solar greenhouse: Modified bamboo-steel frame	Solar greenhouse: Modern zinc-coated steel frame	Gutter-connected heated greenhouse: Polycarbonate matte	Gutter-connected heated greenhouse: Glass greenhouse
	Construction cost (yuan/m²)[z]	40–60	150–200	650–750	850–950
Depreciated value	Duration (years)	5–10	15–20	20–30	20–30
	Value/year (yuan/m²)	4–12	7.5–13.3	21.7–37.5	28.3–47.5
Production cost	Annual production material input (yuan/m²)	4.8	4.8	5.5	5.5
	Labor input (yuan/m²)	7.2	7.2	6.5	6.5
	Heating energy input (yuan/m²)[y]	0	0	89.6	89.6
	Wet-curtain cooling cost (yuan/m²)[x]	0	0	4.0	4.0
	Production cost (yuan/m²)	12	12	105.6	105.6
Vegetable productivity	Annual vegetable income (yuan/m²)[w]	45	45	60	60
	Net income (yuan/m²)	21–29	19.5–25.5	−67.3 to −83.1	−73.9 to −93.1
Ratio of annual input/output	Input:output	1:1.88	1:1.76	1:0.44	1:0.42

[z]1 yuan/m² = $0.1465/m² = $0.0136/ft².

[y]Heating cost was calculated by assuming that the gutter-connected greenhouse needs to be heated 100 d in winter, and needs burn 1.12 kg·m⁻² (0.229 lb/ft²) of coal per day at unit price of 0.80 yuan/kg ($0.1172/kg, $0.0532/lb).

[x]Cooling cost was calculated by assuming that the gutter-connected greenhouse needs to be cooled 100 d in summer, and needs consume 0.4 kW·m⁻² (0.037 kW/ft²) of electricity per day at unit price of 0.80 yuan/kW ($0.1172/kW).

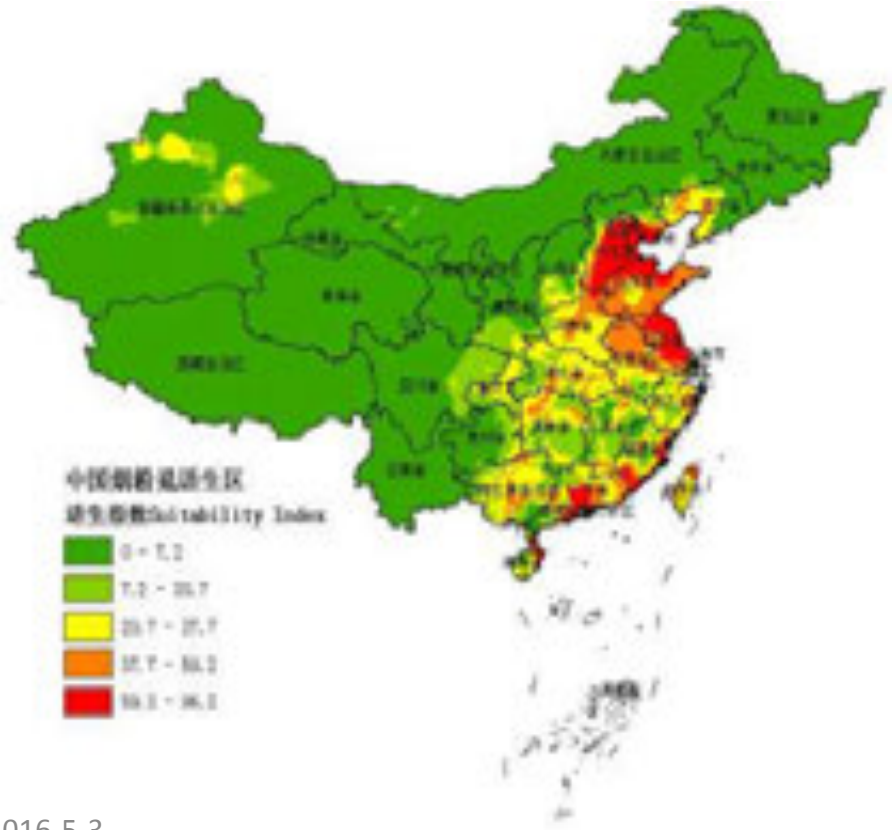
[w]Annual vegetable income was calculated by assuming vegetable price is 2.0 yuan/kg ($0.2930/kg, $0.1329/lb) and annual average yield of solar greenhouse and gutter-connected greenhouse in 3 years was 22.5 and 30.0 kg·m⁻² (4.61 and 6.14 lb/ft²), respectively.

Some problems

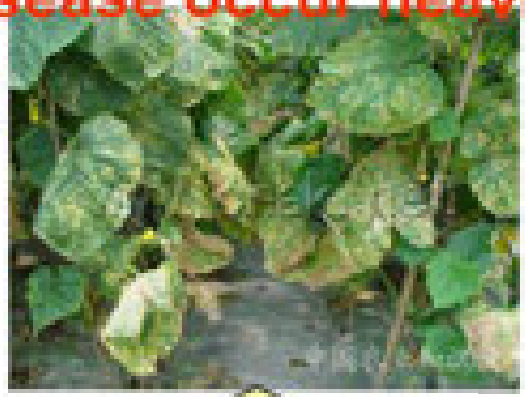
- Lack of unified plan and strategy
- Less ability of environment control
- Heavy soil continuous cropping obstacles, and diseases and pests
- Lower efficiency of production

Diseases and insect pests are the major limitation for agricultural production

- The usual loss for horticultural crops is more than 20% due to pests, and the improper control may result in loss of 50-60 %, especially no harvest when the heavy situation occurs.



The improper control for diseases and pests affect Agricultural product quality safety



Disease occur heavily

Monitor and model

Post control

Spray when symptom occurs

Rules on sprays

Overuse pesticide

Pesticide residue

GAP risk analysis

Affect quality safety

Hurt to health and environment

Increase the pest resistance

IPM system

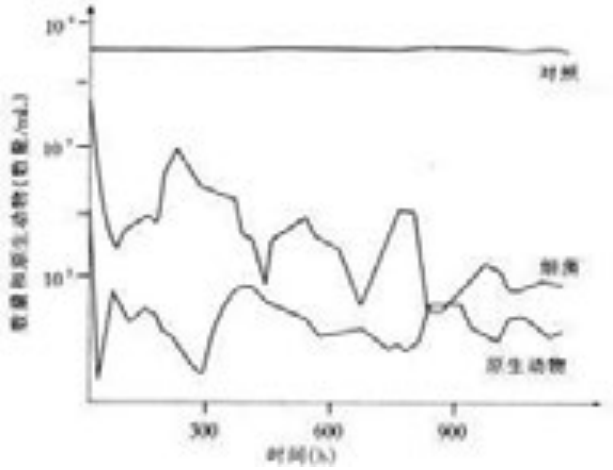
Lack for early warning

Traditional pathogen monitoring method

Spore traps

Collection by labor

Microscope testing



Spore analysis

Traditional pest monitoring method

Field sample

Expert identify

On site testing

Statistic analysis

Lower efficiency of usage on data

Paper

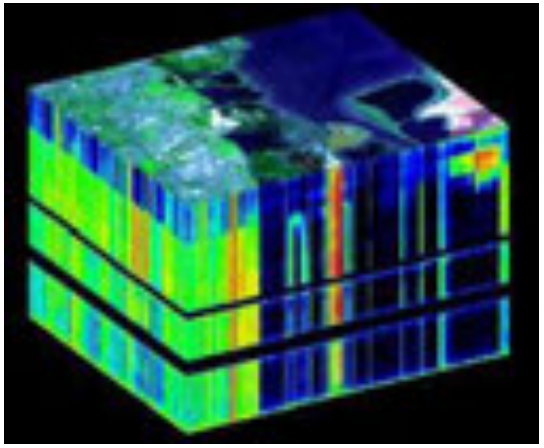
Computer

PDA

Cell phone

Weather station data has not been well used

Urgent need of Intelligent, automatic tools



Hyper spectrum

Machine vision

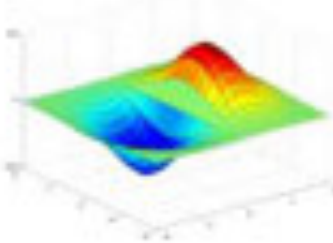
Voice

Infra red

IOT, Cloud computing, big data has great potential

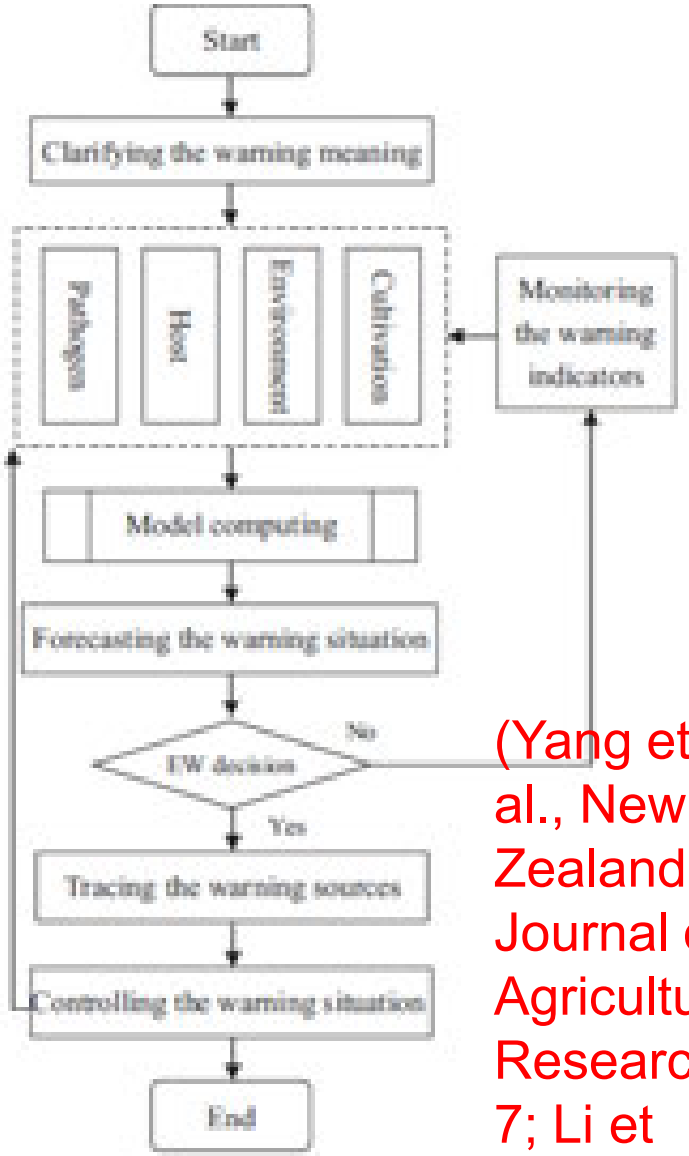
Trends in Plant Protection Science

- **Thousands years ago: Experiment**
  - Field survey
  - Express the natural phenomenon
- **A hundred years before: Theory**
  - Disease epidemiology and insect ecology
  - Mathematical Model
- **Last several decades: Computing**
  - ICT application
  - Computer simulation
- **Nowadays: Big Data**
  - Data-intensive scientific discovery
  - Global pest forecast and control



Our goal

- Automatic monitoring
- Precision model
- Decision and control



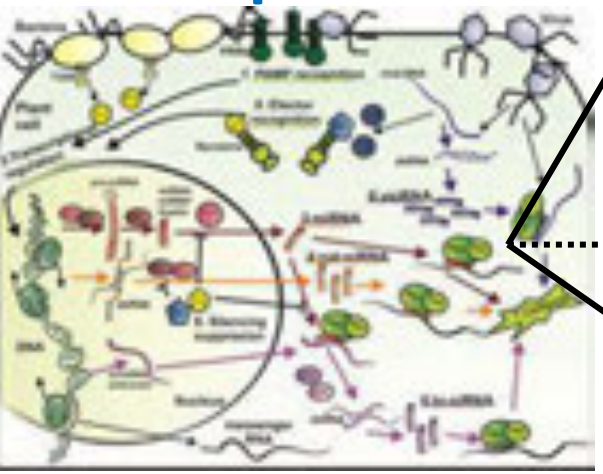
(Yang et al., New Zealand Journal of Agricultural Research, 2007; Li et

3.1 Monitoring the pest tetrahedron

Complex system of disease pyramid

Host phenotyping: Hyperspectral, High-throughput, online

Pest detection: from Molecular to Population



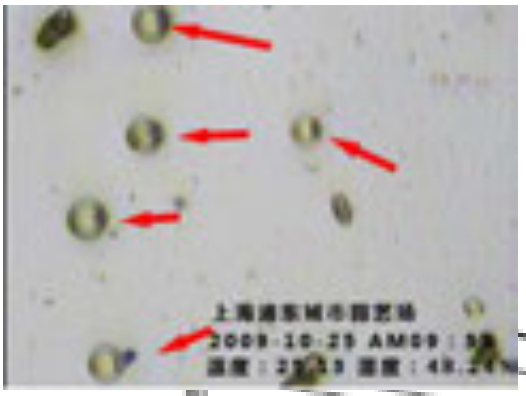
Plant disease and insect early warning model and system

