

A Simulation Analysis on the Economic Impact of U.S. Tangerine Importing in the Korean Citrus Industry

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미국 탄저린 수입이 감귤산업에 미치는 경제적 파급효과의 시뮬레이션 분석

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Abstract The acreage of tangerines in the U.S. sharply rose from 19,000 ha in 2009 to 27,000 ha in 2016, an increase of 42% in 7 years. Considering the recent surge in tangerine exports to Japan, the export volume of 6-7 thousand tons is highly likely to increase in the future. Therefore, the purpose of this study was to analyze the economic impact of U.S. tangerine imports on the Korean citrus industry under various scenarios. In order to examine the possibility of imports of U.S. tangerines, the unit price of U.S. exports to Japan was used since U.S. tangerines are not imported to South Korea. Citrus fruits are divided into field citrus, house citrus, and late-maturing citrus (including winter season citrus) based on the cultivation method and variety used to analyze. Considering both the field and house seasons, the import volume of U.S. tangerines can be expected to rise from roughly 4,700 tons in 2021 to 10,000 tons in 2027. Imports of U.S. tangerines may be pushed up or delayed depending not only on the harvest method and quality of domestic field and house citrus but also on the harvest of U.S. tangerines. However, it is necessary to note that tangerines could be imported after 2021, when the tariff rate on U.S. tangerines will fall below 50%.

요약 미국의 탄저린 감귤류 재배면적은 2009년 19,000ha에서 2016년 27,000ha로 급격히 증가하여 7년 동안 42% 증가했다. 최근 일본으로의 수출이 급증함에 따라 향후 약 6~7천 톤의 수출량이 증가할 가능성이 높다. 따라서, 본연구의 목적은 미국 탄저린 수입이 감귤산업에 미치는 경제적 파급효과를 다양한 시나리오를 통해 시뮬레이션 분석을 하는데 있다. 미국 탄저린감귤의 수입 가능성을 조사하기 위해 미국 감귤이 수입된 적인 없기 때문에 미국 탄저린 감귤의 일본 수출 단가가 사용되었다. 감귤류는 재배 방법과 품종에 따라 노지감귤, 하우스감귤, 한라봉 등 만감류(월동 온주 포함)로 분류하였다. 노지와 하우스감귤의 생산시즌을 고려해 보면, 미국 탄저린감귤의 수입량은 2021년 약 4,700 톤에서 2027년에는 10,000톤으로 증가할 것으로 예상된다. 미국 탄저린감귤의 수입은 국내산 노지와 하우스감귤의 생산량과 품질뿐만 아니라 미국산 탄저린감귤의 생산량에 따라 변동될 수 있다. 그렇지만, 미국 탄저린감귤의 관세율이 50% 이하로 떨어지는 2021년 이후에는 수입될 수 있다는 점을 명심해야 한다.

Keywords : U.S. Tangerine, Economic Impact, Simulation Analysis, Korean Citrus Industry, Demand-Supply Equilibrium Model, Dynamic Recursive Simulation

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1. Introduction

The acreage of tangerines in the U.S. has been increasing sharply after 2010. The acreage rose from 19,000ha in 2009 to 27,000ha in 2016, an increase of 42% in seven years. As a result, the total output was 596,000 tons in 2009 and exceeded one million tons in 2016. The output exceeded out of Korean citrus output. According to the U.S. tangerine production trend by region, an attention needs to be paid to the fact that the outputs in Florida and Arizona constantly declined, but those of California rapidly grew. The output between 2016/17 was 868,000 tons, an increase of 141% from that of 2009/10, providing a lot of implications for us to consider. According to U.S. tangerine export volume by nation, the proportion Japan accounted for was particularly large and the proportion of export to Japan has been rapidly increasing. The proportion rapidly rose from 31% in 2013/14 to 56% in 2017/18. Considering the recent surge in exports to Japan, the export volume of around 6-7 thousand tons is highly likely to increase further in the future[1-3].

