Agricultural Engineering for Sustainable Agriculture in Korea

The 3rd. Technical Committee APCAEM/UNESCAP
at Beijing, China
20-21 Nov. 2007

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1. Situation in EFA

- Gradually reduced the chemical input since the 1995.
- The input of herbicide was not reduced.
- Animal manure was utilized as fertilizer
  - To compost manure : 88.8%,
  - Liquid purification : 7.3%
  - Others 4%
- Fertilizer production system
  - Among the livestock farmers 90% have
  - Active sludge or entrust treatment : 10%

2.2 Production and marketing of EFAP

○ Recent production of EFAP

Items	1999	2000	2001	2002	2003	2004	2005
Farms (1,000 houses)	1	2	5	12	23	29	53
Cultivation area (1,000ha)	1	2	5	11	22	28	50
Production (1,000M/T)	27	35	87	200	365	461	798

○ EFAP annually increased by 30 ~ 40%.

○ Trend of the EFAP will be increased in the future

○ The EFAP of the total agricultural products

- ('00) 0.2% → ('02) 1.1 → ('04) 2.5 → ('05) 4

○ The EFAP

- Crops ('05) : serial 12%, vegetable 41%, fruits 36%, special crop 11%
- Input ('05) : low chemical 61%, no chemical 30%, organic 9%

○ The EFAP is large items with small quantity

○ Marketing system : direct transaction, farmer and consumer EFAP specialized market system

○ Total scale of EFAP market : 780 bill. Won

○ The number of EFAP shops : more than 1,000 places,

The EFAP authentication system

○ EFAP authentication

- Organic agricultural products,
- Semi-organic agricultural products,
- No chemical input agricultural products,
- Low level chemical input agricultural products.

(EFAP authentication symbol)

The EFAP authentication procedure

- Request to Agricultural Quality Manage Office → consideration → letter reply → inspection of products at field and market → notify the results → authentication as a EFAP
- Authentication office
  - Nat'l Agricultural Products Quality Management Office
  - Private authentication office : 17 offices
- Effectiveness of authentication : one year.

3. Government policies for EFA

3.1 Target

- Reducing agri. chemical input by 40% till 2013
- Increasing the authenticated EFAP 10% of total
- To assure the farmer's income through EFAP
- Consumer's can buy EFAP with trust basis.

Table 2. EFAP production rate

Items	2005	2006	2008	2010
EFAP(1,000ton)	798	940	1,410	1,880
EFAP production rate of total(%)	4	5	7.5	10.0

3.2 Direction

- Natural recycling EFA ... harmonize the agriculture and environment.
- Supporting people's well-being life .... Quality and safety food
- Enhancement of agri. products' international competition
- Increasing farmers' income for EFAP production

- Contribution to the national environment conservation
  - Providing the people's relaxation space

4. Major supporting activities for EFAP

4.1 Supporting of EFAP production foundation

○ Supporting necessary facilities and equipment

- For drinkable water resource protection area
- For practicing the environment friendly agri. area

※ Involved in more than 10 farmers or 10ha

○ Establishment 1,500 area up to the 2013

- Current EFAP production area were 742 location

○ Support facilities and equipment

- Micro-organism propagation
- Organic resource production
- Agricultural by-products use composting
- EFAP production and marketing

4.2 Greenfield management in winter season

- MAF executed green field since 1998
- Cotents of project
  - Green manure crop … reduce the fertilizer
  - Forage crop ….cattle feed

Green field management area (1,000ha)

Items	2000	2001	2002	2003	2004	2005	2006
Forage crop	38	48	48	50	50	33	38
Green manure	46	67	78	75	66	105	138
Total	84	115	126	125	116	138	176

4.3 Environment friendly farming

4.3.1 Support of environment friendly farming

- Supplement the reduced farmer's agri. income annually
  - Help the farmer's uncertain crop yield
  - Extending the practicing EFF

4.3.2 Execution of EFAP project

- EFAP authenticated farmers/farmers group.
- Request in spring at district office
- Farming area : less than 5ha
- Type : organic, semi-organic, no chemical use, low input chemical
- Duration : 3 years

4.3.3 Supporting EFA related farming materials

- Organic fertilizer
  - Support polish for chemical fertilizer had abolished ('05)
  - Support of purchasing cost for organic fertilizer.

