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World food supply and demand projections to 2027:

The results by the World Food Supply and Demand Model



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I. Introduction

Since 2008, the Ministry of Agriculture, Forestry, and Fisheries has been using the World Food Supply and Demand Model to develop a global projection for food supply and demand for the next decade. This report shows its outline projections to 2027. This model reconstructs the model used by the Ministry in previous world food supply and demand projection estimates by fundamentally revising the equations and parameters in light of changes in the world food supply and demand environment.

II. Overview of the World Food Supply and Demand Model

1. Model structure

This model has been developed using the approach described below (See “Reference 1”).

(A) Consumption

The consumption of each commodity (as demand) is principally determined by country/region’s total population, real gross domestic product (GDP), real economic growth rate and commodity prices.

(B) Production volumes

a. The production of crops are principally determined by the harvested land area and its yield. The yield is determined by trends, and the harvested land area is determined by the real producer price (i.e., the price that the producer receives in the market, with financial and other direct or indirect assistance added) of the applicable commodities and simulating commodities in the previous year.

b. The production of livestock are principally determined by its per-head production and its number of animal heads. The per-head production is determined by trends, and number of animal heads is determined by the previous year’s number and the real producer price and feed cost for the applicable and simulating commodities.

(C) Prices

International commodity prices are principally determined at the equilibrium point which the demand and supply for each commodity corresponded to.

2. Commodity covered

The model covers 20 commodities in total. They cover six crops (wheat, corn, rice, other crops, soybeans, and other oilseeds), five meat/egg items (beef, pork, chicken, mutton, and eggs), four processed crops (soy meals, other oil meals, soybean oil, and other vegetable oils), and five milk/dairy products (raw milk, butter, powdered skim milk, cheese, and full-fat powdered milk).

3. Base and target years

For the sake of a projection for the next 10 years, 2027 is set as the target year and 2015 as the base year in this report. However, the base year figures estimated for the model represent averages for the three-year period from 2014 to 2016.

4. Projected items

The projected items are production, consumption, and net exports (or net imports) for each commodity/region, as well as the international reference prices (real and nominal) for each commodity.

5. Scope of the projections with regional classification

The model projection covers the entire world (all countries), and is divided into eight geographically determined categories of regions (the regions are subdivided into 31 countries/sub regions; See Reference 2). The supply and demand projections for each commodity are presented in this report for these eight categories. The main objective of the World Food Supply and Demand Model is to project the global food supply and demand trends in the future. In addition, this year's projection has been extended based on the method used for the previous year's version, and incorporated the recent observations of the supply and demand markets for major producing/consuming countries for each commodity as reference values, thus clarifying the change factors for the projected values.

6. Population and economic growth rates

a. The 2027 global population is estimated at 8.33 billion, based on the United Nation's *World Population Prospects: The 2017 Revision*.

b. GDP (real) data in 2027 is estimated based on the World Bank's *World Development Indicators 2017*, and estimates of real economic growth rates are applied based on the International Monetary Fund (IMF)'s *World Economic Outlook 2017* from \$10,255 in the base year to \$12,903 in the target year.

III. Results and Discussion

1. Assumptions

The projections have some assumptions that the current growth in the yield of cultivated crops will continue in the future, and that there are no particular limitations on the expansion of the existing harvested area under cultivation. Furthermore, the demand function for corn-based bioethanol and biodiesel feedstock (that is produced from either soybean or one of the other vegetable oils) was endogenized in the model. The model is set up in such a way that the biofuel demand is principally determined by the factors such as the price of crude oil, corn, soybean oil, and other vegetable oils. However, provisional calculations were made under the assumptions that the consumption estimates mentioned in the biofuel policies of countries such as the USA and Brazil will be sustained in the future.

2. Projection results

Outline of the projection results

Economic growth as a whole has slowed all over the world and would continue at a sluggish pace for the next decade in some developed and emerging nations such as China, Brazil, Russia, and India. In the medium term, the slow growths are anticipated to continue, leading to a slowdown in the demand for agricultural products. Despite this, an increase in demand for agricultural products would be expected, due to the increasing demand for food and feed, primarily seen in emerging and developing countries, as the population continues to relatively grow and income levels increase in the coming decade. Meanwhile, on the supply side, production of agricultural commodities is expected to primarily grow due to the increase in crop yield. Thus, it is projected that the demand for grains will be satisfied by its supply, and the international reference price of grains will continue to remain stable for the next decade.

(A) Projections for production, consumption, and net imports/exports by region

The production, consumption, and net imports/exports by region for each major commodity are outlined below, both for a base year (the average of the values for 2014 to 2016) and in 2027. The 2027 figures are shown based on the projection results. Additionally, the projection tables clarify some selected countries that are primarily major producers and consumers of each commodity.

a. Wheat

Table 1 Projection results for wheat by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	741.0	856.2	717.8	856.1	0.0	0.0
North America	87.6	95.7	40.8	44.6	42.5	51.1
Latin America	28.1	33.6	38.9	45.3	-10.2	-11.6
Oceania	28.1	32.9	8.4	9.5	18.2	23.4
Asia	280.6	325.8	311.4	383.1	-48.0	-57.4
Middle East	39.4	48.7	60.1	74.6	-19.7	-25.9
Europe	253.1	287.1	185.0	203.6	66.1	83.4
Africa	24.1	32.4	72.8	94.8	-48.6	-62.4
(Reference)						
EU	154.3	170.8	127.8	142.3	26.2	28.4
Russia	64.2	75.6	37.5	40.7	24.8	34.9
Canada	29.6	34.5	9.1	10.8	21.6	23.6
USA	58.0	61.2	31.7	33.7	20.9	27.4
Australia	27.7	32.5	7.5	8.5	18.7	24.0
Ukraine	26.3	31.3	11.3	11.8	15.5	19.6
China	129.7	132.6	115.6	135.9	-3.3	-3.4
India	89.8	111.8	93.1	116.2	-0.5	-4.4

