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Korea's Controlled Horticulture

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Agricultural Situation

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Report Highlights:

Korea has an active greenhouse farming culture, accounting for about 12 percent of agricultural output by value. While much of the growth in greenhouse farming was stimulated by government programs beginning in the early 1990s, greenhouse farming has gradually decreased since the end of government programs in 2012. In 2016, 50.2 percent of greenhouse area was dedicated to fruit-bearing vegetables and fruit, such as watermelon, tomatoes, strawberries, yellow melons, and green chili. The balance of greenhouse area is dedicated to leafy and stems vegetables (9.9 percent), other vegetables (27.8 percent) including potatoes, condiment vegetables, root vegetables, etc., fruit trees (9.3 percent) and flowering plants (2.8 percent).

Korea's Controlled Horticulture Industry

Korea produces various fresh vegetables, flowering plants, and fruits in greenhouses in what is known as “controlled horticulture” or “greenhouse farming”. In the past, Korea’s controlled horticulture industry played an important role in supplying fresh agricultural products throughout the year for the domestic market, but now the objectives are broader: Producing more high quality and value-added fresh produce for export markets, supplying safer foods to consumers, and maintaining stable prices for the Korean agricultural market.

Although the Uruguay Round of WTO trade negotiations wasn’t finalized until 1994, the talks led to an opening of the Korean agricultural market beginning in 1990. As a countermeasure against the agricultural market opening, for the 21 years between 1991 and 2012 the Republic of Korea Government (ROKG) agricultural budget included about 950 million USD for the greenhouse sector for new construction of glass greenhouses, efficiency for energy use and horticulture quality improvement.

Sector	1990	2010	2014	2015	2016	1990 / 2016 Growth (%)
Agriculture	17,860	46,134	49,238	48,979	47,596	166.5 %
Greenhouse Agriculture	880	6,166	6,485	6,222	5,605	536.9%
Greenhouse Vegetables	641	5,315	5,783	5,592	5,048	687.5%
Flowering Plant	239	851	702	630	558	133.5%
Greenhouse Agriculture / Agriculture	4.9%	13.4%	13.2%	12.7%	11.8%	

Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

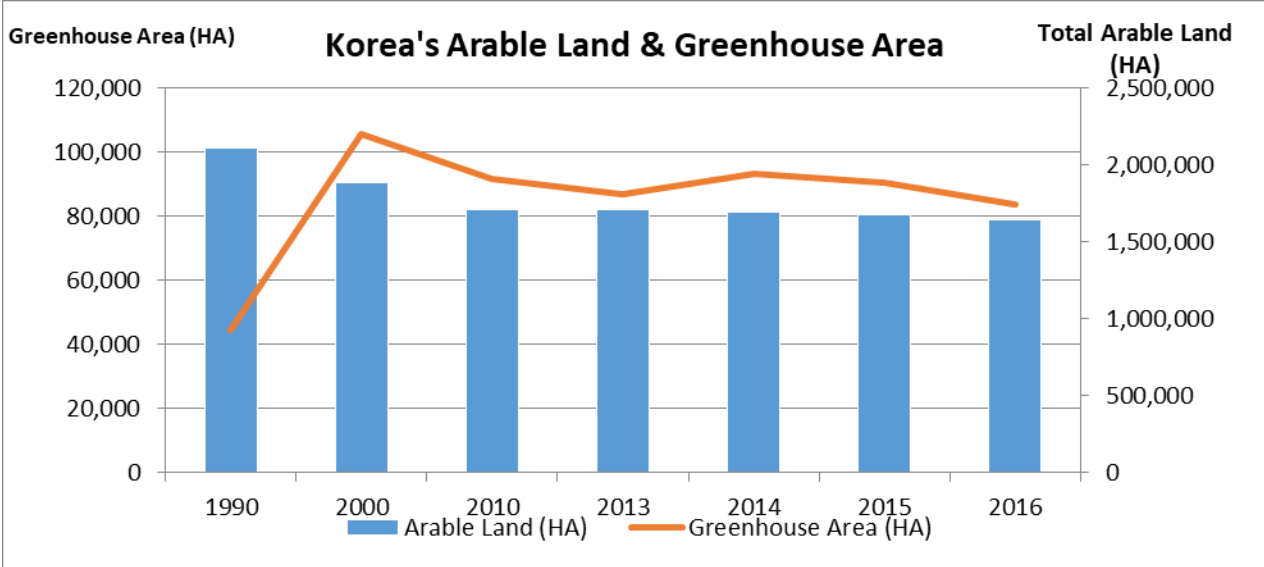
As a result, the output of the controlled horticultural industry in Korea increased by six times to 5.3 billion USD in 2016 from only 760 million USD in 1990. Notably, the growth of vegetable output in controlled horticulture increased eight times during the same period (over 26 years). However, the output of flowering plants only doubled during the same period due to the reduced demand since 2008 (world financial crisis) and the lower profit ratio compared with other crops. In 2016, the output of controlled horticulture accounted for 12 percent of total agricultural output (45 billion USD).

