Driving Strategies and Mechanical Technologies for Conservation Agriculture in Korea

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Outlines

1. Goals of environmental friendly agriculture in Korea
2. Strategies to foster environmental friendly agriculture
3. Technology development for conservation agriculture
4. Various mechanical technologies for CA
5. Conclusions



Policy for environmental friendly agriculture in Korea

Goals of environmental friendly agriculture in Korea

◆ Estimated over-applied fertilizer for paddy rice production (as of 2002)

Component	Recommended rate (kg/10a)	Applied rate (kg/10a)	Over-applied rate (kg/10a)	Over-applied ratio (%)
Nitrogen	11.0	14.8	3.8	25.6
Phosphorous	4.5	6.4	1.9	29.7
Potassium	5.7	7.3	1.6	21.9
Total	21.2	28.5	7.3	25.7

Goals of environmental friendly agriculture in Korea

- Reduction goals for chemical fertilizer and pesticide application

	2003	2005	2008	2010	2013
Rate per ha (kg/ha)	(100%)				(60%)
- Chemical fertilizer	375	374	290	260	225
- Pesticide	12.4	11.8	10.1	9.1	7.4

Goals of environmental friendly agriculture in Korea

◆ Goal of environmental friendly agricultural products

(Unit: thousand ton, %)

	2005	2006	2008	2010
Environmental friendly products (A)	798	940	1,400	1,850
Total agricultural products (B)	18,800	18,700	18,600	18,500
Ratio (A/B)	4	5	7.5	10.0

Strategies to foster environmental friendly agriculture in Korea

◆ Production area

□ Establishment of nature circulation type agriculture linking sowing and livestock farming

○ Environmental friendly organic livestock product: increase to 1% out of total livestock product by 2010

□ Stabilization of farmers' income through increase of EFA direct payment unit cost

○ Expansion of environmental friendly livestock farming direct payment to 20% of total registered livestock farming by 2013

□ Establishment of whole year production system through support of EFA technology and material

○ Expansion of insect control through natural enemy to 50%(50,000 ha) of the protected horticulture by 2013

Strategies to foster environmental friendly agriculture in Korea

◆ Distribution area

□ Reduction of distribution cost by construction of distribution center dedicated for EFA products

□ Control of supply-consumption by self-reliance fund for EFA products, activation of publicity

□ Rearing of 30 regional production-distribution base organizations, diversification of distribution channel

Strategies to foster environmental friendly agriculture in Korea

◆ Consumption area

□ Publicity extension of EFA products, improvement of reliability through after-service control

○ Introduction of recall system for entire EFA products by 2010

□ Security of large-volume demand of EFA products (e.g., school meal supply)

□ Groping a way for foreign export of EFA products

Strategies to foster environmental friendly agriculture in Korea

◆ System area

□ Modification of EFA certification system (e.g., revision of EFA fostering law)

○ Abrogation of low-pesticide certification by 2010

□ Transfer of EFA certification to private organization, rearing of private certification organization

□ Expansion of traceability system on a full scale for EFA products

○ Operation of full scale traceability system for organic farming household by 2008

Strategies to foster environmental friendly agriculture in Korea

◆ Agricultural material area

□ Introduction of verification and management of environmental friendly agricultural material (EFAM) (Rural Development Administration, RDA)

□ Analysis of characteristics and effects of EFAM

□ Establishment and operation of laws for management and utilization of livestock waste (or manure)

Strategies to foster environmental friendly agriculture in Korea

◆ Technology development area

□ Technology development and extension by RDA and research groups

○ Development and extension of EFA standardized technology necessary in the farming fields

□ Resource-making of livestock manure, development of environmental friendly pesticide control technology

□ Development and expansion of processed food using EFA products

Strategies to foster environmental friendly agriculture in Korea

◆ Local agriculture area

- □ Achievement of nutrient balance for regional unit field and reinforcement of agricultural environment resource management
- □ Promotion of urban consumers' experience of EFA and interchanges between urban and rural societies
- □ Encouragement of participation of local government (e.g., by awarding an EFA prize)