Supported quantity of organic fertilizer

Years	2004	2005	2006
Quantity (M/T)	600,000	700,000	1,200,000

4.4 Establishment on foundation of natural recycling agri.

4.4.1 Establishment of EFA zone

○ Constraint in management of the manure

- Animal farms are not even proportion in geographically
- Transportation cost is too high.
- Disposal of the manure to sea should be stop by 2012

○ Establishment of EFA zone

- Nature's ecological function by materials recycling
- Helping crops growth and raising animal's healthy
- Linkage of EFA zone within river flow line and regency

※ The area will renew to natural recycling, EFA zone

4.4.2 Executing program

- ○ Duration : 2005 ~ 2013 (9 years)
- ○ Scale of work : total 50 zone
  (each zone area has 1,000ha)
- ○ Work plan
  - 2005 : work models, management program etc.
  - 2006 : 3 unit as the model
  - 2007 ~ 2013 : establishment of 6 ~ 7 zone every year
- ○ Support items
  - Cultivation and livestock resource recycle centers
  - Environment friendly machine & equipment, production facility
  - Agri. and livestock production & marketing facility
  - On-site marketing and sightseeing facility

4.5 Animal manure resource development

4.5.1 Situation

○ Due to livestock big scale …… increase the manure
- Animal manure : (‘80) 35.8 → (’00) 47.8 → (’05) 50.6mill. ton

○ Manure composting → fertilizer resource

4.5.2 Executing program

○ Supporting the resource reuse facilities for livestock farmers'
- Support facilities : (’02) 1,700 ea. → (’06) 1,700

○ Establishment of manure resource reuse facilities
- Established 43 "ALMFDC " up to the 2005
- ALMFDC have pumping, transportation, application equipment
- Construction of liquid manure container : 428 ~ 800 ea. /yr

○ Organic livestock : animal raising standard were established

4.6 Expedited production of EFAP and marketing

- ○ To enhancing the consumers' confidence
  - – Strengthening the education and information for EFAP
  - – Education on EFA for farmer
  - – On-site field visit tour for urban consumers'
  - – Advertisement for EFAP authentication symbol.
- ○ Supporting direct marketing : Agri. Coop, related organization
- ○ Suggestion to join on EFAP by local Agri. Coop.

5. Agricultural Engineering for EFA energy

5.1 situation

○ Enacted national energy utilization rationalization law('02)

- The law No. 4 → national energy basic plan
- Plan suggested the 5% by new & renewable energy
- Detailed plan and executing necessary action

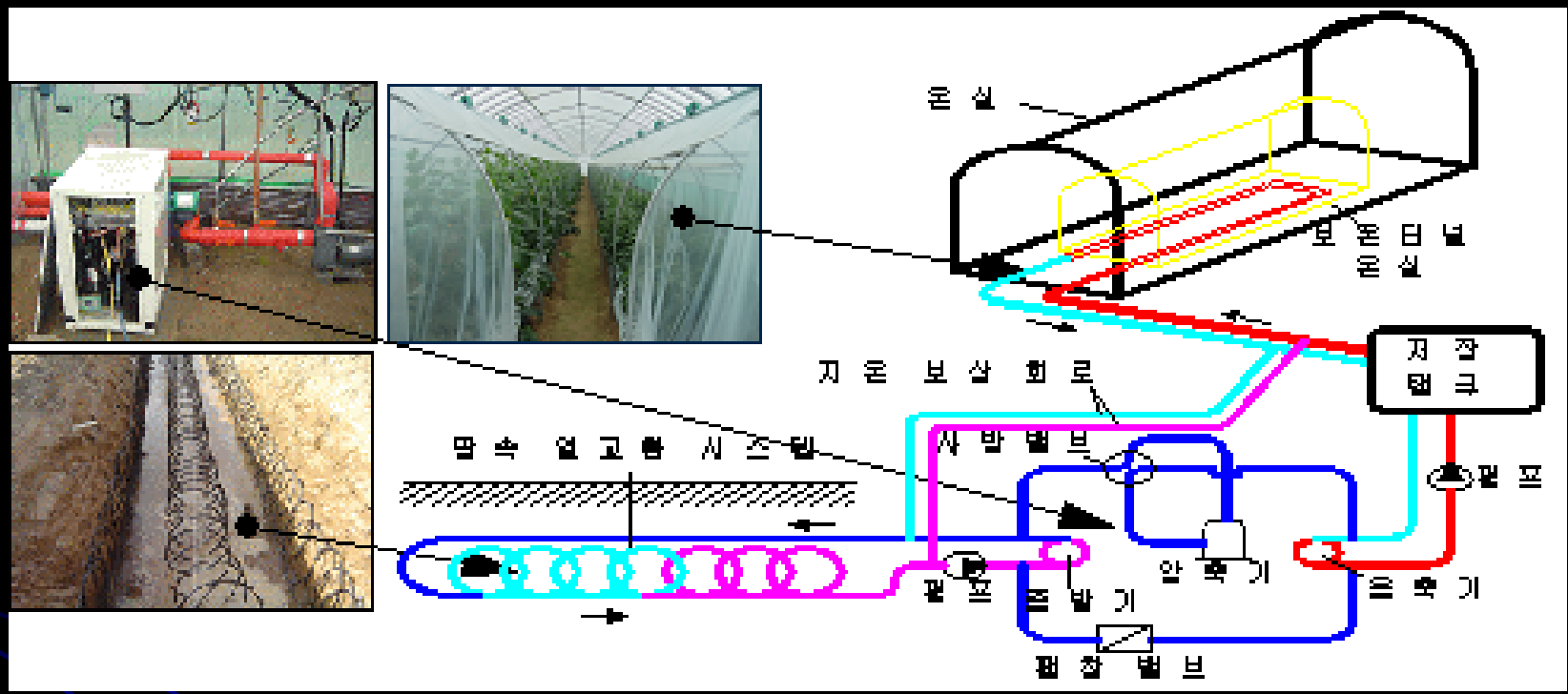
○ Agri. energy : 2,690 thous. ㎘/yr (40% by greenhouse)

○ Bio-fuel crop → impact the food crop production system

※ Renovation of agri. structure in future technology

5.2 Development of energy reduction technology

- Multi-layer thermal curtain system → save fuel 46%
- Coal bunt warm air heater → save heating cost 42%
- Center operated inside tunnel → save heating cost 60%
- Heat recuperator for heater → reduced heating cost 10%
- Geo-thermal using heat exchanger with heat pump
  → effective in heated greenhouse



Multi-layer thermal curtain system

※ save heating fuel 46%

Coil tube hot water heat exchanger

1) Heat exchange capacity is 409kcal/3.3m3┌h
2) Coil system can move easy

Natural air drier-cum-low temperature storage bin

1) increased germination rate of 12%
2) Decreased the cracked rate 11%
3) 28% higher the value add