However, Korean controlled horticulture is not as competitive in productivity and size as other countries such as the Netherlands. The Korean controlled horticulture industry is smaller in size and heavily depends on cheap plastic greenhouse production. (Notably, there is some glass greenhouse production for products such as paprika and tomatoes.)

Korea's Arable Land and Controlled Horticulture Area

Korea’s total arable land declined gradually from 2.1 million hectares (Ha) in 1990 to 1.64 million ha in 2016, decreasing about 465,000 hectares (22 percent) over the past 26 years due to the following changes in the Korean rural sector: 1) reduced farm population and increased aging population causing farmers to give up farming, 2) expansion of urban development and increased property value near urban areas, 3) lowered local agricultural competitiveness resulting from an increasingly open market since the 1990s from Uruguay Round WTO negotiations in 1994 and many FTAs since 2000 with agricultural exporting countries.

On the other hand, the area of controlled horticulture increased to 105,758 hectares (ha) in 2000 from 44,613 ha in 1990, as a result of the government support program for facility modernization (greenhouse) for controlled horticulture which ran for 21 years (1991 – 2012). In 2016, the controlled horticulture area totaled 83,629 ha, about an 87.5 percent increase from 1990, attributable to: 1) the government support program for 21 years during 1991 – 2012 after the Uruguay Round negotiation for agricultural market opening, 2) demand increase for fresh agricultural produce including vegetables and fruits during the winter season, 3) expansion of the urban population and increased demand for fresh produce due to an increase in disposal income.



Source : Ministry of Agriculture, Food and Rural Affairs (MAFRA)

Korea’s controlled horticulture covered only 2.1 percent of total arable land in 1990. The percentage increased steadily and reached around five percent in 2000, and has maintained around the five percent level (about 85,000 hectares) to date.

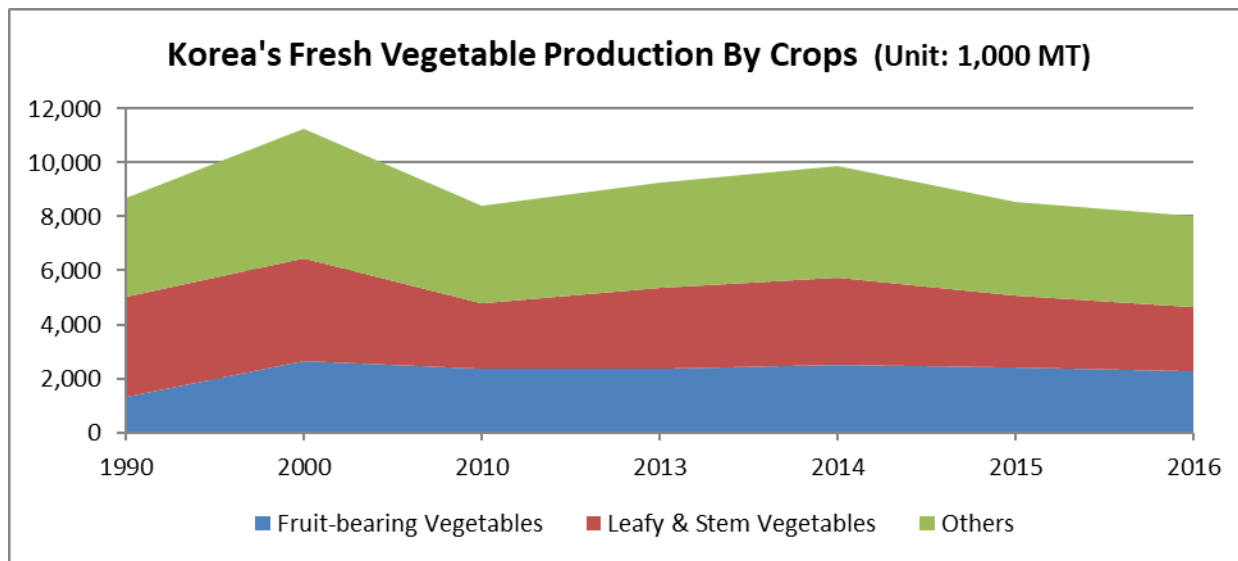
Year	Total Arable Land (HA)	Greenhouse Area (HA)	Ratio of Greenhouse Area (%)
1990	2,109,000	44,613	2.1%
2000	1,889,000	105,758	5.6%
2010	1,715,000	91,648	5.3%

