Technology for overcoming the Global Tetralemma

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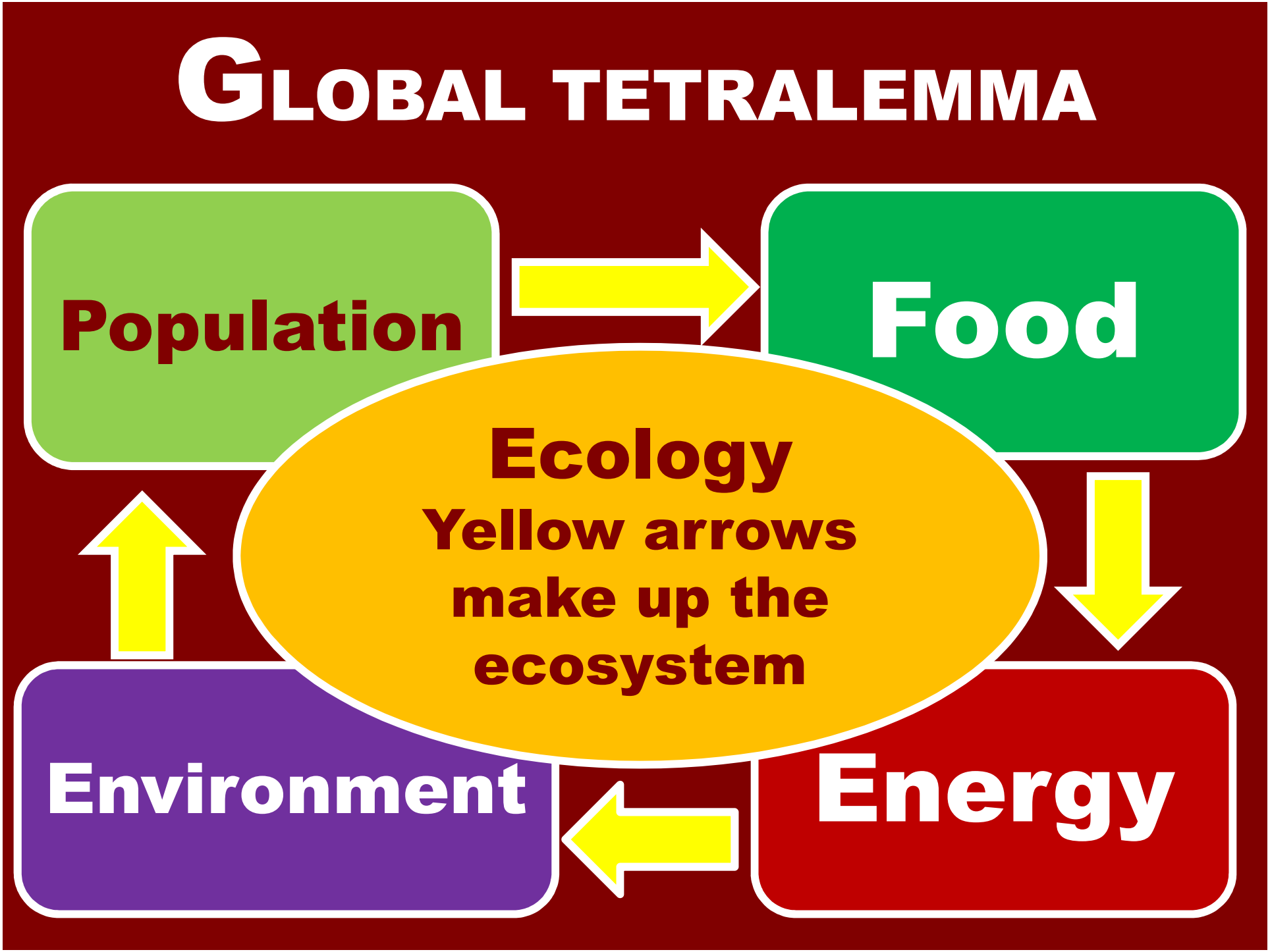

Global tetralemma
Population
Food
Ecology
Yellow arrows make up the ecosystem
Environment
Energy

Economy breaks Ecology

Population
increase

Human's
Economic Activity

Food
Production increase
Food security 2QSL
Traceability
Food mileage
Virtual water

Energy
Energy resource shift
Alternative energy
Bio-fuel (Bio-ethanol, Biomass, Bio-gas)
New energy resources
Renewable energy
EV, FCV

Environment
CO_2 production
Climate change / Global warming
Waste treatment
Carbon footprint, SDGs

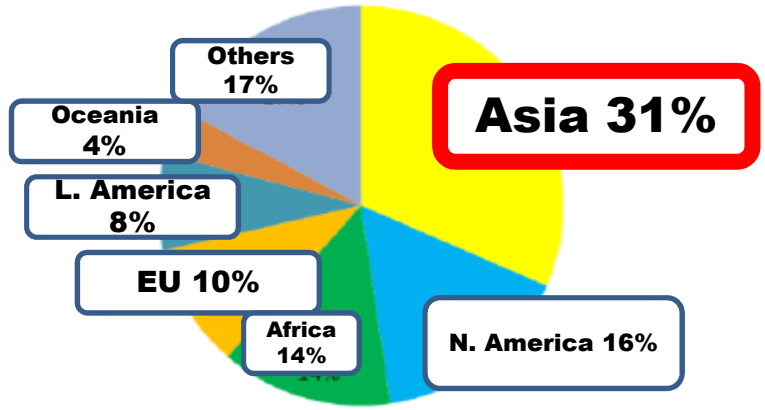
World agriculture made from FAO Report 2006

Nation	Farming area (%)
Asia	31 %
N. America	16 %
Africa	14 %
Europe	10 %
L. America	8 %
Oceania	4 %
Others	17 %

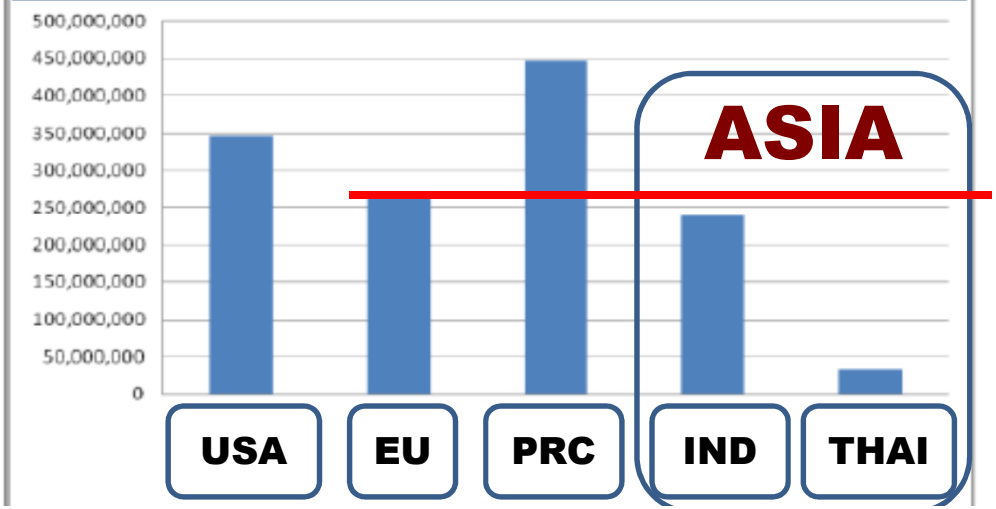
Nation	Cereal Production (100 mil.ton)
USA	3.50
EU	2.70
P.R.C	4.50
India	2.40
Thailand	0.30
Total	13.40

