



Ministry of Foreign Affairs

Greenhouse Horticulture in South Korea

Commissioned by the Netherlands Enterprise Agency

*>> Sustainable. Agricultural. Innovative.
International.*

Greenhouse in South Korea

June 2021

LAN Seoul

1. Summary

Korea's ornamental plant production has decreased since 2005, and the vegetable production has decreased since 2010. The horticulture greenhouse area has declined accordingly, and was 56,467 ha in total in 2019. Vegetables accounted for 96% of the use of the total greenhouse area. Most of greenhouses in Korea are low-tech plastic greenhouses mainly for growing watermelons, melons, strawberries, cucumbers and pumpkins. Contrary to the low-tech plastic greenhouse area, the hi-tech glass greenhouse area has steadily grown and reached 367 ha in 2019.

As the largest exporter of paprika into Japan, Korea is increasingly building hi-tech glass greenhouses for paprika and other vegetables. The demand for hi-tech glass greenhouses for growing tomatoes and strawberries is also emerging. Policies to upgrade low-tech greenhouses to mid- or high-tech greenhouses help the development of greenhouses, while small farm sizes, continuous opposition from existing farmers and protectionism still form obstacles. Yet increasing interests in hi-tech horticulture by the Korean society and businesses leads to new opportunities.

The prospect for ornamental plants is still gloomy. The total glass greenhouse area for ornamental plants has shrunk by about 60% over the last 17 years. This is because the Korean flower market still aims at low-quality products with a shorter flower duration for ceremonial occasions.

In order to do business in Korea, it is important to understand cultural difference in business, and to find the right Korean partners who can speak English well, with the required license, experience and network in the Korean horticultural sector.

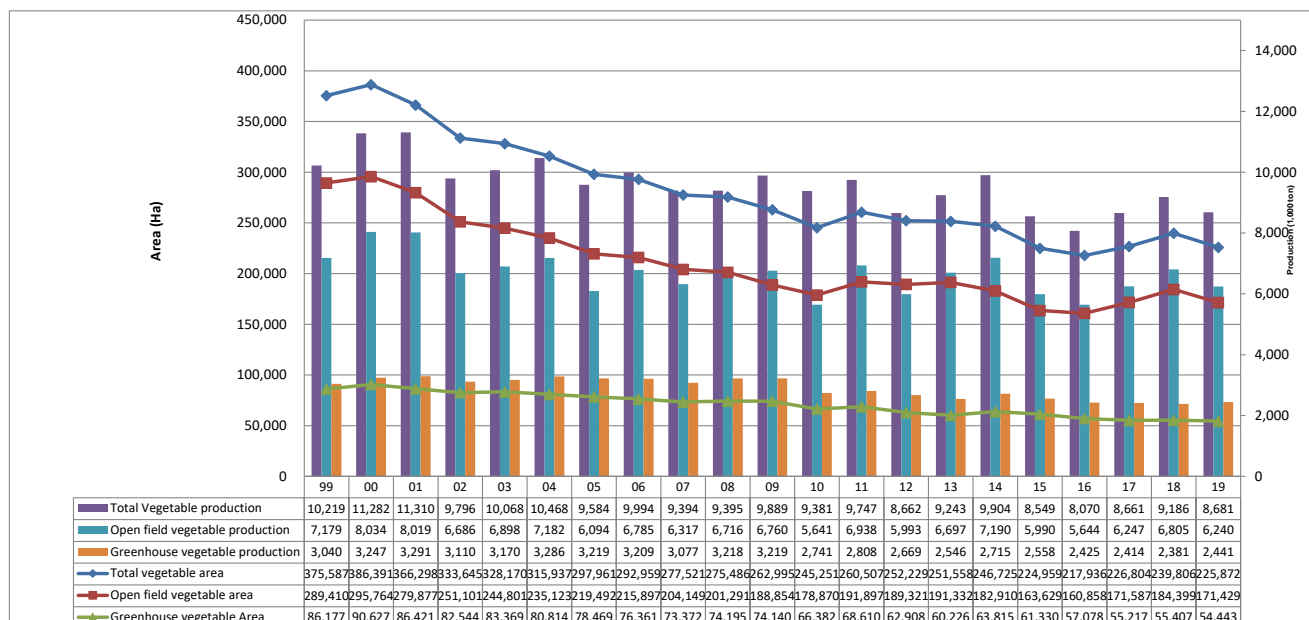
2. Overview Korean Horticulture

1) Vegetables

Korea is one of the largest countries in per-capita vegetable consumption in the world. Total vegetable production was estimated at 8.7 million ton produced in 225,872 ha in 2019. Since 2000, both total vegetable area and its production have decreased. Compared to other Korean agricultural products such as grains, fruits and meat, the self-sufficiency rate of vegetables is as high as 83%. Koreans enjoy the so-called Asian vegetables such as Chinese cabbage and radish, which are different from vegetables largely produced in Europe or America. Furthermore, Korean vegetables are mostly consumed fresh as Kimchi (fermented Chinese

cabbage or radish), leaf vegetables used with BBQ or side dishes. Refrigerated or dried vegetables are not in demand.

Figure 1. Vegetable production and farming area by open field / greenhouse by year



* Potatoes are not included in vegetables according to Korea's classification.

Table 1. Vegetable production by vegetable group by year (Unit: 1,000 ton)

Year	Fruit-bearing	Leaf	Root	Condiment	Total
2006	2,694	3,531	1,648	1,904	9,994
2007	2,667	2,956	1,300	2,239	9,394
2008	2,777	3,134	1,531	2,057	9,395
2009	2,708	3,237	1,386	2,310	9,889
2010	2,639	2,411	1,160	2,221	9,381
2011	2,232	3,456	1,348	2,401	9,747
2012	2,075	2,839	1,222	1,017	8,662
2013	2,353	3,013	1,396	2,279	9,243
2014	2,508	3,239	1,400	2,524	9,904
2015	2,406	2,681	1,392	1,897	8,549
2016	2,262	2,397	1,107	2,129	8,070
2017	2,221	2,977	1,251	2,030	8,661
2018	2,219	3,025	1,325	2,435	9,186
2019	2,259	2,449	1,195	2,549	8,681

In 2020, paprika accounted for 42% of Korea's vegetable export by value. The largest exported vegetables after paprika are oyster mushrooms, Enoki mushrooms, Chinese cabbage and tomatoes. Japan was the largest export destination accounting for 51% of Korea's total vegetable export, followed by the US, Taiwan and the Netherlands. The Netherlands imported USD 9.8 million of vegetables from South Korea in 2020, mainly oyster

mushrooms (84%) and Enoki mushrooms (12%). As for paprika, 99.7% of total paprika export goes to Japan. Korean paprika gained 83% of the market share of imported paprika in the Japanese market. In 2019, Korea and China agreed on import requirements for the export of paprika into China, and in August 2020 Korea exported paprika into China for the very first time. After opening the market in China, Korea is currently trying to open the Vietnamese market.

