

## Review of Rice: Production, Trade, Consumption, and Future Demand in Korea and Worldwide

Jong-Min Jeong<sup>1</sup>, Eun Chong Kim<sup>2</sup>, Shoba Venkatanagappa<sup>2</sup>, and Jeom-Sig Lee<sup>1,2,†</sup>

**ABSTRACT** Being a staple food for more than half of the population of the world and South Korea, rice is an important crop. For the past 20 years, global paddy rice cultivation area and production have shown an annual growth of 0.46% and 1.61%, respectively. Global rice consumption for food and processing has increased by 1.37% and 3.68%, respectively. Due to the main reason for such increasing human population, it is expected that from 439 million tons in 2010, additional 116 million tons will be needed in 2035. Global rice imports and exports have doubled in the last 20 years. However, in spite of such increment, global rice exports in 2013 were 8.4% of the total production. It is thought that rice protection policies in the producing countries are the main reason for such small scale of rice trading. In the past 5 years, India recorded the largest growth rate in rice exports (51.4%), whereas China showed the largest growth rate in imports (61.0%). For global utilization of milled rice during the same period, approximately 79.4% was used as food, 7.2% as animal feeds, and 1.4% for processing. Regionally, Asia has shown a similar pattern to the global rice usage, whereas utilization for processing in America, for food in Africa, and for animal feed in Europe was relatively higher than the global rice usage. Korea's cultivation area and production since the last 5 years, are 0.5% and 0.8% of those of the world, respectively. Its annual rice export is approximately 3,000 tons, which is 0.01% of the global rice export. Korea's rice utilization is high for food and low for feed and for processing relative to global rice utilization. Therefore, a review must be conducted to increase Korea's utilization of rice for processing and for feed production.

*Keywords* : consumption, demand, global rice, Korean rice, production, trade

### ABBREVIATIONS

aT : Korea Agro-Fisheries & Food Trade Crop  
CGIAR : Consultative Group for International Agricultural Research  
CIAT : International Center for Tropical Agriculture  
FAO : Food and Agricultural Organization  
GRiSP : Global Rice Science Partnership  
IRRI : International Rice Research Institute  
MAFRA : Ministry of Agriculture, Food and Rural Affairs of Korea  
RDA : Rural Development Administration of Korea  
SK : Statistics Korea  
USDA : United States Department of Agriculture

**Rice**, globally, is a socially and economically important crop. It is a staple food of more than a half of the world's population (IRRI *et al.*, 2013). Rice provides 21% of global human per capita energy and 15% of per capita protein (Gnanamanickam, 2009). Today, rice is cultivated in over 100 countries coming from all continents except Antarctica (FAO, 2017a; USDA, 2017). There are about 144 million rice farm families in the world comprising 25% of total world farmers, a significantly large number. In 2016, the rice harvest area was only 8% of the global crop cultivation area but the amount of production was 30% and the economic value was 13% of the world crop value; hence, the amount of production per unit area and the economic value are greater than those of the other crops (CGIAR 2017, IRRI 2017).

<sup>1</sup>National Institute of Crop Science, Rural Development Administration, Jeonju 55365, Korea

<sup>2</sup>Plant Breeding Division, International Rice Research Institute, Los Banos, Philippines

<sup>†</sup>Corresponding author: Jeom-Sig Lee; (Phone) +82-31-695-1845; (E-mail) [leejsyr@korea.kr](mailto:leejsyr@korea.kr)

<Received 28 May, 2017; Revised 21 July, 2017; Accepted 27 July, 2017>

Rice in Korea is also a socially and economically important crop. It holds the highest proportion in agriculture and forestry where there are 635 thousand rice cultivating households which comprises 58% of the total farm households. The value of rice production in 2015 was highest being \$7.5 billion which is about 16% of the gross agricultural and forestry production value (MAFRA, 2016a). The value-added of rice is approximately twice the total agricultural production value (RDA, 2011). Today's oversupply of rice is greatly affecting the society of Korea. The main reason is that the decline in rice consumption is higher than the decline in rice supply (production and stocks). In other words, the declining rice consumption and importing of rice has resulted in excess stocks. It has been observed that the Korean rice is facing a crucial turning point where the social problems such as tariffication of rice imports and decreased income of the rice farmers.

This paper reviewed rice production, trade, consumption and demand of the world and Korea over the past 20 years to provide basic information to promote rice consumption and to propose tariff measures on rice imports.