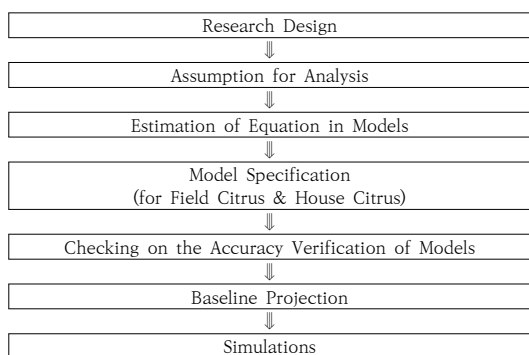


Fig. 1. Main Frame to Research

U.S. tangerines have not been imported to South Korea so far, however considering the case of Japan, U.S. tangerines might be imported to South Korea at any time. This study focus to review the possibility to import U.S. tangerines

and to simulate to analyze on the Economic Impact of U.S. Tangerine Importing in the Korean Citrus Industry. In order to examine the possibility of imports of U.S. tangerines, the unit price of U.S. export to Japan is used. Citrus fruits are divided into field citrus, house citrus, and late-maturing citrus(including winter season citrus) based on the cultivation method and the variety to analyze and the supply-demand equilibrium models are specified to simulate. This paper was carried out to compensate based on the research report[1].

2. Assumption for Analysis

In order to simulate on the economic impact of U.S. tangerines importing, the field citrus model and house citrus model are used, because the U.S. tangerines could be imported to South Korea in the harvested seasons of field citrus and house citrus. Here is what we introduce several assumptions for analysis[1, 5]

The total population is derived from the estimate of the future population by the Statistics Korea. The economic growth rate is presumed based on the projections made by the Bank of Korea and the recent government's macroeconomic policy. For the medium- to long-term exchange rates, since no projections from specialized agencies are available, it is assumed that the average level of 2018 will be maintained afterwards. The consumer price is based on the projection made by the Bank of Korea(as of January 2018) and is assumed to remain at an annual average of 1.7% in 2018 and 2.0% from 2019 to 2027. To make each economic variable within the demand and supply models real variable, the GDP deflator and the Consumer Price Index(CPI) are used: however, a medium- to long-term GDP deflators are estimated by using variables, such as the economic growth rate, the consumer price, and the exchange

rate[1, 9-10].

The import unit price of U.S. oranges is determined by examining the import unit price of the past three years for each season(for field citrus, and house citrus). For the import unit price of U.S. cherries, that of 2017 is used[1, 7-10].

For the import unit price of U.S. tangerines, Japan's recent import unit price is reflected. The import unit price during the house season is based on Japan's 2017 import unit price. In order to reflect the competitive relationship with high quality house citrus, the unit price differences between high quality and medium quality U.S. tangerines are taken into account, and the inflation rate(an annual average of 2%) is also considered[1].

Table 1. Import Price from US (USD/MT)

Category	Field Citrus Season	House Citrus Season
Oranges	1.56	1.54
Cherries	-	9.10
Tangerines	1.50	1.99

Source: Korea Customs Service, USDA/ERS

U.S. cherries are imported from January to March and from September to December, and the import volume is low in April and that the imports of the fruit are concentrated between May and August. Such a monthly import trend of cherries is reflected in the model for house citrus[1, 4-6].

3. Estimation Results of Major Equations

We introduce the estimation results of main equations in the field citrus model and house citrus model as follows. The estimation method makes use of the ordinary least squares[1-2].