Figure 2. Per-capita vegetable consumption by year (Unit: Kg)

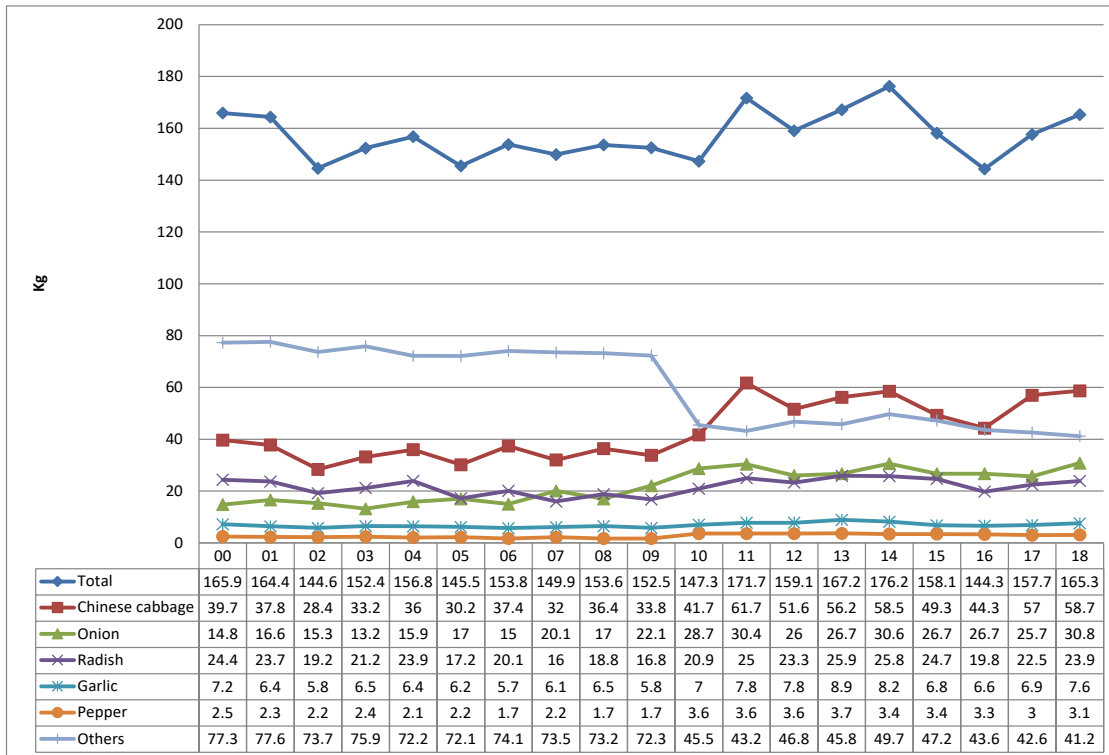
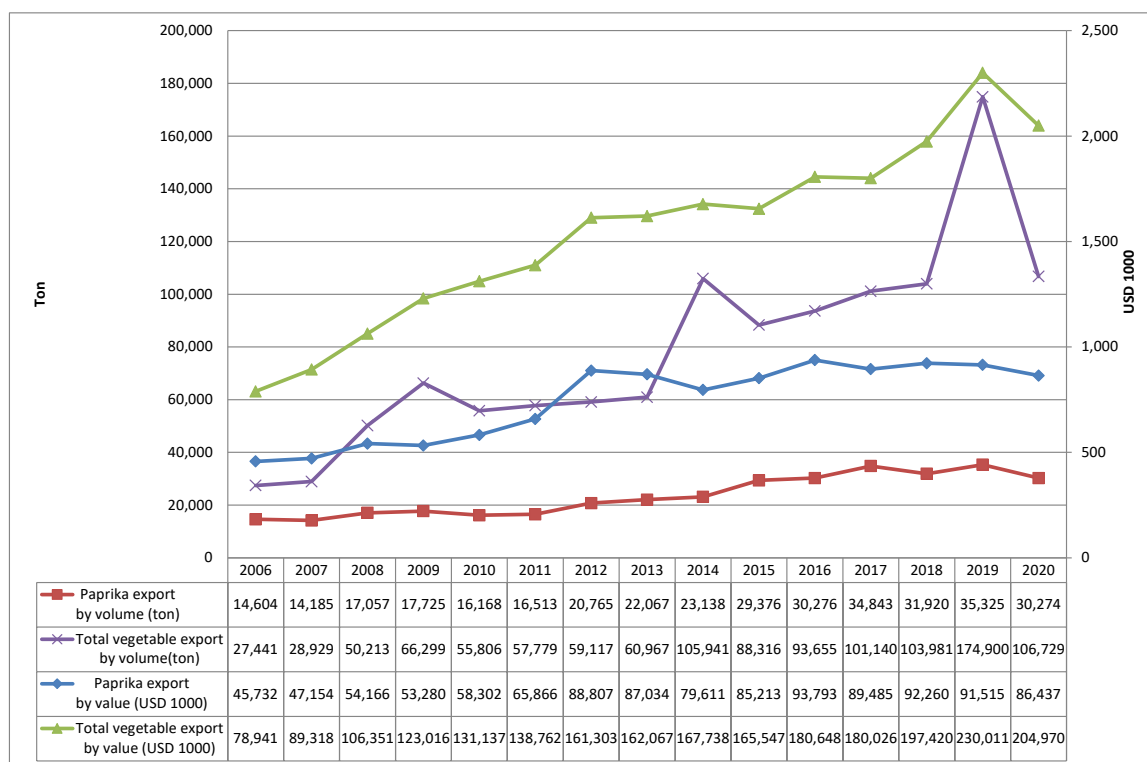


Figure 3. Export of vegetables from Korea by year



2) Ornamental plants

Total ornamental plant production was in 2019 estimated at KRW 517.4 billion (EUR 382 million), from 4,244 ha of farming area. The total ornamental plant area increased until 2005 in line with the growing flower consumption. However since 2005, this area has diminished drastically due to the shrinking flower consumption caused by the world economic downturn. The consumption didn't recover even after the economy was turned around. Korea's flower consumption derives mainly from business concerns that handle ceremonial occasions and from floral decorations in hotels. Individual consumption is still very low compared to other developed countries. Ornamental plant exports have also shrunk since 2010 as shown in figure 6.

Very recently, younger generation has started enjoying flowers to decorate their houses by regularly buying or subscribing for flowers. They complain for a short vase-life of the local flowers. The Korean flower sector has been aiming at ceremonial uses which generally don't need long lasting flowers. Korean flowers are therefore hardly stored or transported by cold chain. To satisfy the demand of customers in need of long lasting flowers, however flower imports have soared since 2018.