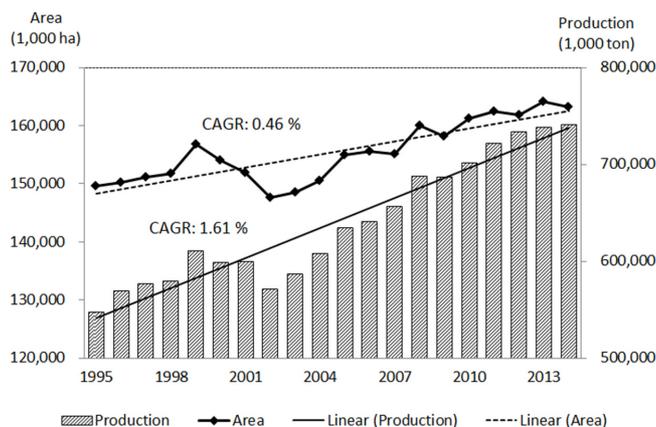
### Rice cultivation and production

The global paddy rice harvested area for the past 20 years (1995~2014) had been increasing from 149.6 million hectares in 1995 to 163.2 million hectares in 2014, an annual

increase of 0.46% (Fig. 1). The paddy rice production also increased from 547.4 million tons in 1995 to 740.9 million tons in 2014, an approximate increase of 1.61% per year. Therefore, it is shown that the production increase is affected more by the increase in quantity per unit area than the increase in cultivation area. According to the preceding research, the global paddy rice production increased by 130% from 1966 to 2000. About 84% of the rice production growth has been attributed to modern farming technologies such as semi-dwarf, early-maturing varieties that can be planted up to three times per year and are responsive to nitrogen fertilizer (Kush, 2004; Maclean *et al.* 2002). According to the recent report by IRRI *et al.* (2013), production increased by 2.24% per year from 1961 to 2010 which is comprised of 1.74% by the increase of quantity of production per unit area and 0.49% by the increase of cultivation area. It was concluded that the phenomenon is mostly caused by the increase of production quantity per unit area.

For the last five years (2010~2014), the global paddy rice harvested area was 162.7 million hectares, paddy rice production was 741.5 million tons, and yield was 4.47 tons per hectare (Table 1). The proportion of cultivated area by region was 88.4% in Asia, 6.9% in Africa, 4.2% in America, 0.4% in Europe, and 0.1% in Oceania. The paddy rice yield per hectare by region in increasing order was Oceania, Europe, America, Asia, and Africa. The paddy rice harvested area and production of Korea were 0.5% and 0.8% of those of the world respectively. The yield per hectare was higher than the global average but was similar to the nearby nations like China and Japan. On the other hand, it was lower than that of the nations such as USA, Australia, Spain, and Greece and so on.

Today, rice is cultivated on over 100 countries from every continent except Antarctica but the top 10 countries account for 85% of the rice production (FAO, 2017a). Paddy rice production by region is 90% in Asia where one to three countries within this region produce the large part. Therefore, the global rice production is concentrated on some countries among and within the regions. It is assumed that there is a high probability that the supply will be greatly affected if the production decreases in some of the main rice producers due to some reasons such as the climate change in the future.



**Fig. 1.** Changes in global paddy rice cultivation area and production during the past twenty years. Data Source: FAOSTAT (1995~2014). Compound annual growth rate (CAGR %) was calculated from the following formula (CAGR (%) =  $(A/B) \times 100 \wedge (1/N)-1$ , A = value in the first year (1995), B = value in the last year (2014), and N = number of years in a period (20).

