



Indoor Cultivation for the Future

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(Presented by Chieri Kubota, The University of Arizona)



Background in Japan



- Issues:
 - Increasing pressure to change the structure of Japanese agriculture and food production
 - Public concerns over nutrition and food safety
- Trends:
 - Increasing interest in plant factories in Japan
- Advantages:
 - Strong support from local and federal governments
 - Consumer's appreciation of high technology in agriculture

Hardware and Software Needs for Indoor Cultivation



Hardware



- Affordable systems for various scales of production

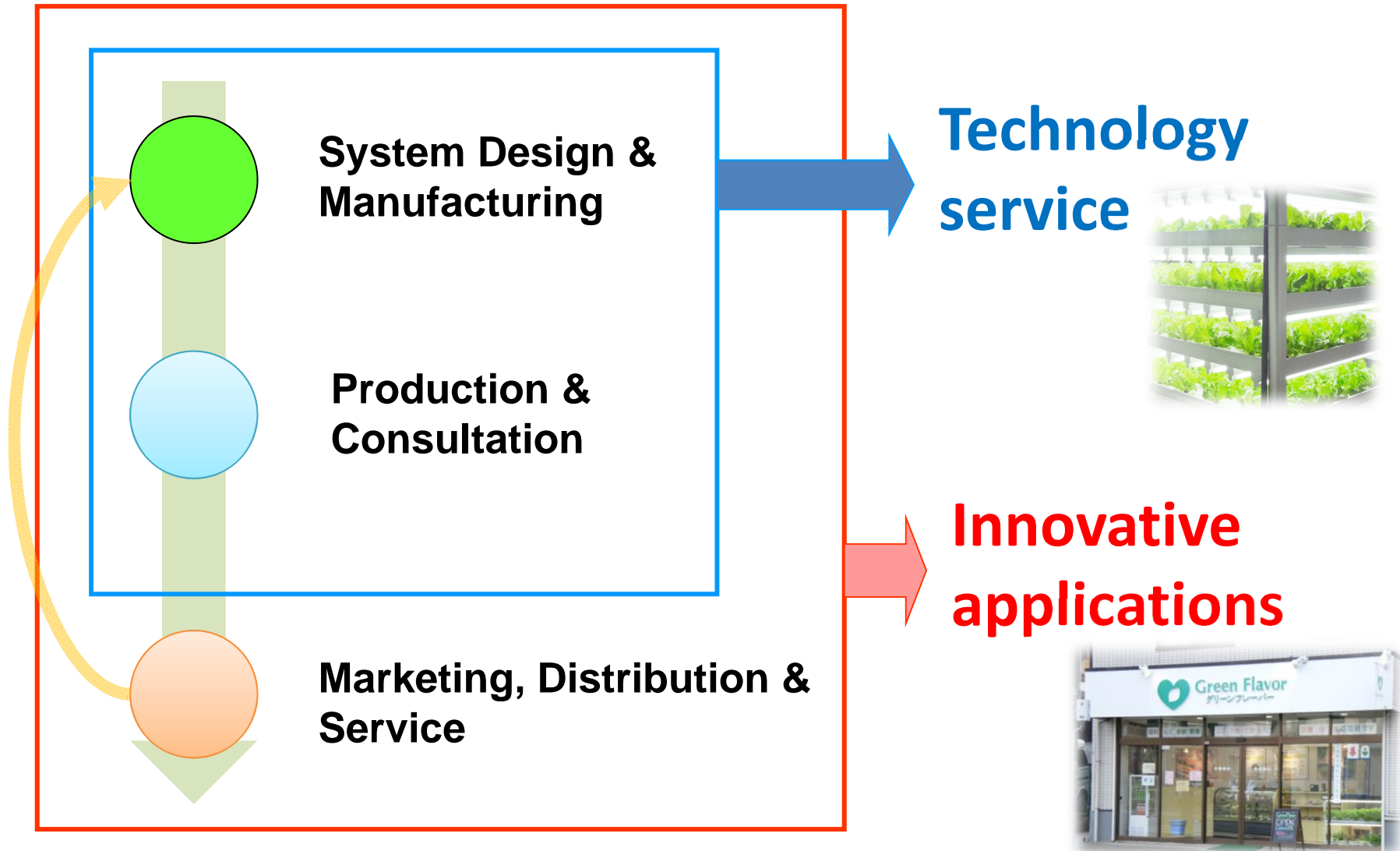
Software



- High quality and nutritional produce
- Manuals -- Suitable for beginners

Indoor Cultivation

Vertically Integrated Business Models

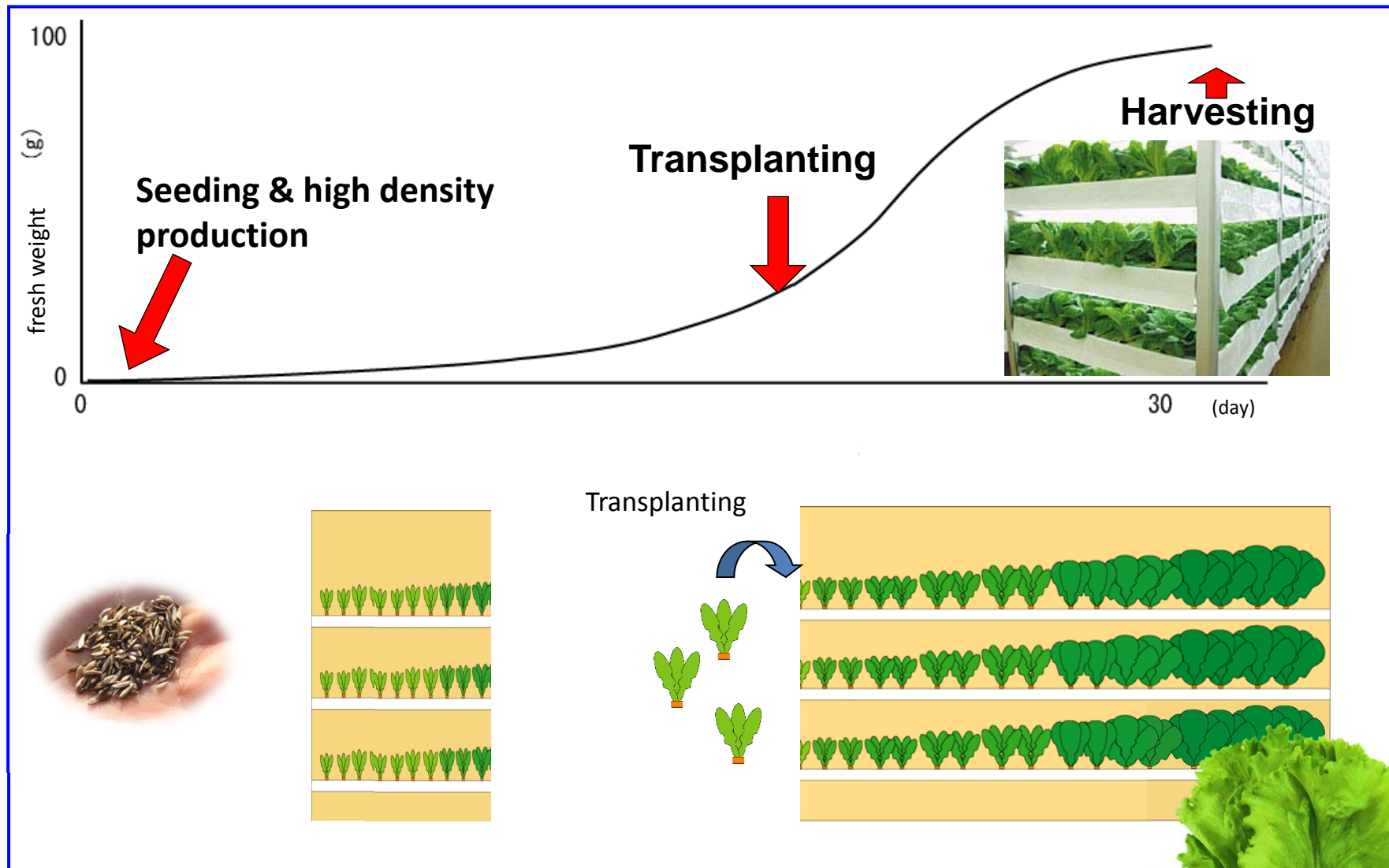


Key Technologies (Hardware)



- Production capacity (examples)
 - 300 lettuce heads /day (60 m² or 650 ft² foot print)
 - 10,000 lettuce heads /day (1200 m² or 0.3 acre)
- Hydroponic (NFT) system
 - Nutrient circulation
 - EC/pH control
- Environmental control
 - Thermostat-based temperature control
 - CO₂ control
 - Fluorescent lamps and/or LEDs
- Hygiene
 - Air cleaning (filtering) system, lab suit
 - Air shower for workers before entering
 - Water shower prior to access for complete removal of pathogens in large scale facilities

Typical Production Schedule (Lettuce)





Competitive advantages

- Food safety
- Traceability
- Little waste
- Standardized quality
- Year-round availability



Lettuce produced in GreenRoom™

- 97-98% harvestable aerial biomass
- Waste 2-3 % of biomass



Conventional lettuce head

- 60-70% harvestable aerial biomass
- Waste 30-40% of biomass (outer leaves and center cores)

Technologies (Software)

Growing manuals for 40 different leafy crops/herbs.



レタス



からし水菜



水菜



春菊



みつ菜



グリーンリーフ



ペパーミント



コリアンダー



ケール



ルッコラ



サンチュ



レタス



グリーンリーフ



サンチュ



ロメイン

Opportunities - Designing Flavor

Flavor = f (Genotype, Environment, Human Perception)



Applications



Applications – Retail + Indoor Cultivation



- Renovating existing buildings in urban/suburban areas
- Integration of production system inside the retail stores (zero transportation).
- Urban “roadside stand”

Applications – Restaurant + Indoor Cultivation

- A large restaurant chain with ~200 locations in Japan
- ~6 tons of Mizuna leaves are produced for 100 of their chain restaurants in Japan



Applications – Restaurant + Indoor Cultivation

- A large pizza restaurant chain with ~59 locations in Japan
- Indoor production for romaine lettuces for their salads



Unique Applications - Responses to 3/11 Disasters

- Collaboration with GE Japan to build an indoor cultivation farm in Miyagi, Japan.
- Kids veggie farms (school projects to support STEM education and lunch programs) in Fukushima, Japan



Unique Applications – Extreme Climate + Indoor Cultivation



- South Pole Showa Station
- ~3 m² mini system built in 2008 to supply fresh vegetables
- Online consulting



Unique Applications – MIRAI

Shopping Mall + Indoor Cultivation

- LaLaPort Shopping Mall, Kashiwanoha, Japan
- A 6.6 m² (71 sq ft) for demonstrating production of lettuce and herbs



Industry-Academia Collaborations

- Plant Factory Consortium funded by Ministry of Agriculture, Forestry and Fisheries (MAFF)
- Consortium members
 - Mirai (Leader)
 - Chiba University (Organizer)
 - Iwatani (CO₂, Pest management)
 - Kajima Construction
(Architectural design)
 - Showa Denko (LED)
 - Panasonic (Fluorescent light)
 - Marubeni (Marketing)
 - Toyo Valve (Nutrient sterilization)



MAFF Demonstration Plant

Community Application

- Regional community social network for micro gardeners

A collaboration with Chiba University, Panasonic, and Mitsui-Fudosan (urban developer)



MIRAI garden for home



Social networking site for home gardeners



User information website

Kashiwanoha community networking pilot project



Consulting and supplying materials/recipes

University research park



MIRAI garden website/SNS



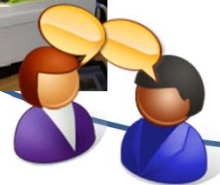
Kashiwa City
Kashiwanoha district



Shopping mall
veggie garden
(transplant supply)



Community
user group



Economic analysis of indoor lettuce production

Items	Note
Building size (modular building)	1,300 m ² (14,000 ft ²) footprint (1,100 m ² or 12,000 ft ² footprint for 4,536 m ² production area)
Crop	Leafy lettuce (10,080 heads per day, 100 g per head)
Nutrient delivery and lighting systems	NFT Combination of LEDs and white fluorescent lamps
Other facilities	Office space, packing area, storage, cold storage (200 m ²)
Other equipment	Cooling/heating, seedling production systems, irrigation tanks and injection systems, climate controller etc.
Equipment/facility life	Production systems for 7 years; 15 years for other equipment; 20 years for the building

Balance estimate

Items	Income/Expense	Note
Annual gross sales	~\$4.1 M (331M Yen)	~\$5.68/lb (10% product loss)
Annual costs (total)	~\$3.4 M (274M Yen)	~\$4.70/lb
Investment return		6 th year

1 lb = 0.45 kg

Capital costs: 7.4 million US dollars (590M Yen)

Items	Costs	Note
Building	180M Yen (31%)	New construction
Construction	110M Yen (19%)	Utility set up
Equipment and facilities	300M Yen (51%)	NFT systems, irrigation systems, lighting systems, others

Annual operation costs: 3.4 million US dollars (274M Yen)

Items	Costs	Note
Salaries and wages	71.3M Yen (26%)	Two full time workers + hourly laborers (210 h/day, \$10/h)
Materials	15.4M Yen (6%)	Packing materials, seeds, light bulbs, fertilizers, chemicals, etc.
Utilities	72.6M Yen (26%)	369MW/month power use + water use
Transportation and shipping	6.0M Yen (2%)	
Other costs	49.2 M Yen (18%)	Facility/equipment maintenance, consulting
Depreciation	59.2 M Yen (22%)	

VF Challenges – Our Experiences

- It is all about having the **right kind of people with experience and training** in the production operation
 - *“Just like successful wineries and sake makers need excellent viticulturists and sake masters”*
- Indoor cultivation will never be the same as ‘industrial factory manufacturing’ and needs a **non-linear approach** by understanding the nature of biology and agricultural business

Questions?