Figure 4. The number of farmers and farming area for ornamental plants by year

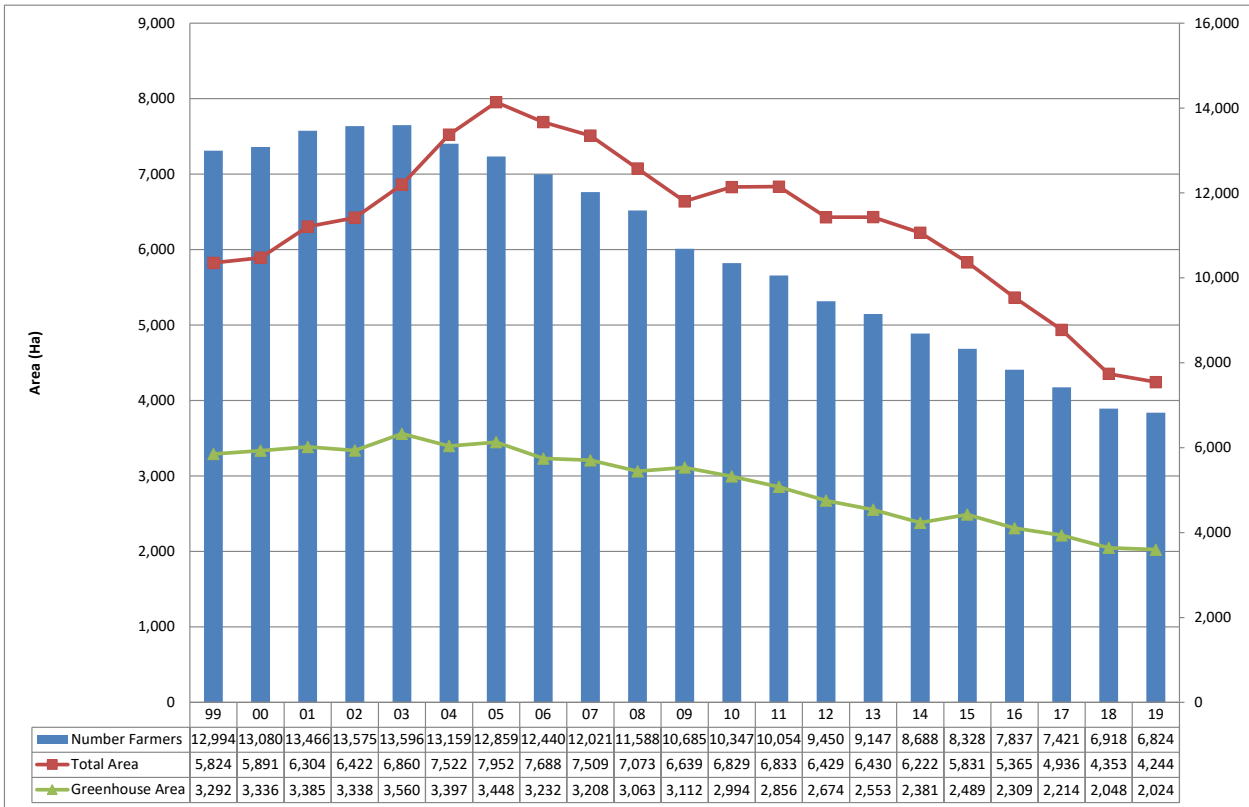
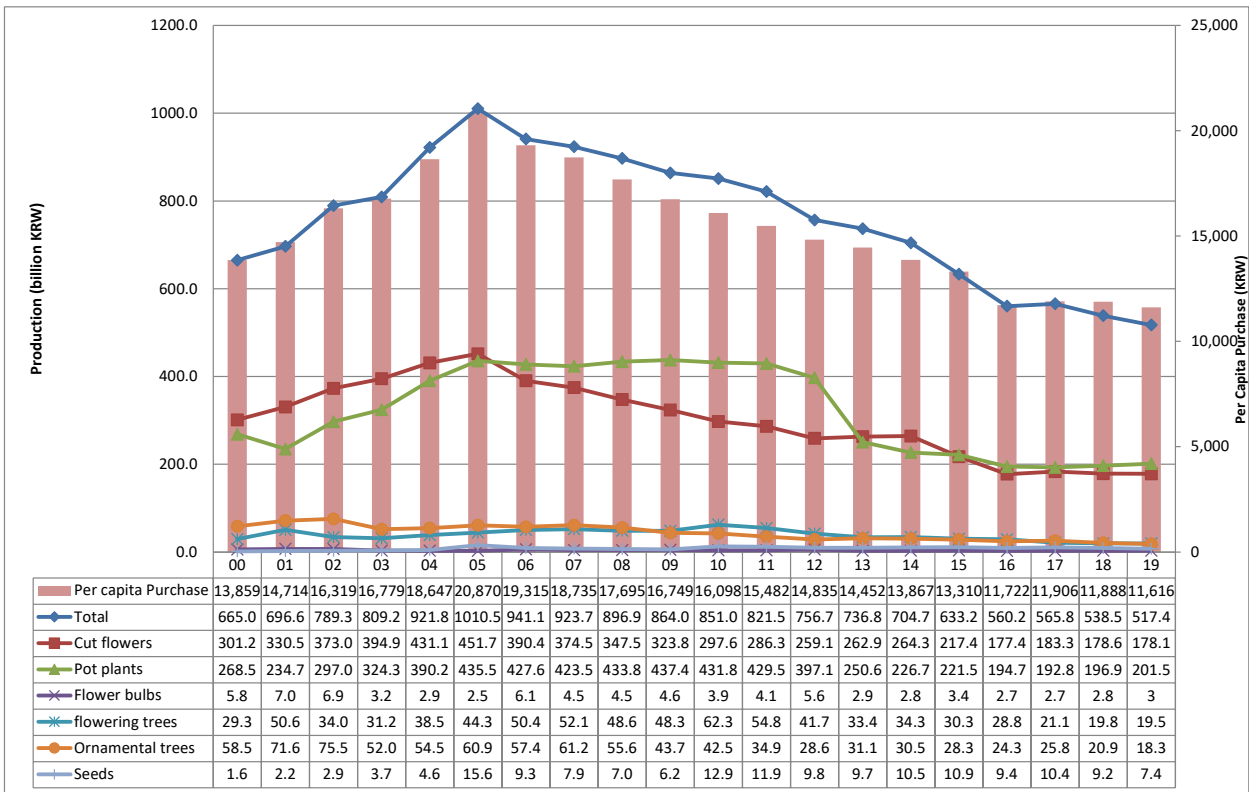
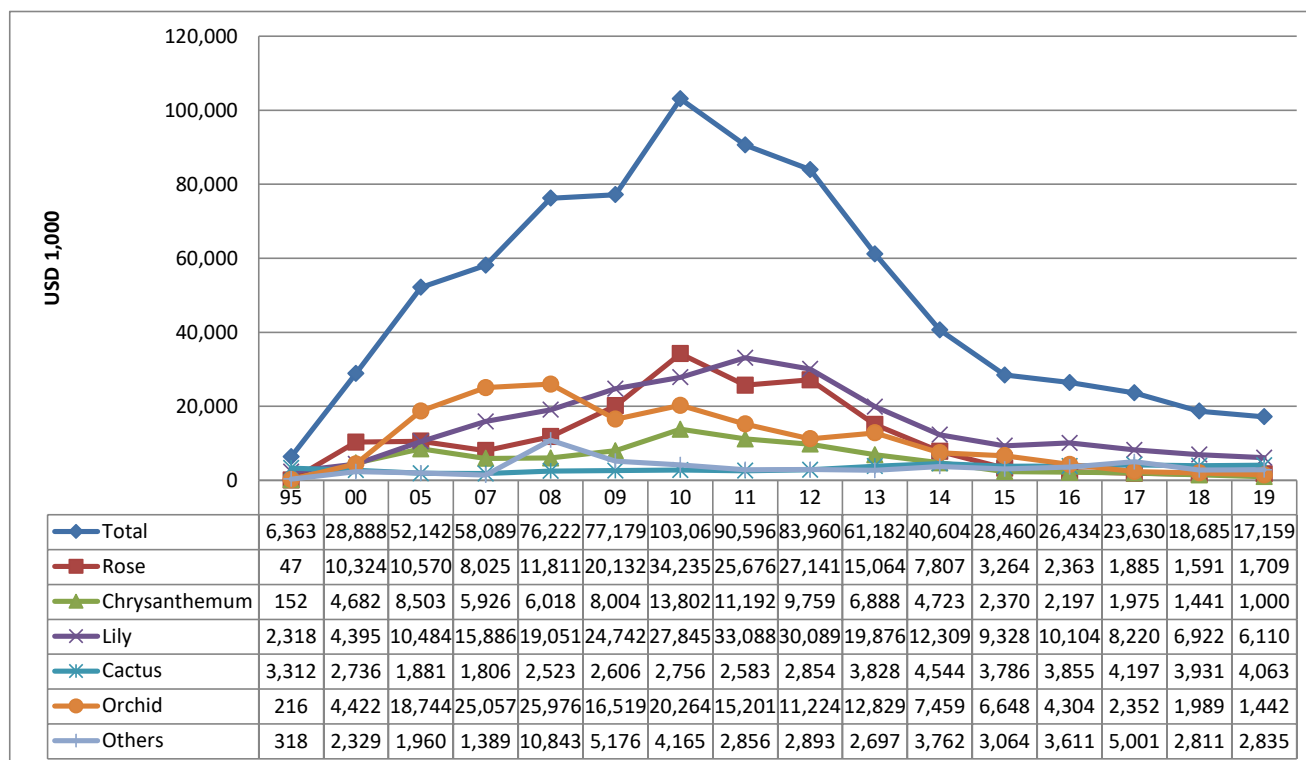


