

International Seminar on Restructuring and Strengthening Research &
Development for Agricultural Engineering

Research & Development for Agricultural Engineering in Korea

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❑ SITUATION OF AGRICULTURE

Total land area : 9,965ha

Cultivated land : 1,824 thous. ha
paddy 61%,
upland 39%

Cultivated land per farm household : 1.43 ha

Import of agri. & livestock products : 9,758 mill. US\$

Export of agri. & livestock products : 2,072 mill. US\$

● Agricultural production

○ Major crops cultivated

- Grain : rice, soybean, barley
- Special crops : sesame, peanuts, mushroom
- Horticulture : red pepper, garlic, onion, flower
- Orchards : apple, pear, grape, orange, peach

○ Livestock

- Native cattle 1,819,000 heads
- dairy cattle 479,000 "
- Pig 8,962,000 "
- Chicks 109,628,000 "

● Farm household economy

(Thous. Won)

Year	1980	1990	2000	2005
Farm household income (A)	2,693	11,026	23,072	30,503
Agricultural income	1,755	6,264	10,897	11,815
Non-agricultural and transferred income (B)	938 (34%)	4,762 (43%)	12,175 (52%)	18,687 (61%)
Farm household debt	339	4,734	20,207	27,210
Rural wage (male, Won/day)	6,509	18,563	48,039	58,955

Note : 1 US\$ equals to around 1,000 Won

● Farm population and farm occupation (thous. %)

Year	Total population	Farm population	Farm occupation
1980	38,124	10,827 (28.4)	3,723
1990	42,869	6,661 (15.5)	3,100
2000	47,008	4,032 (8.6)	2,203
2005	48,294	3,433 (7.1)	1,747

□ Situation of agricultural Engineering

● Ownership of major agricultural machinery (unit : ea.)

Items	1980	1990	2000	2005
Power tiller	289.8	751.2	939.2	819.6
Tractor	2.7	41.2	191.6	227.9
Rice transplanter	11.1	138.4	341.9	332.4
Reaper binder	13.7	55.6	72.3	60.0
Combine	1.2	43.6	86.9	86.8
Power cultivator	-	50.7	378.8	382.8
Grain drier	1.6	17.7	55.6	70.4
Speed sprayer	1.2	4.9	28.9	38.8
Warm air heater	-	-	127.6	186.2
Agri. products drier	-	59.4	164.5	184.1

※ Agricultural machinery yearbook KAMICO 1985, 1999, 2006

● Mechanized farm operations in crop production (2004)

Rice production		Up-land crop production	
Farm operation	Mechanized (%)	Farm operation	Mechanized (%)
Land preparation	99.1	Land preparation	97.4
Transplanting	98.4	Planting & transplanting	2.5
Harvesting	99.4	Vinyl mulching	39.6
Drying	53.2	Pest controlling	88.8
Pest controlling	99.5	Harvesting	99.4

● Labor input hours in animal husbandry

(unit : h/head, year)



Items	Beef cattle	Milking cow	Growing pig	Laying hen	Broiler chick
1995	106.5	202.8	15.1	94.2	20.7
2005	54.9	93.1	1.3	29.2	0.9

❑ **Recent situation in agricultural engineering**

○ **Reduced farming labor**

- Farm labor has changed to aged farmers
- Rural society faced the shortage of farm labor
- Increase the farming cost

○ **Overcoming int'l competition of products market (DDA, FTA)**

○ **Reduces agri. products' post-harvest loss (around 25~30%)**



○ **Farmers' desire in farming**

- Easy operation of machinery
- Safety operated machinery
- Suited to Korean farming condition
- High performance agricultural machinery
- Alternative energy resource development

○ **Agricultural facilities' damages from natural disasters**

- Heavy rain, strong wind and heavy snow falls



○ **Rising international crude oil price**

– 23.8 \$/barrel (2002) → \$ 61.6 (2006)

○ **Consumers' desire**

- Quality agricultural products
- Safety agricultural products
- Low price of agricultural products



❑ **PROGRESS OF R&D FOR AGRI. ENGINEERING**

○ **In the 1980s**

- Release the seasonal labor peak
- Power tiller implements
- Tractor implements



○ **In the 1990s**

- Glasshouses and PC houses
- Rice Processing Complex
- Machine vision use fruits grading
- Low temperature agri. products storage system
- Rice direct seeding



