Multicountry Observational Study Mission on Agricultural Innovations in Japan to Increase Productivity
APO Center, Tokyo,
11:20 - 12:30 June 6, and 14:00 - 14:45 June 28, 2016

Precision Agriculture Technologies for Efficient Use of Agricultural Inputs and Reducing Environmental Impacts of Farming

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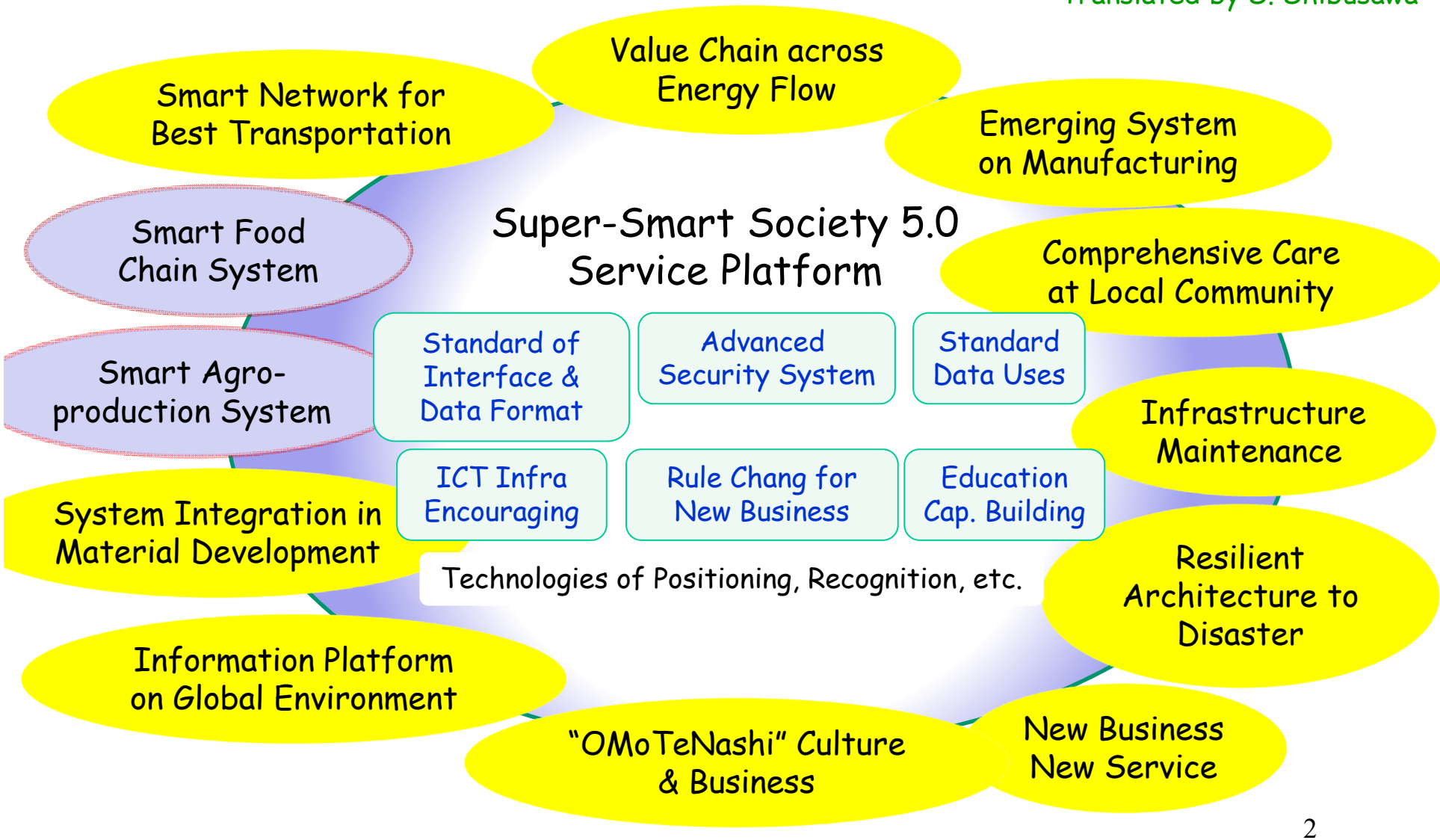
Advisory (Agriculture), CSTI, Cabinet Office
Advisory (Agriculture), IT Strategic Headquarters, Cabinet Secretariat

- Community-based Precision Agriculture
- Precision Water-saving Scheme
- Agro-medical Foods

In the 5th Basic Program for Science and Technology
Council of Science and Technology Innovation, Cabinet Office, Japan. 2016.1.19.

Translated by S. Shibusawa

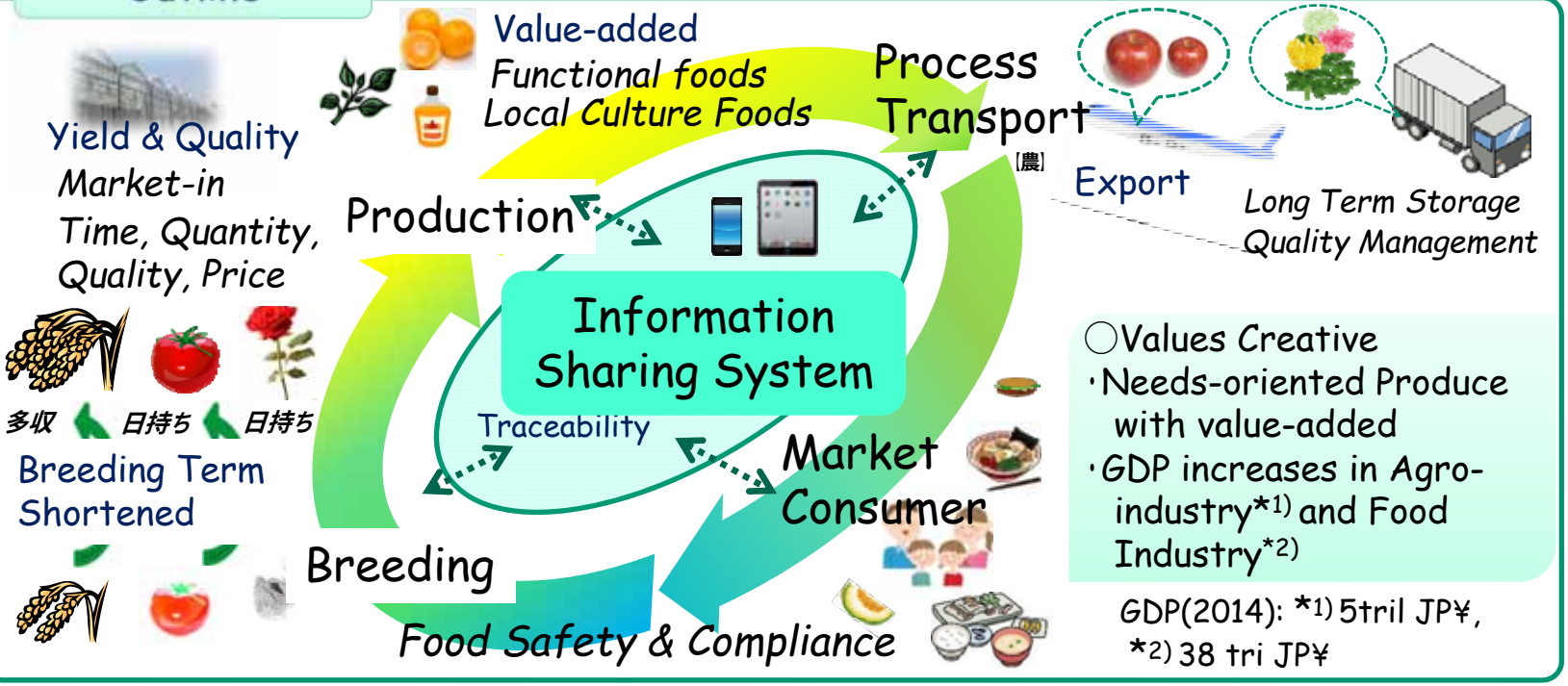


① Smart Food Chain System

Food Supply Chain Composed of Breeding, Production, Processing/Transport and Market, Meets the Demand of Consumer on Quality and Value-added.

- New Variety with potential of high yield, freshness-keeping, and so on.
- Functional Foods, Next-generation Greenhouse Management, Value-added Produce.
- Export-oriented Quality Control for Transportation,

Outline



○Values Creative
- Needs-oriented Produce with value-added
- GDP increases in Agro-industry*1) and Food Industry*2)

GDP(2014): *1) 5tril JP¥, *2) 38 tri JP¥

Strategy for Creation and Application of Agricultural Information

The Strategic Headquarters for the Advanced Information and Telecommunications Network Society, Cabinet Secretariat, Japan.
2014.6.3

Agricultural Competitiveness by Use of Agro-information

- Break down the strategy into actions on inter-operability, portability, standard, and manual guidelines.
- Transparency and active uses of farm land information
- Administrative inter-department collaboration

Competitive Agriculture

AI-oriented agriculture and business models
- Cost performance
- Correct production and shipping
- Next generation and players
- Value-added produce

Information Creation & Application

Value chain of agro-information
- Active performance of growers' potential
  - Branding with evidence of performance
  - Market evaluation and price management
  - Advertising to frontier of customers
- Value-added information management and export business

Marketing Activity

Paragricultural Industry

Integrated agricultural service to growers' needs
- Solution service on farm work mechanization and facilities
- Apply the deep experience of manufacturing into management
- Agro-service networks on-demand

Reconfirm and encourage the value of informatization with know-how

Management of intellectual properties on information with know-how worldwide

One trillion-yen exports of agricultural products in FY2020

Paragriculture: para-agriculture, cf. paramedical

Guidelines on Agro-informatics Issued by Government in 2016

Cabinet Secretariat

Roadmaps on "Strategy for Creation and Application of Agricultural Information"

