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Status of Secondary Crops in the Republic of Korea*

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Agricultural statistics of the Republic of Korea

The Korean economy is dynamically changing in the 21st Century and agriculture is also changing greatly. The gross national product (GNP) per capita of Korea increased from US$ 5,833 in 1990 to US$ 18,372 in 2006. However, the unemployment ratio also increased from 2.4 to 3.5 per cent. Agricultural gross domestic product (GDP) was 21,736 billion Won, only 2.6 per cent of total national GDP. The number of people employed in agriculture was also lower at 3,304,000 persons down from 14,442,000 in 1970. This corresponds to 6.8 per cent of the total Korean population.

Many factors have negatively affected Korean agriculture. In the late 1990s the International Monetary Fund (IMF) damaged the Korean economy after many investors reduced their investments in Korean industries. Increases in production costs were caused by high land and energy prices. Also, farming became unprofitable due to low consumption of agro-products – an effect of the depressed economy. The former government adjusted policies to lay the foundation for strong agricultural recovery. The vitality of rural communities suffered because of a rapid decline in rural population.

The closing of schools, and poor education facilities forced farmers to abandon their homes and leave rural areas. Insufficient amenities in rural areas hampered the welfare of low-income earners, the aged, and female farmers; and poor cultural and medical conditions limited rural settlement. As a result: rural labour quality rapidly deteriorated; the proportion of aged farmers increased drastically; and ever widening income disparity, emerged. Farmers over sixty years of age increased from 17.8 per cent in 1990 to 40.7 per cent in 2006, and younger farmers aged in their twenties decreased from 31 per cent in 1990 to 6.8 per cent in 2006.

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Unprofitable farming increased and aggravated the income gap between rural and urban households. Agricultural income slowly increased while non-farming income rapidly increased. Ultimately, the ratio of farm and urban household income widened from 97 per cent in 1990 to 78.1 per cent in 2006.

Korean people mostly consumed grains (72 per cent) such as rice, barley, soybean, wheat and corn in 1970 but by 2006, the share of per capita food consumption had changed to 30 per cent for grains, 45 per cent for vegetables and fruits, and 25 per cent for meats and milk.

Table 1. Major economic indicators

Year	Per capita GNP (US$)	Export (US$ billion)	Import (US$ billion)	Unemployment (%)
1970	277	0.9	1.8	1.4
1980	1 598	17.2	21.6	5.2
1990	5 833	65.0	69.8	2.4
2000	10 841	172.3	160.5	4.1
2006	18 372	325.4	309.4	3.5

Table 2. Value of gross domestic product

Year	Total (billion Won)	Agriculture (billion Won)	Percentage of total
1970	2 771	645	23.3
1980	37 032	5 607	15.1
1990	178 628	15 212	8.5
2000	517 096	23 867	4.6
2006	847 876	21 736	2.6

Table 3. Total and agricultural populations

Year	Total (thousand)	Agriculture (thousand)	Percentage of total
1970	32 231	14 422	44.7
1980	38 124	10 827	28.4
1990	42 869	6 661	15.5
2000	47 008	4 031	8.6
2006	48 279	3 304	6.8

Table 4. Farm population by age group (Unit: %)

Year	(%) of total	Under 20	20–49	50–59	Over 60
1970	44.7	53.9	30.5	7.7	7.9
1980	28.4	45.4	34.2	9.9	10.5
1990	15.5	31.6	33.9	16.7	17.8
2000	8.6	17.9	32.3	16.8	33.1
2006	6.8	14.1	27.1	18.1	40.7

Table 5. Rural and urban household incomes

Year	Farm household income[a] (A)	Urban household income[a] (B)	Ratio (A/B)
1970	256	338	75.9
1980	2 693	2 809	95.8
1990	11 026	11 319	97.4
2000	23 072	28 643	80.5
2006	32 303	41 321	78.1

Note: [a] Unit = thousand Won;
Non-agricultural income of farm household = 32%.

Table 6. Per capita consumption of selected commodities[a]

Year	Grains	Rice	Vegetable	Fruits	Meat	Egg	Milk
1970	219	136	60	14	5	4	2
1980	195	132	120	22	11	12	11
1990	167	120	133	42	20	17	43
2000	153	94	166	58	32	18	59
2006	137	79	145	62	34	22	64

Note: [a] Unit = kg per capita per annum.