**Table 1.** Global and regional paddy rice harvested area, production and yield during the last five years (2010~2014).

Region and country	Harvested area (1,000 ha, %)	Production (1,000 ton, %)	Yield (ton/ha)
World	162,704 (100.0)	727,289 (100.0)	4.47
Asia	143,893 (88.4)	667,023 (90.4)	4.57
India	43,523 (26.7)	155,213 (21.3)	3.57
China	30,168 (18.5)	202,223 (27.3)	6.70
Indonesia	13,507 (8.3)	68,682 (9.4)	5.08
Bangladesh	11,434 (7.0)	51,009 (7.0)	4.46
Thailand	11,577 (7.1)	35,584 (4.9)	3.07
Japan	1,592 (1.0)	10,613 (1.5)	6.67
Americas	6,775 (4.2)	36,683 (5.0)	5.42
Brazil	2,517 (1.5)	12,044 (1.7)	4.80
USA	1,158 (0.7)	9,433 (1.2)	8.18
Colombia	491 (0.3)	2,889 (0.4)	4.30
Peru	383 (0.2)	2,889 (0.4)	7.53
Ecuador	369 (0.1)	1,529 (0.2)	4.15
Africa	11,272 (6.9)	28,076 (3.9)	2.49
Nigeria	2,719 (1.7)	5,215 (0.7)	1.92
Guinea	1,555 (1.0)	1,870 (0.3)	1.20
Madagascar	1,103 (0.7)	4,235 (0.6)	3.86
Tanzania	988 (0.6)	2,303 (0.3)	2.34
Mali	642 (0.4)	2,068 (0.3)	3.38
Europe	682 (0.4)	4,513 (0.6)	6.65
Italy	233 (0.1)	1,485 (0.2)	6.39
Russian	196 (0.1)	1,030 (0.1)	5.23
Spain	116 (0.1)	899 (0.1)	7.75
Greece	31 (0.0)	236 (0.0)	7.53
Portugal	30 (0.0)	178 (0.0)	5.90
Oceania	82 (0.1)	774 (0.1)	9.34
Australia	78 (0.0)	764 (0.1)	9.95
Fiji	3 (0.0)	6 (0.0)	2.51
Solomon	1 (0.0)	3 (0.0)	2.03
Papua New Guinea	0.4 (0.0)	1 (0.0)	1.98
Micronesia	0.1 (0.0)	0.2 (0.0)	1.64
Korea	849 (0.5)	5,620 (0.8)	6.63

Data source: FAOSTAT (2010-2014). The countries belonging to each region were selected from the top five countries based on the harvested area except Japan.

### Rice trade

The global import and export doubled from 25 million tons and 27 million tons respectively in 1994 to 56 million tons and 64 million tons respectively in 2013 (Table 2). During the same period, the import increased 4.73% per

year and the export increased 4.43% annually; the average annual growth rate of those was higher than the production growth rate which is 1.71%. Despite such growth rate, the rice export in 2013 is only 8.4% of the total production. The main reason the global trade of rice is low (20% of

**Table 2.** Changes in global paddy rice supply and trade during the last twenty years (1994~2013).

Year	Production (1,000 ton)	Export (1,000 ton, % <sup>1</sup> )	Import (1,000 ton, %)
1994	538,309	27,276 (5.1)	25,029 (4.7)
1995	546,944	34,334 (6.3)	31,133 (5.7)
2000	598,425	36,281 (6.1)	32,585 (5.5)
2005	633,771	45,738 (7.2)	41,202 (6.5)
2010	700,923	52,467 (7.5)	47,142 (6.7)
2013	742,800	62,144 (8.4)	56,401 (7.6)
CAGR (%) <sup>2</sup>	1.71	4.43	4.73

Data source: FAOSTAT (1994~2013).

<sup>1</sup>(%) was calculated the percentage of each value relative to production. <sup>2</sup>CAGR (%): Compound annual growth rate.

wheat and 10% of corn) was reported as following: firstly, the tendency of instant consumption of rice in the place of production; secondly, the implementation of strict price assistance and food policies on import and export to the producers for food security of the Asian countries that produce around 90% of rice; lastly, the subdivision of rice according to the ecotype (Indica, Japonica, Jasmine), intensity of processing (paddy rice, steamed rice, rice), and quality grade (broken rice ratio) (Muthayya *et al.*, 2014; IRRI *et al.*, 2013).

Especially, the market for Japonica, favorite medium-short grain rice, is only 10% of the overall rice trade (RDA 2011). By observation, the reason for such low trading of Japonica rice is because of its low production (10% of the overall rice production) and preference limited to nations like Korea, Japan, and some parts in Europe.

The average annual growth rate of export and import in Africa is 6.16% and 6.54%, respectively, which are greater than the average global export (4.43%) and import (4.73%) (Table 3). Such high increase of average annual growth rate is caused by the growth of rice consumption per capita from 15 kg in 1970 to 39 kg in 2013 in Western Africa where rice became an important food resource next to cassava and corn (FAO, 2016; IRRI *et al.*, 2013). On the other contrary, export in Oceania decreased by 1.27% and import increased by 4.66% annually. This resulted from the decrease in rice production of Australia which produces 90% of the rice in Oceania.

