

Technology for overcoming the Global Tetralemma

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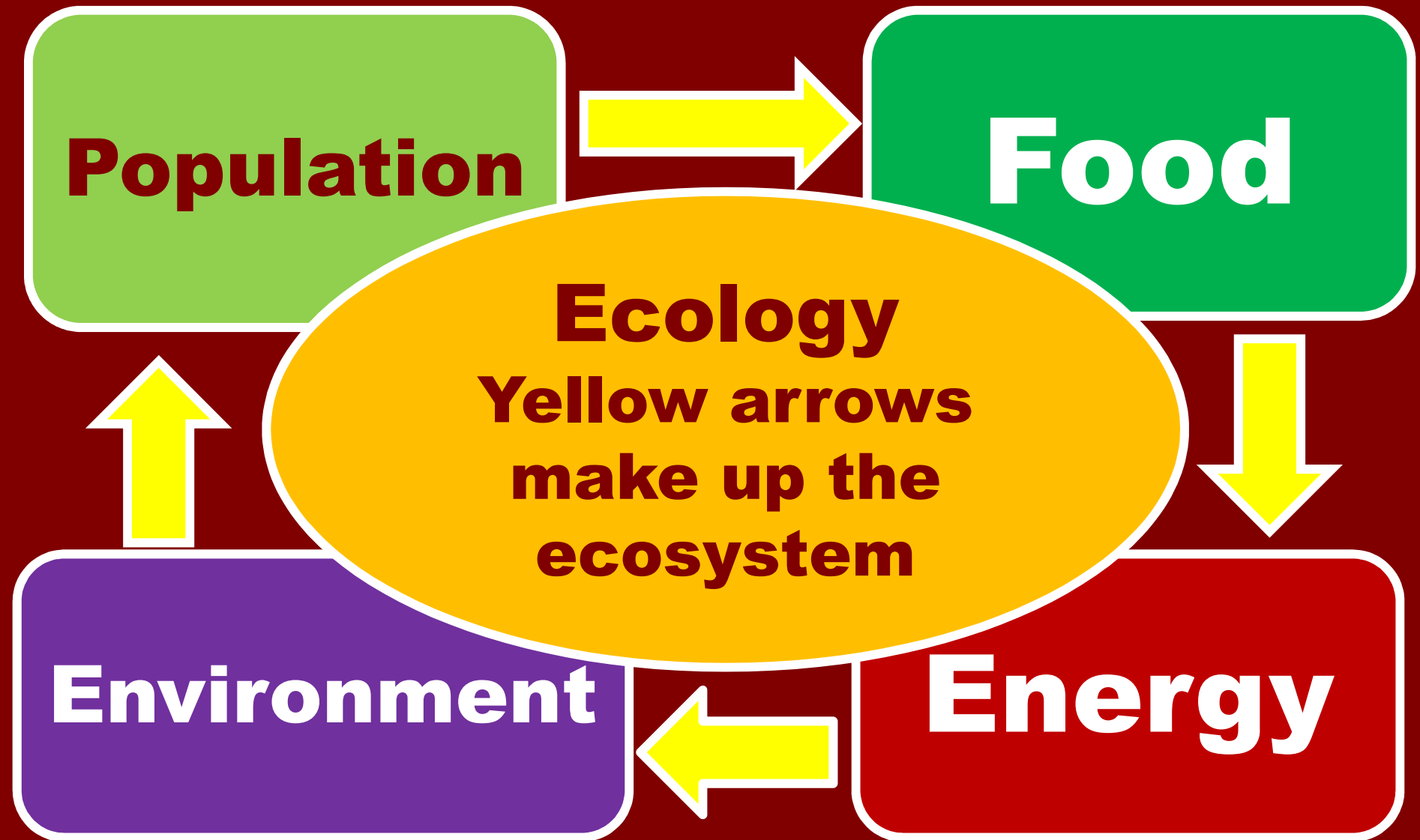
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GLOBAL TETRALEMMA



ECONOMY BREAKS ECOLOGY

**Population
increase**

**Human's
Economic Activity**

Environment

**CO₂ production
Climate change /
Global warming
Waste treatment
Carbon footprint, SDGs**

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**

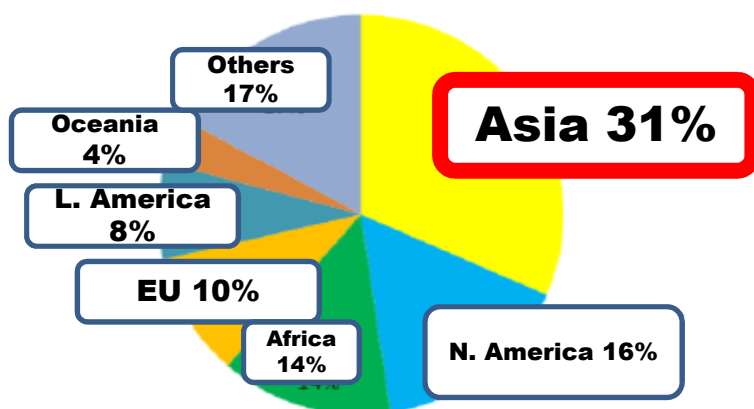
World agriculture made from FAO Report 2006