The country produced 4,680,000 mt[1] of rice from 980,000 ha of farmland in 2006. This constituted 93 per cent of total grain production, 32 per cent of agricultural production and 42 per cent of farm receipts for that year. Rice is the most important staple crop of farmers and the people. It is also an integral part of the culture, tradition and social and political stability in the Republic of Korea. Rice policy is the core of Korean agricultural policy.

Barley, soybean, wheat and corn are considered to be secondary crops. Production of barley reached 154,000 mt with a planted area of 58,000 ha in 2006. It comprised only 1.1 per cent of total grain production. Soybean production was 156,000 mt coming from 90,000 ha in the same year. It had a 3 per cent share of total grain production. Wheat production was about 2,000 mt planted on 2,000 ha. Corn production reached 65,000 mt planted on 14,000 ha.

In 2006 rice consumed in Republic of Korea was mostly locally produced (99.4 per cent) as was the majority of barley at 52.8 per cent. Commodities mostly imported were soybean (with only 11.3 per cent domestic production) and corn (with just 0.8 per cent domestic production). As a whole, the grain food self-sufficiency ratio is very low at just 29 per cent. Open global market policies in the 1980s and implementation of WTO agreements

[1] mt = mega ton.

in the late 1990s followed by the Uruguay Round changed Korean agricultural policy. Agricultural products with low prices were increasingly imported and this threatened the domestic market, particularly food/feed grains.

Table 7. Production of secondary crops[a]

Year	Rice	Barley	Wheat	Soybean	Corn
1970	3 939	1 590	219	232	68
1980	3 550	811	92	216	154
1990	5 606	416	1	233	120
2000	5 291	163	1	113	64
2006	4 680	154	2	156	65

Note: [a] Unit = 1,000 mt.

Table 8. Area planted in secondary crops[a]

Year	Rice	Barley	Wheat	Soybean	Corn
1970	1 203	730	97	295	47
1980	1 233	331	28	188	35
1990	1 244	159	0.3	152	26
2000	1 072	68	1	86	16
2006	980	58	2	90	14

Note: [a] Unit = 1,000 ha.

Table 9. Self-sufficiency ratio of selected commodities

Year	Rice	Barley	Corn	Soybean	Beef	Chicken	Milk
1970	93.1	106.3	18.9	86.1	100	100	100
1980	95.1	57.6	5.9	35.1	93.1	100	100
1990	108.3	97.4	1.9	20.1	52.5	100	100
2000	102.9	46.9	0.9	6.4	52.8	93.5	80.1
2006	99.4	52.8	0.8	11.3	47.9	90.5	69.7

The agricultural policy of the Republic of Korea

The Doha Development Agenda of the World Trade Organization (WTO) negotiated reduced subsidies and tariff barriers among its members. Ninety per cent of subsidies went to the rice industry alone and minimal amounts to competitive secondary crops. Unprofitable farming increased debt, and aggravated the income gap between urban and rural households. China as a WTO member has invaded the Korean market with its low-priced commodities. These conditions were reasons for readjusting Korea's local rice production and secondary crop policies.

The first agricultural policy was directed towards high-quality, high-value and increased export of agricultural products. The policy included the following objectives:

- dominate domestic market with high-quality local produce competing against low-priced, poor-quality imported produce;
- high-quality agriculture refers to the industry that produces differentiated products including produce from environment-friendly agriculture; and
- production of high-value, processed food and non-food, including medicines.

The second agricultural policy was to improve living conditions of rural areas both for farmers and 'green' tourists. The policy included the following objectives:

- remove living standard differences between rural and urban residences;
- make rural areas attractive for urban citizens; and
- generate income to complement agriculture income in rural areas.

Finally, the third agricultural policy was to remove uncertainties in income and farming. The policy included the following objectives:

- expand the incentives for better and multifunctional land uses, such as direct payment;
- remove the income gap and compensate for the disadvantages of agriculture compared with other industries; and
- reinforce training and education programmes to advance technologies and management ability.

New major agricultural policy instruments introduced to assist farmers include:

1. restructuring and adjust existing programmes to comply with the directions of agricultural policies;
2. developing and promote promising new areas;
3. readjusting rice industry policies;
4. promoting export agriculture;
5. systematic promotion of environment-friendly agriculture;
6. advancing agro-marketing systems;
7. consumer-oriented supply of safe foods;
8. urgently addressing farm debt;
9. form safety networks to stabilize incomes;

10. construct crisis management systems and prevent natural disasters;
11. prepare agriculture after reunification; and
12. improve the rural environment for living and well-being.