<Field Citrus Model>

- Acreage for Field Citrus (1,000 ha)
 - Dependant Variable: LOG(FLD_ACR)
 - R²: 0.932, D-W: 2.290, SAMPLE: 1992-2017

Variable	Estimate	t-value
LOG(INPUTP/GDPDEF)	-0.05081	-0.57208
LOG(FLD_NFP(-1)/GDPDEF(-1))	0.01366	0.55347
LOG(FLD_NFP(-2)/GDPDEF(-2))	0.08063	3.71592
LOG(FLD_NFP(-3)/GDPDEF(-3))	0.01751	0.76171
LOG(FLD_ACR(-1))	0.93439	10.81029
Constant	-0.05251	-0.19970

Note. FLD_ACR: Acreage for field citrus, INPUTP: Input price
FLD_NFP: Field citrus price received by farmers
GDPDEF: GDP deflator

- Field Citrus Price Flexibility Function (KRW/kg)
 - Dependant Variable: LOG(FLD_NCP/GDPDEF)
 - R²: 0.528, D-W: 1.687, SAMPLE: 1997-2016

Variable	Estimate	t-value
LOG(FLD_PERD)	-0.85320	-2.85311
LOG(FLD_FP_USORG/GDPDEF)	0.21131	0.78269
DM_FLD_NCP('02, '12, '15)	-0.25893	-2.06356
Constant	3.87584	3.02130

Note. FLD_NCP: Field citrus auction price at a wholesale market
FLD_PERD: Per capita field citrus consumption
FLD_FP_USORG: U.S. orange price
GDPDEF: GDP deflator
DM_FLD_NCP: Dummy variable

- Field Citrus Price Received by Farmers (KRW/kg)
 - Dependant Variable: LOG(FLD_NFP)
 - R²: 0.787, D-W: 2.106, SAMPLE: 1995-2017

Variable	Estimate	t-value
LOG(FLD_NCP)	1.07417	8.80639
Constant	-1.10810	-1.27903

Note. FLD_NCP: Field citrus auction price at a wholesale market
GDPDEF: GDP deflator

- U.S. Orange Import Volume (1,000 tons, during the field citrus season)
 - Dependant Variable: LOG(FLD_IMQ_USORG)
 - R²: 0.894, D-W: 1.707, SAMPLE: 2006-2017

Variable	Estimate	t-value
LOG(FLD_FP_USORG/GDPDEF)	-2.69777	-5.33364
LOG(FLD_NCP/GDPDEF)	0.89548	2.15557
DM_FLD_IMQ_USORG ('08, '11, '14, '17)	-0.84182	-4.88593
Constant	15.63016	8.71447

Note. FLD_IMQ_USORG: U.S. orange import volume
FLD_FP_USORG: U.S. orange price
FLD_NCP: Field citrus auction price at a wholesale market
DM_FLD_IMQ_USORG: Dummy variable

〈House Citrus Model〉

- Acreage for House Citrus (ha)
 - Dependant Variable: LOG(HUS_ACR)
 - R²: 0.976, D-W: 2.676 SAMPLE: 1992-2017

Variable	Estimate	t-value
LOG(HETP(-1)/GDPDEF(-1))	-0.28706	-4.97795
LOG(HUS_NFP(-1)/GDPDEF(-1))	0.09023	0.70740
LOG(HUS_NFP(-2)/GDPDEF(-2))	0.08856	0.75288
LOG(HUS_NFP(-3)/GDPDEF(-3))	0.03530	0.33240
LOG(HUS_ACR(-1))	0.65549	17.28227
DM_HUS_ACR(99)	0.36973	5.09844
Constant	1.21372	2.38133

Note, HUS_ACR: Acreage for house citrus
 HETP: Farm light and heat expenses
 HUS_NFP: House citrus price received by farmers
 GDPDEF: GDP deflator
 DM_HUS_ACR: Dummy variable

- House Citrus Price Flexibility Function (KRW/kg)
 - Dependant Variable: LOG(HUS_NCP/GDPDEF)
 - R²: 0.860, D-W: 2.549, SAMPLE: 2006-2016

Variable	Estimate	t-value
LOG(HUS_PERD)	-0.52359	-1.93259
LOG(HUS_PERD_CRY)	-0.00946	-0.18168
LOG(HUS_FP_USORG/GDPDEF)	0.21370	0.85561
LOG(PNDINC/GDPDEF)	1.14411	1.47238
DM_HUS_NCP1(06, '14-'16)	-0.12784	-2.86596
Constant	-7.55564	-0.73386