Cultivation record: holistic, traceable, visible

Environment monitoring: integrated, dynamic and heterogeneous

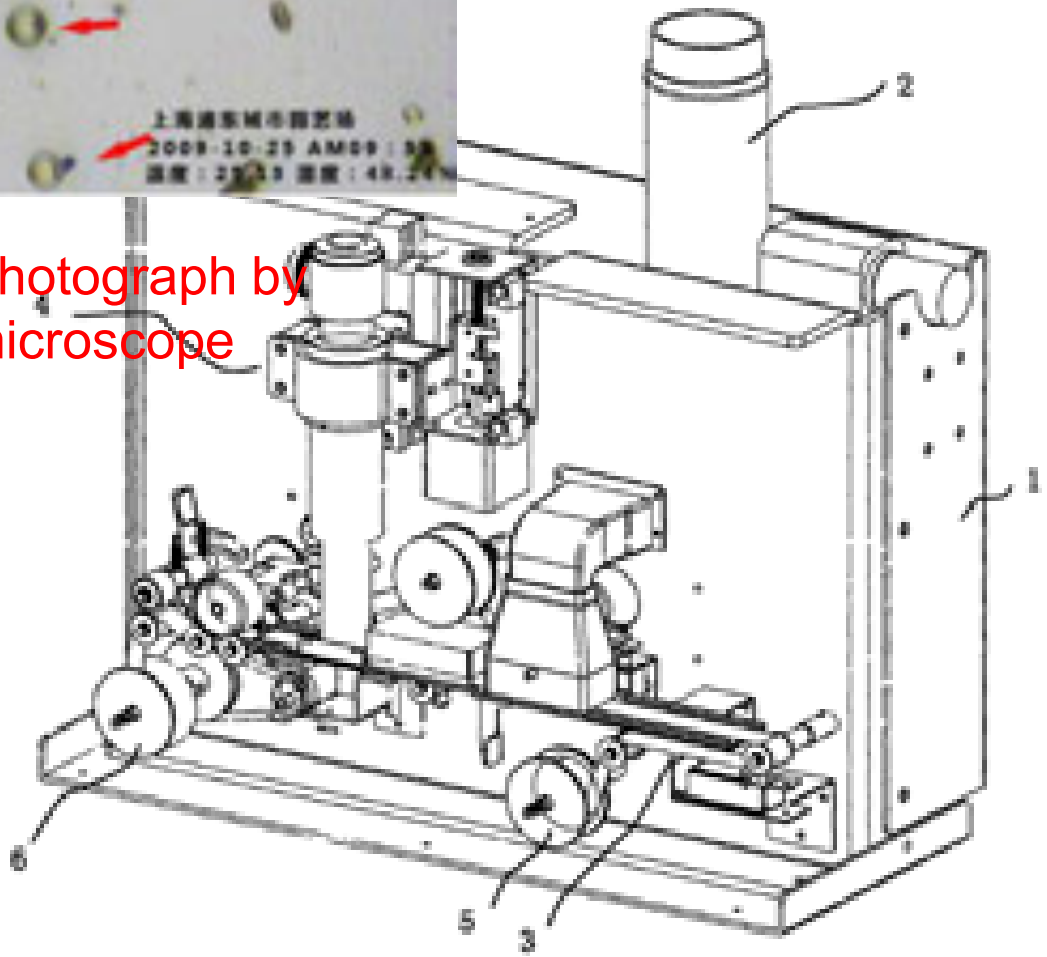
(1) Pest monitoring equipment in fruits

Plant pathogen detection



Photograph by microscope

Micro spores collection



Patent: ZL201010178307.2

(2) Monitoring inside and outside environment of the facilities

NERCITA has developed ten types greenhouse sensors

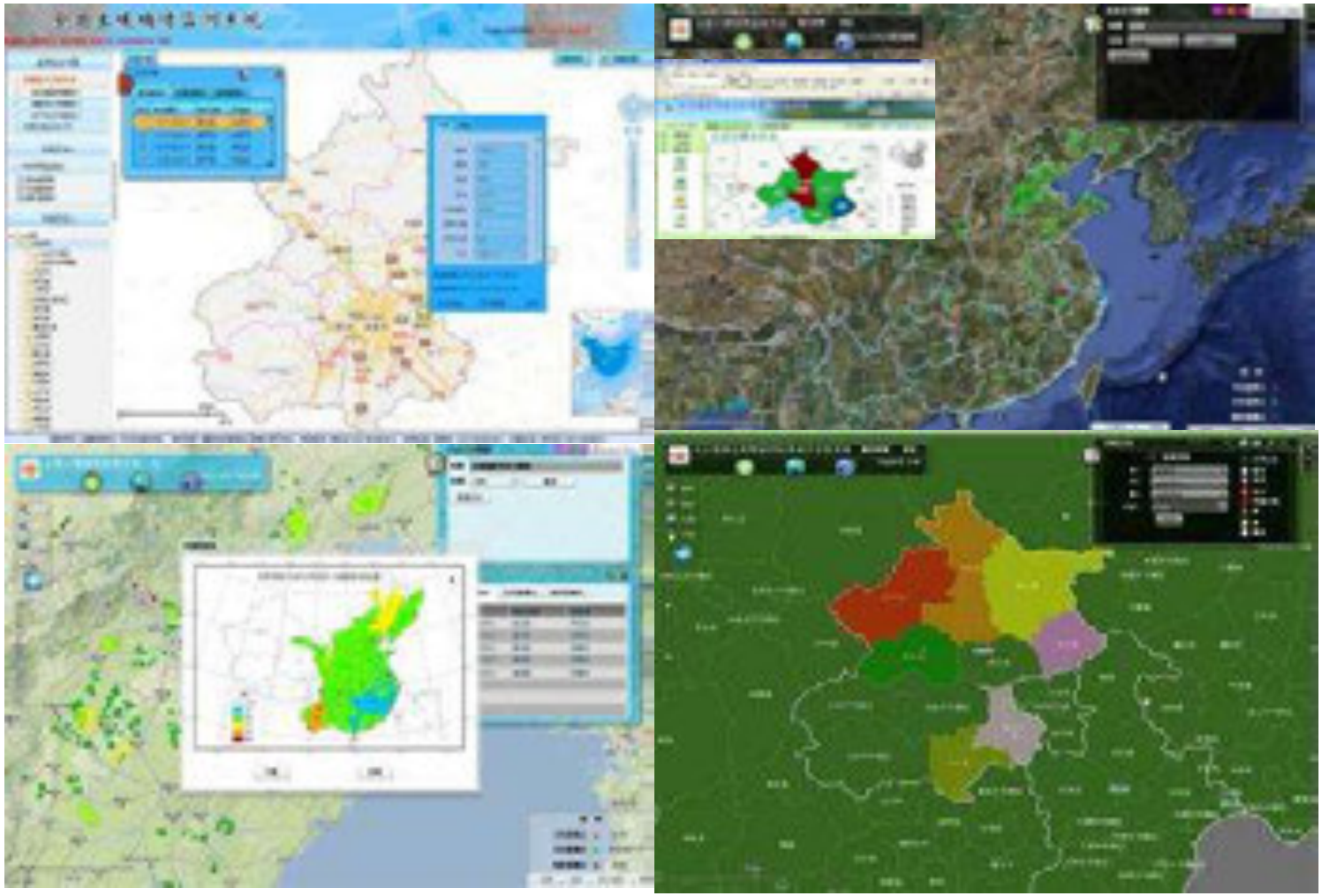
- **Technologies: drift suppressing, nonlinearity compensation**
- **Advantages: precision, stable, consistent**
- **Practical use: information acquisition in greenhouse**

Soil moisture monitoring

Integrated station

Indicators	Functions
Soil info	Four channel of soil temperature, soil moisture and eight channel for other sensors.
Weather parameters	Air temperature, relative humidity, wind velocity, wind direction, solar radiation, atmosphere, rainfall, ET
Display	LCD touch screen
Communication	GPRS,GSM,WAN
Protocol	Standard MODBUS
Data storage	20000 rows
Programming	Online programming
Transfer method	At different interval, called by cell phone

Web specific map and short message services



Agricultural soil moisture disclose and service software

农业部办公厅文件

农办农[2010]80号

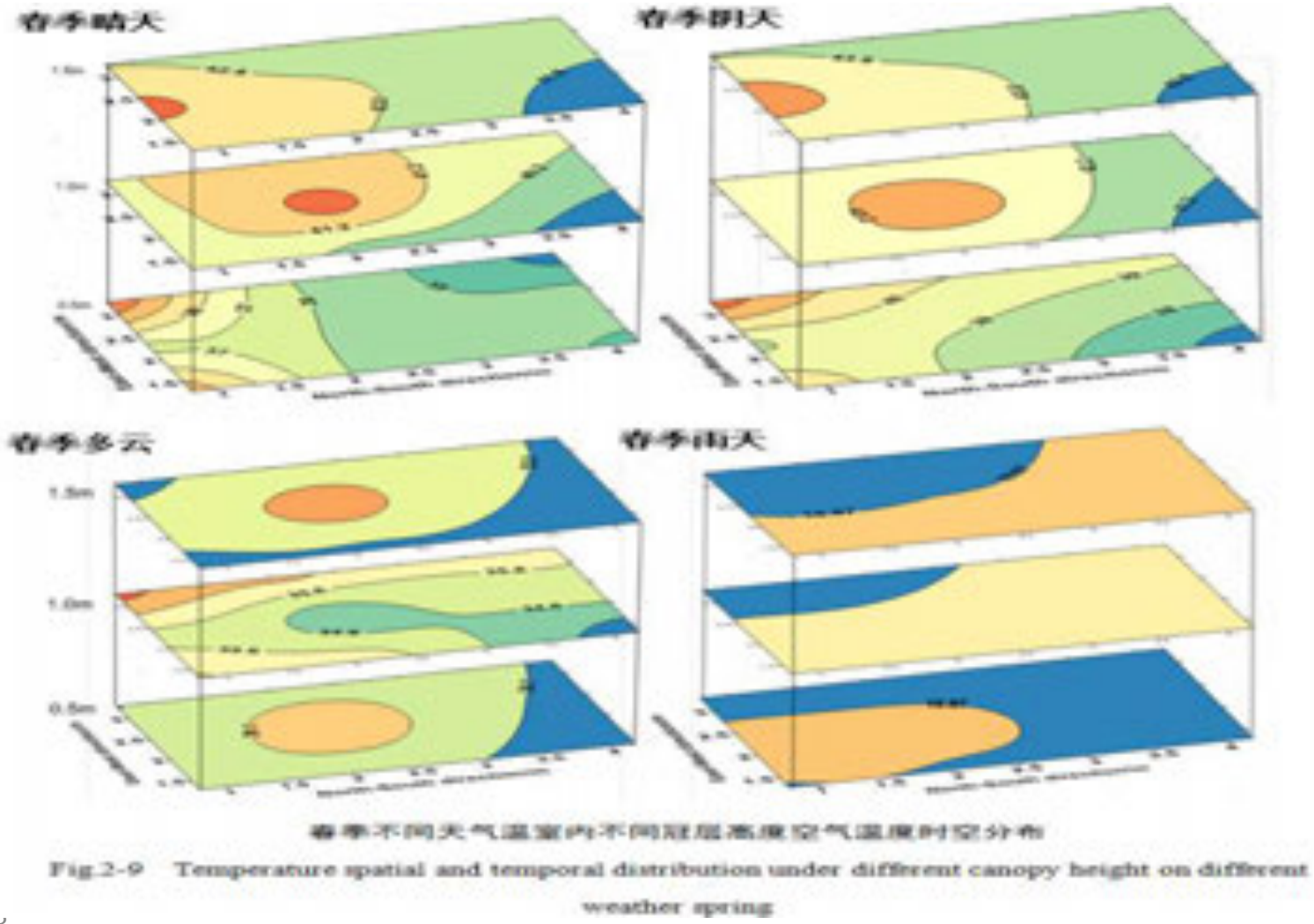
农业部办公厅关于做好土壤墒情
监测工作的通知

各省、自治区、直辖市农业（农牧）厅（委、局），新疆生产建设兵团农业局：

农业部办公厅关于印发《全国土壤墒情监测工作方案》的通知

- The system has got the funding of 800 million RMB from MOA since 2012

Time-space distribution of greenhouse environment

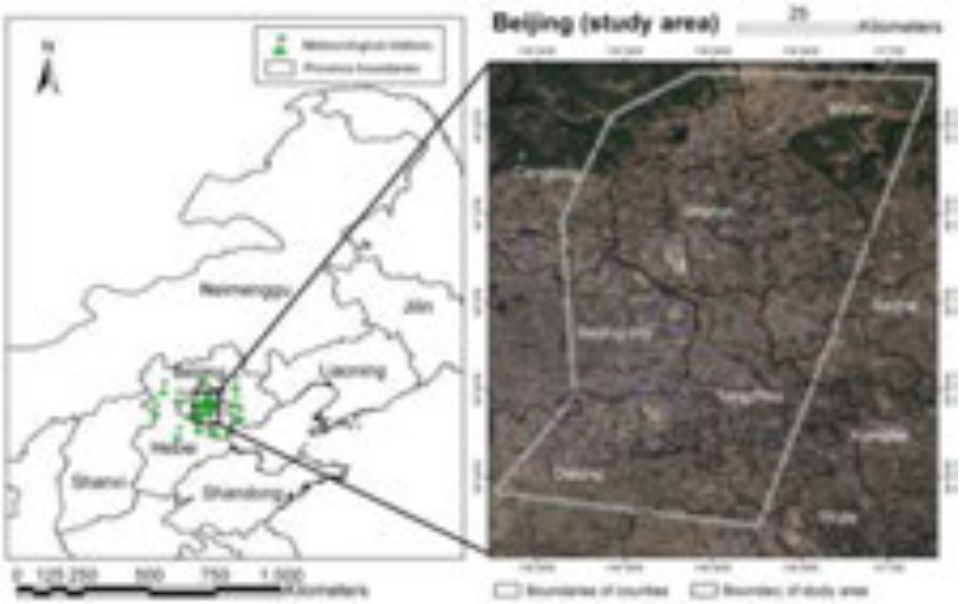


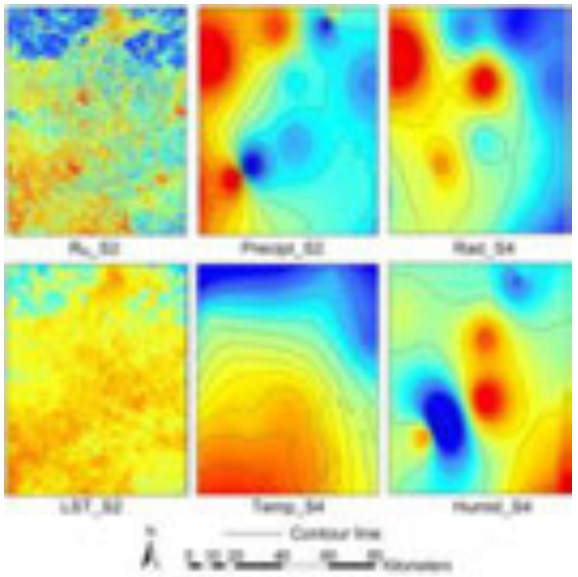
春季不同天气温室内不同冠层高度空气温度时空分布

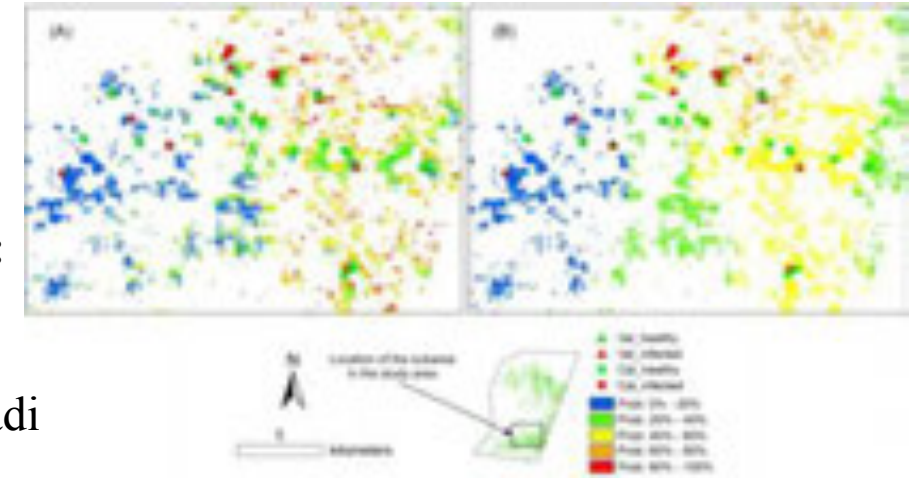
Fig.2-9 Temperature spatial and temporal distribution under diffirent canopy height on diffirent weather spring

Northern horticulture，2015

Environment monitoring combing remote sensing and meteorology information







- **Vegetarian status variables:**

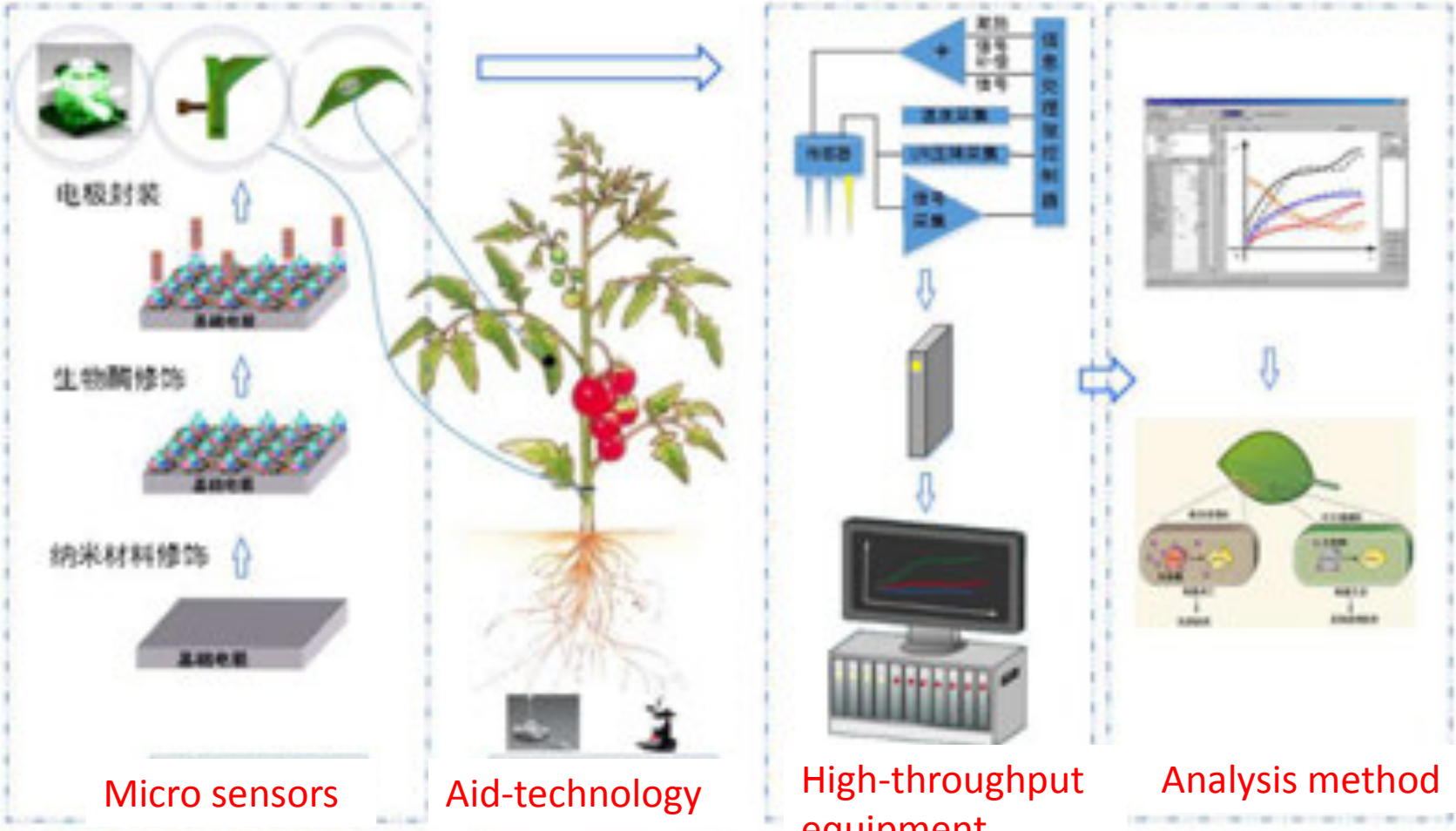
TVI, SAVI, DSWI, SIWSI

- **Farm environment variables:**

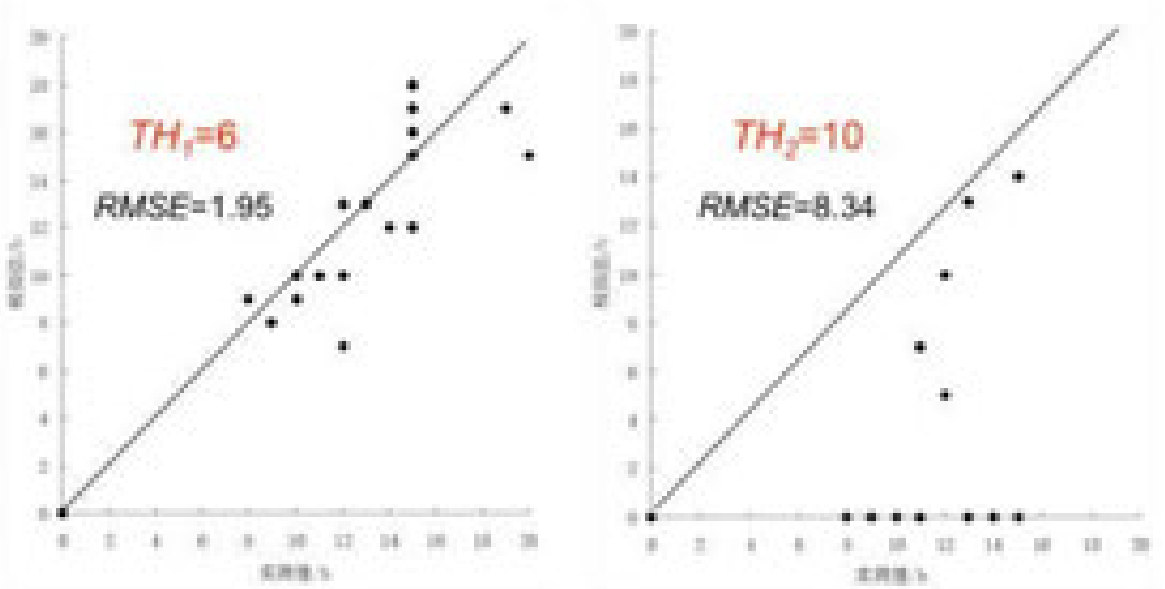
Land surface temperature (LST)

Temperature, rainfall, humidity, radi ation

(3) Host phenotyping: Hyperspectral, High-throughput, online



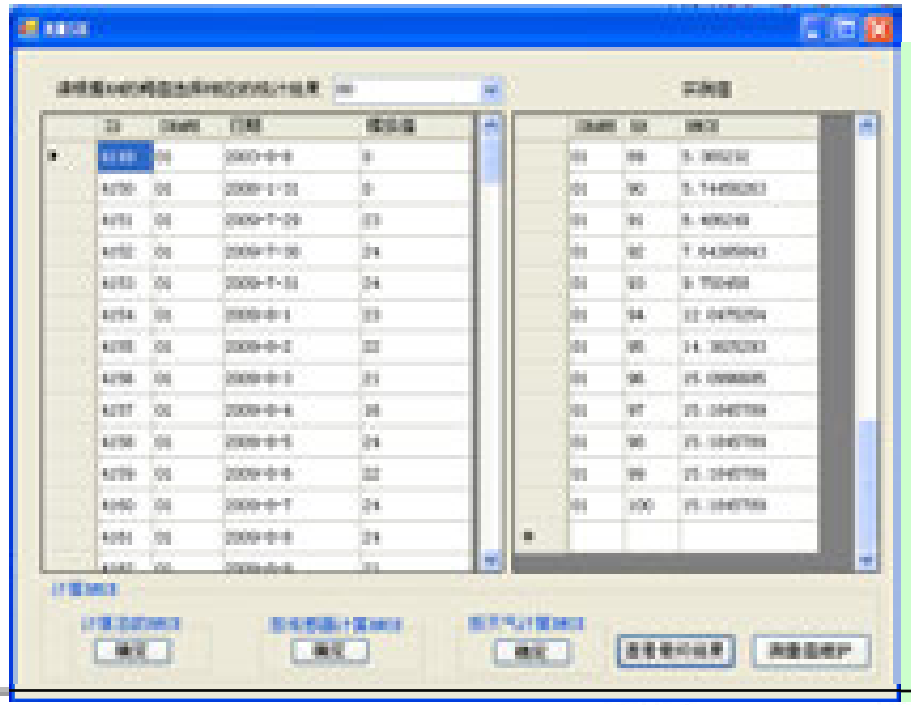
The calibration method for leaf wetness sensors



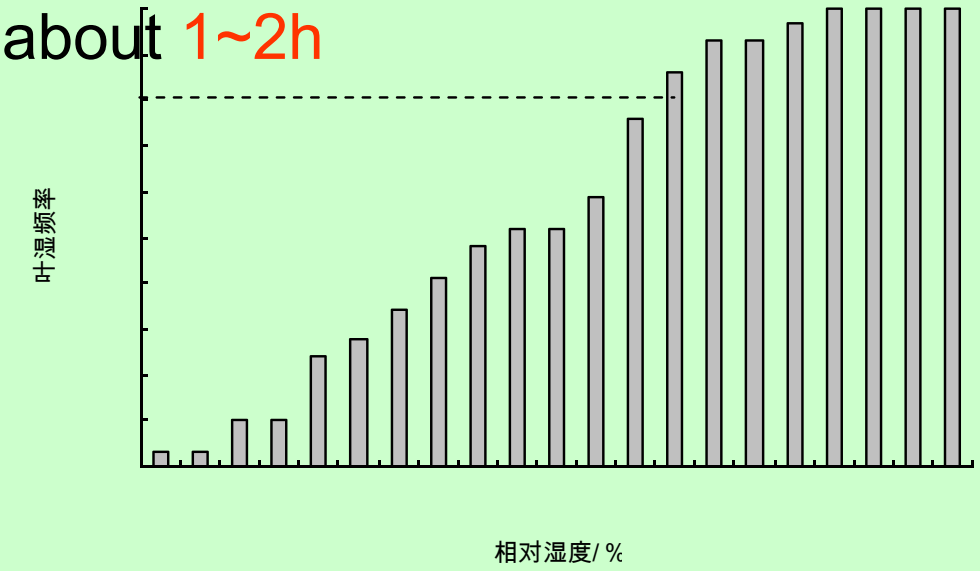
叶片部位	准确率F_c	灵敏度C_{si}	误报率F_{AR}	偏差率B_s
左侧叶缘	0.75	0.25	0.36	0.46
右侧叶缘	0.79	0.23	0.16	0.29
叶尖	0.83	0.28	0.15	0.35
叶背面	0.63	0.13	0.48	0.29
[illegible]	0.70	0.12	0.08	0.14

(Li et al., Transaction of CSAE, 2010b)

The estimation model based on RH



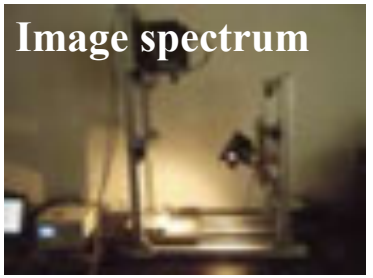
RH≥89% or 90%, the errors are about 1~2h

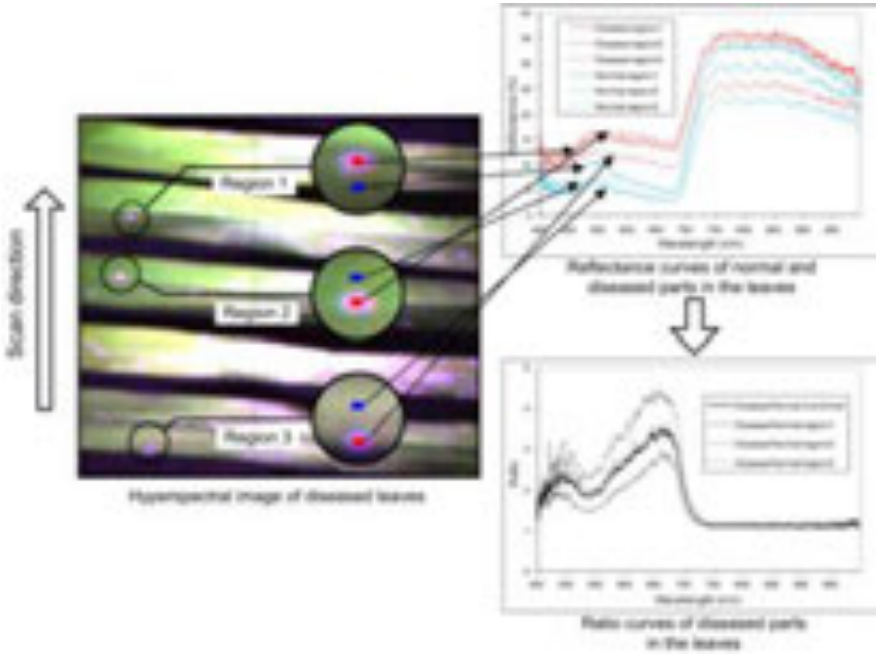


	a	*b/h*	R^2	*W*	*C*	*MAE/h*	*MBE/h*
试错法	1.22	-3.17	0.73	0.89	0.82	2.03	0.03
平均值法	1.25	-2.86	0.74	0.89	0.82	2.14	0.76
叶湿频率法	1.27	-6.58	0.62	0.78	0.69	3.55	-2.65

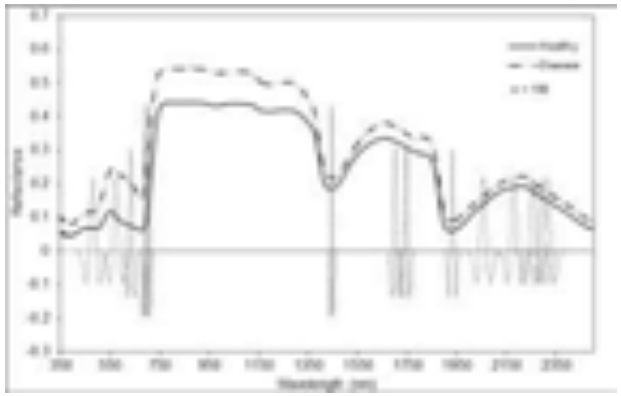
(Li et al., Transaction of CSAE, 2010c)

Crop disease spectrum characteristics and info abstraction

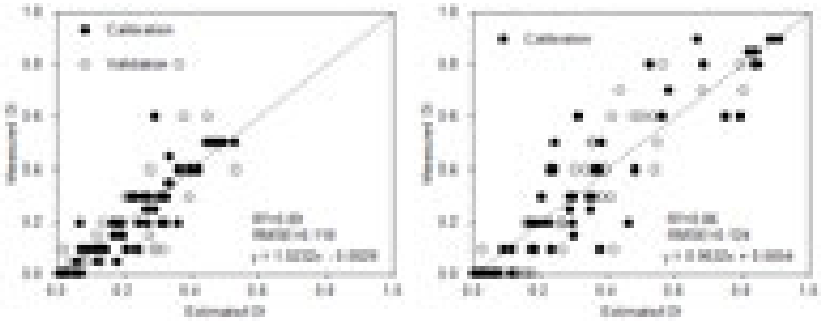




Analysis and process of image spectrum information



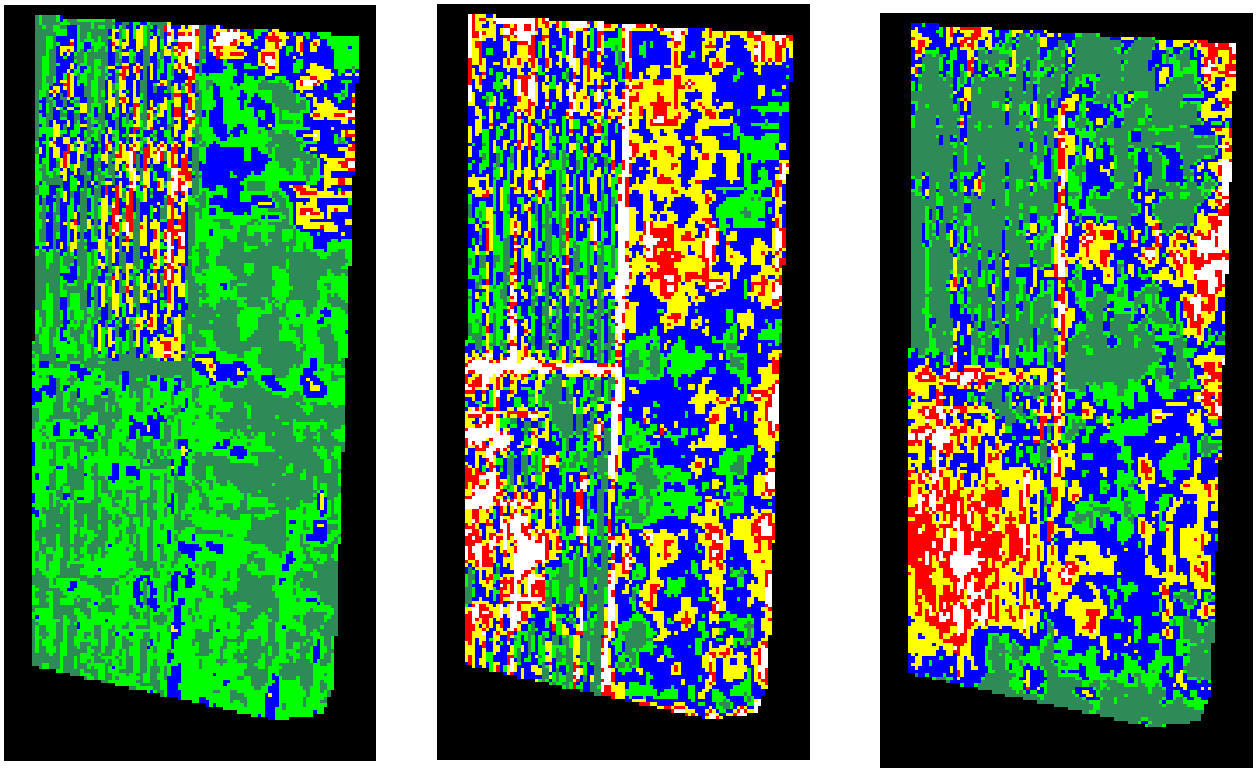
Spectrum abstraction



Disease intensity modeling

Crop disease monitoring

$$Disease\_index = \frac{R_{Disease} - R_{Normal}}{R_{Normal}} \times \frac{NIR_{Normal} - NIR_{Disease}}{NIR_{Normal}}$$

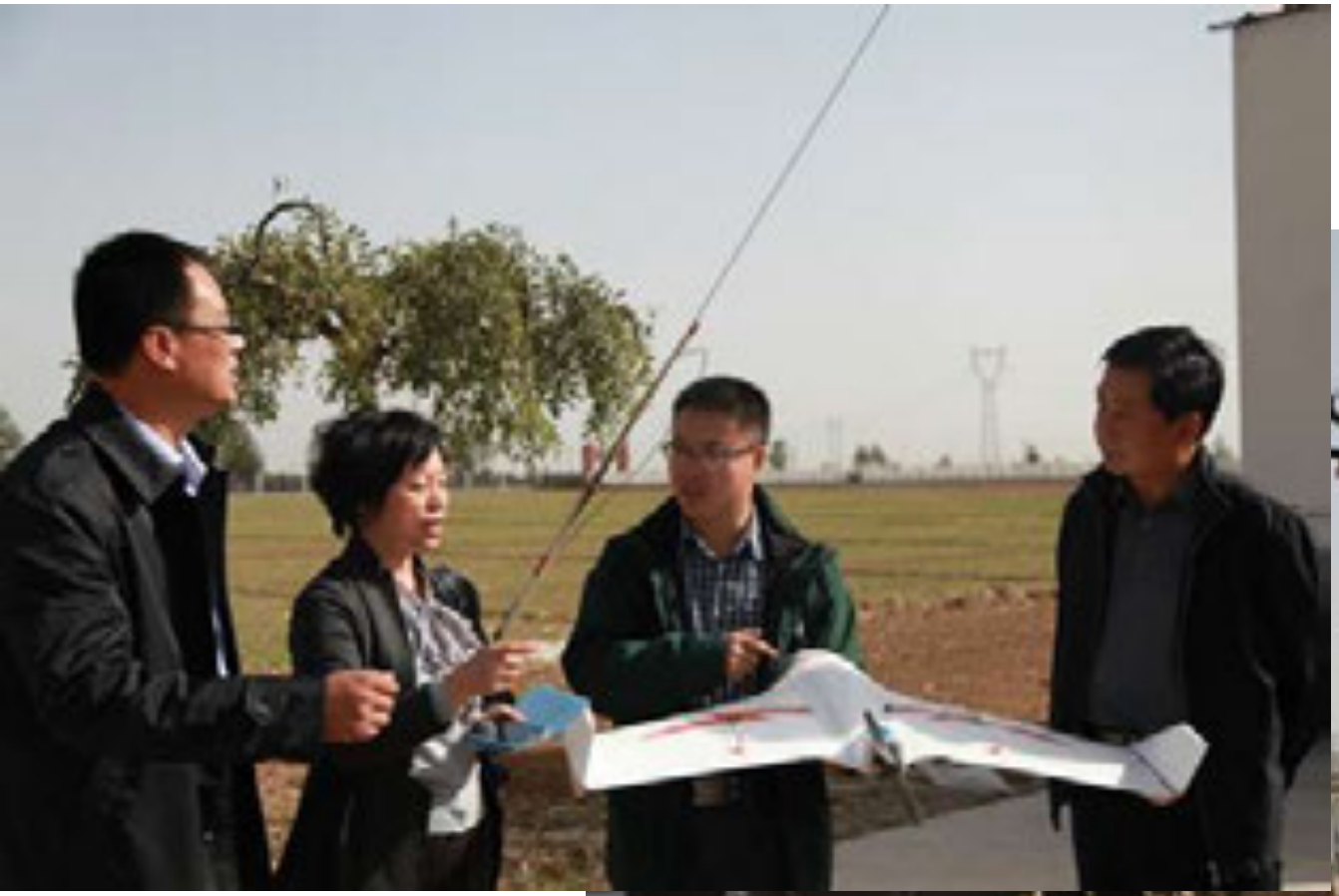


PHI image spectrum based disease index monitoring in different stages

NERCITA has developed five crop information analysis systems

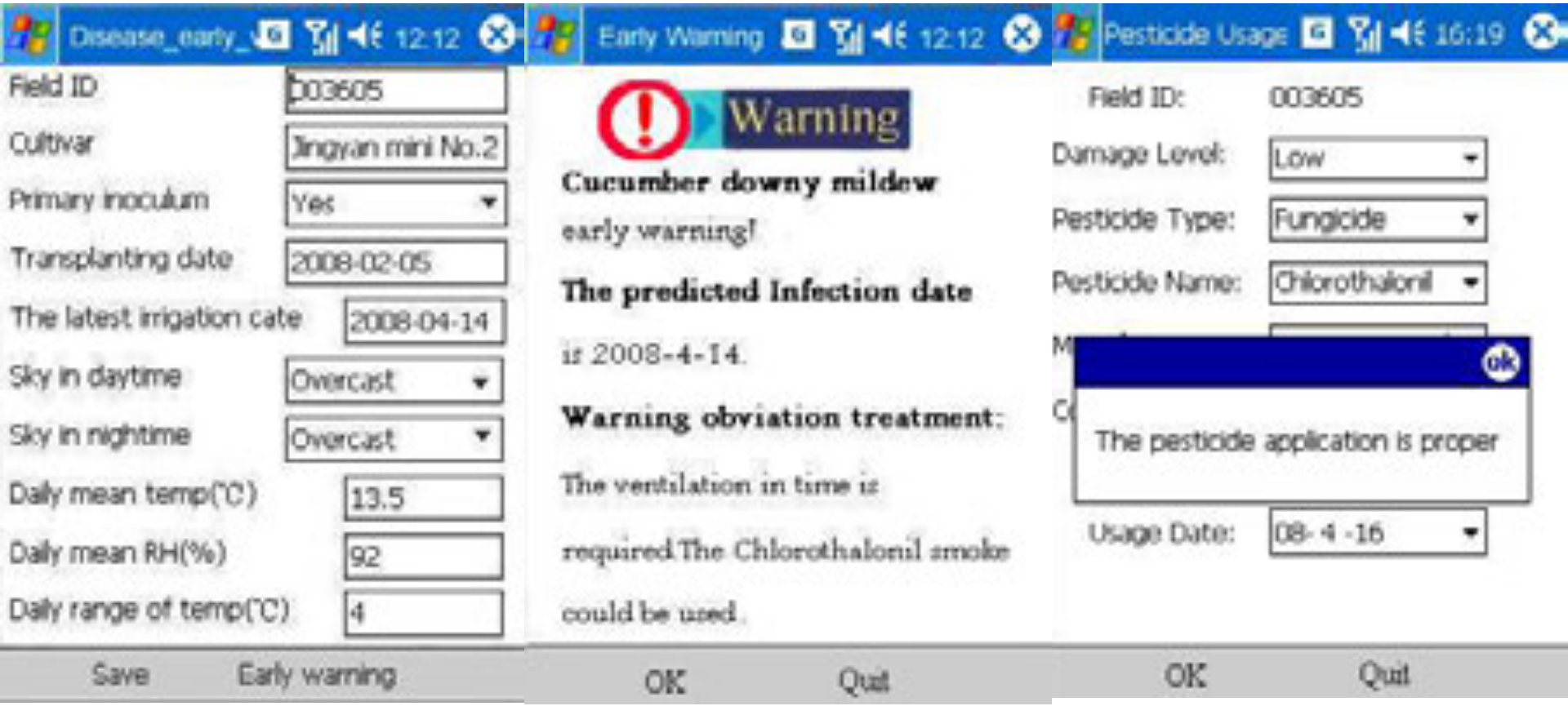
With machine vision and Hyperspectral technologies, we have realized non-damage detection for greenhouse crop nutrition, growth diagnosis, main agricultural parameters.

UAV in application



(4)Portable agricultural record keeping system

Production record keeping system

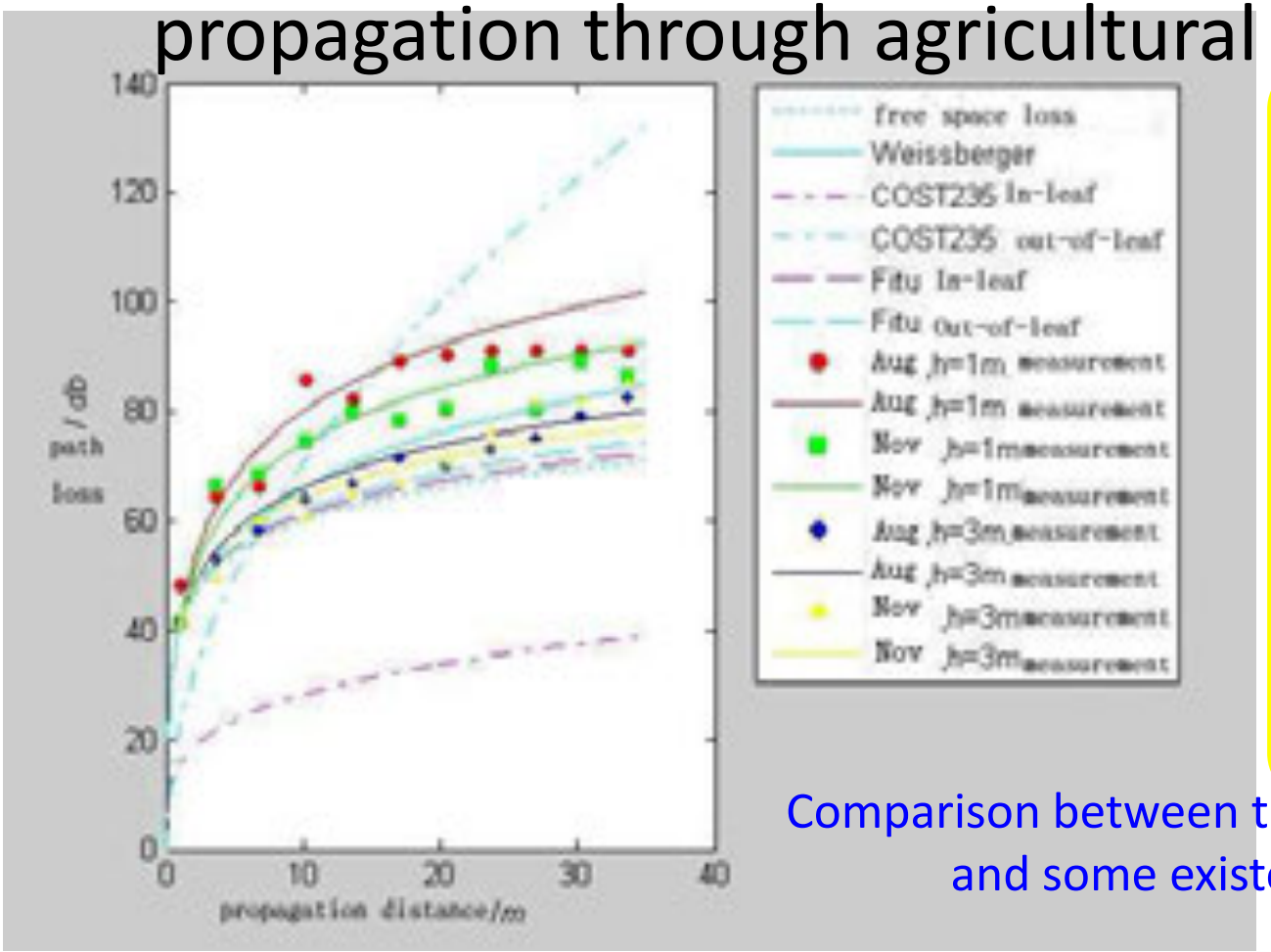


Field image monitoring

病斑面积识别

(5) Wireless Sensor Network application

- Research on characteristics of radio propagation through agricultural environment



Comparison between the measured data and some existed models

Conclusions

The existed models fail in estimating the path loss in orchard.

The path loss change great in different heights at the same time

Great change exists in path loss at different times in the same height.

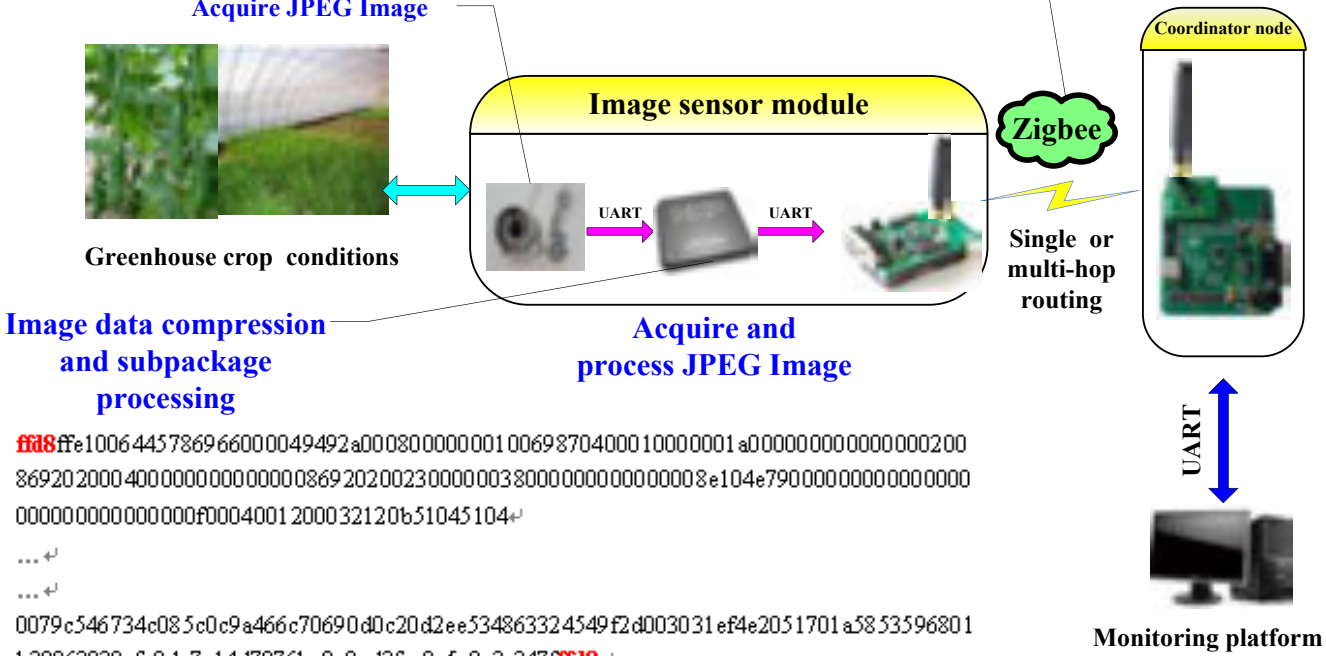
The new model can well estimate the path loss in different height and times.

(5) Wireless Sensor Network application

- ZigBee-based wireless sensor network image transmission technology

2Bytes	2Bytes	8Bytes	1Bytes	1Bytes	0-80Bytes
0xFF 0xD8	ZigBeeNetwork layer address	ZigBee MAC layer address	Serial number	Data payload Length	Data payload

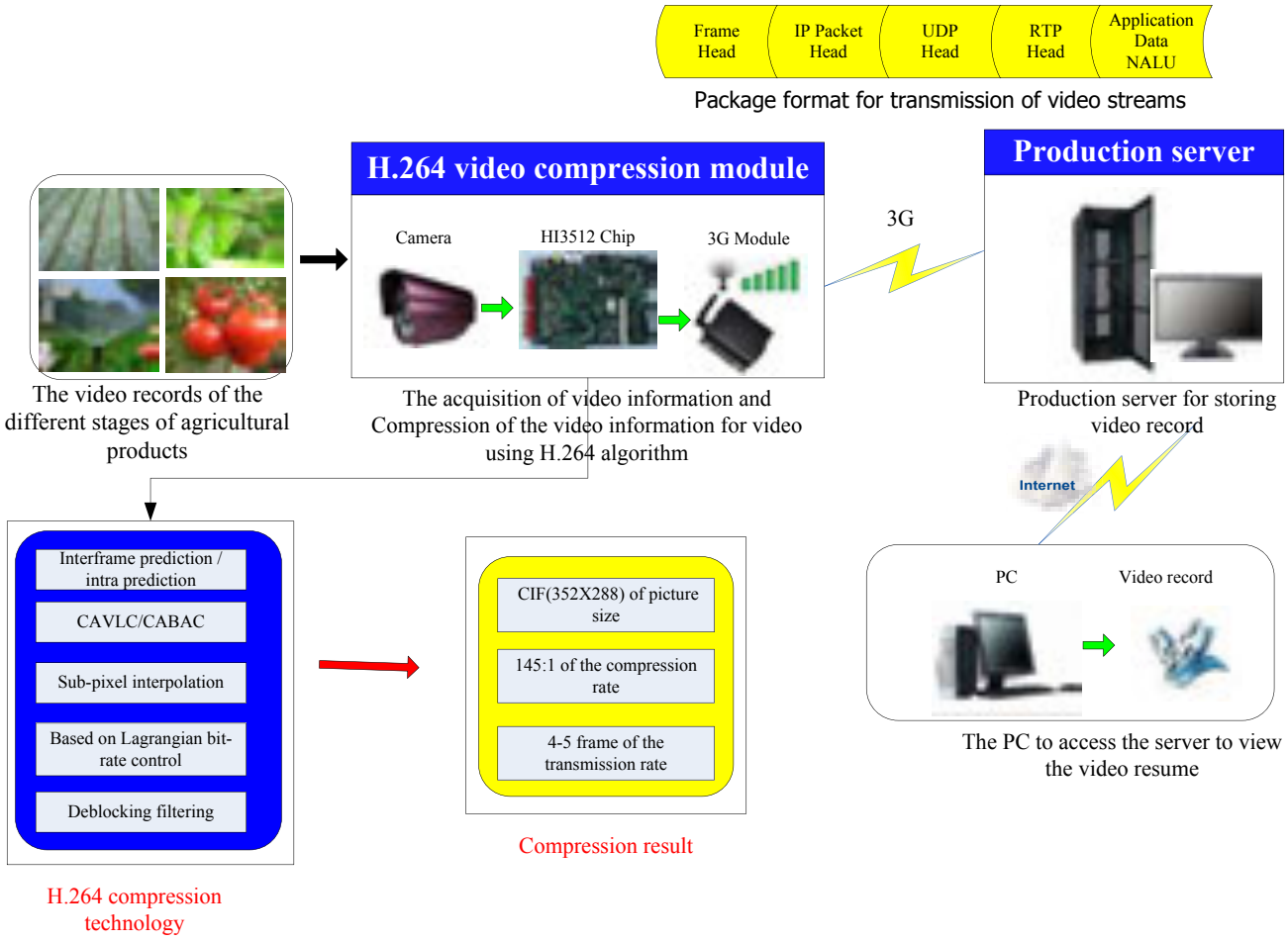
Image data packet format



ffd8ffe1006445786966000049492a0008000000010069870400010000001a000000000000000200
869202000400000000000000869202002300000038000000000000008e104e790000000000000000
0000000000000000f0004001200032120b51045104↵
…↵
…↵
0079c546734c085c0c9a466c70690d0c20d2ee534863324549f2d003031ef4e2051701a5853596801
b29063938cfc8dc7e14d7076be0e0ed3fca9a5a8e3a347ffffd9↵

(5) Wireless Sensor Network application

- H.264 video compression technology



3.3 Model establishment

Field experiment

Clarifying the meaning of warning

- These warnings would include disease occurrence (yes or no) and its probability.

Table 1
Categories and a summary of calculation results of the early warning model for primary infection of cucumber downy mildew in solar greenhouses (EWMPICDW) in each day.

N	Estimated – Yes	Estimated – No
Observed – Yes	Hits (*X*)	Misses (*Y*)
Observed – No	False alarms (*S*)	Correct negatives (*Z*)

Forecasting the warning situation

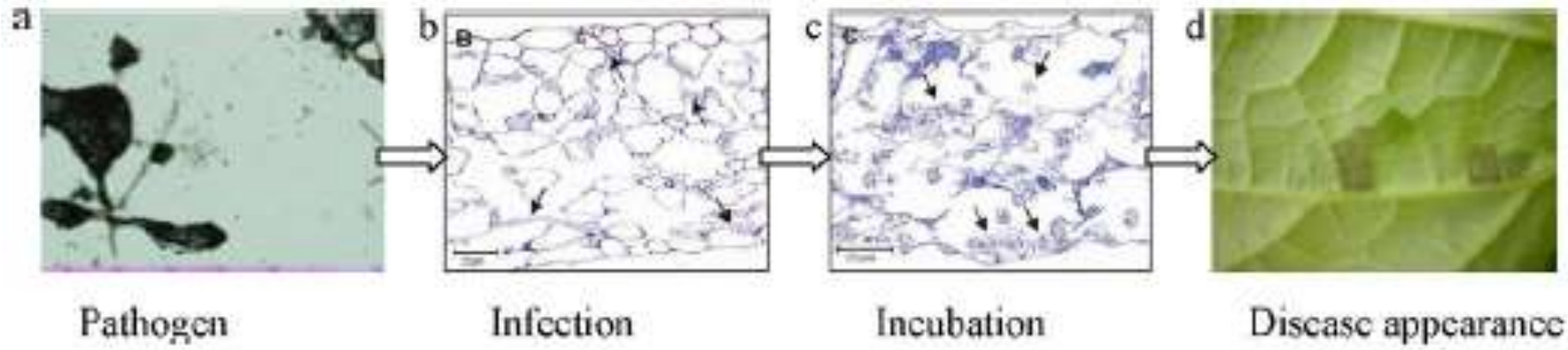


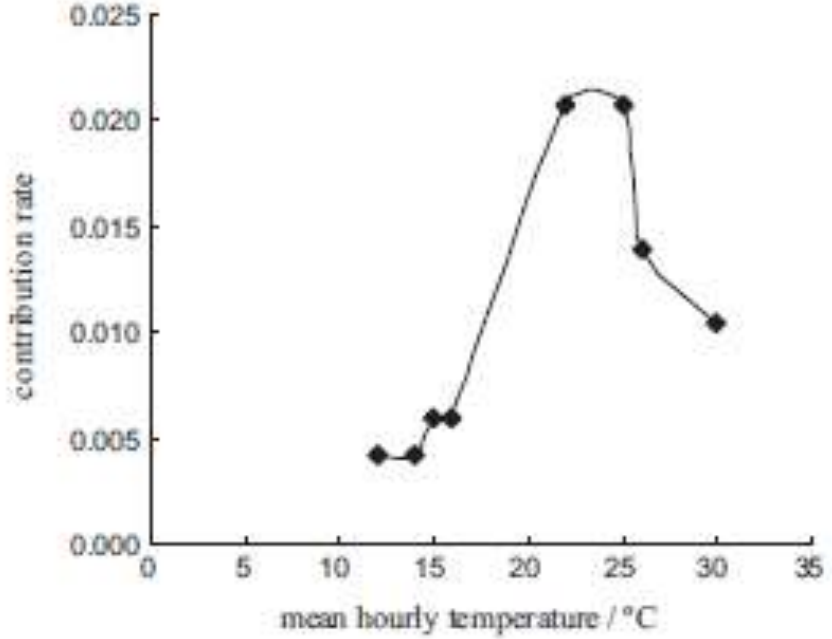
Fig. 3. The primary infection mechanism of cucumber downy mildew.

(Lindenthal et al., 2005)

- Infection condition early warning sub model
  - **LWD × TLWD ≥ 40 h ℃ (LWD ≤ 2h,**
  - **5 ℃ ≤ TLWD ≤ 30 ℃) (Cohen, 1977)**

Forecasting the warning situation

- Incubation period early warning sub model



(Fu and Yao, 1983)

Fig. 4. Fitted curve of the mean hourly temperature and contribution rate for incubation of cucumber downy mildew in solar greenhouses.

$$y = \frac{0.0165}{1 + 10389.2 \times \exp(-0.5743 \times t)} \quad (p = 0.0033)$$

Validation by 4-year data

Table 2
Disease investigation results in Xiaotangshan and BAAFS.

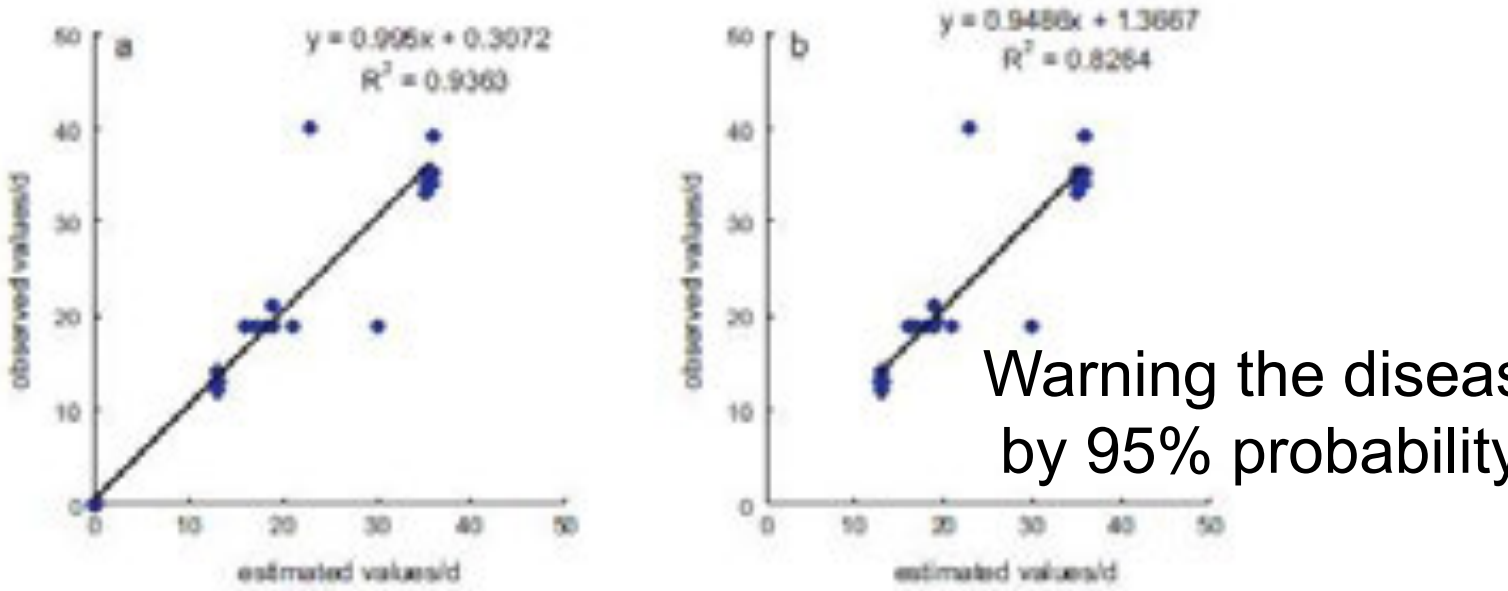
Year	Point	Predicted infection date	Predicted occurrence date	Observed occurrence date	Year	Point	Predicted infection date	Predicted occurrence date	Observed occurrence date
Xiaotangshan					BAAFS				
2006	1[a]	21-October	26-October	26-October	2008	31[b]	N	N	N
2006	2[a]	21-October	26-October	26-October	2008	32[b]	N	N	N
2006	3[a]	21-October	26-October	26-October	2008	33[b]	N	N	N
2006	4[a]	21-October	26-October	26-October	2008	34[a]	30-October	4-November	21-November
2006	5[a]	21-October	26-October	26-October	2008	35[c]	2-December	10-December	20-November
2006	6[a]	21-October	26-October	26-October	2008	36[a]	13-November	17-November	20-November
2006	7[a]	21-October	26-October	26-October	2008	37[a]	12-November	17-November	16-November
2006	8[a]	21-October	26-October	26-October	2008	38[c]	2-December	9-December	16-November
2006	9[a]	21-October	26-October	26-October	2008	39[c]	25-November	1-December	14-November
2006	10[a]	21-October	26-October	26-October	2008	40[a]	11-November	16-November	16-November
2006	11[a]	21-October	26-October	26-October	2008	41[a]	12-November	17-November	13-November
2006	12[a]	21-October	26-October	26-October	2008	42[c]	N	N	14-November
2006	13[a]	21-October	26-October	27-October	2008	43[b]	N	N	N
2006	14[a]	21-October	26-October	26-October	2008	44[c]	11-November	16-November	14-November
2006	15[a]	21-October	26-October	26-October	2008	45[d]	11-November	16-November	15-November
2007	16[a]	13-February	21-February	24-February	2009	46[a]	16-April	20-April	19-April
2007	17[a]	21-February	7-March	24-February	2009	47[b]	N	N	N
2007	18[a]	16-February	24-February	24-February	2009	48[b]	N	N	N
2007	19[a]	15-February	24-February	26-February	2009	49[d]	16-April	20-April	19-April
2007	20[a]	16-February	26-February	24-February	2009	50[b]	N	N	N
2007	21[a]	16-February	24-February	24-February	2009	51[c]	N	N	20-April
2007	22[a]	14-February	21-February	24-February	2009	52[b]	N	N	N
2007	23[a]	16-February	24-February	26-February	2009	53[b]	N	N	N
2007	24[a]	13-February	21-February	24-February	2009	54[c]	N	N	20-April
2007	25[a]	16-February	23-February	24-February	2009	55[c]	N	N	20-April
2007	26[b]	N[e]	N	N	2009	56[b]	N	N	N
2007	27[b]	N	N	N	2009	57[b]	N	N	N
2007	28[b]	N	N	N	2009	58[b]	N	N	N
2007	29[b]	N	N	N	2009	59[b]	N	N	N
2007	30[b]	N	N	N	2009	60[b]	N	N	N

[a] The predicted infection date or predicted occurrence date was earlier than the observed occurrence date.
[b] The cucumber downy mildew did not appear, and the model did not present early warning (true negative points, TNP).
[c] The model did not present infection and occurrence early warning before the observed occurrence date.
[d] The predicted infection date was earlier than the observed occurrence date, but predicted occurrence date was later than the observed occurrence date.
[e] N denoted no predicted infection, predicted disease occurrence or observed disease occurrence.

Model evaluation

Table 4
Bayesian analysis of early warning results of the early warning model for primary infection of cucumber downy mildew in solar greenhouses (EWMPICDW).

	Estimated – Yes	Estimated – No	Total number	Prior probability	Posterior probability
Observed – Yes	X = 84 $P(B\|A)$ = 0.68	Y = 39 $P(\bar{B}\|A)$ = 0.32	123	$P(A)$ = 0.68	$P(A\|B)$ = 0.96
Observed – No	Z = 34 $P(B\|\bar{A})$ = 0.06	Z = 578 $P(\bar{B}\|\bar{A})$ = 0.94	612	$P(\bar{A})$ = 0.32	$P(\bar{A}\|\bar{B})$ = 0.58
Total number	118	464	735		



Warning the disease by 95% probability

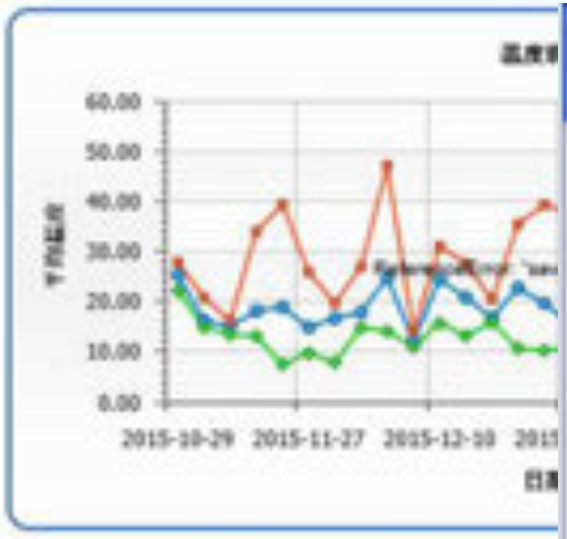
Fig. 5. Comparison of the occurrence date between observed values and estimated values under the early warning model for primary infection of cucumber downy mildew in solar greenhouses (EWMPICDW).

(Zhao et al., Computers and Electronics in Agriculture2011)

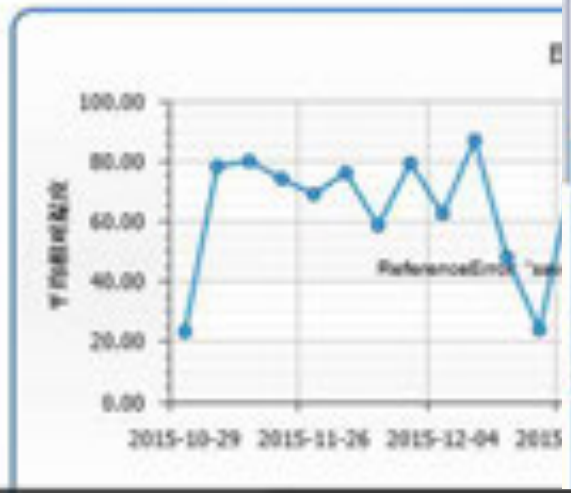
3.4 Decision and conducting

Early warning system application

http://scjcyj.tjny.gov.cn/ITPFV/login.aspx



下图是走棚以来每日



黄瓜霜霉病预警模型

（1）菌源条件

如果温室前茬种植过黄瓜或发生过黄瓜霜霉病，或者附近温室或露地发生黄瓜霜霉病，就具备菌源条件。

（2）初侵染预警

计算每天的叶片湿润时间。叶片湿润时间的获得，采用每天超过93%的相对湿度的小时数作为估计。计算叶片湿润时间内的平均温度。

$LWD*TLWD\geq 40$ ($LWD\geq 2$，$5\leq TLWD\leq 30$)

式中：*LWD*——叶片湿润时间，h；*TLWD*——叶片湿润时间内的平均温度，℃。满足上述条件，霜霉病菌就可能侵染。

（3）潜育期/发病日期预警

此后开始启动每小时平均温度t与潜育期贡献率y的模型公式。当y累计达到1时，潜育期结束。式中：y——潜育期贡献率，无量纲；t——每小时的平均温度，℃。

$$y=\frac{0.0165}{1+10389.2\cdot\exp(-0.5743\cdot t)}$$

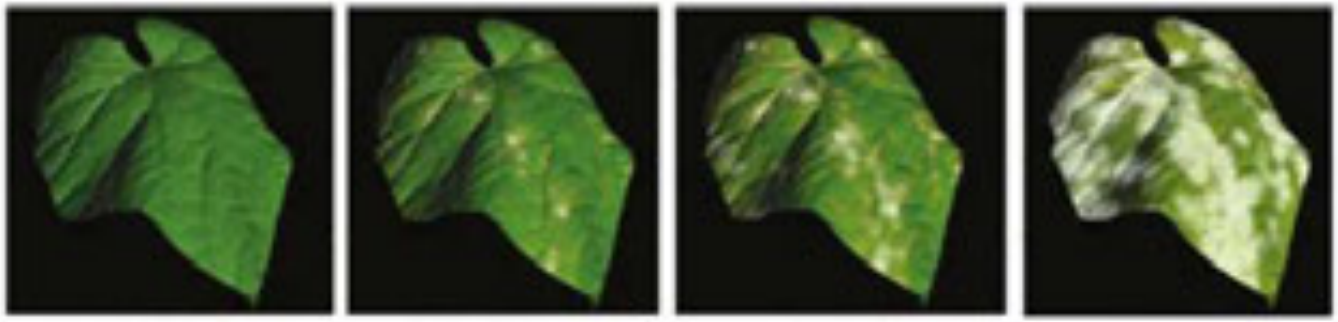
（4）发病概率预警

级别	绿	蓝	黄	橙	红
初侵染发生分级	无警	轻警	中警	重警	巨警
霜霉病初侵染发生概率a（%）	a=0低	0<a≤40较低	40<a≤60中等	60<a≤80较高	80<a≤100很高
对应温湿度范围	日均温低于15或高于25℃	日均温15-20℃，相对湿度60-	日均温15-20℃，相对湿度85%	日均温20-25℃，相对湿度60-	日均温20-25℃，相对湿度85%

Visual simulating appearance of plant leaves infected by disease and insect pests

Fig.7 Actual plant disease images

本文算法可通过病情调节参数 a，进而控制病情指数，进行定量化的病情模拟，图 8 为不同病情指数下白粉病表观模拟（D_0=0.44，P_{19}=0.47）。与图 7a 进行对比可知，本文方法在病斑分布、霉层表现等方面均符合实际病斑的特征。



注：D_0=0.44，P_{19}=0.47

Fig.8 Appearance of powdery mildew of cucumber of different disease indexes

Miao et al, 2014

New systems


CPRMS Ver1.0
农作物有害生物远程管理系统
全国农业技术推广服务中心
国家农业信息化工程技术研究中心


中国移动
下午1:47
20%
微信(2)
农产品质量安全服务
识别结果：59
识别结果：319
识别结果：319

Potato late blight warning system

Spraying machine

Robot for spraying

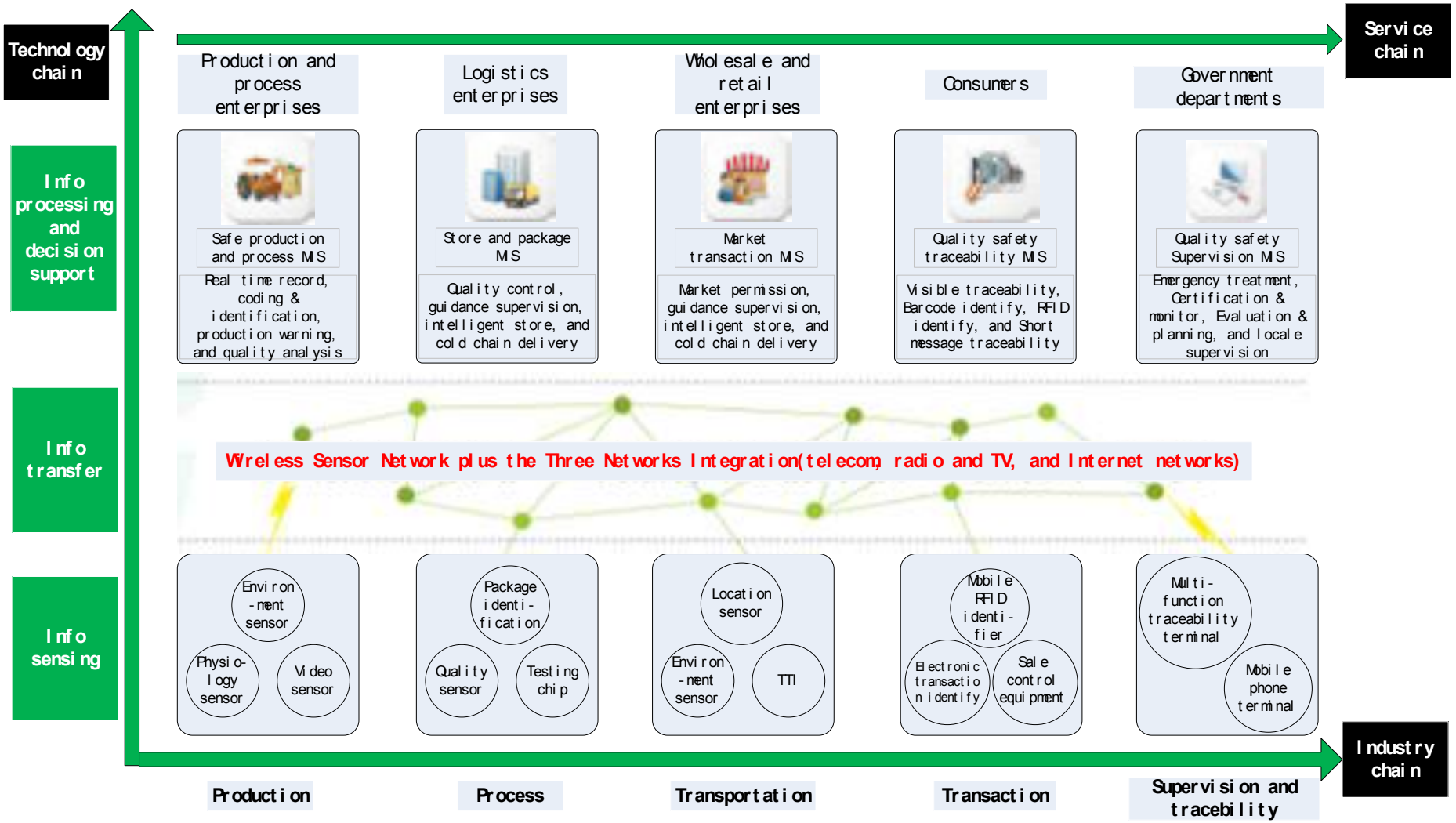
Robot platform for multi-span greenhouses

Remote Spay robot for solar greenhouses

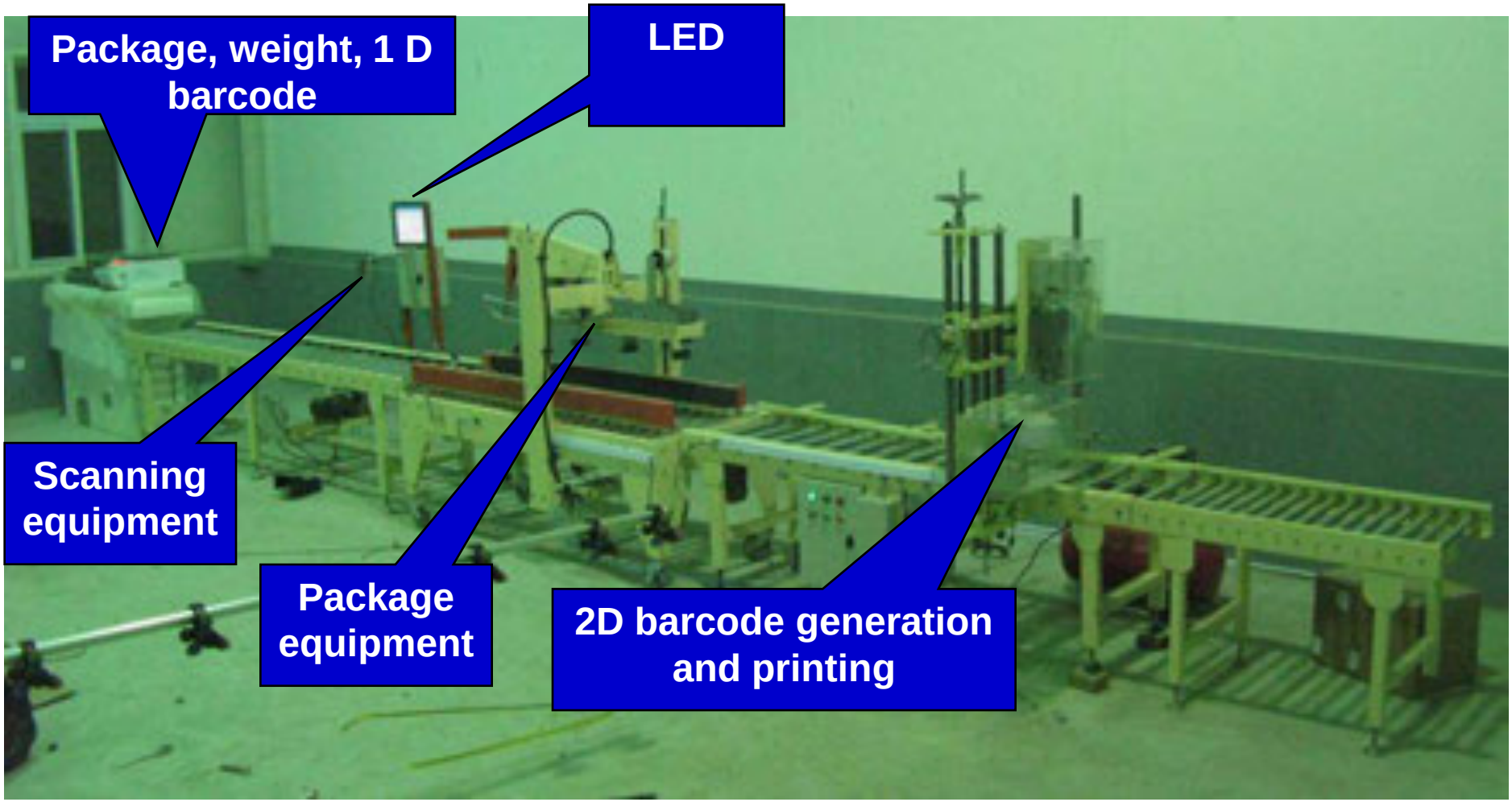
Variable rate spraying system based on machine vision

This kind of sensor-based variable rate sprayer can find weeds on-line in the field automatically, so where is weeds where is spraying.

4. Logistics

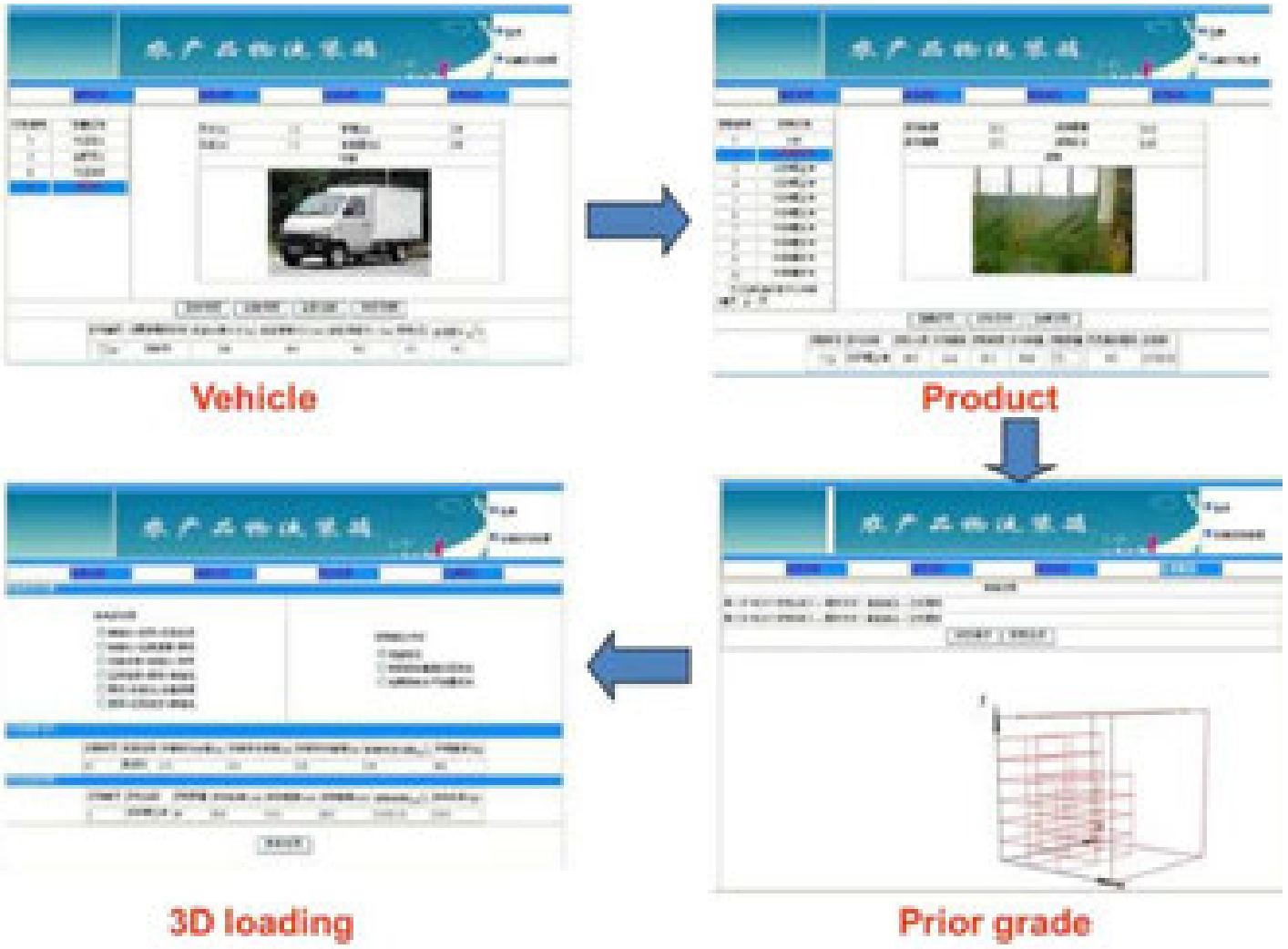

Technology chain
Service chain
Info processing and decision support
Info transfer
Info sensing
Production and process enterprises
Logistics enterprises
Wholesale and retail enterprises
Consumers
Government departments
Safe production and process MIS
Real time record, coding & identification, production warning, and quality analysis
Store and package MIS
Quality control, guidance supervision, intelligent store, and cold chain delivery
Market transaction MIS
Market permission, guidance supervision, intelligent store, and cold chain delivery
Quality safety traceability MIS
Visible traceability, Barcode identify, RFID identify, and Short message traceability
Quality safety Supervision MIS
Emergency treatment, Certification & monitor, Evaluation & planning, and locale supervision
Wireless Sensor Network plus the Three Networks Integration(telecom, radio and TV, and Internet networks)
Environ-ment sensor
Physio-logy sensor
Video sensor
Package identi-fication
Quality sensor
Testing chip
Location sensor
Environ-ment sensor
TTI
Mobile RFID identi-fier
Electronic transactio n identify
Sale control equipment
Multi-function traceability terminal
Mobile phone terminal
Industry chain
Production
Process
Transportation
Transaction
Supervision and tracebility

Auto packaging line for agricultural products

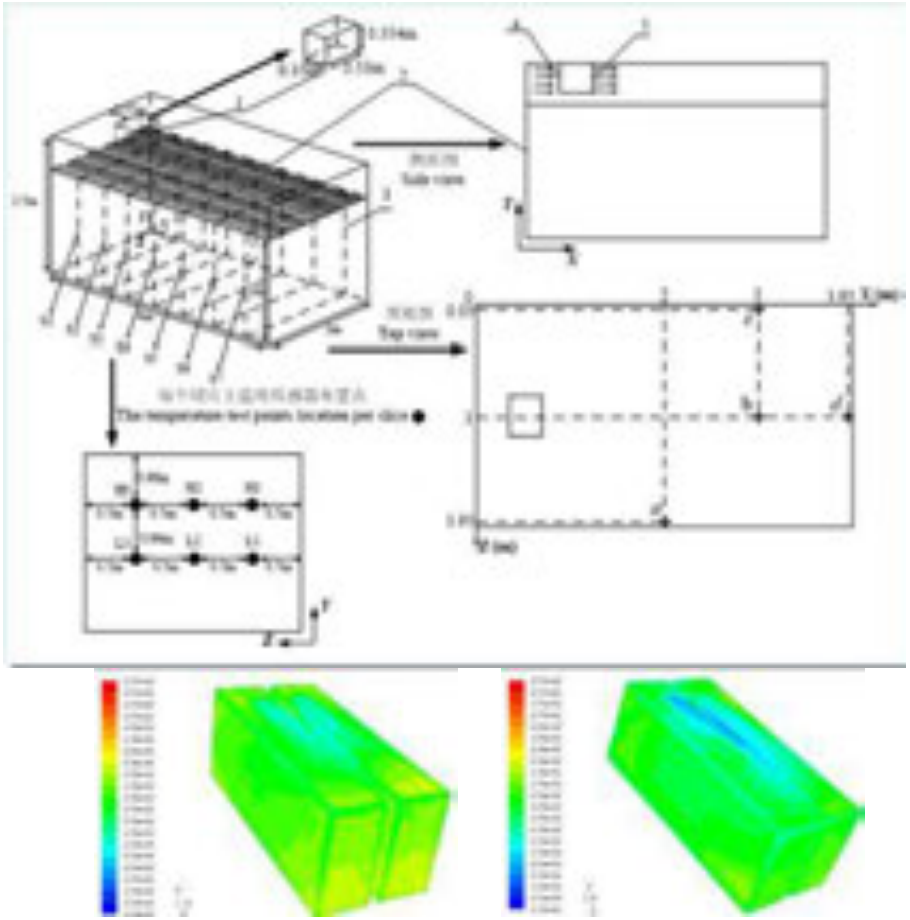


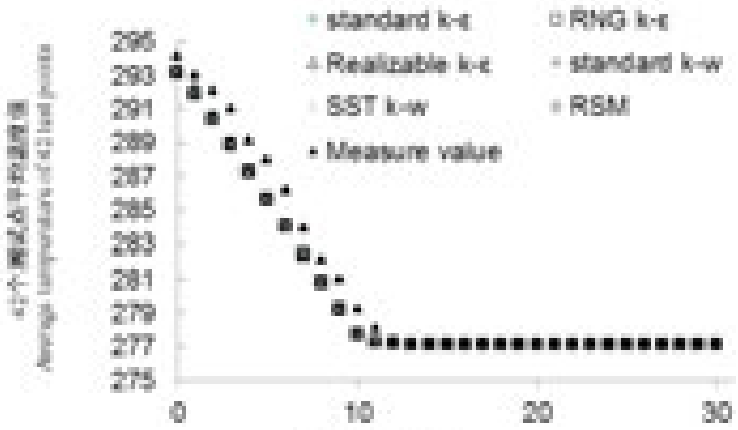
Logistics management system

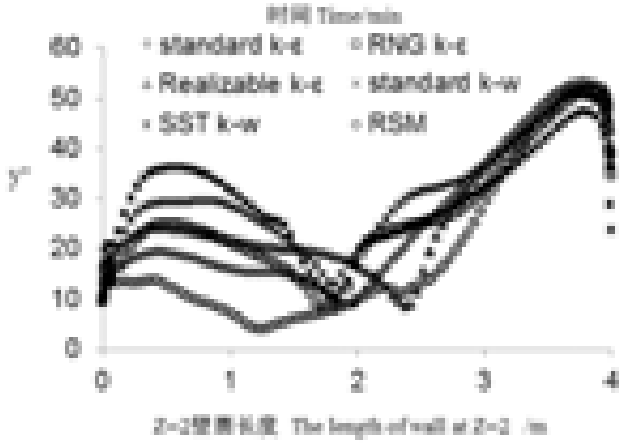
Logistics loading and 3D display



Temperature dynamic modeling in cold chain







Transaction management

- Electronic scale for traceability using barcode

Type	Portable	Pillar base	weigh-bridge
Max scope	**30Kg**	300Kg	1t or individual size
Division value	10g	20g	0.1kg
Main functions	Weighting, location, 2D barcode printing and data wireless transfer		
Characteristics	RFID identification	Multi-form of barcode printing	IPC control and touch screen
Applied scene	High-level agri-product, cooperative with direct package in field	Cooperatives or whole sale market with mid-amount	Cooperatives or whole sale market with big amount

Transaction management

- Transaction management system

Quality traceability-website

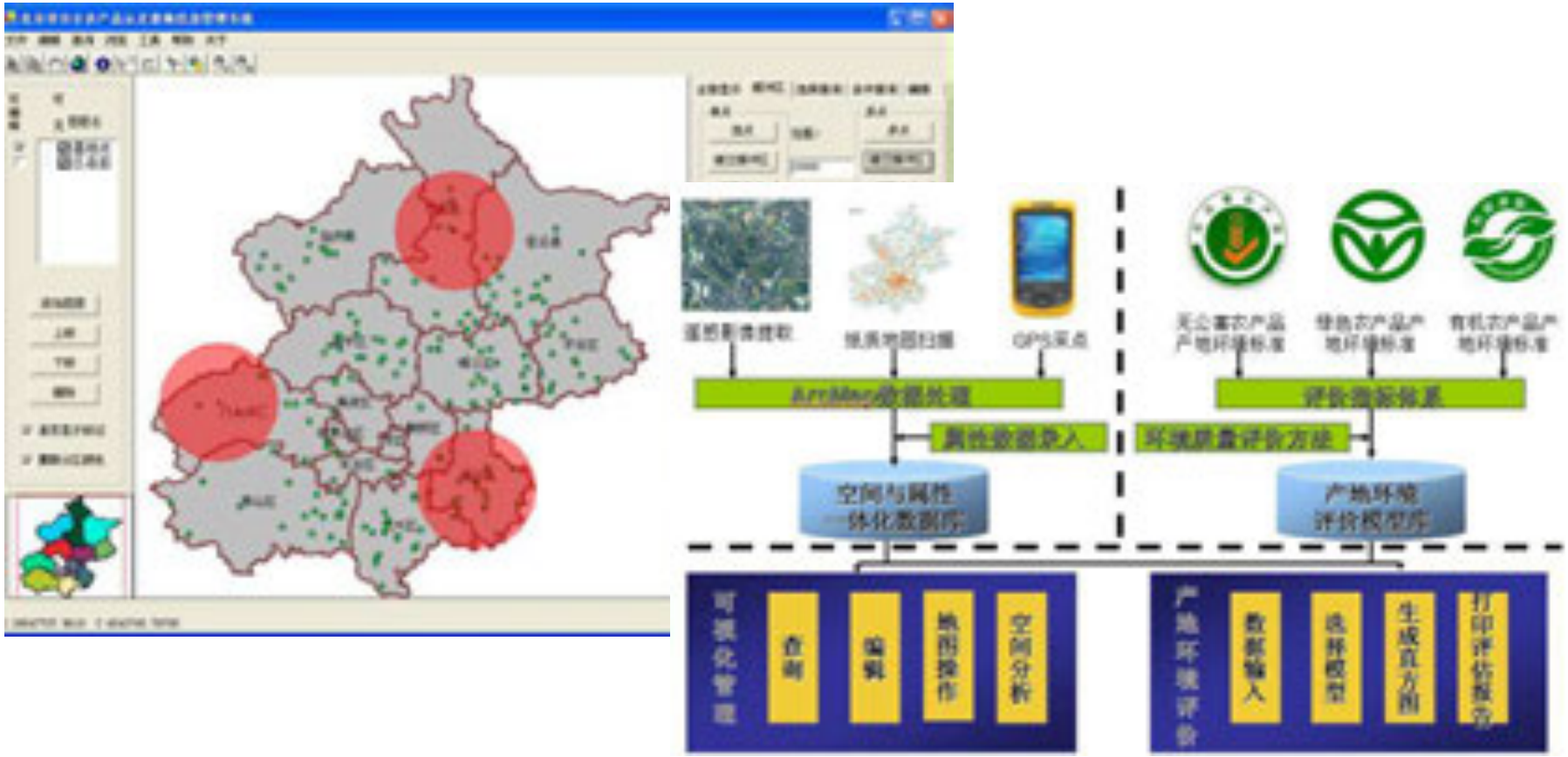
Quality traceability-cell phone

- Support Android, IOS with 1D and 2D barcode

Quality traceability-touch screen

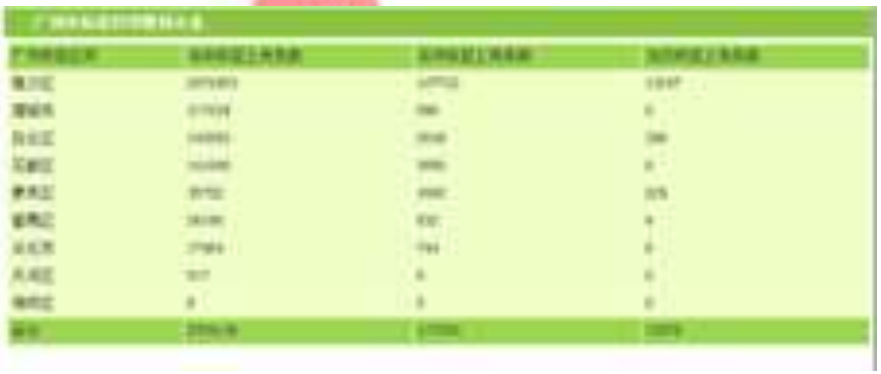
Government supervision

- Environment evaluation systems for agricultural production field



Government supervision

- Supervision platform for agricultural product quality safety



5. Application

- Applied in more than 10 provinces with 254 bases

Application-typical cases

- Vegetable quality safety management and traceability in Tianjin

Tianjin case

Cooperated with Tianjin Pollution-Free Agri-Products (Crop Planting) Management Center

2012-2015: 30000 ha non-pollution vegetable bases (total vegetable area is 90000 ha in Tianjin, with 70000 ha in greenhouses, 7.5 billion RMB);

260 million tons, 57% of total vegetable supply for Tianjin;

Establish the supervision system from Municipal, county, town to enterprise;

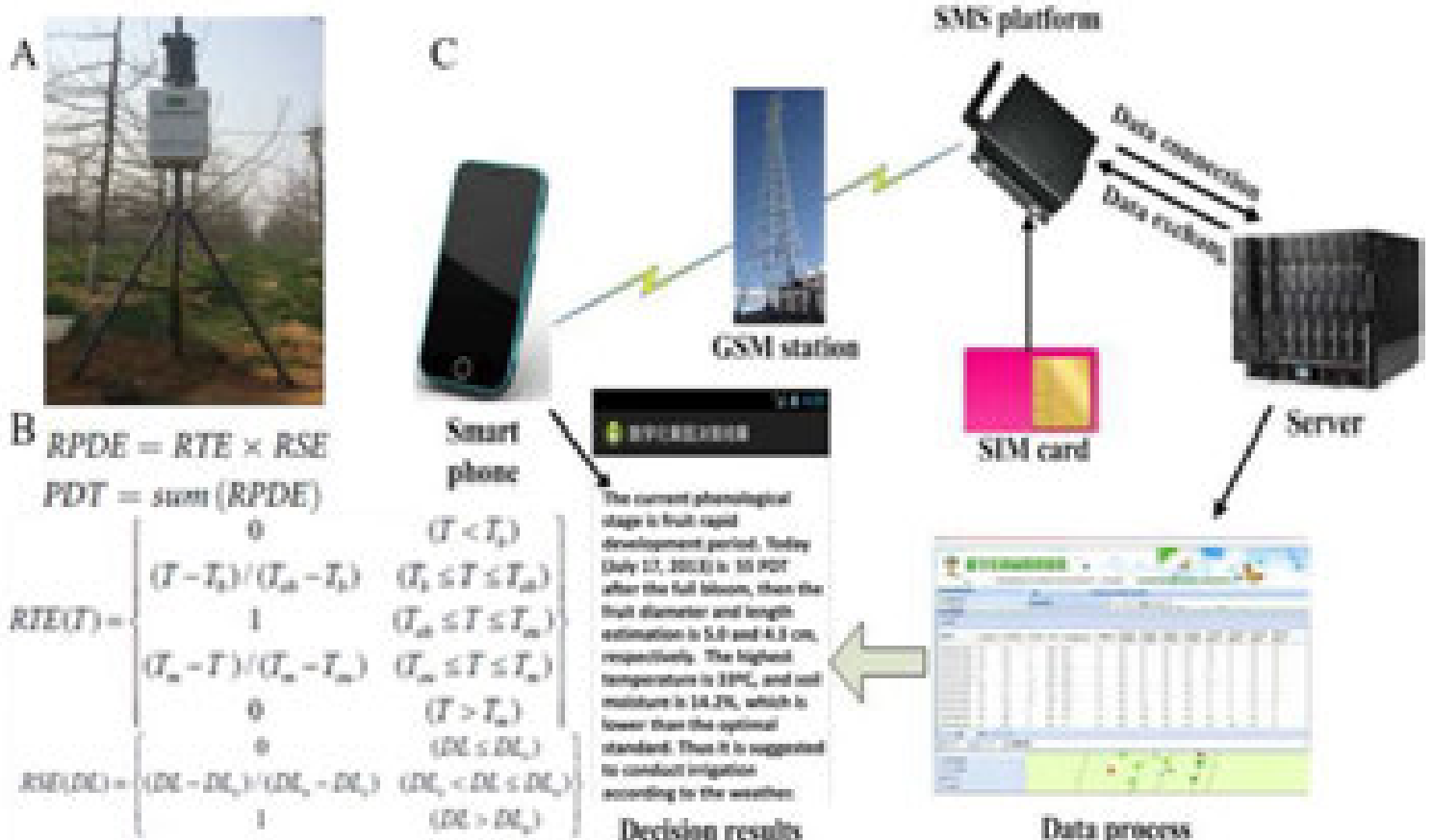
More than 5 million production record in the platform, to support the reduction of 19 million RMB

Training in Tianjin

Applied in Tianjin vegetable traceability for supermarket

Application-typical cases

- Digital orchard management and DSS in Shandong province



Application-typical cases

- The sturgeon caviar processing traceability for the first class food of *lufthansa*

Application for livestock products

Beef traceability in Binzhou, Shandong province

Application-typical cases

- Agri-product traceability for the whole supply chain of field to community model

6. Cooperation with Spain

INTRODUCTION of TEAP (PIRSES-GA-2013-612659)

- A Traceability and Early warning system for supply chain of Agricultural Product: complementarities between EU and China" (TEAP)

-Marie Curie Actions → Mobility

- IRSES → *International Research Staff Exchange Scheme*

- Objectives of the program:

  - ❑ Exchange/sharing of "actual" knowledge
  - ❑ Foster collaboration between institutions
  - ❑ Analyzing possible collaborations
  - ❑ Preparing further research projects.

It is a Mobility action!! → Sharing/Improving actual knowledge.

1) INTRODUCTION

PARTICIPANTS

UAL - University of Almeria
AUA - Agricultural University of Athens
UB – University of Bonn
UNIPI – University of Pisa
UPM - Polytechnic University of Madrid

NERCITA - Beijing Research Center for Information Technology In Agri.
CAU - China Agricultural University
SDAU - Shandong Agricultural University
TJCC - Tianjin Climate Center
TMMCNAP - Tianjin Pollution-Free Agri-Products Management Center
GZNCP -Guangzhou Agricultural Products Quality &Safety Supervisory Institute

2) OBJECTIVES

Specific – Thematic Objectives

- Share knowledge about four main lines:

1.Good Agricultural Practices and Quality Standards in application;

2.Alert programs in the production and disease warning models;

3.HACCP software in the logistics;

4.Traceability systems for the supply chain of agricultural products “seed-to-plate”.

2) OBJECTIVES

General – Final Objectives

- Improve future collaboration between partners:

A.Preparing new research common projects, such as Horizon 2020 Work Programme

B.Developing thematic networks with the participation of both sides;

C.Supporting long time expertise exchange.

3) STRUCTURE

- Work Packages:

Work package n°	Work package title	*Coordinators*	Start month	End month
1	Agricultural Products Quality and Safety Standards in application.	NERCITA / AUA+UAL	11-2013	09-2014
2	The optimum techniques of environment, fertilizer, water management for horticulture	AUA+UNIPI / CAU + SDAU	11-2013	07-2014
3	Early detection of pathogens and pests: molecular, serological and conventional techniques.	UB / NERCITA + CAU	09-2014	02-2015
4	Integrated Production and alert programs.	UAL / TJCC+ GZNCP	09-2015	05-2016
5	HACCP system in the fresh agri-product logistics for quality safety control.	UPM+AUA/ NERCITA	02-2015	08-2015
6	Traceability Systems in EU and China.	CAU+NERCITA/ AUA	06-2016	09-2016
7	Common challenges in AP quality. Proposal of joint research activities	NERCITA /UAL	09-2016	08-2017

TEAP kick-off meeting, 2013

Study on greenhouse environment modeling and disease warning

- Cooperation and write a paper "*Development of Air Temperature Model for Chinese and Spanish Traditional Greenhouses* " to IJABE.
- Prof. Xue and Li were invited for Jorge's thesis defensing meeting. Ms. Wang Hui has been enrolled as the PhD candidate of computer major in ARM group of UAL.

Study on cold chain logistics

- Cooperated with Prof. Luis Ruiz García, Departamento de Ingeniería Agroforestal, UPM, and write two papers:
- 1）Artificial Neural Networks and thermal image for temperature prediction in apples. Food and Bioprocess Technology
- 2）CFD simulation of airflow and heat transfer during forced-air precooling of individual apples. International Journal of Refrigeration

Study on agri-product supply chain

- Cooperated with Fernando Bienvenido of UAL, Cynthia Giagnocavo from Coexphal/UAL, Pedro Hoyos Echevarría of UPM

Some visits

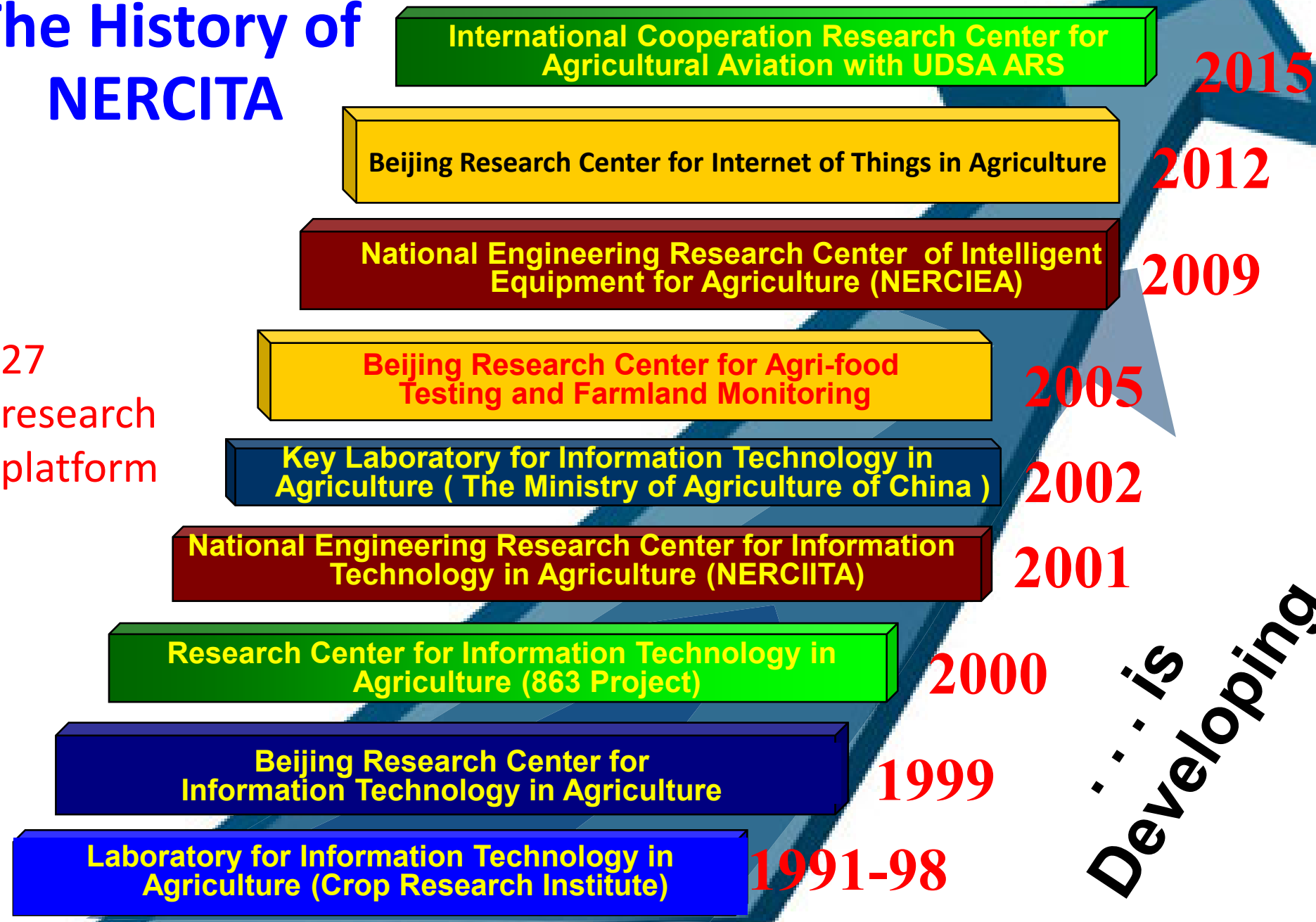
BAAFS

北京市農林科學院

Beijing Academy of Agricultural and Forestry Sciences

- **National Engineering Research Center for Information Technology in Agriculture**

The History of NERCITA



27 research platform

Departments

15 Research Dept. and 6 Administration Dept.:

- Software Engineering
- Information Engineering
- Cartoon and Animation Design
- Intelligent System
- Environment Resources
- Remote Sensing (RS)
- Logistic Information
- Intelligent Equipment
- Agricultural Automation
- Precision Agriculture
- Biological Equipment
- Strategy Research
- Digital Farming
- Intelligent Testing
- Agricultural Aviation

- Administration Division
- Program and finance Division
- Sci-Tech Management Division
- International Cooperation Division
- Achievement Transfer
- Experimental Station

- One enterprise: Beijing Paid Weiye Science and Technology Co. ltd
- One base: Xiaotangshan National Precision Agriculture Research and Demonstration Base
- One Academic Society: Beijing Society of Agricultural Informatization

Development Strategies

Technological Innovation According to Demand

Sustainable Development

- Technological Innovation
- Platform Construction
- Products development

Hi-Tech

Ease of Use

Participate

Technological Innovation

Fit Market Competition

Resources Integration， Advantage Development

National Demand Application Demand → Technological Innovation + Demonstration Extension + Industrial Development → Competitive

Human Resources

- **Research Team：** 408 in total, 119 regular staff, 161 employed by enterprise, 128 Master and Doctor students with Post-doctor
- **Titles：** 16 investigators , 26 associate investigators, 5 senior engineers; 80% with Master and Doctor degree, 100 Doctors
- **Team：** 硕/博导13人；863专家1人；千人计划1人；国务院津贴3人；国家百千万1人，农业部杰出人才及创新团队 1人，北京百名领军人才 1人，北京百千万5人；北京突贡2人，北京新星25人，北京优青4人，北京优秀人才22人，农科院青年基金 14 人。
- **Major: Computer/Electronics/Automation/Mechanical equipment:40%, Agriculture: 30%, researchers combined with computer and agricultural sciences: 30%**

Status

- Planning and design of ICT in agriculture for Ministry of Agriculture, Ministry of Science and Technology, Ministry of Industry and Information
- Team leader organization for agricultural application of national standard working group for internet of things
- National consulting expert for rural informatilization
- National high-tech program expert

Research achievement and effects

- More than 80 Invention patents, 137 practical models patents; more than 600 software registrations80;
- Published more than 1203 papers indexed by SCI/EI
- 22 S&T awards with more than provincial level, with 3 national awards
- Extension to 30 provinces with economic benefit of 1 billion yuan


北京市自主创新产品
证书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- 3 national and 1 international awards

world summit
on the information society
Geneva 2003 - Tunis 2005

Infrastructure

Xiaotangshan base: window

National Experimental Station for Precision Agriculture

Laboratory with 1050M^2

Equipments

170 hp Tractor

Maize Harvester with Sensors

Disk Harrow

Conbine Harvester

16 Greenhouses

Farm Machine Warehouse with 1130M²

Further work

- 1) Cooperation in the model and system in different area of ICT in agriculture.
- 2) Supply chain management of agri-products
- 3) Apply the research in the practices.
- 4) Future research project.

Thank you!