○ **In the 2000s**

- **Environment friendly agricultural products**
- **Optimized fertilizing precision farming**
- **Products quality improvement processing**
- **Farm operation robots**

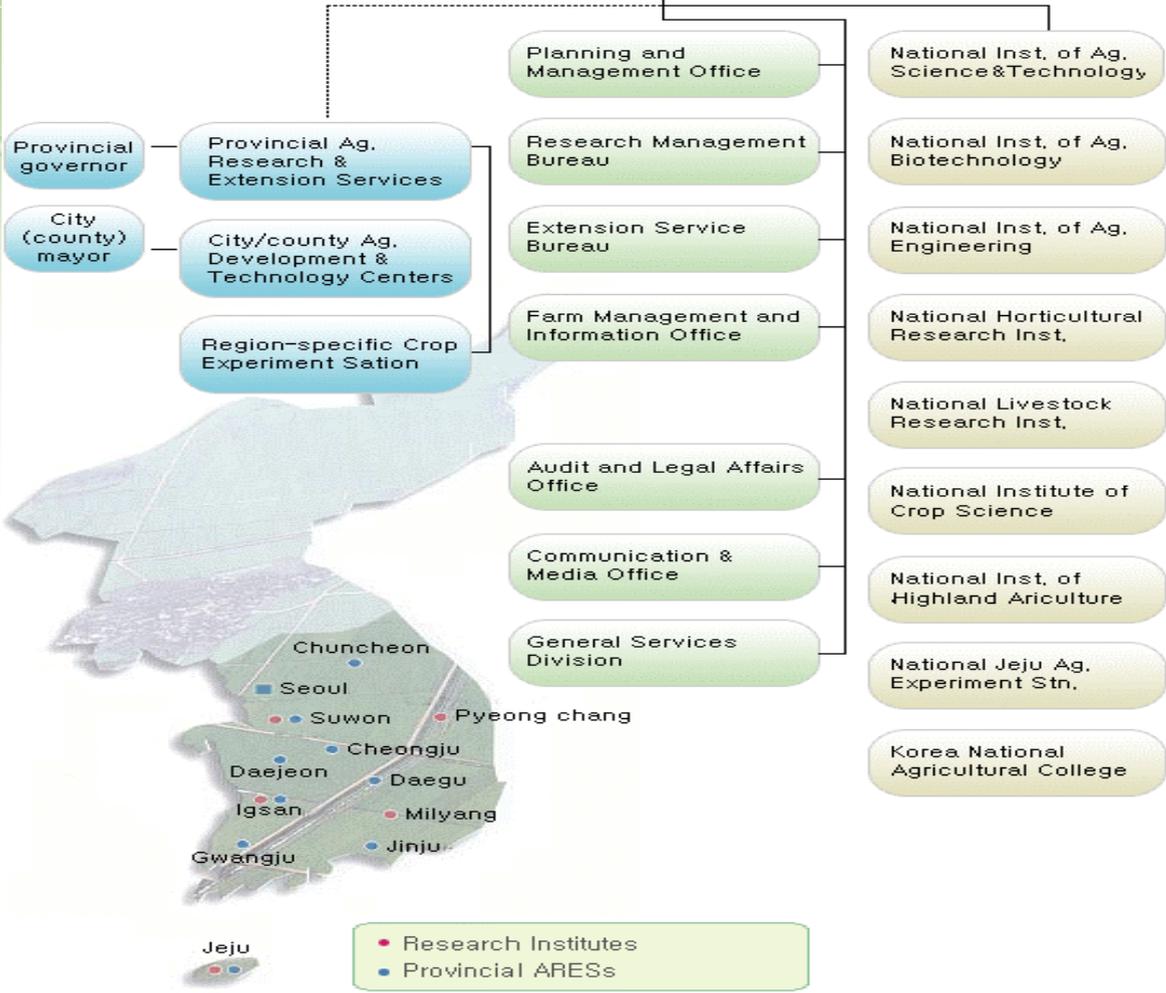
□ RDA and Affiliated Institutes

○ Activities

- Research and development of agricultural technologies
- Dissemination of agricultural technologies and extension services
- Quality control of fertilizers, pesticides,
- Agricultural mechanization
- Training for rural development and home improvement.