Figure 5. Production and per capita consumption of ornamental plants by year



* 1 EUR = around KRW 1,351 as of 14 June 2021

Figure 6. Export of ornamental plants from Korea



3. Greenhouse in Korea

1) Greenhouse for vegetables

In 2019, total greenhouse area for vegetables was 52,094 ha, of which 51,719 ha were plastic greenhouses, and 329 ha were glass greenhouses. The total vegetable greenhouse area has decreased since 2010, while the glass greenhouse area has increased consistently for the production of high-value vegetables such as paprikas and tomatoes.

Table 2. Vegetable greenhouse area by material type by year (unit: Ha)

Year	Total	Plastic greenhouse	Hard board greenhouse	Glass greenhouse
2006	46,354	46,094	45	215
2007	50,157	49,828	104	225
2008	50,297	49,990	55	252
2009	50,024	49,605	133	286
2010	48,835	48,465	98	272

2011	49,537	49,175	88	274
2012	47,924	47,556	90	278
2013	51,058	50,686	67	306
2014	51,787	51,382	76	329
2015	52,526	52,099	76	351
2016	51,909	51,477	79	353
2017	52,418	51,997	75	346
2018	51,244	50,876	65	285
2019	52,094	51,719	65	310

Watermelons have the largest greenhouse area with more than 9,300 ha. They are mostly produced in the ground in low-tech plastic greenhouses. Fresh peppers, cucumbers and melons (Korean variety called Chamwe) are also mostly grown in low-tech plastic greenhouses. Strawberries are recently moving to mid-tech or hi-tech greenhouses with substrates. Korean strawberry varieties such as Seolhyang and Jookhyang are getting popular in Southeast Asia and Australia, and strawberry farmers are increasingly investing in hi-tech greenhouses.

Table 3. Major greenhouse vegetables in 2019

	Total area (ha)	Greenhouse area (ha)	Greenhouse area ratio (%)	Total production (1,000 ton)	Greenhouse production (1,000 ton)	Greenhouse Production Ratio (%)
Watermelon	11,972	9,325	77.9	476	391	82.1
Strawberry	6,462	6,421	99.4	234	233	99.6
Tomato	5,706	5,706	100.0	359	359	100.0
Pepper (fresh)	4,256	4,256	100.0	176	176	100.0
Cucumber	4,962	3,963	79.9	366	325	88.8
Melon (KR variety)	3,648	3,488	95.6	150	147	98.0
Pumpkin	9,874	3,060	31.0	344	166	48.3
Lettuce	3,629	2,916	80.4	96	83	86.5
Green onion	17,170	2,699	15.7	464	74	15.9
Spinach	5,189	2,522	48.6	71	42	59.2
Carrot	2,069	2,069	100.0	67	67	100.0
Chinese cabbage	25,837	1,633	6.3	1,860	71	3.8
Paprika	728	728	100.0	81	81	100.0
Radish	19,503	550	2.8	1,111	24	2.2
Pepper (powder)	31,644	0	0.0	76	0	0.0
Garlic	27,689	0	0.0	388	0	0.0
Onion	21,777	0	0.0	1,594	0	0.0

The greenhouse area using Coco peat has grown almost double over the last 5 years. Farmers increasingly choose Coco peat due to their cheap prices and convenience in recycling. Pearlite is also growing showing around 25% growth over the last 5 years.

Korean farmers mostly use ground water, which is available in a majority of farming lands in Korea. Most of low-tech/mid-tech greenhouses use this water without extra treatment. Hi-tech glass greenhouses on the other hand usually install reverse osmosis filters.