Note, HUS_NCP: House citrus ex-farm price to Nonghyup stores
 HUS_PERD: Per capita house citrus consumption
 HUS_PERD_CRY: Per capita U.S. cherry consumption
 HUS_FP_USORG: U.S. orange price
 PNDINC: Per capita national disposable income
 GDPDEF: GDP deflator
 DM_HUS_NCP1: Dummy variable

- House Citrus Price Received by Farmers (KRW/kg)
 - Dependant Variable: LOG(HUS_NFP)
 - R²: 0.915, D-W: 1.780, SAMPLE: 2000-2017

Variable	Estimate	t-value
LOG(HUS_NCP)	0.66699	12.67006
DM_HUS_NFP(12, '14, '15)	-0.14776	-4.68019
Constant	2.47889	5.65590

Note, HUS_NFP: House citrus price received by farmers
 HUS_NCP: House citrus ex-farm price to Nonghyup stores
 DM_HUS_NFP: Dummy variable

- U.S. Cherry Import Volume (ton)
 - Dependant Variable: LOG(HUS_IMQ_USCRY)
 - R²: 0.972, D-W: 2.030, SAMPLE: 2001-2017

Variable	Estimate	t-value
LOG(HUS_FP_USCRY/GDPDEF)	-1.50931	-2.96490
LOG(HUS_NCP/GDPDEF)	0.87293	0.84054
DM_HIMQ_USCRY(03, '09, '15)	0.05253	0.42655
AR(1)	0.90426	17.65874
Constant	14.42169	2.48539

Note, HUS_IMQ_USCRY: U.S. cherry import volume
 HUS_FP_USCRY: U.S. cherry price
 HUS_NCP: House citrus ex-farm price to Nonghyup stores
 GDPDEF: GDP deflator
 DM_HIMQ_USCRY: Dummy variable

- U.S. Orange Import Volume (ton, during the house season)
 - Dependant Variable: LOG(HUS_IMQ_USORG)
 - R²: 0.840, D-W: 2.335, SAMPLE: 2007-2017

Variable	Estimate	t-value
LOG(HUS_FP_USORG/GDPDEF)	-1.22538	-1.83394
LOG(HUS_NCP/GDPDEF)	1.13601	0.73333
DM_HUS_IMQ_USORG(11, '12)	0.51579	2.88034
AR(1)	-0.50361	-2.43152
Constant	5.86696	0.75869

Note, HUS_IMQ_USORG: U.S. orange import volume
 HUS_FP_USORG: U.S. orange price
 HUS_NCP: House citrus ex-farm price to Nonghyup stores
 GDPDEF: GDP deflator
 DM_HUS_IMQ_USORG: Dummy variable

4. Accuracy Verification of the Models

A comparison between simulated values from the model and actual values during the out-of-sample period(2013-2016) is carried out to check the prediction accuracy of the simulated values. The RMSPE(Root Mean Square Percent Error) are used as criteria to check the accuracy[1].

Table 2. Verification of Prediction Accuracy(RMSPE) (Verification period: 2013-2016)

Cropping Pattern	Acreage	Output	Consumption	Auction Price
Field Citrus	5.55	11.26	13.26	15.51
House Citrus	8.03	7.12	7.13	6.52

As a result of the prediction accuracy of the model, a prediction accuracy is displayed in acreage for field citrus of 5.55%, output of

11.26%, consumption of 13.26%, and auction price of 15.51%. A relatively satisfactory prediction accuracy is exhibited in the acreage, and the output[1, 4]. As for the house citrus model, a very satisfactory prediction accuracy is displayed with acreage of 8.03%, output of 7.12%, consumption of 7.13%, and auction price of 6.52%. This is thought to be the results of the constant pattern of supply and demand quantity and prices as the quality of house citrus does not vary much from year to year[1, 2, 4].

5. Baseline Projection(2020–2027)

The outlook may vary depending on the changes in the conditions of the citrus industry, including the yield of citrus fruits with respect to weather conditions, macroeconomic conditions, import situations, and introduction policies. The acreage of field citrus plunged from 13,870ha (estimate) in 2020, showing a gradual decrease afterwards, it is expected to reach 12,500ha in 2025, and 12,300ha in 2027[1, 3].

Table 3. Baseline Projection of Field Citrus

	Acreage	Output	Price received by farmers	Import of U.S. oranges	Gross Revenue (real)
	000ha	000tons	KRW/kg	ton	Hundred M KRW
2020 (est.)	13.87	427.9	958.04	5,369.2	3,648.6
2025	12.46	384.6	1,174.59	6,970.1	3,745.3
2026	12.35	380.9	1,205.38	7,269.4	3,762.3
2027	12.27	378.6	1,231.69	7,557.2	3,774.8

Gross revenue is expected to remain at the current level due to the modest price increase effect caused by a decrease in the mid- to long-term market supply. Field citrus seems to be affected mainly by the demand of field citrus and policy variables, rather than external variables since it is the season that seasonal tariffs of U.S. oranges are not applied and that the impact of U.S. cherries is insignificant. Therefore, it is

necessary to make a special effort to boost demand regarding production and distribution policies for quality improvement. In other words, without the quality improvement of field citrus, the possibility that the production sector will shrink even more than expected can not be ruled out[1].

Recently, the acreage of house citrus rapidly increased from 284ha(actual) in 2016 to 321ha(tentative) in 2018. Even though seasonal tariffs are applied to U.S. oranges during the house citrus season and U.S. cherries continue to be imported, the acreage increased rapidly because the effect of moving from winter season citrus to house citrus worked as the main factors. There will be no further effects from tariff cuts because tariffs haven't been imposed on U.S. oranges since 2018[1].

Table 4. Baseline Projection of House Citrus

	Acreage	Output	Price received by farmers	Import of U.S. cherries	Gross Revenue (real)
	ha	000tons	KRW/kg	000tons	Hundred M KRW
2020 (est.)	331.07	25.7	3,976.3	18.2	900.9
2025	332.11	25.8	4,438.5	21.9	949.6
2026	332.14	25.8	4,540.2	22.6	959.8
2027	330.48	25.7	4,652.4	23.6	966.8

However, the recent hike in cherry imports has slowed the acreage growth trend, so the acreage is expected to reach 332.1ha in 2025 and 330.5ha in 2027. As a result, the actual price received by farmers is expected to slightly rise to 96.69 billion KRW in 2027, up by 15.6 billion KRW from 2017. However, due to the above-mentioned surge in U.S. cherry importation during the house season and the expected import of U.S. tangerines, which will be discussed in the next section, it is believed to be the cultivation method which demands a special attention. In addition, it seems that there will be significant production shrinkage and losses of net income if no proper action is taken[1, 3-4].

6. Simulation of U.S. Tangerine Effects

The acreage of tangerines in the U.S. sharply rose from 19,000ha in 2009 to 27,000ha in 2016, an increase of 42% in seven years. As a result, the total output was 596,000 tons in 2009 and exceeded one million tons in 2016 with 693,000 tons of fresh tangerines and 340,000 tons of processed ones[1, 4-5].

Table 5. Acreage and Output of U.S. Tangerines

Year	Acreage (000ha)	Output (1,000 tons)		
		Total	Fresh	Processed
2009/2010	19	596	462	134
2011/2012	21	644	512	132
2013/2014	24	726	604	122
2015/2016	26	935	625	310
2016/2017	27	1,033	693	340

Source: USDA, *Citrus Fruits summary*, each year

According to the U.S. tangerine production trend by region, an attention needs to be paid to the fact that the outputs in Florida and Arizona constantly declined, but those of California rapidly grew. The output between 2016/17 was 868,000 tons, an increase of 141% from that of 2009/10, providing a lot of implications for us to consider[1].