RDA

Rural Development Administration



Major R&D Activities of NIAE



Brief History

1962 **Founded as Institute of Agricultural Engineering and Utilization, RDA**



1979 **Established as NAMRI, RDA**

1994 **Extended Functions to the Testing and Evaluation of Agricultural Machinery**

1995 **Assigned as OECD Agricultural and Forestry Tractors Testing Institute**

1999 **Appointment as Chief Secretary Institution of the ISO Agricultural Machinery**

2004 **National Institute of Agricultural Engineering**

Functions



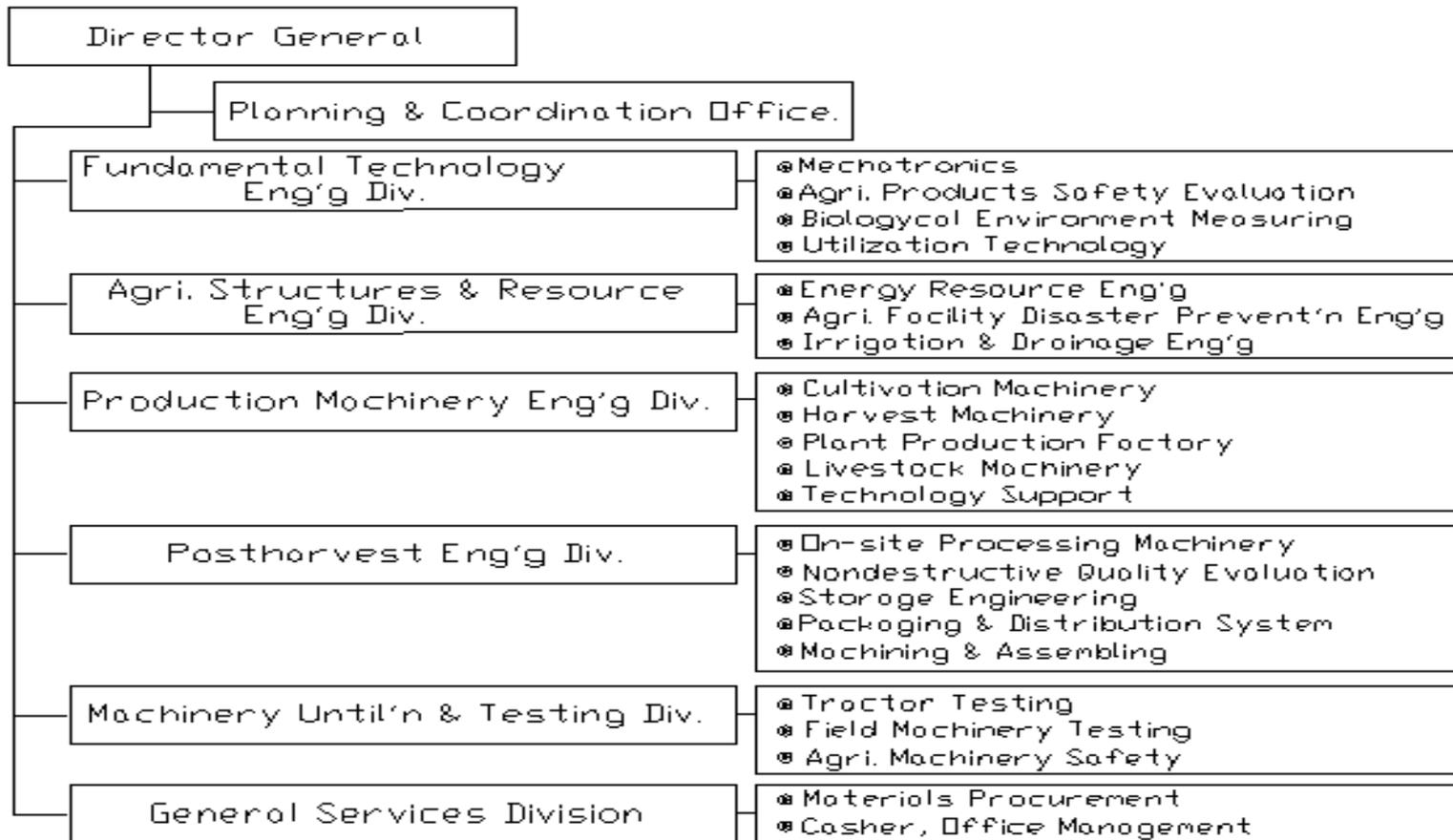
Research for promoting agricultural engineering

- ❑ **Technology Development for High Efficiency and Automization in Agricultural Operation**
- ❑ **Development, Improvement and Promoting Practical Use in Agricultural Machinery**
- ❑ **Mechanization Technology Development for Postharvest Management**

Testing and evaluation of agricultural machin

- ❑ **Inspecting Performance and Safety of Agricultural Machinery**
- ❑ **Testing OECD Tractors**

Organization

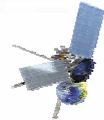


Personnel : 117

(Researcher 77, Engineer 3, Technician 30, Administrator 7)



Fundamental Technology Engineering Division



Research and development of automation and robotize of farm operation, agricultural products safety evaluation technology, biological environment measurement and information technology, development of agricultural machinery utilization and safety accident prevention technologies are the major R&D area

Mechatronics Lab.

❖ Research area are bio-mechatronics, farming robot and farm automatic grafting robot for fruit vegetable, environment control system of bio-reactor for culturing tissues, autonomous tractor and strawberry harvest robot are under developed.



▲ Control technology which operates farm vehicle monitoring remote image through internet

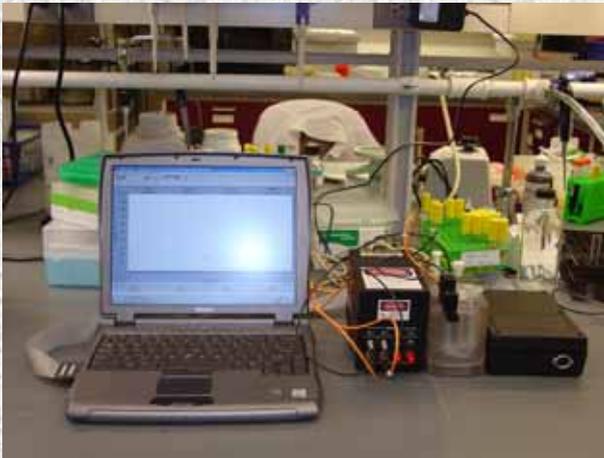


▲ Grafting machine which can automatically carry out the series process such as cutting, joining, clipping, discharging for grafting gourd family vegetables

◀ automatic washing device of vessel in plant tissue culture. It is 2 types for triangle flask used to laboratory and for cylindrical vessel used to farm

Agricultural products safety evaluation Lab.

❖ This laboratory specializes evaluation technologies of agricultural products safety. Main research areas are rapid detection of foodborne pathogens and detection of chemical residues in agricultural products by using up-to-date sensor technologies, such as biosensors, surface plasmon resonance sensor, and sensor array. A fiber-optic biosensor for Salmonella detection has been developed. Currently, we are developing an impedance biosensor for Salmonella detection and a surface plasmon resonance sensor for pesticide detection



▲ Fiber-optic biosensor for Salmonella detection

▼ Impedance biosensor for Salmonella detection



Bio-environment & information Lab.

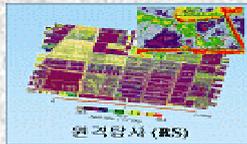


❖ Conducts research on engineering technologies for precision agriculture to address and manage the within- and inter-field variability and optimize inputs on a point-by-point basis to improve profitability and to reduce possible environmental damage using various state-of-the-art technologies such as GPS, GIS, RS, and IT. On-going projects focus on soil sensors for major physical and chemical properties for optimum soil management and a production information acquisition system for agricultural traceability.

저투입 친환경 정밀농업 개념도



도량정보 (센서기술)



원격탐사 (RS)



행적정보 (센서기술)



위치별 수확량 측정



원격 모니터링 (정보통신)



변량 작파, 이앙·사비



병해충 예찰 및 정밀방제

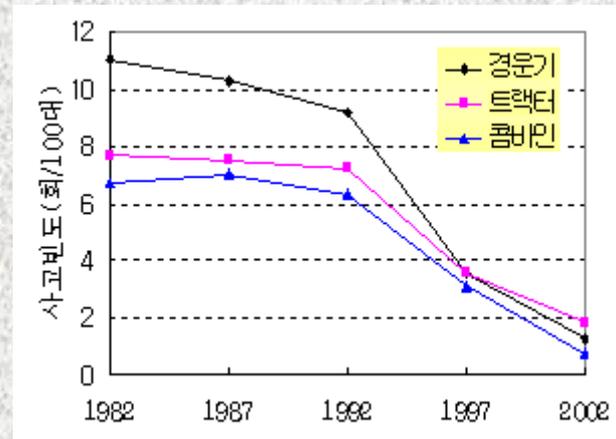


최적 의사결정 (GIS)

Utilization & Management Technology Lab.

