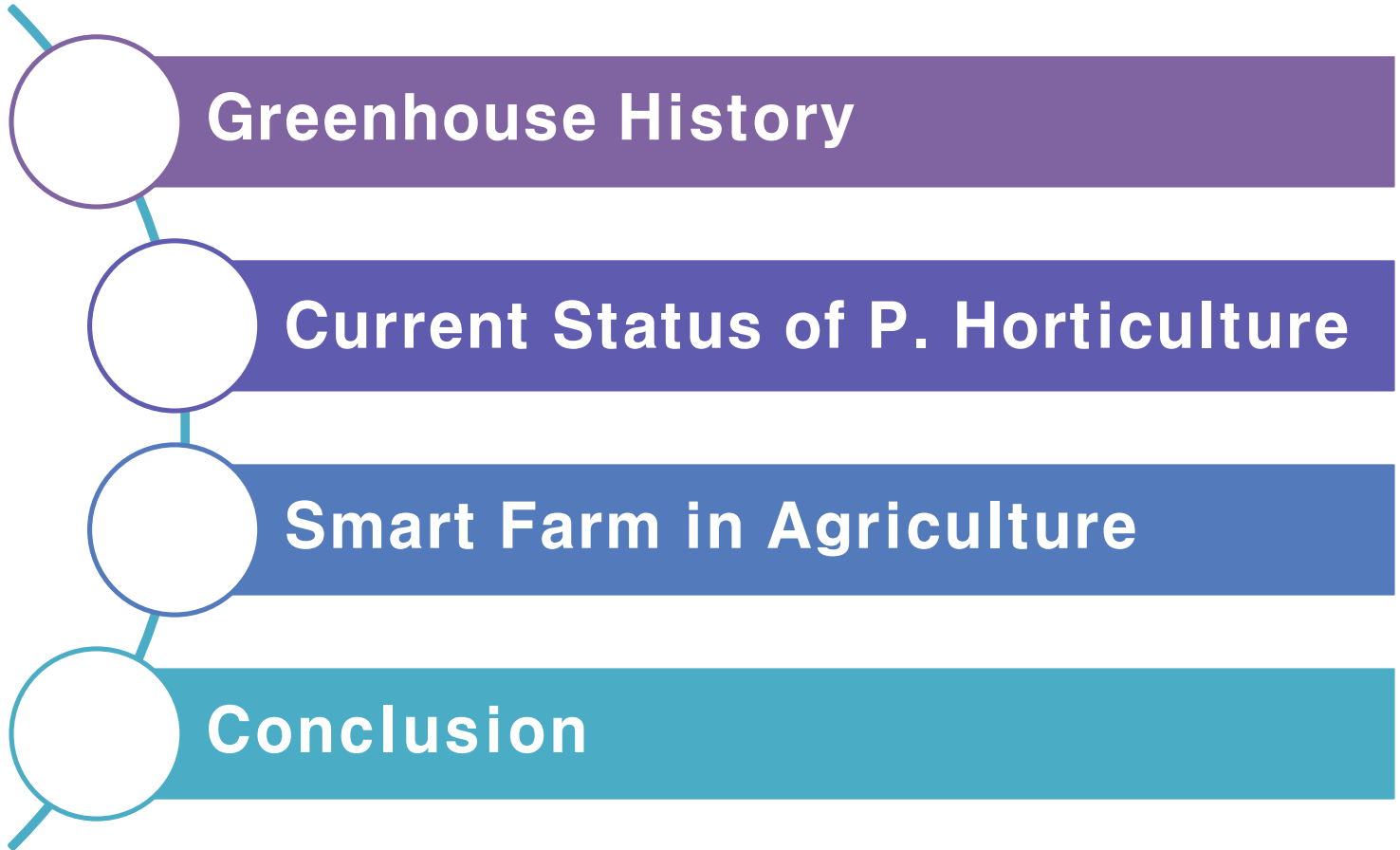


# Smart Farming in South Korea

발표자 : STEPI 이주량 본부장

본 자료는 농진청 원예특작과학원 시설원예연구소 이강진 소장의 자료임을 밝힙니다.

# CONTENTS :



# History of Greenhouse in Korea



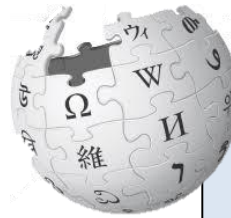
## Smart Farm (Smart Agriculture)

- Protected Plant Farm (**Greenhouse**, ...)
- Animal Farm
- Open field farm

## ■ History of Protected Horticulture in Korea

1450's

造家大小任意三面築蔽塗紙油之南面皆作箭窓塗紙油之造突勿令煙生突上積土一尺半許春菜皆可載植於夕令溫勿使入風氣天極寒則厚編飛令掩窓日瑗時則撤去日日酒水如露房內常令溫和有潤氣勿令土白乾又云作(光)於築外掛釜於壁內朝夕使釜中水氣薰扁房內



*The first description of a heated greenhouse is from the **Sanga Yorok**, a treatise on husbandry compiled by a royal physician of the Joseon dynasty of **Korea** during the **1450s**, in its chapter on cultivating vegetables during winter.... The Annals of the Joseon Dynasty confirm that greenhouse-like structures incorporating ondol were constructed to provide heat for mandarin orange trees during the winter of 1438.*

*The concept of greenhouses also appeared in the **Netherlands** and then **England** in the **17th century**, ...*





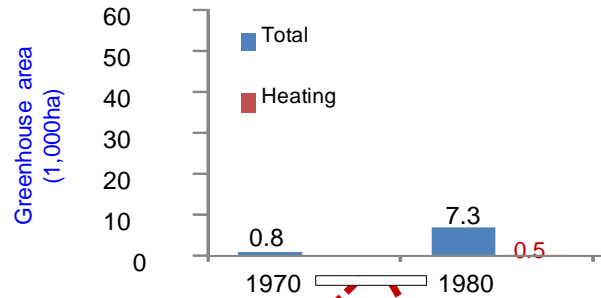
## Changes of greenhouses in Korea



- The First plastic greenhouse
- Wood, bamboo, PVC ('54)



# Changes of greenhouses in Korea



Pohang steel company



Petrochemical complex (Ulsan)



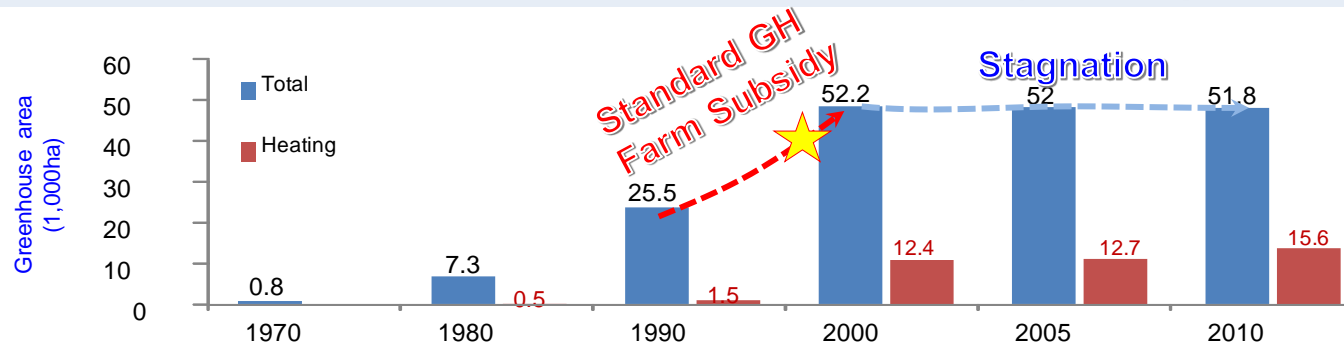
Iron pipe, soft film ('70)



Iron pipe, soft film,  
heat insulation, scale up ('80)



# Changes of greenhouses in Korea



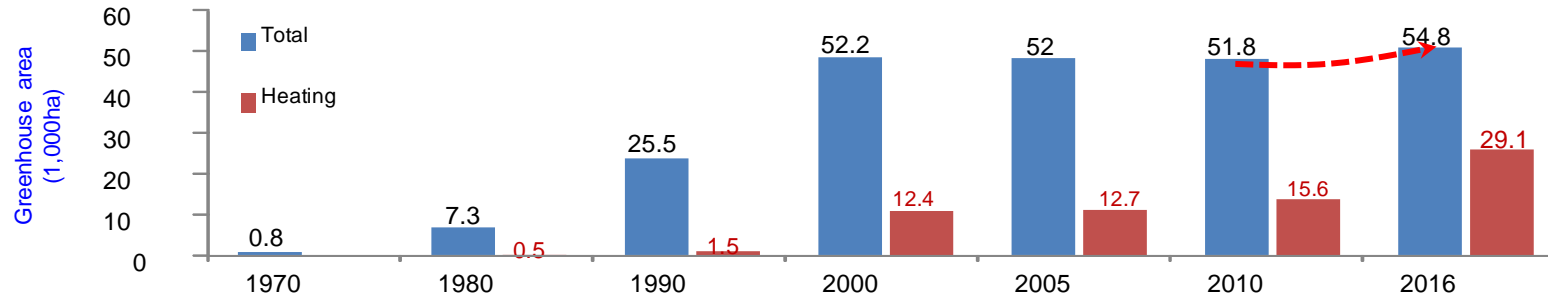
- Modernizing / Automation, labor saving
- Standard model for greenhouse ('90)



Large scale & multi span ('00)



## Changes of greenhouses in Korea



- Greenhouse farming in Korea had developed very quickly since 1980s.