The import and export of milled rice during the last 5 years (2009~2013) of top 10 countries is shown in Table 4.

**Table 3.** Compared with the compounded annual growth rate by region for paddy rice supply and trade during the last twenty years (1994~2013).

Region	CAGR (compounded annual growth rate, %) <sup>1</sup>		
	Production	Export	Import
World	1.71	4.43	4.73
Asia	1.67	5.16	4.34
Americas	1.11	2.86	2.65
Africa	3.82	6.16	6.54
Europe	1.92	2.68	1.92
Oceania	0.33	-1.27	4.66

Data source: FAOSTAT (1994~2013).

The average annual growth rate of export is highest in India (51.4%) while import is highest in China (61.0%). Thailand, Vietnam, and India makes up 59% of the global export while 9 countries including Nigeria, Philippines, Iran, and China imported more than a million tons in a year. During the same period, Korea exported 3 thousand tons of milled rice a year which is equivalent to 0.01% of the global export and imported 383 thousand tons which is 1.1% of the global import. The declination of the average annual growth rate of export by 22.4% is because the export decreased from 4.5 thousand tons in 2009, the year that had highest export, to 1.7 thousand tons in 2013. However, the export increased to 2.4 thousand tons in 2016 and still in its slowly increasing trend (aT 2017).

Changes in ranking of major countries in milled rice import and export since 1990 to present are shown in Table 5.

**Table 4.** Top ten countries of milled rice import and export during the last five years (2009~2013).

Entry	Export			Import		
	Country	1,000 ton (%) <sup>1</sup>	CAGR (%)	Country	1,000 ton (%)	CAGR (%)
1	Thailand	8,333 (23.4)	-5.7	Nigeria	1,975 (5.7)	17.2
2	Viet Nam	6,385 (17.9)	-9.9	Philippines	1,253 (3.6)	-31.1
3	India	6,230 (17.5)	51.4	Iran	1,253 (3.6)	28.4
4	Pakistan	3,517 (9.9)	8.6	Saudi Arabia	1,237 (3.6)	-0.9
5	USA	3,254 (9.1)	2.1	Iraq	1,209 (3.5)	4.6
6	Uruguay	915 (2.6)	-2.4	Indonesia	1,191 (3.5)	17.4
7	Brazil	844 (2.4)	8.5	CoteD'Ivoire	1,157 (3.4)	-7.9
8	Italy	740 (2.1)	0.0	China <sup>2</sup>	1,168 (3.4)	61.0
9	Myanmar	648 (1.8)	-12.8	Arab Emirates	1,067 (3.1)	-17.5
10	Argentina	591 (1.7)	-2.1	South Africa	989 (2.9)	14.2
	World	35,675 (100)	5.3		34,463 (100)	6.6
	Korea	3 (0.01)	-22.4		383 (1.1)	23.7

Data source: FAOSTAT (2009~2013).

<sup>1</sup>(%): Represents the ratio of each country's exports and imports to the world. <sup>2</sup>China: China mainland.

**Table 5.** Changes in ranking of major countries in milled rice import and export over the last twenty years (1990~2013).

Country	Ranking <sup>1</sup> of export by year				Country	Ranking of import by year			
	1990	2000	2010	2013		1990	2000	2010	2013
India	6	6	5	1	China	-	-	8	1
Thailand	1	1	1	2	Nigeria	-	5	2	2
Viet Nam	3	2	2	3	Iran	2	3	5	3
Pakistan	4	5	3	4	Benin	-	-	-	4
USA	2	4	4	5	Iraq	6	2	6	5
Uruguay	9	7	7	6	South Africa	-	-	-	6
Brazil	-	-	-	7	Saudi Arabia	-	4	4	7
Italy	5	8	6	8	Senegal	4	-	-	8
Argentina	-	-	-	9	Malaysia	9	10	7	9
Myanmar	-	-	-	10	CoteD'Ivoire	7	-	9	10
Egypt	-	-	8	-	Philippines	1	8	1	-
China	8	3	9	-	Brazil	3	9	10	-
Australia	7	9	-	-	Bangladesh	5	-	-	-
% <sup>2</sup>	88.0	88.8	85.5	87.5	% <sup>2</sup>	28.3	38.1	37	38.7
Korea (1,000 ton)	0.5	0.1	3.8	1.5	Korea (1,000 ton)	2	155	321	580

Data source: FAOSTAT (1990~2013).