Estimating long-term and short-term demands for agricultural machinery, developing mechanization models by crops and farm sizes, determining standard mechanized cultivation models, collecting and offering information for agricultural machinery and investigating machinery utilization status, by which the laboratory produces effective machinery utilization schemes and produces agricultural mechanization policy materials.

▼ Publications for efficient and safe use of agricultural machinery



▲ To prevent accidents related to farm machinery, analyzing the cause of accidents and publishing materials for farmer training and government support



Agricultural Facilities & Resources Engineering Division

Development for natural disaster damage reduction technology for agricultural facilities, agricultural energy saving technology and new and regeneration energy utilization technology, mechanization on bio-diesel raw material production, water management and rural environmental engineering technology.

Energy & Resources Engineering Lab.

❖ Area researches on energy saving and efficient use, upgrading of energy saving agricultural facilities and machinery, utilization technology for alternative energy such as solar, geothermal and wind energy etc. and recycling and energy conversion technology for biomass and livestock manure etc. Recently conducted projects are automatic rolling shutter for greenhouse thermal tunnel, orchid farm use dehumidifier, geothermal heat pump system and greenhouse use coil tube heat exchanger for hot water heating.



▲ Dehumidifier for produced horticulture

▼ Automatic rolling shutter for opening and closing of greenhouse thermal tunnel



Agricultural facilities & Disaster Prevention engineering Lab.



Accomplishment of the Engineering research for mechanical analysis, stress and strain analysis by FEM, durability test of agricultural structures and machines, and the design of optimum environment control system for greenhouses, livestock facilities by airflow analysis using computational simulation methods.

▼ Technical research to prevent deep snow disaster of agricultural structures



▲ The wind tunnel testing building for airflow analysis of agricultural structures

Irrigation & Drainage Engineering Lab.

Area researches on irrigation and drainage for efficient water management, design of environment friendly agricultural land infrastructure for land plots, small streams, farm loads etc. Currently being conducted a soil moisture content control technique in paddy field for paddy and upland rotational land use system, automation of irrigation and drainage control of paddy field, and water leakage decreasing through levee for paddy field.

- ▼ Automatic irrigation quality measuring device with long term battery

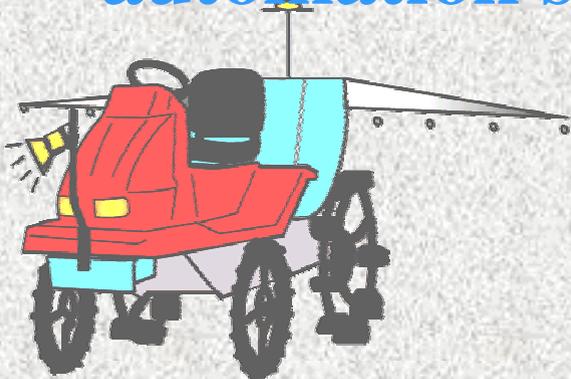


- ▲ Development of diversion gate with long term durability and ergonomic design



Production Machinery Division

Development of integrated mechanization on land preparation, planting and transplanting, crop tending, harvesting operation, and development of automation system on greenhouse and livestock.



Crop Cultivation Machinery Lab.



researches on the development of crops seeding, planting and transplanting machinery. For the crops cultivation machinery, fertilizer application, vinyl and paper mulching, weed controlling, pest controlling machinery. Recent activities of development are rice direct seeder, garlic planter, vegetable transplanter for chinese cabbage and red pepper, paper mulching device for rice transplanter.



▼ Weed control in rice field by paper mulch rice transplanter

▼ The partial tillage rice transplanter can achieve partial tillage, rice transplanting and fertilizing by one operation



Harvesting Machinery Lab.