0.4ha / farm

- Covering material : Plastic film 99% (structure : single-span 85%)

\* Heating 34.6% / Information Equipment 30% / Hydroponic 3,355ha (6.5%)

('10~)

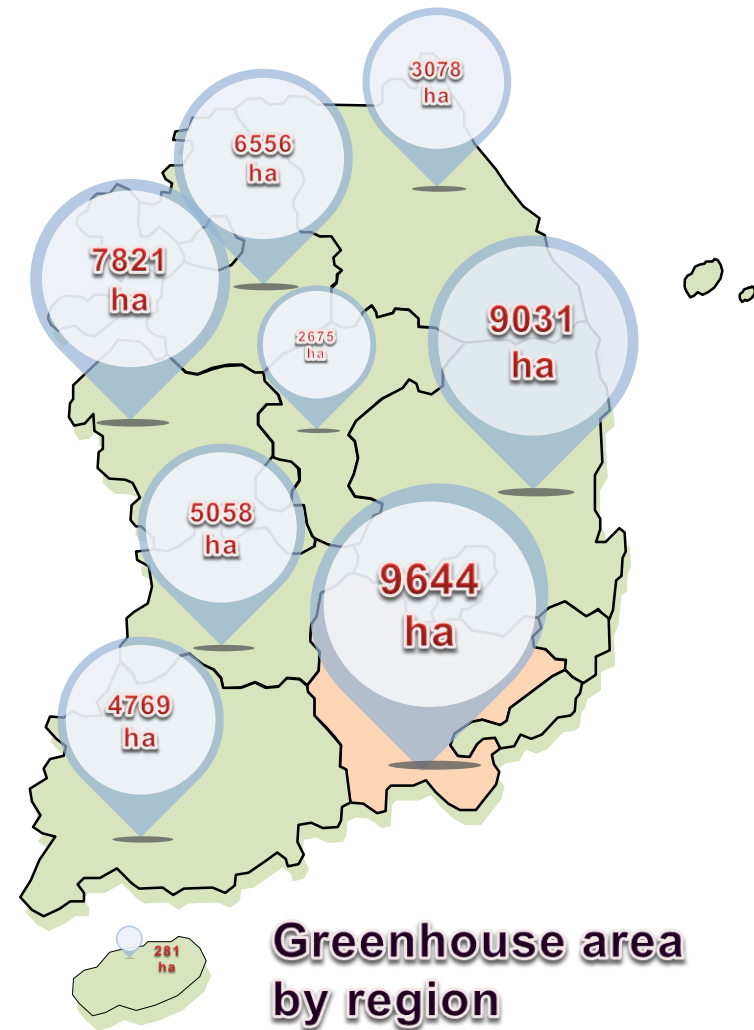
- Improving structure / Plant factory

• ICT & GreenHouse → More advanced cultivation environment  
• BT




## Greenhouse cultivation (2017)

Crop	Cultivation area(ha)	Production (1,000 ton)	Major crops
Total	55,217	2,414	Total vegetable area 226,804 ha
Root	845	35	Radish
Leaf	9,470	296	Chinese cabbage, lettuce, chives, spinach, water parsley.
Fruit vegetable	38,623	1,904	Watermelon, strawberry, tomato, green pepper, paprika, cucumber, oriental melon, squash, melon
Condiment	2,846	72	Green onion, garlic
Others	2,153	61	Cauliflower, red cabbage



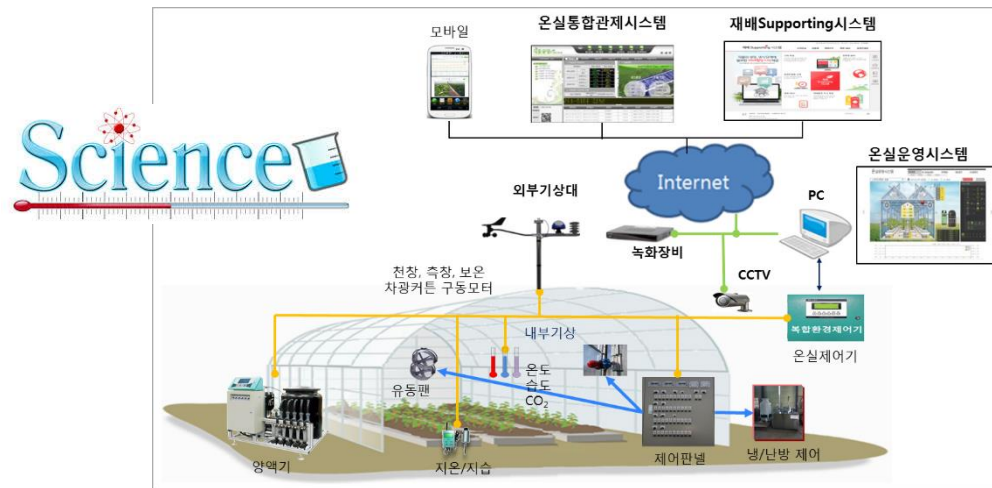
\* 762 ha ('70)



Country	Area (ha)	Cite
China	2,760,000	Yang, 2011
<b>Korea</b>	<b>52,418</b>	<b>MAFRA, 2017</b>
Spain	52,170	EuroStat, 2005
Japan	43,000	RDA, 2019
Turkey	33,151	TurkState, 2007
Italy	26,500	EuroStat, 2007
Mexico	11,759	SAGARPA, 2010
Netherland	10,370	EuroStat, 2007
France	9,620	EuroStat, 2005
United States	8,425	US Census Hort Spec 2010

# Structure and technology of greenhouse

*Advanced ICT equipment can not guarantee increased production and income. Users must have an understanding of greenhouse structure, materials, energy, environment, pest control, and cultivation techniques ...*



# Structure



- Plastic house



(85%)

Single-span type



(12%)

Multi-span type



Tunnel type



Mammoth type



## ■ Covering Materials

- Glass – 투명유리, 산광유리
- Plastic Film

**연질** (Sheet Plastic, 0.075~0.2mm) : PE, EVA, **PVC**, PO

**경질** (Rigid Plastic, 0.1 ~ 0.25mm) : PET

**경질판** (Plastic Sheet, 0.5~ 2mm) : FRP, FRA, PC, Acryl, MMA

소각과정에서 유해가스, 환경오염 물질 발생

### 필름용 고분자 - 폴리올레핀계

구분	분류	예
범용 고분자	폴리에틸렌(PE) 폴리프로필렌(PP) 에틸렌/비닐아세테이트(EVA) 폴리부텐	HDPE, LDPE, LLDPE, OPP, CPP

범용 필름의 종류	특징	용도
저밀도 폴리에틸렌 (LDPE)	가공성, Heat Seal성, 투명성 양호 내유성, 강성 떨어짐	식품포장 전반, 의약품 포장, 산업자재
선형 저밀도 폴리에틸렌 (L-LDPE)	협착물 열접착성, Hot Tack성 우수 내충격성 양호 가공성이 다소 떨어짐	식품포장, 산업자재
고밀도 폴리에틸렌 (HDPE)	내열성, 병습성, 강성 우수	식품포장, 산업자재
폴리프로필렌 (PP)	내열성, 내유성, 강성 양호 Heat Seal 온도가 높다	식품포장, 산업자재
에틸렌 초산 비닐 공중합체 (EVA)	열접착 강도, 저온 열접착성, 협착물 열접착성, Hot Tack성, 내충격성, 내 Pin-hole성, 내한성 양호	식품포장, 산업자재



LLDPE



LDPE



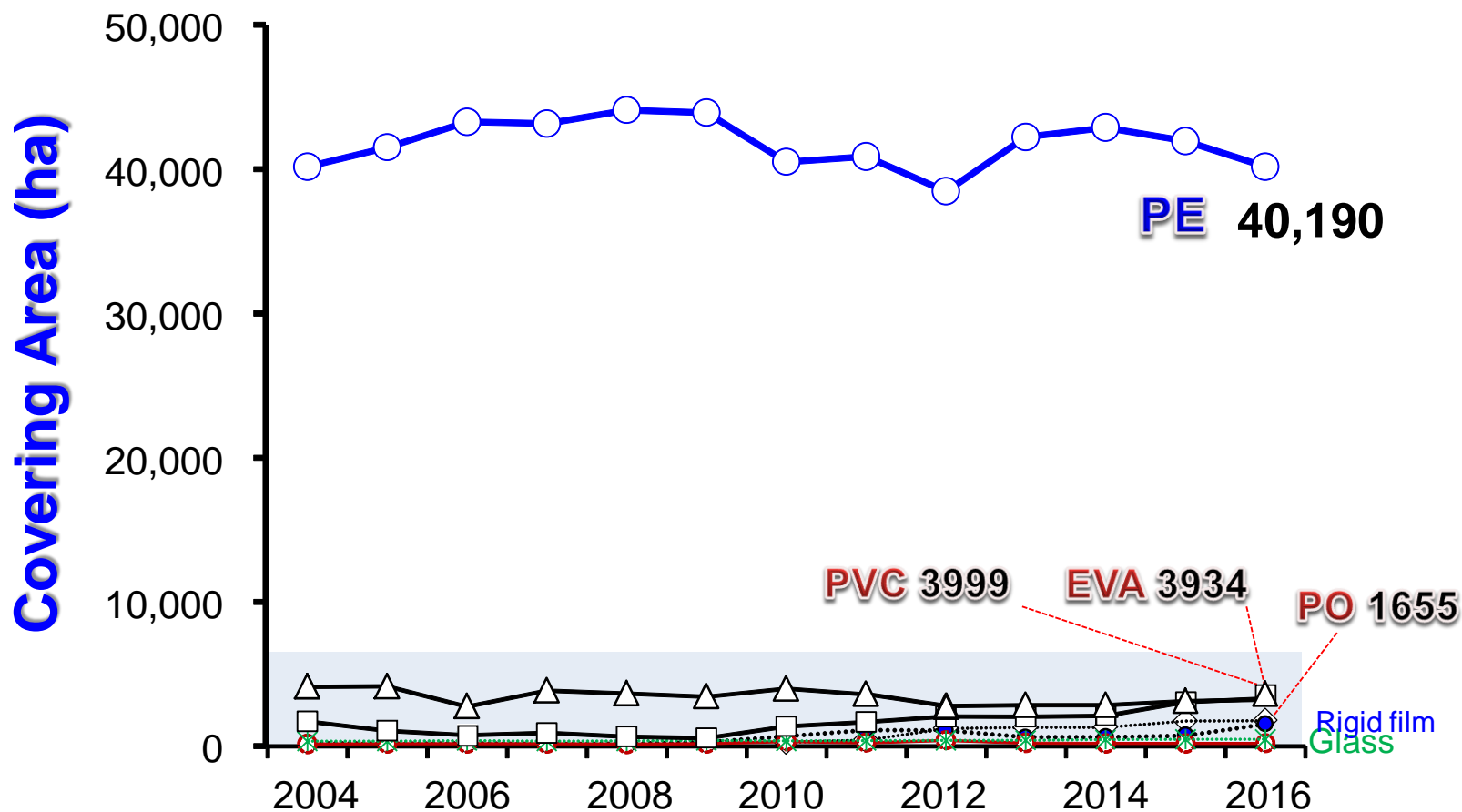
HDPE

**PVC** (Poly vinyl Chloride)

**PE** (Poly Ethylene)

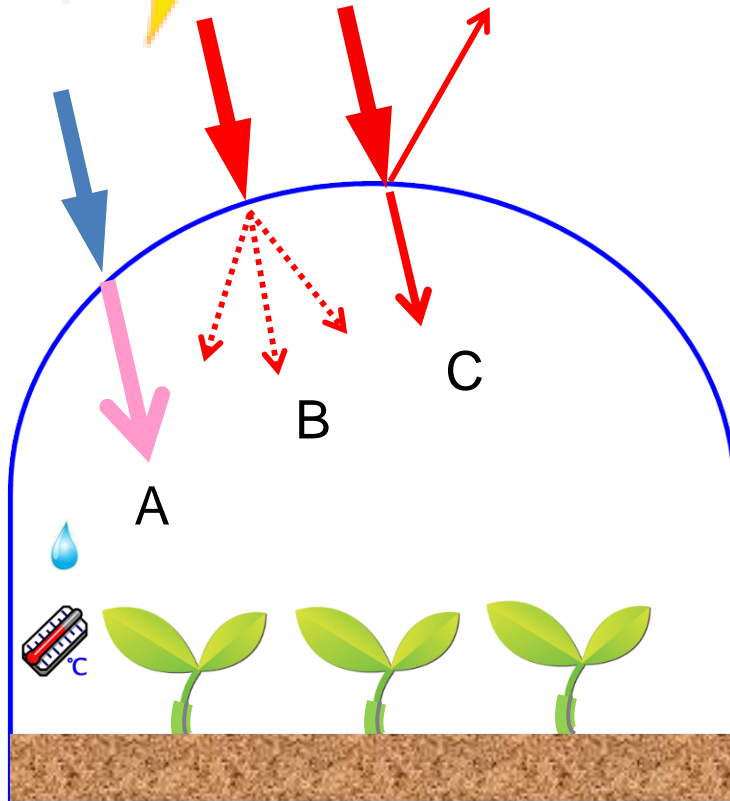
**EVA** (Ethylene Vinyl Acetate)