2013	1,711,436	86,795	5.1%
2014	1,691,113	93,511	5.5%
2015	1,679,023	90,468	5.4%
2016	1,643,599	83,629	5.1%

Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

Korea's Controlled Horticulture History

In the 1970s, the industrial development period in Korea, the area for greenhouse production located near urban areas increased rapidly due to the resulting increased demand for fresh produce during the winter season caused by the expansion of the urban population. In the 1980s, the demand for fresh vegetables increased due to the increased interest and understanding of diet that accompanied Korean economic development. In the 1990s, Korean greenhouse production developed with the introduction of modernized horticultural facilities. Investment increased along with government support programs designed to help farmers adjust to the agricultural market opening after the Uruguay Round negotiations began. In the course of this century, the area for controlled horticulture decreased gradually due to the end of government support programs in 2012.



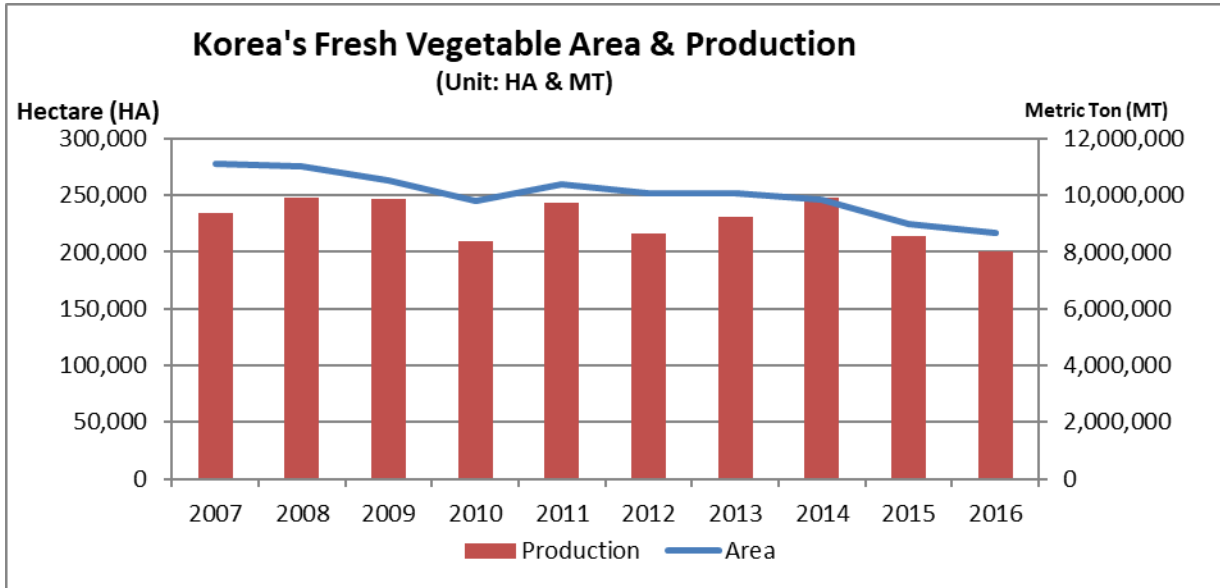
Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

In the past, flowering plant production was representative of Korean controlled horticulture. Flowering plant production in greenhouses increased substantially in the 1990s due to a government support program but has stagnated since the end of government support program in 2012. Flower demand has also reduced, and flowering plants have a lower profit ratio compared with other agricultural crops.

