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International Rice Outlook: International Rice Baseline Projections 2022-2032

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The supplementary Microsoft Excel Tables include detailed country-by-country deterministic and stochastic projections.

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International Rice Outlook: International Rice Baseline Projections 2022–2032

Alvaro Durand-Morat, Subir Bairagi, and Willy Mulimbi[1]

Highlights

- Input costs have remained high since the war in Ukraine started. Although rice prices have increased in the last several months, production costs have increased more than proportionally, undermining rice profitability.
- We project that global rice production will exceed global rice consumption for most of the coming decade, with a small deficit developing by the end of the projected period.
- The projected growth in production is almost exclusively due to productivity gains.
- The projected growth in global rice consumption is exclusively driven by population growth, as the average global per-capita rice consumption is estimated to decrease in the coming decade.
- The international prices of long-grain and medium-grain rice are projected to increase in nominal terms but decrease in real terms in the next decade due to ample rice supplies.
- We project that rice demand in Africa will continue to grow at a high pace, thus supporting a fast growth in regional production and imports.
- Global rice trade is projected to increase in nominal and relative (to supply) terms, with Africa being the main driver of the expansion.
- Rice exports will remain highly concentrated among the top 5 exporters. India will remain the largest exporter of rice, while Thailand will consolidate as the second-largest exporter in the coming decade. Myanmar, Cambodia, and Vietnam are expected to grow their export market share, while Pakistan and the U.S. are expected to lose market share in the coming decade.
- On the rice import side, we project that China, Indonesia, the EU, and Saudi Arabia will lose market share, the Philippines' market share will remain unchanged, while Nigeria, Cote d'Ivoire, and Iran will grow their market shares by 2030–2032 relative to the situation in 2019–2021.

Introduction

Rice prices in Asia increased since the Summer of 2022 mainly due to worries about a reduction in rice production in India caused by an abnormal monsoon season (Fig. 1). The upward trend in export prices solidified after India implemented a 20% export tariff on brown and milled long-grain rice, and a complete ban on exports of broken rice, in September 2022 to curve down exports and release the pressure on domestic rice prices. India's rice export prices increased since then and proportionally to the value of the export tax. The latest estimates put rice production at 128 million metric tons (mmt) in 2022/2023, only slightly below the record-high production of 129.5 mmt in 2021/2022.

The export prices out of Thailand and Vietnam increased 14% and 16% between September 2022 and April 2023 in accordance with the higher export prices of India (Fig. 1). Despite the export tariff, India remains the most competitive supplier among the top Asian exporters. The U.S. export price for long-grain rice has been consistently above that of other Asian exporters, but the gap widened even more in 2022 after two consecutive short U.S. crops.

The high U.S. export prices undermined the export competitiveness of the U.S. rice industry. In the first eight months of the current 2022/2023 marketing year (in the U.S. this goes from August to July), U.S. long-grain and medium-grain rice exports were 27% and 32% below the previous year's volumes. Exports of long-grain paddy rice were 48% below the previous year's numbers, primarily due to the significant loss of market share in Mexico and Central America, which are increasingly sourcing paddy rice from Brazil. Exports of U.S. milled long-grain rice have remained at the same level as a year ago, largely thanks to the rise of Iraq as a relevant export market.

The primary goal of this report is to discuss the main findings of our 2022–2032 baseline projections for the global rice market. The projected period includes the ongoing 2021 marketing year since, at the time of the estimation, a large share of the 2021 rice crop in the northern hemisphere and most of the 2021 rice crop in the southern hemisphere was still underway. It is important to state that the results in this report do not account for the changes in the global economy that occurred since January 2023.

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Materials and Methods

Arkansas Global Rice Model (AGRM)

The Arkansas Global Rice Model (AGRM) generates a baseline projection of the global rice economy. The AGRM is a partial equilibrium economic model that covers over 70 rice-producing, -consuming, and -trading countries worldwide. Each country's rice economy is specified as a system of equations representing rice demand, production, trade, and prices for the two major rice types: long-grain and medium-grain rice. Domestic support and trade policies are embedded in the model equations.

The AGRM can be specified mathematically with the following system of linear equations (1–14) demand, supply, and price transmission).

where the subscripts c, r, and t, respectively, are the country, rice types (long- and medium-grain), and year; PC and TC are, respectively, the per capita and total rice consumption; POP = population; RP, PP, MP, and XP are the retail, farm, import, and export prices, respectively; SRP and SPP are, respectively, the retail and farm prices of substitute crops for rice, such as wheat. I = per capita income; AH = harvested rice area; Y = paddy rough rice) yield; M = imports; X = exports; BS and ES are the beginning and ending stock, respectively, where $BS = ES_{t-1}$; WP = world rice price (Thai 5% broken), which clears the rice markets; ER = exchange rates; TS and TD are the total supply of rice and demand for rice, respectively; σ = paddy to rice conversion ratio; τ and ω are import tariff and export tax, respectively; λ = floor price; MSP = minimum support paddy price; α, β, γ, δ, θ, and φ are the respective demand, supply, and price transmission elasticities, either estimated or taken from the relevant literature. A more detailed specification of the model can be found in Mane and Wailes (2012) and Wailes and Chavez (2011).

$$PC_{c,r,t} = \alpha_0 \times RP_{c,r,t}^{\alpha_1} \times SRP_{c,r,t}^{\alpha_2} \times I_{c,r,t}^{\alpha_3} \quad (1)$$

$$TC_{c,r,t} = PC_{c,r,t} \times POP_{c,t} \quad (2)$$

$$AH_{c,r,t} = \beta_0 \times AH_{c,r,t-1}^{\beta_1} \times PP_{c,r,t}^{\beta_2} \times SPP_{c,r,ct}^{\beta_3} \quad (3)$$

$$Y_{c,r,t} = \gamma_0 \times Fert_{c,r,t}^{\gamma_1} \times Time^{\gamma_2} \quad (4)$$

$$TP_{c,r,t} = \sigma \times Y_{c,r,t} \times AH_{c,r,t} \quad (5)$$

$$ES_{c,r,t} = \delta_0 \times TP_{c,r,t}^{\delta_1} \times RP_{c,r,t-1}^{\delta_2} \quad (6)$$

$$RP_{c,r,t} = \theta_0 \times PP_{c,r,t}^{\theta_1} \times MP_{c,r,t}^{\theta_2} \times (1 \times \lambda) \quad (7)$$

$$PP_{c,r,t} = \varphi_0 \times RP_{c,r,t}^{\varphi_1} \times MP_{c,r,t}^{\varphi_2} \times MSP_{c,r,t}^{\varphi_3} \quad (8)$$

$$MP_{c,r,t} = WP_{r,t} \times ER_{c,r,t} \times (1 + \tau) \quad (9)$$

$$XP_{c,r,t} = WP_{r,t} \times ER_{c,r,t} \times (1 - \omega) \quad (10)$$

$$TS_{c,r,t} = TP_{c,r,t} + M_{c,r,t} + BS_{c,r,t} \quad (11)$$

$$TD_{c,r,t} = TC_{c,r,t} + X_{c,r,t} + ES_{c,r,t} \quad (12)$$

$$\sum_c M_{c,r,t} = \sum_c X_{c,r,t} \quad (13)$$

$$TD_{c,r,t} = TS_{c,r,t} \quad (14)$$

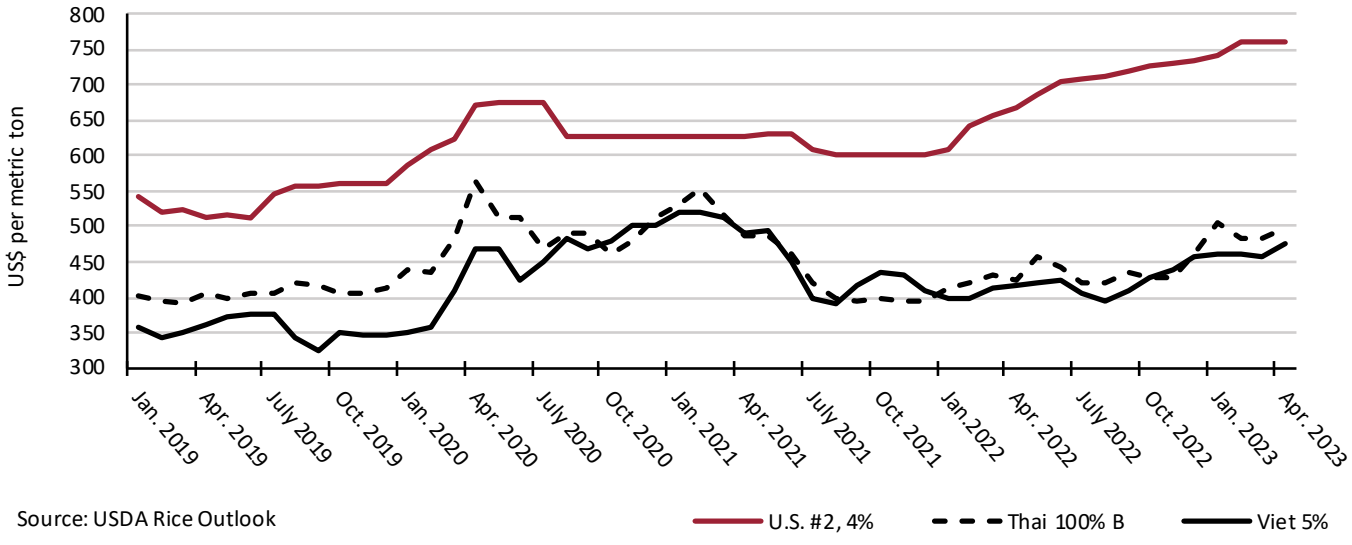


Fig. 1. The monthly average export price of long-grain rice from selected exporters.