Exhaust heat recovery system for warm air heater

1) Heat recuperator reduced heating cost 10%

Exhaust heat recovery system for agri. products drier

5.3 Development of bio-energy technology

○ R&D for bio-gas electricity generation plant

- National Institute of Agricultural Science and Technology
- National Institute of Livestock

bio-gas electricity generation plant

○ R&D for bio-diesel

Rape seed seeding in autumn

Rape harvesting in spring

Field adaptation test for mechanized rape seed production

1) Performance of rape seed combine : 2h/ha
2) Harvesting loss : 2%

6. Natural recycling agricultural system in livestock

6.1 Adoption of animal manure treatment system

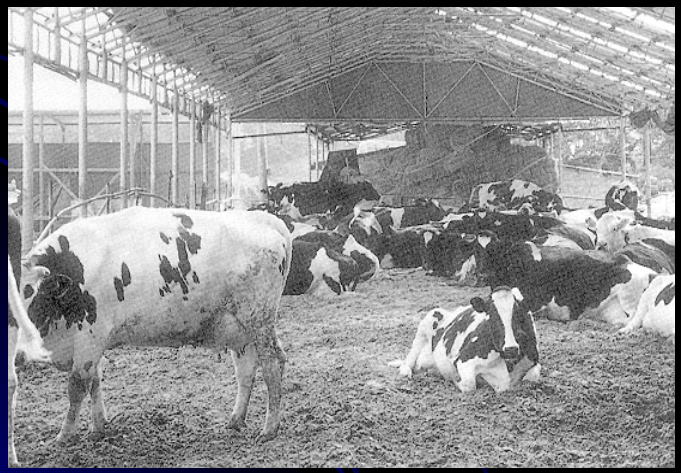
- ▽ Cattle farms → use sawdust in animal stall
- ▽ Broiler farms → use sawdust in chick house
- ▽ Laying hen → drying manure and conveying by belt
- ▽ Pig farm → much difficult technically and high costly

Animal liquid manure purification with active sludge

Animal raising method and manure delivery

Laying hen cage – fan, belt

Broiler house – loader



Dairy shelter – loader

Piggery house – slurry

6.2 Animal manure composting fermentation-drying system

▽ Fermentation-drying composting station
▽ Fermentation media : sawdust, wood chip, rice husk,
▽ Forced aeration fermentation with mixing device

Rotary type animal manure fermentation ┌drying system

1) Types : escalator, rotary, screw type etc.
2) High in initial investment cost

□ Liquid manure storage-fermentation-spreading system

○ Liquid animal manure storage-fermentation

Liquid manure storage container
1) Capacity : 200 ~ 500㎥

Offensive odor emitting facility

Animal manure storage tank sediment cleaner

○ Liquid animal manure field application

Subsurface liquid manure injector

Surface liquid manure injector

Hose drawn manure spreader

Slope land use manure spreader

7. Green field management movement

7.1 Cultivation of mechanized forage crop

▽ The second crop in paddy field during winter and spring

▽ Whole crop barley make wrap silage for cattle feed

"green field management movement" in winter

Harvesting of whole crop barley

Wrapping of whole crop barley

7.2 Mechanized cultivation of green manure

- ▽ Reduction of chemical fertilizer input in rice field
- ▽ Growing green manure crops : Chinese milk, hairy vetch, sorghum

Chinese milk

Green manure treatment for Sudan grass

8. Precision agricultural system

▽ Technologies developed

- Bio-environment measurement : soil sampling, soil strength, crop growing condition, yield monitoring for rice
- Mapping software to create electronic maps
- Variable rate fertilizer application system

▽ Soil strength : physical property → hard-pan detection, tillage etc.