Korea's Vegetable Production & Area

In 2016, Korea produced greenhouse vegetables on 56,405 ha, which accounted for about 26 percent of total vegetable area (217,261 ha). By another measure, Korea produced one-third of fresh

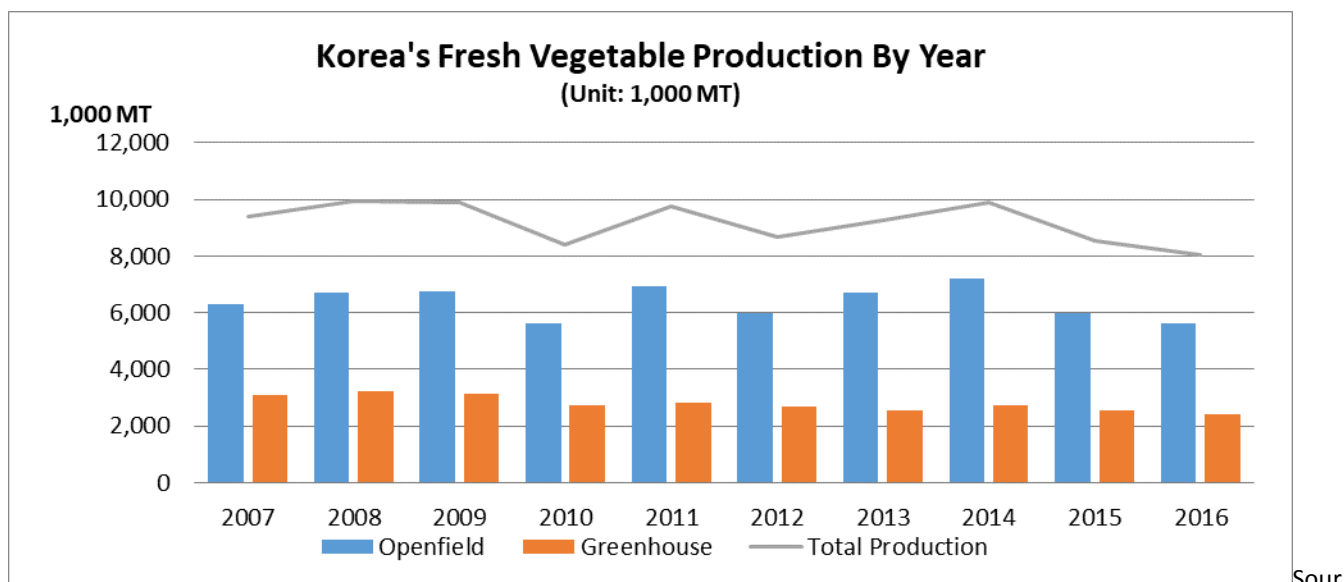
vegetables (2.4 million MT) from greenhouses out of a total eight million MT in fresh vegetable production in 2016.



Source: Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

Korea's total vegetable production area declined steadily by 22 percent (60,260 ha) for the past decade from 277,521 ha in 2007 to 217,261 ha in 2016 mainly due to the following: 1) increased fruit and vegetable imports, and 2) reduced Korean cabbage area caused by reduced Kimchi (fermented spicy pickled vegetables, which are mainly made of Korean cabbage and radishes) consumption during the same period. In the past, Koreans ate a lot of Kimchi since it was difficult to obtain fresh vegetables and fruits throughout the year. However, as disposal income increased over the past two decades, Koreans are demanding more fresh vegetables or high quality vegetables and fruits rather than the conventional pickled vegetables that were common with grain based diets of the past.

Korea's Vegetable Production by Area & Year



Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

Year	Fruit-bearing ¹ , Leafy, Stem and Root Vegetables	Fruit Tree	Flowering Plant	Others	Total
1990	39,994	0	2,429	2,190	44,613
2000	90,627	3,402	4,936	6,793	105,758
2010	66,382	6,225	3,731	15,310	91,648
2013	60,226	7,801	2,939	15,829	86,795
2014	63,815	8,473	2,958	18,265	93,511
2015	61,330	8,808	2,893	17,437	90,468
2016	56,405	7,811	2,343	17,070	83,629

Source: Korea Statistics Information Service (KOSIS) and MAFRA

Greenhouse Vegetable Production and Area

In 2016, the total area of fruit-bearing vegetables in Korea decreased to 52,058 ha, 9.8 percent down from 57,685 ha in 1990 due to reduced open field production. Meanwhile, there was increased production in greenhouses caused by steady, year-round demand and increased disposable income for various fresh fruit and vegetables.

In 2016, the majority of Korean farmers involved in greenhouse vegetable and fruit production produced fruit-bearing vegetables on 41,979 hectares, which accounted for 50 percent of total greenhouse area. These fruits and vegetables include watermelon, tomatoes, strawberries, yellow

¹ Fruit-bearing vegetables: Fruits of edible plants such as tomato, pepper, eggplant, cucumber, zucchini, strawberry, watermelon, melon and etc.

melons, green chili, etc. The area dedicated to this produce had more than doubled to 58,171 ha in 2000 from 24,180 ha in 1990. Since then, it gradually decreased to 41,979 ha in 2016.