Guide for Providers and Users on Business Contract of ICT Service in Agriculture

Ministry of Agriculture, Forestry and Fishery

Guidelines for Name of Crops

Guidelines for Name of Farm Works

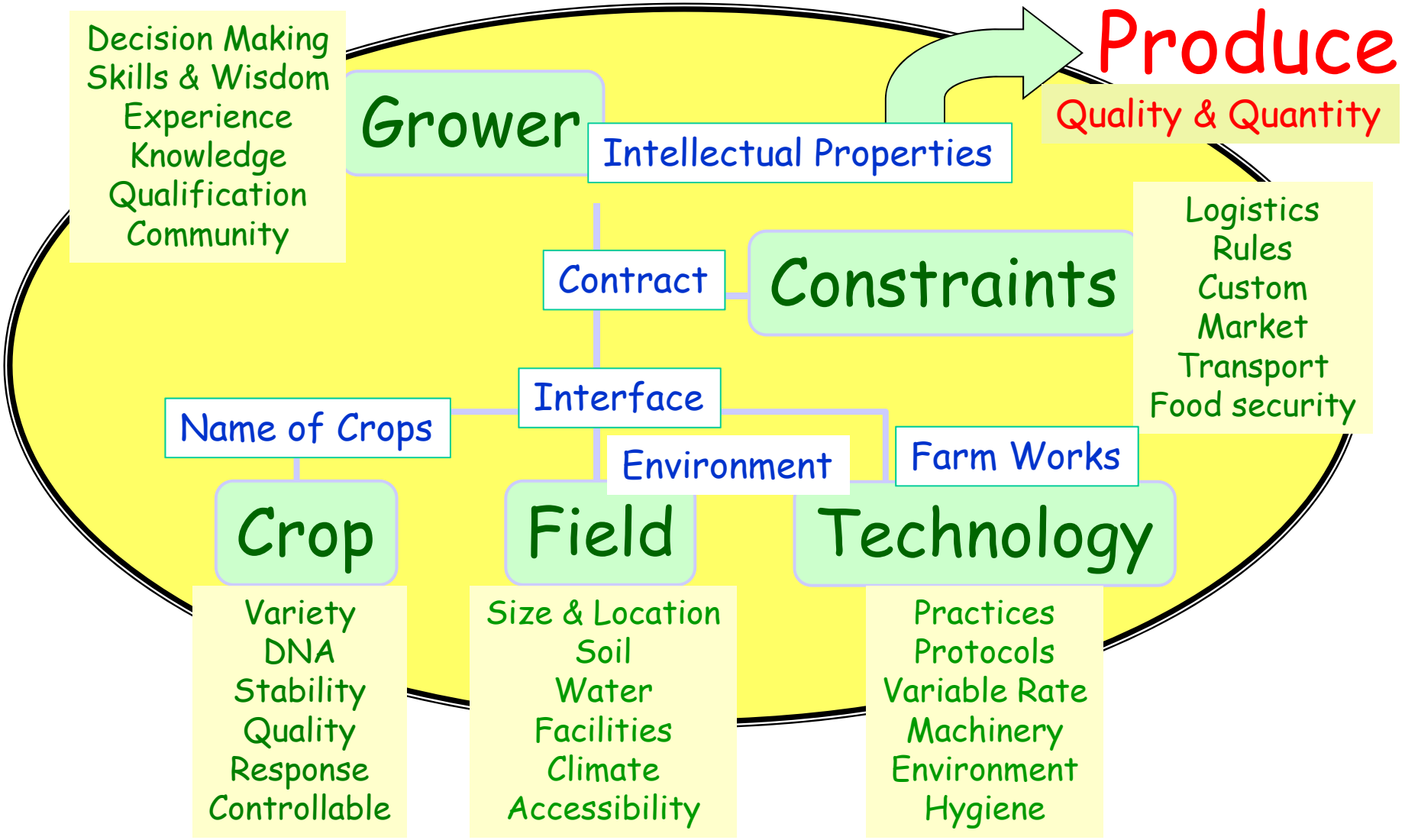
Guidelines for Uses of Intellectual Properties on ICT Application in Agriculture

Ministry of Internal Affairs and Communications

Guidelines for Environmental Information on ICT Systems Used in Agriculture

Guidelines for Interface of Data Exchange on Agricultural Information

Five Factors of Farming System and Standards



Definition of Precision Agriculture

- **This report defines precision agriculture as a management strategy that uses information technologies to bring data from multiple sources to bear on decisions associated with crop production.**

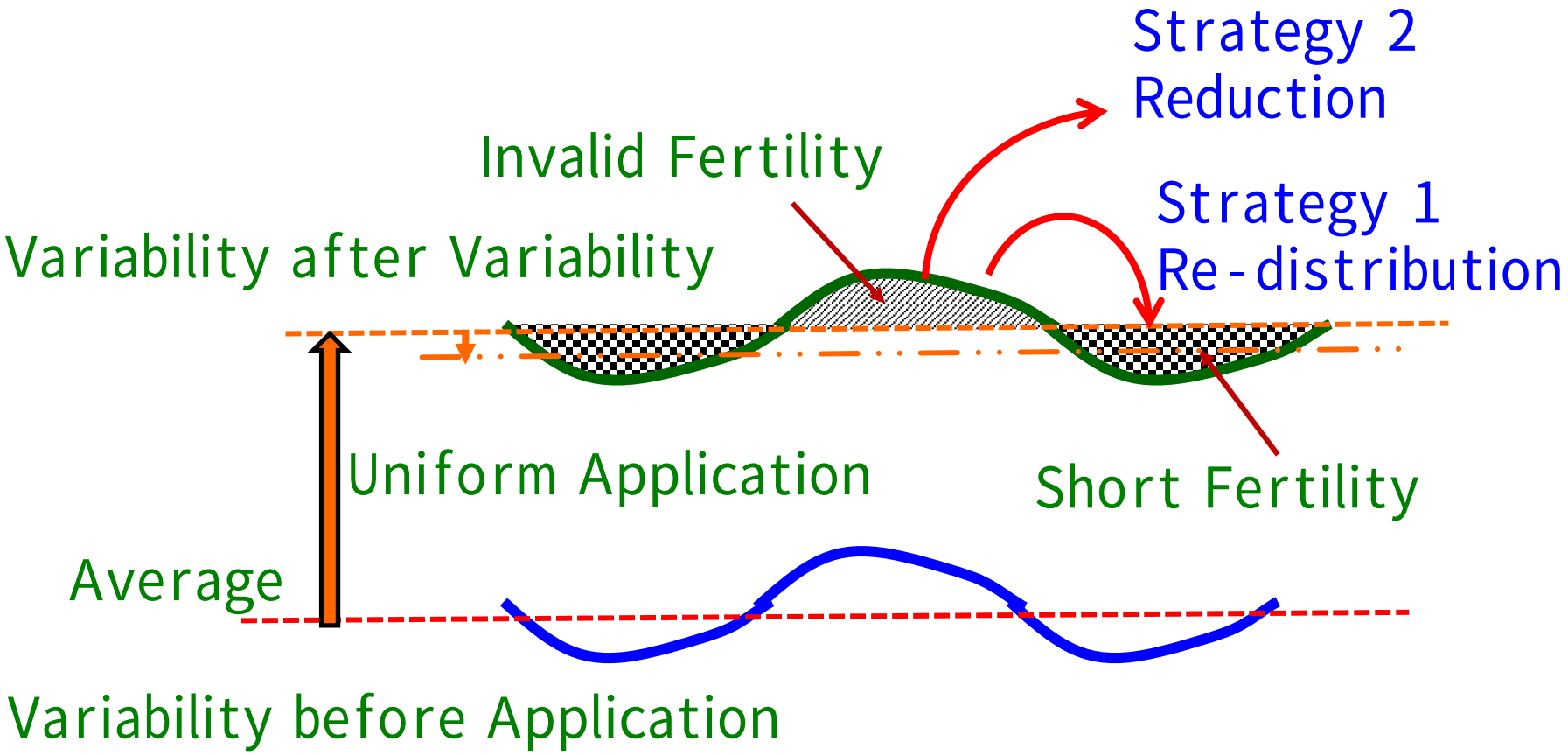
- **A key difference between conventional management and precision agriculture is the application of modern information technologies to provide, process, and analyze multisource data of high spatial and temporal resolution for decision making and operations in the management of crop production.**

National Research Council (NRC) (1997): ***Precision Agriculture in the 21st Century***, National Academy Press, Washington, D. C.

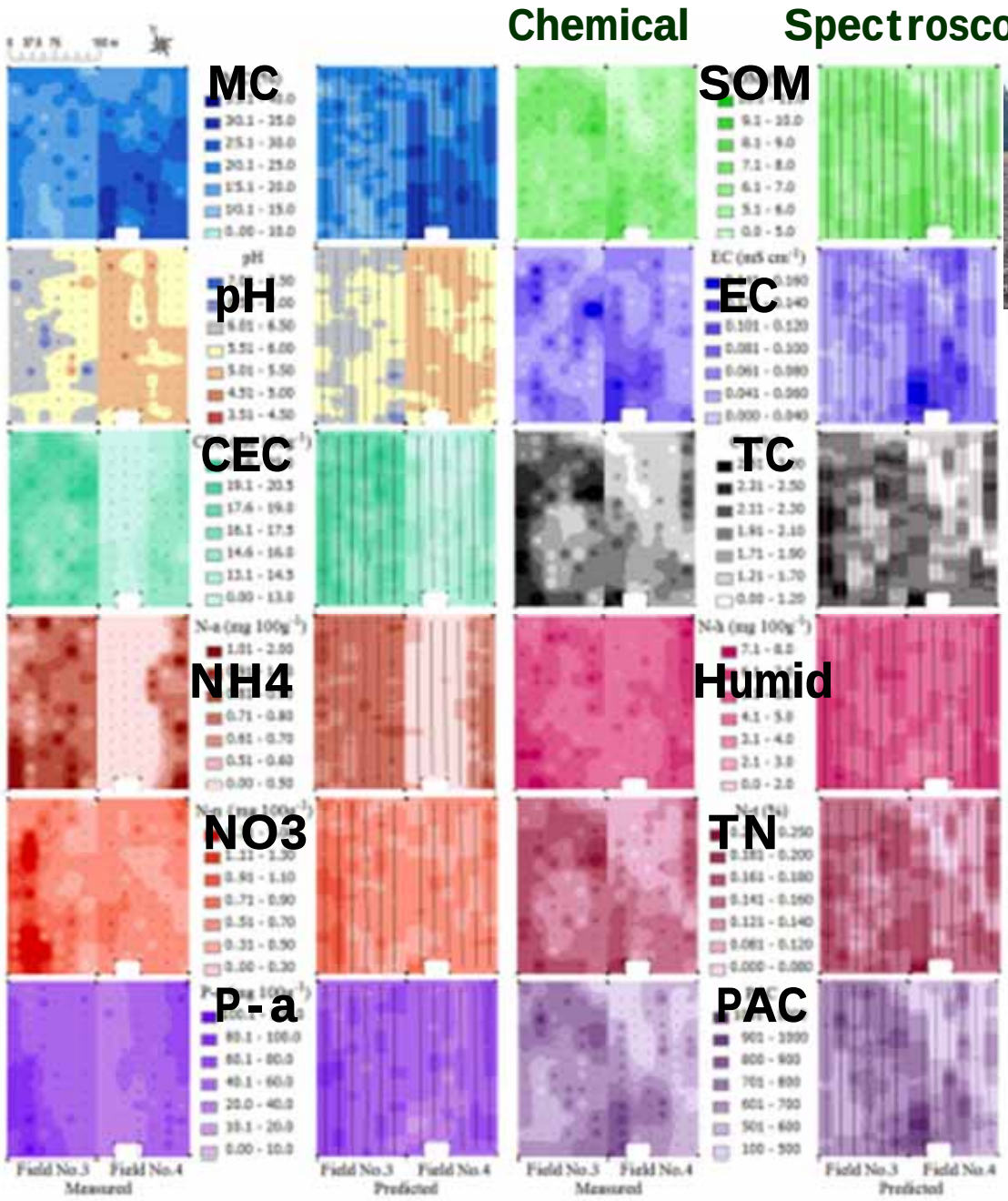
Variability of Paddy Field (2002.9)