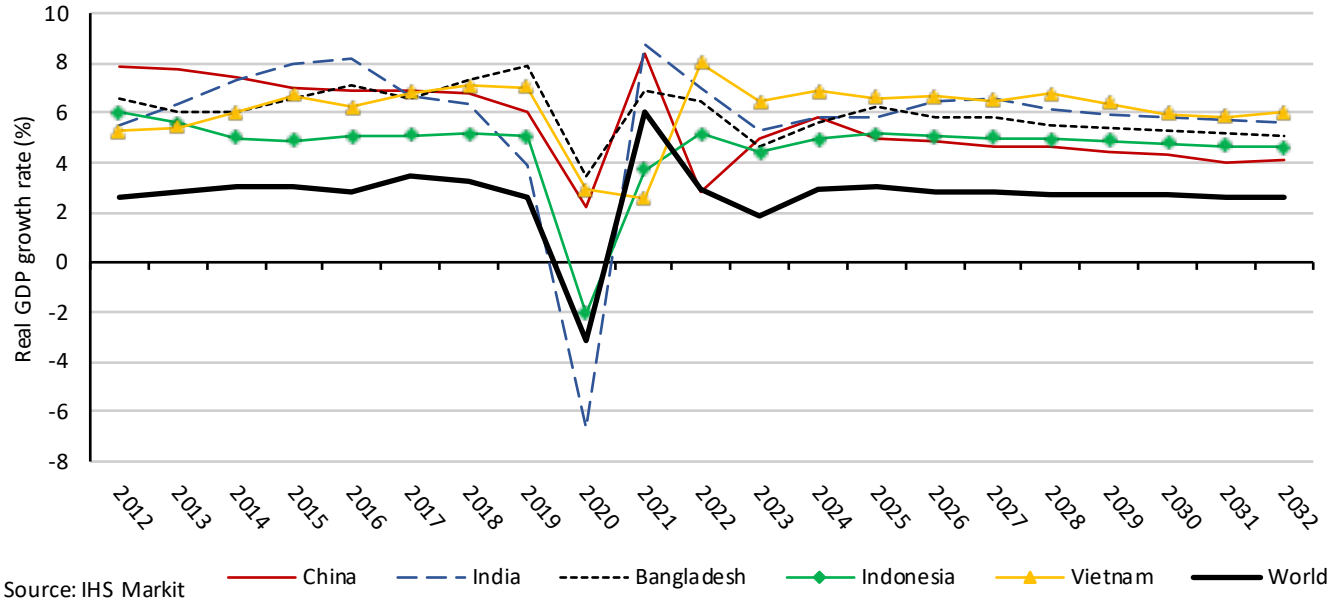
Global Macroeconomic Assumptions

The macroeconomic projections used to calibrate the AGRM model came from IHS Markit, representing the projections as of January 2023. The projections suggest that, globally, the economy will grow at a similar rate in the next decade (2.7% a year) compared to the last (2.6%). Looking at the top-5 rice-consuming countries, the projections over the next decade relative to the last point to a lower rate of economic growth in China and Bangladesh and a higher rate in India, Indonesia, and Vietnam (Fig. 2). Looking at the largest rice markets in the Western hemisphere, economic growth is projected to strengthen in Brazil and decrease in the U.S., Colombia, and Peru relative to their performance in the last decade.

The population is projected to grow globally over the next decade but at a lower rate (0.8% a year) than that observed in the last decade (1.1% a year) and is expected to reach 8.61 billion by 2032. The population growth rate will decline across all regions but most severely among developed countries. For instance, the population growth rate is expected to decrease to 0.25% a year among OECD countries, relative to 0.54% in the last decade. Among developing countries, the population is expected to grow at 2.0% a year in the coming decade relative to 2.2% in the past decade. Population growth rates in the top-5 rice-consuming countries are expected to continue decreasing in the coming decade, following a similar trend observed in the last several years (Fig. 3). Most notoriously is the projected decrease in population in China from 1.426 billion in 2021 to 1.410 billion in 2032.

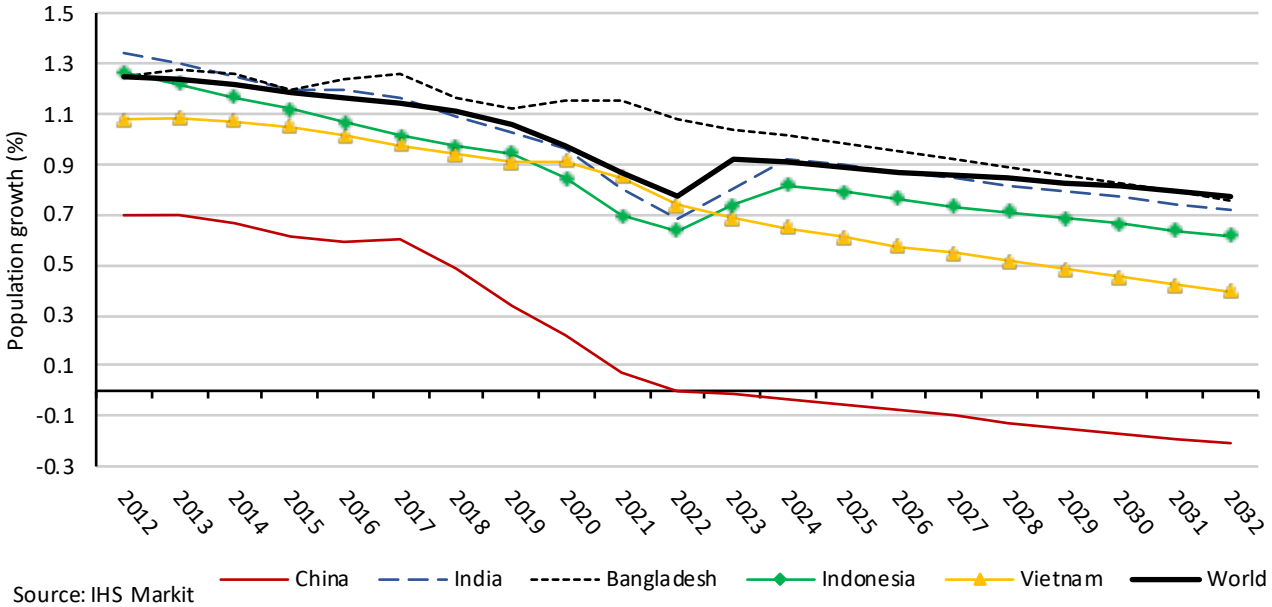
Stochastic Simulation Method

A stochastic component based on the probabilistic distribution of rice yields is also integrated into the AGRM to capture risks and uncertainties associated with the global rice sector.



Source: IHS Markit

Fig. 2. Economic growth projections for the top-5 rice-consuming countries in the world.



Source: IHS Markit

Fig. 3. Population growth projections for the top-5 rice-consuming countries in the world.

The stochastic framework is generated using multivariate empirical distributions (MVE) of the deterministic yields. Yield is chosen as the stochastic variable because it varies by year and country, and is very sensitive to seasonal changes, weather conditions, and water availability—factors that are critical for rice production. The stochastic rice yields are simulated using @Risk© (Palisade, Ithaca, N.Y.) based on historical rice yield data from 1992 to 2022. For each country, the distribution of detrended residuals is estimated and used to simulate yield variability in the next decade, accounting for yield correlation across countries. Finally, 100 random yield observations are drawn and used to generate stochastic results.

Results and Discussion

Global and Regional Rice Market Outlook: Results from the Deterministic Baseline Analysis

Table 1 presents the current and projected global rice supply and utilization. Global rice production has outpaced consumption every year in the last decade, but since 2019 the global surplus has decreased and turned negative (consumption outpaced production) in 2021. Still, on average, global production has outpaced consumption by 4.5 mmt a year in 2019–2021. The stock-to-use ratio reached its highest value (37.7%) in 2020 and decreased slightly in 2021 (35.4%), averaging 36.7% in 2019–2021. Despite the high level of global rice stocks, rice prices have trended upward since 2015, which partly reflects that most rice stocks are not readily available for trade but play an important food security role in some markets. For instance, China and India held 62% and 19% of the global rice stocks in 2019–2021, largely for domestic food security reasons, and therefore they may not be readily available for trade. The stocks held by the top-five net rice exporters (excluding India), which may be deemed as readily tradable, amounted to 4.8% of the global rice stocks in 2019–2021, down from 11.2% in 2013–2015, driven primarily by a sharp decrease in ending stocks in Thailand.

Despite the growth in rice trade relative to supply observed over the last two decades, rice remains thinly traded, with only 10% of the rice supply traded internationally in 2019–2021, compared to 16% for corn and 25% for wheat. Aside from the fact that most rice is consumed where it is produced without crossing borders, the low trade share may also result from the fact that rice remains a highly protected commodity, particularly in many Asian countries where rice is the staple food. Asia dominates the global rice market and accounts for 90% of production, 86% of consumption, 95% of stocks, and 84% of global exports between 2019 to 2021. We project that the share of rice production that is traded internationally will grow to an average of 11.5% by 2030–2032 as demand continues to grow and outpace production in many regions, including Africa and the Middle East.

The international price of long-grain (LG) rice, the most popular type of rice produced and traded worldwide, is projected to grow steadily but marginally in nominal terms over the next decade (Fig. 4). We project that the nominal price of Thai LG 100% B rice will increase on average 1.01% from its 2019–2021 level, reaching an average of $502/mt in 2030–2032, while the price of U.S. LG (#2 LG Gulf) will increase by 0.47% a year from its 2019–2021 level and reach $670/mt by 2030–2032 (Fig. 4). The significant gap between the price of LG rice from Asia and the Western Hemisphere witnessed over the last several years is expected to continue over the next decade. The reason is that importers in the Western Hemisphere continue to source rice mainly from regional suppliers (e.g., U.S. and Mercosur) despite the price discounts for Asian rice. The international nominal price of medium-grain (MG) rice, represented by the U.S. MG#2 (FOB California), is projected to remain above US$1,000/mt throughout the projected period but to reach its highest value in the 2022 crop year, decrease in the medium term, and start increasing back again to reach $1,172/mt by the end of the projected period. In real terms (adjusting for inflation), the international price of LG (Thai LG 100% B) and MG (U.S. #2 MG California) are projected to decline by 0.81% and 2.07% annually, respectively, over the next decade.