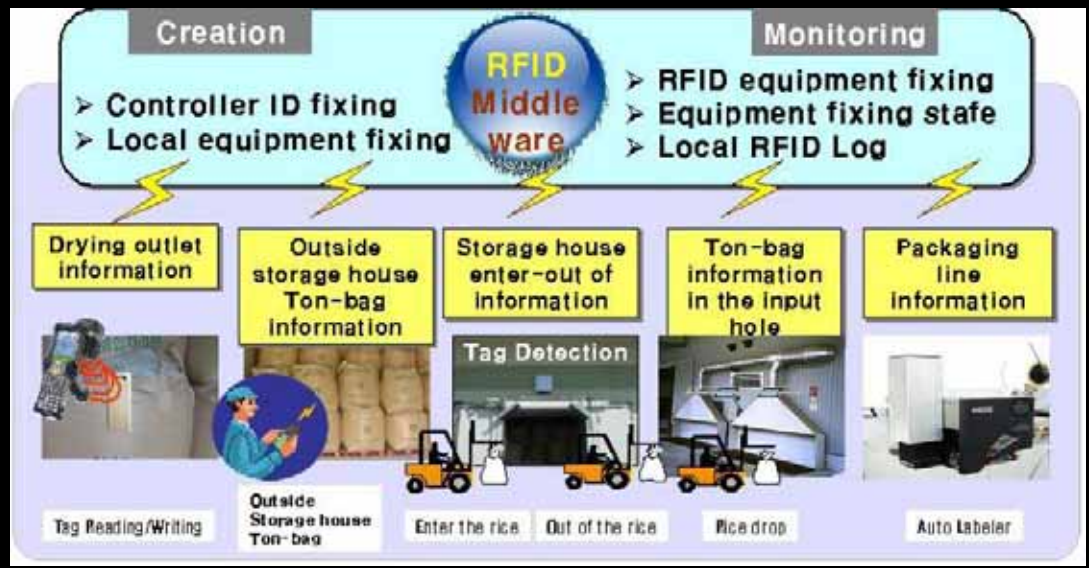
Soil strength measuring system

Yield monitoring system

Map-based variable fertilizer applicator for transplanter

1) Save 17% of the conventional fertilizer

Fertilizing map



RFID use rice production history system

9. Agriculture production machinery

9.1 Weeding machine for rice field

Weeding machine for rice field

1) Weed control 97.2% for machine planted
2) save 94% of weeding labor

9.2 Paper mulching rice transplanter

- ▽ Environmental friendly work .... no uses herbicide
- ▽ Prevention of weed growth by paper mulching
- ▽ Bio-degradable paper decomposed after 60 days

Paper-mulching rice transplanter

1) Weed control value of 98%

9.3 Strip tillage rice transplanter

Strip-tillage rice transplanter

1) Reduction of miss-planted rate
2) Save fertilizer about 20%

9.3 Partial tillage direct seeder

Partial tillage rice direct seeder

1) Reduce the 50% of the fuel
2) Work performance of 3.8h/ha at 0,5m/s
3) Working cost can reduced 23%

9.4 Pesticide & insecticide minimized spraying system

Electrostatic speed sprayer

1) Coverage rate of droplets was 22% at 7.5kV

2) Reduced the chemical solution 10.6%

10. Agricultural products safety

10.1 Agricultural products cleaning

▽ Applicable : tomato, apple, fresh green perilla leaves, etc.

▽ Removal residue : dust, earth, pesticide

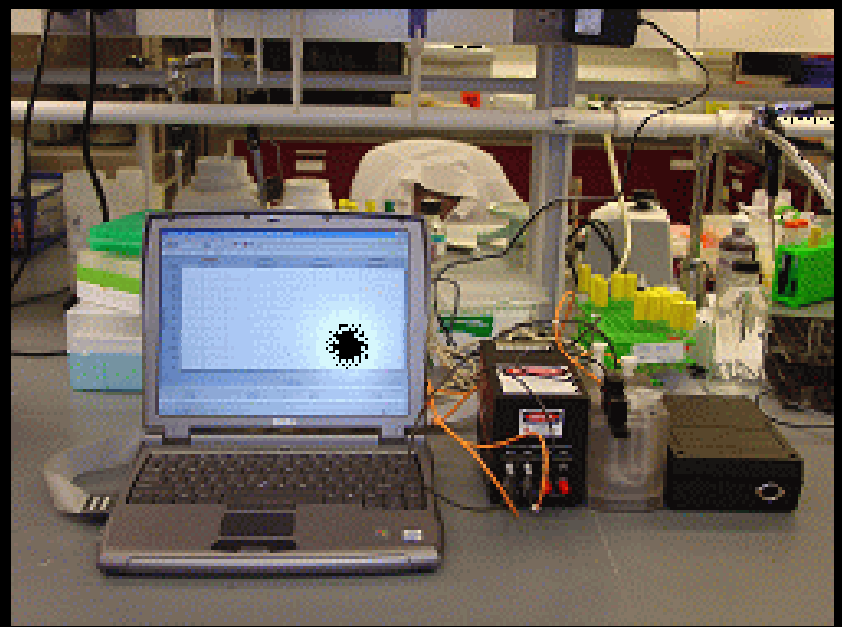
▽ Effect : eat without wash, long time storage