Secondary crop R&D for poverty alleviation

Barley cultivation and production in the Republic of Korea declined from 2001 to 2005 because of the low purchase ratio of unhulled barley (69 per cent) and rye (53 per cent) as affected by restructuring and adjusting programmes to comply with the directions of agricultural policies. Demand for barley is divided into government purchase and general market circulation. Consumption per person of barley increased from 1.1 kg in 1990 to 1.5 kg in 2005. Moreover, the amount of barley stored increased from 236,000 mt in 2001 to 310,000 mt in 2005. Production of malting barley was 93,000 mt planted on 22,000 ha. Barley self-sufficiency gradually decreased from 29 per cent in 2001 to 27 per cent in 2005. Area planted to whole crop forage barley increased from 859 ha to 9,686 ha in 2006. By 2010, 50,000 ha will be planted in whole crop forage barley. The Farmer-National Agricultural Co-operative Federation-Korea Federation of Livestock Co-operatives Network will commercially sell this to livestock farmers.

Table 10. Planted area, production purchase ratio of barley

Division	Barley type	2001	2002	2003	2004	2005
Planted area (1 000 ha)	Unhulled	14	12	9	9	8
	Rye	48	36	24	27	28
	Malting	29	30	29	24	22
Production (rough grain, 1 000 mt)	Unhulled	50	49	35	38	38
	Rye	222	139	88	120	141
	Malting	111	111	97	91	93
Purchase ratio (%)	Unhulled	65	88	72	68	69
	Rye	79	81	71	64	53
	Malting	72.0	82.9	77.3	85.7	87.1
Government undertaking ratio (%)	Unhulled	95	88	100	100	100
	Rye	20	25	63	39	27
	Malting	-	-	-	-	-

The first R&D policy for poverty alleviation through barley involved processing and product development studies for consumption of barley. Raw barley was processed into local specialized brands, and high-quality raw material barley: malt, barley tea and barley shoot vegetable, among others.

The second R&D policy for poverty alleviation through malting barley was to support development of a special local beer brand. Beer results varied depending on the district where it was produced and quality of the raw malting barley.

Finally, the third R&D policy for poverty alleviation developed whole crop silage barley varieties. Barley in Korea is used as silage instead of food. To breed varieties that are useful for forage production, we are focusing on high biomass and livestock-preferred forage such as the hood, awnless, smooth awn type varieties, and those with high lysine content.

Soman, Wooho and *Yuyeon* showed weaker winter hardiness, but better resistance to lodging, shattering, and BaYMV (Barley yellow mosaic virus) than those of check cultivar *Sunwoo* and *Sangweon*. *Soman* is suitable for cropping after rice in central Korea because of its early maturity, which is six days earlier than those of check cultivar *Olbori.* Furthermore, *Soman* has high silage quality and dry matter yield.

Wooho and *Yuyeon* have smooth awn and hood type and were developed in 2005 and 2006, respectively. Hooded and smooth awn types were derived from the artificial cross. The two lines of smooth and rough awn were not significant in growth except in maturing time, while smooth awn lines were better than those of rough ones in silage quality. Recently, our research has focused on the livestock-preferred characteristics of barley such as awnless, hooded, and smooth awn types, and those with high lysine content. For new ruminant-palatable barley cultivars, we developed silage for cattle feed from *Yuyeon*. The experiment showed higher feed concentrate requirements (12.9 kg/day/body, 14 per cent) and daily weight gain (1.46 kg/day, 35 per cent) than those of cattle fed with silage from *Olbori* (common awn). These results showed ruminant-palatable barley with smooth hood, awnless type, and fragile stem is a good source of whole crop forage for breeding.

Figure 1. (a) Awnless type in improving one, (b) heading time of *Soman* and *Sunwoo* (right), and (c) maturing time of *Soman* and *Sunwoo*

(a) (b) (c)

Figure 2. Heading time of (a) *Yuyeon* and (b) *Sunwoo*, (c) preference test between (A) rough awn and (B) hood type, (d) magnified shape of rough (left) and smooth awn (right)

(a) (b) (c) (d)

Whole barley crops can be ensiled because of their abundant availability for producing highly nutritious silage for cattle feed. This can also reduce the reliance on imported forage and increase the utility rate of cropping systems in rice fields in Korea. Thus, the objective of this study was to investigate the growth, feed efficiency, and carcass characteristics of *Hanwoo* cattle when fed using whole crop barley silage (WCBS) and rice straw silage.