## Greenhouse Area by Covering Materials



시설채소 온실현황 및 채소류 생산실적, 농림축산식품부, 2017

## ▪ Functional Materials for Covering



### A. 광전환필름

- UV-A → Visible Ray(Red, Blue)

### B. 산란광 필름

- Less different temperature
- Equal light under structure

### C. 열차단 필름

- Insulation enhancement
- Decrease of heating load

광 제어를 통한 광이용 효율 증진 및 온도 조절

## ▪ New greenhouse model



Eaves height 5.4m, Ridge height 7.4m



Arch type



Eaves 4.5m  
Ridge 6.5m

- Taller, stronger (suitable for each crop), better environment than the old model.
- 30~40% higher yield than the old model, 90% level of glasshouse yield.
- Construction cost: 2/3 level of glasshouse



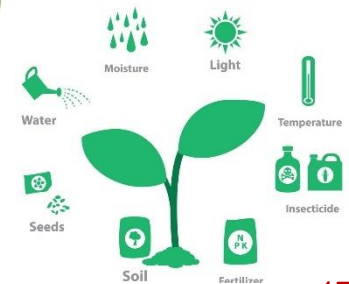
# Environment Control

Temp., Humidity,      CO<sub>2</sub>,      Light,      Irrigation, ..  
→ 창문, 냉난방기, 제습기      / CO<sub>2</sub> 시비기      / 스크린      / 양액기 ...

What for ?

- For optimum plant growth & Improving crop yield

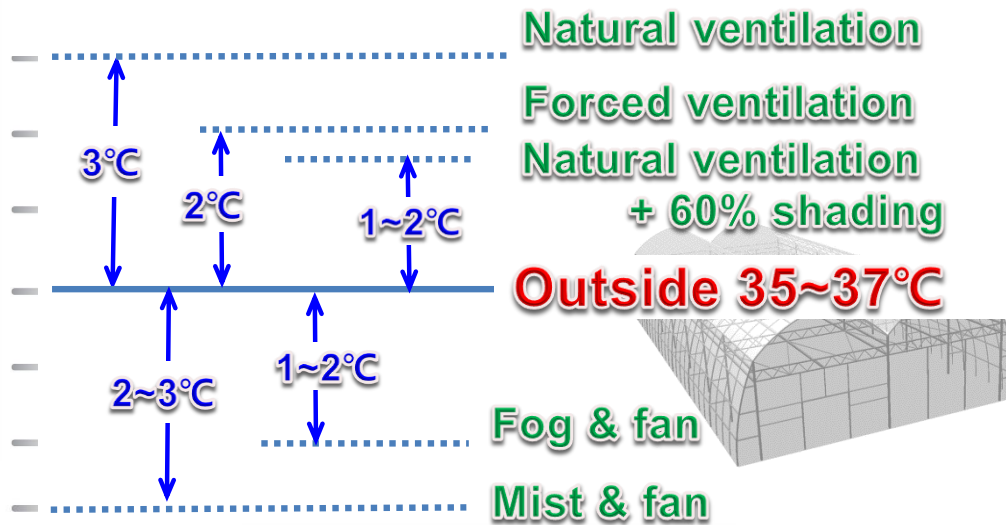
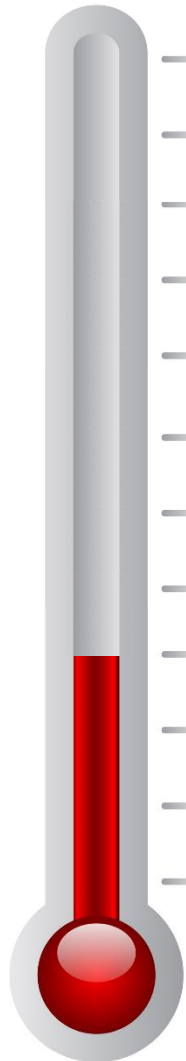
- ① Temperature
- ② Light
- ③ Humidity
- ④ CO<sub>2</sub>
- ⑤ Nutrient Fertilizing
- ⑥ Pest Control



# Environment control

Temp., Humidity, Light, CO<sub>2</sub>, Irrigation, ..

## ■ Cooling



Aluminum screen  
for shading



Paint spray  
for shading



### Fog & fan

- Temperature drop: 6~7°C
- Humidification
- Low installation and operation cost



Fan & Pad system

## ■ Artificial lighting

- Lighting
  - Long-day treatment
  - Low illumination, night break
- Supplementary lighting
  - Accelerating photo-synthesis



## ■ CO<sub>2</sub> enrichment

- Fruit vegetables → paprika
- 1,000ppm → **high yield**  
(20-30%)

Liquefied



Kerosene



Solid type



## ■ Automatic irrigation

- Timer : 1-2L/plant/day, 4-12times
- Solar radiation sensor
- Lysimeter
- Moisture sensor (Tensiometer, FDR, TDR)



Tensiometer



Timer



Solar radiation sensor



Lysimeter



FDR sensor





# More Crops with Less water

Drip irrigation  
**Significant savings in water usage**

# Hydroponics

## ■ What is ?

- Definition : The method of growing plants **without soil**, using mineral **nutrient solutions** in a water solvent.
- Medium : Perlite, rockwool, clay pellets, peat moss, or vermiculite, etc.

## ■ Advantages

- **Growth is fast**
- **Better for the environment (less water)**
- Make better use of space and location
- Saving labor and time

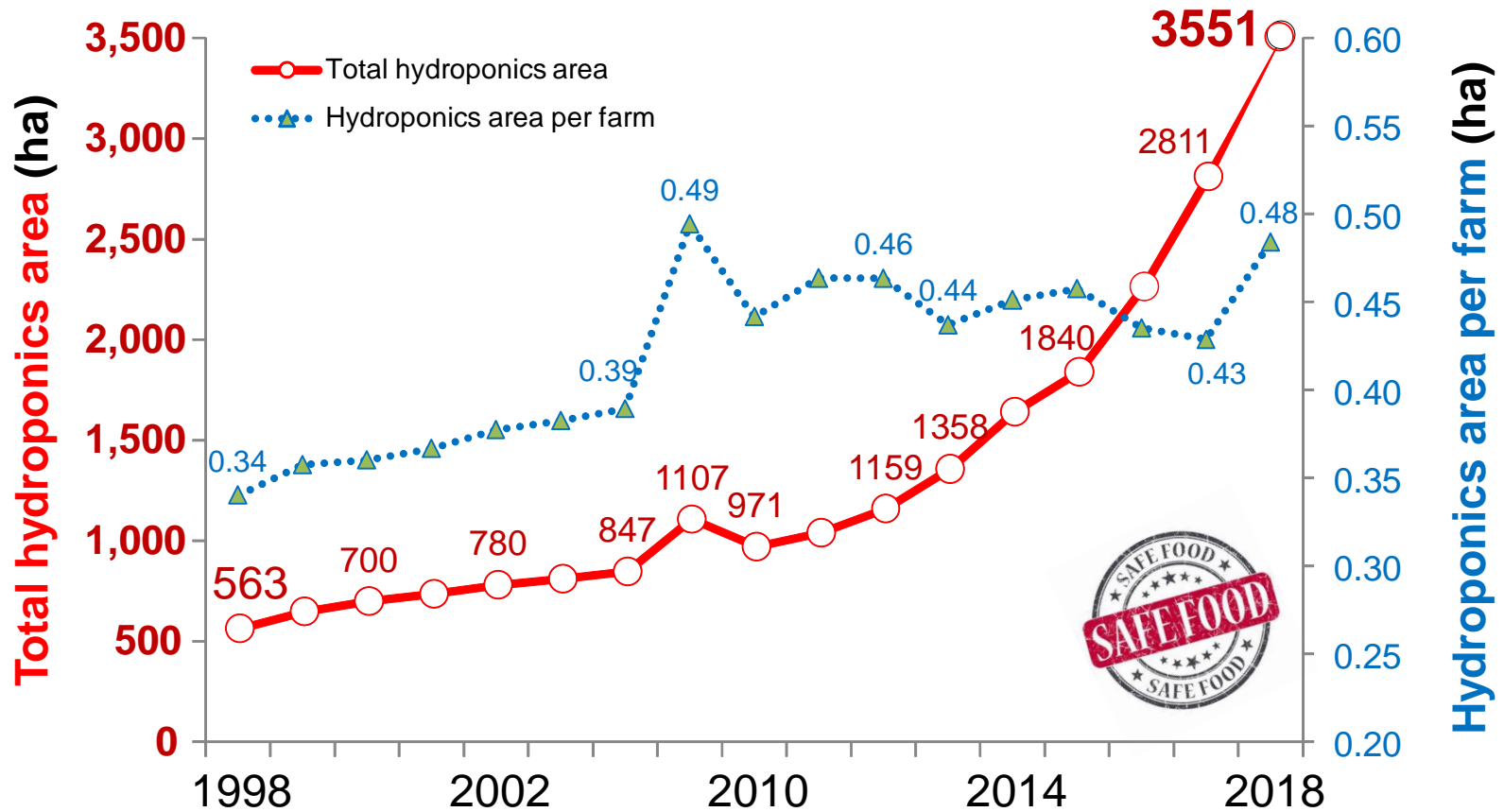
## ■ Disadvantages

- **Experience and technical knowledge**
- **Initial installation cost**



**Tomato grown on coir substrate  
in hydroponics**

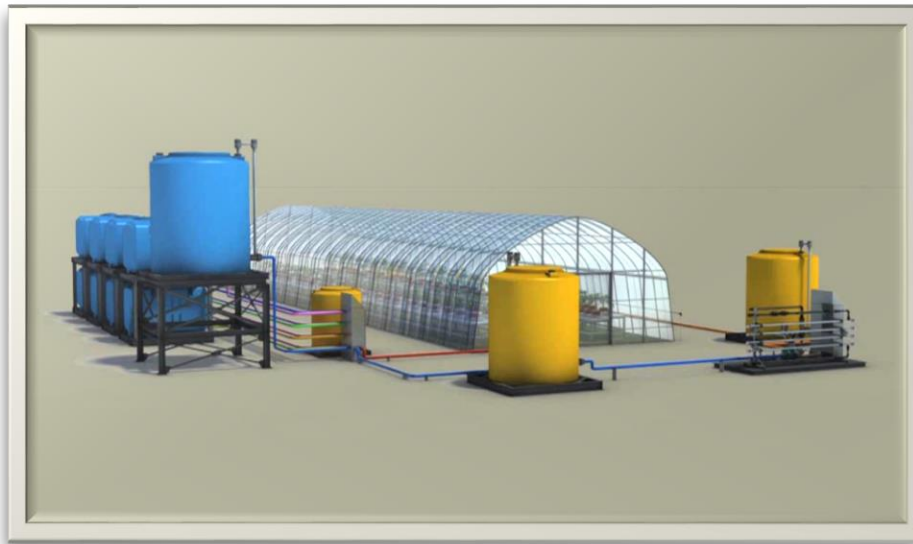
## Changes of hydroponics cultivation area in Korea