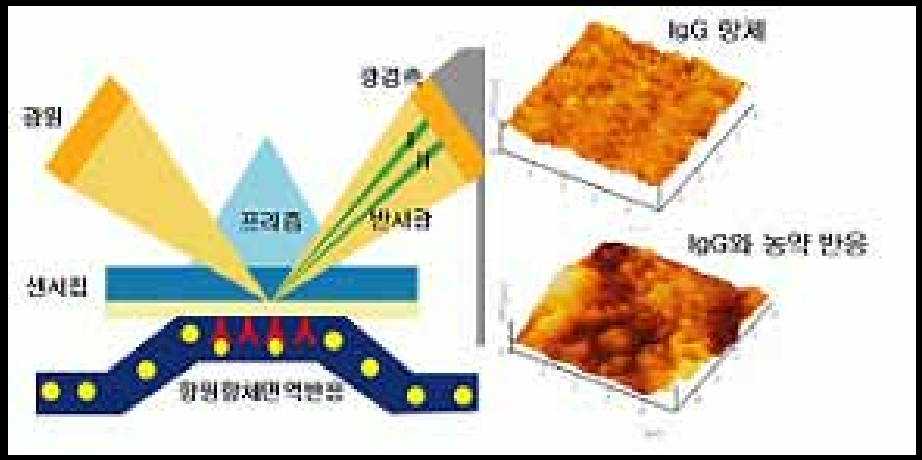
Cleaning system for leafy vegetable

10.2 Gems and agricultural chemical detecting

- ▽ Discrimination of improper ingredients in agricultural products
- ▽ Sensor and detection system
  - Fiber-optic biosensor for Salmonella detection
  - Surface plasmon resonance sensor for **pesticide** detection
  - Image processing detection : foreign objects.

Fiber-optic bio-sensor for Salmonella detection





SPR bio-sensor for pesticide residue detection

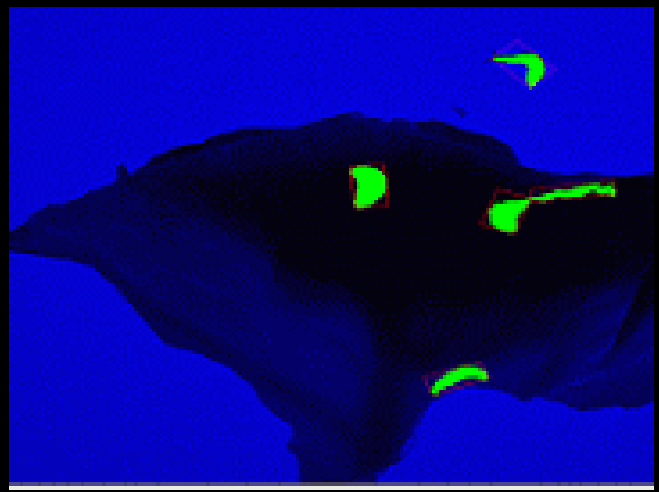


Image processing use detection of foreign objects

<사진제공 : 사이버농업홍보관>

Thank you for your attention