At the regional level, Asia is projected to account for the bulk (73.0%, or 24.8 mmt out of the 34 mmt increase) of the growth in rice production in the next decade, followed by Africa with 6.3 mmt or 18.5% of the growth, and America with 2.1 mmt or 6.2% of the growth (Fig. 5). The share of production from Africa

Table 1. Projected world rice supply and utilization (in 1,000 metric tons of milled rice unless indicated).

Attributes	2019–2021 Average	2030–2032 Average	Nominal Change	% Change
Area Harvested (1000 ha)	164,334	166,024	1690.27	1.03%
Yield (kg/ha)	3.09	3.26	0.17	5.61%
Production	507,741	541,743	34,002	6.70%
Beginning Stocks	182,751	194,008	11,257	6.16%
Domestic Supply	690,491	735,751	45,260	6.55%
Consumption	503,239	541,553	38,314	7.61%
Ending Stocks	184,615	195,137	10,522	5.70%
Total Trade	50,482	62,371	11,889	23.55%
Stocks-to-use Ratio[a] (%)	36.69	36.03	-0.65	-1.78%

[a] Globally, the stock-to-use ratio is estimated as ending stocks over consumption.

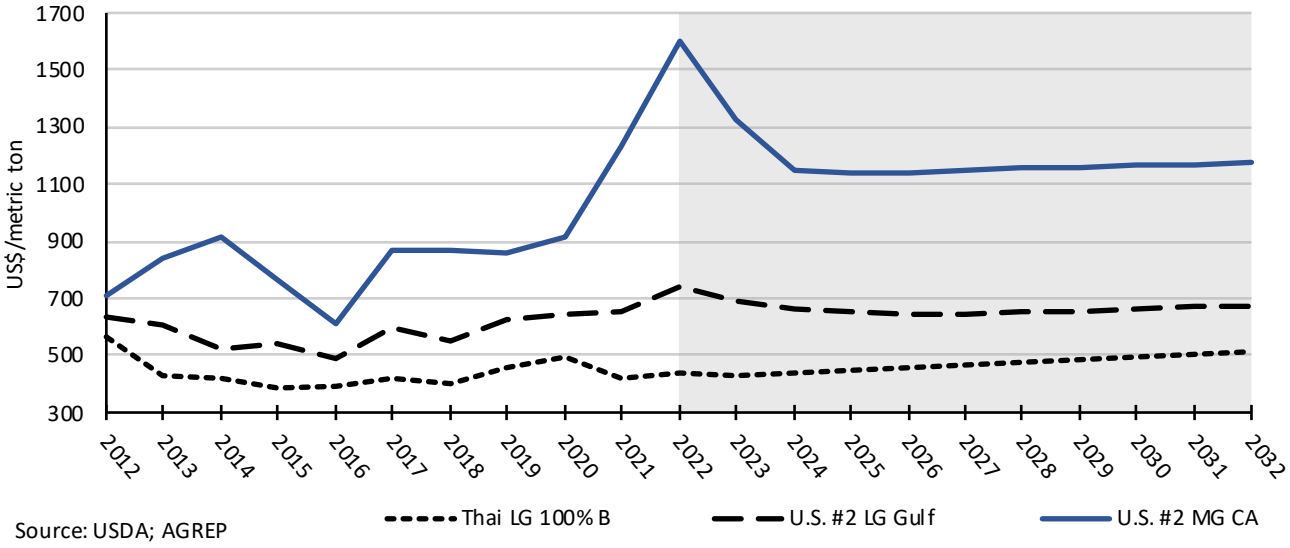


Fig. 4. The nominal international price of long-grain (LG) and medium-grain (MG) rice. The gray-shaded area represents the projected period between 2022 to 2032.

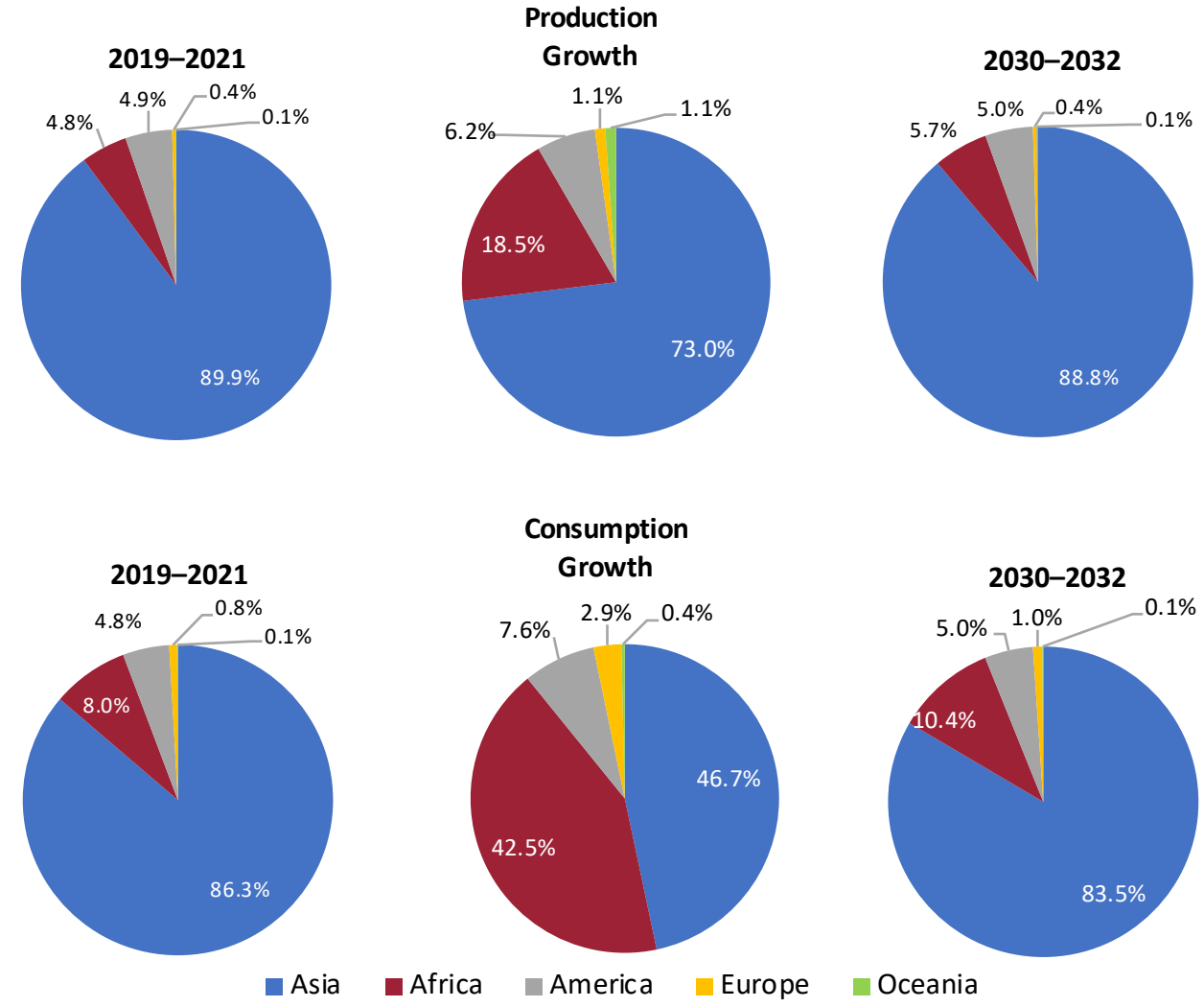


Fig. 5. The projected trend of regional rice production and consumption over the next decade.

and America is expected to expand at the expense of Asia and Oceania, but the later will still account for the bulk (88.8%) of global rice production in 2030–2032. Relative to the 2019–2021 production levels, Africa will experience the largest growth in production with a 25.7% cumulative increase from 2019–2021 to 2030–2032. The efforts to bolster production in Africa after the rice crisis of 2007–2008 resulted in an impressive 51.4% increase in rice production in the last decade (2009–2011 to 2019–2021). We project that the growth continue strong in the coming decade, but at a slower pace than that shown last decade.

The projections on the consumption side are similar to those on the production side. Asia is projected to account for the largest nominal growth in consumption (46.7%, or 17.9 mmt out of 38.3 mmt), although the growth is smaller than that projected last year due to the decrease in population projections in China. Africa will experience the second largest growth in consumption in nominal terms, with 16.3 mmt or 42.5% of the projected growth (Fig. 5). Africa is expected to maintain an impressive growth in consumption over the next decade relative to the 2019–2021 level, increasing rice consumption from 40.3 mmt in 2019–2021 to 56.5 mmt in 2030–2032, a 40.4% increase. In the last decade, rice consumption in Africa grew 61.8% due to rapid growth in per-capita consumption and population. We project that growth will slow down some but still remain strong in the coming decade. Africa's share of global consumption is projected to increase over the next decade, primarily at the expense of Asia.

Africa is projected to continue driving the growth in global rice trade to serve the fast-growing demand. We project that Africa will account for 76.2% of the growth in imports in the next decade and will surpass Asia and become the largest rice importer in 2030–2032. On the export side, Asia accounts for the bulk (94.9%) of the growth in exports and expands its dominance on the export side (Fig. 6).