- The lab. conducts the development of harvester for grain crops, vegetables and fruit. The chinese cabbage harvester, spinach harvester, root and bulb crops such as carrot, sweet potato, potato and garlic harvesters are being developed



◀ A garlic digger mounted on tractor that can harvest seed garlic produced from bulbils or regular garlic bulb

A electric-powered Leek harvester that cuts one row of leek and collects the leek plants in the harvesting box ▶



Plant Production Factory Lab

The laboratory aims to develop machine technique for reducing cost and labor in agricultural work and to study plant production factory system to produce a high quality horticultural crop all the seasons of the year



▲ Plant production factory system with nutrient management automation system, greenhouse control system, row-spacing system

▼ Steam sterilization system for sterilizing horticultural growing media made by farmers



Livestock Machinery Lab.

- Researches on the development of forage production equipment, automatic control of animal raising system and animal manure treatment machinery. Recent activities of development are slaughter animals' transportation vehicle, internet network use chicks weight and environment monitoring system, chicks' feeding and egg laying monitoring system. As the environment friendly researches are animal liquid manure well fermentation apparatus, animal manure sediment cleaning machine for liquid manure container as well as mushroom substrate material composting - sterilization machine for oyster mushroom growing.



- ▲ The improved slaughter pig's transportation shelter adopted side air inlet with roof exhaust system, and the shelter can reduce the pig's stress and offensive odor.

- ▼ The substrate material fermentation and sterilization machine for oyster mushroom can reduce the drudgery on mushroom substrate production farm operations from water wetting work to fermentation and pasteurization.





Postharvest Engineering Div.

Researches on development and improvement of technologies for physiology control, maintaining and improving the commodity value, management for freshness and safety from harvest to consumers' table.

Development of machines, equipments and integrated system has been focused on pre-cooling, cold storage, washing, cutting, drying, sorting, packing,.

On-site Processing Machinery Lab.

Researches are development of horticultural products' on-site processing for trimming, washing, peeling, slicing, drying to improve the agricultural products' quality, cost saving and value adding.

▼ A system for cleaning fresh lettuces leafy vegetable system



▲The calyx-remover for sliced dry redpepper

Storage Engineering Lab.

Researches are controlled atmosphere storage, precision cold storage, pre-storage treatment and automatic storage environment control for stable supply of fresh, high-quality and safe agricultural products. Automatic measuring device of rice constituent contents, environmental control device for cold storage house using mobile phone were developed recently.



◀ Paddy rice storage dryer



▲ Environmental control device for cold storage house using mobile phone

Nondestructive Quality Evaluation Lab.

Researches are rapid internal and external quality evaluation of agricultural products using the NIR spectroscopic analysis, image processing, acoustic wave, NMR, X-ray. Nondestructive quality evaluation system for apple, pear, peach, red pepper and tangerine developed were commercialized. Recent activities are nondestructive quality evaluation machine for water melon, portable real-time sensor for quality evaluation of sugar content, maturity of fruits at orchard and market.



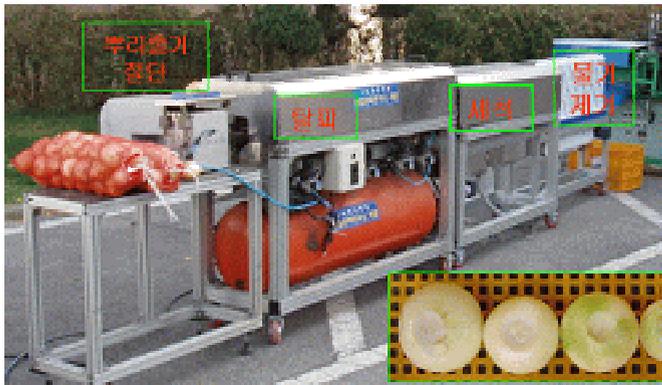
▲ Nondestructive quality evaluation system for watermelon



▲ Portable quality evaluator that can measure the sugar content and maturity of fruits rapidly at orchard and supermarket.

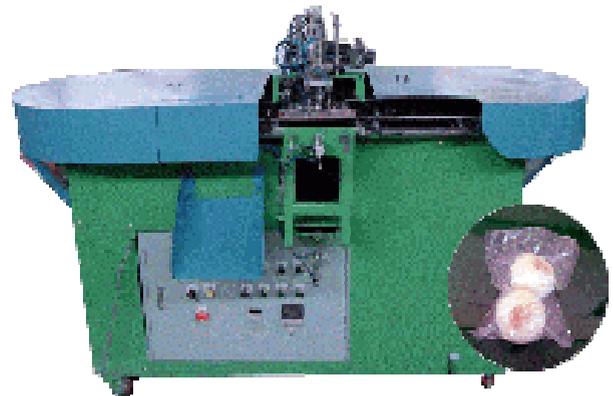
Packing & Distribution system Lab.