## ■ Closed hydroponics in Korean style

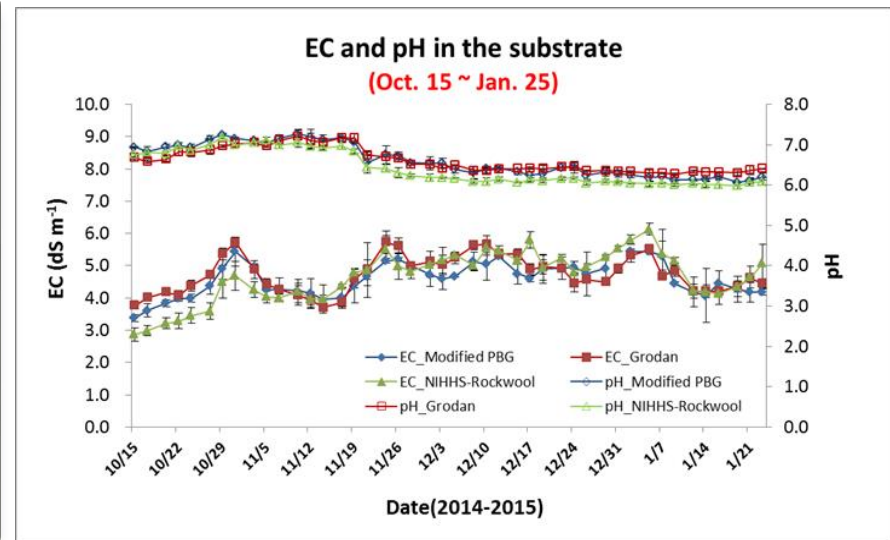
- Crop : **Paprika**
- Development of nutrient solution compositions with growth stages
- Water and fertilizer consumption decreased by **20-40%**(7.7 million/ha)



Closed hydroponics system

Penetration rate

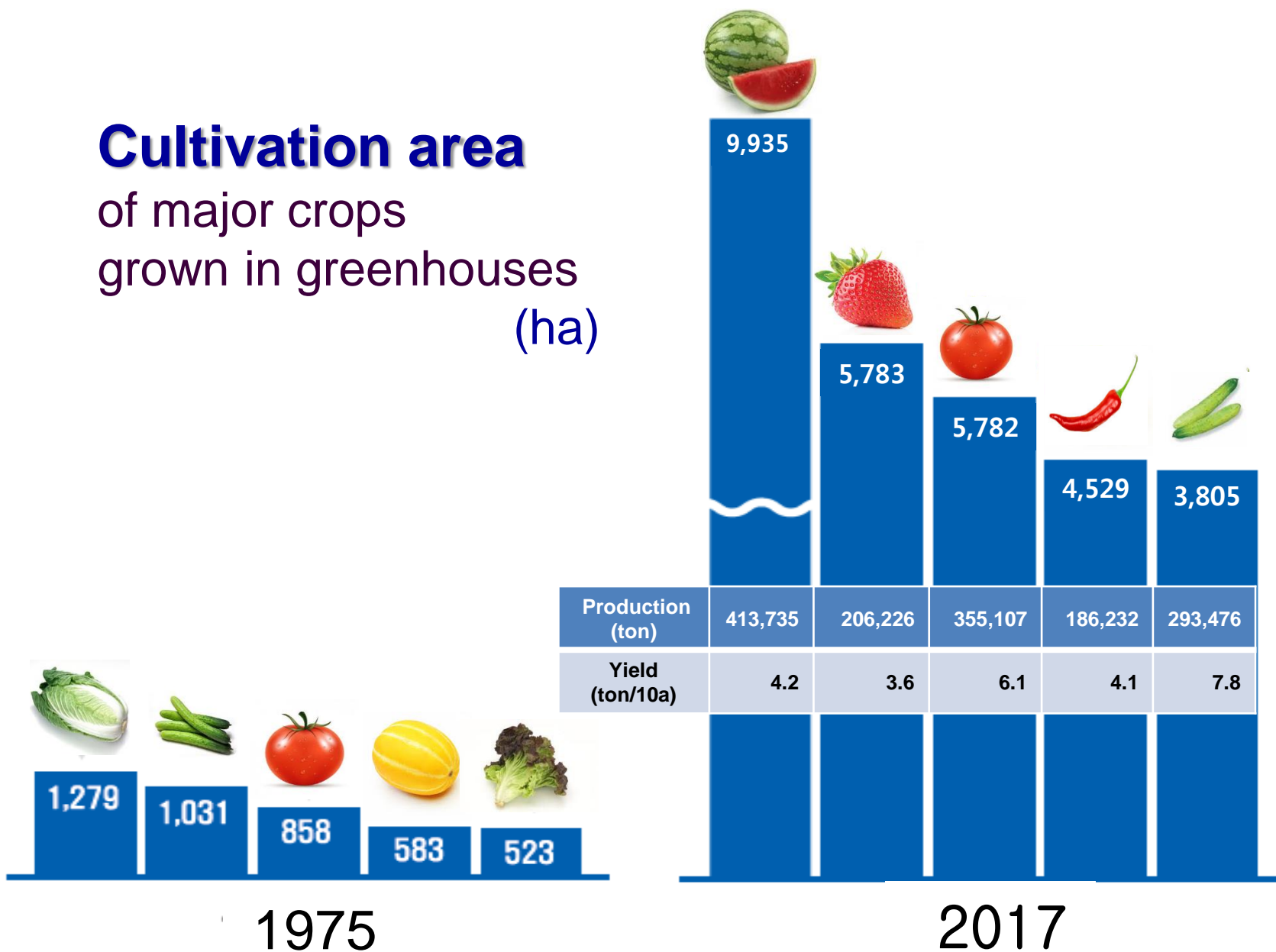
: Netherland **95%**, Korea **5%**

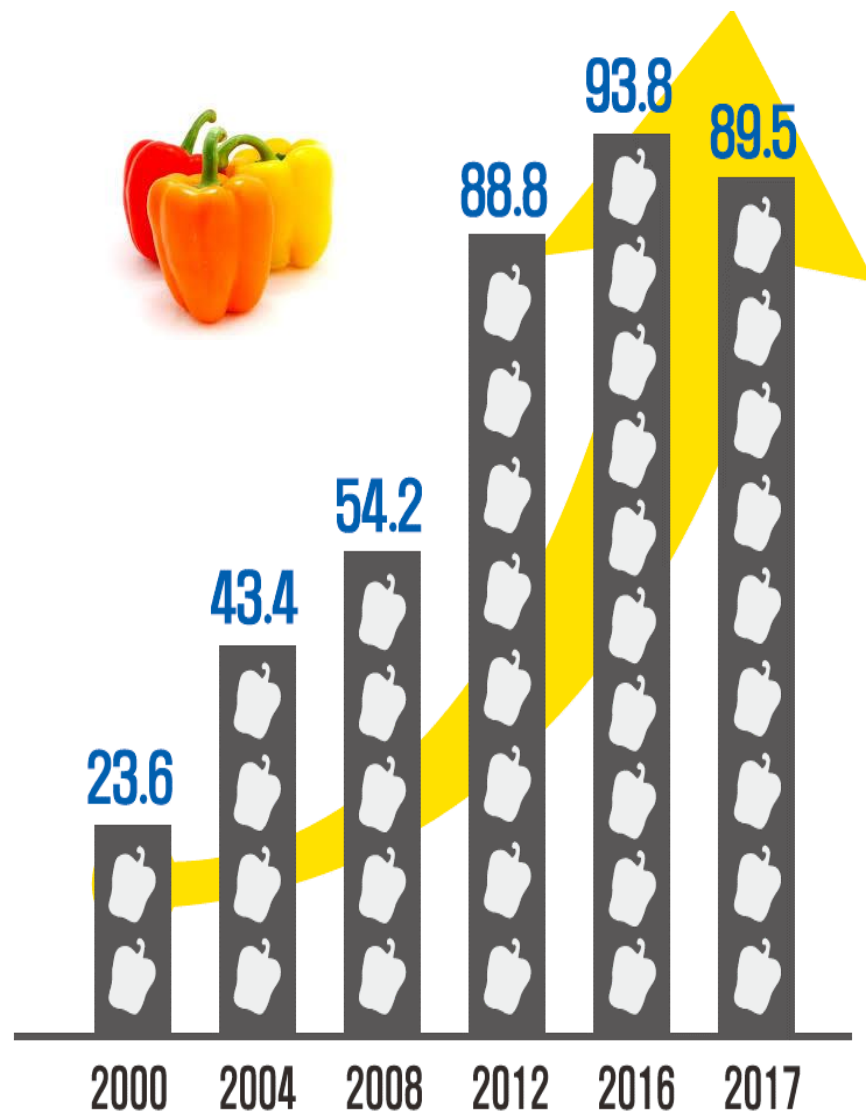
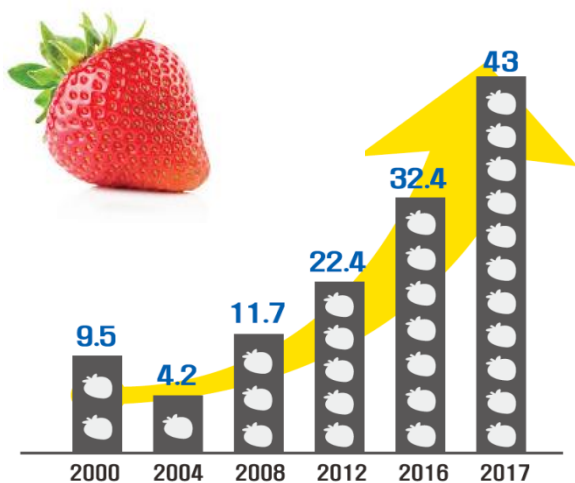