EU = India + Thailand

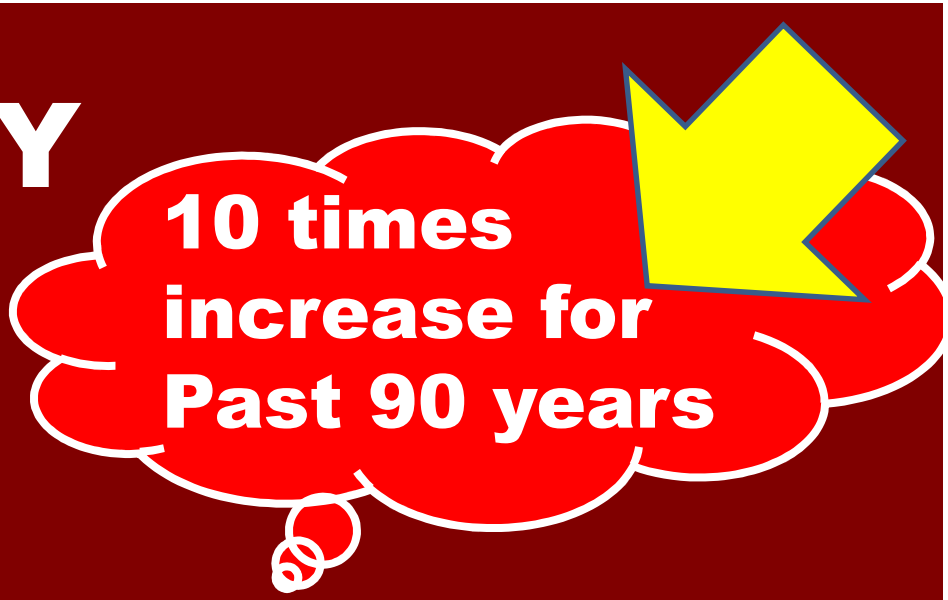
World cultivated farmland, (%)



Cereal Production, 10,000 ton



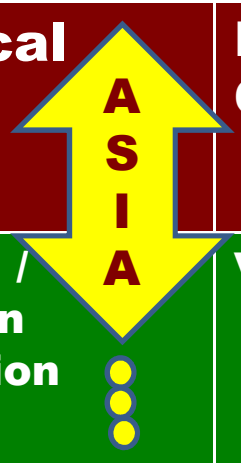
PRODUCTIVITY INCREASE



- **0.5 person / acre**
  5 person / acre
  1920 ~ 2010 (for 90 years)
  1 ha = 2.4711 acre, (1 acre = 0.40ha)
  1 ha = 10,000 m2
- **Population increase rate per year**
  80 million
- **World cultivated land**
  17,298,900 (km2) 11.61 (%)

COMPARISON OF GENERATION CHANGE

Generation	Agriculture	E/E Industry	ICT, Communication
1G	Man power	Vacuum tube	Analog wireless technology mobile network
2G	Animal power	Transistor	Digital wireless mobile phone system
3G	Mechanical power	Integrated Circuit	First global standard mobile communication system
4G	Automation / Robotization Tractorization	VLSI	IMT -Wireless system compliant with Advanced standards
5G	Digital Farming Unmanned Autonomous guidance	Next era Mobile communication system based on	Wider range and higher frequency band of 6GHz, Communication data volume & speed



ROLE OF AGRICULTURE

- Agriculture can solve most of the issues in
- Bio-resource production
  - Food resources
  - Energy resources
  - Environmental resourc
  - Material resources
- Reason why BCGE, SA, PA, Cluster Farm are closed u

BCGE:
Bio Circular Green Economy
SA: Smart Agriculture
PA:
Precision Agriculture
CF:
Cluster Farming

What technology is needed ?

Issues to dolve

- **Food**
  2QLS
- **Energy**
  RE, NE
- **Environment**
- **Material**
  New material, CNF

Human survival

Most of the Problems are caused by Human Economic Activity

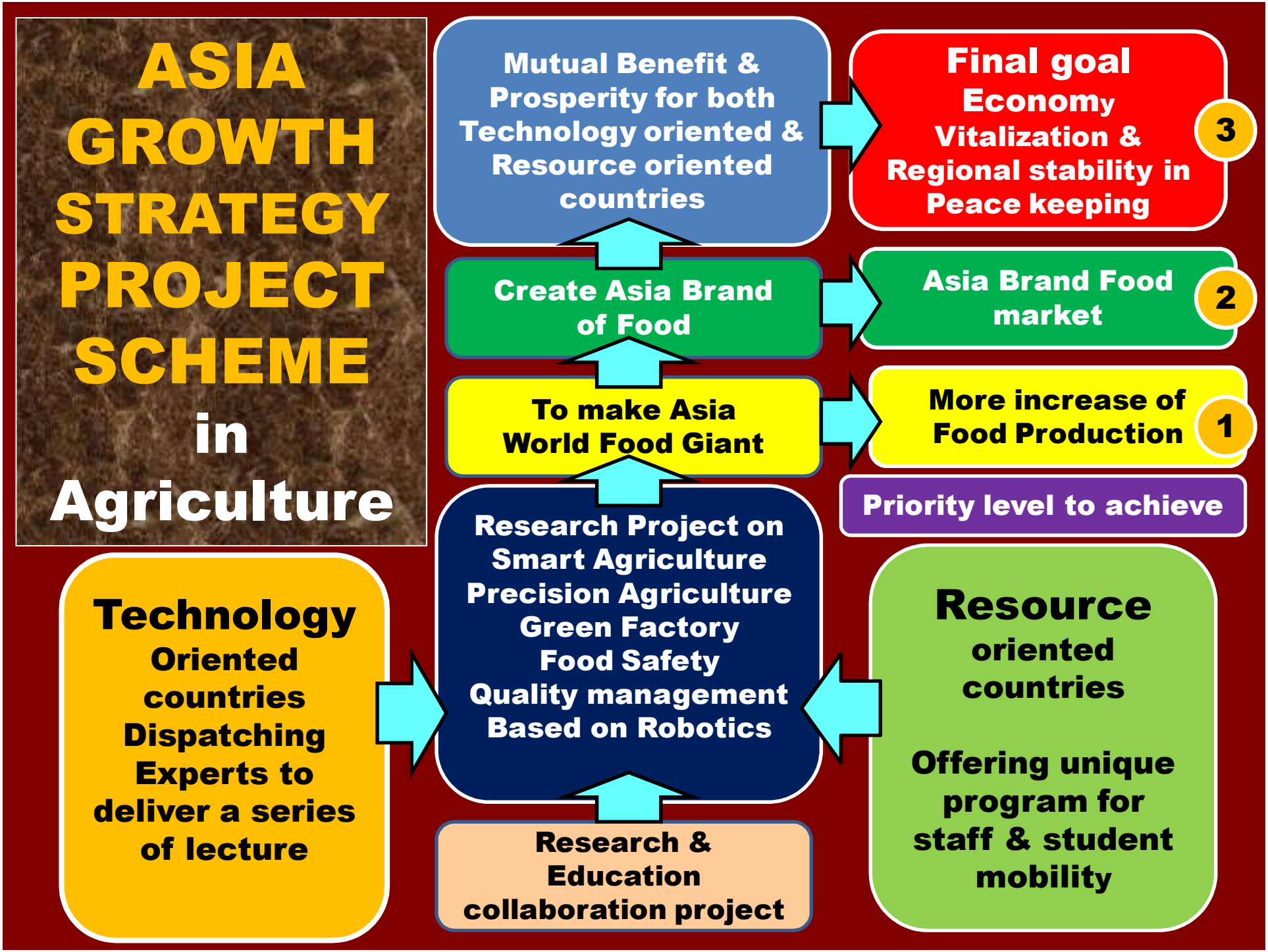
Under

ASIA

SUSTAIN-ABILITY

Industry sector

- **Agriculture**
  SA, BCGE, CF
- **Medicine Health**
- **Environment**
- **Others**


ASIA GROWTH STRATEGY PROJECT SCHEME in Agriculture
Mutual Benefit & Prosperity for both Technology oriented & Resource oriented countries
Final goal
Economy Vitalization & Regional stability in Peace keeping
3
Create Asia Brand of Food
Asia Brand Food market
2
To make Asia World Food Giant
More increase of Food Production
1
Priority level to achieve
Research Project on
Smart Agriculture
Precision Agriculture
Green Factory
Food Safety
Quality management
Based on Robotics
Technology
Oriented countries
Dispatching Experts to deliver a series of lecture
Resource
oriented countries
Offering unique program for staff & student mobility
Research & Education collaboration project

ASIA RICE PROJECT

- **Industry sector:** → **Agriculture**
- **Project title:** → **Asia Rice Project**
- **Objective crop:** → **Rice (& others)**
- **Purpose :** → **To make Asia a Food Pantry to access to the upcoming food shortage issue**
- **Method:** → **High Tech Agriculture Application and Its Transfer / Human Resources Development**
- **Technology** → **Precision Agriculture, Robotics, Green Factory, Quality Control for Food Security, Smart Agriculture**

Asia Techno Farm, Role of 3 BODIES

1 University

Provides
1) Program
2) Facility (Farm)
for program operation

Program scheme

Asia Techno Farm program

Facilitated at Some of the National organizations Universities Research Institutes in Some ASEAN member Agricultural countries