Table 4. Greenhouse types by shape (2019, unit: Ha)

Plastic greenhouse						Hard board greenhouse				Glass greenhouse			
Single			Linked			Single		Linked		Single	Linked		
Tunnel	Arch	Others	Tunnel	Arch	Others	Roof	Arch	Roof	Arch		Roof	Venlo	Others
24,515	19,352	538	2,351	3,970	67	5	19	9	31	3	113	158	35

Table 5. Greenhouse types by nutrition (2019, unit: Ha)

Solid medium				Water			
Pearlite	Rock wool	Coco peat	Others	DFT	NFT	Spray	Others
824	303	1,568	631	73	22	76	200

Regarding energy use in Korean greenhouses, around 71% of the total greenhouse area is not heated in the greenhouse as they are mostly low-tech plastic greenhouses, growing vegetables only between late winter and early spring. Oil is the largest energy source for Korean greenhouses. Diesel is the most popular one but its use has decreased almost in half over the last 5 years. Instead, Kerosene use increased, and almost tripled, during the same period. Gas, electricity and geothermal energy are also growing. Recently built Hi-tech glasshouses tend to choose electricity as their energy source as it is cheap and convenient. Unlike the Netherlands, Korea has little gas pipeline to countryside and limited farms with CHP system. The Korean government therefore has since 2010 started promoting geothermal energy with a subsidy program.

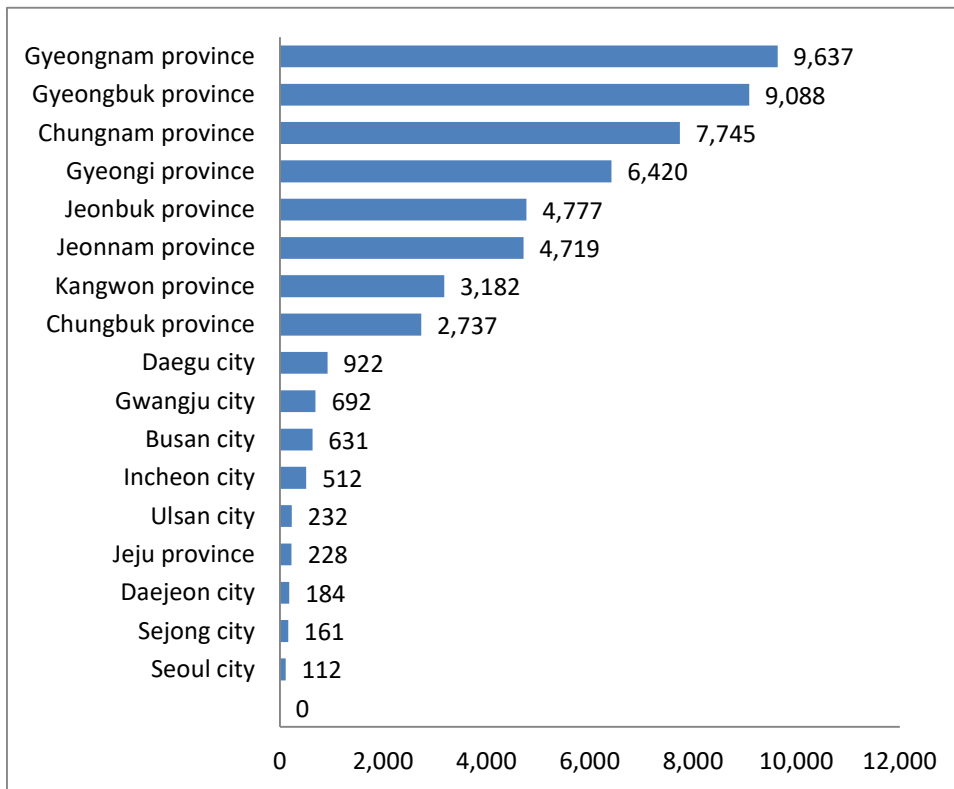
Table 6. Greenhouse types by energy source (2019, unit: Ha)

No heating	Heating												
	Solid fuel						Oil				gas	electricity	Geothermal
	Waste wood	briquette	Coal coke	Waste tire	Wood pellet	Others	Diesel	Heavy oil	kerosene	Others			
30,348	82	167	37	1	586	276	4,686	1,636	1,949	462	84	1,420	237

Gyeongsangbuk and Gyeongsangnam provinces in south-east of the country are the main vegetable greenhouse districts in Korea, which have the geographic advantages for transportation of fresh vegetables to

Japan. According to the 2019 statistics, around 36% of greenhouses are located in these provinces. The most fast-growing greenhouse area in Korea however is in south-west of the country (Jeonbuk, Jeonnam and Chungnam provinces) as several reclaimed land projects are implemented in this region.

Figure 7. Vegetable greenhouse area by province (2019, unit: ha)



2) Greenhouse for ornamental plants

Total greenhouse area for ornamental plants was 2,024 ha in 2019, of which 1,918 ha were plastic greenhouse and 57ha were glass greenhouses. Most of cut flowers and pot plants in Korea are grown in greenhouses.

Ornamental plant growers are less positive about high-tech greenhouses than vegetable growers who are aware of the necessity of high-tech greenhouses for the production of high-value vegetables meant for export. As mentioned earlier, the Korean flower sector aims at ceremonial uses rather than individual uses. The demand for high quality flowers is relatively low, and farmers prefer cheap low-tech plastic greenhouses. This is the reason why the glasshouse area for ornamental plants decreased from 140 ha in 2002 to 57ha in 2019.

Greenhouse for ornamental farms are largely located in Gyeonggi province where farmers can transport flowers easily to Seoul.

Figure 8. Greenhouse area for ornamental plants by year (unit: ha)

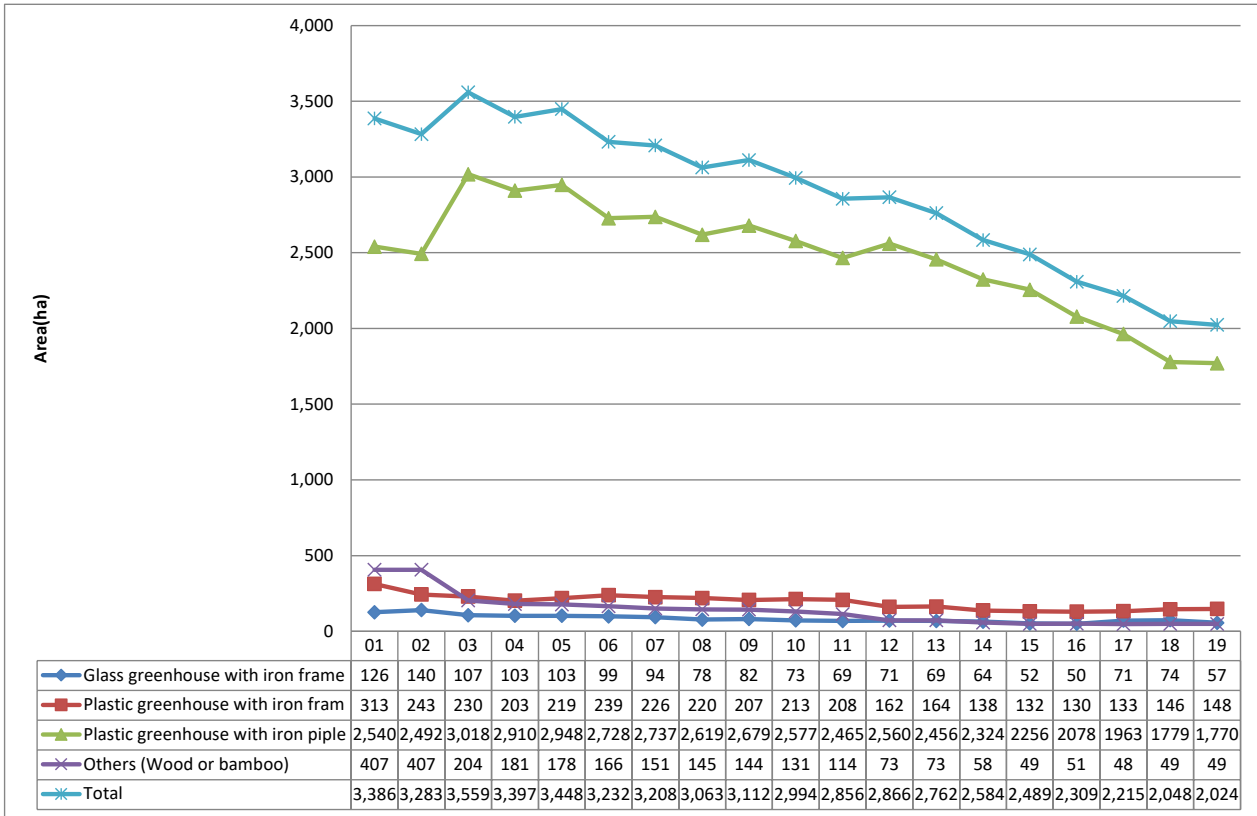
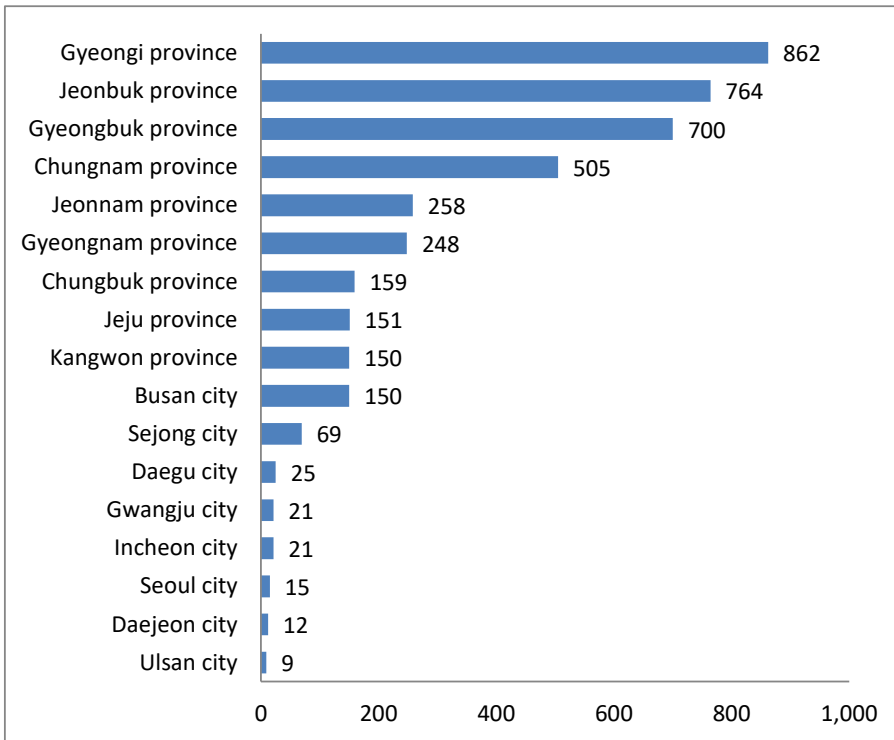


Figure 9. Ornamental plant greenhouse area by province (2019, unit: ha)



3. History of Korean greenhouse horticulture and lessons learned

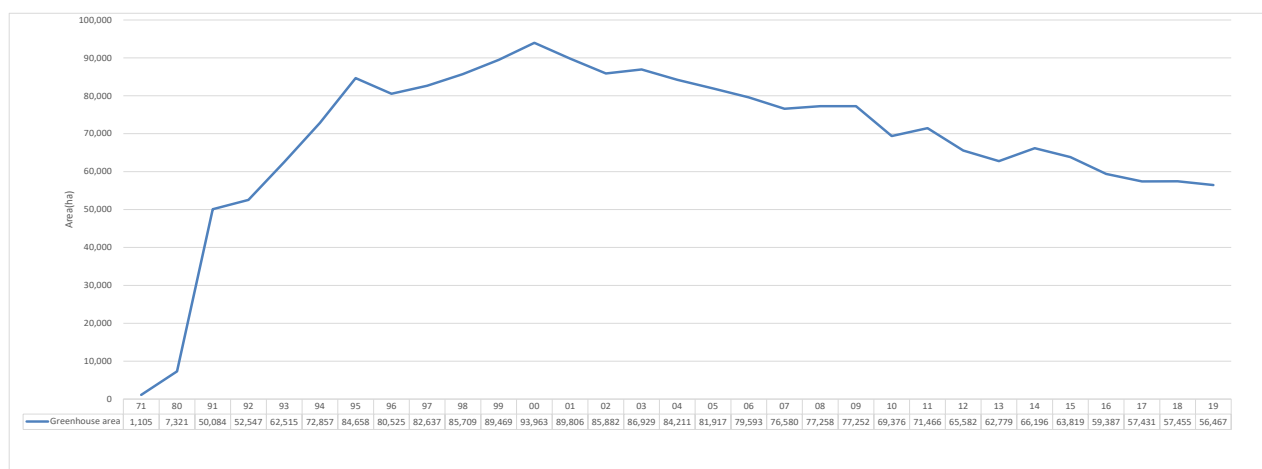
1) Before 1990: development of plastic greenhouse

Korea has an extreme climate with hot and humid summers, and cold and dry winters. Korean farmers started growing some vegetables in plastic greenhouses in the winter to avoid hot summer's sun. The amount of sunshine in Korea is much more than in the Netherlands (Korea: 2,420 hrs, The Netherlands: 1,480 hrs), and Koreans believed that plastic was enough for growing horticultural crops. As Korean farmers were small and couldn't afford to pay for modern glasshouses, Korea developed cheaper plastic greenhouses without sophisticated system for them. Korea calls this development in 1980s and 1990s "white revolution".