Technology development for conservation agriculture

Precision agriculture (PA) in Korea

◆ Precision agriculture technology development

- Soil strength sensor

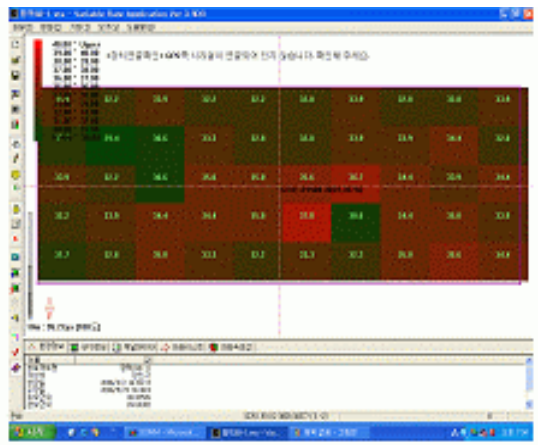
  - measures soil strength, an important soil physical property
  - for hardpan detection
  - and optimum tillage
  - mechanically and reliably

Digital soil strength sensor

◆ Variable rate technologies

- Motor control type by P.W.M
- The unit uses positioning information (e.g., GPS)
- Electronic fertilization application map prescribed by soil testing results
  - to apply fertilizer variably by location (cell size : 7.2m × 10m)
- Save 17% of the conventional fertilizer application amount without yield loss.

Map-based variable fertilizer applicator attachable to a transplanter



Fertilizer application map by mapping S/W

Obstacles and perspectives for Korean PA

- Korean PA is in the stage of basic technology development and on-farm performance test, but for practical application and confirmation of the positive effects, expansion of understanding on PA and development and improvement of Korea-specific application models.
- Conceptual approach is more important than technical approach in PA. Instead of simultaneous and full scale application of entire technology, it would be better for Korean agriculture with small sized paddy rice fields to start with application and verification of each technology and expand step by step based on the bio-environmental information.
- Through these application strategy, Korea, the most over-applying country of chemical fertilizer and pesticide, would reduce the amount of fertilizer and pesticide application and contribute to sustainable agriculture for production of environmental friendly and safe agricultural products.

Soil erosion prevention technology

◆ Status of soil erosion in Korea

● Annual soil loss up to 485 MT/ha in upland fields using the USLE (Universal Soil Loss Equation).

▪ Soil loss from different cropping system by lysimeter study on a sandy loam with 20% slope

Cropping system	Annual soil loss(MT/ha year)	
	First year	2nd to 5th year
Clean tilled	209	112
Corn	108	43
Upland rice	64	43
Barley-soybean	53	27
Barley-Sweet potato	39	14
Grass	67	1

◆ Status of soil erosion in Korea

- Nutrient loss from corn field measured

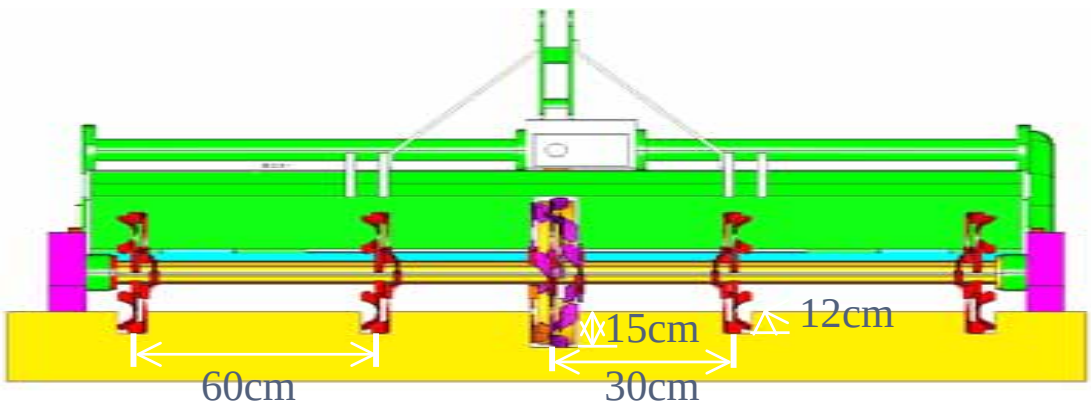
		Soil management practice	
		Contour	No till
Nutrient loss By runoff(kg/ha..year)	N	15.5	14.0
	P_2O_5	10.0	3.9
Soil loss(MT/ha.year)		21.5	8.2

- Tillage system is critical to prevent soil erosion
  - no-tillage for soil conservation save 62% of soil erosion and 32% of nutrient loss.