<sup>1</sup>Rankings are ranked in the top ten countries. <sup>2</sup>%: Percentage of major countries in the world rice export and import.

Thailand had the highest rank in export until 2010, but India has become the highest ranker in 2013. Brazil was the major milled rice importing country but ranked 7th in the export in 2013. Moreover, China was a major exporter

and importer but imported the most during the year 2013.

In the global milled rice export and import, Korea contributed 0.1% and 1.1% respectively. The increase of milled rice import in Korea is due to the Minimum Market-Access

(MMA) Import Commitment after the Uruguay Round Agreement on Agriculture in 1990s. Since 2015, there is no increase in amount of resources by MMA Import Commitment while higher tariff is applied to imported milled rice (MAFRA, 2014).

### Rice consumption

The global milled rice supply from 1994 to 2013 has increased by 1.58% annually. The rice for food use was 1.37% per year which is slightly lower than the total rice supply (1.58%). On the other hand, the rice for feed and processing were 2.31% and 3.68% respectively which are higher than the total rice supply (Table 6). Among the total rice supply in 2013, 79.3% was for food, 7.1% was for feed, and 1.4% was for processing. The rice for feed use during the last 20 years was 6~7% of total rice supply which is the next highest after the supply for food use

(79~82%). Korea had no rice allotted for feed use. Recently in 2016, 101 thousand tons of rice were used as feed due to oversupply and 520 thousand tons are planned to be allotted for feed use in 2017 (MAFRA, 2016b).

The milled rice utilization during the last 5 years (2009~2013) by region is shown in Table 7. Asia had similar values with the global average but use for processing in America, for food in Africa, and for feed in Europe is relatively higher than the global average. According to FAO (2017a), the rice utilization in Korea was 91% for food use and 0.5% for processing. On the other hand, MAFRA (2016a) reported 62% for food use and 9% for processing; the difference of data is seemed to be caused by the difference in the amount of stock and in the standard of classification of milled rice for food and for processing. The standard of classification of FAO and MAFRA is following. The milled rice for processing in Korea is classified

**Table 6.** Global milled rice supply and utilization during the twenty years (1994~2013).

Year	Supply (1,000 ton, %)	Utilization (1,000 ton, %)					
		Food	Feed	Processing	Seed	Waste	Other
1994	352,958 (100)	291,564 (82.6)	21,786 (6.2)	3,390 (1.0)	10,974 (3.1)	18,966 (5.4)	6,290 (1.8)
1995	364,708 (100)	298,216 (81.8)	23,788 (6.5)	3,440 (0.9)	11,287 (3.1)	20,850 (5.7)	7,132 (2.0)
2000	396,030 (100)	323,113 (81.6)	26,827 (6.8)	4,047 (1.0)	11,226 (2.8)	22,565 (5.7)	8,269 (2.1)
2005	415,823 (100)	339,932 (81.7)	26,172 (6.3)	4,985 (1.2)	11,544 (2.8)	22,434 (5.4)	10,753 (2.6)
2010	459,396 (100)	365,703 (79.6)	32,943 (7.2)	6,155 (1.3)	11,927 (2.6)	26,716 (5.8)	15,953 (3.5)
2013	475,659 (100)	377,287 (79.3)	33,596 (7.1)	6,738 (1.4)	12,197 (2.6)	27,377 (5.8)	18,464 (3.9)
CAGR (%)	1.58	1.37	2.31	3.68	0.56	1.95	5.83

Data source: FAOSTAT (1994~2013).