Picture 1. Korea's low-tech greenhouses



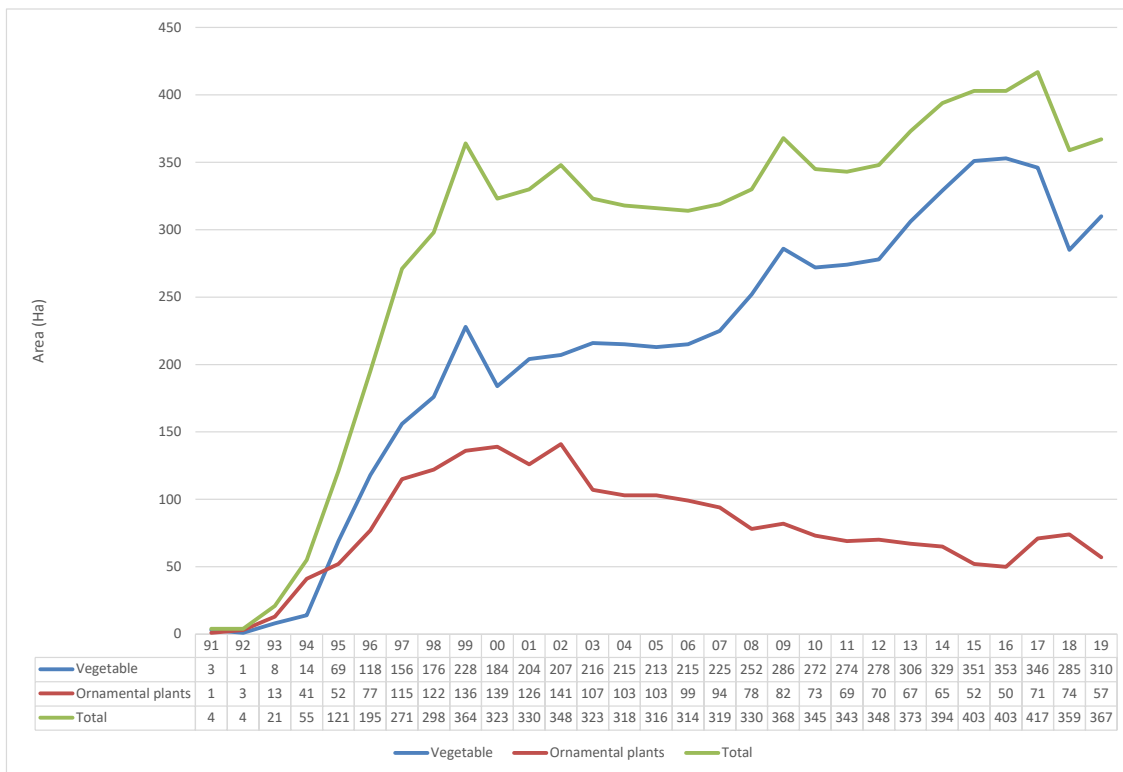
Figure 10. Total greenhouse area by year (ha)



2) 1990~1999 – Start of subsidy program for glasshouses

In 1990s, Korean greenhouse horticulture continued to grow. In order to make the greenhouses more efficient and to modernize them, MAFRA (Korean ministry of agriculture) made a subsidy program for hi-tech greenhouses. Many vegetable and flower farmers applied for the subsidy program, and hi-tech greenhouses were largely built based on the program. Most of greenhouses were built by Dutch greenhouse builders on a turnkey basis, because local (plastic) greenhouse builders had little knowledge or technology for hi-tech greenhouses. There were two requirements for those who wanted to receive the subsidy: 1) more than two farmers should work together for the greenhouse and 2) the products should be exported.

Figure 11. Glass greenhouse area by year (ha)



* Lessons learned in the cooperation between Korea and the Netherlands in 1990s

- By working together between the two countries, several success cases were made; Korea became the largest exporter of paprika to Japan. Most of the leading vegetable exporters in Korea were established in this period.
- The requirement for the partnership of more than two farmers was an obstacle to success: farmers often conflicted due to lack of spirit of cooperation.
- Most of greenhouses for ornamental plants were not successful. Korean flower farmers suggest that expensive glasshouses are not necessary for flowers because Koreans don't have an eye for high-quality flowers produced in hi-tech glasshouses. Thus, most of recent state-of-the-art greenhouses are concentrated on vegetable farming.

Picture 2. Mid-tech plastic greenhouse for rose



3) 2000~2008– Stagnation

After the subsidy program was finished, there was almost no large-scale glasshouse project in Korea. Since local farmers are not big or wealthy enough to pay for hi-tech greenhouses, no one could invest in new hi-tech greenhouse projects without a subsidy provided by the government. Many Dutch companies and their local partners therefore left the sector in Korea.

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Picture 3. Mid-tech plastic greenhouse for tomato with an automatic roof vent



4) 2009~ 2013 – Unfruitful efforts to revive the sector

MAFRA (Korean Ministry of agriculture) announced a large scale agri-food complex project in 2009. The plan was to lease reclaimed lands such as Saemangeum, Youngsan river and Hwaong (locations indicated in picture 3) to large-scale companies and offer support for infrastructure and fund. The Korean government promoted hi-tech greenhouses for these areas because they believed hi-tech greenhouse horticulture would promote agricultural export.

Around 114 ha in Saemangeum, 200 ha in Youngsan River and 100 ha in Hwaong were assigned to agriculture companies. One of the largest investors was Dongbu group, the largest fertilizer maker in Korea, which secured 50 ha in Saemangeum and 100 ha in Hwaong for vegetable farming. 50 ha in Youngsan-river was assigned to Hanbetall, a new company established by paprika farmers near Youngsan-river area. Nongsan trading which had been successful in exporting paprika to Japan since 1990s also received 64 ha in Saemangeum. Many other non-agricultural companies were also interested in vegetable farming in hi-tech greenhouses.

However, the projects failed or came to a sudden halt: Dongbu group had begun building the Asia's largest, cutting-edge glass greenhouse of 12 ha in size, with an investment of KRW 57 billion (EUR 43 million) in Hwaong in February 2011. Dongbu completed the greenhouse late 2012 and began growing tomatoes, with harvest and exports scheduled in March 2013. Right after the completion of the greenhouse, Dongbu decided to halt its massive glass greenhouse business at Hwaong. The decision was reached as the nation's agricultural community vehemently protested against the business, saying the Dongbu's entry into the large-scale farming sector threatened their livelihoods. Dongbu group, as a result, stopped all its on-going projects and horticulture plans not only in Hwaong but also in Saemangeum. After a long controversy, the greenhouse in Hwaong was sold to a company called Wooil farm. This case impacted all the ongoing discussions regarding the development of the Korean horticulture, leading to the government's decision to also stop supporting agricultural companies for greenhouse projects. Hanbetall was not financially able to continue the project without financial supports by the government. Nongsan Trading also decided not to proceed with the project.