Country-Specific Rice Market Outlook: Results from the Deterministic Baseline Analysis

Rice Consumption. The food basket in various developing countries is expected to transform in mainly two directions, namely, substitution between food items, such as increasing consumption of animal protein and less of cereals, and within

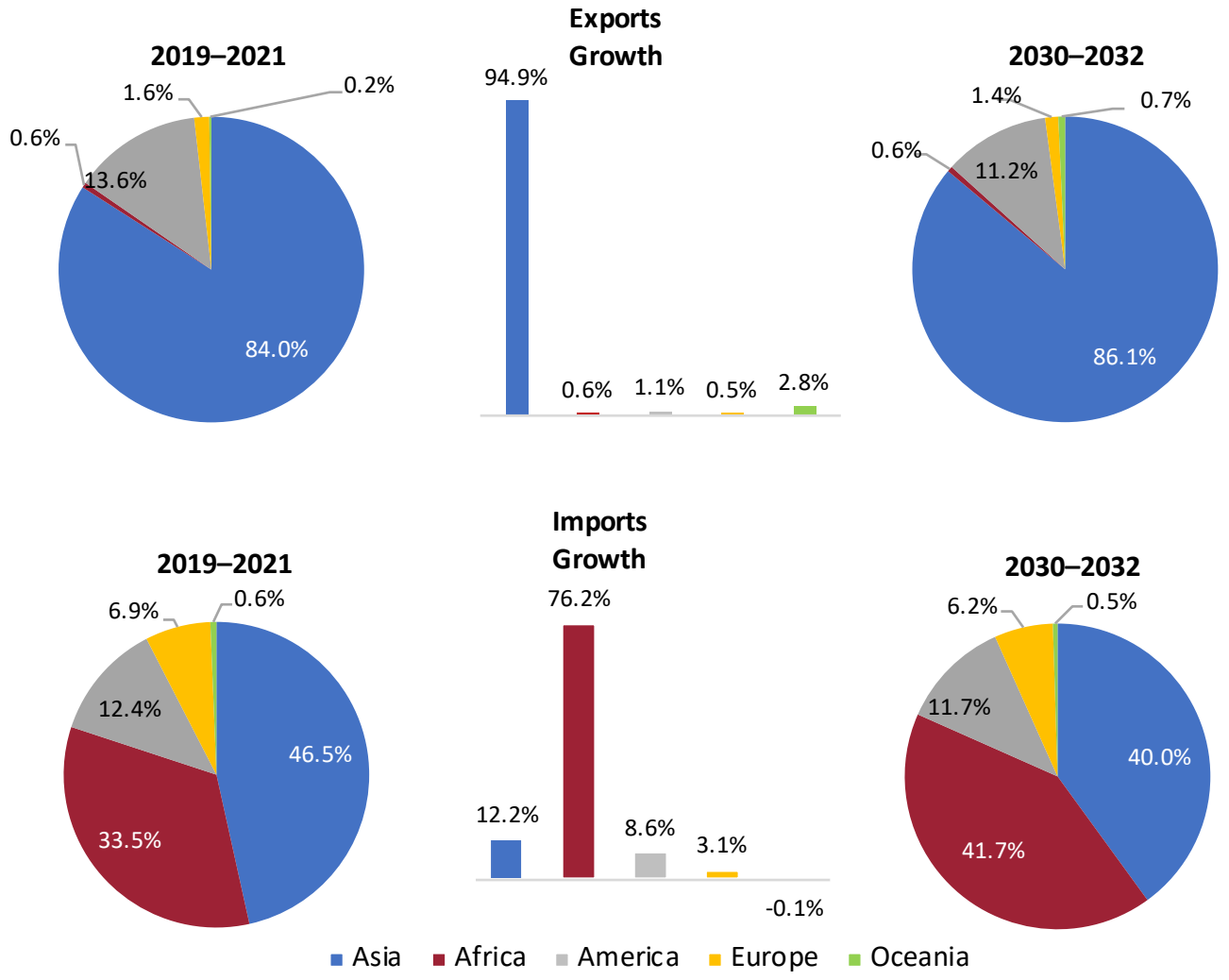


Fig. 6. The projected trend of regional rice export and import shares over the next decade.

food items, such as increasing consumption of aromatic or brown rice at the expense of regular white rice (Bairagi et al., 2020, 2022; Mottaleb et al., 2018). As such, the demand for staple food in Asia, such as rice and wheat, will decline, and the demand for non-staple food, such as vegetables, will increase in the future (Pingali, 2015).

Our projections suggest that per-capita consumption in many Asian countries, including the five largest rice consumers (China, India, Bangladesh, Indonesia, and Vietnam), will decline in the coming decade (Fig. 7). However, total consumption will increase purely based on population growth, except in China, Japan, and South Korea, where total consumption is projected to decline in the next decade. Moreover, total rice consumption is projected to increase strongly across most African countries based on higher per-capita consumption (supported partly by growing income levels in some countries where rice is a normal good) and strong population growth (Van Oort et al., 2015). For instance, looking at the largest rice markets in the continent, we project that total consumption in Tanzania and Nigeria will grow by 53.7% and 37.9%, respectively, over the next decade, driven mainly by population growth since per-capita consumption increases by only 6.2% and 4.5%, respectively. Rice consumption in Egypt is expected to grow 23.2% over the next decade, but purely based on population growth. In Madagascar, rice consumption is expected to grow by 26.0% based on population growth despite a projected 2.5% decrease in per-capita consumption. Finally, rice demand is projected to grow in all Latin American countries except Brazil, the largest rice market outside Asia, where a 5.0% decline in per-capita consumption will almost offset the increase in population by 2030–2032. For the projected changes in consumption in other countries, see Appendix Table A1.

Rice Production. We project that production in China, the largest rice producer in the world, will decrease slightly by 0.93% over the next decade (Fig. 8). Some of the reasons explaining this decrease in production include the increasing competition

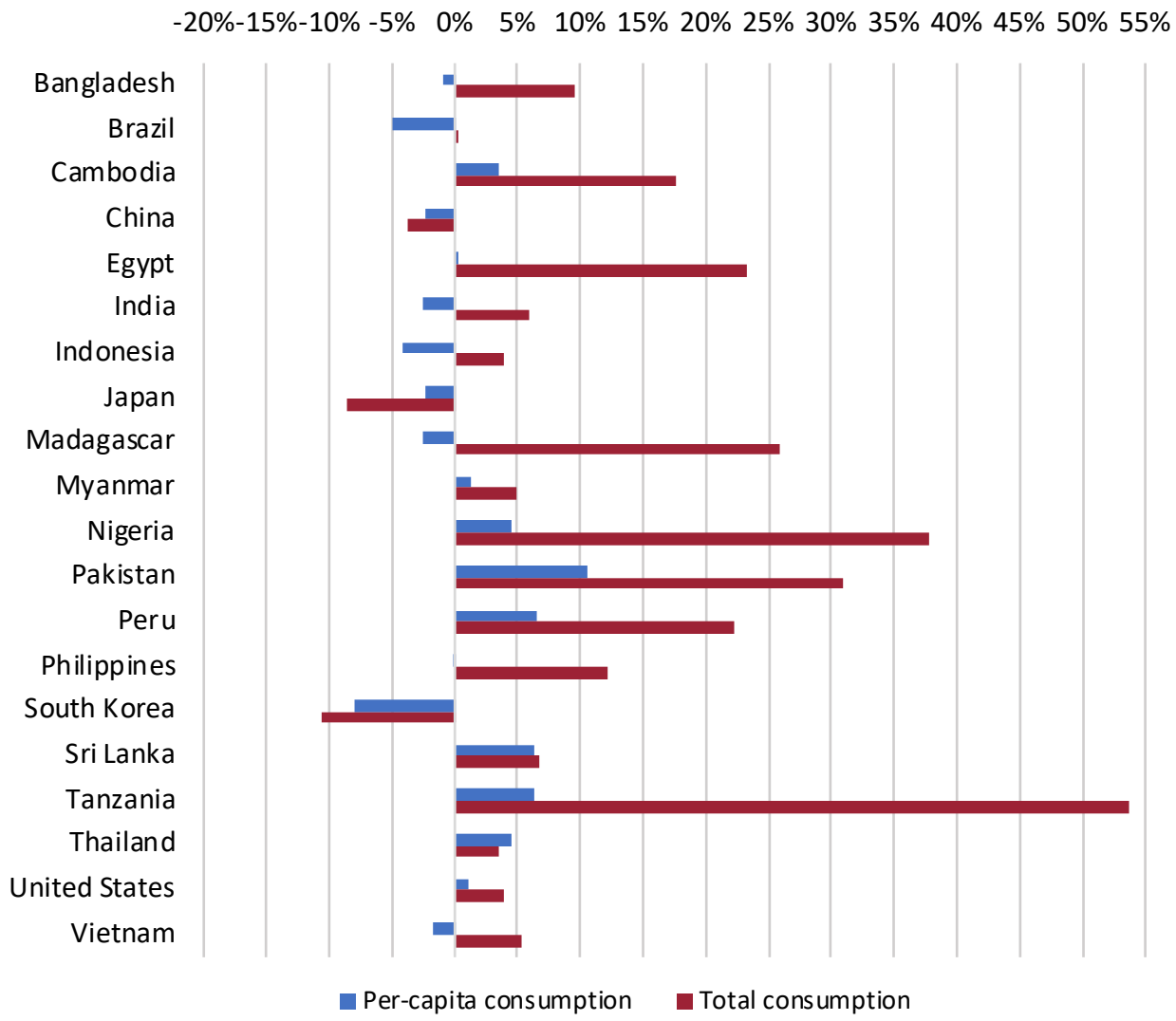


Fig. 7. Projected changes in per-capita and total rice consumption among the 20 largest rice markets in 2030–2032 compared to 2019–2021.

with other field crops, such as soybeans and corn, and the lower pressure on rice from a food security point of view as demand slows down and the stock level remains high. On the other hand, we project that production in India will continue to grow but at a slower pace than that observed in the last decade and supported primarily by yield gains as the area decreases marginally. The future path of rice yields in India is a key variable that could greatly impact the global rice market in the coming decade. In Indonesia, we project rice production will grow only slightly in the next decade (4.6%) based almost exclusively on yield gains. In Nigeria, Africa's largest rice producer, we project rice area and yield to continue growing, increasing production by 18.6% by the end of the next decade. In Tanzania, we project a 45.57% increase in rice production, driven mostly by an increase in area. In Latin America, we project that the shift in production in Brazil from upland to irrigated rice will ease some as the bulk of the shift has already happened. Brazilian rainfed rice area stood at an average of 25% of the total area in 2015–2020, relative to 38% in the 1990s. Therefore, the rice area is projected to decrease by a cumulative 3.4%, while yields are expected to increase by 4.18%, yielding a slight increase in rice production. In Peru, the second-largest rice producer in Latin America, we project rice area and yields to grow, leading to a 17.1% increase in production by the end of the next decade. For the projected changes in production in other countries, see Appendix Table A1.