Global Solution
1 (Food & Energy / Environment)

- Smart Agriculture
- 2 Precision Agriculture
- 3 Agricultural Robot
- 4 Green Factory
- 5 Special Education
- 6 Social service

2 Government

Provides Budget as National project

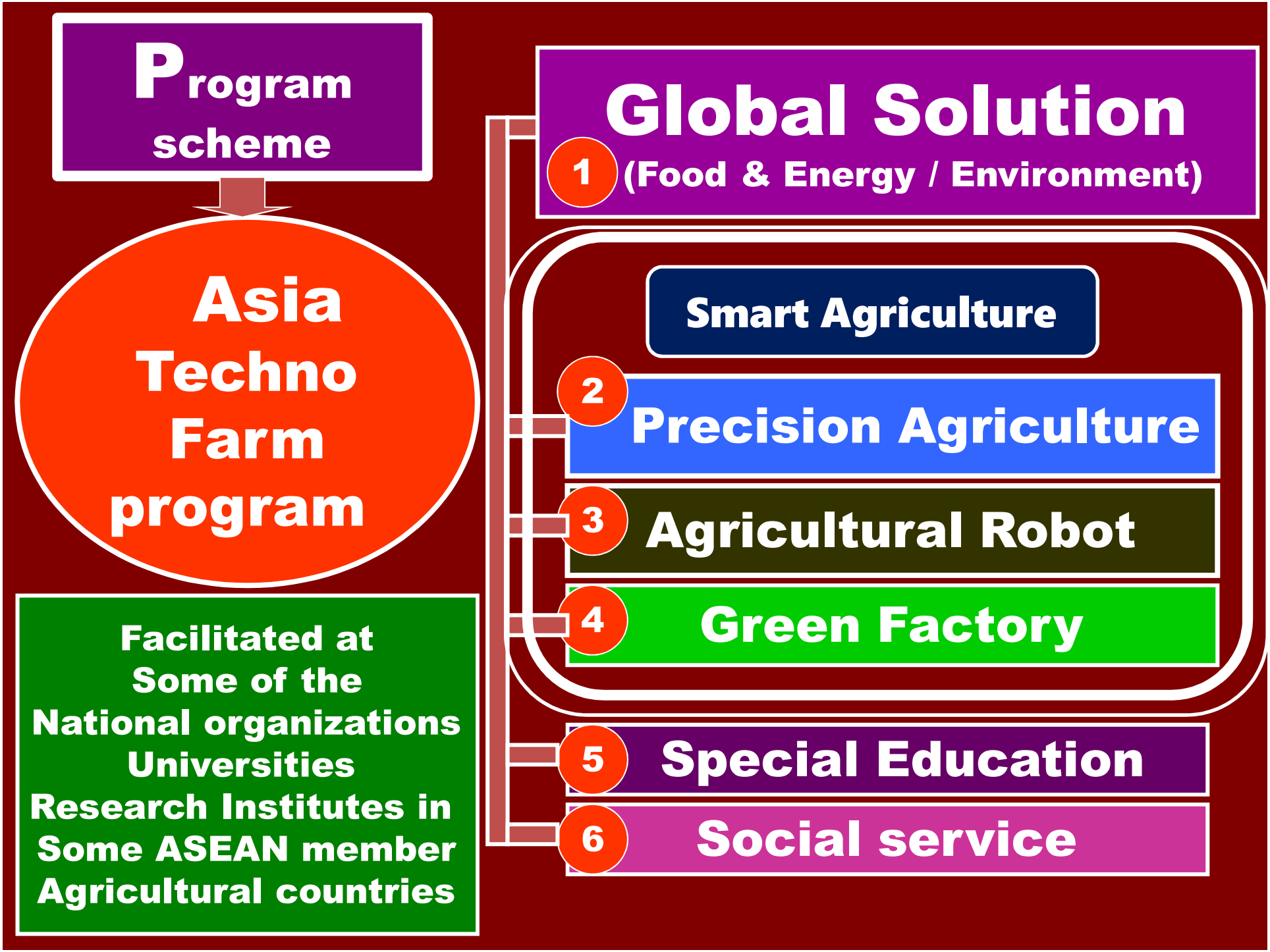
3 Industry

provides
1) Machines / equipments
2) Technician

Techno Farm

- For Demonstration
- For Experiment
- For FFA Practicing

Monthly / Regular Meeting to get together


Program scheme
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Global Solution
1
(Food & Energy / Environment)
Smart Agriculture
2
Precision Agriculture
3
Agricultural Robot
4
Green Factory
5
Special Education
6
Social service

FFA

Smart Agriculture Trainer Training Center

FFA program participants
Almost 10 ~ 15 accepted from ASEAN countries / one time

PROGRAM

Length: 6 month

Contents : Smart farming
- Precision Agriculture
- Robotics
- Green Factory
- Emerging Technology available for Agriculture

Data acquisition:
- Sensing, Monitoring ,
- Gathering , Processing

Practical skill up:
- One season cultivation

Qualification
- Final report submission & Presentation
- Certificate issue & grant

Invited lecturer

- One week stay / one time visit
- Series of lecture given for 4 days
- 2 days visit on site

WHY ?
- To know more Asian Agriculture
- More communication with trainees
- English improvement

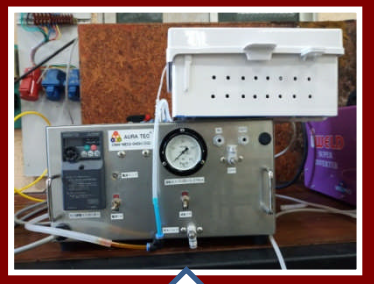
VISIT TO LECTURER'S LABO

At the end of program, 2 weeks tour may be offered

Lectures may be invited from countries around the world as well as Asia

EMERGING TECHNOLOGY

- **Emerging technologies applicable usefully to Agriculture**



- **Information technology (ICT, IoT)**
- **Nano technology**
  - **Nano bubbles: Sterilization of Agri – Prods.**
  - **CNF: Cellulose Nano Fiber**
- **Plasma: Waste to Energy**
- **Biotechnology: R/D of New variety**
- **Cognitive science**
- **Robotics: Mobile harvester**
- **Artificial intelligence**

Fruit harvesting robot

ASEAN UNIVERSITY CONSORTIUM

- **The other activity toward the Asian Economic Community establishment is The "ASEAN UNIVERSITY" Consortium already established**
- **The ceremony was held at IPB, Bogor Agricultural University, Indonesia and agreed to take action for further promotion in October, 2012 in association with JICA**

ASEAN UNIVERSITY CONSORTIUM

Established in October 27-29. 2012

Declaration of ASEAN Universities Consortium on
FOOD & AGRO-BASED ENGINEERING &TECHNOLOGY EDUCATION
(Bogor Declaration)
and
Initiation of ASEAN Universities Consortium on
ENGINEERING EDUCATION

October 27-29, 2012
IPB International Convention Center, Bogor

JICA Group Training Program

It should be focused on FFA growing program In Asia, not in Japan

Acceptance by local government & JA

Trainees at Host Farmer's rice processing facility

Practicing on local farm

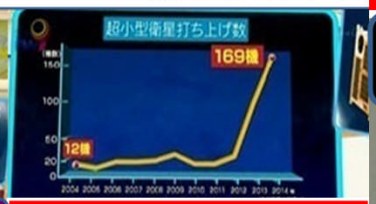
1st FILIPINO SATELLITE

①

SATELLITE BUSINESS

②

News on air about Super Small Scale Size Satellite Development



Increase of Super Small Scale Satellite Development by private industry

Ministry of Science & Technology Administrative Officer Government of The Philippines

③

TOHOKU UNIVERSITY

UNDER ASSEMBLY OPERATION

Six Filipino students joined the project for satellite development

Two DIWATA satellite will be developed. One was developed this time

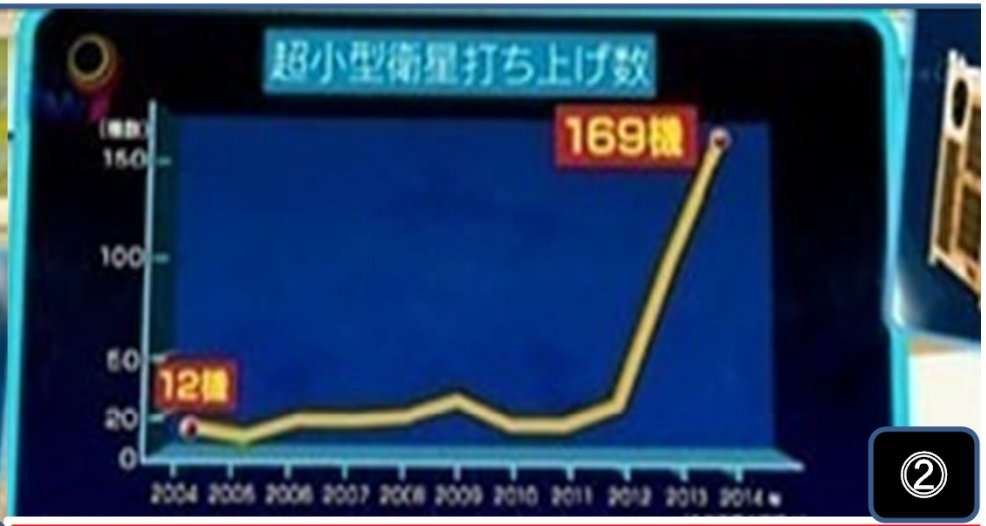
④

Four monitoring cameras are mounted on satellite DIWATA-1

MOU AGREED BETWEEN JAPAN & PHILIPPINES

SATELLITE BUSINESS & Human Resource D.