**Table 7.** Regional milled rice supply and utilization during the last five years (2009~2013).

Region	Supply (1,000 ton, %)	Utilization (1,000 ton, %)					
		Food	Feed	Processing	Seed	Waste	Other
World	465,414 (100)	369,680 (79.4)	33,286 (7.2)	6,306 (1.4)	12,026 (2.6)	27,084 (5.8)	17,034 (3.7)
Asia	411,321 (100)	326,100 (79.3)	31,771 (7.7)	4,759 (1.2)	10,928 (2.7)	23,106 (5.6)	14,657 (3.6)
Americas	22,890 (100)	17,577 (76.8)	373 (1.6)	1,443 (6.3)	469 (2.1)	2,006 (8.8)	1,023 (4.5)
Africa	26,580 (100)	22,145 (83.3)	765 (2.9)	81 (0.3)	526 (2.0)	1,916 (7.2)	1,149 (4.3)
Europe	4,123 (100)	3,460 (83.9)	374 (9.1)	22 (0.5)	98 (2.4)	51 (1.2)	118 (2.9)
Oceania	499 (100)	397 (79.5)	2 (0.4)	2 (0.3)	5 (1.0)	6 (1.1)	88 (17.6)
Korea	4,469 (100)	4,085 (91.4)	0 (0.0)	22 (0.5)	26 (0.6)	308 (6.9)	29 (0.6)
Korea <sup>↓</sup>	5,833 (100)	3,592 (61.6)	0 (0.0)	530 (9.1)	38 (0.6)	-	-

Data source: FAOSTAT (2009~2013). <sup>↓</sup> Korea: MAFRA (2009~2013)

as all milled rice consumed in companies. But FAO classifies all the milled rice used for the production of cake, oil, bran, starch, rice flour, and rice-fermented beverages as processed rice (FAO, 2017b). Korea classifies the rice for processing by the consumer while FAO classifies the rice for processing by the purpose of processing. For example, the instant cooked rice produced by a company is classified as processed milled rice in Korea while the same is classified under rice for food in FAO.

The data during last 6 years (2011~2016) to supplement the KOSIS statistical data on the utilization of milled rice for processing is as shown in Table 8. Korea's annual

consumption of milled rice for processing is 600 thousand tons. Among those, approximately 60% is for processed food production and 40% is for beverage production (KS 2017). The annual growth rate of use of milled rice for processing was small, being only 0.4%. However, milled rice for cooking products grew by 2.46% annually because of the production of food products such as instant cooked rice but milled rice used for beverage production decreased by 2.03% due to the declination of alcohol source.

The global annual rice consumption per capita during the last 20 years (1994~2013) grew 0.15% every year in average from 52.4 kg to 53.9 kg (Table 9). The regional average

**Table 8.** Changes in annual processing rice consumption by processing companies in Korea during the last six years (2011~2016).

Industry	Year (1,000 ton, %)						CAGR (%)
	2011	2012	2013	2014	2015	2016	
Total	646 (100)	571 (100)	526 (100)	535 (100)	575 (100)	659 (100)	0.40
Subtotal of food	335 (51.9)	356 (62.4)	418 (79.4)	399 (74.6)	370 (64.2)	378 (57.4)	2.46
Grain processing	32 (4.9)	30 (5.3)	47 (8.9)	54 (10.0)	42 (7.2)	47 (7.1)	8.00
Starch and sugar	12 (1.8)	14 (2.4)	15 (2.8)	13 (2.4)	13 (2.3)	12 (1.9)	1.14
Rice cake	162 (25.0)	183 (32.1)	204 (38.7)	188 (35.2)	171 (29.7)	170 (25.7)	0.97
Cocoa and confectionery	7 (1.0)	8 (1.4)	8 (1.6)	7 (1.3)	7 (1.3)	9 (1.4)	6.00
Noodles and macaroni	11 (1.6)	10 (1.8)	12 (2.2)	10 (1.8)	11 (1.9)	10 (1.5)	-1.10
Paste manufacturing	17 (2.6)	18 (3.2)	11 (2.1)	12 (2.3)	11 (1.9)	11 (1.6)	-8.63
Food for cooking products	79 (12.2)	74 (13.1)	101 (19.1)	98 (18.4)	96 (16.8)	100 (15.2)	4.90
Subtotal of beverage	311 (48.1)	215 (37.6)	108 (20.6)	136 (25.4)	206 (35.8)	280 (42.6)	-2.03
Rice wine	61 (9.4)	61 (10.8)	47 (9.0)	47 (8.8)	46 (8.1)	52 (7.8)	-3.30
Alcohol source	244 (37.8)	148 (25.9)	56 (10.6)	78 (14.7)	156 (27.1)	222 (33.7)	-1.84

Data source: KOSIS (2011~2016).