Rice Trade. Global rice trade grew 42.2% in the last decade (from 35.5 mmt in 2009-2011 to 50.5.0 mmt in 2019–2021), and we project it will continue to grow but at a slower pace, reaching 62.4 mmt by 2030–2032, that is, a cumulative 23.6% growth from its 2019–2021 level. Rice trade is highly concentrated on the export side, with five countries (India, Thailand, Vietnam, Pakistan, and the U.S.) accounting for 76.2% of the total volume of exports in 2019–2021, down from 79.2% in 2009–2011. We project that the U.S. will drop out of the top-five rice exporters to the 7th place, and Myanmar and China will become the 5th and 6th largest rice exporters in 2030–2032. Arguably the most

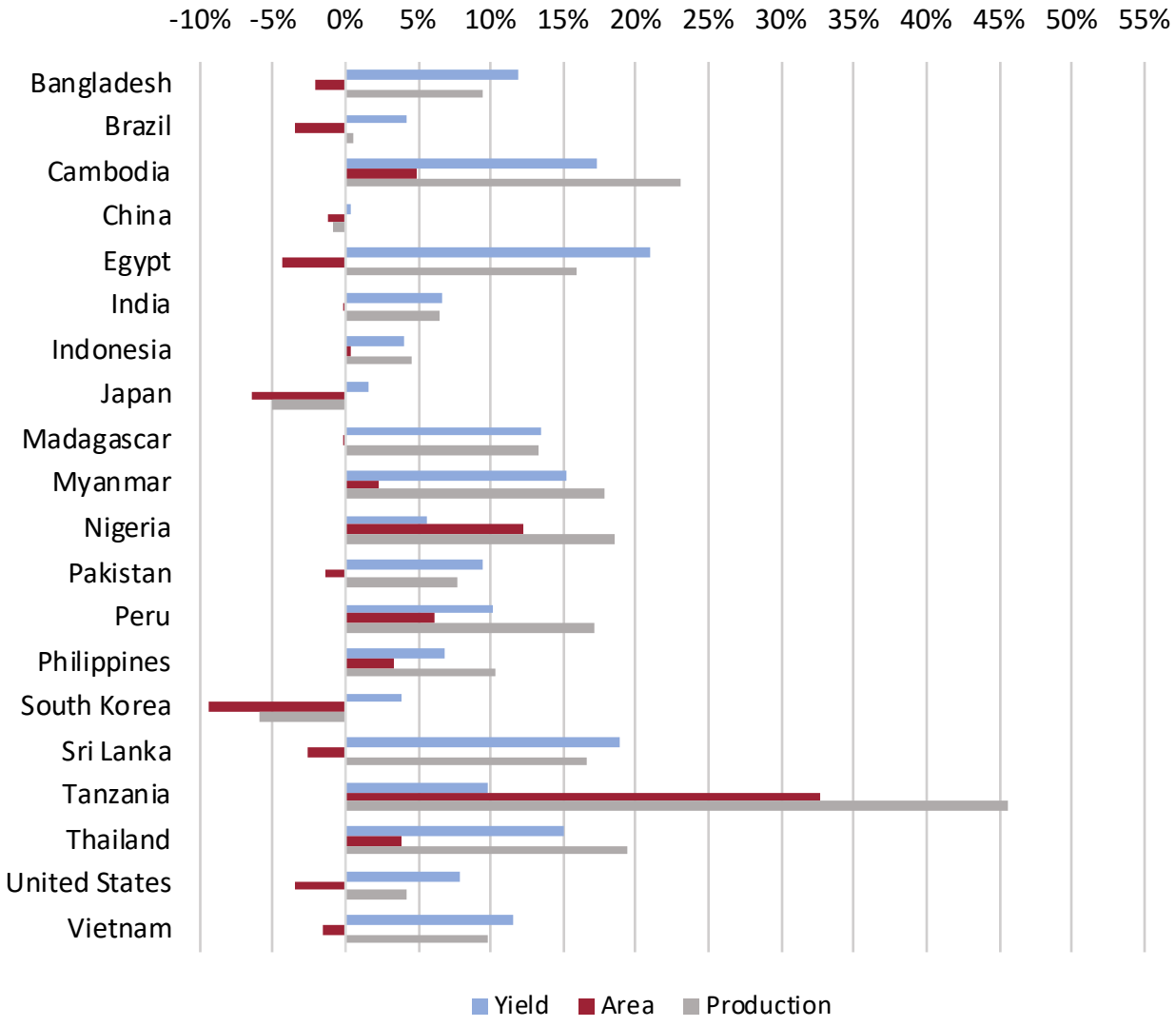


Fig. 8. Projected changes in rice yields, area, and total production among the 20 largest rice producers in 2030–2032 compared to 2019–2021.

prominent development on the export side in the last decade has been the rise of India as a steady and leading exporter of rice, growing from a 14.3% export share in 2009–2011 to more than one-third (36.2%) in 2019–2021 (Fig. 9). We project that India will remain the largest exporter of rice in the coming decade, accounting for 34.8% of the global rice exports in 2030–2032. Thailand is regaining the market share lost in 2021 and 2022 due to a series of weather-related production shocks that have tightened the market and undermined its competitiveness. We project that Thailand will increase its presence and consolidate as the second-largest exporter after India. Myanmar, Vietnam, and Cambodia are expected to grow their export market share, while Pakistan and the U.S. are expected to lose market share in the coming decade. Finally, we project that China will become a more consistent exporter, holding a 5.2% market share by 2030–2032.

The import side of the global rice market is much less concentrated than the export side, with the top-five importers accounting for around a quarter of global imports in 2019–2021. We expect that the low concentration will continue next decade, with increases in market shares in large African rice importers such as Cote d'Ivoire and Nigeria and a decrease in the market share of China and Saudi Arabia (Fig. 10). For the projected changes in exports and imports in other countries, see Appendix Table A2.

U.S. Rice Market. The results in this section differ slightly from those presented by FAPRI in its 2023 U.S. Agricultural Market Outlook. Regardless of the slight differences, the main findings reported by FAPRI are consistent with those presented in this report.

Table 2 presents the U.S. rice supply and utilization by types (namely, LG and MG, where MG includes both medium- and short-grain rice). We project that the production of LG rice will grow from 147 million hundredweight (cwt) in 2019–2021 to 158.8 million cwt by 2030–2032, equivalent to an annual rate of 0.8%. To put these numbers in perspective, we project the LG rice crop in 2030–2032 to be smaller than the most recent highest production of 2016 (166.7 million cwt) and 2020 (170.8 million cwt). Most of the gains are expected to come from yield

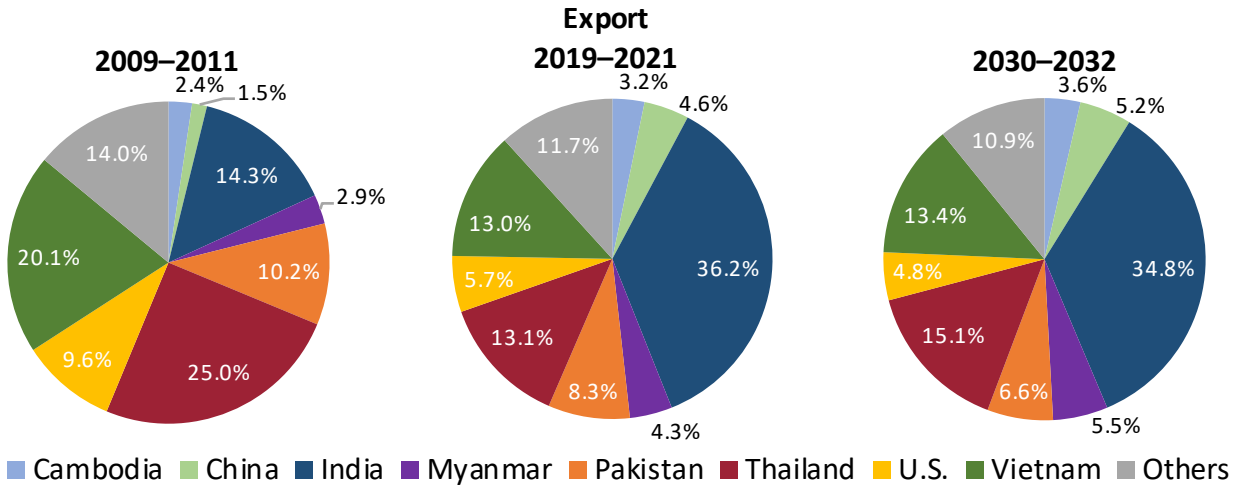


Fig. 9. Historical and projected export shares by the top rice exporters.

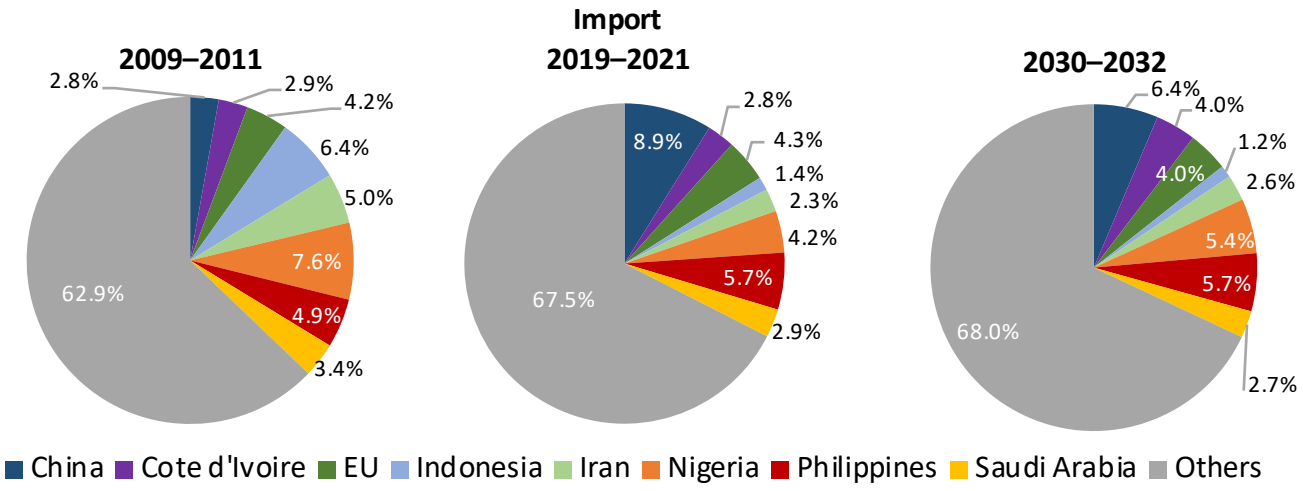


Fig. 10. Historical and projected import shares by the top rice importers.

improvements, which include farm-level as well as milling yield gains. The baseline projections implicitly assume that the industry follows through with its commitments to improve the milling and culinary quality of LG rice, which will not only increase milled rice output (higher milled rice and head rice yields generate more milled rice per unit of paddy rice), but also help reverse the loss of competitiveness that U.S. LG rice has experienced in core export markets such as Mexico and Central America in the last decade.

Exports of LG rice are projected to increase in 2023, plateau in the midterm, and increase after 2028 as regional trade integration with Costa Rica and Colombia is fully implemented. We project that trade will reach 72.4 million cwt by 2030–2032, a volume similar to the average exported in 2015–2017 (Fig. 11). We expect that the U.S. will continue trading LG rice primarily across markets in the Western hemisphere, in many of which U.S. rice has preferential treatment under regional trade agreements. In recent years U.S. LG rice has not been competitive vis-à-vis LG Asian rice in other markets of interest, such as the Middle East and Africa, and we project that that situation will continue in the next decade. We project that domestic use (consumption plus residual) will grow slower in the coming decade relative to that observed in the past decade. On the import side, it is important to notice that we include imports of aromatic (jasmine and basmati) rice as LG rice. With that in mind, we project that imports will grow marginally (0.11% a year between 2022–2032) and much slower than they did in the last decade.

Looking at the MG segment of the market (Fig. 12), we project that the production of MG rice will increase significantly in 2023 and 2024 as planting in California returns to a normal pattern after several years of drought conditions and stabilize after that at around 50 million cwt. To put these numbers in perspective, we project a volume of production in 2030–2032 similar to the 2017 crop year average. Exports of MG rice are expected to decrease by 9.3% from 26.5 million cwt in 2019–2021 to 24 million cwt in 2030–2032. Although we treat MG as a single commodity, in reality, California Calrose MG rice and mid-South MG rice serve very different markets and attract different prices. California MG rice is exported primarily to markets in Northeast Asia (e.g., Japan, South Korea, Taiwan) and within WTO-negotiated schedules, which are expected to remain mostly fixed in the near future. On the other hand, MG rice from the mid-South competes more openly in key markets in northern Africa, the Middle East, and a few Western hemisphere markets such as Canada and Puerto Rico, where it has recently faced strong competition from China. Imports of MG rice (primarily to Puerto

Table 2. United States rice supply and utilization by types.

	All Rice			Long-grain			Medium- and short-grain		
Variables	2019–2021	2030–2032	Annual Growth	2019–2021	2030–2032	Annual Growth	2019–2021	2030–2032	Annual Growth
Planted area (1000 acres)	2649.3	2557.8	-0.35%	1988.7	1968.2	-0.10%	660.7	589.6	-1.13%
Yield (lb/ac)	7603.5	8204.7	0.76%	7385.9	8066.4	0.89%	8273.4	8666.2	0.46%
Production (million cwt)	201.5	209.9	0.41%	147.0	158.8	0.77%	54.5	51.1	-0.64%
Beginning stocks (million cwt)	37.2	39.8	0.68%	26.4	29.5	1.11%	10.8	10.3	-0.44%
Imports (million cwt)	36.4	43.6	1.82%	29.3	34.9	1.79%	7.1	8.7	1.98%
Supply (million cwt)	275.1	293.3	0.64%	202.7	223.2	0.97%	72.4	70.1	-0.32%
Domestic use (million cwt)	149.6	158.6	0.59%	115.4	122.9	0.63%	34.1	35.7	0.45%
Exports (million cwt)	90.0	94.4	0.49%	63.5	70.4	1.04%	26.5	24.0	-0.98%
Ending stocks (million cwt)	35.5	40.3	1.27%	23.8	29.9	2.31%	11.7	10.4	-1.19%
Demand (million cwt)	275.0	293.3	0.64%	202.7	223.2	0.97%	72.3	70.1	-0.31%
Farm price ($/cwt)	14.7	16.4	1.13%	12.7	14.4	1.24%	24.2	26.3	0.84%

Rico), although small relative to total supply, have increased sharply since 2016/2017 and are expected to continue growing in the coming decade. We project that domestic use (consumption plus residual) will grow marginally in the coming decade relative to the 2019–2021 level, reaching 35.7 million cwt in 2030–2032, similar to the level reached in 2018–2019.

Figure 13 illustrates the dynamics of U.S. rice farm prices. The price of LG rice is projected to go back to trend and decrease in the short and medium term from the high reached in 2022 to remain below $15/cwt over the next decade. The price of MG from California is projected to decrease in 2023 from the record-high prices observed so far in 2022 and go back to prices more in accordance with the trend in 2024 and thereafter, reaching $26.3/cwt by 2030-2032. We project the significant price gap between MG from California and LG and MG from the mid-South will remain in the coming decade.

Key Results from the Stochastic Analysis

The stochastic simulation generates a probability distribution for each endogenous variable in the model. For the sake of brevity, we discuss here the stochastic projections for a few selected variables. All other stochastic results are available from the authors upon request.

Table 3 shows the stochastic results, represented by the mean, 5th, and 95th percentile values for the international reference price of LG rice (represented by Thai 100% B), the global levels of production, consumption, and exports. Fig. 14 shows the stochastic projected behavior of the export price of Thailand LG 100% B rice, the reference price that clears the international LG market. The gray-shaded area marks the range of variability between the 5th and 95th percentile. We project that the export price of Thai LG 100% B will be highly volatile in the short term, with a 90% confidence that the price

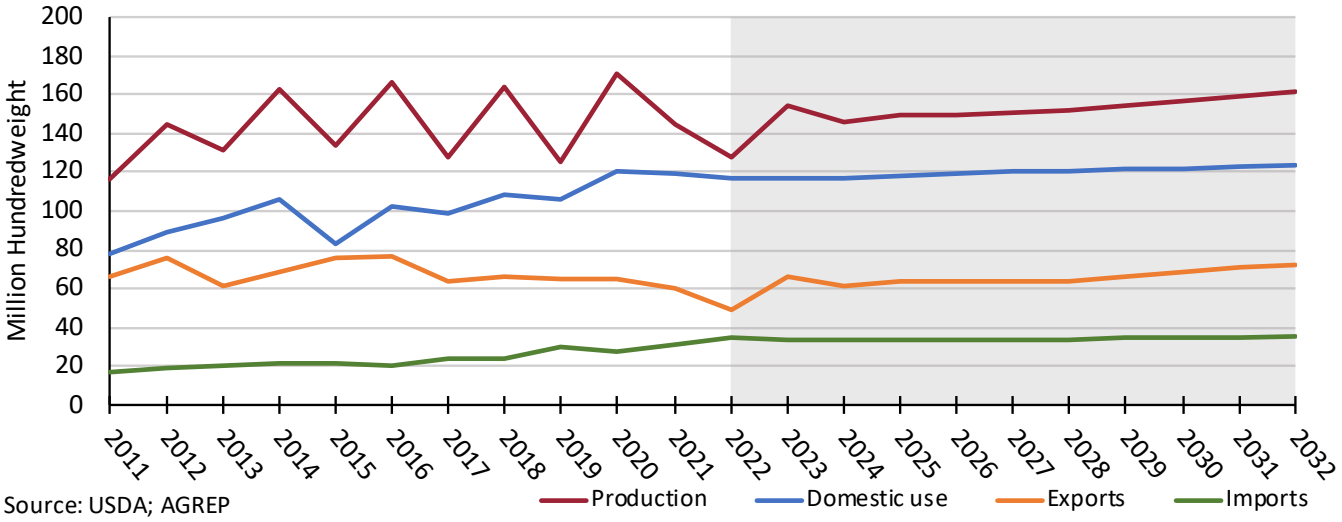


Fig. 11. Historical and projected behavior of selected U.S. long-grain rice market variables. The gray-shaded area represents the projected period between 2022 to 2032

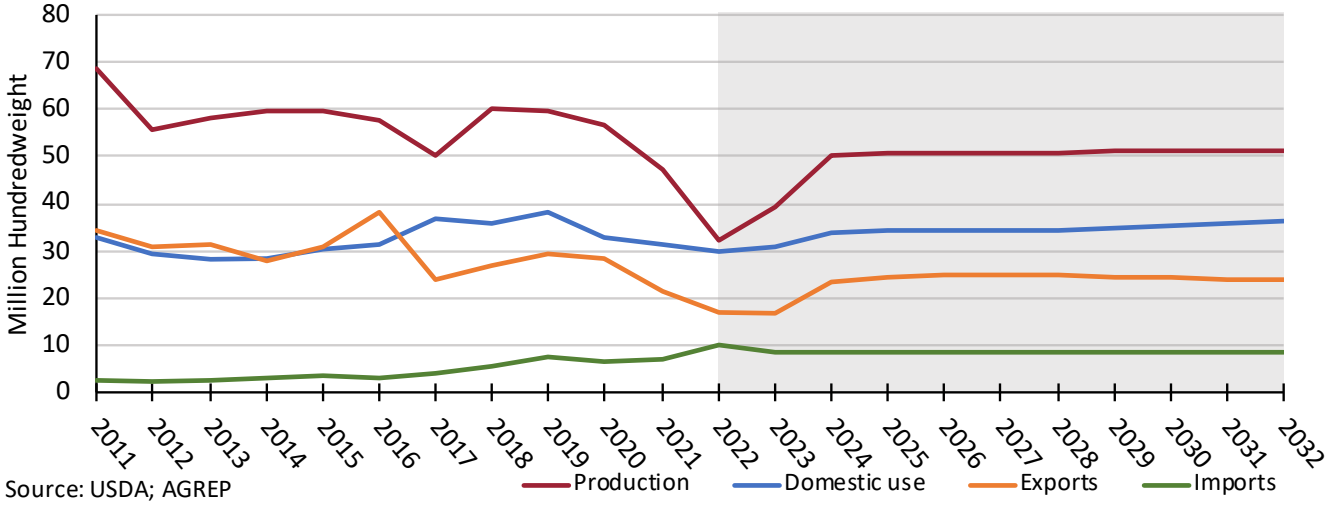


Fig. 12. Historical and projected behavior of selected U.S. medium-grain rice market variables. The gray-shaded area represents the projected period between 2022 to 2032.

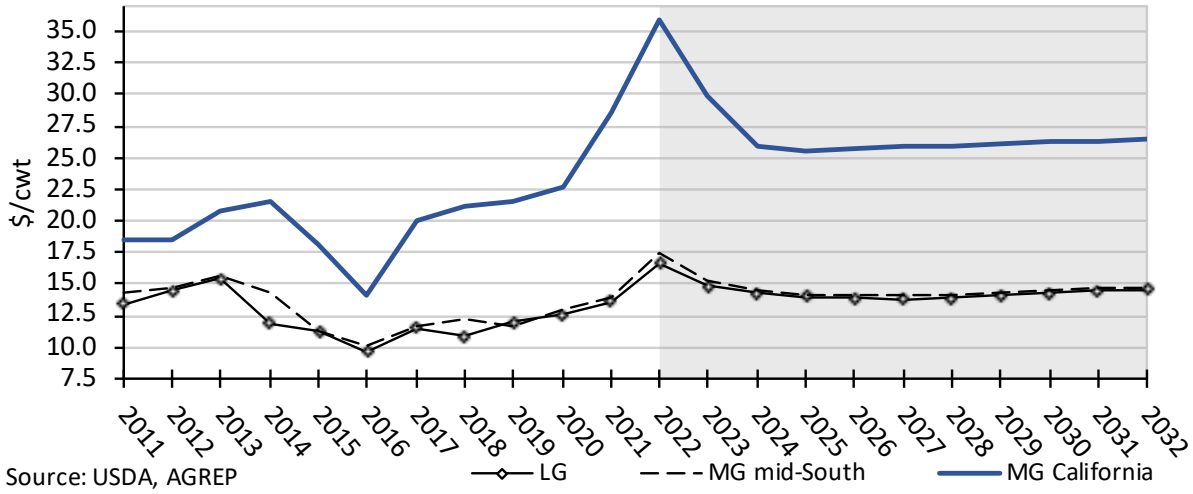


Fig. 13. Historical and projected behavior of U.S. rice prices by type, in nominal U.S. dollars. The gray-shaded area represents the projected period between 2022 to 2032.

Table 3. Stochastic projections (5th and 95th percentile) of the international reference price (Thai 100% B), global production, consumption, and exports.

	Thai 100% B (US$/mt)			Production (mmt)			Consumption (mmt)			Exports (mmt)		
Year	5th	Mean	95th	5th	Mean	95th	5th	Mean	95th	5th	Mean	95th
2011		592.0			469.5			455.1			40.0	
2012		565.0			476.1			462.2			39.4	
2013		428.0			481.4			472.3			43.3	
2014		420.0			483.0			473.4			43.9	
2015		386.0			476.7			467.5			40.7	
2016		394.0			491.8			477.9			47.9	
2017		418.0			494.8			481.2			47.9	
2018		399.0			498.2			485.1			44.2	
2019		457.0			498.9			493.0			43.4	
2020		490.5			509.3			498.8			51.2	
2021		416.0			515.0			517.9			56.8	
2022	350.7	435.7	588.0	494.0	506.6	512.5	498.3	506.7	512.5	49.6	53.0	58.0
2023	346.8	429.8	571.6	505.7	513.5	519.5	502.6	511.1	517.3	47.9	53.0	59.5
2024	364.4	436.8	555.4	513.9	518.5	524.4	508.7	515.4	521.1	49.8	54.8	61.6
2025	382.1	446.3	549.3	519.1	522.3	528.1	514.0	519.6	524.8	51.8	56.5	63.3
2026	395.3	454.5	549.0	523.5	526.1	531.6	518.7	523.6	528.5	53.1	57.6	64.3
2027	406.7	462.9	552.8	527.2	529.3	534.7	522.9	527.4	532.2	54.4	58.7	65.3
2028	417.2	472.4	558.8	530.9	532.7	537.9	526.7	531.1	535.7	55.4	59.6	66.2
2029	426.4	481.7	564.8	534.4	535.9	540.9	530.6	534.7	539.2	56.4	60.6	67.1
2030	436.6	492.3	572.6	537.6	538.9	543.7	534.3	538.2	542.6	57.4	61.5	68.0
2031	446.9	502.9	580.9	540.8	541.8	546.4	537.8	541.5	545.8	58.5	62.4	68.9
2032	457.0	512.3	587.6	543.8	544.6	549.1	541.5	544.9	549.1	59.5	63.2	69.7

will be between US$350.7/mt and US$588/mt in 2022. The increasing rate projected for the next decade will take the Thai LG 100% B to a mean level ranging between US$457/mt and US$588/mt by 2032. As shown in Fig. 15, the US #2 LG Gulf is expected to be highly volatile in the short term, with a 90% confidence that the price will be between US$632.7/mt and US$920.9/mt in 2022. We estimate that the volatility of US #2 LG will recede by the end of the projected period, with a 90% confidence that this price will be between US$622.4/mt and US$747.8/mt by 2032. Finally, Fig. 16 suggests that the US #2 MG California price also will be highly volatile in the short term, with a 90% confidence that the price will be between US$1,230/mt and US$2,040/mt in 2022. We estimate that the US #2 MG volatility will decline by the end of the projected period, with a 90% confidence that the US #2 MG price will range between US$1,079.4/mt and US$1,301.5/mt by 2032.

The stochastic projection of global production (Fig. 17) and consumption (Fig. 18) show a low variability under the assumptions of this study. With 90% confidence, we project that production will be between 543.8 and 549.1 mmt and consumption between 541.5 and 549.1 mmt by 2032. Global rice ending stocks, on the other hand, are between 49.6 and 58 mmt, decrease marginally in 2023 before increasing to reach a range between 59.5 and 69.7 mmt in 2032 (Fig. 19). Finally, we project with 90% confidence that global rice exports in 2022 will have an increasing volatility ranging between 141 and 256 mmt at the end of the next decade (Fig. 20).

Key Market Variables to Watch

China's Rice Stocks

China currently has a record level of stocks, estimated at an average of 115.3 mmt in 2019–2021. The current stock level amounts to nearly 76.6% of China's annual rice consumption relative to the demand. The stock buildup that started in the late 2000s is supported by a sustained level of production facilitated by favorable domestic policies, a steady volume of imports under the auspice of the WTO, and a slowdown in total rice consumption. One of the key questions looming over the rice market is what China will do with its rice stocks. More precisely, the question is whether stocks will continue building up more in light of the projected decrease in total consumption in the

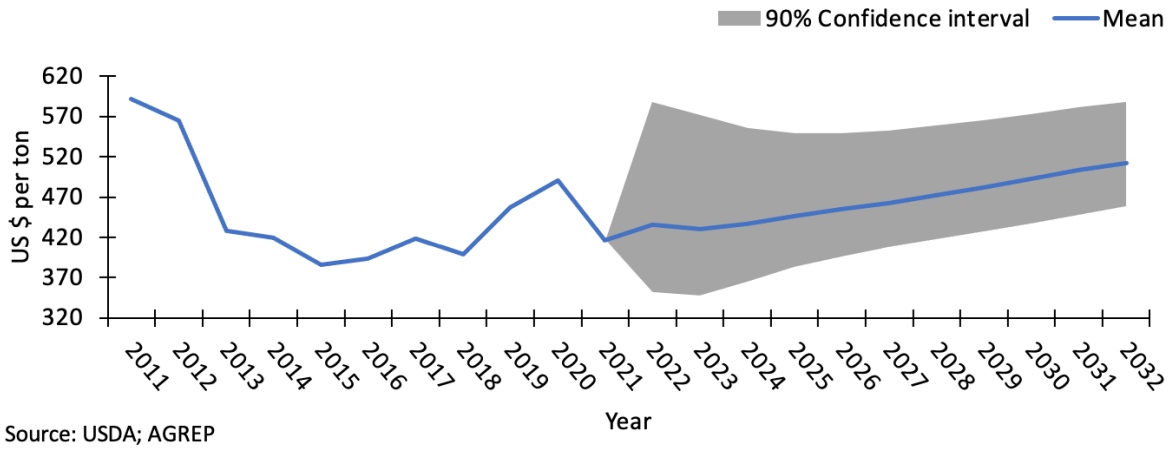


Fig. 14. Stochastic projection of the export price of Thai long-grain 100% B rice in the next decade. The gray-shaded area indicates the 90% confidence interval area based on stochastic projections for the period between 2021 to 2032.