News on air about Super Small Scale Size Satellite Development



Increase of Super Small Scale Satellite Development by private industry

Ministry of Science & Technology Administrative Officer Government of The Philippines

Workshop on Precision Agriculture and Agricultural Machinery Industry for Thailand 4.0

Date: September 19 ~ 20, 2017

Location: TISTR Lamtakhong Research station, Ministry of Science and Technology, Pakchong Nakorn Rachasima

Thailand Institute of Scientific and Technological Research has MOU agreed with NARO, Japan etc. after this workshop event

To whom is the technology transferred ?

FFA program can play a role for growing and training trainer including future successor

FOOD SECURITY

FOOD SECURITY CONSISTS OF:

1. ENOUGH QUANTITY PRODUCTION TO SUPPLY & FEED
2. QUALITY CONTROL & MANAGEMENT
3. SAFETY STANDARD PROTOCOL BY TRACEABILITY
4. PRODUCT LIABILITY BETWEEN PRODUCER & CONSUMER

SMART AGRICULTURE

- "Smart Agriculture" is a new agricultural initiative and ideal way to improve production / quality & productivity by use of IT, ICT & IoT based advanced technologies
- Big data should be gathered, processed and analyzed, then they are combined and used for "final decision making"

SMART AGRI (PA) IS JIT SYSTEM IN AGRICULTURE

- Already popular system in car industry as TOYOTA initiated

Reduce total Loss

Time, Energy, Space, Labor, Resources

JIT (Just In Time) system is similar to the "Variale Rate Control" in Precision Agriculture

1) What do we need ?

2) How many (or how nych)?

3) When ?

What ?

How many?

By When ?

Definition of Smart Agriculture

- Ministry of Agriculture, Forestry and Fisheries, Japan defines smart agriculture as

"New agriculture that enables hyper labor cost saving and high-quality products production by utilizing such as cutting-edge technologies robotic technology and ICT"

Continued 1

- "Smart Agriculture" can achieve
  - Large-scale farming system based on highly advanced, automated machinery
  - High-yield, High-quality products production by fully use of : Sensing technology, Large data, and precisely operated Robotic machines

Continued 2

- It can be expected to have more "Merits" additionally such as

  1) CO_2 mitigation and labor saving, and precision farming operation (Environment friendly) by

  2) Combining know-how with data and assisting operating function, and

  3) Providing important and necessary information to consumers by

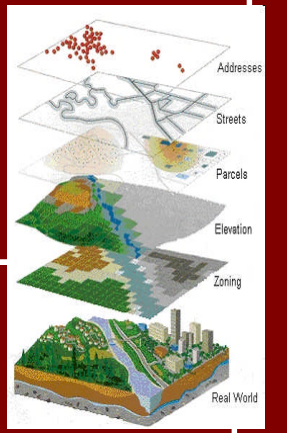
  4) Providing final products information to the consumers for Food safety (Traceability)

Precision Agriculture

- **Precision Agriculture has variable rate control function for reducing loss, and saving, time materials and energy**
- **The concept of this farming system is similar to the car manufacturing system named "Kanban (or Kaizen) system" consisting of the variable rate control as shown below**

PRECISION AGRICULTURE

- Autonomous guidance by “GPS”
- “GIS” for data mapping to provide the necessary required data and the accurate operation to automatically guided agricultural machinery
- Various data mapping such as Soil fertility, Moisture content, Nitrogen content, even for yield after harvest can be mapped by “GIS” and provided timely and appropriately when the machine comes to the right specific site shown by ”GPS”



Remote / Direct Sensing

Remote sensing

- **Photo from aircraft**
- **Image from artificial satellite**
- **Plant nutrition and water condition while growing (NDVI)**

Farmland management

(Direct sensing by the sensors attached to machine such as a tractor

- **Yield : Flow sensor (impact force, weight, volume), Moisture sensor (capacitive type using metal plate), Speed (vehicle speed) sensor (Doppler type), Display**
- **Growing rate and level of weeds and pests**
- **Plant (crop) density**
- **Distribution of variability within the field**
- **Direct measurement by sensors attached to machine such as a tractor**


Real time sensing
Prof. Shibusawa, S
Tokyo A&M University
Soil hardness, Moisture content
measuring while tilling

ROBOTICS IN AGRICULTURE

- Ultimate stage of mechanization
- Energy & Labor saving
- Timely operation
- Higher stable productivity
- Avoidance of dangerous & dirty farming operation
- Uniform & high quality products production
- Problems for negotiation:
  Safety & Product Liability assurance for extension, Intellectual copy right submission & Registration for patenting

Agricultural Robot

- The 1 st International conference held by ASAE in Tampa, Florida, USA 1983
- IARP, Avignon, France 1988
- IEEE, Hitachi, Tsukuba, Japan 1990

- Mobile agricultural machinery robotization such as Tractor, Combine, Transplanter etc. (Field Robotics)
- Various harvesting robots developed for Fruit, Vegetable harvesting robots
- Production system changed Farming

Mass Production	Agricultural to Industrial	Flexible Manufacturing
Less - variety mass production Majority Cropl	to	Multi - variety less amount of production Minority Crop
	Processed to fresh market	

Difference between Industrial and Agricultural Robots

No.	Item	Agricultural robot	Industrial robot
1	Robot motion	Move to work Search, Find, Identify, Off road	Stay and wait for the work coming Not mobile
2	Objective work	Non standardized Size, Color, Shape, Maturity Hardness, Location	Standardized Designated set position
3	Operation	Autonomous	Program based
4	Function	Learning	Teaching
5	Structure	More complicated	Comparatively simple

Various Robots in Agriculture

Tomato harvesting robot Panasonic

Tomato fruit under harvesting, Panasonic

Recent Robot in Agriculture

- Stable yield promising
- Selective harvest of matured target fruits only
- Taste & Protein known before harvesting