Table 6. Output of U.S. Tangerines by region (unit: 1,000tons)

Year	2009/10	2011/12	2013/14	2015/16	2016/17
Florida	192	183	125	61	70
California	360	396	534	788	868
Arizona	13	7	5	-	-

Source: USDA, *Citrus Fruits summary*, each year

According to U.S. tangerine export volume by nation, the proportion Japan accounted for was particularly large and the proportion of export to Japan has been rapidly increasing. The proportion rapidly rose from 31% in 2013/14 to 56% in 2017/18. Considering the recent surge in exports to Japan, the export volume of around

6-7 thousand tons is highly likely to increase further in the future[1]. The numbers in the parentheses in Japan mean the proportion of export to Japan. The monthly export trends of U.S. tangerines show that the exports are slow between February and April and concentrate during field and house seasons. Considering the production and export trends of U.S. tangerines, it is necessary to take into account the situation in which U.S. tangerines are imported to South Korea during field and house seasons and conduct a virtual simulation analysis to understand its import possibility and ripple effects[1, 5-6].

Table 7. U.S. Tangerine Export Volume by Nation (unit: 1,000 tons)

Year	Japan	Netherlands	Canada	Belgium	New Zealand	Mexico
2013/14	5,516 (31)	3,056	5,460	2,266	42	353
2014/15	7,543 (40)	5,893	3,698	578	0	406
2015/16	6,480 (50)	1,163	3,161	749	23	423
2016/17	7,010 (54)	3,050	545	664	269	201
2017/18	6,564 (56)	2,960	-	29	776	44

In order to examine the possibility of imports of U.S. tangerines, the unit price of U.S. export to Japan is used because U.S. tangerines are not imported to South Korea. We assumed that the import unit price(CIF) of U.S. tangerines that Japan paid was 1.5 USD/kg and estimated the wholesale price after reflecting distribution costs. The tariff rate for U.S. tangerines continued to decline from 144% in 2011 and is expected to be "0" in 2026, suggesting that the estimated wholesale price of U.S. tangerines may fall under that of field citrus in 2025. As such, this study analyzed the market impact by assuming that U.S. tangerine imports would start from 2025[1, 3-4].

Table 8. Simulation of U.S. Tangerines(Field Citrus)

	Acreage	Output	Wholesale price	Estimated tangerine wholesale price	Import of tangerines
	000ha	000 tons	KRW/kg	KRW/kg	000 tons
2020 (est.)	13.87	427.90	1,721.8	2,916.3	-
2024	12.64	389.91	1,995.3	2,205.7	-
2025	12.46	384.55	2,031.1	2,028.1	3.80
2026	12.34	380.92	2,077.5	1,850.4	4.21
2027	12.25	378.12	2,121.9	1,850.4	4.21

According to the analysis, the import volume of U.S. tangerines would be 3.8-4.2 tons at an estimated wholesale price between 1,850 and 2,028 KRW in 2025-2027, which will result in a fall of field citrus price in the domestic market and lead to a decrease in the real net income by 4.69-5.24 billion KRW. The tangerine import unit price (CIF) is assumed to be 1.5 USD/kg, considering Japan's average annual import price[1].

Table 9. Simulation of U.S. Tangerines(House Citrus)

	Acreage	Output	Wholesale price	Estimated tangerine wholesale price	Import volume of tangerines
	ha	000tons	KRW/kg	KRW/kg	1,000 tons
2020 (est.)	331.07	25.72	6,060.1	4,547.1	-
2021	332.38	25.82	5,790.8	4,355.5	4.69
2022	330.89	25.71	5,970.1	4,154.4	4.95
2023	328.15	25.49	6,161.8	3,943.6	5.26
2024	325.60	25.30	6,355.1	3,722.6	5.62
2025	323.82	25.16	6,544.0	3,491.3	6.04
2026	322.54	25.06	6,727.7	3,249.2	6.55
2027	319.82	24.85	6,998.1	3,314.2	6.39