Soil erosion prevention technology

◆ Strip-tillage equipment to reduce soil erosion

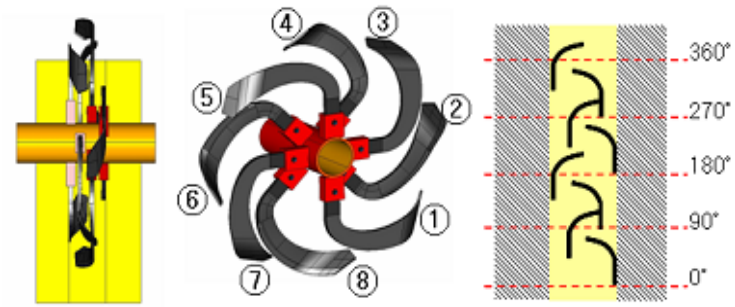
- Till only strips to be seeded and the rest of the field covered with chopped rye to reduce soil erosion
  - have 8 fodder-chopper type rotary tillage blades
  - the row width, tillage depth, and row spacing : 8, 12, 60 cm



Strip-tillage equipment

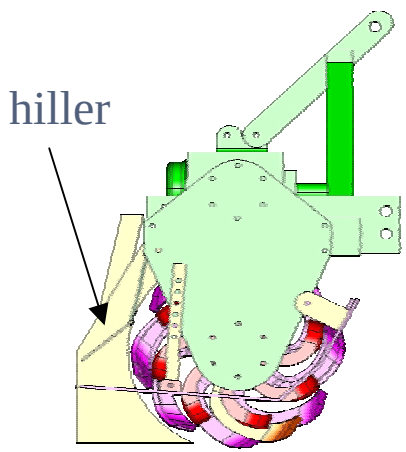
◆ Strip-tillage equipment to reduce soil erosion

- Tillage blades of strip-tillage equipment



Top view/ Isometric view/ Sequence of soil cutting

- Rotary tillage blades is arranged inwards direction
  - scattered soil is gathered in the seeding furrow



◆ Strip-tillage equipment to reduce soil erosion

- Experimental fields

Conventional tillage (up & down)

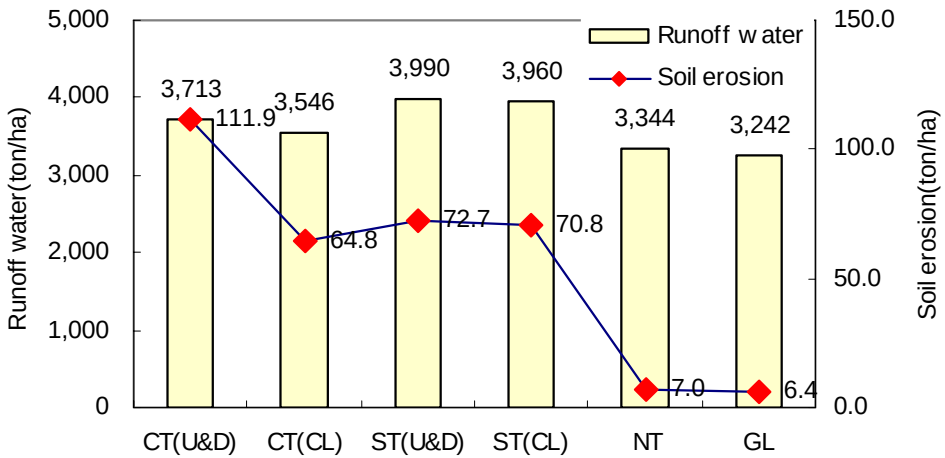
No-tillage and conventional tillage(contour line)

Strip-tillage(contour line)

Strip-tillage(up & down)

◆ Strip-tillage equipment to reduce soil erosion

● Amount of runoff water and soil erosion by tillage methods



(CT: Conventional tillage, U&D: Up and down, CL: Contour line,
ST: Strip-tillage, NT: No-tillage, GL: Grassland)

● Strip-tillage along contour lines caused soil erosion of 70.8 ton/ha, which was 37% less than 111.9 ton/ha for conventional tillage in the up-down direction