In this period, the Korean farmers who had learned about Dutch greenhouse horticulture systems through Dutch practical training companies or institutes tried build their own greenhouses which was not necessarily on a turnkey basis. Many greenhouses were built with a combination of Dutch climate control system, Dutch interior automation system, local frame/aluminum/glasses (constructed by local companies) and other local products. Dongbu greenhouse in Hwaong was also built in this way. However, not having the necessary knowledge and system support, the farmers faced a number of challenges after the completion of these greenhouses, such as experiencing mis-match between systems or water leakage.

Picture 4. Reclaimed lands for greenhouses in Korea



Lessons learned from the projects between 2009 and 2013

- Opposition by local farmers is an obstacle in greenhouse business in Korea. For conglomerates who want to start horticultural business in Korea, they have a higher chance of succeeding by not receiving any subsidy from the Korean government in order to avoid confrontations with Korean farmers.

- Small companies or cooperatives of small farmers are usually not financially strong. As it is generally not easy to receive subsidies from the central or regional government, these farmers or cooperatives are likely to give up their projects or plans if they fail to secure subsidies.- Local greenhouse builders are very strong in lobbying to get greenhouse building projects. They used to make their own products through acquired knowledge about Dutch products, but the quality is often not satisfactory to local farmers.
- In relation to ambitious governmental greenhouse projects, many regional or central government officials or researchers visited the Netherlands to learn about Dutch horticulture. Most of these visits have not resulted in actual cooperation or business. The effectiveness of such visits need to be checked more carefully.

5) 2014~ 2017 – a difficult market with limited opportunities

After the symbolic case of Dongbu, all the discussions to make large modern greenhouse districts were canceled or suspended. Conglomerates which were considering to invest in agriculture also withdrew their plans. After some time, LG group (LG CNS) tried to join hi-tech horticulture by making more than 100 ha glasshouses in Saemangeum. This project was also withdrawn due to opposition by farmers' organizations. Under this situation, two different ways were developed to continue financing hi-tech greenhouses:. One way was governmental support for promising farmers. Korean government chose a couple of promising farmers and financed their plans for building hi-tech greenhouses. Woodeumgee farm built 2 ha semi-closed greenhouse in this way. This farm is successfully expanding business. The second way was participation by SME companies. Korean farmers are very sensitive about conglomerates' penetrating or influencing the agriculture sector. JOIN, one of the largest egg companies, made 3 ha of hi-tech greenhouse to start a horticulture business without having any trouble with farmers or farmers' organizations.

Picture 5. A semi-closed greenhouse built by a local farmer in cooperation with a NL horticulture company



Lessons learned in the projects between 2014 and 2017

- Opposition by local farmers is still an obstacle in greenhouse horticulture business in Korea, but it is becoming much weaker. As long as it is not a renowned conglomerate, any companies can enter the sector.

6) 2018- now – smart farming is becoming a trend

“Smart Farm” is becoming a trend as a new business for the future. The trend started when the Korean government announced “the fourth industrial revolution” policy in 2018. In line with this line of policy, MAFRA (Korean ministry of agriculture) designated 4 Smart Farm Innovation Valleys(SFIVs) at Sangju, Gimje, Goheung and Miryang, where hi-tech agriculture training centers, greenhouses / vertical farms for lease and demo farms would be established. The Netherlands’s involvement and support in these projects is limited, as the Korean government generally does not involve foreign companies in governmental projects. Having said this, the facilities are already facing a number of challenges each valley has trouble securing knowledge or trainers. Other than the 4 SFIVs, a couple of regional governments or organizations are also working on state-of-the-art greenhouses, demo farms, training centers and agro-tourism districts. The Agriculture office at the embassy of the Netherlands in Seoul is keeping in touch with some of them, who are open to Dutch companies and technologies.

This trend raised awareness about greenhouse horticulture among non-agricultural businesses including financial services, making it easier for farmers to receive funds from banks. Several greenhouse projects were funded in this manner.

4. Summary of opportunities and obstacles for Dutch horticulture companies

- The policy of the Korean government is to promote more added-value agriculture and agri-food exports. To accomplish it, Korea focuses on hi-tech greenhouse horticulture in new (reclaimed) lands. Many of greenhouse projects planned for reclaimed lands have been canceled or delayed due to lack of investment and/or opposition from existing farmers. In spite of that, this policy and direction will remain unchanged.

- If the Korean customer is a conglomerate, opposition by local farmers may be an obstacle in greenhouse projects.

- If the Korean customer is a small farmer or an SME company, they will most likely not face any resistance from other farmers. Dutch horticulture companies wishing to cooperate with such companies however need to check whether the customer has already secured the required budget. Small farmers or companies rely very much on governmental supports, and it is not always successful to acquire subsidies from the government.

- There are several local greenhouse builders, with limited level of technology. From lessons learned over the last decades, experienced farmers in Korea are aware of the problems in greenhouses built by local builders. In spite of that, local builders would get projects as a result of their strong lobbying activities.

- Korean customers have a tendency to ask Dutch horticulture companies a lot of information before starting their greenhouse projects. Koreans are generally very precise and demanding when it comes to details. Dutch builders are often left with no choice but to provide the relevant information. It is recommended to have a close

conversation with Korean customers from the beginning to create and secure trust between both parties and to avoid unfair treatment and leaving with empty hands.

- It is not always easy to start business in Korea due to two fundamental reasons; one is the language barrier and the other is acquiring the needed license(s) for doing business in Korea. Koreans, notably elder generation, cannot speak English well. For greenhouse construction, it requires a construction license owned by a Korean person. It is critical therefore to find right Korean partners who can speak English and arrange the needed license. Good network and experience in the greenhouse horticulture sector are also important. The agriculture office, LAN Seoul, has been playing a crucial role in bringing the parties together and facilitating new or expanding businesses across Korea.

5. Relevant fairs & magazines

1) Fairs

TAMAS: Agricultural machinery and Seeds show, covering various agricultural items such as machinery, greenhouse, seed, fertilizer and etc.

The website is <http://www.tamas.or.kr>. This show is held in November every other year, and the next one is in 2021.

KIEMSTA: Korean International Exhibition of Machinery, Equipment, Science and Technology for Agriculture.

The website is http://kamico2020.ezshosting.com/kor/sub01/sub_01_1.html. This show is held in October every other year, and the next one is in 2022.

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2) Magazine

The Monthly Horticulture (<http://www.hortitimes.com>) is the most read magazines among horticulture stakeholders. It is in Korean language.

6. Source

- Statistics from MAFRA (<http://www.mafra.go.kr>)

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This publication was commissioned by the ministry of Foreign Affairs.

© Netherlands Enterprise Agency | August 2021
Publicationnumber: RVO-167-2021/RP-INT

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