Change of EC and pH in the substrate on paprika

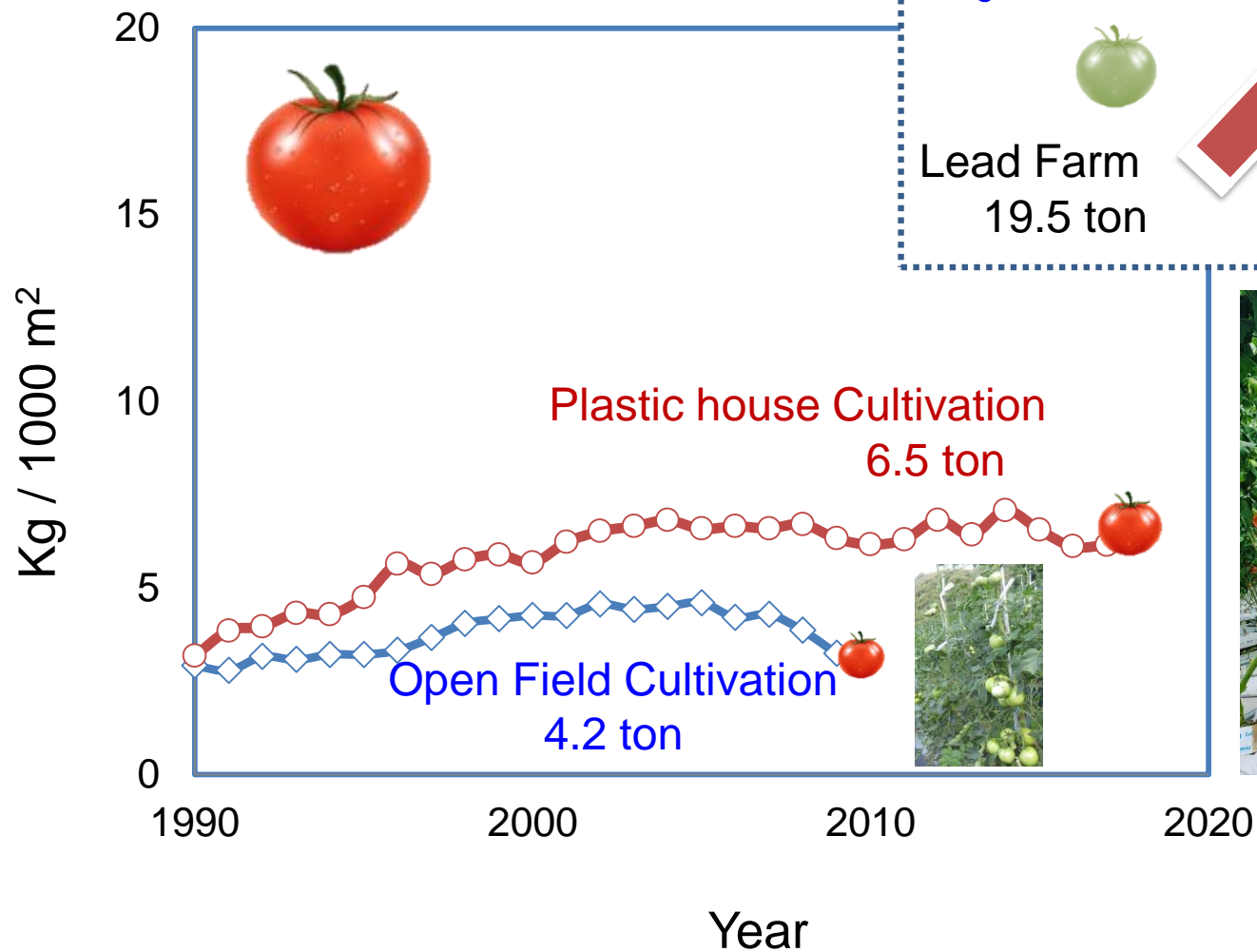


# Cultivation area of major crops grown in greenhouses (ha)





## ■ Tomato Yield per 10a



Long-term Cultivation

Lead Farm  
19.5 ton

Smart Farm  
28.2 ton





CHAPTER

Farm

# Smart farm policy as driving force

정부, 스마트팜 혁신밸리 대상지역  
Smart Farm

2022년까지 전국 4곳  
2일 상주·김제 2곳 먼저 선정  
임대형 스마트팜·실증단지·  
창업보육센터 등 시설 조성



문재인 대통령은 17일 “스마트팜은 소프트웨어·사물인터넷(IoT)·제조업 등 다양한 분야에서 새로운 시장을 만  
든다”며 “관련 산업이 함께 발전할 수  
있도록 범부처가 협력해달라”고 당부  
했다.



◆정부, 혁신밸리 조성지역 선정=농  
림축산식품부는 스마트팜 혁신밸리를 조  
성할 지역으로 경북 상주와 전북 김제를 선정했다. 정부는 2022년  
까지 전국 4곳에 스마트팜 혁신밸리 조  
성할 계획이다.



Smart Farm

혁신성장, 스마트팜이 선도  
대상 청년농업인, 전후방 산업으로 확대

마토-인삼 재배... ‘스마트팜’선 365일 봄이예요  
Smart Farm



완벽히 차단해 운영하는  
고 있다. 기후 등 외부의  
인공 환경을 구축해야 해  
식물 생장과 관련한 모든  
통제에 안정적으로 작동  
가 높다. 노 단장은 “고  
하면 충분히 경제성을 회  
악물 원료 등에 쓰이는  
품질로 안정적으로 공급  
연구 중”이라고 설명했다.

시스템은 한국에너지기술연구원에서 맡아 개  
발했다. 지하수, 공기열, 태양열 등 복합 열원  
을 이용해 에너지를 공급한다. 장기상 책임연  
구원은 “지열만 이용해 냉난방 하는 기존 시설  
보다 에너지 효율이 30% 이상 높고, 연료는 33%로  
이 된다. 김호연 연구원은 “이  
쪽에는 등 식물에 스트레스  
로 사포닌을 더 많이 생성  
있다”고 말했다.

부부는 지난 16일 제5차  
관회의를 통해 관계부처와  
스마트팜 확산 방안을 발표  
빅데이터, 사물인터넷 등 4차  
기술을 활용한 스마트팜을 개  
고령화 등으로 어려움을 겪고 있  
는 농·어촌의 성장동력으로 보고  
해 왔다.



attracting attention as a driving force for agricultural growth

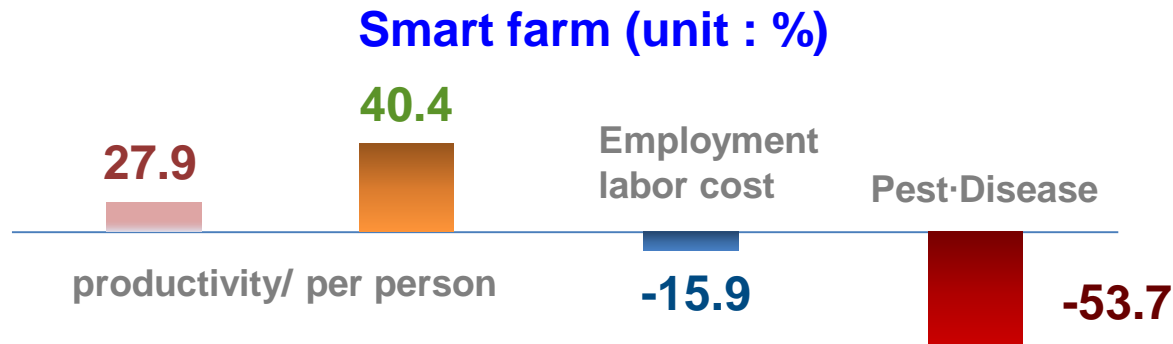
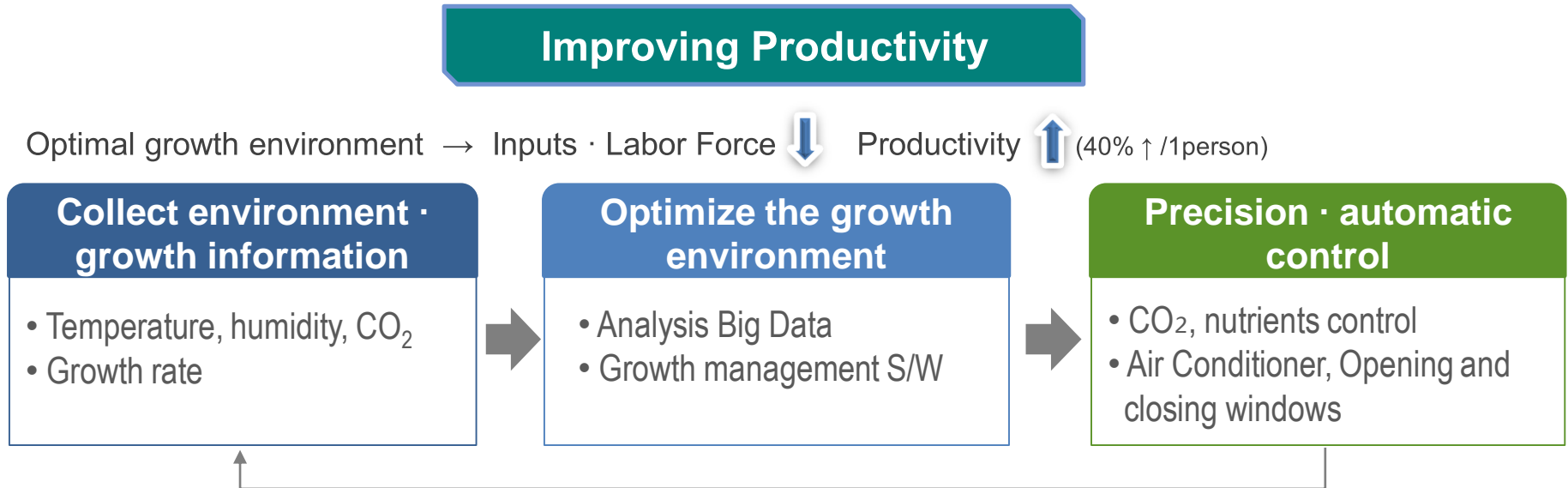
스마트팜 솔루션 융합연구단 실증단지에서 한국과학기술연구원(KIST) 조진형 연구원이 토마토 생육 정도를 살피  
고 있다. 작은 사진은 한국과학기술연구원에서 개발한 인공지능이 바둑에 있는 표시를 따라 이동 중이다. 수확  
한 작물을 이용하는 데 쓰인다. 강릉=이매영 동아사이언스 기자

조기성과 창출을 위한 스마트팜 혁신밸리  
“자과회의, ‘스마트팜 확산 방



# Why Smart Farm?

*Farms that make use of digital applications to establish and maintain the optimal growth environment*



## Increasing Export

Annually stable production at controlled state-of-the-art facilities



Meets buyer's demand (Safety, uniformity, year round supply)



Increasing Export (fresh products, etc.)

## Creating Job

- Expand production jobs  
(Smart farm executives, professional growers, etc.)
- Create related industry jobs (system developers, consultants, etc.)

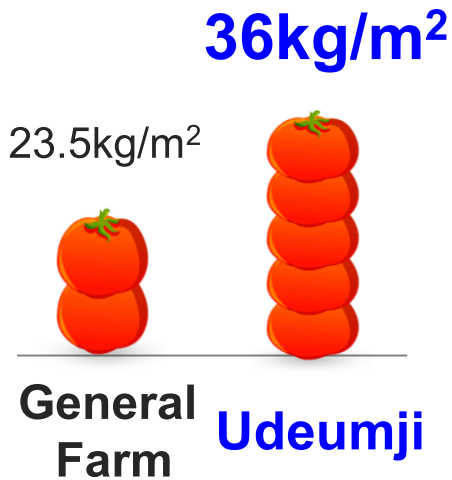
### Gyeongbuk Smart Farm

*Employed 28 regular workers and 24 local residents  
in a 5ha smart farm*

# Why Smart Farm?

Best Case : Udeumji farm

Attracted private investment



First Smart farm

Fund raising  
5M US\$





# Policy Direction

## Policy Beneficiaries

## Contents

### Existing Farmer

The distribution of farm units

→ **Scaling and consolidation**

- Unveils domestic and overseas markets based on a large and stable supply system.