From Dr. Toriyama

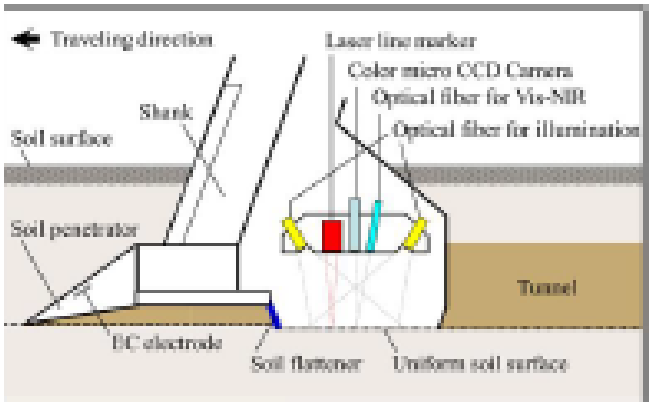
Variable Management Strategy



Another Story?



RTSS



Soil Parameters Map.

4 ha Field, Hokkaido.
Measured in 2008.
(Kodaira et al, 2012)

PAC: Phosphate Adsorption Coefficient

Tools for Traceable Management

Consumers' reliability

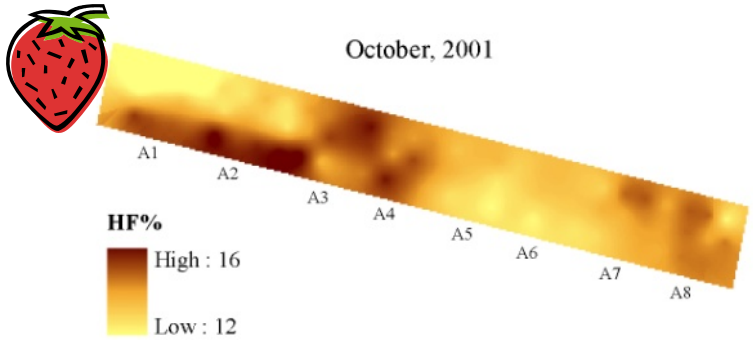
Inhabitants' reliability

PA Produces Information

Information-added products

Information-oriented fields

Farmer ID
Field ID
Product ID
History
Quality
Contents



Soil map
Yield map
Disease map
Weed map
Environment impacts
Cost map

Community-based Scheme

Farmers

Industry

PA-Community

Learning group of wisdom farmers

Technology platform of companies

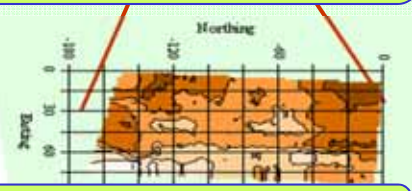
Create and Manage information-oriented fields

Create and manage information-added produce

Manage hierarchical variability

Variability in farmers on motivations, crops, etc.

Between-field Variability due to cropping



Within-field variability

Supply user-innovative technologies
Get the customers

Manage variability in needs of
- In-shop markets
- Farmers markets
- Hobby gardeners

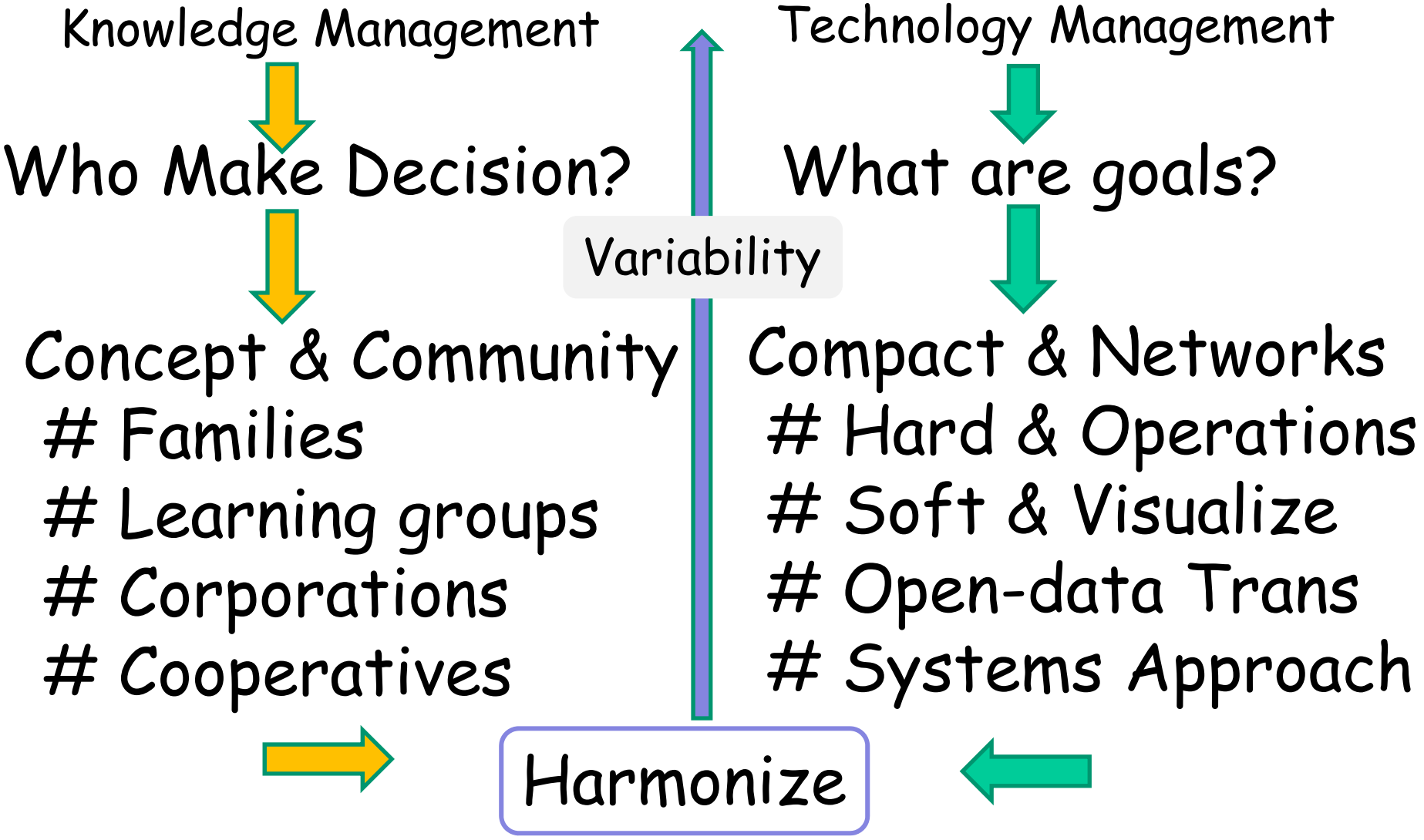
Local bio-industry complex city-sponsored

Cooperatives

Local Gov

Government

Community-based Precision Agriculture



Five stakeholders on the community-based PA

City Honjo, Saitama, Japan

Honjo Precision Farming Society (April '02)
Membership: 16 expert growers (2013)
Collab. Scientists, Engineers, Farmers Corp.,

Farmers

Industry

Field demonstration of real-time soil sensor (March 2003)