Soft fruit harvesting robot Mie University, Japan

Unmanned combine harvester YANMAR Co. Ltd

Group control operation of multiple moving vehicles

Multiple agricultural tractors
Prof. Noboru Noguchi

Multiple truck vehicles
Ministry of Land, Infrastructure, Transport and Tourism

Continued

Off-road,
Low-driving speed, Less rush

Master
Manned / Unmanned control

Slave 1
Slave 2
Slave 3
Slave4

Unmanned

Paved-road,
High driving speed, More rush

Master
Manned / Unmanned control

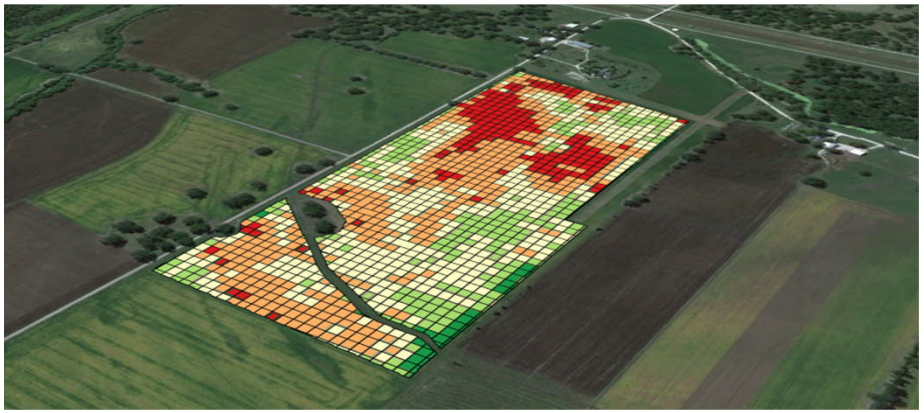
Slave 1
Slave 2
Slave 3
Slave4

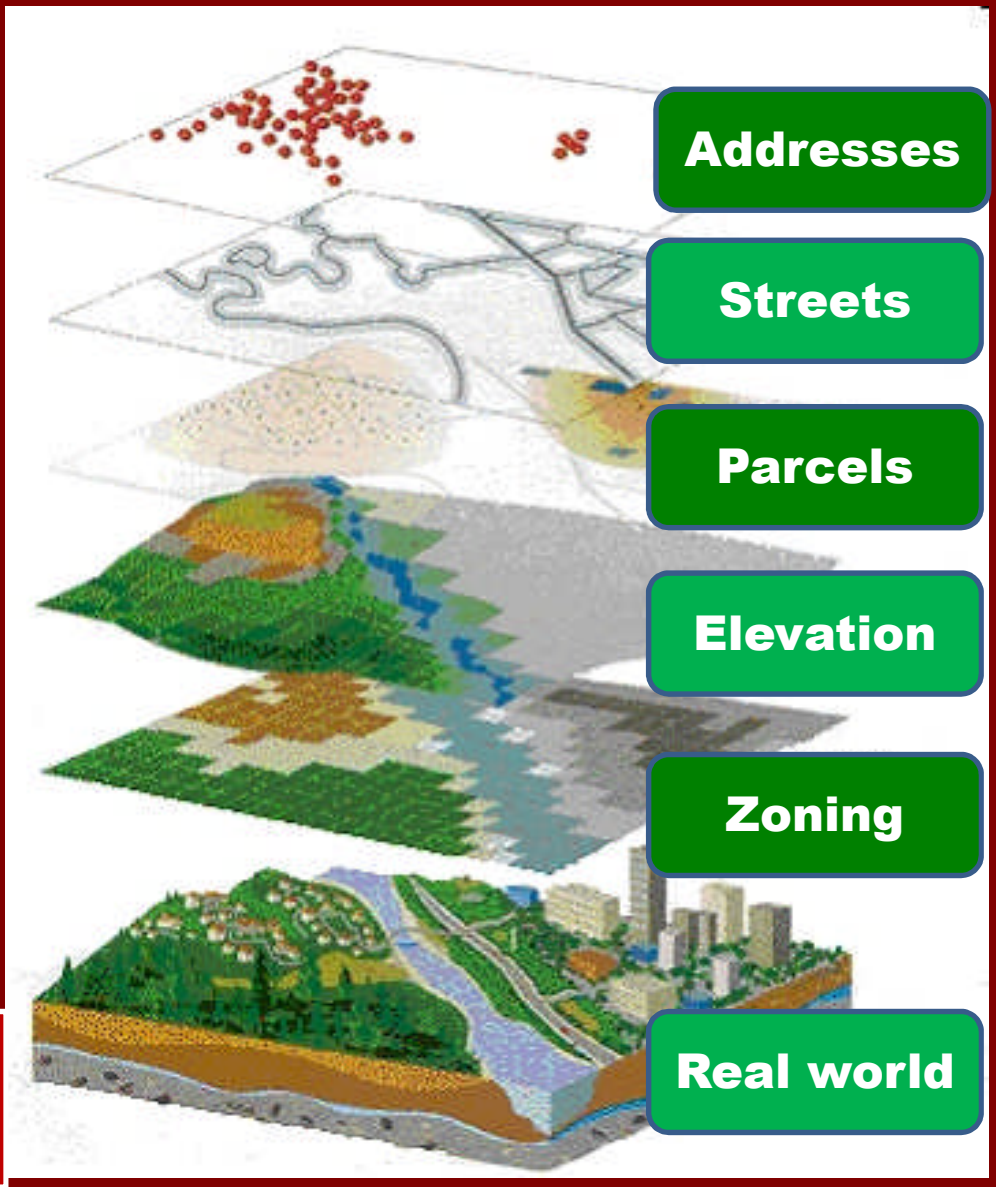
Unmanned

Application of Drone

- Drone covers a huge area monitoring, measuring and doing operation in a short time
- Data obtained can be used for
  - Identification of farmland location
  - Growing condition of crops and its control by NDVI
  - Various Data gathering for data mapping seed sowing
  - Application of seed sowing & spreading chemicals such as herbicide, pesticide, fertilizer etc.
- Obstacles to negotiate
  - Aviation law / Regultion due to Drone size, capacity & performance
  - Actual work accuracy
  - Payload

Data Mapping by Drone





Mihoko.mochizuki Agtech, IoT, Data, Drone, May 18, 2016

GREEN FACTORY

- Free from Natural environment
- Completely closed system
- Automatic Growing model of securing the constant stable yield
- Fresh and Safe, value added vegetables production & supply
- Higher potentiality for medicinal / pharmaceutical crop cultivation
- Job opportunity expansion

GREEN FACTORY (Merits)

1) Possible to cultivate many times regardless of the season
2) Possible to create a business by selling nursery plant before harvesting
3) Fresh and safe vegetable supply
4) Environmentally controlled completely
5) Safe cultivation possible regardless of the external environment
6) No need to prepare a large farmland
7) Value added medicinal and pharmaceutical crop cultivation

GREEN FACTORY


Osaka Prefectural University,
Japan

Granpa

Dome Farm

Kanagawa, Japan

Source

Ceiling of Dome

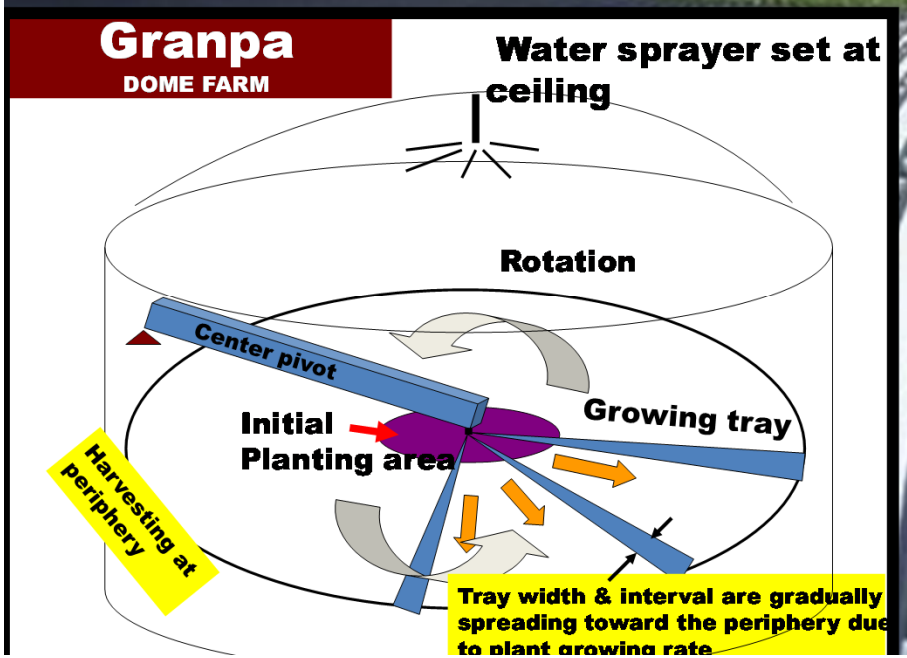
Mist sprayer

Center pivot

Door

Entrance / Exit

Growing tray



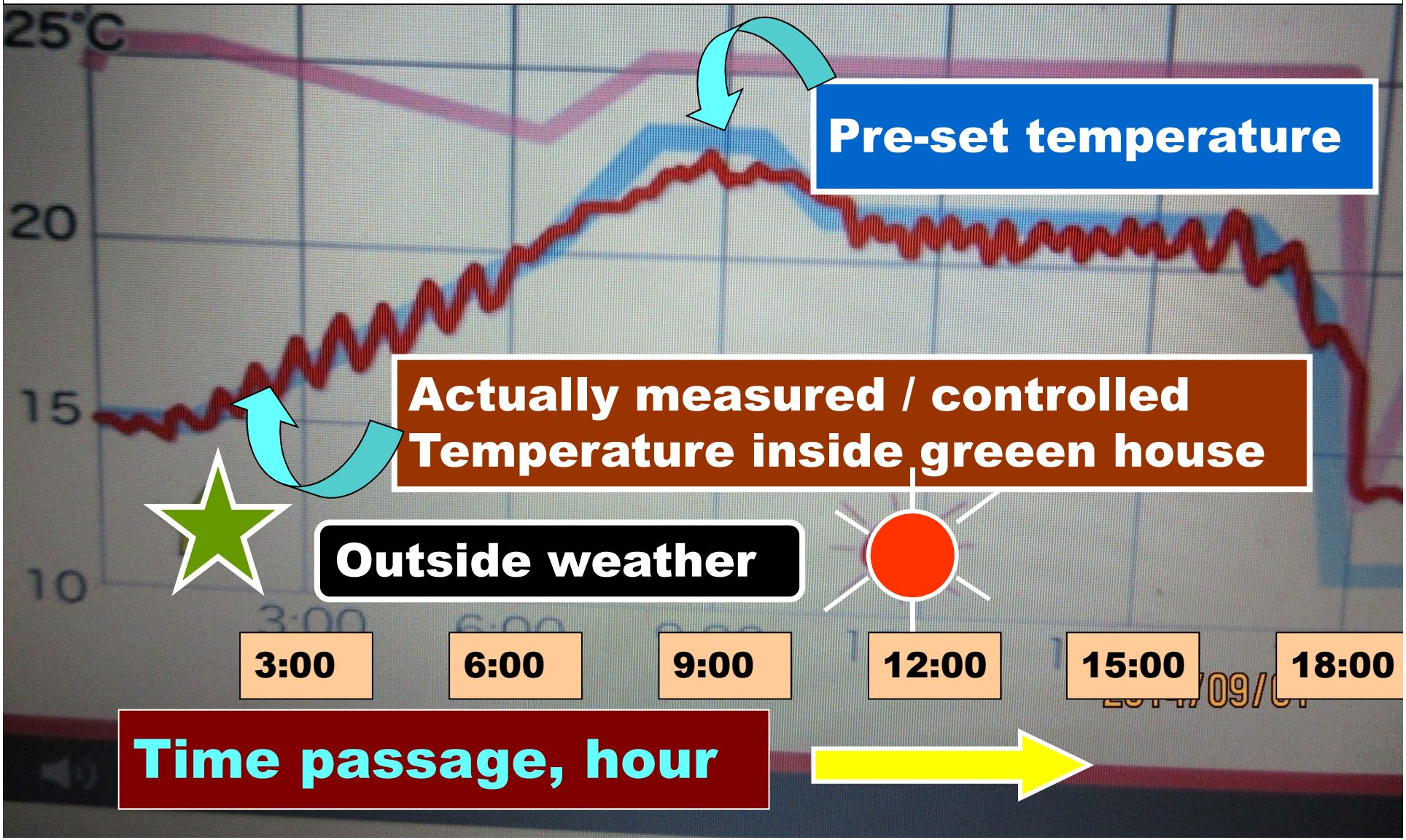
RFID Reader terminal

Completely closed system

GREEN FACTORY

Personal / Community use

TOMATO GROWING PROGRAM

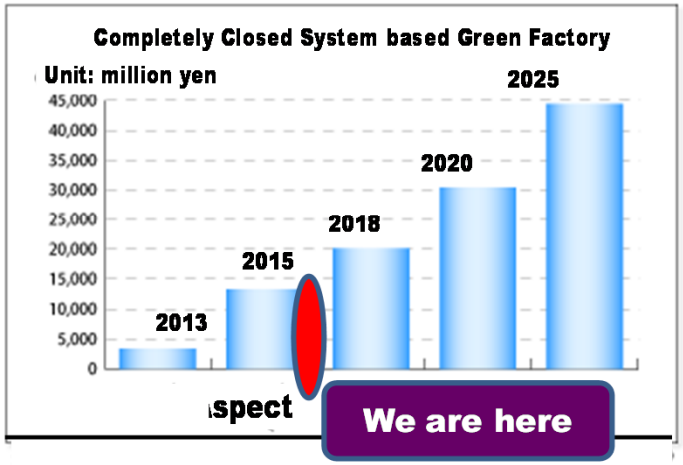


GREEN FACTORY

Hydroponic Commercial Product for sale in Thailand

System comparison	Open	Closed
Yield / Unit Area	1	100
Growing speed	1	2.5
Water use	1	1/100
Closed Green Factory system	Fluorescent	LED
Electricity consumption	1	- 40%
Yield /Unit area	1	1.5

FUTURE ASPECT OF GREEN FACTORY MARKET



Source: YANO RESEARCH INSTITUTE OF ECONOMY

EUGLENA (Algae)
Decarbonization Business Project

BIO JET FUEL SUPPLY INDUSTRY

EPCO
Electric Power Company

CO_2

EUGLENA Co. LTD

HITACHI PLANT Co. LTD

Plant providing

Providing crude oil before refining

Providing residues such as proteins

AIR LINE CO. LTD

Use of bio-jet fuel for existing engines

ASTM-D1655
Use of compliant algae fuel

JX NISSEKI

Bio-jet fuel refining

Industry Farm

Diversion to food, feed & fertilizer

現場の環境や動植物のモニタリング、監視等を行うセンシング機能
それらと通信技術を一体化したモニタリングデバイス
“FieldServer（フィールドサーバ）”！

Characteristic features
- Handy data acquisition
- Covered by wireless
- Remote controlled

Various usage of Proximy sensors Field Server

AGRIBIOMETRICS

NEC
March 07, 2011

Net pattern of individual mask melon recognition and Identification technology applied to the Traceability

TOYOTA
GOOD HARVEST PLAN

operator Skill

operator Skill

operator Skill

豊作計画

ログアウト

実績一覧 指標

本日の作業予定

10:00 鍋田 代かき 10/10

15:00 東末広 田植え 1/5

本日の平均作業時間 (h/10a)

代かき 1.4h

田植え 0.8h

TOYOTA GOOD HARVEST PLAN SYSTEM

Work contract

FARMER A

Work contract

FARMER B

Work contract

LAND OWNER C

Total 800 Farmers join

Agricultural Corporation

Company

Management Indicator

Diary

PLAN

REC

FARM IT MAN. CLOUD

F DB

OP DB

Plan

REC

Operator ①

Operator ②

Operator ③

S. phone

Puddling

Transplanter

Fertl. Appli.