### Young Farmer

**A new Start-up program for Young Farmers  
Creating a Smart Farm (rental)**

Establishment of funding, farmland, and business rehabilitation support system

### Related Industry

**Establishment of Smart Farm Complex**

- Innovates technology, creates new markets through joint R&D of agricultural, corporate and research institutes.

### Smart Farm Innovation Valley

Production and distribution, human resources development, technology innovation, and growth of comprehensive industry

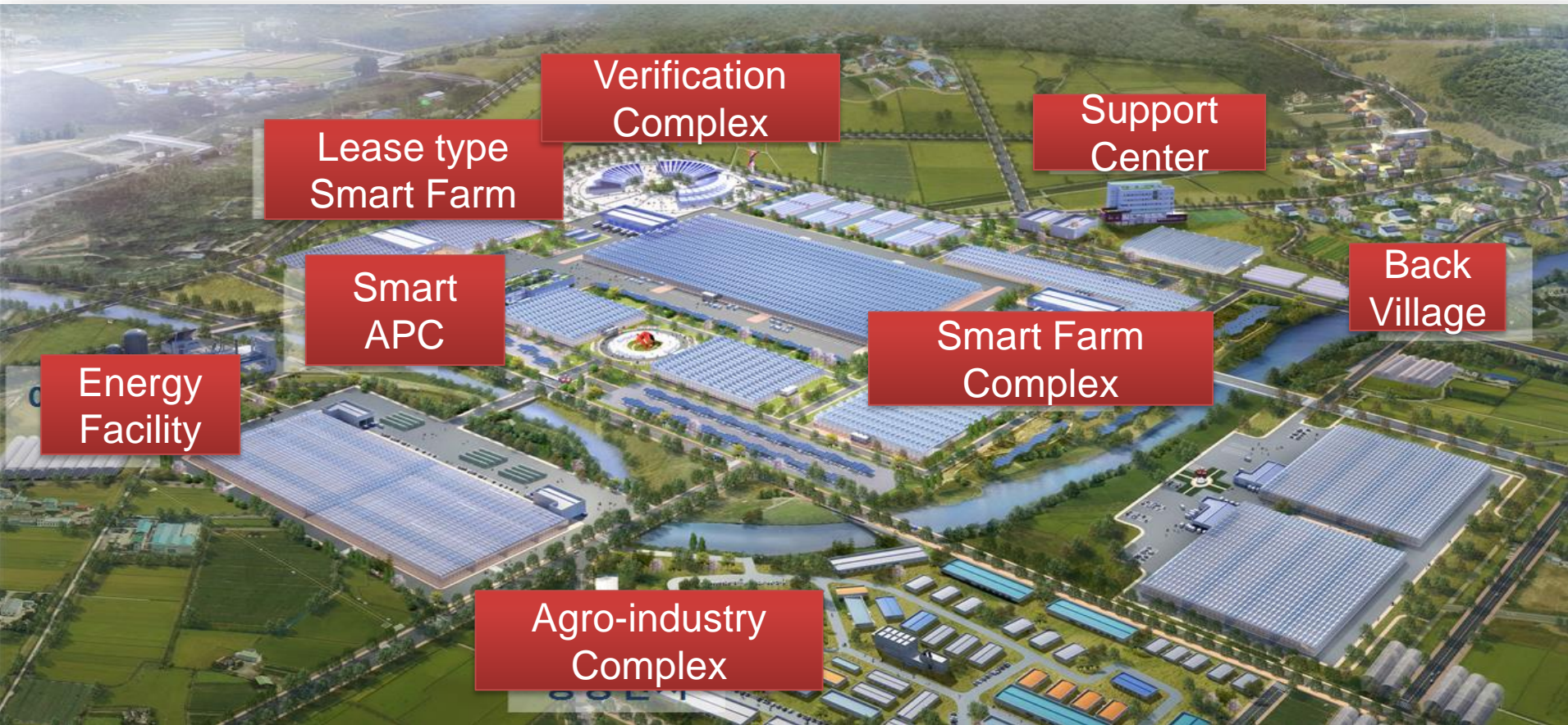




## ▪ Smart farm Innovation Valley

Smart farm

- Young-age Smart Farmer
- Establishment of Industry Ecosystem



(Scale) 4 sites by 2022 (20ha + α/site)

(Role) Production, Distribution, Settlement Supporting, Field test Research, Regional specialization

## ■ Stages of Smart farm technology

**1<sup>st</sup>**  
**(16)**

## Farmers control farms **directly remotely** through images and other sensors

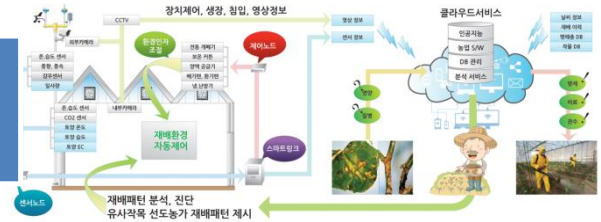
**“Farm work more comfortable by smart technology”**  
**Relieve out of tied time and space to control greenhouse environment**



**2nd**  
**('18)**

## Environment can be automatically controlled

“Increasing productivity and quality by smart technology”  
Upward leveling of farming skills by analysis of big-data and advanced prescription



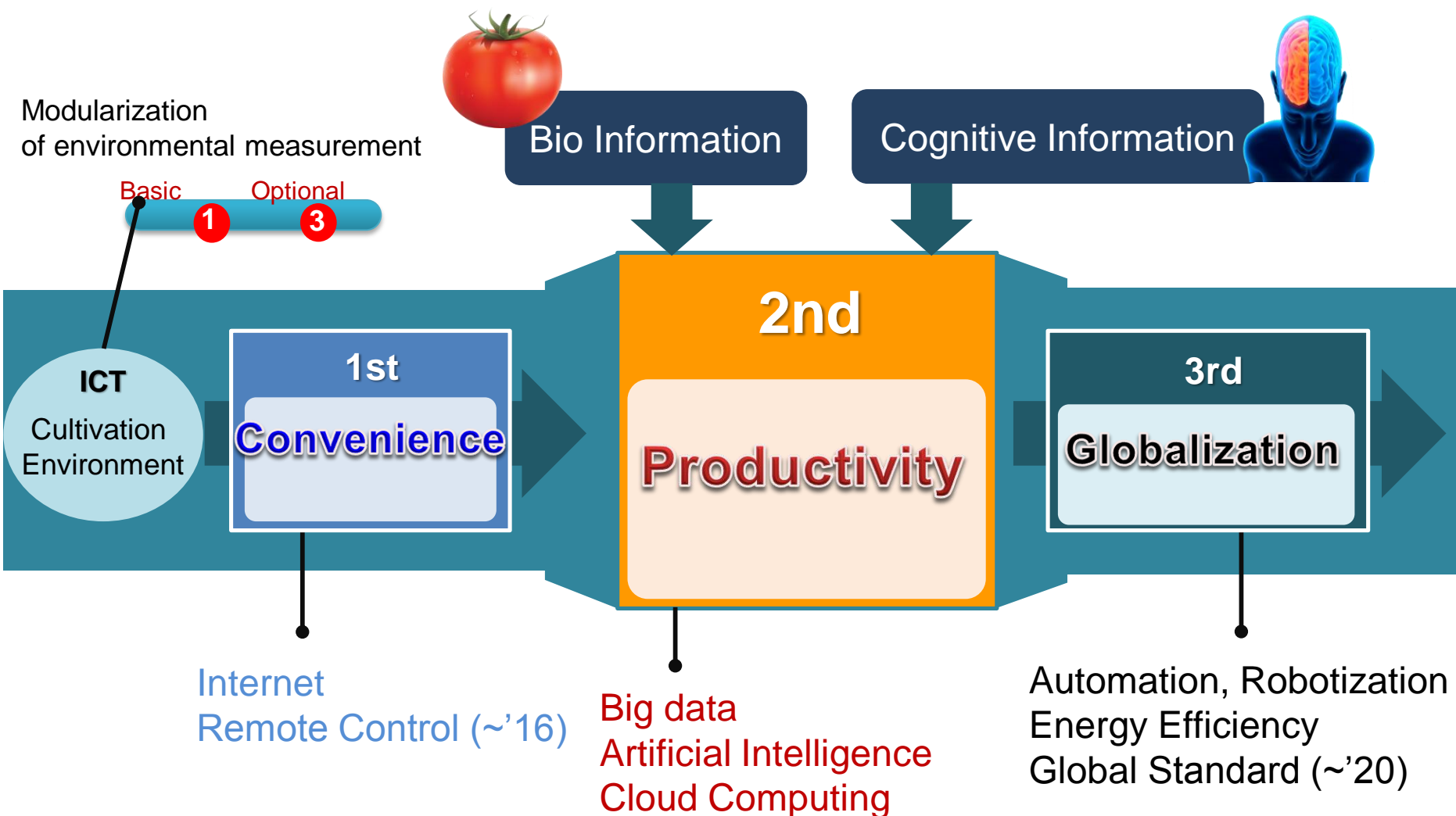
**3<sup>rd</sup>**  
**(<sup>1</sup>20)**

## Optimally control energy of smart farm system and robot farm work

**“Developing agriculture industry by Korean smart greenhouse”**  
**Entering global market** by adjusting international standards



## ■ Stages of Smart farm technology





# What can we change ?

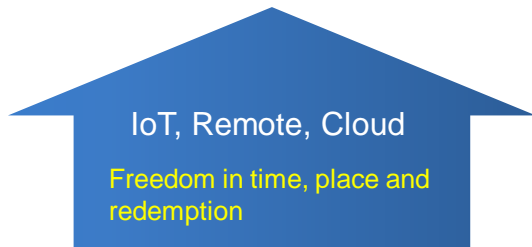
With smart farm technologies

## AGRICULTURE

Young people are coming



Convenient farming



Hard

Innovation grows with creative ideas



Easy



Difficult

Both producers and consumers are satisfied



Services



Production



# Technologies for smart farming



## ▪ Plant Smart Farm



최첨단 스마트팜 기술이 적용된  
파프리카 농장

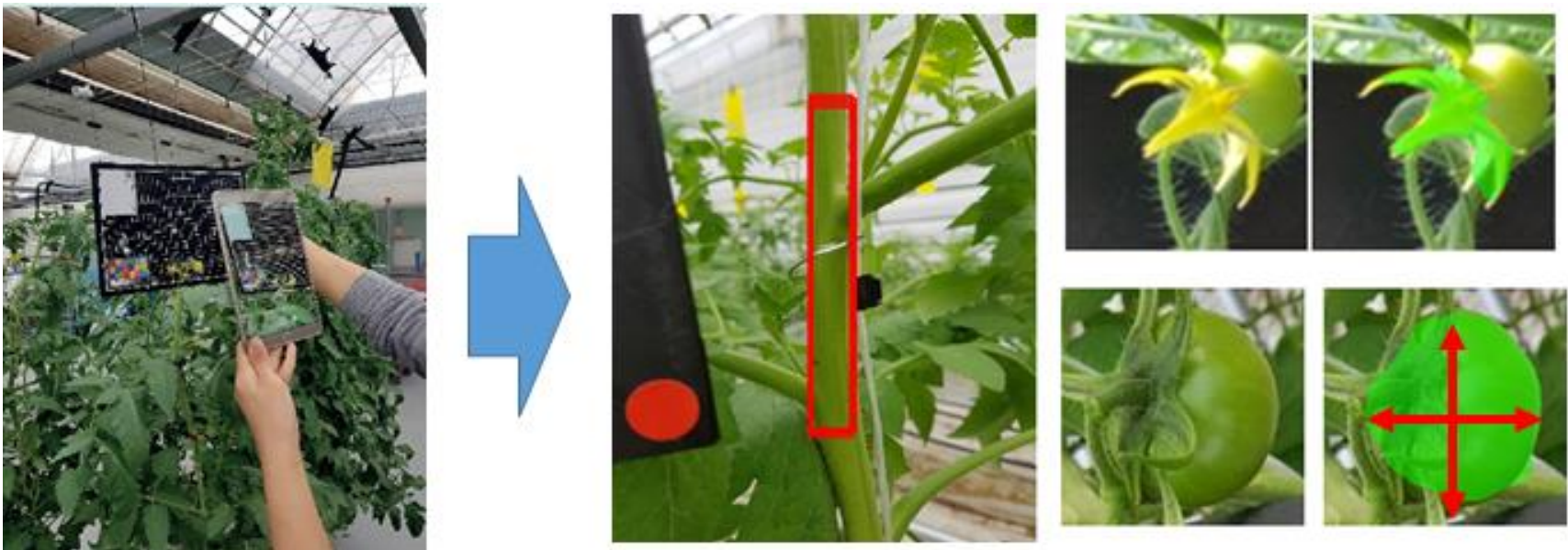
8.6M US\$(2017)