WCBS showed higher moisture content (64 per cent), total digestible nutrient (TDN, 63.6 per cent) and crude protein content (7.1 per cent), and acid detergent fiber (ADF, 32.0 per cent) than rice straw silage (12.3 per cent, 38.2 per cent, 4.4 per cent and 45 per cent, respectively). Cattle fed with WCBS showed higher feed concentrate requirements (3.0 kg/day/body) and daily weight gain (0.86 kg/day) than cattle fed with rice straw silage (2.7 kg/day/body, 0.82 kg/day, respectively). The percentage of first, first+ and first++ grade of *Hanwoo* steers was higher for WCBS (88 per cent) than for rice straw (50 per cent). Marbling score of steers was also higher using WCBS (5.5) than rice straw (3.4), but no significant differences of meat and fat colours were found. These results indicated that whole crop barley silage could be used as an alternative roughage source in the diet of dairy cattle.

Figure 3. The effect of weight gain according to feeding whole crop barley silage for *Hanwoo* steers (GP – growing period; FP I – fattening period 1; FP II – fattening period 2; and FP III – fattening period 3)

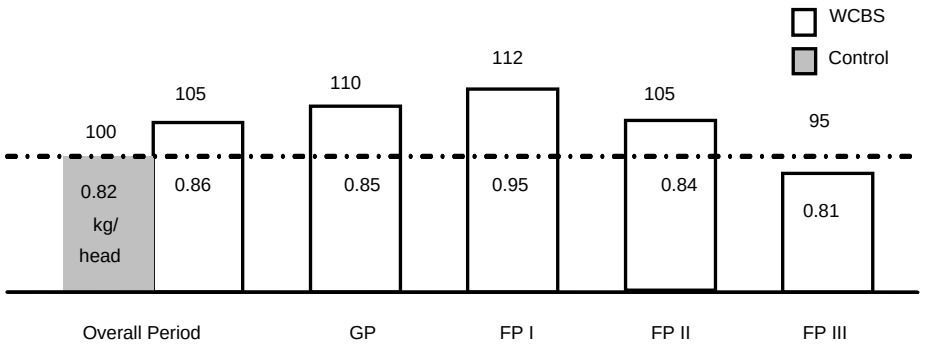
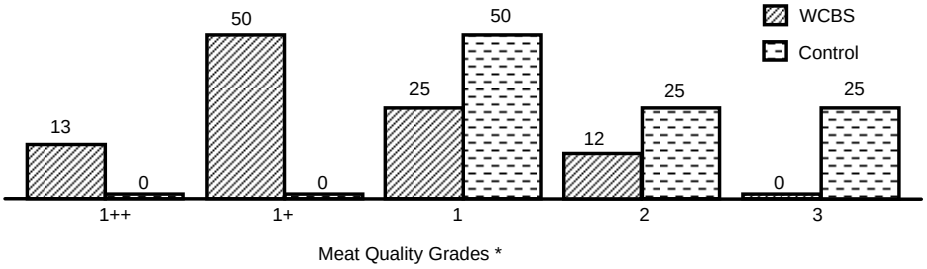


Figure 4. Ratio of meat quality grade of *Hanwoo* steers (%) (meat quality grades with lower numbers are better quality)



Soybean is the most important secondary crop in the Republic of Korea that has been used as an ingredient in the traditional Korean diet. Soybean production reached 183,300 mt, planted on 104,500 ha in 2005. The planted area has continuously decreased from 188,000 ha in 1980. However, after WTO and the readjustment of Korean rice policies, Korean farmers have been planting soybean in paddy fields instead of rice since 2005 resulting in an increased cultivation area for soybean. Soybean self-sufficiency increased slightly from 6.5 per cent in 2000 to 8.5 per cent in 2005. Importation in 2005 had increased to 1,348,000 mt about 3.2 times more than that in 1980. Another important point is soybean is being increasingly used in animal feed because as the Korean economy has improved, diets have also changed; with meat consumption per capita increasing.