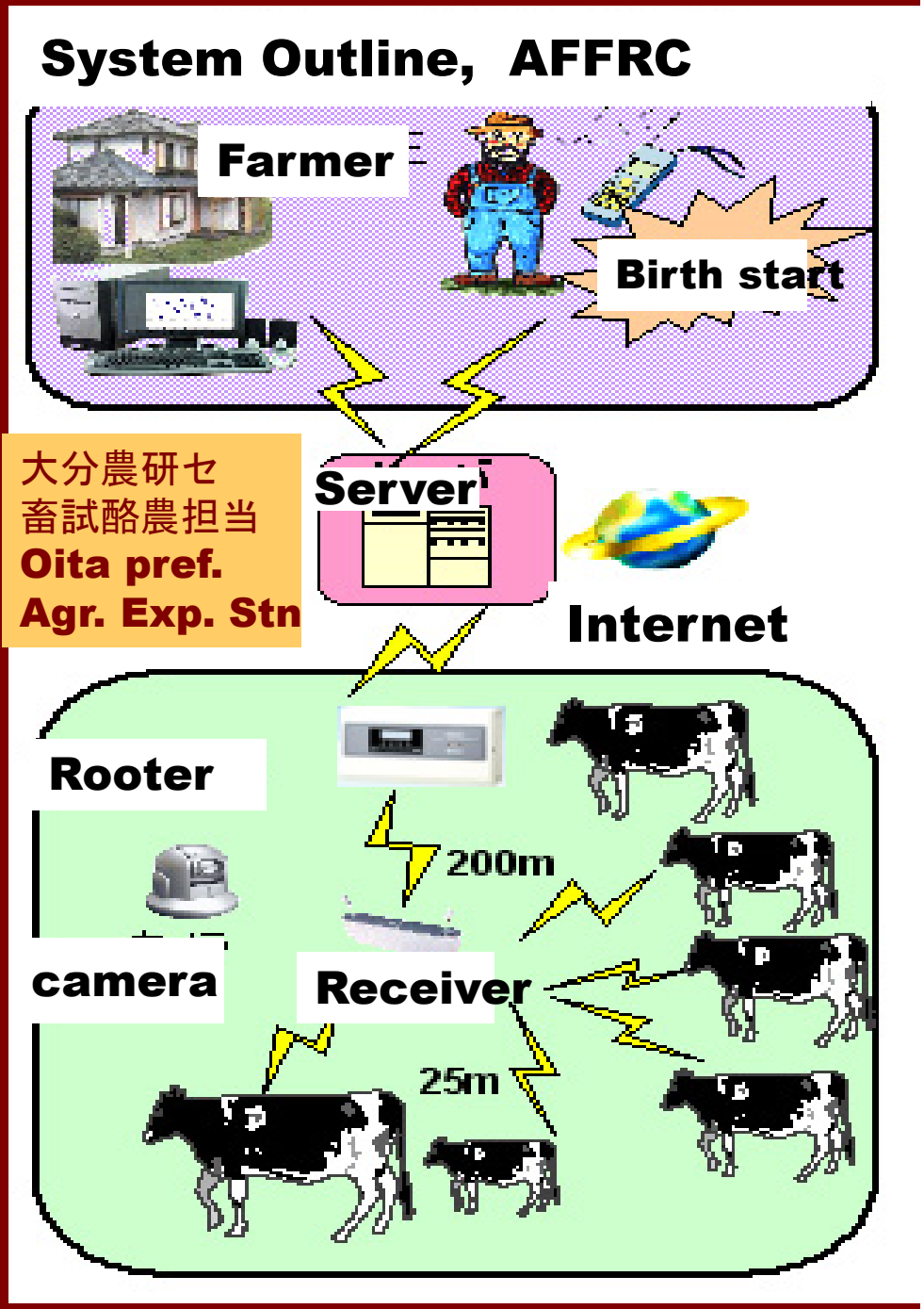
A	A	A	B	C
B		B	C	C
A	B	C	C	

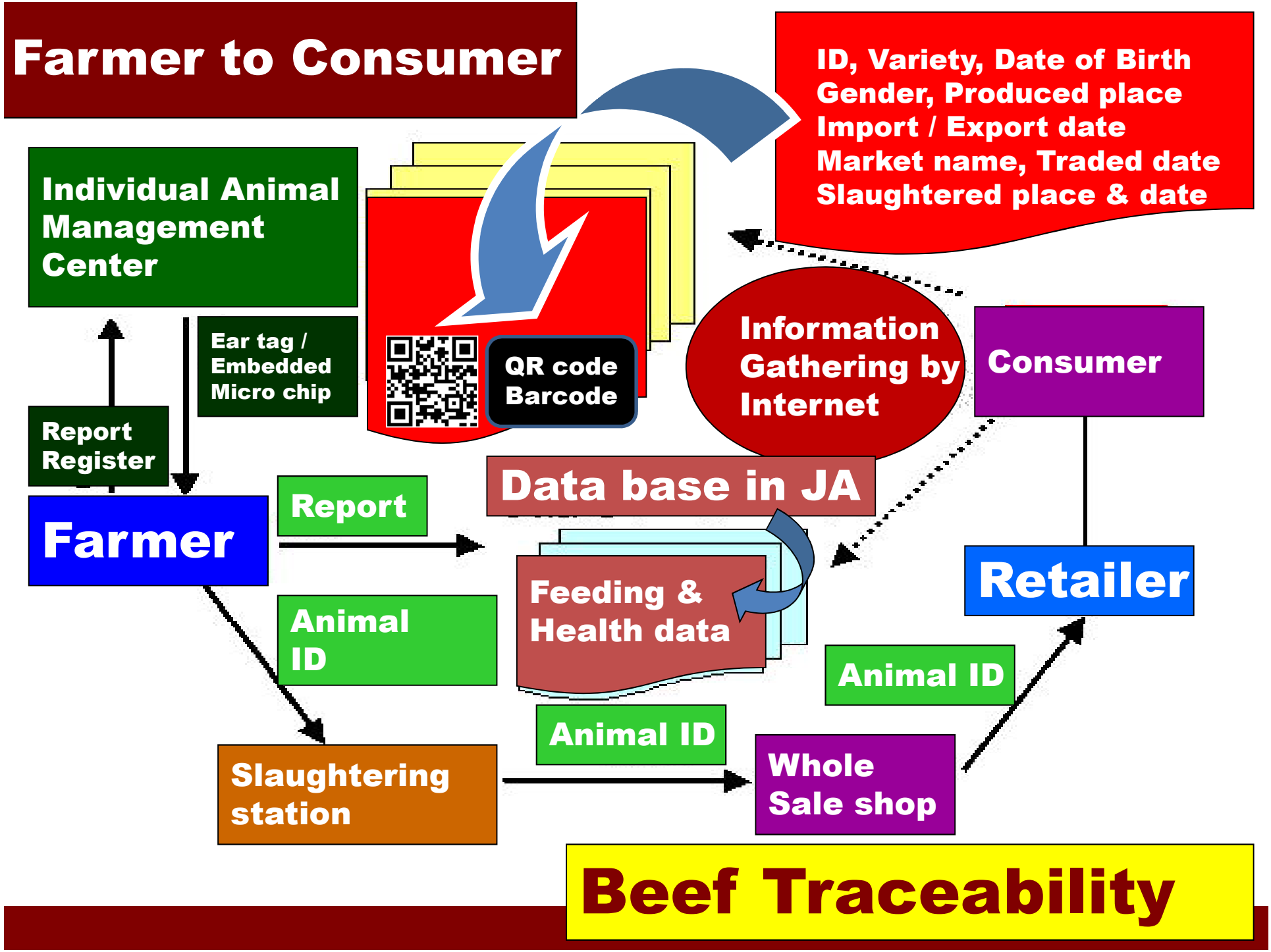
Paddy field 2000 sections

In case of NAGOYA

ANIMAL FACTORY

- **Individual animal health management**
- **Daily health information acquisition from animal body temperature**
- **Animal daily dynamics information acquisition**
- **GMO silk production**




Farmer to Consumer
ID, Variety, Date of Birth
Gender, Produced place
Import / Export date
Market name, Traded date
Slaughtered place & date
Individual Animal Management Center
Ear tag / Embedded Micro chip
QR code Barcode
Information Gathering by Internet
Consumer
Report Register
Data base in JA
Report
Farmer
Feeding & Health data
Retailer
Animal ID
Animal ID
Animal ID
Slaughtering station
Whole Sale shop
Beef Traceability

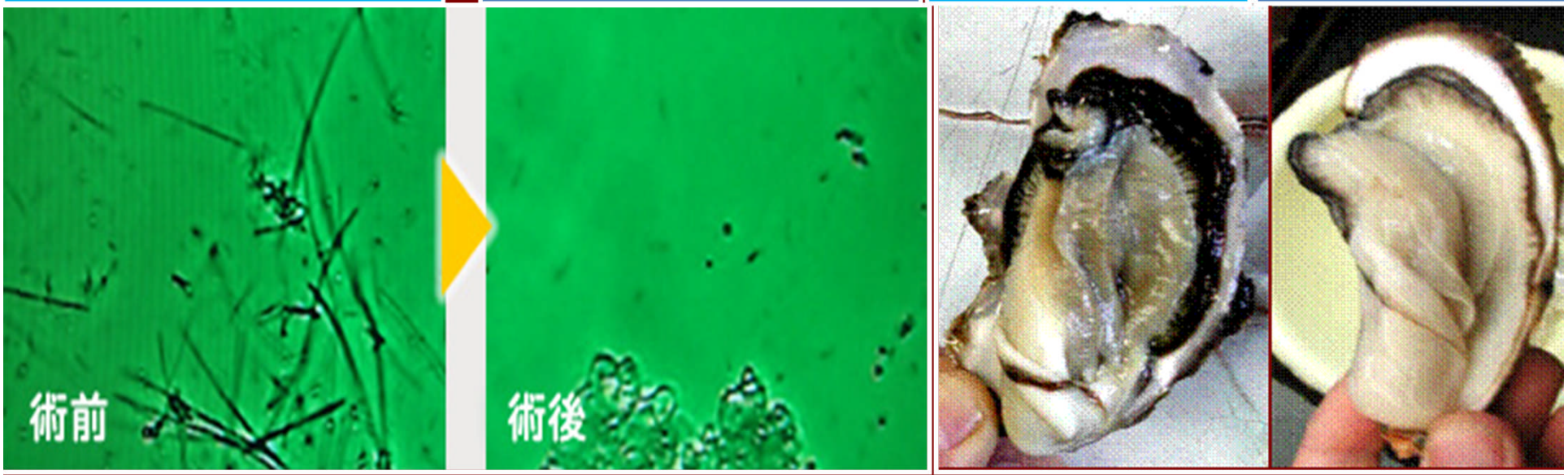
Nano Fiber / Nano Bubbles Water

- Cellulose Nano Fiber - 5~7 times Stronger than metal
- Oxygen Nano Bubbles
- Ozone Nano Bubbles
- Nitrogen Nano Bubbles
- Applied industrial sector
- Food safety – Vegetable sterilization
- Aquaculture (Fishery) – Oyster sterilization
- Dentistry – Periodontology / Periodontics

OZONE NANO BUBBLE

- **Food safety – Vegetable sterilization**
  Aquaculture (fishery) – Oyster sterilization
  Dentistry – periodontology / periodontics
  Medical science - Cancer cell control

Before	After	Before	After



Nano Bubbubles Application to Agrculture, - BIO-DIVERCITY -

Why Nano Bubbles?