Year	Planted Area (Unit: HA)			Production (Unit: 1,000 MT)		
	Sub Total	Open Field	Greenhouse	Sub Total	Open Field	Greenhouse
1990	57,685	33,505	24,180	1,326	693	634
2000	75,694	17,523	58,171	2,651	432	2,219
2010	56,480	9,574	46,906	2,369	263	2,106
2013	54,030	10,860	43,170	2,353	345	2,009
2014	57,525	10,832	46,693	2,508	343	2,165
2015	56,650	11,349	45,301	2,406	343	2,063
2016	52,058	10,079	41,979	2,262	297	1,965

Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

The area for leafy and stem vegetables in greenhouses in Korea is relatively smaller than the area for these vegetables in open field production. The main crop in open field production is Korean cabbage, which is generally produced in large fields in the autumn in preparation for making Kimchi during the winter season. In 2016, Korea produced about 1.8 million tons (about 75.6 percent of total leafy and stem vegetable production) of Korean cabbages on 24,902 ha.

In 2016, greenhouse area for leafy and stem vegetables was 8,273 ha, about 300 ha lower than the area in 1990. On the other hand, the total area for leafy and stem vegetables decreased 32.2 percent to 42,913 ha in 2016 from 63,345 ha in 1990 due mainly to decreased Kimchi consumption, increased vegetable imports, and changed dietary patterns to include more animal protein and fruit consumption base from a grain base and pickled vegetables diet.

Year	Planted Area (Unit: HA)			Production (Unit: 1,000 MT)		
	Sub Total	Open Field	Greenhouse	Sub Total	Open Field	Greenhouse
1990	63,345	54,776	8,569	3,716	3,499	217
2000	74,276	58,336	15,940	3,782	3,262	521
2010	47,313	34,636	12,677	2,411	1,994	416
2013	52,188	41,480	10,708	3,013	2,673	340
2014	53,060	42,420	10,640	3,239	2,897	342
2015	46,481	36,253	10,228	2,681	2,374	307
2016	42,913	34,640	8,273	2,368	2,120	248

Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

2016 Composition of Agricultural Crops in Greenhouses

In 2016, the area of fruit-bearing fruits and vegetables accounted for 50.2 percent (41,979 ha) of total greenhouse area (83,629 ha) followed by leafy and stem vegetables with 9.9 percent, 9.3 percent for fruit trees and 2.8 percent for flowering plants. Within the greenhouse area dedicated to fruits and

vegetables, Korean farmers grow watermelons the most, on 11,167 ha, followed by tomatoes on 6,391 ha, strawberries on 5,884 ha, etc. For greenhouse leafy and stem vegetables area, Korean lettuce, spinach and chives are the main crops. For greenhouse fruits, Korean farmers grow mostly citrus and grapes on 4,058 ha and 2,240 ha, respectively.

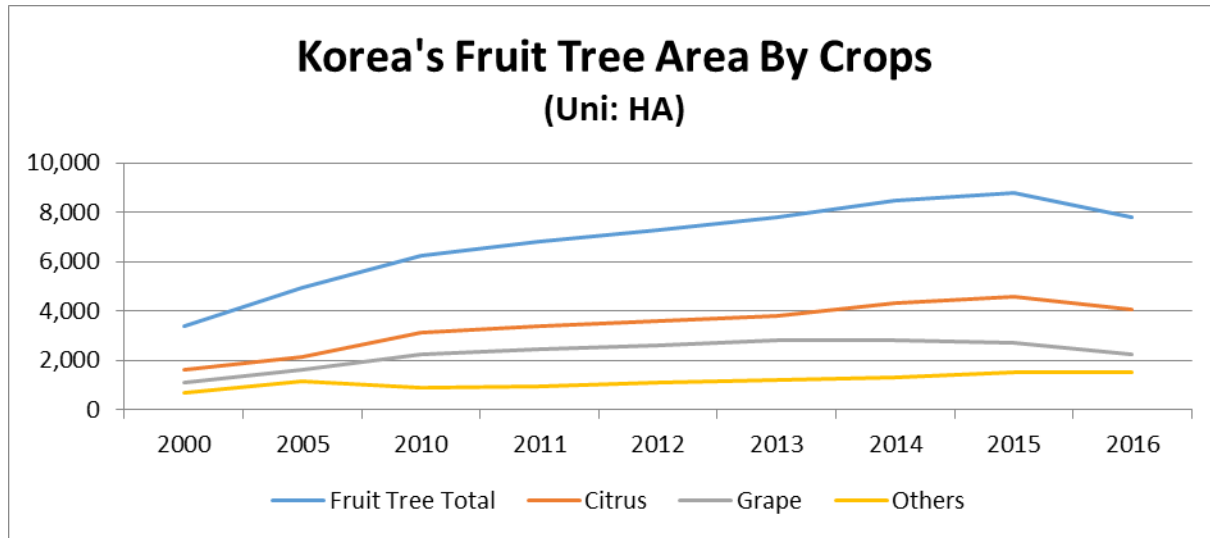
Table 6: Korea's Greenhouse Area By Main Crops in 2016 (Unit: HA & Percentage)		
Crops	Planted Area	Share (%)
Fruit-bearing Vegetables	41,979	50.2
- Watermelons	11,167	13.4
- Tomatoes	6,391	7.6
- Strawberries	5,844	7.0
- Yellow melons	4,872	5.8
- Green chili	4,455	5.3
- Cucumbers	3,906	4.7
- Others	5,344	6.4
Leafy and Stem Vegetables	8,273	9.9
- Korean Lettuce	2,627	3.1
- Spinach	2,264	2.7
- Chives	1,412	1.7
- Korean Cabbage	1,136	1.4
- Others	834	1
Flowering Plant	2,309	2.8
Tree Fruit	7,811	9.3
- Citrus	4,058	4.9
- Grape	2,240	2.7
- Others	1,513	2
Other Vegetables	23,257	27.8
Greenhouse Total	83,629	100