The most important R&D policy for poverty alleviation through soybean as a secondary crop was cultivation in paddy fields that affected mechanization and farming

systems. Korean farmers plant their crops in small size upland fields or the levees of rice paddy fields. These cultivation methods made the introduction of mechanization very difficult.

Planting soybean in paddy rice field initially resulted in an increase in stem length, lodging score, flowering days and maturity date, but a decrease in stem diameter. As the planting density increased, the stem length and lodging score also increased, but stem diameter decreased. The number of pods per unit area, and grain yield of *Taekwangkong* were higher when planted on June 5 with planting density of 16.6 and 19.0 plants/m2. *Pungsannamulkong* produced a higher number of pods per unit area and grain yield when planted on June 10 with planting density of 19.0 and 22.0 plants/m2.

Table 11. Planted area, production and consumption of soybean

Year	1980	1990	1995	2000	2001	2002	2003	2004	2005
Planted area (1 000 ha)	188	152	105	86.2	78.4	80.8	80.4	85.3	105.4
Production amount (1 000 mt)	216	233	160	113.2	117.7	115.0	105.1	138.6	183.3
Yield capacity (kg/10a)	115	153	152	131	150	142	131	163	174
Self-sufficiency (%)	35.1	20.1	9.9	6.4	7.7	7.3	7.3	7.1	8.5
Self-sufficiency (Except feeding, %)	64.3	64.9	37.0	28.2	28.1	28.5	29.0	25.0	29.8
Consumption per capita (kg)	8.0	8.3	9.0	8.5	8.2	8.4	8.0	8.5	9.0
Import amount (1 000 mt)	417	1 092	1 435	1 496	1 365	1 503	1 535	1 297	1 348

Table 12. Optimum planting time and planting density of soybean in paddy field

Regions	Planting date	Planting density (cm)	Plants/10a
Central	May 20 – June 5	60×20, 70×15	16 600 – 19 000
Southern	June 5 – June 15	70×15, 60×15	19 000 – 22 000

Figure 5. Sowing and growth aspects of soybean in paddy field

Labour saving method by seeder

Field inputted complex technology

The cultivated area of soybean in drained paddy fields is increasing annually. The Rural Development Administration has developed a new cultivation method for soybean in drained paddy fields and has demonstrated the new method. This cultivation method decreases excessive water stress (high ridge method), uses adaptable variety (*Daewonkong*), adjusts suitable planting time and density (early June, 19,000 plants/10a), improves labour-saving planting (seed spacing drill), requires soil testing fertilizer, and identifies proper rotation period (1 year for rice; 3 years for soybean).

Another special project was conducted making a special regional production complex for a new Korean soybean variety, *Daepungkong*. This new variety was high yielding and had good processing properties and increases yield and agriculture income. The success of this variety was made through an expansive dissemination and development of soybean products at Pocheon-City in 2005 and 2006.

Table 13. Comparison of agronomic characteristics

Cultivation type	Planting density (cm)	Stem length (cm)	Lodging (1-9)	Number. of branches (no./plant)	100-seed Weight (g)	Seed yield (kg/10a)	Index
New cultivation	52.3	7.4	1.4	41.5	23.2	265	134
Conventional	48.3	7.7	3.7	37.8	22.9	198	100

Figure 6. Stages of soybean production

High ridge-spacing drill

Reproductive stage

Harvesting by combine

The complex was composed of 14 farmers cultivating 10 ha and showed a remarkable average yield of 339 kg/10a in 2005. After evaluation of the field trial during grain filling stage, *Daepungkong* received excellent scores from 80 participants, and also many farmers were interested in this variety. These results were achieved due to the co-operation between the National Institute Crop Science (NICS) and Pocheon-City Agricultural

Technology Service Center (ATSC), the dedicated efforts of members and agricultural co-operatives, and the dissemination of main cultivation technology as practiced by farmers. The main cultivation technology was disseminating high quality seed, applying adequate fertilizer, planting at optimum time and density, topping-off when over grown, co-operative control, and harvesting. In conclusion, our demonstration projects supported farmers needs for crop variety and helped improve agriculture income through adding value from manufacturing soybean products and satisfied consumers' desires for high-quality soybean products.

Figure 7. Aspects of project with new soybean variety

Field evaluation meeting | *Daepungkong* at R8 stage | Soybean curd