- Paddy field (up) and Tadpole shrimp (down)
- Normally under herbicide free, the Rice Yield fall in half, but it doesn't
- Weeds don't grow

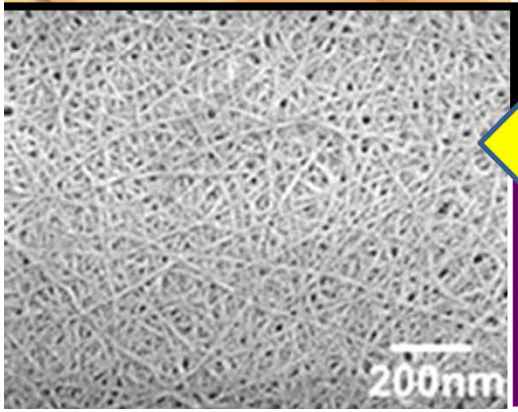
MICRO NANO BUBBLE

Pressurized solution method
Diameter of bubble is less than 50 micro meter. It shows white turbidity。

Sakishima canal of Nanko, Osaka In the past, foul odor in the breeding of algae was awful became clean after five years introduced in the purification by micro bubbles

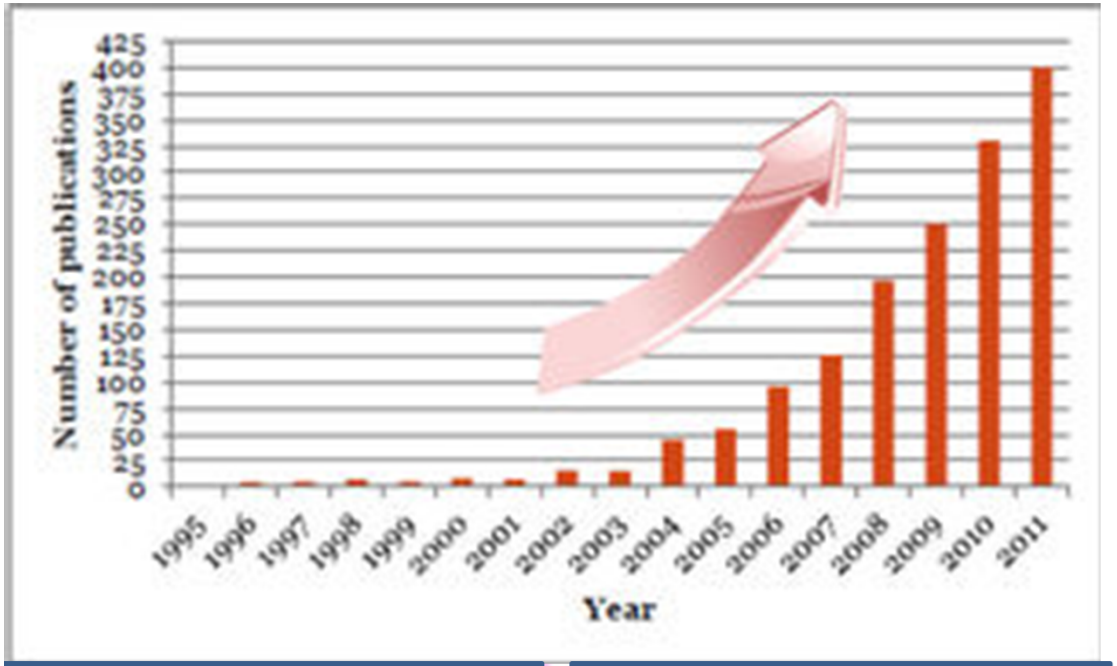
CELLULOSE NANO FIBER

- **Prof. Hiroyuki Yano, Humanosphere Research Institute, Kyoto University, Japan**
- **CNF: Stronger 5 times & lighter1/5 than steel metal. In addition it costs 1/6 compared with Carbon Fiber**
- **Higher Heat resistant**



CNF in wood cell Courtesy : Prof. Hiroyuki Yano

CNF Transparent sheet developed by Oji Holdings & Mitsubishi Chemistry

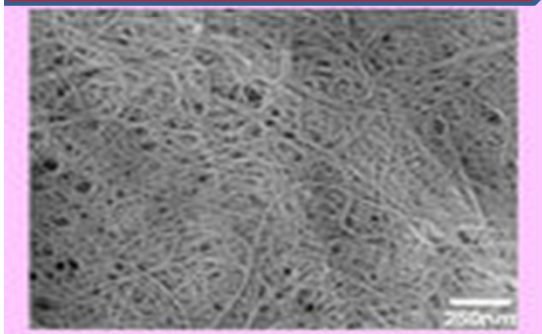


CNF

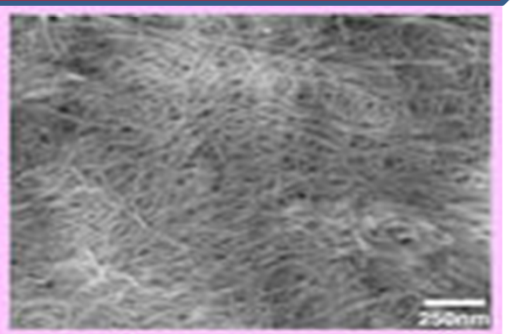
Cellulose Nano Fiber

- **Number of research paper is increasing drastically**
- **CNF can be made from various cellulose material such as Wood, Rice straw, Cassava & Potato**

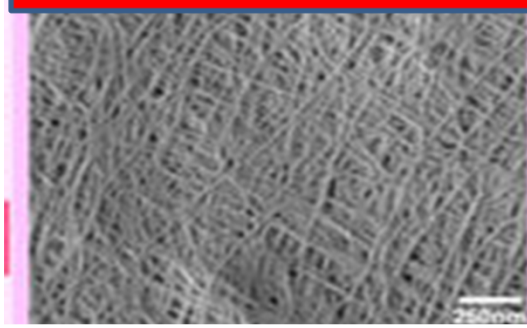
Wood



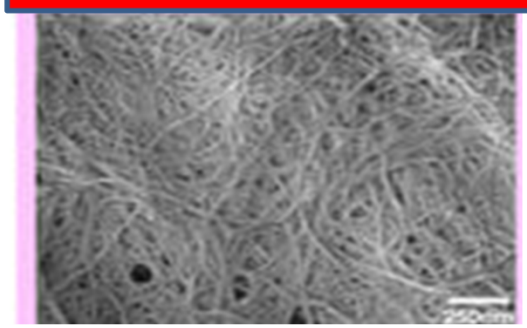
Rice straw



Cassava



Potato



Conclusion

1) "Small scale farming" should be shifted to "Large scale one"
2) For promoting Asian Agrifuture, "The ASEAN Community based Project" should be launched as soon as possible
3) FFA (Future Farmer of Asia) growing program should be started as the strategic policy

Continued

4) **Micro-Nano bubbles technology** may be one of the hopeful higher potentialities in Agriculture
5) **Precision Agriculture** secures the stable yield of agricultural products in reducing total loss
6) **Nano bubble water** can deeply penetrate cells and wash out bacteria, therefore nano bubble water has a key for solving the problem

POLICY & TECHNOLOGY

1) Increase of "Demand and Consumption for New Market Development is the basic Countermeasure, not to control the production.
2) Policy should "Encourage farmers" but poor Policy interrupts R/D and Technology innovation
3) Cheap "Simple machines" are good, but "User need"s should be carefully considered.
4) Problems should be Technologically solved.

Thanks

for attention & patience

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