Researches one step mechanization system on Agricultural products Packaging Center (APC) for safety distribution of agricultural products with fresh and high quality, environment friendly packaging materials for agricultural products. Currently the one step mechanization system that have functions of pre-processing, sorting, washing, packaging for onion and cucumber etc. as well as the distribution and management system using RFID mobile application technique were being developed.



▲ Full mechanization system for onion peeling, washing and packaging

▼ Nozzle type vacuum packaging machine for peeled onion



Machinery Utilization & Testing Division



Management of customer fitted agricultural machinery testing & evaluation system, and development of agricultural machinery safety level evaluation technology.

Tractor Testing Lab.

Tractor's testing laboratory is carrying out the functional check of motor vehicles for agricultural work that are tractors, power tiller, cultivator, engine and etc. and is developing the testing method and the evaluating criterion of agricultural machinery. Also, Research on part standardization of agricultural machinery is carried out.



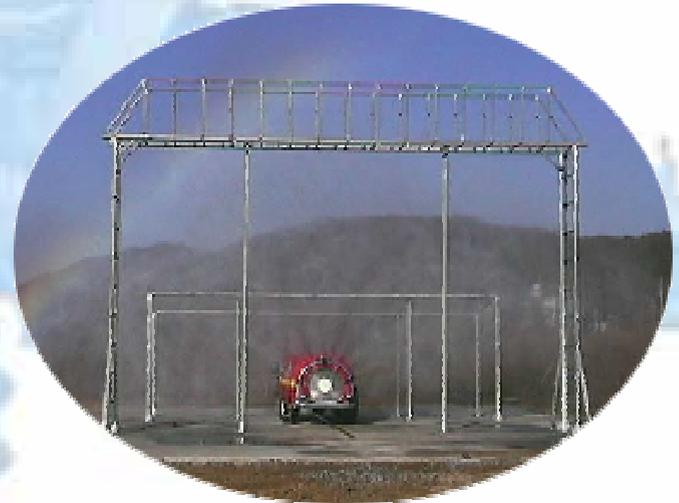
▲ Overall PTO performance of agricultural tractor such as power, torque, speed, fuel consumption, and specific fuel consumption is tested

Field Machinery Testing Lab.

Performance and safety aspects of Agricultural machinery for tillage, harrowing, transplanting, pest control, harvest, transportation, livestock production, green house, drying, grading, sorting etc. are tested.



▲ Performance test of combine harvester



▲ Measurement of droplet coverage of speed sprayer

Safety Testing Lab.

Test on machinery for post-harvest, green house and livestock

- Dryers, separators, agricultural heaters and coolers, etc.

- Forage harvesters, forage mixers, bailers, etc

▼ Executing the ROPS test and FOPS test for evaluating the protective structure of agricultural machines. Test is performed by the local test code or international test code(OECD test code, ISO standard, EU directive, ASAE standard.)



▲ Executing the turn-over test of off-road vehicles. The inspection of turn-over angle is performed by the local test method.

❑ Management of Research Procedure

Demand survey for research project

Needs from related sector

- Origin from researchers' project
- Government organization
- Requested from extension offices
- Agricultural related organizations
- Manufacturers
- Farmer's crop / animal study groups
- Universities
- Consumers



Review Seminar for research project

at Lab. → Division

- Project proposal
- Presentation with power point
- Discussion within lab.
- Related researchers

Research project planning meeting by research area (January)

- Consideration by
- Outside consultants, farmers



Mid-term management meeting for research project (July)

- Consideration
- Guidance of work direction
- Outside consultants, farmers



Final evaluation meeting for the research project (November)

- Evaluation of project
- Outside consultants

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● Type of Research Projects

1. Own research projects by NIAE

A. Ordinary research

- Laboratory conducting project under long term research
- The research implemented within the laboratory
- Chief of lab. has responsibility for the project.