## ▪ Plant Smart Farm

### Automatic measuring of crop growth using images acquired by Smartphone

- Key know-how in cultivation technology : Identifying changes in crop growth caused by environmental responses

leaf area, stem thickness, number of flowers and fruits, fruit volume and maturity stage, etc



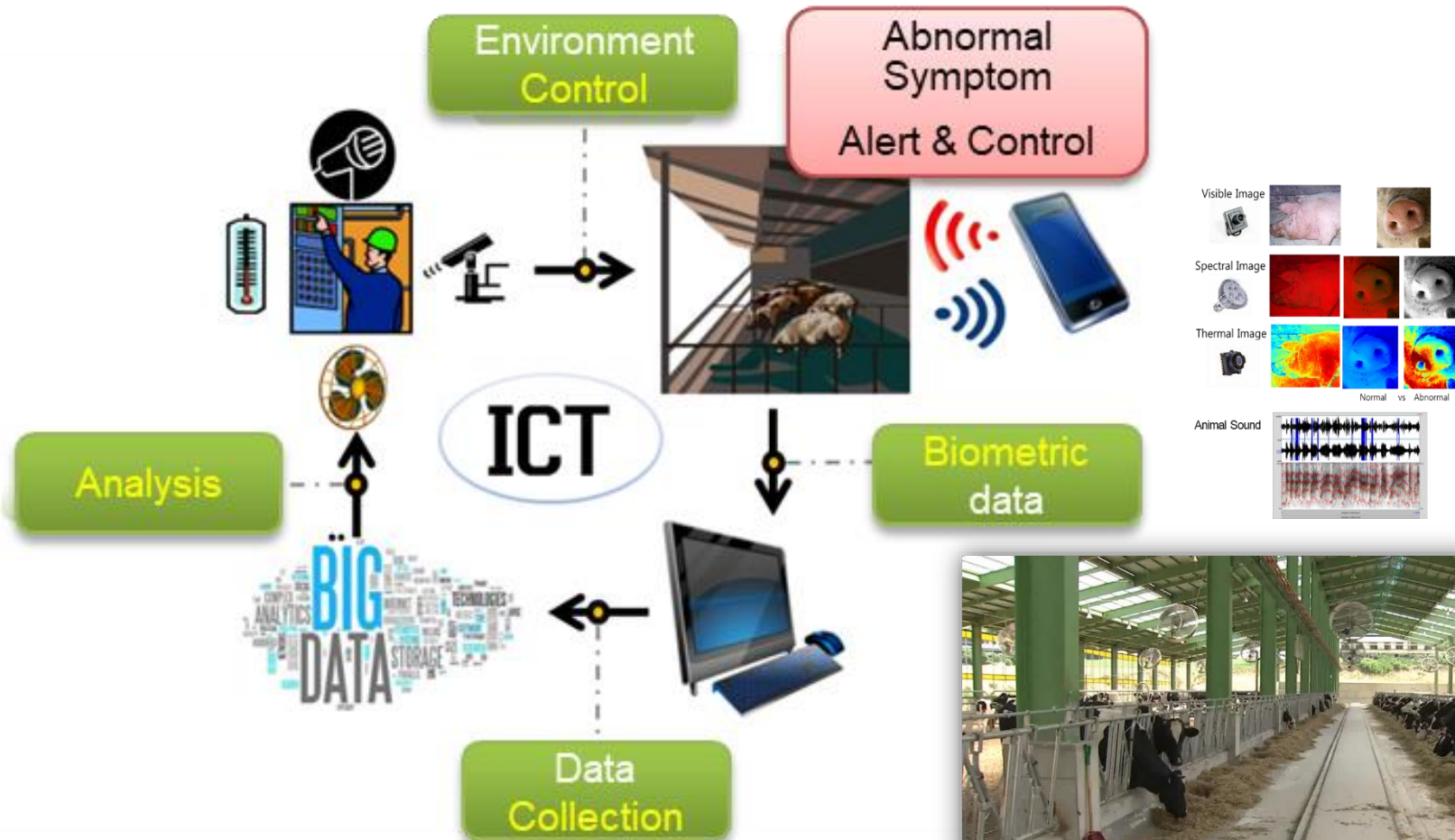




- Developing Technologies for Environmental Management and Unmanned Robotic Operation of the Livestock Barn (Inside/Outside)
- Developing Intelligent Individual Animal Management Technology for Precise Biometric Measurement and Fine Management of Dynamic Organisms

# Livestock Production

- Development of Precise Individual Animal Management Technology for Feeding based Biometric Big-data : **IoT + AI + Big-data + BT**





## 사물인터넷(IoT) 가축관리 시스템 '라이브케어'

### 축사(캡슐)



한우



젖소

- 소의 위(胃)에 캡슐 삽입
- 캡슐은 무독성(옥수수+사탕수수) 재질
- 체온·pH 상태 체크

기지국



### SKT 사물인터넷 전용망

- 수집된 정보 빅데이터 저장



### 유라이크코리아 시스템

- 캡슐 통해 전송된 데이터 분석



### PC·모바일 애플리케이션

- 소들의 체온·pH 정보 제공
- 각 패턴의 변화 분석
- 질병 관리, 영농일지 작성 등



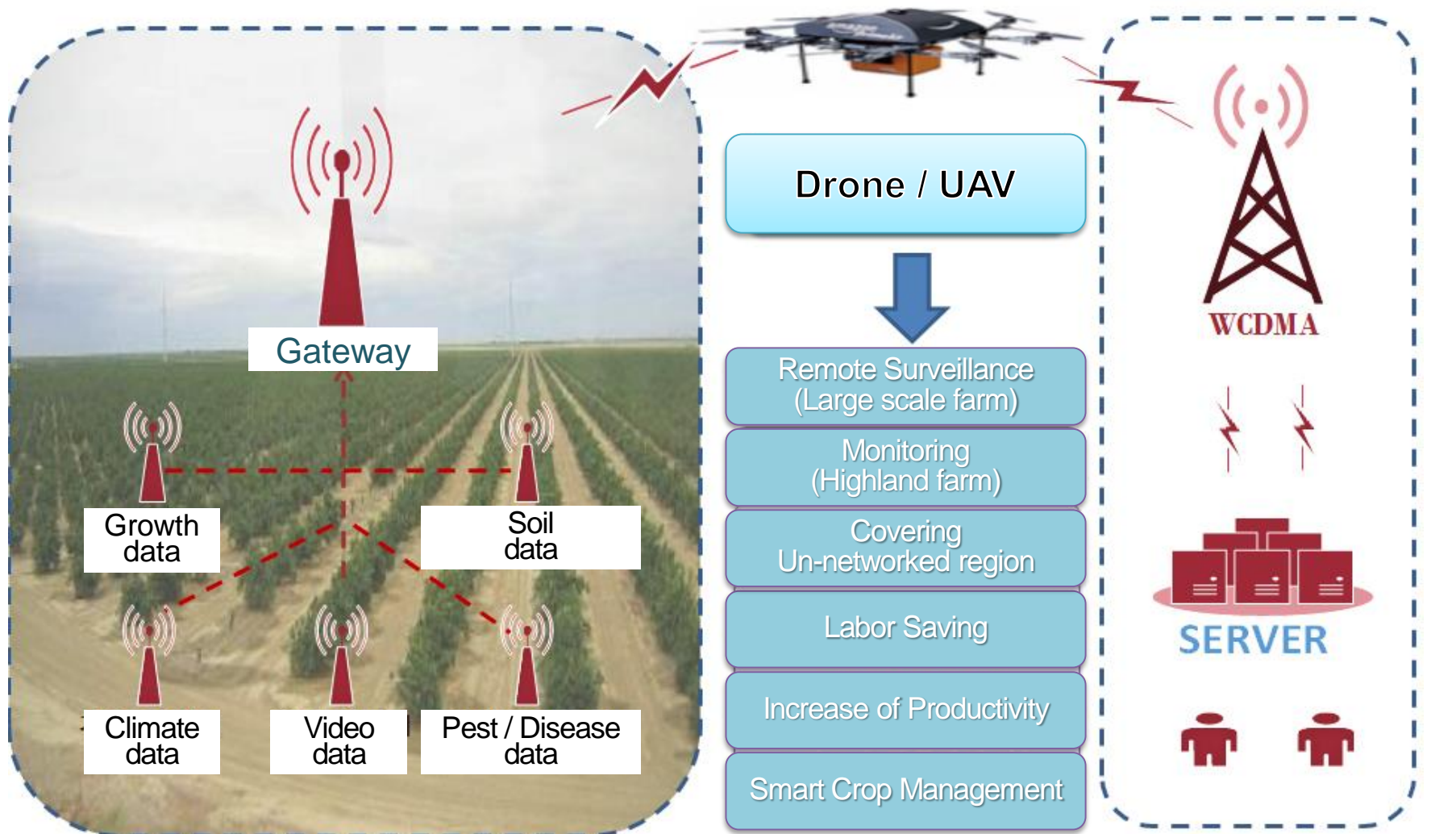
7일 충남 예산군 소재 축사 앞에서 농장주인 조상훈 씨가 라이브케어 캡슐(오른쪽 원통형 기기)과 로라 네트워크 장비를 손에 들고 활짝 웃고 있다. SK텔레콤 제공