- i) In the base year, Europe, North America, and Oceania were net exporting regions, while Africa, Asia, the Middle East, and Central and South America were net importers.
- ii) Although the quantity produced in Central and South America, the Middle East, and Africa is expected to increase compared with the base year, it is predicted that consumption growth will exceed production growth, and that net imports will increase in 2027. The Middle East's net imports are predicted to rise to 25.9 million tons in 2027, and the net imports of not only North Africa but also sub-Saharan Africa are expected to increase due to the growth in total population, reaching 60.4 million tons for Africa. The 2027 projection for Asia is that the net imports in most countries will increase and the region will import 57.4 million tons. China's net wheat imports are expected to remain nearly flat compared with the base year, at 3.4 million tons.
- iii) In North America and Europe, the rate of increase of production will exceed that of consumption as crop yield improves, and the net exports for both regions will increase in 2027. Oceania shows strong growth in its net exports, driven by Australia's performance, and its net exports in 2027 are predicted to total 24.0 million tons. Although the United States' production is anticipated to increase, net exports will rise only slightly because the rate of increase will be slower than that witnessed in the past 10 years. In Europe, although projected consumption has decreased due to the slowing of Russia's economic growth, the production potential is high despite uncertainty over the climate; Russia's 2027 net exports are expected to total 34.9 million tons, far exceeding that of the United States. In the EU, a slight increase in the net exports is predicted, since production exceeds consumption.

b. Corn

Table 2 Projection results for corn by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	1019.1	1188.6	1015.1	1187.6	0.0	0.0
North America	376.5	403.9	317.6	342.8	49.1	60.7
Latin America	158.4	210.5	138.0	173.1	19.8	37.3
Oceania	0.7	0.8	0.7	0.8	0.0	0.0
Asia	291.0	342.1	344.7	409.1	-47.0	-67.4
Middle East	8.5	11.0	24.7	30.9	-16.6	-19.9
Europe	115.5	140.2	100.7	117.2	15.1	23.0
Africa	68.5	80.1	88.7	113.7	-20.4	-33.6
(Reference)						
USA	363.8	389.2	304.8	328.1	49.4	60.8
Brazil	83.0	118.4	58.4	81.0	26.0	37.3
Argentina	33.3	40.1	9.8	11.3	22.7	28.8
Ukraine	26.6	32.3	8.2	9.2	18.9	23.0
EU	65.1	77.6	75.3	88.0	-10.0	-10.5
China	220.0	259.2	230.0	269.5	-3.0	-10.6

- i) In the base year, North America stood out as the top net exporter, followed by Central and South America and Europe. Asia, Africa, and the Middle East were net importing regions.
- ii) Although the production quantity is expected to increase in the net importing regions of Asia and Africa, it is predicted that consumption will increase in 2027. In Asia, the net imports are expected to rise, particularly in China, reaching 67.4 million tons. Although the EU's imports are expected to increase slightly in 2027, an expansion in production in the Ukraine and surrounding areas is predicted to increase European net exports in 2027.
- iii) In North America, demand is suppressed by the effects of the "blend wall," which refers to the problem of the limit imposed on bioethanol production by stipulating an upper limit for the bioethanol gasoline blend ratio to gasoline. Thus, it is anticipated that the continued growth in demand for bioethanol, which is made from corn, will slow. Although growth in the area under corn cultivation is expected to slow, increases in crop yield will keep the production quantity above the quantity consumed, and the 2027 net exports by the United States are estimated to reach 60.8 million tons. In Central and South America, corn production will increase in Brazil and Argentina due to its cultivation as a secondary crop; the production increase in these countries is expected to far exceed the increase in domestic consumption demand for corn used for feed and other purposes. The net exports by Brazil and Argentina in 2027 are estimated to increase to 37.3 million tons and 28.8 million tons, respectively.

c. Rice

Table 3 Projection results for rice by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	478.5	553.9	474.2	553.1	0.0	0.0
North America	6.8	8.0	4.4	5.0	2.2	3.0
Latin America	17.9	22.6	19.3	22.4	-1.3	0.2
Oceania	0.4	0.5	0.4	0.5	0.0	0.0
Asia	428.9	490.8	403.8	464.2	20.6	25.8
Middle East	2.4	2.8	9.1	11.1	-6.5	-8.3
Europe	2.8	3.5	4.7	4.9	-1.9	-1.5
Africa	19.4	25.7	32.3	45.0	-13.0	-19.2
(Reference)						
India	106.0	126.8	96.1	116.6	11.0	10.2
Thailand	17.9	21.3	10.4	11.1	9.6	10.2
Vietnam	27.9	33.2	22.4	26.8	5.5	6.4
Brazil	8.0	10.2	8.0	8.8	0.1	1.4
China	145.6	146.0	141.9	149.9	-4.7	-4.7
Indonesia	36.3	46.9	38.0	47.0	-1.0	-0.1
Bangladesh	34.5	42.4	35.2	43.7	-0.5	-1.3

- i) In the base year, net exporting regions included Asia, which accounts for approximately 90% of the total production and over 80% of the consumption, and North America. However, the quantity produced by the latter region was small.
- ii) Africa, the Middle East, Europe, and Central and South America were all net importing regions.
- iii) In Asia, although demand for rice as food will rise as the population increases, production will also increase satisfactorily, and the net 2027 exports are predicted to reach 25.8 million tons. In particular, Vietnam and Thailand are expected to increase their net export volumes—although the latter will depend on the country's policies. Net export volumes in these countries are expected to increase to 6.4 million tons and 10.2 million tons, respectively. In 2027, India's net exports are expected to decline to 10.2 million tons, although this will depend on the country's reserves and the minimum support price, which is influenced by both climate and government policies. Meanwhile, China's slight trade deficit will continue and net imports are expected to be 4.7 million tons. In Bangladesh, the increase in demand will outpace the increase in production, and its 2027 net imports are expected to rise to 1.3 million tons.
- iv) Despite the trend of slowing population growth in the Middle East and Africa, population growth continues to be higher than that in other regions and is likely to increase consumption and net imports in both areas. The 2027 net imports are expected to be 8.3 million tons in the Middle East and 19.2 million tons in Africa. It is predicted that the increase in net imports by the Middle East and Africa will be met by the increase in net exports from Asia. Although no major changes are anticipated in Europe, the net import quantity is expected to decrease slightly.

d. Other grains (barley, rye, sorghum, etc.)

Table 4 Projection results for other grains by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	262.7	313.1	262.6	313.2	0.0	0.0
North America	29.4	34.0	20.3	23.5	8.9	10.5
Latin America	19.7	22.1	18.8	23.0	1.2	-0.9
Oceania	13.9	17.5	5.6	6.4	7.9	11.1
Asia	31.6	37.6	48.8	56.0	-17.2	-18.3
Middle East	11.3	13.6	25.8	31.9	-14.5	-18.3
Europe	107.8	126.3	90.6	101.9	17.3	24.4
Africa	48.9	61.9	52.9	70.5	-3.6	-8.5
(Reference)						
EU	69.4	80.5	61.1	69.8	8.3	10.7
USA	18.2	20.9	11.8	13.3	6.0	7.7
Ukraine	10.3	13.1	5.5	5.7	4.9	7.4
Russia	23.6	27.5	19.4	21.3	4.2	6.2
India	17.7	21.8	17.5	22.0	0.2	-0.2

- i) In the base year, North America, Oceania, Europe, and Central and South America were net exporters, while Asia, the Middle East, and Africa were net importers.
- ii) Although production is expected to increase in the Middle East and Africa, consumption will also increase, primarily due to demand for alternative grains as feed in the Middle East and as food in Africa, and the quantity consumed will exceed what is produced. It is predicted that this trend will continue, leading to an increase in net imports in 2027. In particular, food consumption of coarse grain, a traditional staple, is expected to increase along with the population growth in sub-Saharan Africa; the net imports are estimated to reach 8.5 million tons in 2027. In the Middle East, it is anticipated that the net exports will reach 18.3 million tons due to increased demand for feed, which constitutes 90% of the total consumption. Meanwhile, in Asia, consumption is expected to surpass production, leading to a slight increase in the net imports.
- iii) In Oceania and Europe, production is predicted to increase steadily if the yearly averages for normal weather are maintained, with net exports in 2027 increasing to 11.1 million tons and 24.4 million tons, respectively. The European countries, including Russia and the Ukraine, have the potential to increase production despite the risk of being easily affected by poor weather conditions. The 2027 net exports are expected to increase, reaching 6.2 million tons and 7.4 million tons in Russia and the Ukraine, respectively. Meanwhile, Central and South America is expected to change from being a net exporter to a net importer due to an increasing demand for feed, which accounts for 70% of all consumption of other grains.

e. Soybeans

Table 5 Projection results for soybeans by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	328.8	397.3	317.7	397.7	0.0	0.0
North America	116.6	137.5	57.3	72.3	56.5	65.3
Latin America	176.5	217.4	104.0	130.7	66.6	87.0
Oceania	0.0	0.0	0.0	0.0	0.0	0.0
Asia	23.7	28.2	122.8	154.7	-101.2	-126.5
Middle East	0.3	0.4	5.4	5.5	-5.1	-5.1
Europe	9.5	11.5	23.4	29.5	-13.9	-18.0
Africa	2.1	2.3	4.8	5.0	-2.8	-2.7
(Reference)						
Brazil	102.6	128.8	44.0	57.8	55.2	71.1
USA	110.3	130.6	54.8	69.0	52.6	61.6
Argentina	58.7	69.9	47.3	55.8	8.8	14.2
India	9.0	10.3	8.8	10.3	0.2	0.0
China	13.0	15.9	96.0	123.8	-84.8	-107.9
EU	2.2	2.5	16.4	21.3	-14.3	-18.8

- ii) In the base year, Central and South America and North America were net exporting regions, while Asia, Europe, the Middle East, and Africa were all net importers.
- ii) Although it is predicted that the Middle East and Africa will continue to have limited production and remain structurally dependent on imports, it is predicted that the level of consumption will be low compared with other regions. Asia and Europe's trade deficit is likely to continue because of their low production levels compared with the demand, and it is predicted that the 2027 net imports will further increase for the EU countries and for China, with EU imports reaching 18.8 million tons and China's imports reaching 107.9 million tons, respectively. China alone accounts for 85% of Asia's net imports, and the region's net soybean imports are expected to rise to 126.5 million tons in 2027.
- iii) North America's net exports are expected to increase to 65.3 million tons, with more than 90% of this quantity coming from the United States. Meanwhile, it is predicted that Central and South America will rapidly increase production, and that the 2027 net exports will also increase significantly, meeting the increase in net imports by North America, Asia, and Europe. In Central and South America, Brazil is the primary exporter; it has sufficient land to expand the area under cultivation without developing the Amazon region. Both crop yield and harvest area are expected to increase, and the 2027 production is estimated to reach 128.8 million tons. Based on these, Brazil's net exports are predicted to reach 71.1 million tons in 2027. Despite the limited size of Argentina's domestic market, the 2027 demand for soybeans, used for the extraction of soybean oil in countries to which it is exported, will be met. It is predicted that the country will rapidly increase its net soybean exports to 14.2 million tons. In future, the increase in Asia and Europe's net imports will be met by rising net exports from Brazil, the United States, and Argentina.

f. Vegetable oil (soybean oil, canola oil, and sunflower oil)

Table 6 Projection results for vegetable oils by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	95.4	116.0	96.3	116.0	0.0	0.0
North America	14.7	18.2	12.7	14.3	1.7	3.9
Latin America	20.3	25.2	14.1	15.6	6.2	9.6
Oceania	0.3	0.4	0.3	0.4	0.0	0.0
Asia	29.6	37.0	40.4	54.7	-10.3	-17.7
Middle East	2.2	2.3	3.9	5.0	-1.6	-2.8
Europe	27.2	31.7	20.8	21.0	6.6	10.7
Africa	1.1	1.3	4.0	5.0	-2.8	-3.7
(Reference)						
Argentina	9.4	11.0	3.4	4.0	6.0	7.0
Ukraine	5.4	5.7	0.6	0.7	4.8	5.1
Russia	4.8	5.4	2.4	2.5	2.4	2.9
Brazil	7.7	10.2	6.4	6.9	1.4	3.3
India	3.3	3.7	9.4	12.7	-6.1	-9.0
China	22.0	28.6	24.9	34.4	-2.3	-5.9
USA	10.7	13.6	11.7	13.2	-1.1	0.4

- i) In the base year, Europe, Central and South America, and North America were net exporting regions, while Asia, Africa, and the Middle East were net importers.
- ii) The per capita increase in consumption in Africa and the Middle East was due to increased population, and in Asia due to economic growth; these are the primary causes of increased consumption overall. Meanwhile, the scope for production growth is extremely limited in both Africa and the Middle East, and Asia is also expected to have difficulties in increasing production sufficiently to meet the growing demand. Thus, it is predicted that the 2027 net imports will increase in all these regions. Africa will see little growth in consumption, and the net 2027 imports are predicted to increase to 3.7 million tons. In Asia, China's per capita consumption is expected to continue to increase despite the signs of an economic slowdown, and it is predicted that the net imports will increase manifold. It is predicted that consumption will also increase in Asian countries other than China, and the 2027 net imports by Asia are estimated to reach 17.7 million tons.
- iii) In Europe, the EU, the Ukraine, and Russia are expected to increase the production of vegetable oils made from sunflower, rapeseed, and other vegetable crops, thus increasing the net quantity exported. Central and South America and North America will both experience an increase in their 2027 net exports, due to production increase that outpaces the domestic demand increase. Central and South America's 2027 net exports will primarily comprise soybean oil. The 2027 net exports of vegetable oil by Argentina and Brazil are expected to increase to 7.0 million tons and 3.3 million tons, respectively, even as these countries experience increased domestic demand and an increase in the net export for soybeans.

g. Beef

Table 7 Projection results for beef by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	61.6	71.4	59.7	71.4	0.0	0.0
North America	12.2	13.5	12.4	13.5	-0.6	0.0
Latin America	17.1	19.8	14.7	17.3	2.2	2.5
Oceania	3.1	3.6	0.8	1.0	2.3	2.6
Asia	15.5	19.2	16.4	22.4	-1.7	-3.2
Middle East	1.9	2.0	2.5	3.3	-0.8	-1.3
Europe	9.9	11.0	10.5	10.7	-0.9	0.2
Africa	2.0	2.3	2.5	3.2	-0.7	-0.9
(Reference)						
India	4.1	5.0	2.2	3.4	1.9	1.6
Brazil	9.5	11.2	7.8	8.9	1.7	2.3
Australia	2.4	2.8	0.7	0.9	1.7	1.9
Argentina	2.7	3.3	2.5	2.9	0.2	0.5
China	6.9	8.7	7.5	10.0	-0.8	-1.3
USA	11.1	12.2	11.4	12.5	-0.6	-0.2

- i) In the base year, Oceania and Central and South America were net exporting regions, while Asia, Europe, the Middle East, and Africa were net importers. Demand and supply were nearly equal in North America.
- ii) Although demand will increase in Asia, the upward trend in beef production, including water buffalo, will continue and India is expected to maintain its relatively high net export level. Across Asia, meat is increasingly becoming a part of the diet as incomes rise, and the previously low level of per capita meat consumption is thus expected to increase. It is predicted that China's net imports will increase to 1.3 million tons in 2027. Consumption amounts will also increase in other Asian countries, and it is estimated that Asia's total imports will increase to 3.2 million tons by 2027. Production levels are relatively low in the Middle East compared with the demand, but there is a pattern of increased consumption due to rising income. Based on this, the 2027 net imports are expected to rise to 1.3 million tons. In Africa, consumption is expected to increase, particularly in northern Africa, and higher net imports are predicted for the entire region. In Europe, the consumption growth is slowing and, due to the predictions of an economic slowdown in Russia, net imports are expected to decrease. Based on such factors, Europe's net imports are expected to fall. The US is raising productivity per head of cattle to increase production and to ensure that it exceeds the growth in consumption, thus creating more exports than imports; North America is thus predicted to become a net exporter.
- iii) Although per capita consumption is high in Oceania, which includes Australia, an increase in consumption is limited by the size of the regional market. Meanwhile, production is steadily increasing and the trend of increasing net exports is expected to continue. The expected 2027 net exports are 2.6 million tons, making Oceania the largest exporting region in the world. In South and Central America, the increase in net exports in Brazil and Argentina leads experts to estimate that the net exports by the South and Central American region will increase. The net beef exports by traditional exporters Brazil and Argentina will increase to 2.3 million tons and 0.5 million tons, respectively, in 2027.

h. Pork

Table 8 Projection results for pork by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	112.5	132.2	117.9	132.2	0.0	0.0
North America	12.8	15.2	10.0	10.7	2.8	4.4
Latin America	6.9	8.8	7.1	8.4	-0.4	0.4
Oceania	0.4	0.4	0.6	0.8	-0.2	-0.3
Asia	64.4	77.5	68.0	84.1	-4.0	-6.6
Middle East	0.0	0.0	0.0	0.0	0.0	0.0
Europe	27.4	29.5	25.4	27.1	2.0	2.4
Africa	0.6	0.8	0.8	1.0	-0.2	-0.3
(Reference)						
EU	23.1	24.6	20.5	21.9	2.5	2.7
USA	10.9	12.7	9.1	9.8	1.8	2.8
Canada	1.9	2.5	0.8	0.9	1.0	1.6
Brazil	3.5	4.7	2.9	3.3	0.7	1.4
China	54.9	66.1	55.9	68.7	-1.2	-2.5

- i) In the base year, North America and Europe were net exporting regions; Asia was a net importing region; and Central and South America, Oceania, and Africa all showed net imports. As the Middle East region is predominantly Islamic, pork supply and demand is very limited.
- ii) Asia accounts for about 60% of the world's pork demand and supply. Although production in Asia will continue to rise steadily in future, economic growth will cause a further increase in the quantity consumed. Consumption will be particularly strong in the southeast Asian countries such as the Philippines and Vietnam, and the 2027 net imports are expected to reach 6.6 million tons. In particular, China's consumption, which accounts for over 80% of consumption in Asia, will continue to grow in future and its net 2027 imports are expected to reach 2.5 million tons.
- iii) In North America, the net export volume is expected to increase to 4.4 million tons, because the decrease in the United States' per capita consumption will be more than offset by the increase in production due to productivity improvements. In South and Central America, the net exports will increase due to rising production in Brazil, and the 2027 net exports are expected to increase to 1.4 million tons. European countries such as Russia, where there is a general sense of an economic slow-down, are displaying a tendency to decrease imports. It is predicted that the increase in per capita consumption in the EU is limited and production will increase. Therefore, the 2027 net exports from Europe are expected to be 2.4 million tons in 2027. In future, it is expected that the increase in Asia's net imports will be covered by the increase in net exports from North America, Europe, and Brazil.

i. Chicken

Table 9 Projection results for chicken by region

(Unit: Million tons)

	Production		Consumption		Net Export (Import)	
	2014-16	2027	2014-16	2027	2014-16	2027
World Total	91.8	115.7	91.7	115.7	0.0	0.0
North America	19.0	21.5	16.0	17.7	3.0	3.8
Latin America	20.9	27.7	18.6	21.0	2.3	6.7
Oceania	1.2	1.5	1.2	1.5	0.0	-0.1
Asia	27.7	36.3	29.5	43.2	-1.8	-6.9
Middle East	3.4	4.8	5.7	8.1	-2.2	-3.3
Europe	15.8	18.8	15.7	17.1	0.2	1.6
Africa	3.8	5.2	5.2	7.0	-1.4	-1.8
(Reference)						
Brazil	12.9	18.2	9.2	10.3	3.8	7.9
USA	17.8	20.3	14.8	16.4	3.0	3.9
Thailand	1.7	2.4	1.1	1.2	0.6	1.2
EU	10.9	12.8	10.6	11.5	0.3	1.3
China	12.9	16.6	12.9	17.5	0.0	-0.9
India	3.9	5.4	3.9	7.6	0.0	-2.2

- i) In the base year, North America and Central and South America were net exporting regions; the Middle East, Asia, and Africa were net importing regions; in both Oceania and Europe, the demand and supply were met.
- ii) Chicken's global consumption is increasing, since it (i) is relatively inexpensive, when compared with other kinds of meat; (ii) fits in with the desire to eat healthier food; and (iii) is not avoided for religious reasons. The consumption is increasing and is keeping pace with economic growth (including with that of the Middle East and Africa), and the 2027 net imports are expected to be 3.3 million tons and 1.8 million tons, respectively. The trend of increased consumption in Asia is expected to continue, and the 2027 net imports are expected to reach 6.9 million tons. Increased consumption is also expected in China, and the net imports are predicted to reach 0.9 million tons. However, as it is easy to expand the production of chicken due to its short production cycle (compared with red meat) and the potential for integration in the production process, it is also possible that the net imports will decrease. Chicken is a food item that is increasingly consumed as economic growth leads to increased disposable incomes; its consumption is also increasing in other Asian countries. It is predicted that the rising demand in these countries will lead to an increase in their net imports.
- iii) Although per capita consumption is relatively high in North America, and particularly in the United States, the consumption growth is comparatively small. Experts expect that the trend of production growth outpacing consumption growth will continue, with the 2027 net export amount reaching 3.9 million tons. Brazil, the world's biggest exporter of chicken, is highly competitive in the international chicken market, and it is predicted that the country will increase its net exports in 2027 to 7.9 million tons. In future, both Central and South America, as well as North America, will increase their net exports, with the increase being driven by Brazil and the United States, thereby meeting Asia's increased consumption.

(B) Projections of per capita consumption

The per capita consumption forecasts in the base year (the average of 2014/2016) and in 2027 are given below for grain, vegetable oil, and chicken. Additionally, for the sake of reference, projection results for the major emerging countries (China, India, Russia, and Brazil), which are expected to have a major impact on the world's food supply and demand as future economic growth takes place, are also given.

a. Grain (total consumption quantity, including grain used for feed)

Table 10 Per capita grain consumption projection results

	Base year (2014-16)		Target year (2027)	
	Value	Index	Value	Index
	kg		kg	
World Total	336.4	100	351.2	104
North America	1,072.0	100	1,068.4	100
Latin America	339.7	100	374.7	110
Oceania	534.0	100	531.8	100
Asia	272.4	100	295.0	108
Middle East	375.9	100	391.9	104
Europe	511.5	100	573.8	112
Africa	209.1	100	206.0	99
(Reference)				
China	371.6	100	409.6	110
India	175.6	100	192.4	110
Russia	461.5	100	514.6	111
Brazil	388.7	100	476.9	123

i) The 2027 per capita grain consumption includes consumption for feed and biofuel production, all regions other than Oceania and Africa are predicted to see an upward trend in consumption, compared with the base year.

ii) For emerging countries such as Brazil and Russia, grain consumption is expected to grow at a relatively high rate. In the livestock net exporting region of Central and South America, there is a very large consumption of grain as feed, while in Europe, grain consumption as feed for livestock production is increasing as the population growth stagnates. Therefore, the rate of increase for these two regions is high.

In Asia, although the diversification and improvement in diet in China and India is increasing the human consumption of vegetable oil and livestock products, as well as the consumption of grain as feed, the per capita consumption of grain as staple food is predicted to stagnate. The rate of increase in the per capita consumption of grain in Asia, the Middle East, and Africa is relatively low compared to countries in Europe and Central and South America. It is predicted that the sluggish growth in consumption due to factors such as a lack of purchasing power will lead to insipid growth.

iii) Population growth in North America is high compared to other regions that include developed nations; existing government policy is leading to an expected slowdown in the demand growth for corn-based bioethanol, resulting in nearly stagnant growth. Additionally, Oceania's per capita consumption is predicted to remain stagnant.

b. Vegetable oil

Table 11 Per capita vegetable oil consumption projection results

	Base year (2014-16)		Target year (2027)	
	Value	Index	Value	Index
	kg		kg	
World Total	13.1	100	14.0	107
North America	35.7	100	36.7	103
Latin America	22.3	100	22.1	99
Oceania	12.2	100	12.3	101
Asia	9.9	100	12.3	124
Middle East	12.3	100	13.3	108
Europe	27.9	100	28.2	101
Africa	3.3	100	3.2	97
(Reference)				
China	18.1	100	24.3	134
India	7.2	100	8.6	120
Russia	16.6	100	17.4	105
Brazil	30.6	100	30.6	100

- i) The 2027 per capita consumption of vegetable oil in North America—a developed region—is expected to rise slightly compared to the base year; an upward trend in consumption is expected in Europe because it includes emerging countries.
- ii) In Asia and the Middle East, the trend of increasing per capita consumption is supported by the economic growth. The relatively high rate of economic growth is predicted to increase consumption in Asia by 24%, caused by an increase in the economic growth rate of 34% in China and 20% in India. However, the 2027 per capita consumption in Asia and the Middle East is expected to stabilize at 12.3 kg and 13.3 kg, respectively. As these quantities represent only about 50% of the per capita consumption in Central and South America, there is ample scope for future increases in consumption.
- iii) It is predicted that the 2027 per capita consumption level in Central and South America will remain nearly stagnant, at about 60% to 70% of the levels in North America and Europe. Due to a slight slowdown in economic growth, Brazil's per capita consumption is expected to decline slightly and stabilize at 30.6 kg in 2027. Africa's low purchasing power and consumption levels imply that per capita consumption will not increase, and it is estimated to be 3.2 kg in 2027.

c. Meat

Table 12 Per capita meat consumption projection results

	Base year (2014-16)		Target year (2027)	
	Value	Index	Value	Index
	kg		kg	
World Total	37.9	100	40.9	108
North America	107.7	100	108.2	101
Latin America	64.6	100	67.0	104
Oceania	115.1	100	119.7	104
Asia	29.8	100	36.0	121
Middle East	30.9	100	36.0	117
Europe	71.0	100	75.8	107
Africa	9.7	100	9.7	100
(Reference)				
China	59.0	100	72.4	123
India	5.5	100	8.6	156
Russia	63.6	100	68.6	108
Brazil	95.9	100	100.8	105

- i) With the exception of North America, an upward trend in the per capita consumption of meat until 2027 is anticipated, when compared with the base year.
- ii) Asia and the Middle East, where per capita consumption levels are relatively low, are expected to witness 2026 growth rates of 21% and 17%, respectively. Asia's relatively high rate of economic growth compared to developed countries will see consumption growth of 23% in China and 56% in India. Although India will experience an increase, particularly in chicken consumption, the base year figure of 5.5 kg per capita will increase to a still relatively low 8.6 kg in 2027, and it is predicted that chicken consumption levels will not even reach Africa's base year levels. In Africa, there was no marked increase in the per capita consumption amount of grain or vegetable oil, and although Africa's consumption level is the lowest among the regions analyzed, it is predicted to be stable at 9.7 kg in 2027.
- iii) The per capita consumption in North America, Oceania, and Europe was already high in the base year, and it is predicted that it will reach 108.2 kg in North America and increase slightly to 119.7 kg in Oceania. Amid predictions of economic stagnation in Russia, the per capita consumption is expected to increase by 8% in 2027, primarily due to a growing demand for chicken. In contrast, the 2027 per capita consumption in Central and South America is predicted to grow by 4% and stabilize at 67.0 kg, which is close to the European consumption level.

(C) International reference price projections

i) Grain and soybean

From 2015 onwards, the demand for grain and soybeans as livestock feed has remained high as emerging and developing countries continue to consume larger quantities of livestock products. While the total population continues to increase despite slower population growth in regions such as Asia and Africa,

the consumption demand for biofuel feedstock, supported by government policies as well as the blend wall, means that there is limited room for bioethanol demand. Indications of a bearish market, such as slow economic growth in some emerging nations, are also evident. Although international prices for grain and soybeans are not expected to return to the low levels seen before 2006, it is predicted that they will remain stagnant. Additionally, the 2027 international prices for wheat, corn, rice, and soybeans are expected to increase by 0.9–2.5% in real terms, and to remain stable.

ii) Vegetable oil (soybean oil and other vegetable oils)

Amid disparate levels of economic growth, and the slowing of the demand growth for the non-edible use of soybean or other vegetable oils, vegetable oil consumption is increasing in emerging countries, particularly those in Asia. In addition, the population continues to increase, especially in Asia and Africa. Given these factors, it is predicted that the international price of vegetable oil is expected to be higher than the price of wheat.

iii) Meat

The population increase in regions such as Asia and Africa ensures a steady consumption of meat. The consumption of chicken is increasing worldwide, facilitated by the growing desire to be healthy and the lack of religious proscription on its consumption. Chicken prices are expected to increase by 5.5% in real terms in 2027. Meanwhile, pork prices are expected to see a similar increase of 3.6% due to increased consumption, primarily in Asia. It is predicted that beef prices will be almost stagnant, with a growth rate of 1.5%. Meat consumption is increasing because of the changes in diet quality that accompanies rising income levels. Meat prices are also affected by the fact that the current price levels for feed corn and grains are holding steady despite slowing growth, and it is predicted that the price of meat will trend slightly upward.

iv) Dairy products

Despite disparities in economic growth, the consumption of dairy products such as butter, powdered skim milk, and cheese is gradually increasing, facilitated by the rise in income levels in emerging and developing countries, with their low per capita consumption. Despite the slowing of the population growth rate, the increasing population will stimulate future demand. As such, international prices are expected to trend upward. However, cheese is different in that it takes time to process and to meet the demand. It is expected that the growth in demand for cheese in emerging economies, particularly those in Asia, will be lower than the demand for butter and powdered skim milk. Thus, a relatively slower growth is predicted.

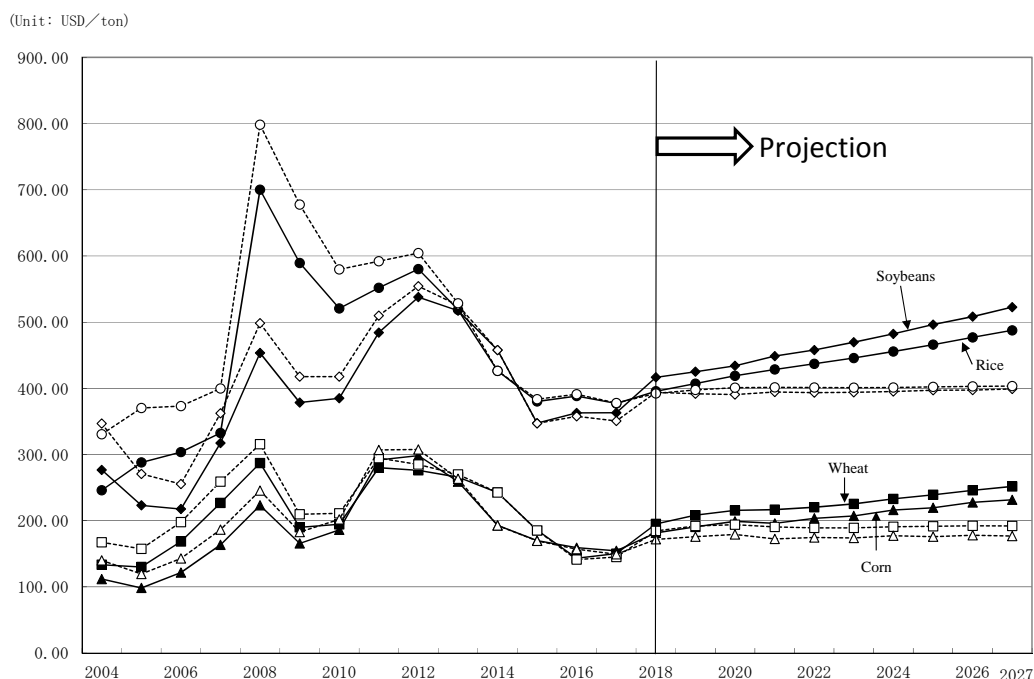


Figure 1 International reference price projections for grains and soybeans
(Solid lines: Nominal prices; Dotted lines: Real prices)

Notes

1. Prices until 2017 are actual prices. Prices for 2018–2027 are projections.
2. Actual and future nominal prices use 2015 (average of three years from 2014 to 2016) as the base year. Wheat, corn, and soybean prices were calculated using the US consumer price index (CPI), and rice prices were calculated using Thailand's CPI (all from IMF data).

Table 13 Base year and target year prices of major items

(Unit: US dollars per metric ton [crops] and US dollars per 100kg [livestock products])

(Unit : USD/ton (Crops) , USD/100 kg (Livestock products))

Commodities	Base year price (2014-16)	2027 (Target year)			
		Real price	Changing rate (%)	Nominal price	
					Changing rate (%)
Wheat	190	192	0.9	252	32.1
Corn	174	177	1.7	232	33.2
Rice	398	403	1.3	488	22.4
Other grains	134	136	0.9	172	27.6
Soybeans	389	399	2.5	523	34.3
Vegetable Oils	749	886	18.3	1,143	52.6
Beef	443	450	1.5	601	35.7
Pork	171	177	3.6	232	35.7
Chicken	247	261	5.6	342	38.3
Butter	351	465	32.4	586	66.8
Non-fat dry milk	302	355	17.5	447	48.0
Cheese	376	390	3.7	490	30.6

Note: Among the target year nominal prices of wheat, corn, soybeans, and vegetable oils, the prices of soybean oil, pork, and chicken were calculated using the US CPI; the prices of other grains and other vegetable oils were calculated using Canada's CPI; the price of rice used Thailand's CPI; the price of beef used Australia's CPI; and the prices of dairy products used New Zealand's CPI (all from IMF data).

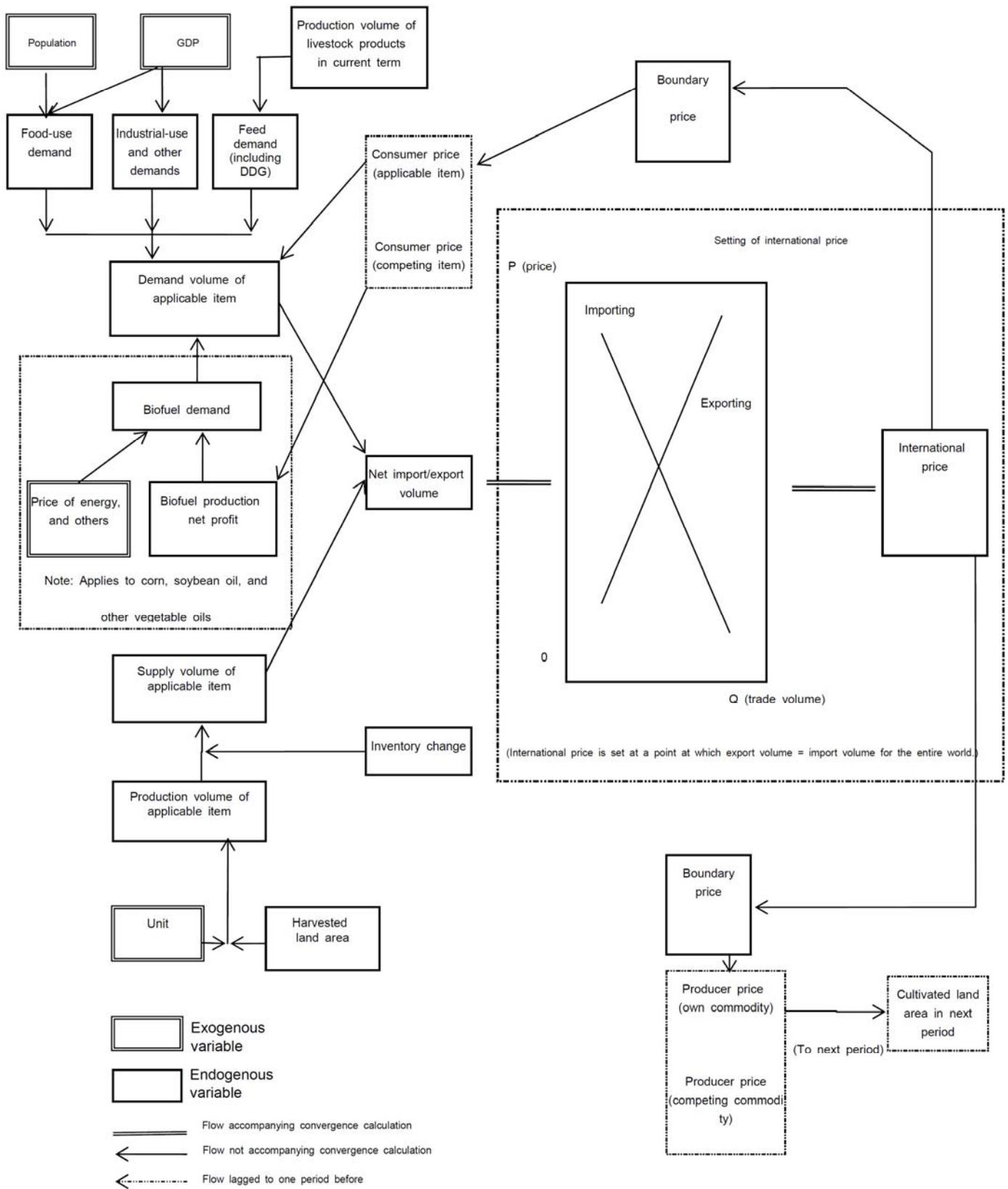
Note: The World Food Supply and Demand Model

1. The World Food Supply and Demand Model was based on a measurement model development system for food supply and demand that was developed by Keiji Ohga, University of Tokyo Professor Emeritus, and Gen Furuhashi, Senior Researcher at the Policy Research Institute, Ministry of Agriculture, Forestry, and Fisheries (PRIMAFF). A refined version of the model was developed at PRIMAFF in 2008. Subsequent refinements were made, such as the incorporation of equations of the World Biofuel Supply and Demand Projection Model developed by Senior Researcher, Tatsuji Koizumi.

The model is projected as a supply-and-demand equilibrium model on a simultaneous equation system, in which the supply and demand of each commodity are matched through its equilibrium price every year for the medium term to the target year, with the entire world as the commodity market and under the assumptions on future population growth rates and economic growth rates. The model consists of about 6,000 equations in the system.

2. The supply and demand balances in each country/region for each commodity conform to the approach used by the United States Department of Agriculture's food supply and demand balance. However, the following specific points should be noted for the items mentioned:
 - (A) The data for rice are for milled rice.
 - (B) Due to data limitations, the effects of stocks of beef, pork, chicken, mutton, eggs, milk, and processed livestock products on supply and demand are not considered.
3. For model projection purposes, the supply and demand quantities of the base year are adjusted as described below. Thus, they do not necessarily match the actual figures.
 - (A) The model assumes commodities' equilibrium of their supply and demand in a single year; therefore, the quantities are adjusted to make the worldwide net imports/exports zero.
 - (B) To prevent discontinuous movements in international reference prices, the figures are adjusted to balance the worldwide production and consumption of each commodity.

Reference 1: Conceptual Diagram of the World Food Supply and Demand Model



Reference 2: Countries and Region Coverage

Countries and region coverage used in the model projections

Region category	Sub-category (country/region name)
North America	US and Canada
Latin America	Argentina, Brazil, Mexico, and other parts of Latin America
Oceania	Australia and New Zealand
Asia	Japan, China, Korea, Thailand, Vietnam, India, Indonesia, Pakistan, Bangladesh, Malaysia, Philippines, Taiwan, and other parts of Asia (including Central Asia)
Middle East	Middle East
Europe	EU (28 countries), Russia, Ukraine, and other parts of Europe
Africa	South Africa, Nigeria, North Africa, and other parts of Africa
Rest of world	Rest of the world
Total	31 countries/regions