**Table 9.** Regional milled rice consumption (kg<sup>↓</sup>) per capita during the last twenty years (1994~2013).

Year	World	Asia	Americas	Africa	Europe	Oceania	Korea <sup>↓</sup>	
							Food	Processing
1994	52.4	77.3	18.9	16.9	3.2	9.7	108.3	-
1995	52.8	78.2	17.3	17.3	3.4	10.0	106.5	-
2000	53.7	78.6	18.7	18.8	4.3	11.5	93.6	-
2005	53.2	77.3	19.6	19.8	4.5	12.6	80.7	-
2010	54.0	78.2	18.6	22.8	4.7	14.2	72.8	7.0
2013	53.9	77.8	18.5	23.9	4.6	13.4	67.2	9.2
CAGR (%)	0.15	0.03	-0.10	1.86	1.92	1.70	-2.48	9.5

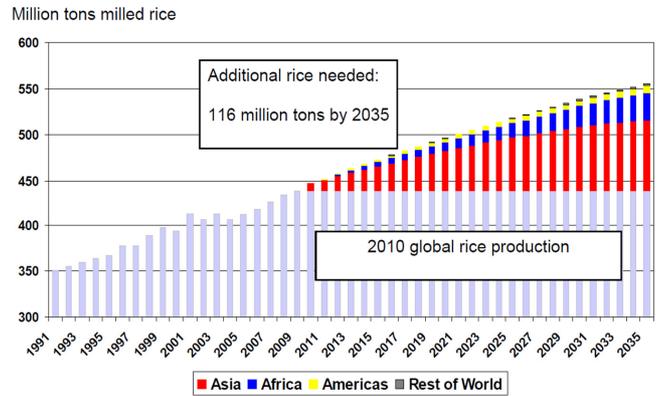
Data source: FAOSTAT (1994~2013). <sup>↓</sup>Kg: Kg per capita per year in milled rice consumption. <sup>↓</sup>Korea: KOSIS (1994~2013) for food and MAFRA (2010~2013) for processing.

annual growth rate in Europe, Africa, and Oceania is 2%. Rice consumption per capita in 2013 was 77.8 kg in Asia, 23.9 kg in Africa, and 18.5 kg in America. Especially, the annual rice consumption per capita in Africa has been constantly growing for the last 20 years from 16.9kg in 1994 to 23.9 kg in 2013. Korea’s rice consumption for cooked rice per capita decreased by 2.48% annually while rice consumption for processing increased annually by 9.5% per year. Between 1961 and 2002, the global milled rice consumption per capita increased by 40% (FAO, 2017). Meanwhile, during the last 20 years (1994~2013) it was about 54 kg which has not changed much. But the global milled rice demand during the same period increased by 74% (Table 6). Such increase in demand is not caused by the increase of per capita consumption of rice but by the growth of population and growth in economy which lead to the substitution of other crops with rice (Seck *et al.*, 2012).

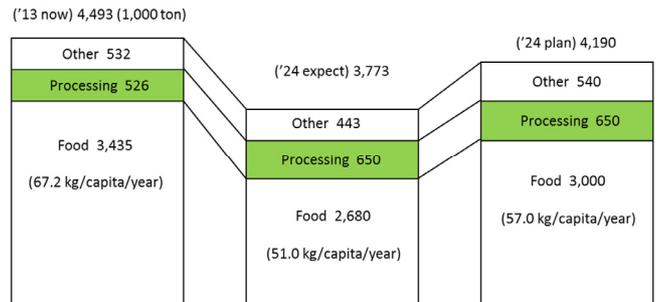
**Future rice demand**

According to IRRI *et al.* (2010), global rice demand is estimated to rise from 439 million tons (milled rice) in 2010 to 496 million tons in 2020 and further increase to 555 million tons in 2035 (Fig. 2). This is an overall increase of 26% in the next 25 years, but the rate of growth will decline from 13% for the first 10 years to 12% in the next 15 years as population growth drops and people diversify their appetite from rice to other foods. Among the various rice consuming regions, Asian rice consumption is projected to account for 67% of the total increase, rising from 388 million tons in 2010 to 465 million tons in 2035 despite a continuing decline in per capita consumption in China and India. In addition, 30 million tons more rice will be needed by Africa, an increase of 130% from the rice consumption in 2010. Globally, farmers need to produce at least 8~10 million tons more paddy rice each year, an annual increase of 1.2~1.5% over the coming decade which is also equivalent to an average yield increase of 0.6 t/ha during the next decade.