# Technology Convergence - Drone & Satellite

## Smart farm

Data Collection  
for Growth & Remote monitoring

Data Integration  
Sensing / Statistics





## CHAPTER

### Young farming entrepreneurs



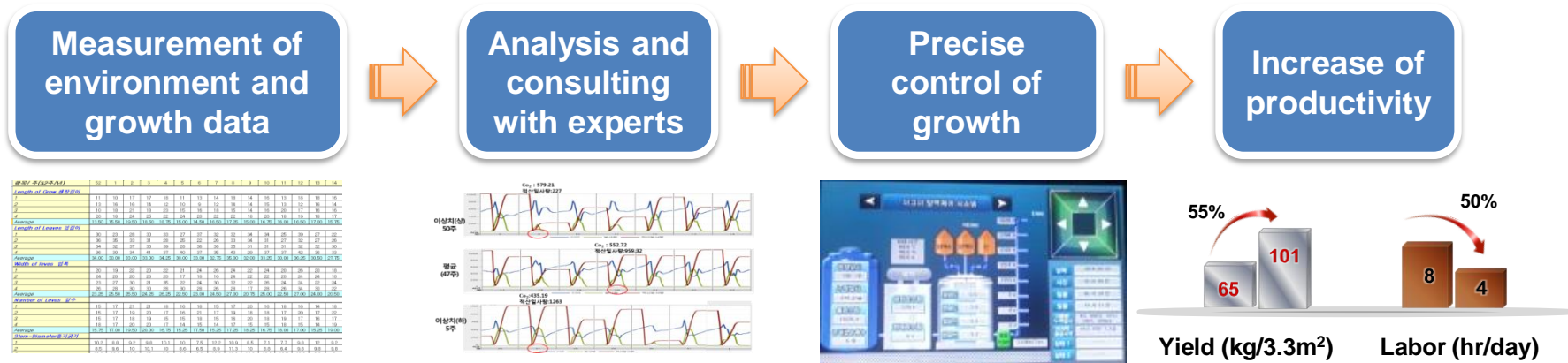
## ■ Hwasun farm




### ► Tomato (multi-span, 1.3ha)

- Yield increase: 65kg/3.3m<sup>2</sup> → 101 (55% ↑)
- Labor saving: 8h/day → 4 (50% ↓)
- Energy saving: 35% ↓

- Increase yield through modernization of the greenhouse, installation of smart farm and consulting by experts





A man with dark hair, wearing a dark long-sleeved shirt and a brown apron, is working in a large glasshouse. He is holding a white pot containing a plant with pink and white flowers. The glasshouse is filled with many other potted plants, mostly flowers in various colors like pink, red, and white. The structure of the glasshouse is visible in the background, with a high ceiling and metal framework.

# 스마트팜(화훼)으로 역대 연봉 홍해수(34) 청년농업인

0.7ha, Glasshouse  
300K US\$  
근권난방시설  
난방비 절감



“농업 없이는 다른 산업이 발전할 수 없으며, 많은 사람들이 IT나 관광 창업에 몰두 할 때, 농업을 가지고 창업한다면 큰 기회가 올 것”



2014 ~

Area : 33,000m<sup>2</sup>

300K US\$(2018)





Area : 19,800m<sup>2</sup>  
Goods : 40 varieties (vegetables)  
Employee : 89 (30.7 years old)  
5.2M US\$(2017)





궁금 타파  
흑염소

KBS1

축산(흑염소)부문  
농업마이스터(전문경영인)

**김영남** 대표  
[흑염소로 연 매출 5억 원]



**“실패,  
성공의 또 다른 이름일 뿐”**

430K US\$/year

## 최초의 여성 축산마이스터

- 25마리 → 1,100마리 (7년간)
- 사육경험 학습(마이스터대학)

**예) 비타민 A(연중 30포), C(간절기나 여름)를 이용한  
사육으로 면역력 강화, 약품 사용 저감,  
건강한 흑염소 생산과 유통**



난 누구?

안녕하세요~  
제가 바로 '피아골 미선씨' 랍니다!



초등학교 때부터 지리산 등산객들에게  
된장을 팔던 **고맙이가 이렇게 자랐습니다**



"저의 꿈은  
이곳 피아골에 청년들을 위한 교육시설을 지어  
대한민국 농업을 이끌어 갈 인재들을 양성 하는 거예요."



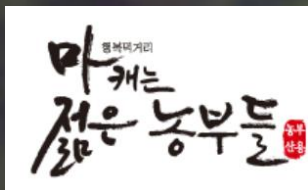
2006~  
장류 연매출 5억원  
연 백만명 방문



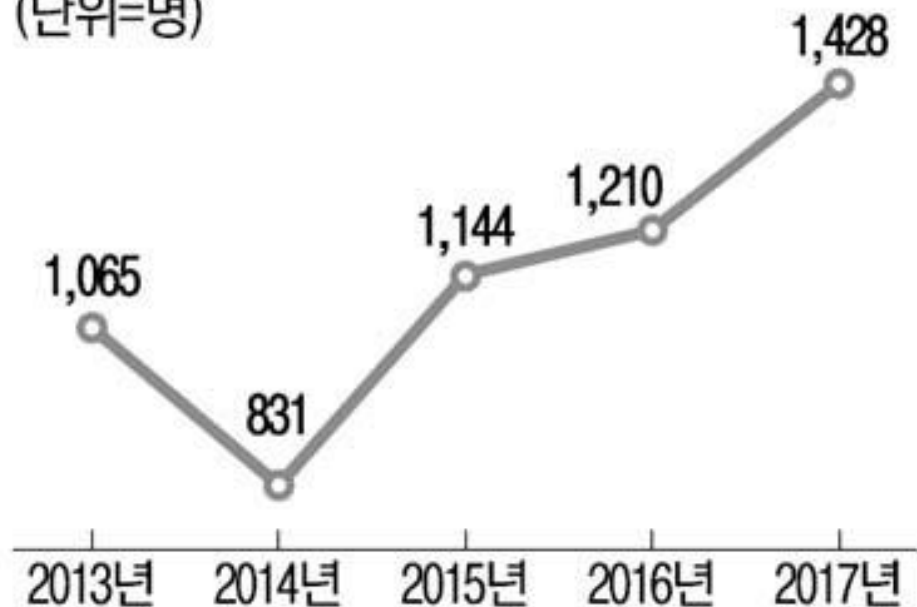
# 우리 농산물로 빵 만드는 바람난 농부 유지혜







## 전국 연 1억원 이상 소득 청년 농가 (단위=명)




\*39세 이하 기준. 자료=통계청



참마

9.7M US\$/year

A portrait of Shimon Peres, an elderly man with white hair, wearing a dark suit, white shirt, and a blue patterned tie. He is looking slightly to the right with a thoughtful expression, and his hands are clasped in front of him. The background is dark and out of focus.

## Agriculture is 95% science, 5% work

*How is it that Israel – a country of 7.1 million, only 60 years old, surrounded by enemies, in a constant state of war since its founding, with no natural resources– produces more start-up companies than large, peaceful and stable nations like Japan, China, India, Korea, Canada and the UK?*

Shimon Peres

## Changes, and Conclusions

농업이 달라지고 있다.  
식량생산에서 벗어나 융복합산업이 되고 있고,  
인간의 삶을 편리하고 풍요롭게 만들고 있다.  
스마트 농업은 농촌의 고령화 문제를 해결하고  
청년들에게 새로운 사업기회를 열어주고 있다.  
첨단 농업은 미래산업으로 각광받으며 세계인의  
주목을 받고 있다.  
우리가 스마트팜에서 길을 찾아야 하는 이유이다





The sound of footsteps  
for agricultural production

농작물은  
농부의 발소리를  
듣고 자란다





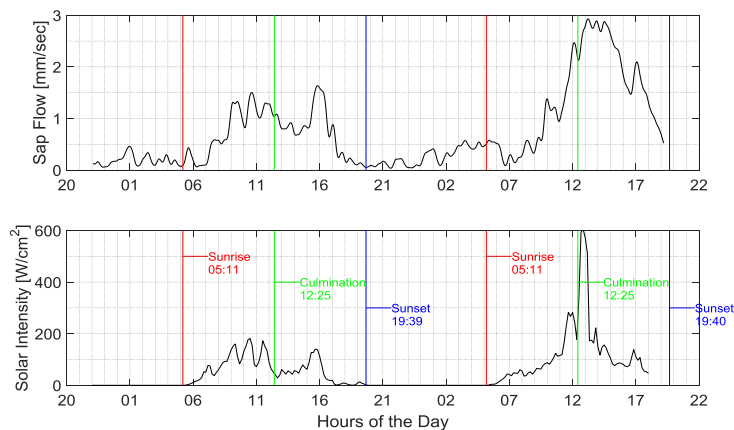
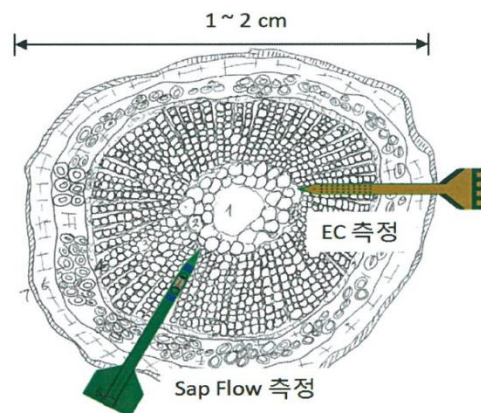
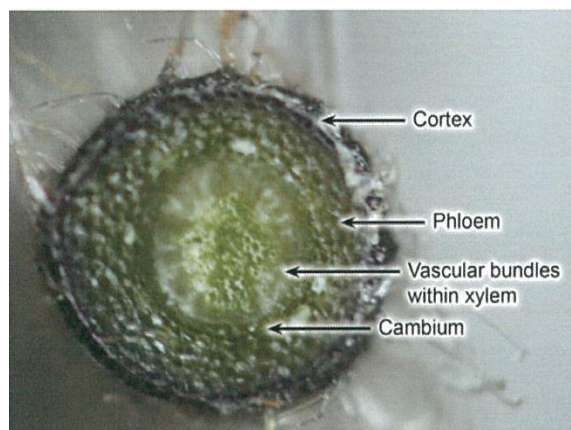
# The global race of smart farming



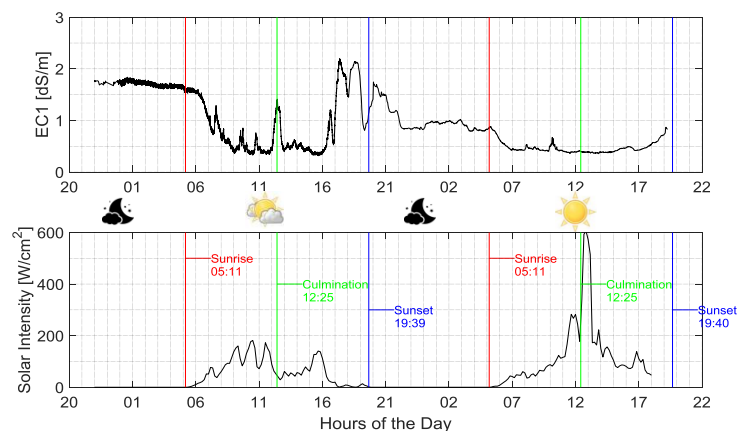
자료: 이주량 외, 스마트농업 현장착근을 위한 기술정책 제고방안, 2018, STEPI

## ■ Measuring crop growth by micro sensor

- Sap flow, EC in tomato stem



Changes of Sap flow by Solar radiation



Changes of EC by Solar radiation