B. Cooperative research within NIAE

- For on-site solving problem
- Short term research for the 3~5 years
- Cooperative project with the other laboratories



A. National Strategy Technology Development Project in RDA

- Facing new circumstance in the country and abroad
- Special tasks oriented
- Practically use oriented
- Wide range subject's combining conclusion project
- Cooperative research among institutes involved in
- Basic science & technologies practical application project



B. Regional specified technology development

- For local circumstance adaptable technology
- Local on-site task solving project
- Local technology's propagation project
- Development of local agricultural technology
- Supporting provincial RDAs and local specified crop experiment station



C. Agricultural Specific Research

- Development of agricultural fundamental technology
- Application of agricultural fundamental technology
- Provided R&D budget for universities, government institutes and private institutes.

D. International Cooperative research

- Cooperative research between overseas institutes
- International research institutes, universities

● Industrial Use of Technology Developed

**Design & manufacture
of prototype by NIAE**

- Research activities

**Manufacture of practical
machine by NIAE**

- Order made semi-commercial
machine

**Farm adaptation study,
by County ATDC**

- Practical use in farms
- More than one farmers

**Improvement of machine
by NIAE**

- Improvement of machine,
repeated testing in field

**Contracting technology
transfer
NIAE to manufacturers**

- Technology transfer to
manufacturers
(Receive industrial properties
fees)

**Commercial production
by manufacturers**

- Production of machinery
- Dissemination of machinery

**Utilization of
technologies for farmers**

- Reduce the labor input
- Helping farmers economy





● **Management of R&D results**



Research results consideration meeting in NIAE



Reviewing the research results in NIAE



Research results deliberation meeting in RDA



Proposal to relative Organization in RDA

● R&D characteristic by financial resource

○ NIAE : 1~10 years

- Individual researches
- Cooperative researches within NIAE and outside

○ Rural Development Administration : 1~5 years

- Cooperative researches among institutes under RDA

○ Agricultural R&D Promotion Center : 1~3 years

- Cooperative researches among universities, institutes and manufacturers

○ Korea Standard Association : 1 year

- Standardization of agricultural machinery parts

● Utilization of R&D Budget

○ **Materials cost**

- Experiment materials purchase
- Prototype manufacturing

○ **Labor cost**

- Assistance worker
- Temporary hired labor for conducting research

○ **Travel cost**

- Business travel for researchers,
- Local and overseas.

○ **Stationery and printing cost**

- Stationery
- Printing material cost.

❑ Extension Service for technology developed

● Farm adaptation study for technology -1

○ Purpose

- Promotion of machine adaptability in field
- Improvement of machine performance
- Easiness of machine use, and machine durability

○ **Financing** : annually 280 mill. Won (NIAE + RDA budget)



● Farm adaptation study for technology - 2

○ Institutions involved

- NIAE : donation of machine, consulting
- ATDC (county agri. extension center) : guidance
- Farmers group : Crop Cultivation Group

○ Evaluation meeting

- Demonstration : machine use farm operation in the meeting
- Evaluation : questionnaire by participated farmers
- Farmer's opinion : suggestions on improvement factors

○ Machine use after evaluation m/t : more than one years



□ Impact Committed By R&D

● Utilization of R&D outcome



○ Technology transfer

- Technology transfer contract with manufacturers
- Commercialization of new machine

○ New farming technologies

- Deliver to extension office
- For farmer

○ Propose the mechanization policy

- Suggests to MAF
- Execution of agricultural mechanization policy

○ Information activities

- Mass media : news paper, TV, radio broadcasting
- Time : during the evaluation M/T and local demonstration

● Impact of R&D committed -1

○ Labor reduced easy farming

- Vegetable transplanter : 6.5 times higher than manual
- Stone picker : only 1/30 in comparison with the manual
- ※ Aged farmer can extending the working age

○ Save the agricultural production cost

- Vegetable transplanter : saved the cost by 85%
- Stone picker : saved the stone picking cost by 71%
- ※ Helping farmer's living economy

○ Environment friendly farming

- Pursues food safety and environmental conservation
- The products receives higher income : 50% higher price
- ※ Farm operations : paper mulching, power weeder etc.

● Impact of R&D committed -2



○ Hygienic agricultural products can adding value

- Dust, earth and pesticide chemical free
- Germ free fruit and vegetables storage more longer time
- Hygienic agri. products changes value added commodities
 - ※ Washed apple receives higher price in market.

○ Thermal energy reducing will saving money

- Products drier's heat exchanger reduces energy by 14.3%
 - ※ Reducible 17,500kL/yr in Korea, if the device adopted 30%
- Reducing CO2 gas emitting : mitigating global warming.

Thank you!