For the U.S. tangerine import unit price(CIF), the price differences between medium and high quality products and an inflation rate of 2% were taken into account in addition to Japan's import unit price of 2 USD/kg. Table 9 shows the results of the virtual simulation analysis of the ripple effects of U.S. tangerines on house citrus. It was assumed that high quality U.S. tangerines are selected and imported under the situation in which the quality and the price of house citrus are higher than those of field citrus. To reflect this situation, as explained in the table note, the

price differences between medium and high quality products(see hallabong) and the inflation rate were considered with Japan's import unit price(CIF) of U.S. tangerines of approximately 2 USD/kg in 2017 as a base. As shown in the table, even though the estimated wholesale price of U.S. tangerines was 4,814 KRW/kg in 2017, which was lower than that of domestic house citrus, it can be assumed that it was difficult to import U.S. tangerines given that the average price of domestic house citrus was 4,281 KRW in 2005-2010(an average of three years except for the lowest and highest). However, the average wholesale price of domestic house citrus was higher than 5,136 KRW in 2011-2015(an average of three years except for the lowest and highest) and an upward trend continued afterwards. However, if the U.S. tangerine price keeps falling due to tariff cuts on U.S. tangerines, the fruit is likely to be imported. In other words, it is possible that U.S. tangerines would be imported at an estimated wholesale price below 4,500 KRW. Based on the results of this study, a virtual simulation analysis was conducted under the assumption that U.S. tangerines are imported from the estimated wholesale price of 4,356 KRW level in 2021. According to the analysis, the estimated wholesale price per kilogram of U.S. tangerines would drop from 4,356 KRW in 2021, due to continued tariff cuts, to 3,249 KRW in 2026 when tariffs are eliminated, leading to an increase in import volume of U.S. tangerines from 4,700 tons in 2021 to 6,600 tons in 2026. As the import volume increases, the acreage for house citrus appears to decline to 319.8ha in 2027, which is a slight decrease (1.2ha) from 321ha(tentative) in 2018. However, it is necessary to note that it can be reduced by as much as 10.86ha compared to the baseline projection, a situation in which U.S. tangerines are not imported. As import volume of U.S. tangerines rises, real net income is expected to fall from 4.53 billion KRW to 8.66 billion KRW. Considering both the field and house seasons,

the import volume of U.S. tangerines can be expected rise from roughly 4,700 tons in 2021 to 10,000 tons in 2027[1, 3, 7].

7. Conclusion

U.S. tangerines are not imported to South Korea, however the acreage of tangerines in the U.S. sharply rose since 2010. As a result, the total output also increased rapidly and exceeded one million tons in 2016 with 693,000 tons of fresh tangerines and 340,000 tons of processed ones. According to the U.S. tangerine production trend by region, an attention needs to be paid to the fact that the outputs in Florida and Arizona constantly declined, but those of California where is close to Asian countries rapidly grew. According to U.S. tangerine export volume by nation, the proportion Japan accounted for was particularly large and the proportion of export to Japan has been rapidly increasing[1, 3-4].

In order to examine the possibility of imports of U.S. tangerines, the unit price of U.S. export to Japan is used and the supply-demand equilibrium models for field citrus and house citrus are specified and accuracy verifications of the models is checked by the reference of RMSPE[1-4].

The simulation results show that considering the field citrus seasons, U.S. tangerines can be imported in 2025-2027, and considering the house citrus seasons, U.S. tangerines can be imported since 2021. However, the imports of U.S. tangerines may be pushed up or delayed depending on not only the harvest and quality of domestic field and house citrus but also on the harvest of U.S. tangerines. However, it is necessary to note that they could be imported after 2021, a year when the tariff rate on U.S. tangerines falls below 50%, and that it is urgent to come up with strategic countermeasures to respond to it[1].

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