Local Gov

City Mayer and Prefecture President
Admired their attainments 2007

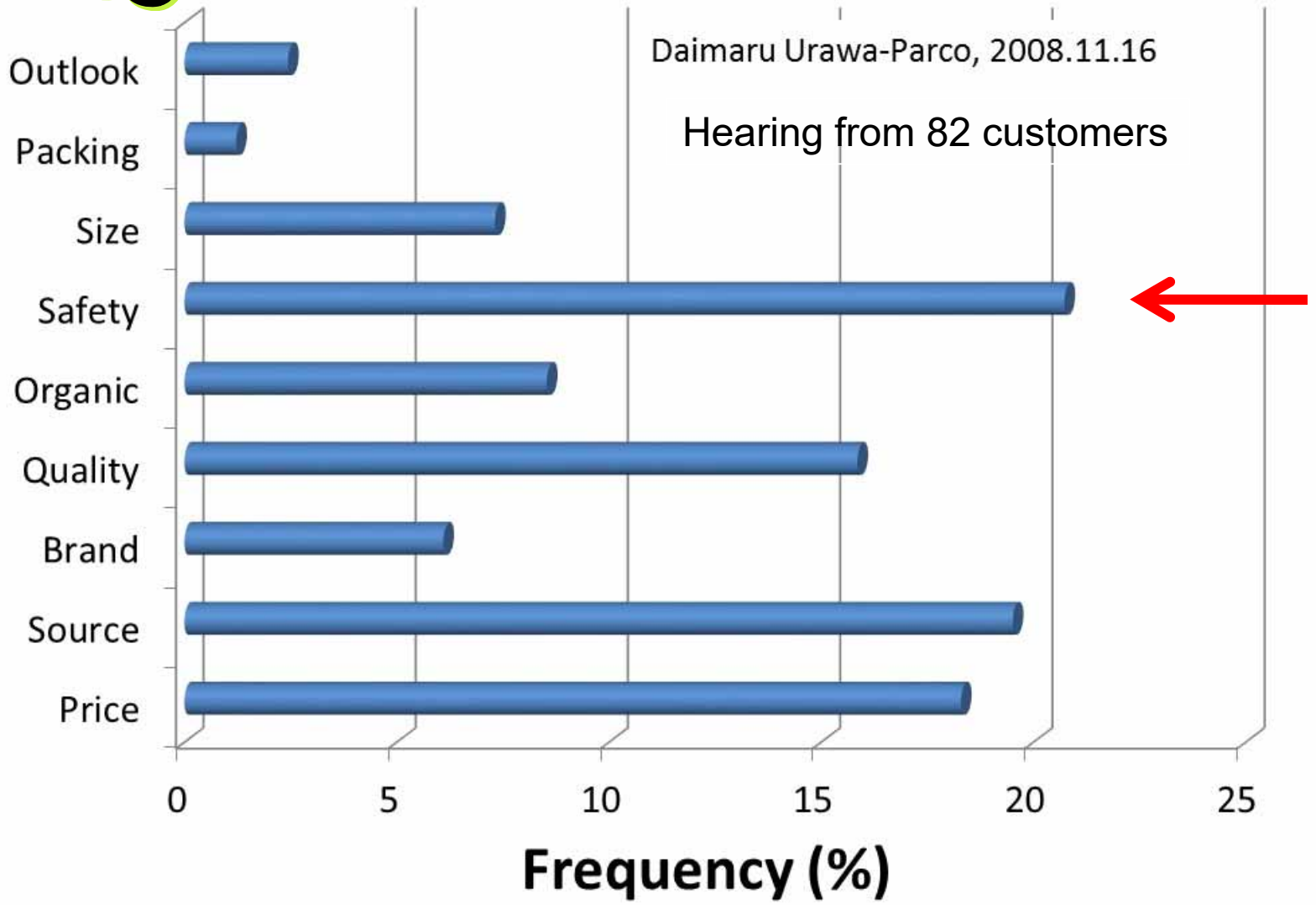
Farmers' Cooperative

In-shop Test at Department Store Using JA Transportation 2005-

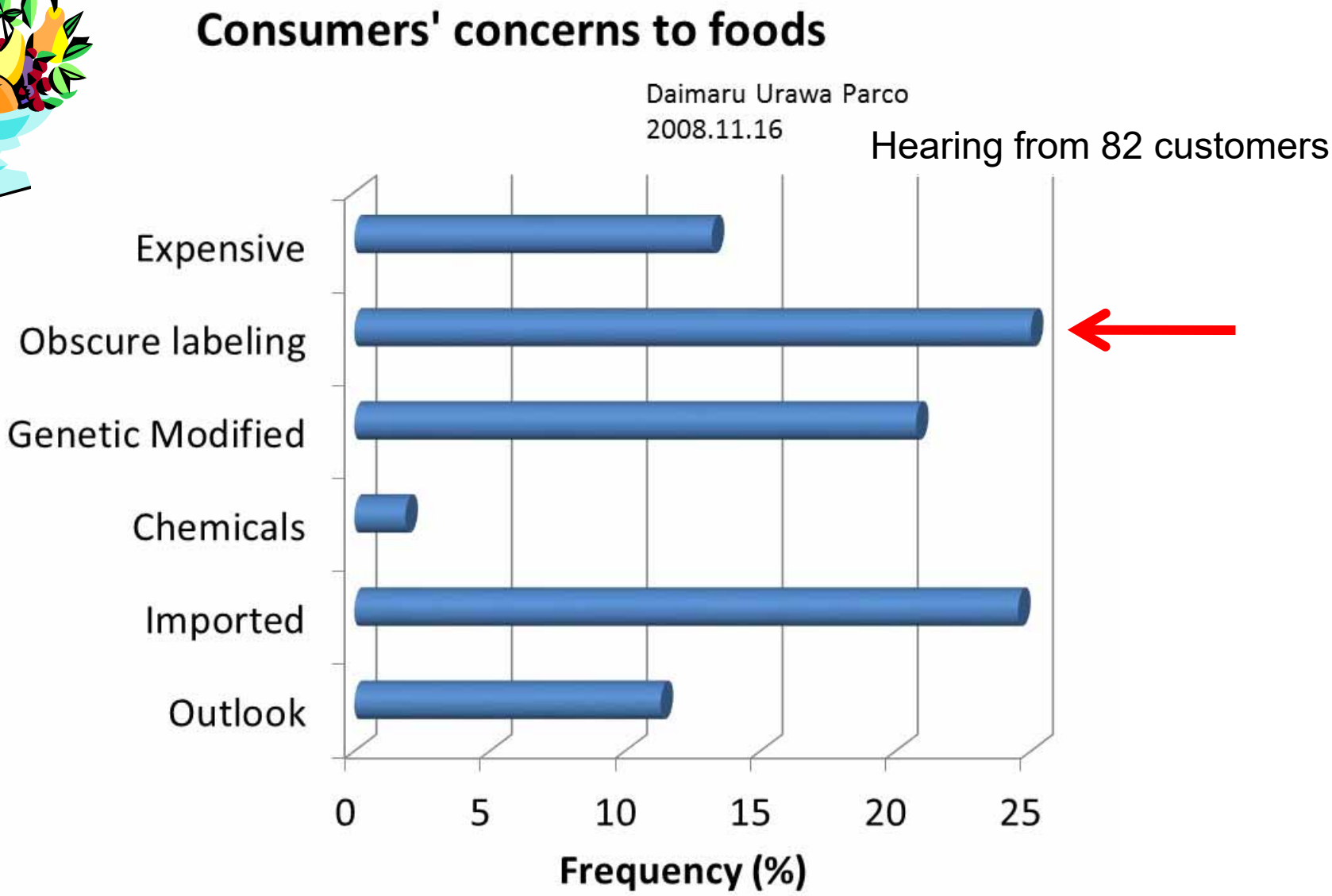
Government

Awarded by Prime Minister For its challenges 2006

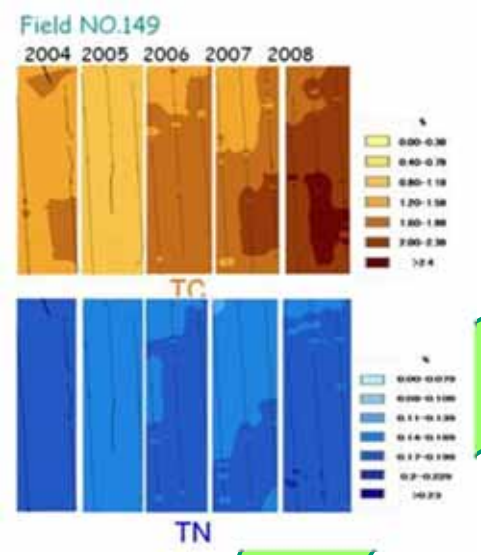
People seek safe foods.



People reject foods without reliability.

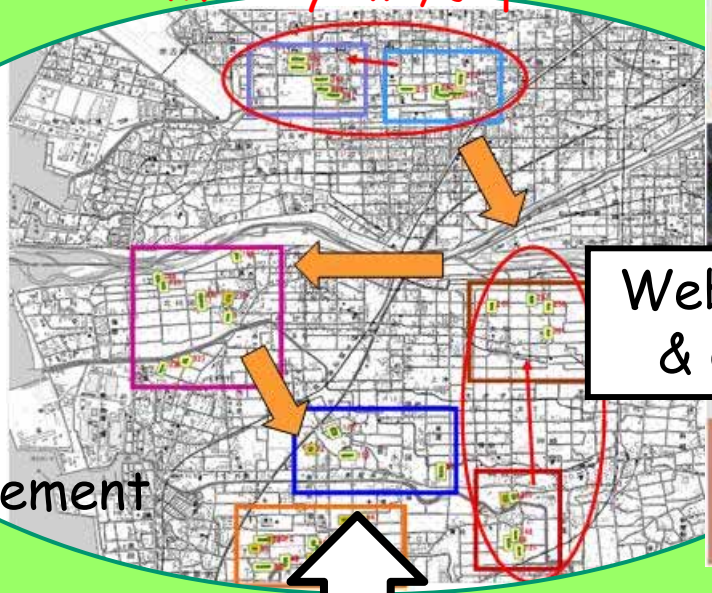


Precision Paddy Management Directly Accessing to Market.



Aged Growers offer Paddy Fields.

30 ha, 400 fields
Matsuyama, Japan



Soil Sensor

TUAT

Precision Paddy Management

Web Branding & Contract

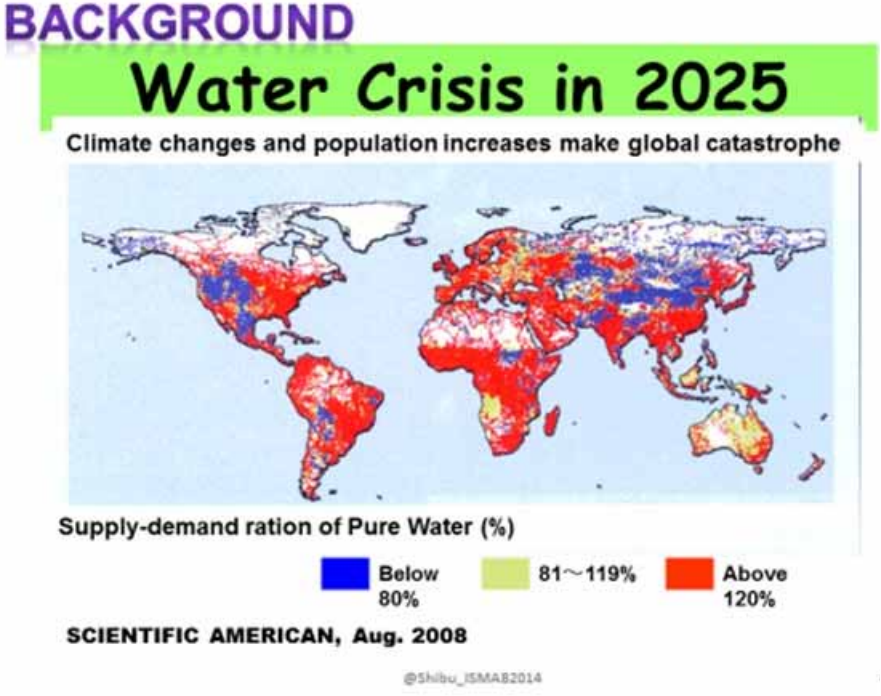
Organic Waste in City
Poultry manure, etc.