Source: 2016 Vegetable Production and Greenhouse Vegetable Production by MAFRA

Greenhouse Fruit Tree Area and Production

The area in Korea's greenhouses dedicated to fruit increased substantially to 3,402 hectares in 2000 from 543 hectares in 1991 due to increased greenhouse tangerine production, and it reached 7,811 ha in 2016, about 129 percent higher than the area in 2000 due to an increased demand for domestically-produced high quality fruits (late varieties of citrus) caused by increased fruit consumption. In 2016, greenhouse citrus area including late varieties was 52 percent of greenhouse fruit tree area (4,058 ha), followed by grape area at 29 percent (2,240 ha). For the past decade, citrus farmers on Jeju Island have shifted their citrus production from open field to greenhouse production steadily to meet the

increased consumer demand for greenhouse citrus, which includes high quality citrus crops, such as late varieties, hybrid citrus, etc., to compete with fruits imported under FTAs from agricultural exporting countries such as Chile, United States, ASEAN members, etc.



Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

Greenhouse Area & Production for Flowering Plants

Korea produced flowering plants on a total of 5,365 hectares in 2016. Among the total area, greenhouse area accounted for 43 percent with 2,309 hectares, while the majority of flowering plants were still produced in an open field (3,056 ha). Since the net profit ratio (36.3 percent) for greenhouse flowering plants is lower than other crops, the greenhouse area for flowering plants decreased or was converted into other crops such as strawberries in recent years.

Year	1990	2000	2010	2014	2015	2016
Area Total (HA)	3,053	5,891	6,829	6,222	5,831	5,365
Greenhouse Area (HA)	1,752	3,336	2,994	2,381	2,489	2,309
Ratio (%)	57.4%	56.6%	43.8%	38.3%	42.7%	43%

Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)

Korea's Greenhouse Type for Vegetable Production

Most of the greenhouses in Korea are plastic greenhouse facilities that were built more than 10 years ago. Plastic greenhouse facilities accounted for 99.2 percent of greenhouses in 2016, and are made of cheap vinyl. The majority are operated in a single greenhouse format (85.2 percent) rather than a linked greenhouse format (11.8 percent). Recently, the area of glass-type greenhouse facilities has increased gradually to produce high quality vegetables such as paprika and tomatoes for the export market. As a result of high tech application and vertical farming, more high tech greenhouses will be built in the coming years.

Table 8: Korea's Greenhouse Facility Area By Type (Unit: HA)

Year	Total	Plastic greenhouse			Glass Type	Hard board Greenhouse
		Sub Total	Single	Linked		
2012	47,924	46,015	40,788	5,227	278	90
2013	51,058	49,450	43,753	5,697	306	67
2014	51,787	50,074	44,177	5,897	329	76
2015	52,526	52,099	44,816	5,916	351	76
2016	51,909	51,477	44,231	6,136	353	79
Share (%)	100	99.2	85.2	11.8	0.7	0.2

Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA)