Current Status of Agricultural Mechanization and Biosystems Engineering Research and their future in Korea

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- Kyeonguk Kim, Professor of SNU
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Background

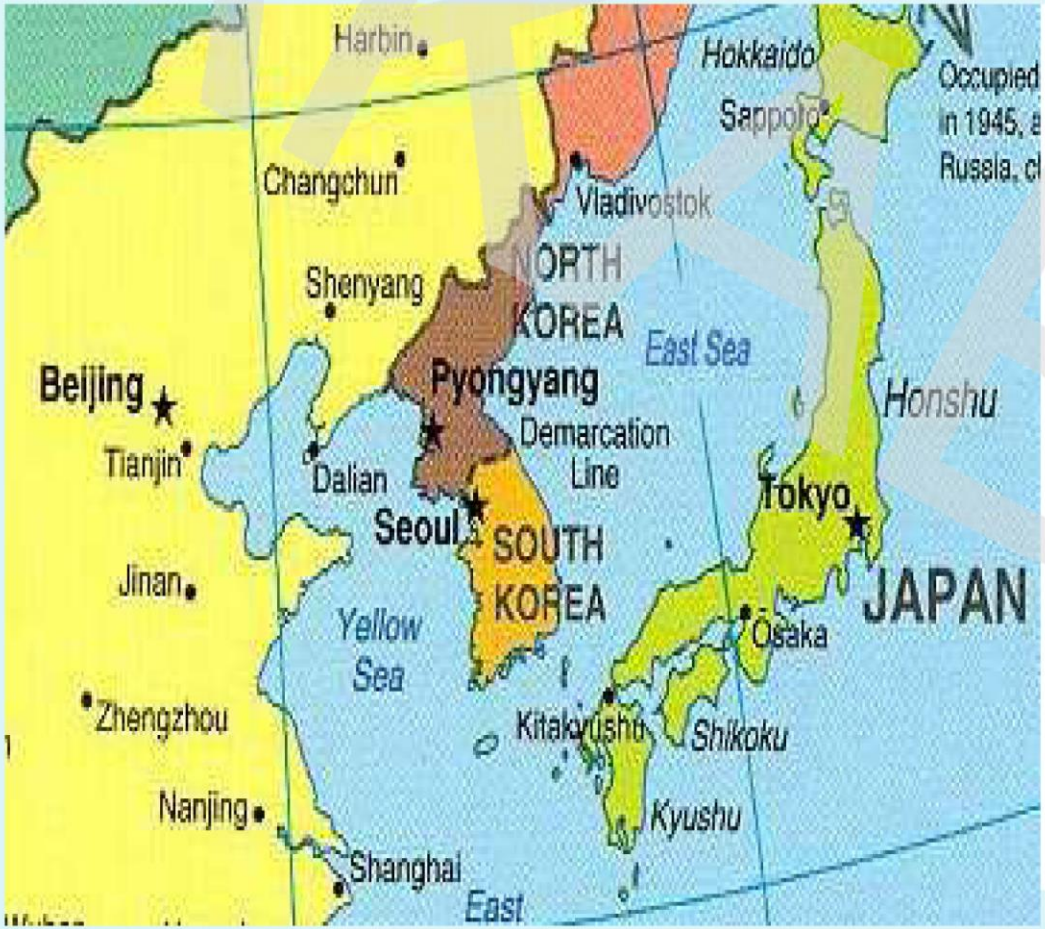
- Korean agricultural mechanization has contributed to a tremendous increase in agricultural productivity.

- Agricultural productivity should be maintained or increased to meet the food demands of over 9 billion people by 2050 while conserving natural resources.

- To introduce the current status of agricultural mechanization and biosystems engineering research in Korea as well as their future

Introduction

Republic of KOREA



Population: 51 Million

Population Growth: 0.45%

Area: 100,210 ㎢

GDP/Capita: US$25,189

GDP Growth: 3%

Farm Population: 3M (6.4%)

Agri. Production: 2.9% of GNP

Agricultural Mechanization in Korea

History of Agricultural Mechanization

1963: Production of Power tillers
1969: Production of Tractors
1972: 1st 5-year farm mechanization plan
1973: Introduction of Rice Transplanter
1976: KSAM Establish
1977: Introduction of Binders
1978: Farm mechanization promotion law
1979: Institute of Farm Mechanization (IFM)
1982: Production of Combine

1995: Agri. machinery inspection from mandatory to optional
2000: No subsidy for purchasing agri. machinery
2002: 7th 5-year farm mechanization plan, Farm population 7.5%
2004: IFM to National Institute of Agricultural Engineering (NIAE)
2008: NIAE to Department of Agri. Engr. under NAAS
2014: 2nd KIEMSTA

Plowing and Rice transplanting

Oxen (1960's)

Power tiller(1970's)

Tractor(1980's)

Manual (~1970s)

Walking (1980's)

Riding (1990's ~)

Irrigation and Weeding

Manual (~ 1960's)

Powertiller Pump (1970,s)

Irrigation Channel (1980,s)

Manual(1960's)

Tractor (1990's~)

Rice Transplanter (1990's ~)

Spraying and Harvesting

Hand sprayer (~1970's)

Power sprayer (1970's~)

Aerial application(1980's~)

Hand reaping (~1970's)

Binder (1980's)

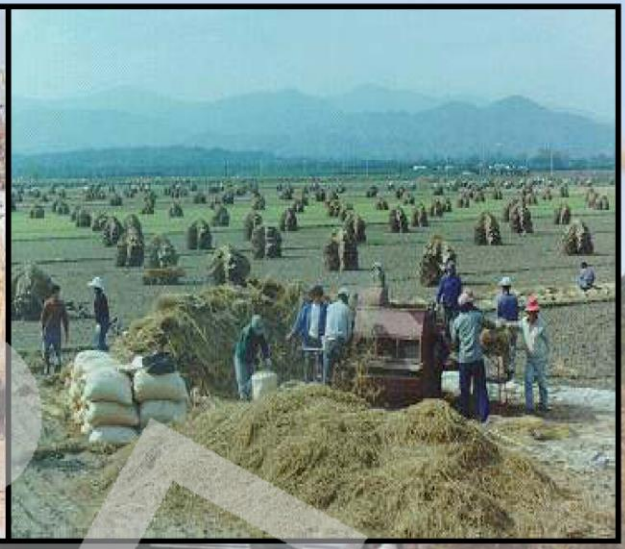
Combine(1980's~)

Threshing and Drying

Treadle thresher(~1950's)

Power Thresher (~1970's)

Self-feeding thresher (~1980's)



Sun drying

Circulating grain dryer(1980's~)

Rice processing complex(1990's~)

Mechanization for Upland Crop Farming

Garlic

Separation

Sorting

Mulching

Seeding

Harvesting

Stem Cutting

- Labor Saving : △ 81%

Mechanization for Upland Crop Farming

Onion

Seeding

Transplanting

Power tiller Harvesting

Type 1 Tractor Harvesting

Type 2 Tractor Harvesting

Cleaning System

Agricultural Mechanization

Rice and Upland Crops (2012)

Rice		Upland crops	
Operation	**Rate (%)**	**Operation**	**Rate (%)**
Tillage	99.9	Tillage	99.4
Transplanting	99.8	Seeding & Transplanting	3.9
Harvesting	99.9	Mulching	64.1
Drying	58.5	Pest control	96.3
Pest control	99.3	Harvesting	14.6

Agricultural Mechanization

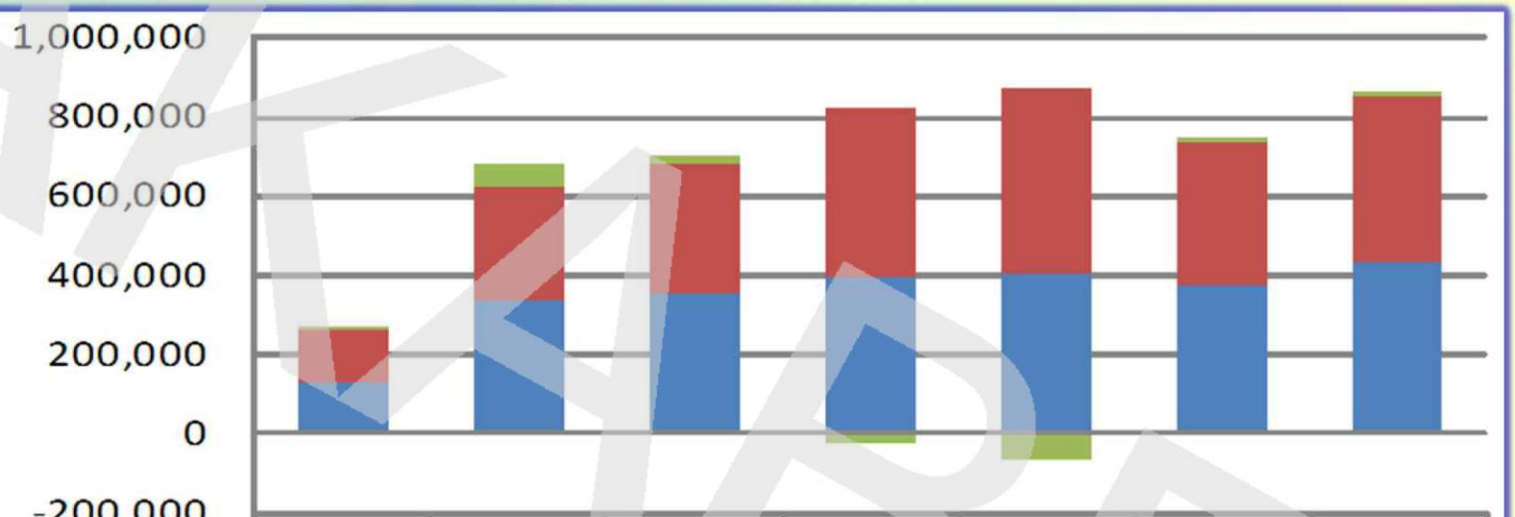
Mechanization Rate of various upland crops (2010)

Crop	Mechanization rate(%)					
	Plowing	Seeding	Mulching	Spraying	Weeding	Harvesting
Soybean	99.1	4.5	62.0	89.0	30.0	12.5
Potato	99.9	14.5	73.1	99.2	30.9	73.0
Cabbage	99.8	0	71.8	96.5	62.8	0
Red Pepper	99.9	0	45.1	88.1	22.6	0
Garlic	99.2	24.8	41.4	97.2	37.4	22.4

Mechanization for seeding and harvesting is most needed.