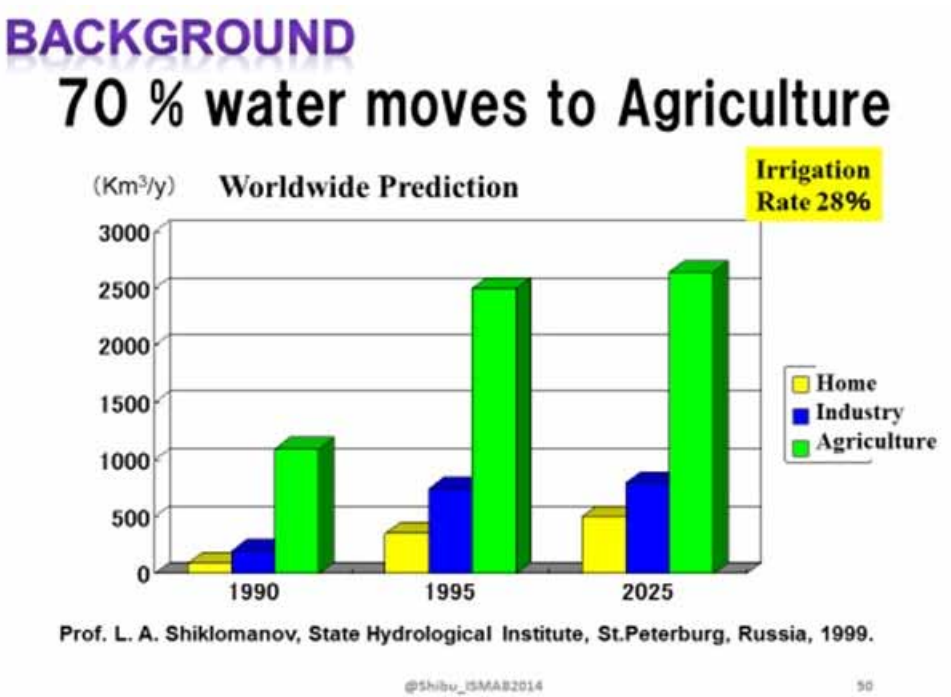
AGURI co.

Precision agriculture technologies for efficient use of agricultural inputs and reducing environmental impacts of farming

- Community-based Precision Agriculture
- Precision Water-saving Scheme
- Agro-medical Foods

Water Saving System For Advanced Precision Agriculture (WSSPA)



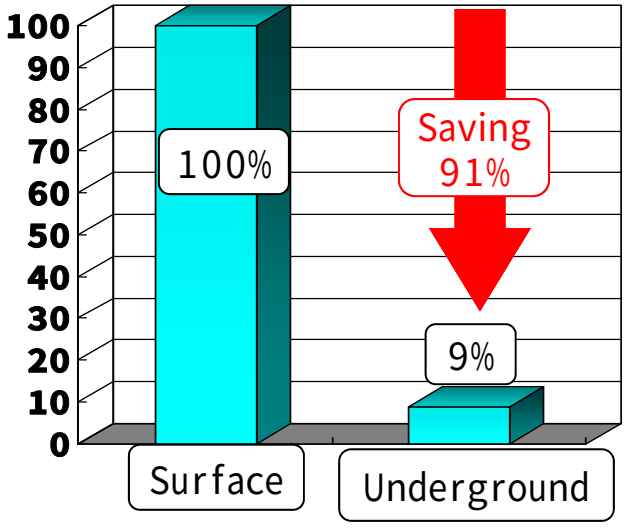


Thanks: CREST (Core Research Evolutionary Science and Technology) program funded through JST (the Japan Science & Technology Agency) by the government of Japan from 2010 to 2015

Controlled Underground Irrigation Provides Potential Precision Irrigation System

Haney Suckle

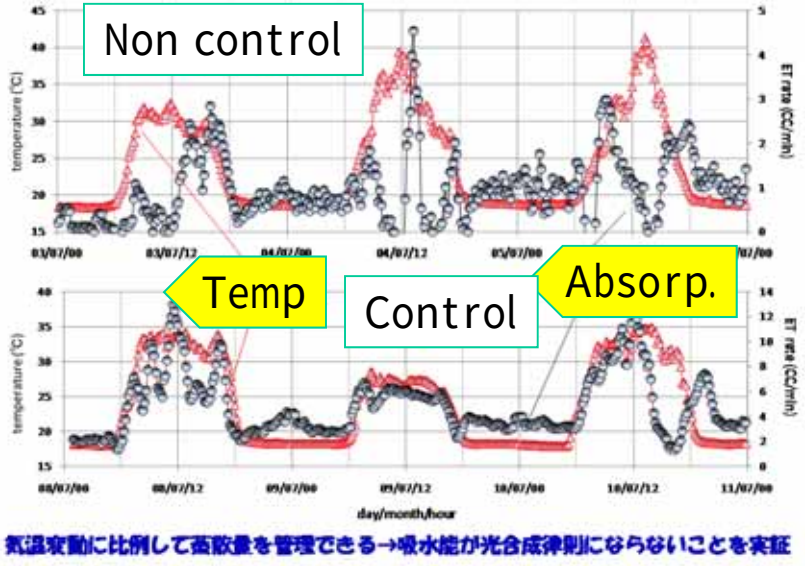
Test Field at Nevada



By Dr. M. Ohaba

Tomato in greenhouse

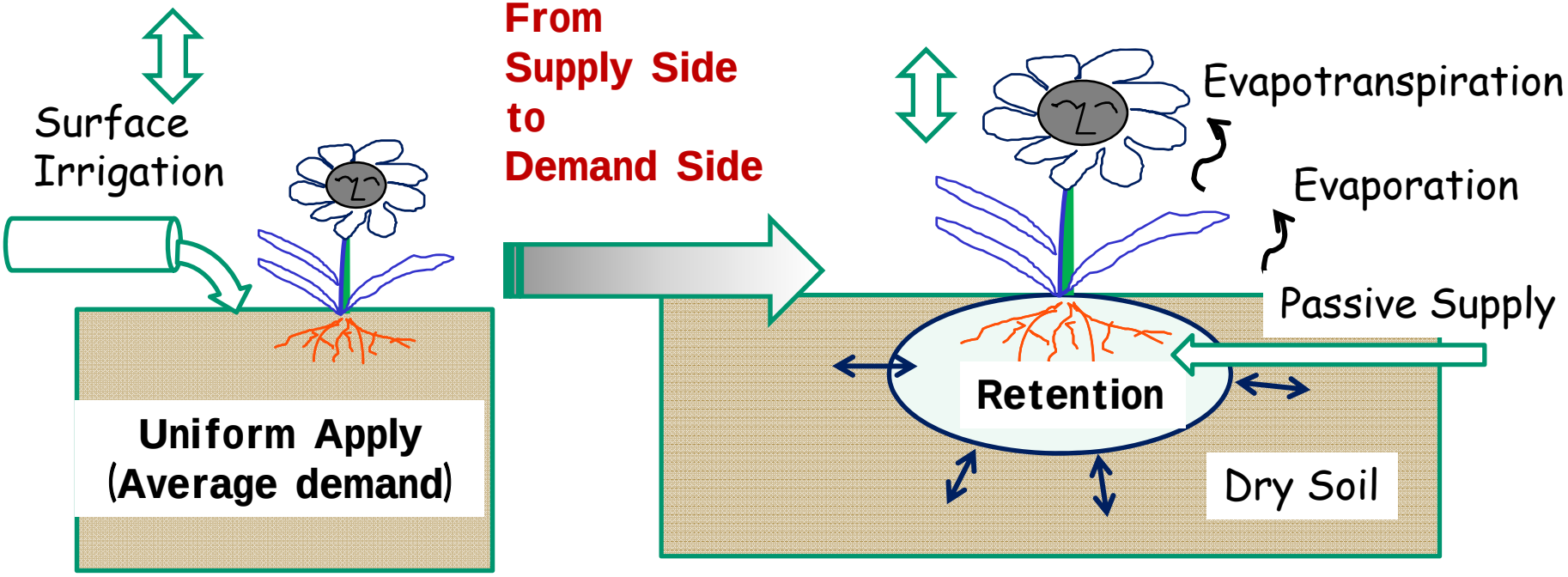
Absorption Harmonized with Temperature



IDEA OF WATER SAVING

Conventional
Encourage Supply Power
Dams & Heavy Infrastructure

New Trial
Precision Water Saving Technique
Needs-oriented, Passive supply



PROJECT OUTLINE

Correct amount, correct time, correct location by correct method.
Key techniques are:
Underground capillary irrigation technique.
Instrumentation of water capacity/stress.
Greenhouse control & water purification/recycle.

※ water-saving greenhouse/plant factory
※ water-saving orchard management
※ paddy water control system FOEAS
※ soil moisture/nutrient mapping and control

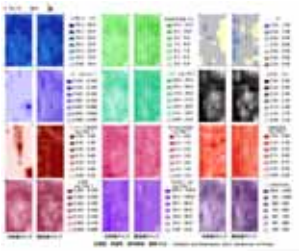
Energy saving by use of heat storage refrigerant

Energy-saving air-conditioning with high-efficient refrigerant

Energy-reduced optimum control of environment

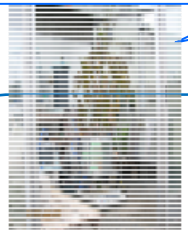
Water-saving System for Agriculture

Application sites



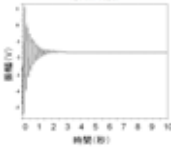
Leaf vibration→water stress index

Tomato cultivation by water-saving system in phytotron



Water-saving irrigation system

Detect plant water stress



Evapotranspiration

Evaporation

Water recycle

Water-level control tank

Water-level control

Supply tank

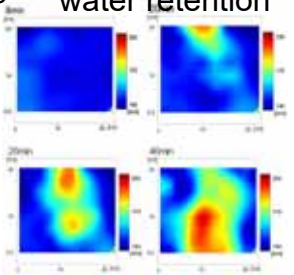
Water retention

Dry soil

Visible image

Detect the zone of water retention

Sonic image of water retention



Thermography of water retention

Uses of rainwater, underground water and waste water.

Underground precise irrigation using water-level control and capillary power

Even a few amount of waste water has to be used in water-shortage areas.

Supply control by the balance between soil water capacity and plant water stress

OBSERVATION

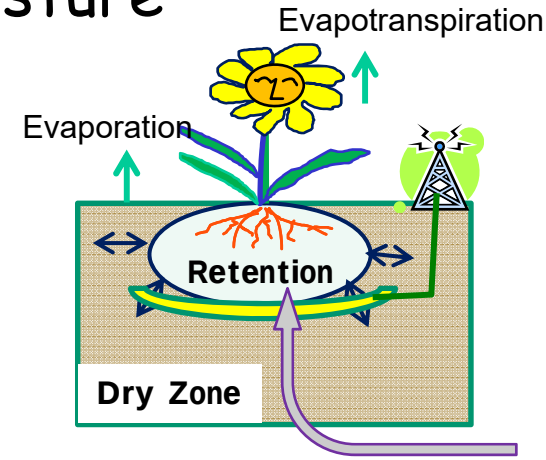
Clay soil, 2 mm screening, equilibrium moisture

Bottom supply

Fiber string

Moistened

Retention cube



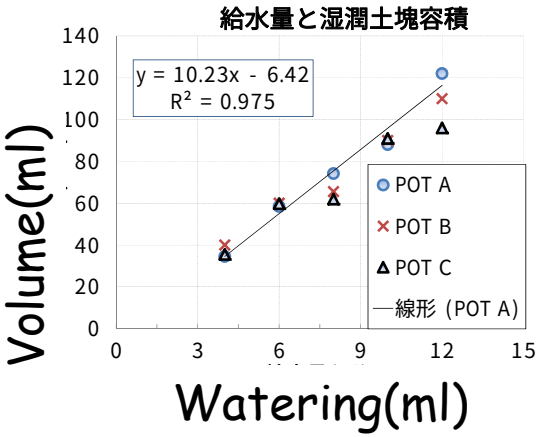
Capillary Supply

Upper supply

Top pore

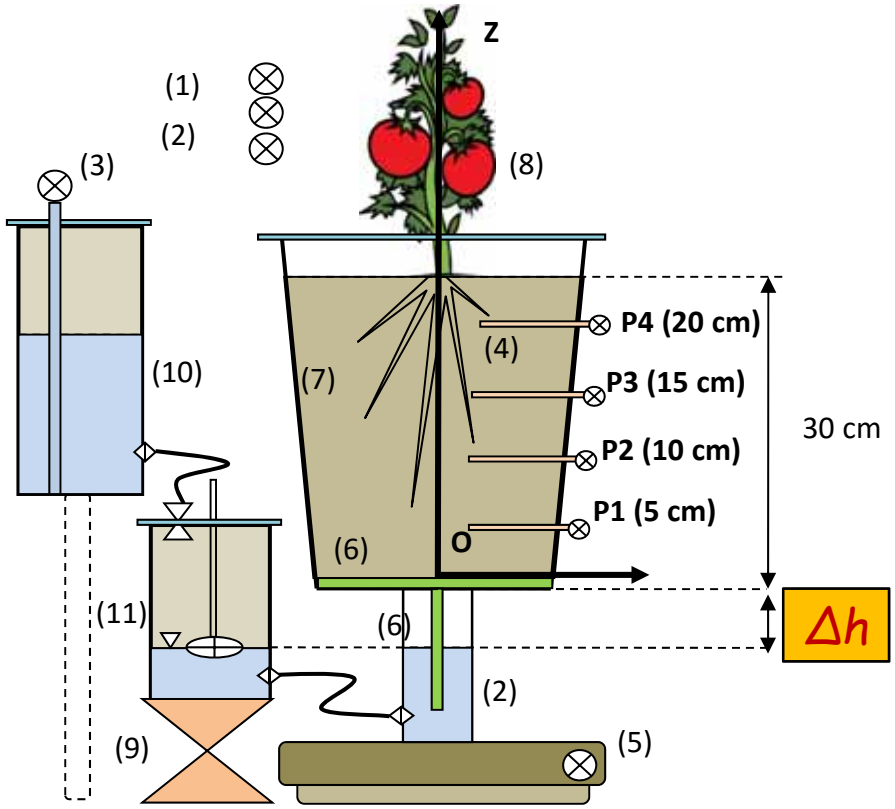
Retention cube

Plant model



By M. Kodaira

Experimental setup



Day after transplant (Day)	Water depth, Δl (cm)
1- 31	-1 cm
32 – 55 **(Day 55)**	-11 cm
56 – 90 **(Day 65)**	-3 cm

No.	Component
1	Quantum (Li Cor, LI-190)
2	Air Temp-Humidity sensor (Vaisala, HMP155)
3	Water level sensor (Watty, HL-G1-0200-R-S)
4	Soil moisture sensor (Decagon, EC-5 & EM5b)
5	Electronic balance (AND, GP32KS)
6	Fibrous interface (TOYOBO, 7210s & A-1) Diameter, 22 cm
7	Organic soil (Masaki, RS-7) Bulk density , 0.18 g/cm^3, VWC, 0.42 m^3/m^3
8	Tomato (Sakata seed)
9	Variable platform
10	Water supply tank
11	Water level regulator tank
	Phytotron (TUAT Fuchu, Japan) •Glass wall and roof •Air Temp: 15C (18:00-06:00) 25C (06:00-18:00) •Air Humidity: 70%

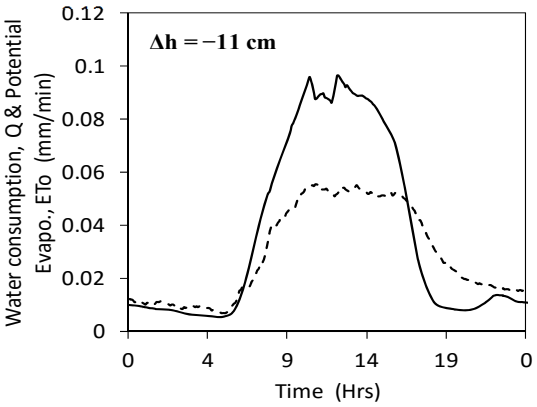
By M. S. B. Zainal Abidin

RESULT

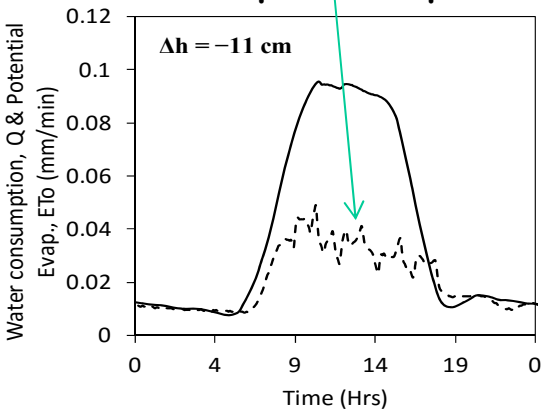
Change of Δh affects evapotranspiration

Evapotranspiration

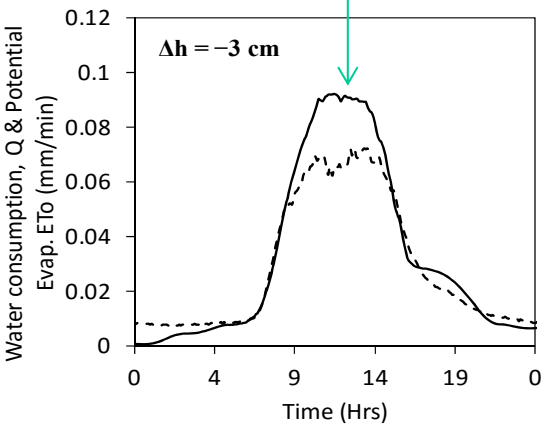
Water consumption



Day 45 after transplant



Day 55 after transplant



Day 65 after transplant

RESULT

Tomato yield production

Yield result	Pot A (variable, Δh)	Pot B (constant, Δh)
Fruits quantity	36	30
Total mass (g)	4795	3217
Average mass (g)	133.2	107.2
Brix (%)	6.52	7.33
Blossom and rot	5	13
Water use efficiency (g/kg)	43.59	20.11

**Higher water use efficiency found from Pot A with the adaptive irrigation system

By M. S. B. Zainal Abidin

RESULT Water usage benchmarking

Total water usage for 1 kg tomato production	(L/kg)
Israel & Almeria (Spain), field production	60
Almeria, unheated plastic house (1990)	40
TUAT Fibrous-capillary system (Pot B)	34.19
Israel, unheated glasshouse	30
Almeria improved unheated plastic house (2000)	27
Holland climate-controlled with CO_2 injection glasshouse	22
TUAT Fibrous-capillary system with adaptive control (Pot A)	20.47
Holland (as above) with drain water re-use	15

**The minimum total water used for 1 kg tomato is found from the fibrous-capillary system with adaptive control

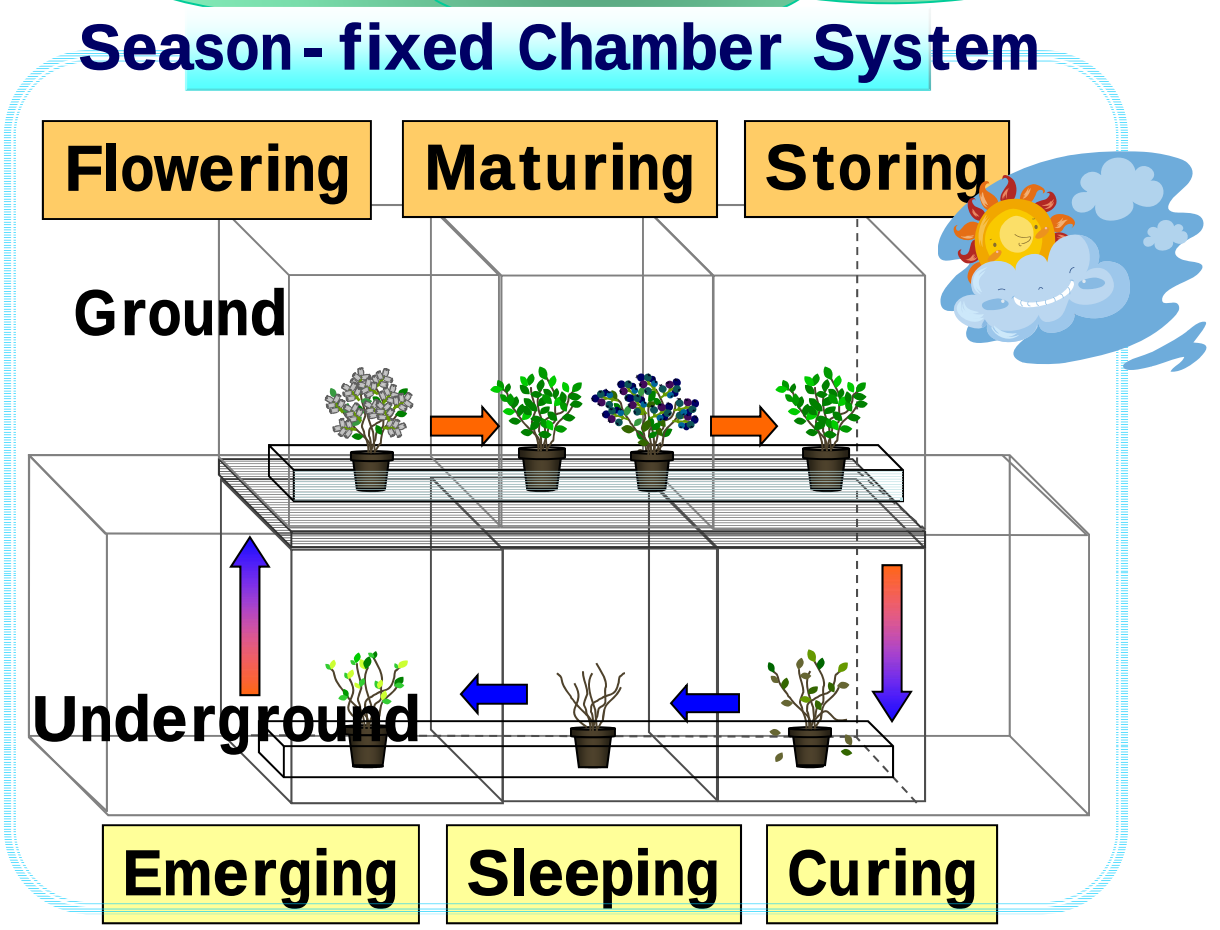
Stanghellini et al., (2003)

By M. S. B. Zainal Abidin

A Skill-recording System: Blueberry Campus Factory in TUAT

Factor six strategy
Lifecycle speed-up,
All season harvest
Variety Selection

Season-fixed chambers
Keep temporal skill & wisdom.



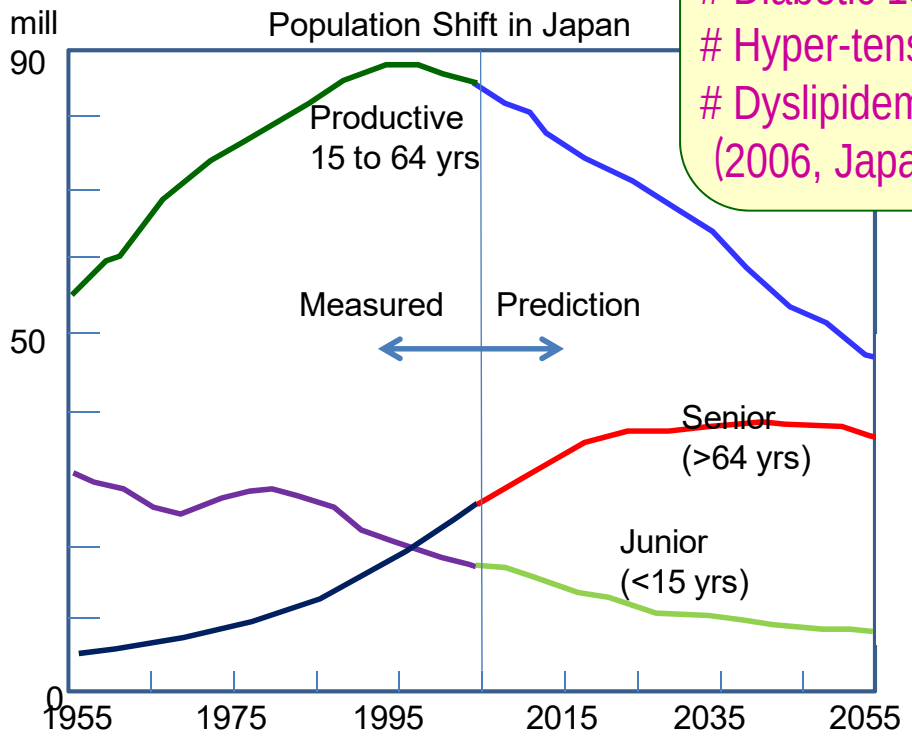
Precision agriculture technologies for efficient use of agricultural inputs and reducing environmental impacts of farming

- Community-based Precision Agriculture
- Precision Water-saving Scheme
- Agro-medical Foods

Super Graying Society creates much more Adult Disease and Medical Expense

Population

30 % of 65 yrs in 2025
Decrease one million per year.



Adult disease

Population of adult disease will be totalized by 140 million.

Diabetic 18.7 million
Hyper-tension 54.9 million
Dyslipidemia 14.1 million
(2006, Japan Health & Nutrition stat)

Medical expense

Total 33 tri yen
Adult disease
10 tri yen

In 2005

Health Sustaining Science

Health lifetime = Mean lifetime

Foods

Agro-medical Foods

Agricultural products which have high content of functional materials with effecting evidence to health and wellness, and which are produced by precision agriculture.

2009 AMI

Agro Medical Initiative : AMI
— Healthy Life Sustainability Networks by Agro-Medical Collaborate —

<AMI Founders>
◎Prof. T. Yoshikawa, Kyoto Medical College
○Prof. K. Chiba, TUAT
◇Prof. T. Kadowaki, University of Tokyo
◇Prof. S. Kaneko, Kanazawa University
◇Prof. J. Nishikawa, TUAT
□Prof. S. Shibusawa, TUAT
Dr T. Tanaka, Kanazawa University
Prof. C. Miyaura, TUAT
Prof. K. Ishihara, TUAT
Dr. A. Hino, Food Research Institute

Others from Companies, Government, and University

◎ Chair Person, ○ Vice Chair Person
◇ Director, □ Secretary General

【AMI Office】
Agro-innovation Center, TUAT
From April, 2009

Silver People Oriented Society
Adults Disease, Medical Expense

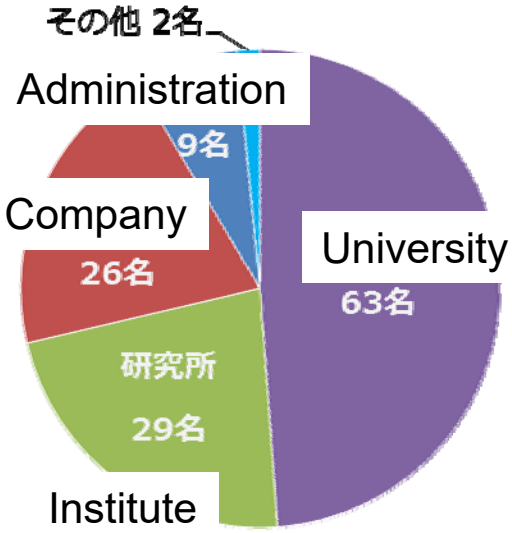
Health Sustainability Science
Health lifetime = Mean lifetime

- **Personalized Nutrition**
- **Evidence-based Prescription**
- **Standardization of process on food production and health monitor**

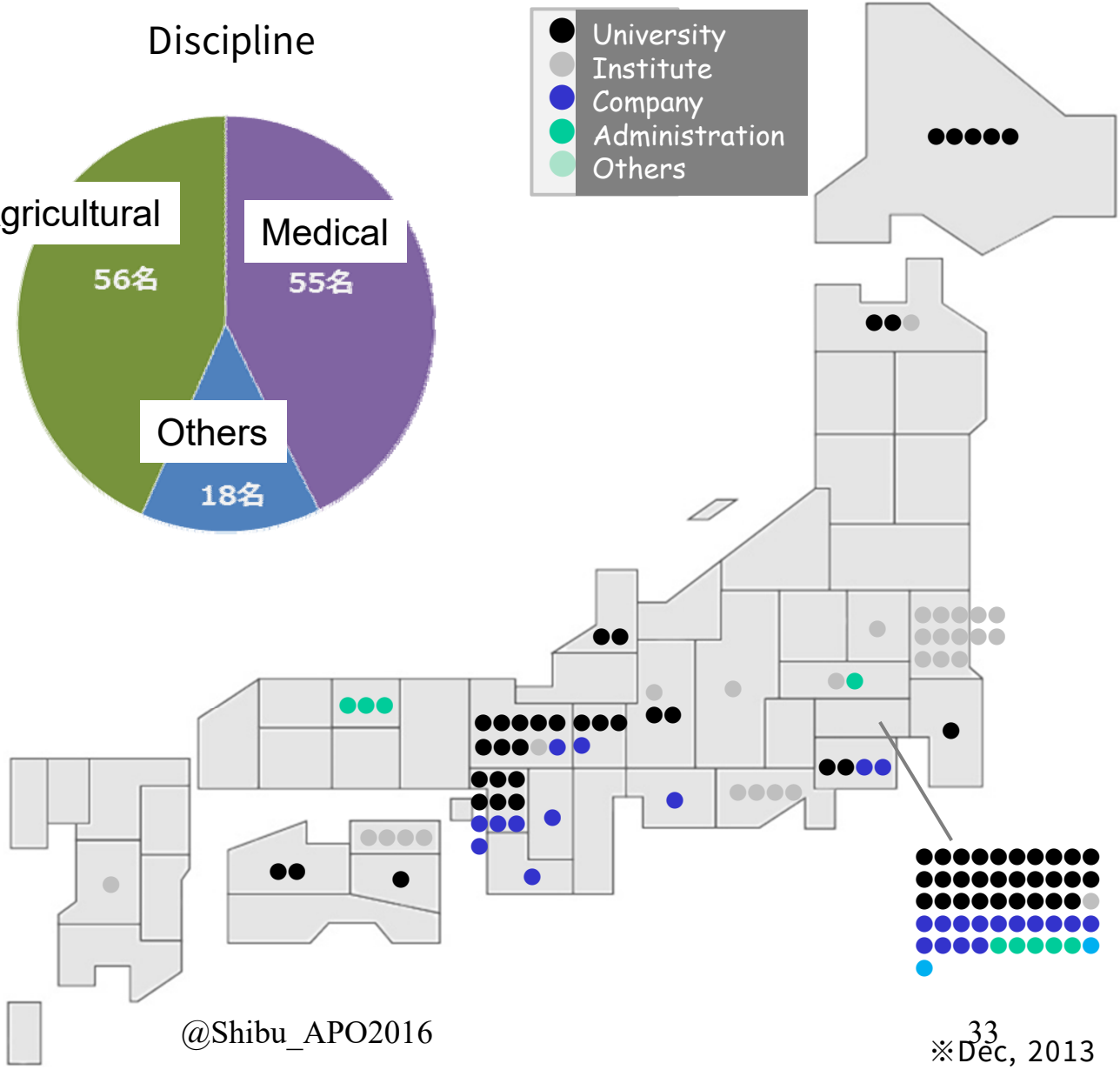
Agro +Medical + Foods

ＡＭＩ Membership 129 (2013)

Organization



Discipline



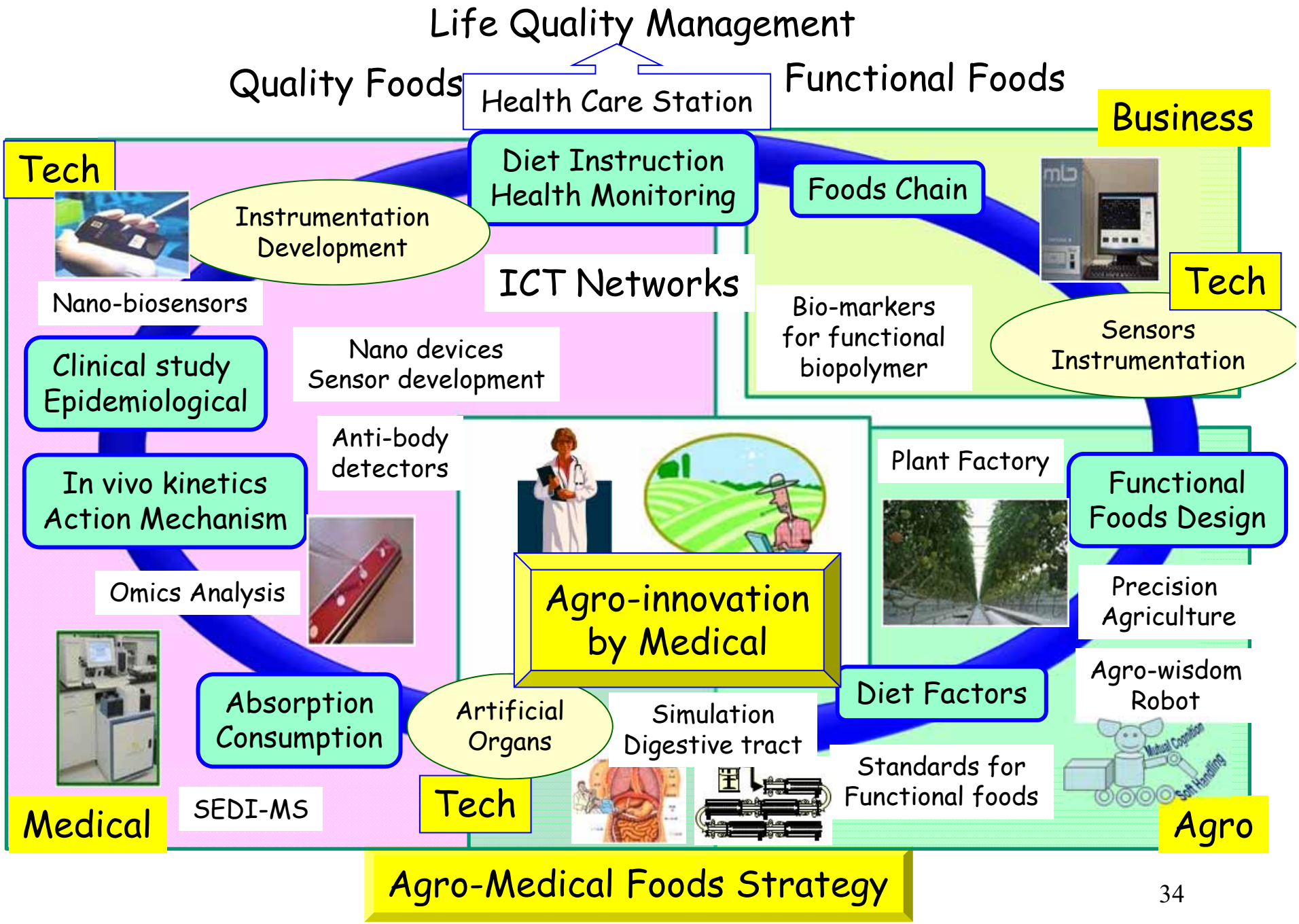
■Academia, Institute, Company, Administration

■Medical and Agricultural Science Fields

■All Japan

@Shibu_APO2016

※Dec, 2013


Life Quality Management
Quality Foods
Health Care Station
Functional Foods
Business
Tech
Diet Instruction
Health Monitoring
Foods Chain
Instrumentation
Development
ICT Networks
Tech
Nano-biosensors
Bio-markers
for functional
biopolymer
Sensors
Instrumentation
Clinical study
Epidemiological
Nano devices
Sensor development
Anti-body
detectors
Plant Factory
In vivo kinetics
Action Mechanism
Functional
Foods Design
Omics Analysis
Agro-innovation
by Medical
Precision
Agriculture
Agro-wisdom
Robot
Absorption
Consumption
Artificial
Organs
Simulation
Digestive tract
Diet Factors
Standards for
Functional foods
Medical
SEDI-MS
Tech
Agro
Agro-Medical Foods Strategy

Tentatively Standardized Development of Agro-medical Foods

	Medical Evaluation Cohort/Intervention/Animals/Cell-culture	Analysis Method Foods /Bio-specimen	Crop Production Breeding/Cultivation/Process/Cook
Onion	o o o o Metabolic Syndrome Dry mouse/eyes Cognitive impatient	o o Quercetin analysis	o o o Quercetin concentration
Green Tee	o o o Immunopotentiative Antiallergic	o o Strictinin Epigallocatechin	o o o Strictinin Epigallocatechin
Orange	o o o o Metabolic Syndrome Fatty liver/ Diabetes		o o o Beta-cryptoxanthin

Soybean
Apple
Spinach
Tomato
Egg plant
Blueberry
Etc.

O: Under investigation (2011)

R&D 3-yr Project on Functional Foods, MAFF. 2012 (2 b JPY)

I Functional Foods

区分	Subject	Organization	Head
直轄	High amylose rice and blood glucose level	◎Niigata University, Jikei Medical University, etc.	K Otsubo
直轄	Barley β-gulkan and Wheat	◎Otsuma Women University, Yokohama East Hospital, etc.	S Aoe
直轄	Brown Rice Effect	◎Tsukuba University, etc.	K Hashimoto
直轄	Rutin and “Manten Kirari” Soba Noodle	◎Hokkaido University, etc.	K Fujino
直轄	β-conglycinin Soybean	◎Kinki University, etc.	T Moriyama
直轄	Quercetin onion and cognitive function	◎Tokushima University, etc.	J Terao
直轄	Citrus β-cryptoxanthin and metabolism syndromes	◎Kanazawa University, etc.	T Ota
直轄	Green tea catechin and fat metabolism	◎Osaka Medical University, etc.	T Hanafusa
外部	Carotenoids and metabolism syndromes	◎Kyoto Prefectural University of Medicine, etc.	T Takagi
外部	GOYA vegetable	◎Suntory Global Innovation, etc.	K Abe
外部	Anti-oxygen foods and sleep improvement	◎Tokyo Medical University, etc.	Y Inoue

R&D 3-yr Project on Functional Foods, MAFF. 2012 (2 b JPY)

II Next Generation of Functional Foods

区分	Subject	Organization	Head
直轄	LOX-1 ligand simultaneous evaluation and food risks	◎NARO Food Res. Inst., etc.	S Machida
直轄	Intestinal tract homeodynamics of procyanidin compounds and lifestyle disease	◎NARO Fruit Tree Science Ints., etc.	T Shoji
直轄	Brain-Intestinum correlation and fermented milk products	◎NARO Livestock & Grassland Res.	C Suzuki
外部	QOL and next generation of functional foods	◎University of Tokyo, etc.	K Abe
外部	Foods serotonin and anti-obesity	◎Tohoku University, etc.	H Aso

III Database & Nutrition Instruction

区分	Subject	Organization	Head
直轄	Functional foods database and personalized nutrition instruction	◎Kanagawa University of Human Service, etc.	T Nakamura

IV Functional Foods Service

区分	Subject	Organization	Head
外部	Tailor-made lunch box for middle-age people	◎Leave a Nest, etc.	S Tsukada

Trend of Agro-Medical Foods and Surroundings

Olympic/Paralympic

2015 2020 2025 2030

Population
10^6 dec./yr
6*10^7 inc./yr

Export Agri.
10^9 JPY

Globalized Agriculture & Industry
Global Chain of Functional Foods

Food Market(Yen)
Global 340*10^9
Japan 70*10^9
Tokuho 0.6*10^9

Supplements 32 bil US$
Functional 1.8*10^9 ¥JP

Global Food Market 680*10^9 JP¥
Domestic 70*10^9 (?)
Functional 4*10^9

AMF
10^9 JP¥

Foods & Health: Critical Collaboration

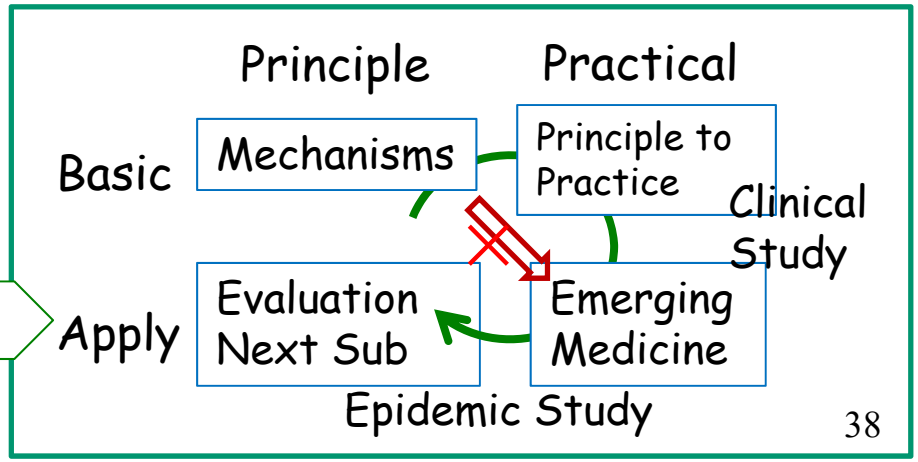
Medical Expense Control Policy

Paradigm Shift: Medical care rich to ahead sick healthy life

Globalized Health & Medical Care Service

Expense 39*10^9 JP¥ (2012)
GNP 8%
Public 15*10^9 JP¥
Insurance 19*10^9 JP¥
30% Lifestyle disease

Change of Medical Research



Dr. R. Nagai
2015.6.24

Future of Agro-medical Care Center. Thank You!