According to the report by MAFRA (2014), it is expected that the per capita consumption will be 51 kg by 2024 if South Korea’s per capita consumption declines in the current rate (Fig. 3). Therefore, the demand in 2024 will be about



**Fig. 2.** Global rice production increase needed to meet the demand by 2035. Source: IRRI, AfricaRice & CIAT (2010).



**Fig. 3.** The Korean milled rice utilization plan for expansion consumption by 2024. Source: MAFRA (2014).

3.77 million tons, a 16% decrease from 4.49 million tons in 2013. As a result, Korea’s consumption goal is to maintain 4.19 million tons which is an amount 11% higher than the expected consumption of 3.77 million tons in 2024. In order to reach the goal, the decline of per capita consumption of rice is delayed and expansion of the utilization of rice processing is promoted. For the same purpose, it is planned to maintain 757 thousand of harvest area and produce 5 tons of milled rice per hectare.

**ACKNOWLEDGEMENTS**

This work was carried out with the support by Rural Development Administration, Republic of Korea and International Rice Research Institute (Project title: The Germplasm Utilization for Value-Added (GUVA) Traits of Japonica Rice (Phase II)).

## REFERENCES

- Consultative Group for International Agricultural Research. 2017. <http://ricecrp.org/importance-of-rice/>. Accessed on 20 April, 2017.
- Gnanamanickam, S. S. 2009. Rice and Its Importance to Human Life. *Biological Control of Rice Diseases* 8 : 1-11.
- Food and Agricultural Organization. 2017a. FAOSTAT Database. <http://www.fao.org/faostat/en/#data/QC>. Accessed on 6 March 2017.
- Food and Agricultural Organization. 2017b. Definition and classification of commodities. Accessed on 2 April 2017. <http://www.fao.org/es/faodef/fdef01e.htm#1.01>
- IRRI, AfricaRice & CIAT. 2010. Global Rice Science Partnership (GRiSP). November 2010. p. 241.
- IRRI AfricaRice & CIAT. 2013. Rice Almanac, 4th edition. p. 298.
- International Rice Research Institute. 2017. World Rice Statistics. [http://irri.org/index.php?Option=com\\_k2&view=item&id=9081&Itemid=100481&lang=en](http://irri.org/index.php?Option=com_k2&view=item&id=9081&Itemid=100481&lang=en). Accessed on 8 March, 2017.
- Khush, G. 2004. Harnessing science and technology for sustainable rice based production systems. Presented at the FAO Rice Conference, Rome, Italy, February 12-13, 2004.
- Korea Agro-Fisheries & Food Trade Crop (aT). 2017. AKATI database. <http://www.kati.net/sta/staRes1.do?MenuCode=822&bbsid=1#>. Accessed on 8 March, 2017.
- Maclean, J. L., D. C. Dawe, B. Hardy, and G. P. Hettel. Eds. 2002. Rice Almanac. Wallingford, UK: CABI Publishing. p. 253.
- Ministry of Agriculture, Food and Rural Affairs. 2014. Measures to stabilize farm household income and development of Rice Industry after Taxation. pp 27.
- Ministry of Agriculture, Food and Rural Affairs. 2016a. Agriculture, Forestry, Livestock and Food Statistics 2009-2016.
- Ministry of Agriculture, Food and Rural Affairs. 2016b. Plan on the use of rice as feed. <http://www.hankookilbo.com/v/4715cf43978d421ca0ee1958dd89955e>. Accessed on 5 March, 2017.
- Muthayya, S., J. D. Sugimoto, S. Montgomery, and G. F. Maberly, 2014. An overview of global rice production, supply, trade, and consumption. *Ann. N. Y. Acad. Sci.* 1324 : 7-14.
- Rural Development Administration. 2011. World Food Crisis and Our Countermeasures based on the RDA Food Supply and Demand Model. p. 302.
- Seck, P. A., A. Diagne, S. Mohanty, and M. C. S. Wopereis, 2012. Crops that feed the world 7: Rice. *Food Sec.* 4 : 7-24.
- Statistics Korea. 2017. Korean Statistical Information Service (KOSIS) Database [http://kosis.kr/statisticsList/statisticsList\\_01List.jsp?vwcd=MT\\_ZTITLE&parentId=F](http://kosis.kr/statisticsList/statisticsList_01List.jsp?vwcd=MT_ZTITLE&parentId=F). Accessed on 13 March, 2017.
- United States Department of Agriculture. 2017. United States Department of Agriculture Foreign Agricultural Service. Database. <https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery>. Accessed on 9 March, 2017.