Various mechanical technologies for conservation agriculture

Weeding machine for rice production

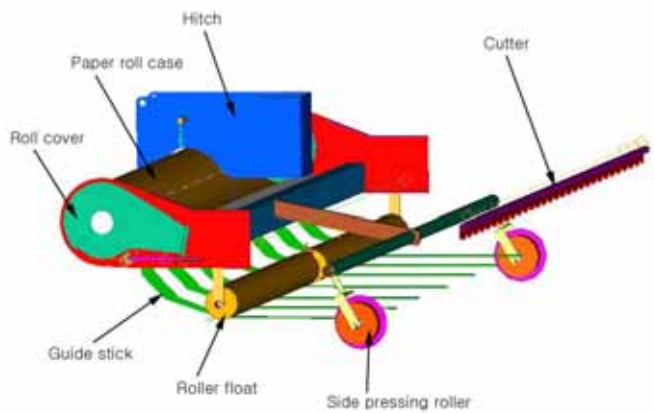
- A walking type 3-row weeding machine for environmental friendly rice production.
  - remove and root out weeds inter- and within- rows
- Adjust operating width : from 18 to 24 cm according to weeding time
- Field capacity : about 10a/hour.
- Showing a rate of weed control : 97.2%
- Save 94% of weeding labor, and is suitable for EFA with no use of herbicides.

Weeding machine

A paper-mulching rice transplanter

- To grow rice in an environmental friendly way
  - by preventing weed growth using paper mulching material, instead of herbicides
  - Weed-preventing mulch paper : PES, 10 ㎛
  - bio-degradable paper was decomposed naturally in 55~60 days after transplanting
- Weed control value : 98%
  - rice yield was 502 kg/10a, with no significant difference from 504 kg/10a for conventional transplanter

A paper-mulching rice transplanter



A paper-mulching device

A strip-tillage rice transplanter

- The unit save tillage energy by till only the strips
- Increase fertilizer utilization by applying slow-release fertilizers
  - in front of strip-tillage blades and covering the slow-release fertilizer with soil.
- Sufficient irrigation for 10 ~ 20 days before transplanting
  - resulted in reduction of miss-planted rate
- Increase of rice yield (about 7%), and save fertilizer application by about 20%

A strip-tillage rice transplanter

Manual & automatic type inlets and outlets for water management in paddy field

- Gates make flow and water level control easier, reduce amount of irrigation water
  - Gate type : Manual, Automatic
- Soil loss was minimized by drain starting from surface water
  - by adjusting rotational angle of the elbow pipes.
- Irrigation water be saved with prevention of water leakage
- Prevent a field levee breakdown by controlling water level automatically
- Water leakage reduce : 12% (manual type) and 93% (automatic type)

Automatic type inlet

outlet

Water proof material to reduce water leakage through the levee and weed growth

- Water leakage through field levee was reduced by installing water proof material
  - water proof material : tarpaulin sheet
- The material is installed to a 20 cm depth in the field side
  - To save levee fall and 75% of water leakage
  - Weed appearance was reduced significantly for levees

(a) No treatment plot (b) Water proof material treatment plot

Weed growth status

Conclusions

● Korea has been continuously promotes environmental friendly sustainable agriculture with well-developed and detail policy and goals since mid-1990. It is planned to reduce application of chemical fertilizer and pesticide by 2013, and also to expand certified environmental friendly agricultural products gradually by increasing area and number of farming household practicing EFA.

- To achieve these goals, Korea established promotion strategies by area and 7 core projects.

● Korea is trying to develop basic technologies for precision agriculture, as an alternative way for EFA, and suitable implementation model for Korean situation.

Conclusions

- Precision agriculture differs from organic agriculture that do not use any chemical agricultural materials, but is expected to settle as a low input sustainable agriculture, because of practical aspect that precision agriculture conducts scientific agriculture using sensors and machinery, which is also suitable for large-sized farming.

- In addition, mechanical technology developed or under development for Korean conservation agriculture includes a strip-tillage equipment to reduce soil erosion, a weeding machine and a paper-mulching rice transplanter to prevent and remove weed without herbicides, a strip-tillage rice transplanter to save energy and fertilizer application.

Conclusions

- And irrigation gates to manage water and water proof materials to reduce water leakage and weed occurrence were also developed. various technologies have been developed and applied to farming for conservation agriculture.

- With these continuous development and distribution of policy and technology for conservation agriculture, Korean agriculture is becoming more environmental friendly and sustainable.

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