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

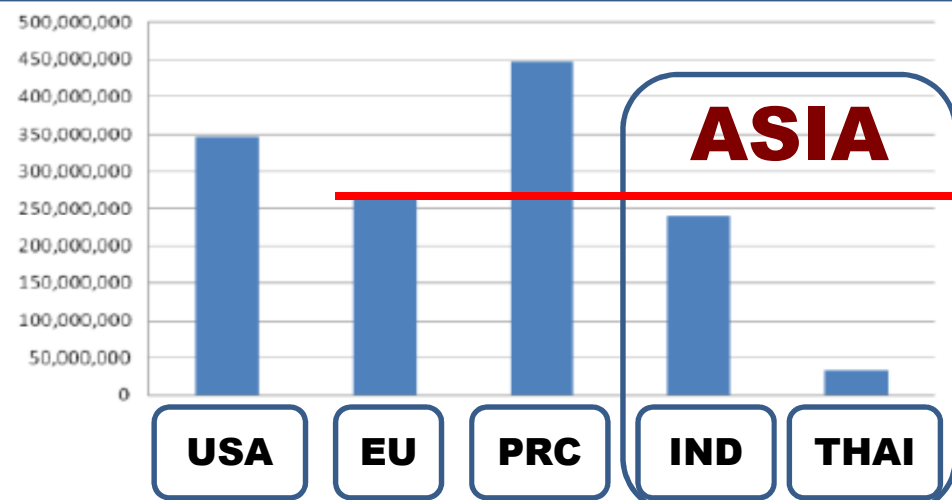
Nation	Cereal Production (100 mil.ton)
USA	3.50
EU	2.70
P.R.C	4.50
India	2.40
Thailand	0.30
Total	13.40

EU =
India
+
Thailand

World cultivated farmland, (%)



Cereal Production, 10,000 ton



PRODUCTIVITY INCREASE



10 times
increase for
Past 90 years

- 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 resources
- Material resources

- **Reason why BCGE, SA, PA, Cluster Farm are closed up**



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**

**Technology
Oriented
countries
Dispatching
Experts to
deliver a series
of lecture**

**Research Project on
Smart Agriculture
Precision Agriculture
Green Factory
Food Safety
Quality management
Based on Robotics**

**Research &
Education
collaboration project**

Priority level to achieve

**Resource
oriented
countries**

**Offering unique
program for
staff & student
mobility**

**To make Asia
World Food Giant**

**Create Asia Brand
of Food**

**Mutual Benefit &
Prosperity for both
Technology oriented &
Resource oriented
countries**

**More increase of
Food Production**

**Asia Brand Food
market**

**Final goal
Economy
Vitalization &
Regional stability in
Peace keeping**

3

2

1

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

**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

FFA

Smart Agriculture Trainer
Training Center

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

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

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

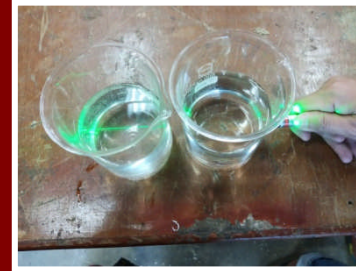
VISIT TO LECTURER'S LABO

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

Tohoku Univ. &
Hokkaido Univ.
jointly assisted for
development

③

TOHOKU
UNIVERSITY

UNDER ASSEMBLY OPERATION

Six Filipino
students
joined the
project for
satellite
development

SATELLITE BUSINESS

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

②

News on air about Super Small
Scale Size Satellite Development

Ministry of
Science & Technology
Administrative Officer
Government of
The Philippines

Increase of Super Small Scale Satellite
Development by private industry

④

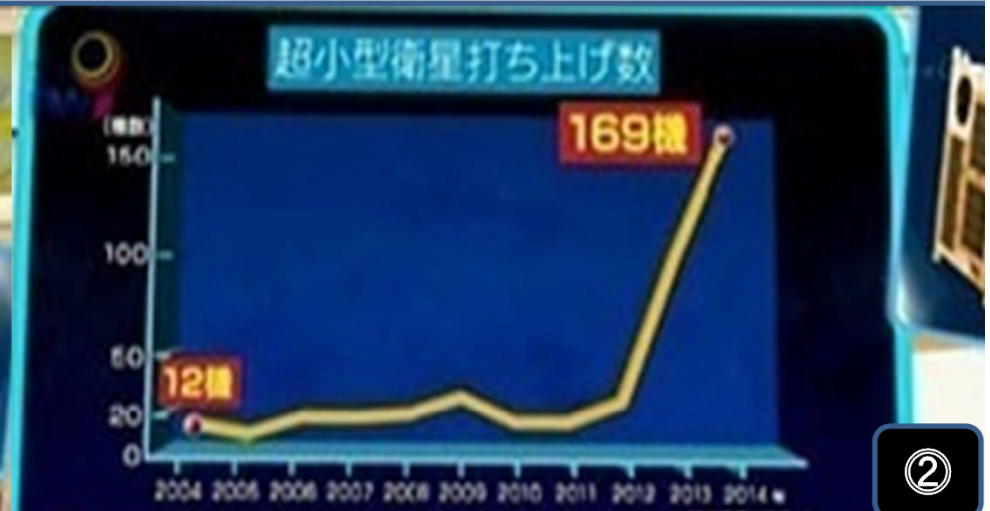
Four monitoring cameras are
mounted on satellite DIWATA-1

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

2QSL

Quantity
Quality
Safety
Liability

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
“**Variable Rate Control**” in Precision
Agriculture

1) What do we need ?

What ?

2) How many (or how much)?

How many?

3) When ?

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

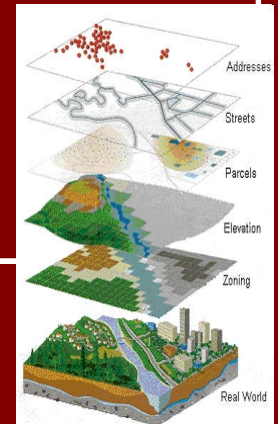
- It can be expected to have more “Merits” additionally such as
 - 1) CO₂ mitigation and labor saving, and precision farming operation (Environment friendly) by
 - 2) **Combining know-how with data and assisting operating function, and**
 - 3) **Providing important and necessary information to consumers 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

Less - variety
mass production
Majority Crop

Agricultural
to Industrial


to

Processed to
fresh market

Flexible Manufacturing

Multi - variety less
amount of production
Minority Crop

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 	<u>Non standardized</u> Size, Color, Shape, Maturity Hardness, Location	<u>Standardized</u> 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

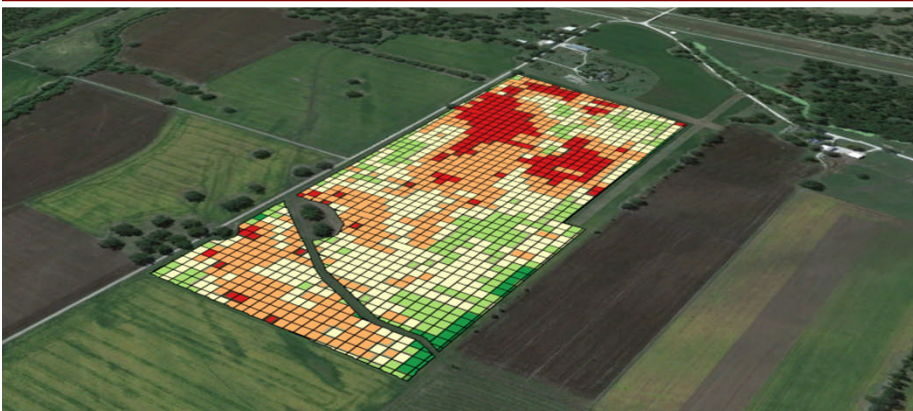
Unmanned

Application of Drone

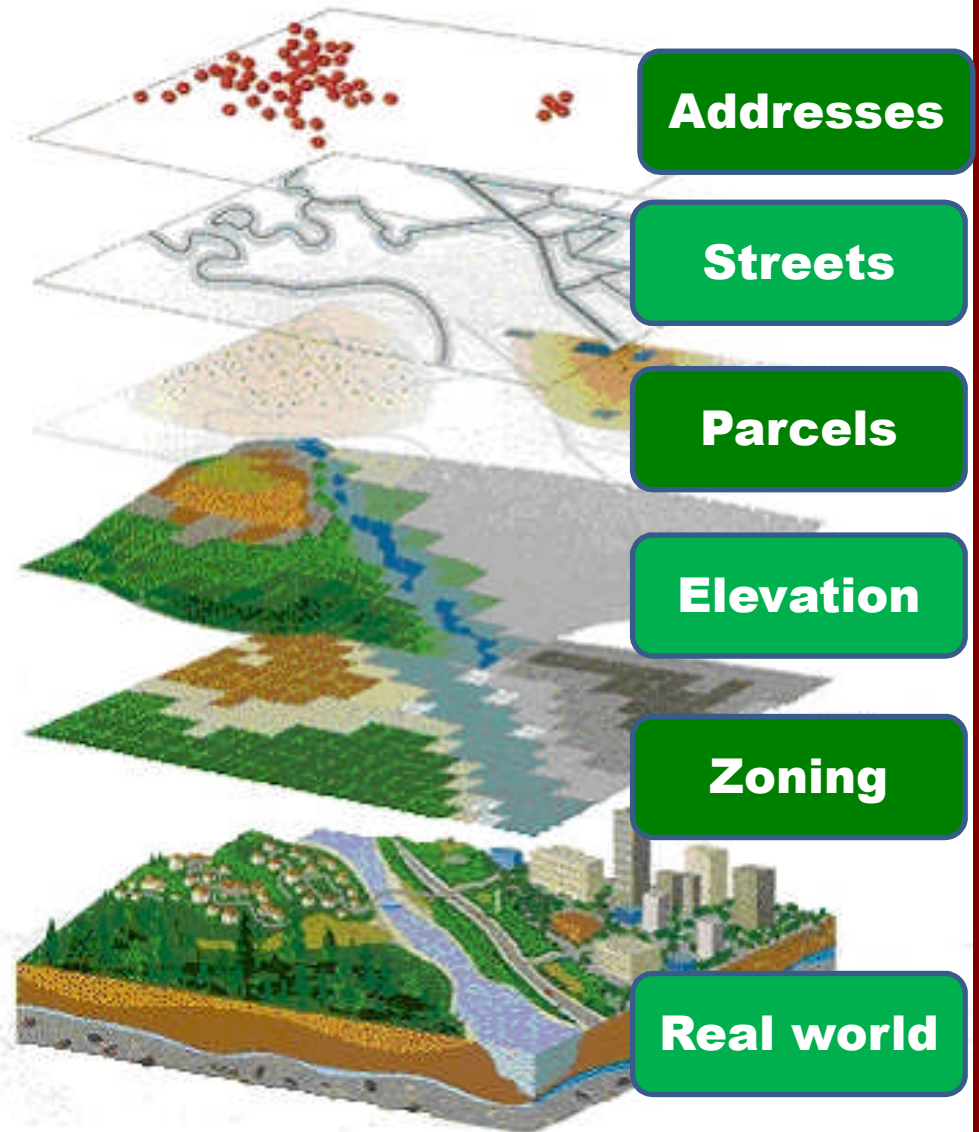


- Drone covers a huge area monitoring, measuring and doing operation in a short time
- Data obtained can be used for
 - Identification of farmland location
 - Growing condition of crops and its control by NDVI
 - Various Data gathering for data mapping seed sowing
 - Application of seed sowing & spreading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

Center pivot

Ceiling of Dome

Mist sprayer

Door

Entrance / Exit

Granpa

DOME FARM

Water sprayer set at ceiling

Rotation

Center pivot

Initial Planting area

Growing tray

Harvesting at periphery

Tray width & interval are gradually spreading toward the periphery due to plant growing rate

Growing tray



**Huge area,
No season
No disease, Safe,
Value added
High productivity**

RFID Reader terminal



**DRIVE GREEN
HIGHWAY**



Completely closed system

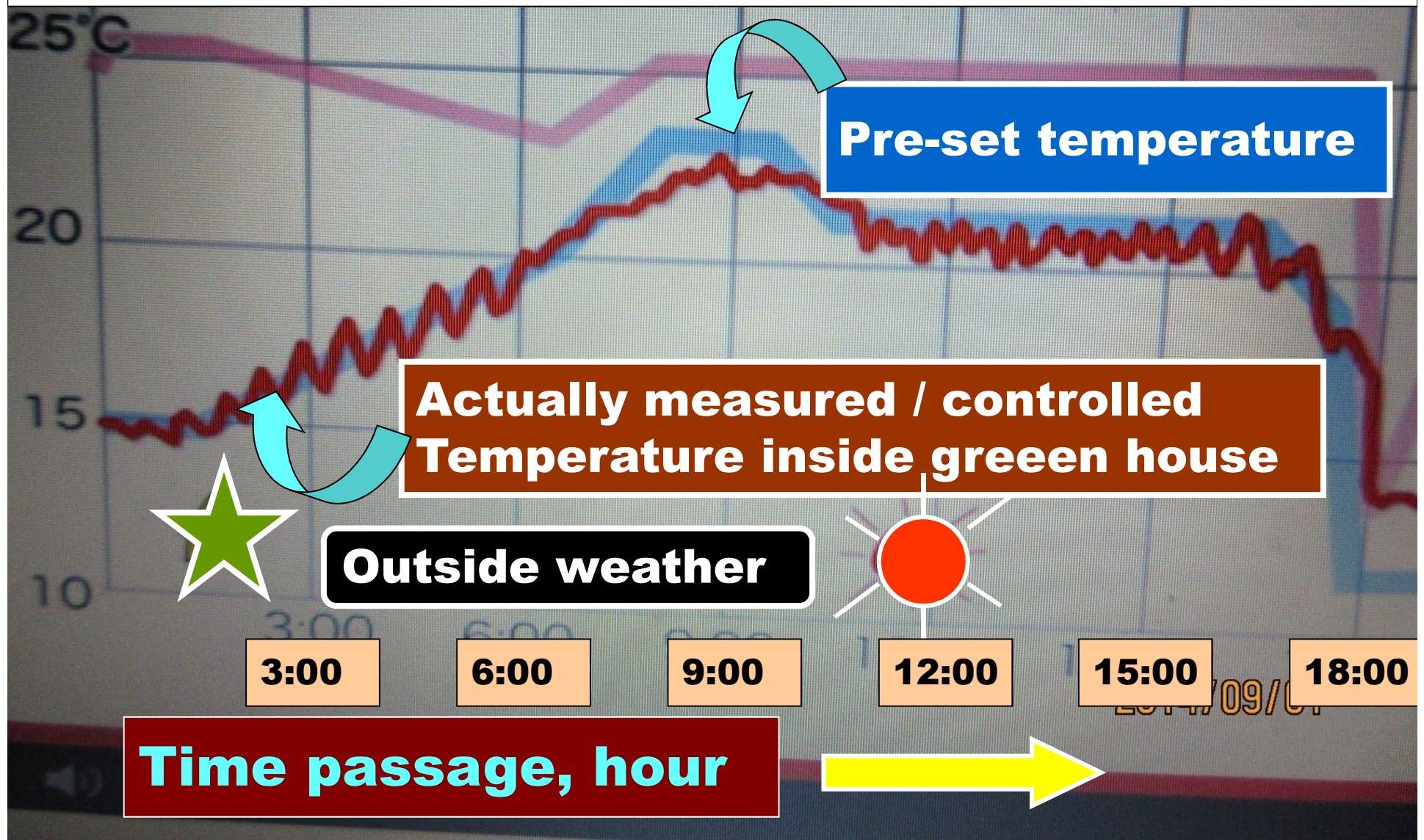


**GREEN
FACTORY**

Personal / Community use



TOMATO GROWING PROGRAM



GREEN FACTORY

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

Hydroponic
Commercial
Product for sale in
Thailand

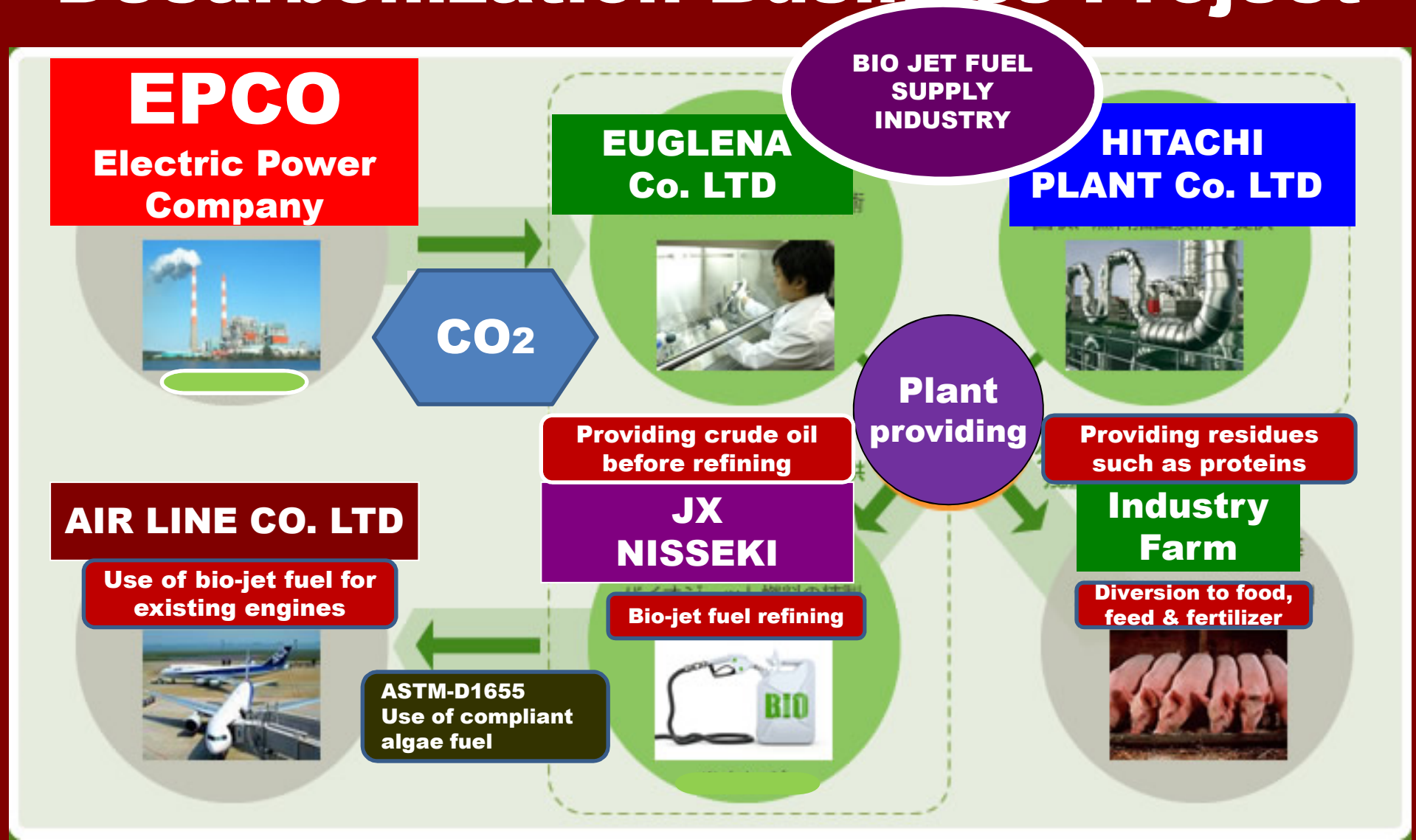
FUTURE ASPECT OF GREEN FACTORY MARKET



Source: YANO RESEARCH INSTITUTE OF ECONOMY

EUGLENA (Algae)

Decarbonization Business Project



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)" !

Solar Illuminance, moisture, soil, air

Cultivation



FieldServer



Environment



Vermin damage



Disaster



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**

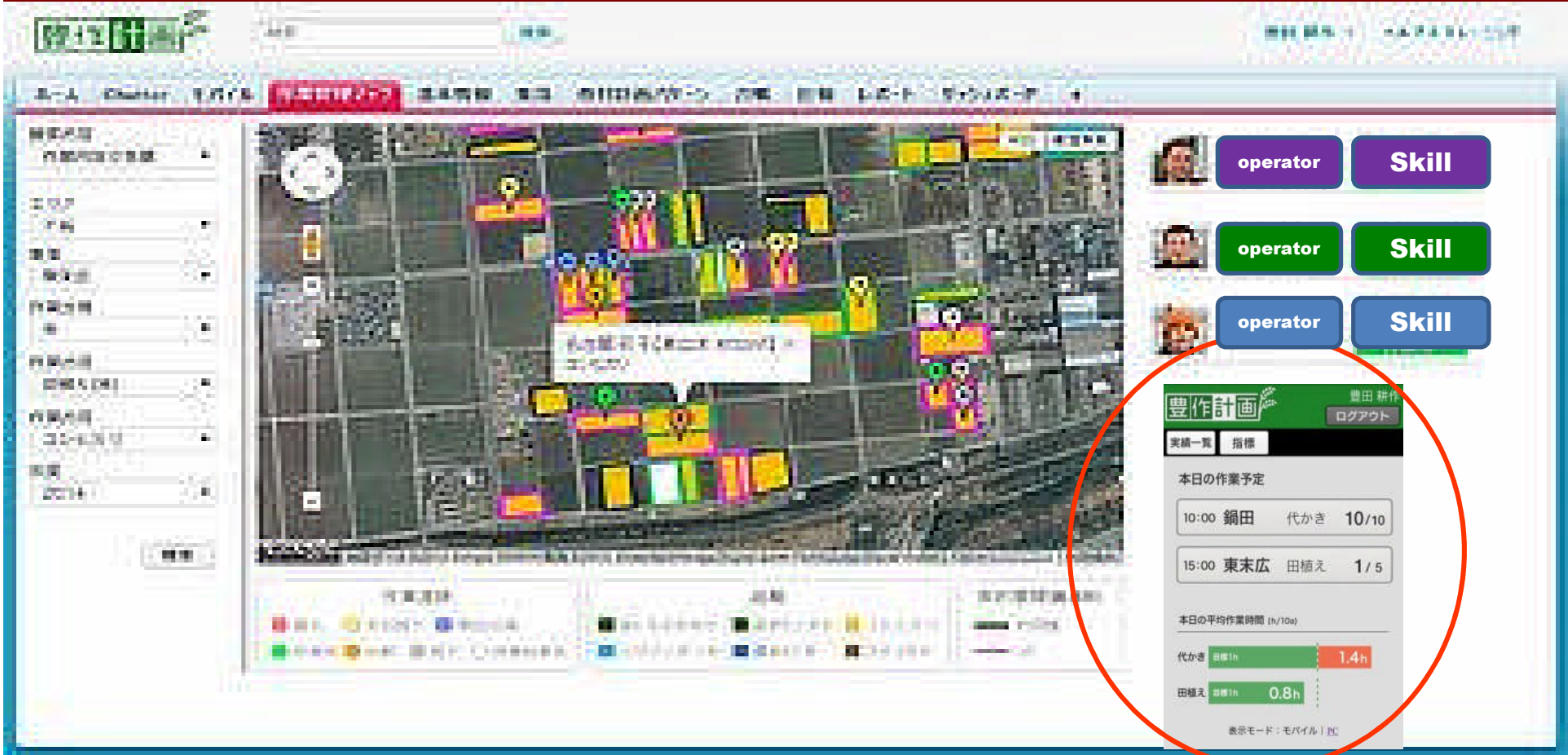


**Melon net
pattern similar
to
Human finger
print**

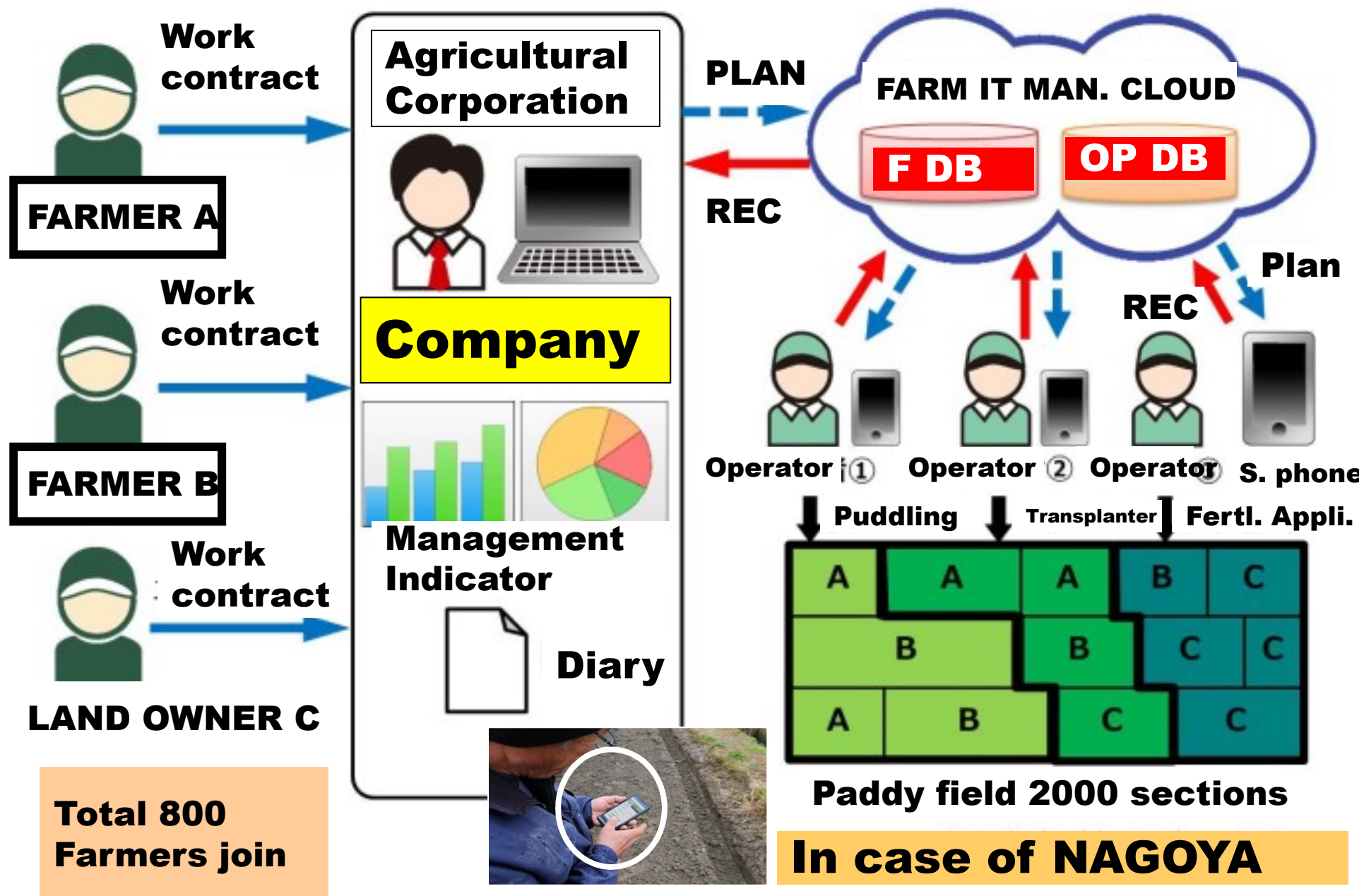
TOYOTA

GOOD HARVEST

PLAN



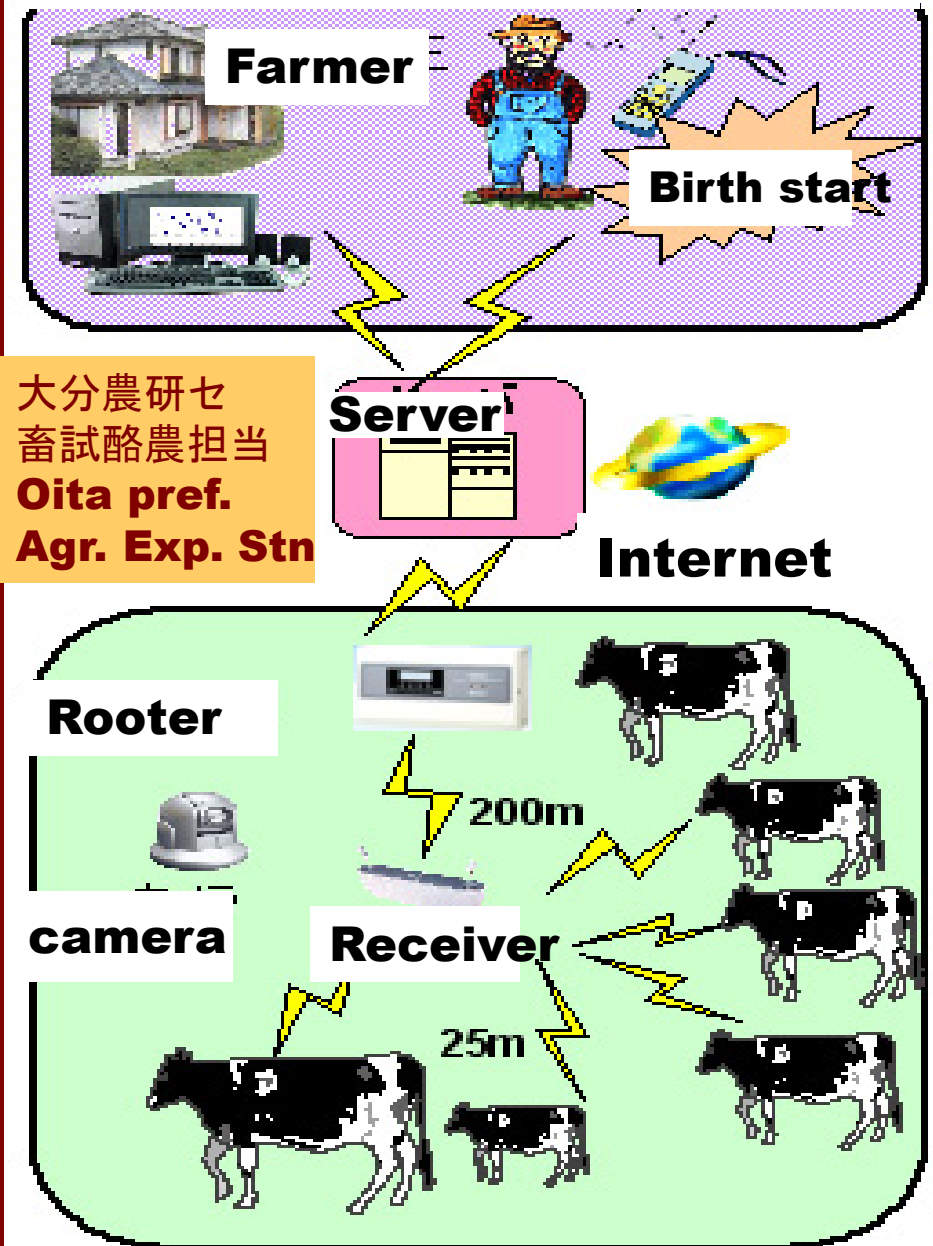
TOYOTA GOOD HARVEST PLAN SYSTEM



ANIMAL FACTORY

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

System Outline, AFFRC



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

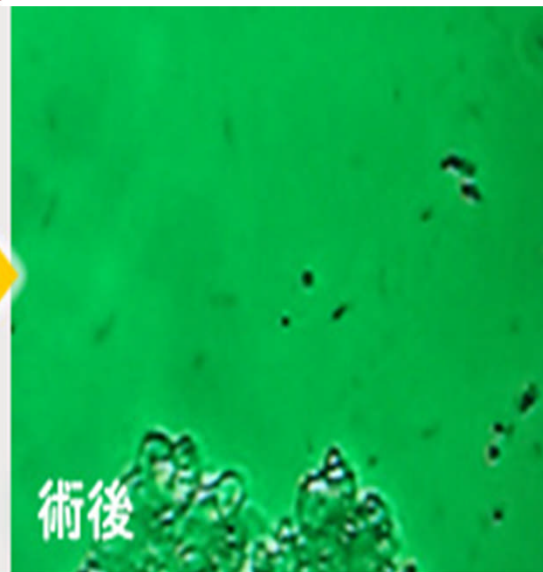
- **Food safety – Vegetable sterilization**
Aquaculture (fishery) – Oyster sterilization
Dentistry – periodontology / periodontics
Medical science - Cancer cell control

Before

After

Before

After



NANO BUBBLES APPLICATION TO AGRCULTURE, - BIO-DIVERCITY -



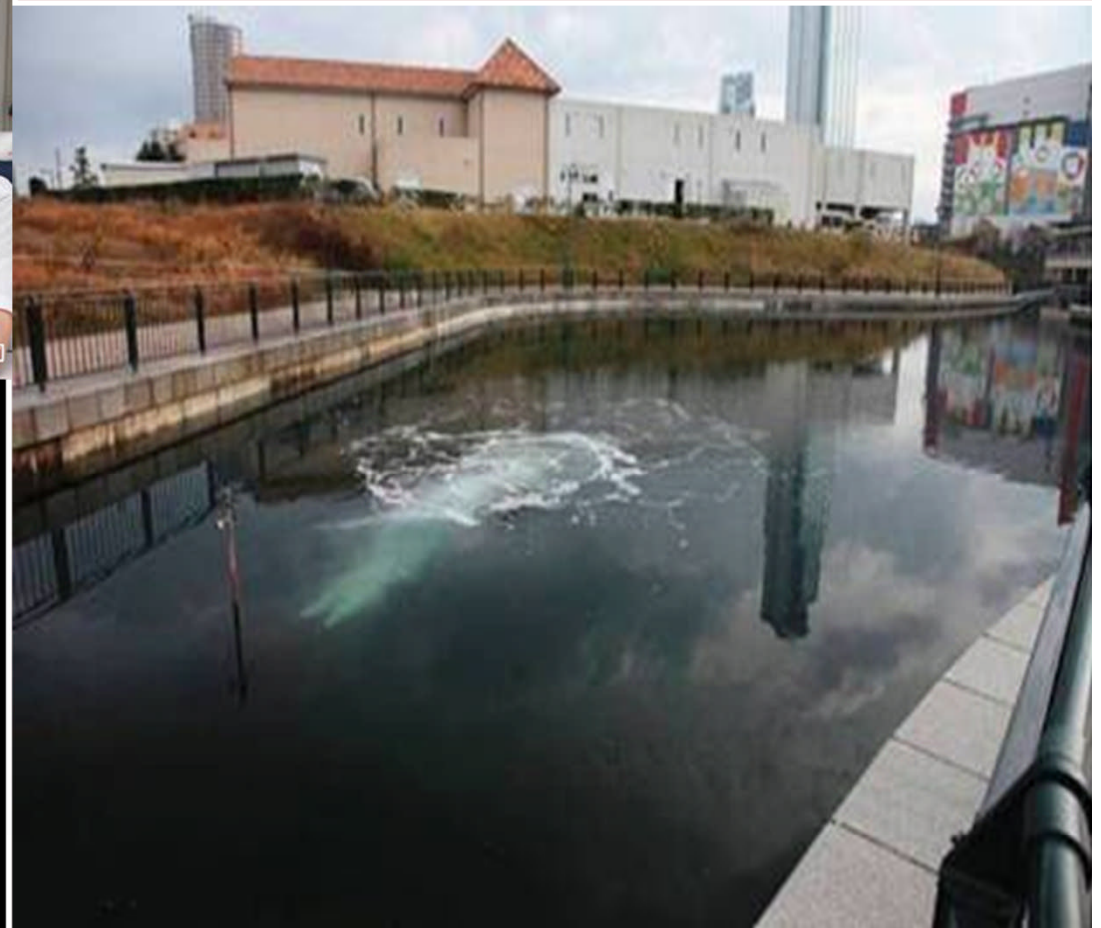
Why Nano Bubbles?

- **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.

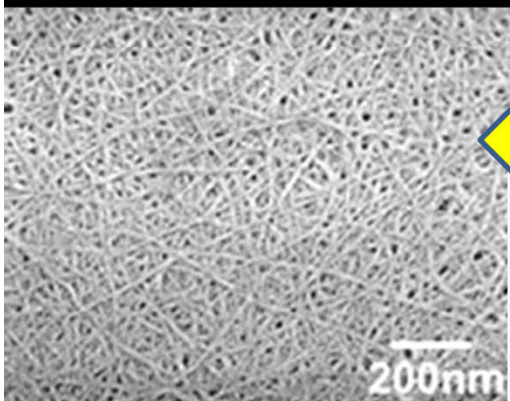


Sakishima canal of Nanko, Osaka In the
past, foul odor in the breeding of algae was
awful became clean after five years
introduced in the purification by micro
bubbles

CELLULOSE NANO FIBER



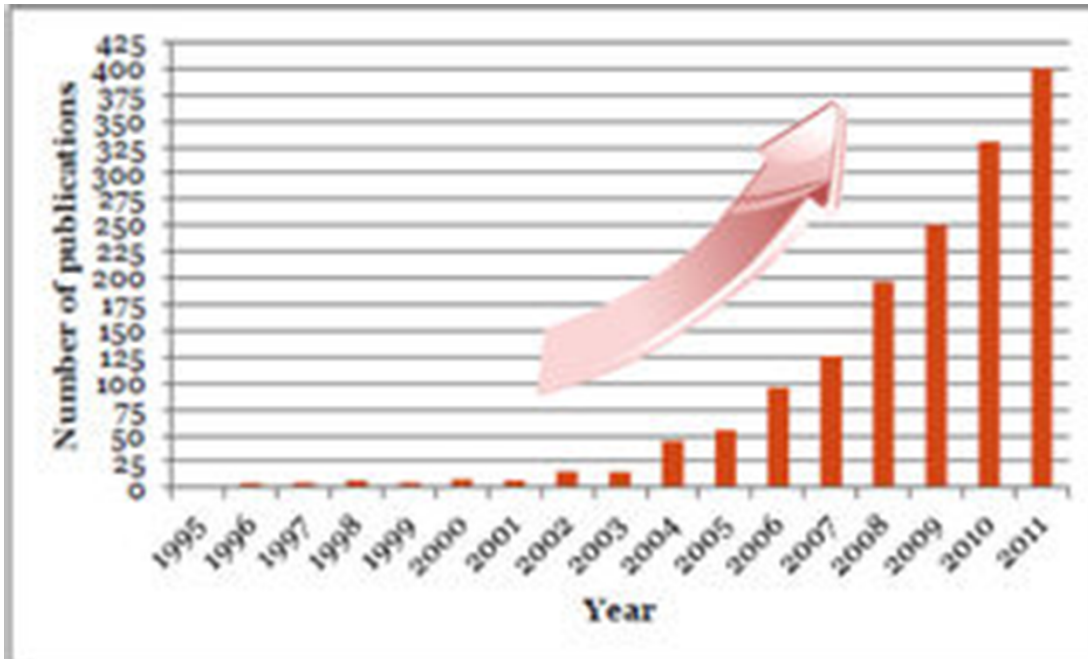
- **Prof. Hiroyuki Yano, Humanosphere Research Institute, Kyoto University, Japan**
- **CNF: Stronger 5 times & lighter 1/5 than steel metal. In addition it costs 1/6 compared with Carbon Fiber**
- **Higher Heat resistant**



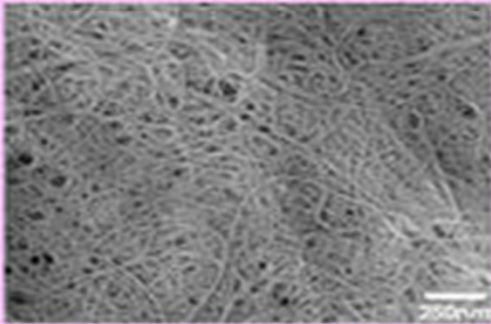
CNF in wood cell
Courtesy : Prof.
Hiroyuki Yano

CNF Transparent
sheet developed by
Oji Holdings &
Mitsubishi Chemistry

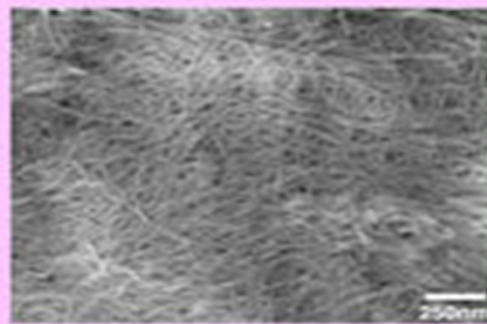




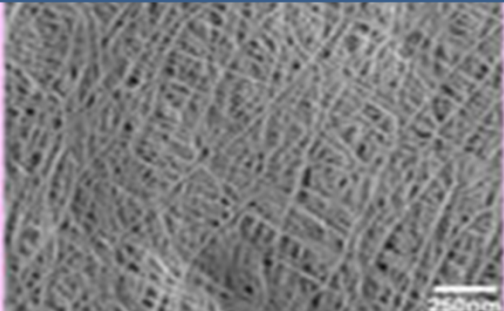
Wood



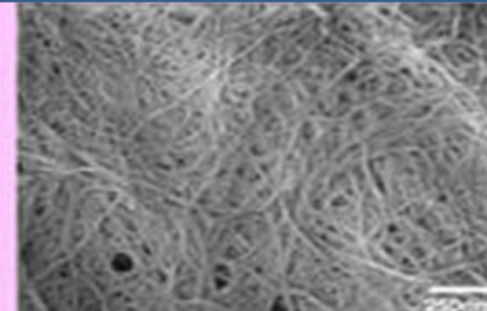
Rice straw



Cassava



Potato



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**

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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