Import/Export of Korean Ag-Machinery

Trade Market (unit: $1,000)

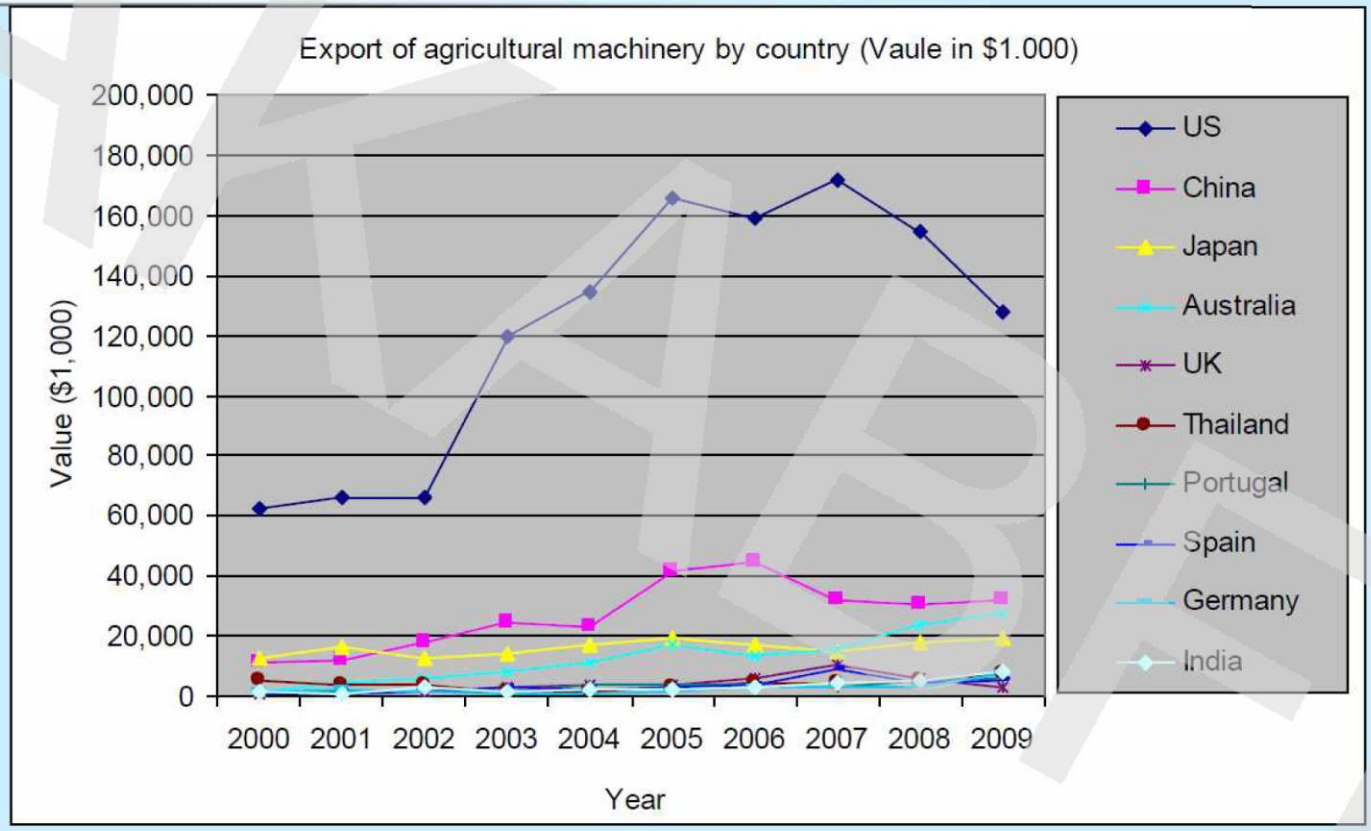


	2000	2005	2006	2007	2008	2009	2010
Trade balance	2,998	58,708	18,658	-22,595	-67,903	13,253	14,452
Import	131,806	282,314	332,211	422,245	470,149	362,204	419,125
Export	134,804	341,022	350,869	399,650	402,246	375,457	433,577

◆ since 2000, trade increased
- 2010, 900M$
- Export is higher than import

Export of Ag-machinery

Export by country (unit: $1,000)

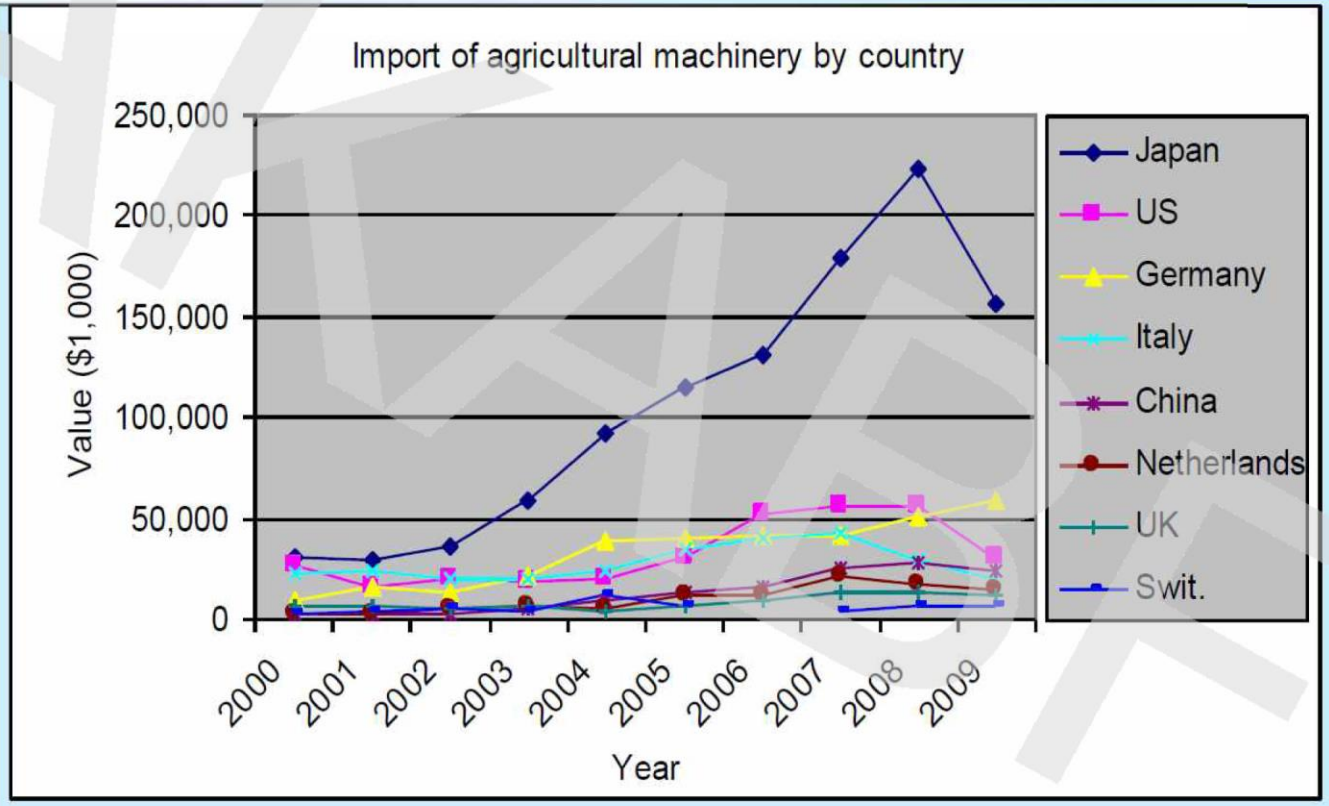


◆ **Mainly tractors exported to US (more than 40%)**

- **Exports to China are not increased**

Import of Ag-Machinery

Import by country (unit: $1,000)



◆ **Mainly tractors(>50hp) imported from Japan (more than 50%)**
- followed by rice transplanters (Japan) and bailers (Europe)

Biosystems Engineering Research in Korea

Agricultural Engineering

- ~2000

Agricultural Engineering

Soil and Water
Agri-Environment

Agricultural Machinery

Power and Machinery
Postharvest Engineering

- 2001 ~ Present

Regional Systems Engineering

Soil and Water Resources
Agri-environment and Rural Systems

Biosystems Engineering

Off-road Machine Systems
Agri-Environmental Systems
IT and Electronics
Agri-Process and Food Engineering
Biological Engineering

Departments of Biosystems Engineering

- 11 Universities
- 17~30 Students

Providence	University	College	Name of Department
Seoul	SNU	CALS	Biosystems Engr.
Kangwon	KNU	CALS	Biosystems Engr.
Gyeonggi	SKKU	CBBE	Bio-mechatronics
Daejeon Chungnam	CNU KGNU	CALS CBIS	Biosystems Machinery Engr. Bio-mechanical Engr.
Chungbuk	CBNU	CALS	Biosystems Engr.
Gyoengnam	GNU	CALS	Bio-industrial Machinery Engr.
Busan	PNU	CLRS	Bio-industrial Machinery Engr.
Gyeongbuk	KNU	CALS	Bio-industrial Machinery Engr.
Gwangju Chonnam	JNU Sunchon Univ	CALS CBIS	Biosystems Engr. Bio-industrial Machinery Engr.
Chonbuk	JBNU	CALS	Bio-industrial Machinery Engr.

Location of BSE Departments

SNU/SKKU
- Off-road, Automation
- Bio-process
- Bio-environment
- Tissue engineering

CNU/Kongju
- Power machinery
- Postharvest Engr.

Chonnbuk National Univ
- IT Center for Ag. Machinery
- Postharvest Engr.

JNU/Soonchun
- Biosystems Instrumentation and Control
- Biosensors

KNU
- Power machinery
- Control and automation
- Bioenergy

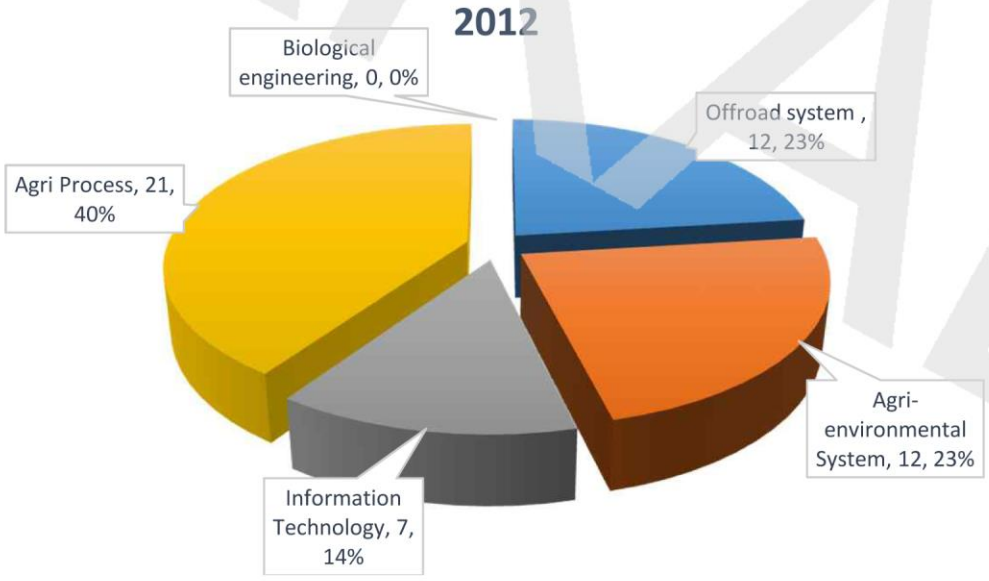
CBNU
- Power machinery
- IT

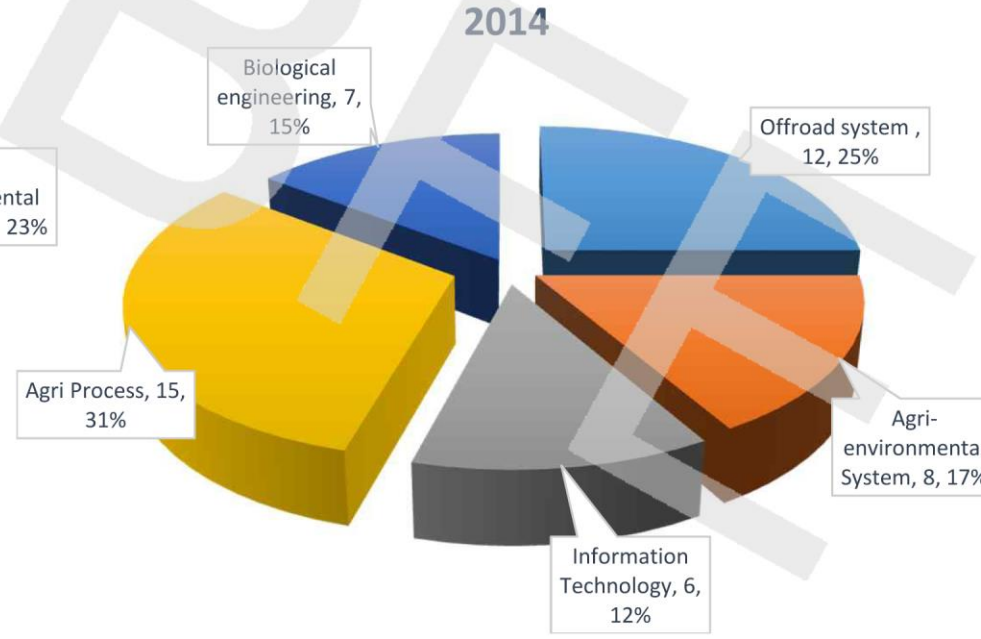
KNU
- Agri. Facilities
- Agri. Robots
- Power machinery

GNU/PNU
- Power machinery
- Bioenergy
- Postharvest Engr.

Search for Research Activities

- Journal of Biosystems Engineering ('12~'14)
- Project reports regarding a research planning

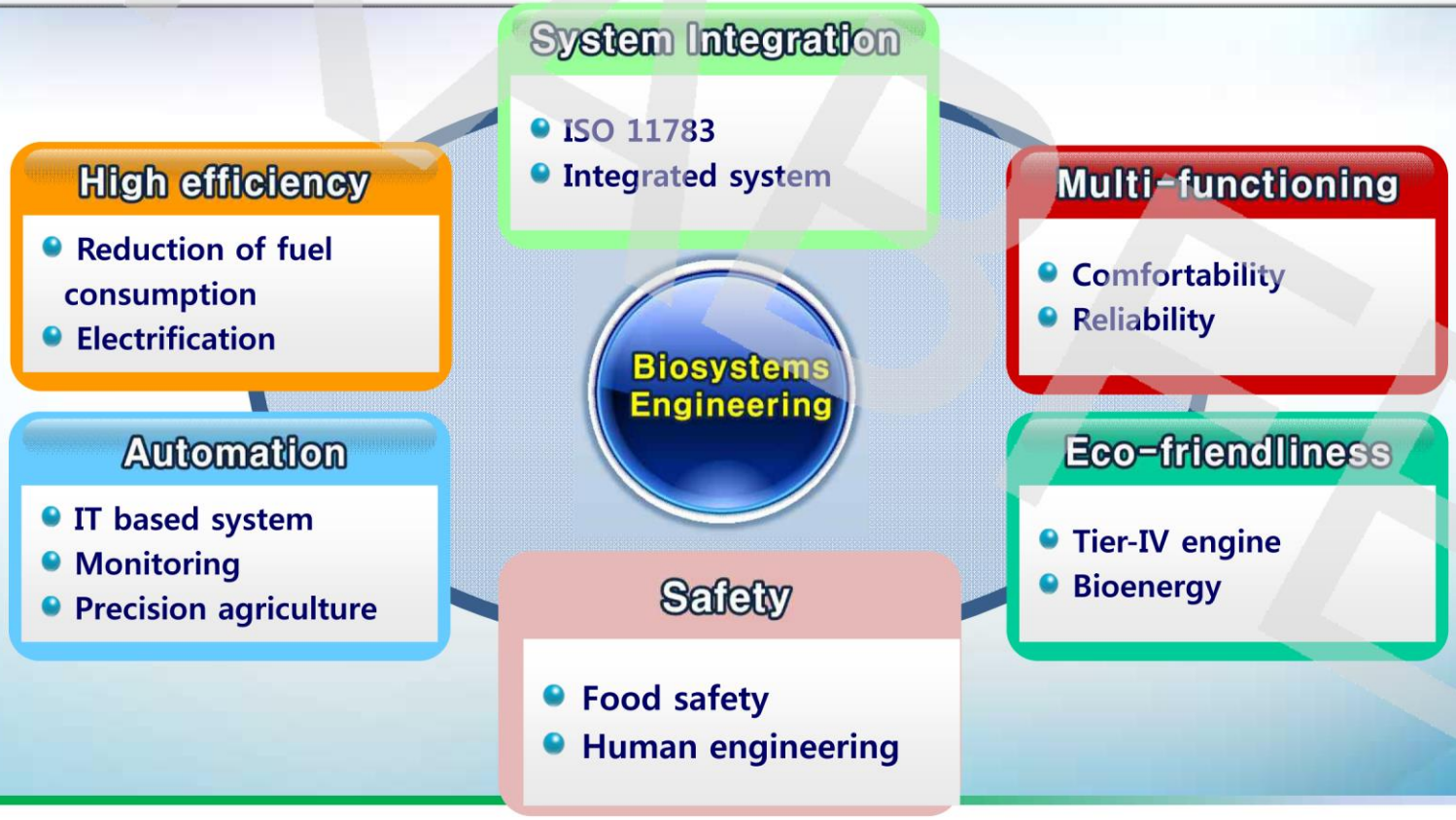




Mega Trends of BSE research

Mega Trends

- High efficiency (to minimize inputs and maximize outputs)
- IT based intelligent and robotic systems
- Engineering techniques for food safety and high value productions



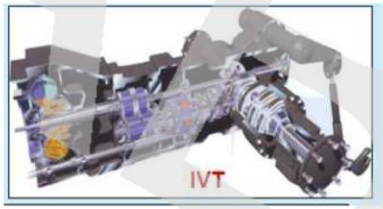
Power and Machinery

- Power systems for environmental conservation
- High efficiency transmission
- Engine and transmission control systems based on load sensing
- Human-machine interface cabin systems

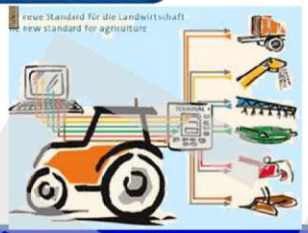
Tier-IV engine

- Green and clean engines

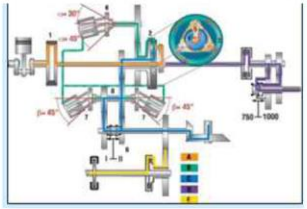
High performance PT



CVT



Load sensing



Integrated control

HMI

Power and Machinery

- Development of intelligent systems for agricultural machinery
  * Self diagnostics and repair system, Auto-steering system, Electronic control system for machine operations
- Precision agriculture applications
- Unmanned systems (farm robots)

PA applications

- Yield monitoring
- Use of drone

Smart ag-machines

Self-diagnoistics

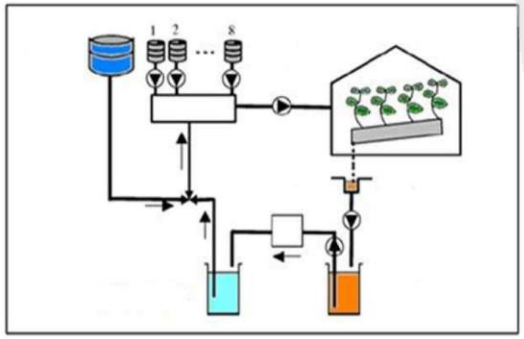
Auto-guided tractor

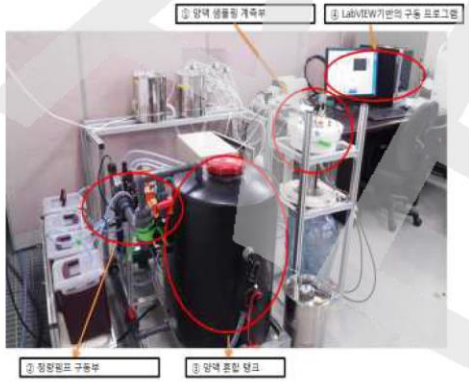
Task monitoring

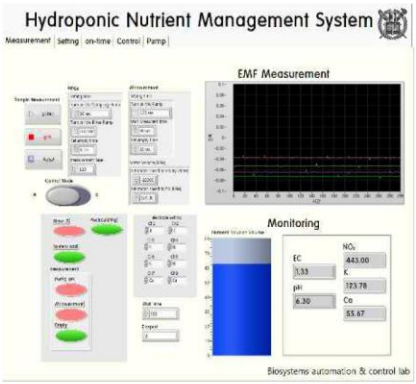
Agricultural Environment and Facilities

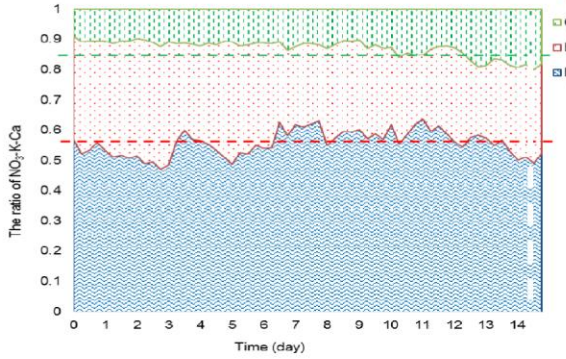
Engineering technologies for automated crop production systems

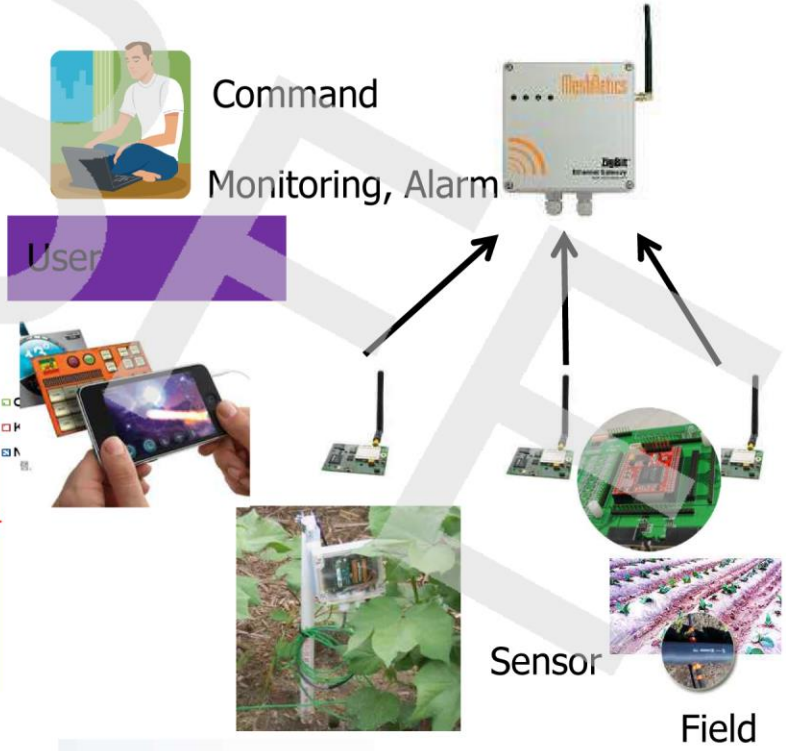
- Hydroponic nutrient management system
- WSN based precision irrigation system







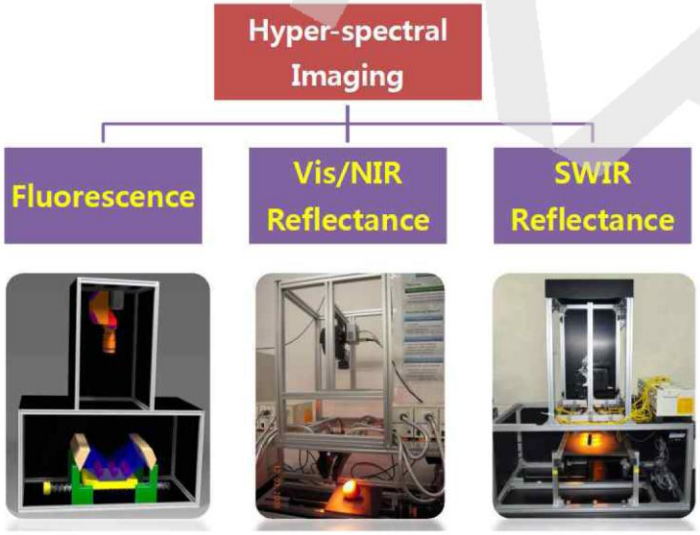




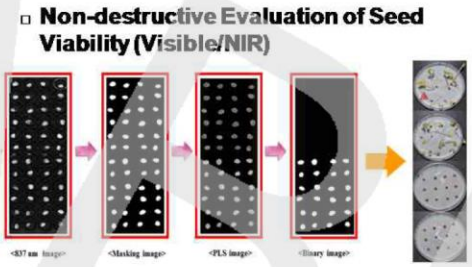
Physical Properties of Agricultural Products

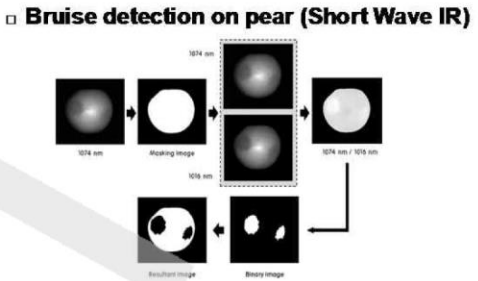
- Nondestructive Sensing & Quality Evaluation Techniques

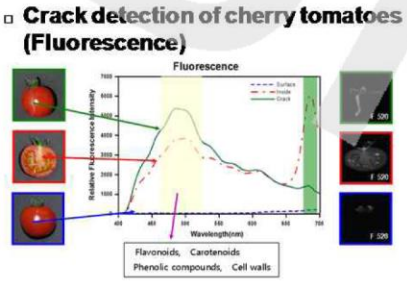
Hyper-spectral Imaging Technique

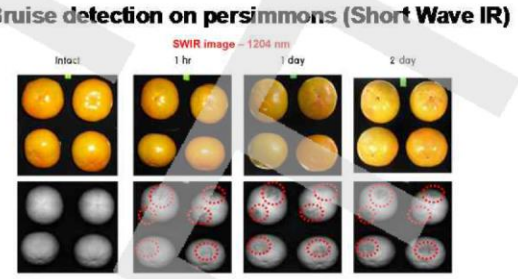


- Nondestructive sensing of seed germination capacity
- Bruise detection on fruit
- Moisture and fat chemical imaging for cooked meat
- Crack detection of cherry tomatoes







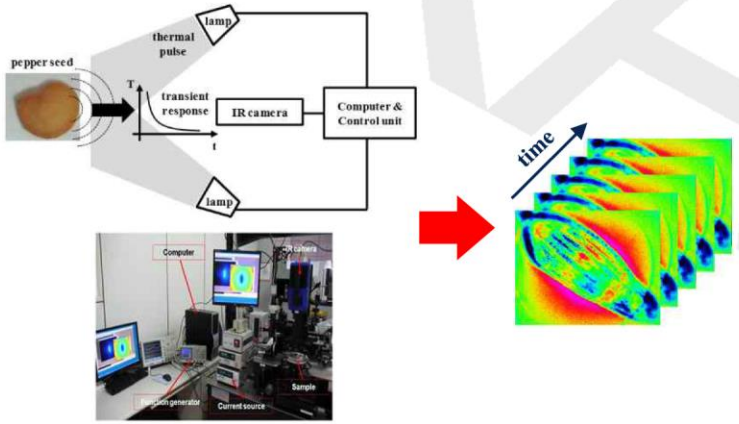


Physical Properties of Agricultural Products

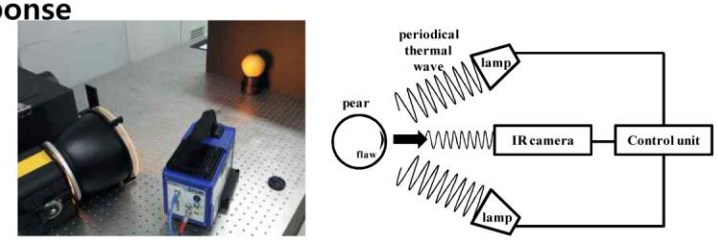
Nondestructive Sensing & Quality Evaluation Techniques

Infrared Thermal Imaging Technique

- Viability Evaluation of Seeds using Thermal Decay Characterization

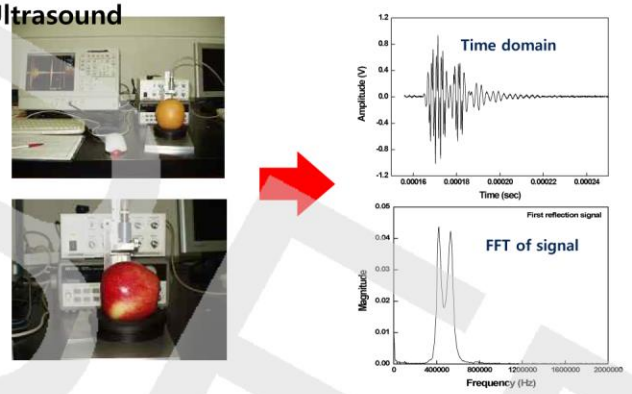


- Evaluation of Mechanical damage on Fruit using Thermal Response

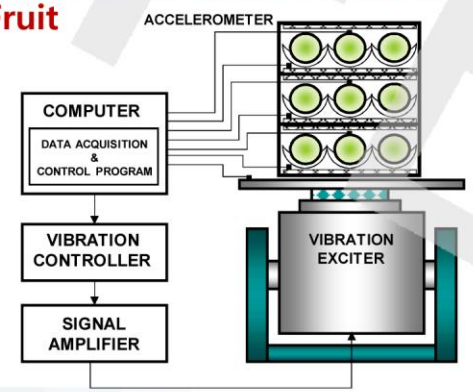


Ultrasound Technique

- Estimation of Bio-yield Strength of fruit using Ultrasound

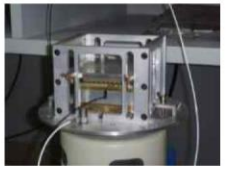


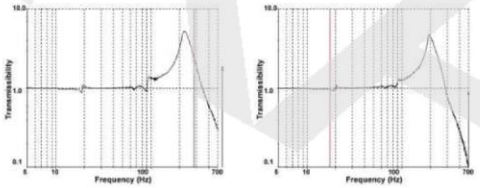
Vibration Characteristics Analysis of Fruit



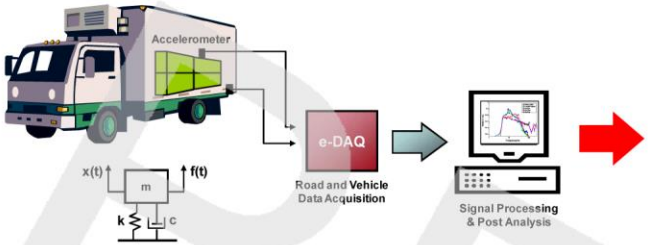
Post-Harvest Process Engineering of Agricultural Products

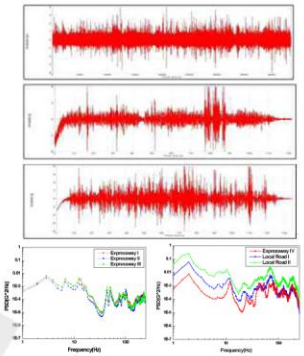
Vibration Transmissibility Analysis of the Corrugated Paperboard for Agricultural Products





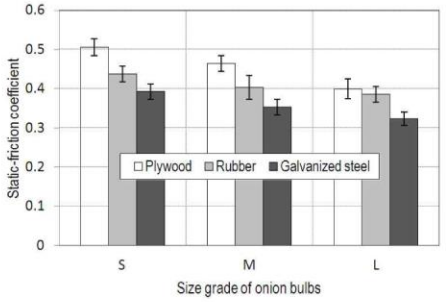
Distribution Environments Analysis of Agricultural Products



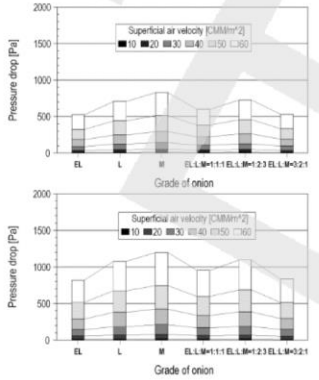


Post-harvest Bulk Handling Machinery System of Agricultural Products

▪ Friction Characteristics



▪ Airflow Resistance Characteristics



Current status of BSE area

Pros

- Diverse and Integrated ➔ Favorable to future students
- No of exported agricultural machines is increased ➔ Job market is still guaranteed
- Various engineering technologies applied to agricultural sciences

Cons

- Small market and less popular as compared to other industries
- No of BSE departments has been being decreased
- Difficulty to have students with high academic ability
- Limitation to have clear originality and identity
- Applications of BSE to livestock and food areas are not common

Directions for Korean BSE

1. Play an important role of keeping agricultural productivity growth to sustainably meet the demands of a growing world while decreasing the cost of agricultural productions

Directions for Korean BSE

2. Gain the global competitiveness of Korean agricultura machinery companies

➔ Continuing demands for students are made.

JOHN DEERE

AGCO
Your Agriculture Company

Kubota

daedong

LS엠트론

TYM 동양물산기업㈜

DK 국제종합기계

Directions for Korean BSE

3. Be more diverse and applicable to agricultural sciences ➔ BSE identity and originality are provided.

Conclusions

- Korean agricultural mechanization has played a important role in increasing the agricultural productivity.

- The number of Korean agricultural machines exported to other countries has been being increased, providing a potential to be an important industry next to the automobile and electronic industries.

- The new research areas of biosystems engineering conducted in Korea should be developed to be applicable to current Korean industry conditions.

Any questions?

감사합니다 !

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