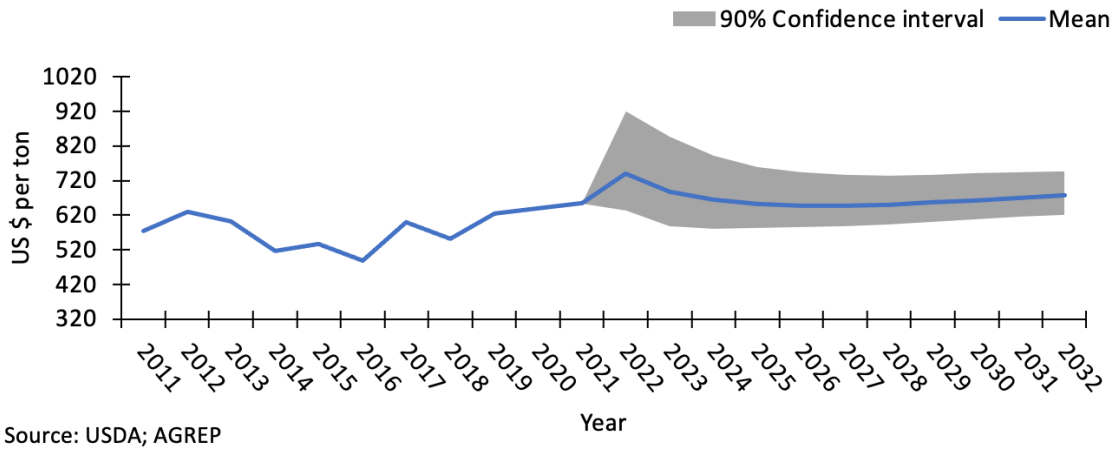
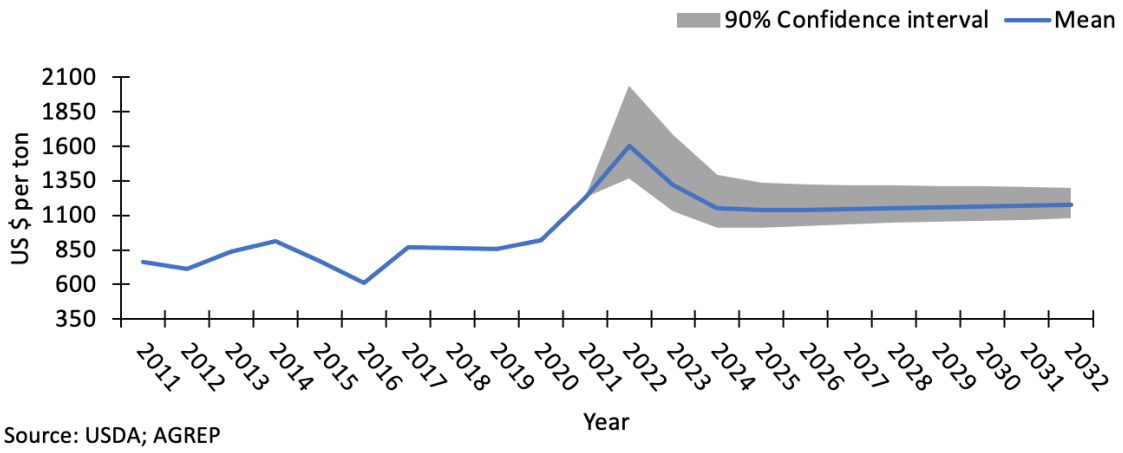
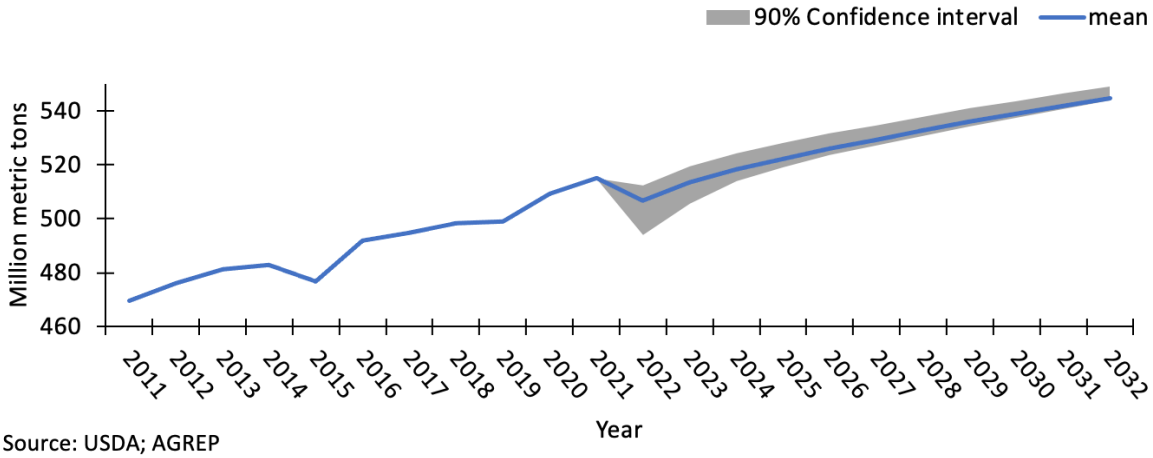


Fig. 15. Stochastic projection of the export price of US #2 long-grain Gulf in the next decade. The gray-shaded area indicates the 90% confidence interval area based on stochastic projections for the period between 2021 to 2032.



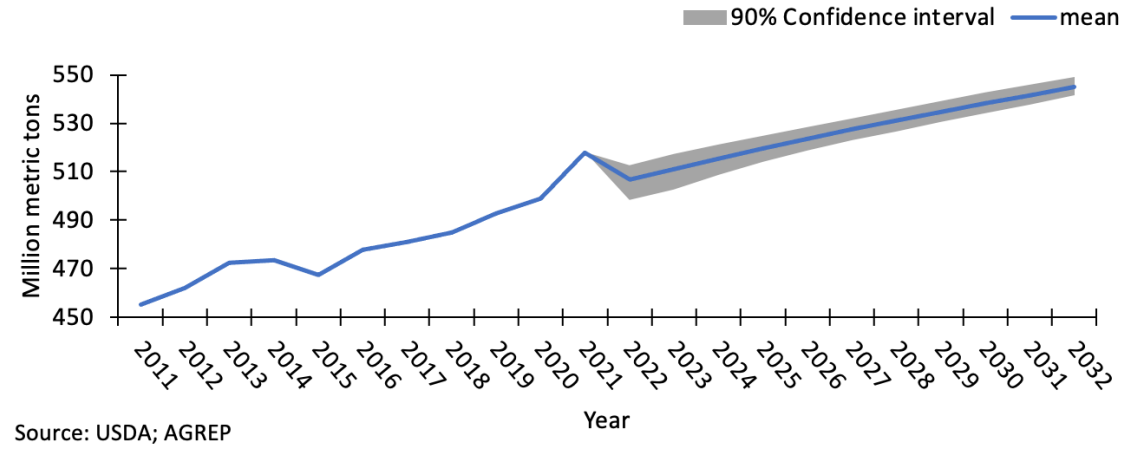
Source: USDA; AGREP

Fig. 16. Stochastic projection of the export price of U.S. #2 medium-grain California in the next decade. The gray-shaded area indicates the 90% confidence interval area based on stochastic projections for the period between 2021 to 2032.



Source: USDA; AGREP

Fig. 17. Stochastic projection of global rice production in the next decade. The gray-shaded area indicates the 90% confidence interval area based on stochastic projections for the period between 2021 to 2032.



Source: USDA; AGREP

Fig. 18. Stochastic projection of global rice consumption in the next decade. The gray-shaded area indicates the 90% confidence interval area based on stochastic projections for the period between 2021 to 2032.

coming decade. The scarce evidence from the last few marketing years suggests that China relies on both exports and increased domestic use to curve down stocks. Rice auctions for feed have been ramping up and are seen as the least disruptive way to address the situation. China used 25 mmt of old-stock rice as a feedstock in 2021/2022 and is projected to use 35 mmt in the next two years (USDA-FAS, 2023). However, China has also been ramping up rice exports, primarily of LG rice destined for Africa, and of Japonica (medium- and short-grain) rice at highly competitive prices for markets in northern Africa (primarily in Egypt), Turkey, and Puerto Rico. Because of the relatively small size of the Japonica rice market and the large volume of stocks of that type held by China, the management of stocks is crucial for that segment of the rice market. Our assumption for the next decade (Fig. 21) is that China will continue building up stocks, but we can infer how a change in this assumption could have enormous implications for the global rice market.

India's Rice Yields and Production

India's production record in the last 20 years has been impressive, expanding from 85.0 mmt in 2000 to 130 mmt in 2021. This trend in production translates to an average growth rate of 1.7% a year, more than double the global average rate over the same period. The production gain came exclusively from yield improvements since the area harvested remained constant since 2000. Average rice yields grew 1.5% a year from 1.90 metric tons per hectare in 2000 to 2.81 metric tons per hectare in 2021 (Fig. 22). Such productivity growth was mainly due to the development and dissemination of improved production technologies such as high-yielding and flood/drought-tolerant rice varieties, the development of irrigation infrastructure, and the use of chemical fertilizer (Kavi Kumar, 2021; Mahajan et al., 2017). Our projections indicate that rice yields in India will continue to grow but much slower in the coming decade. We hypothesize that the yield growths of many of the established rice varieties have nearly exhausted, and

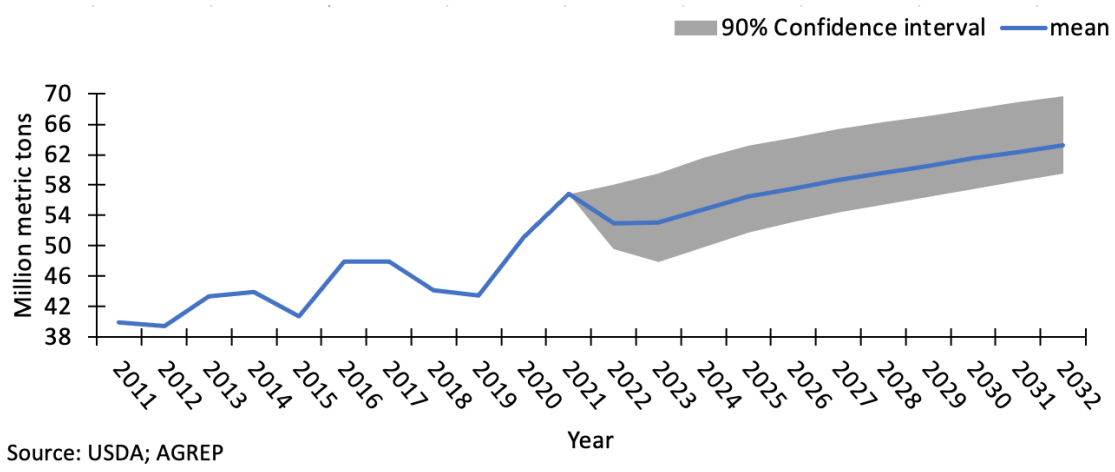


Fig. 19. Stochastic projection of global rice ending stocks in the next decade. The gray-shaded area indicates the 90% confidence interval area based on stochastic projections for the period between 2021 to 2032.

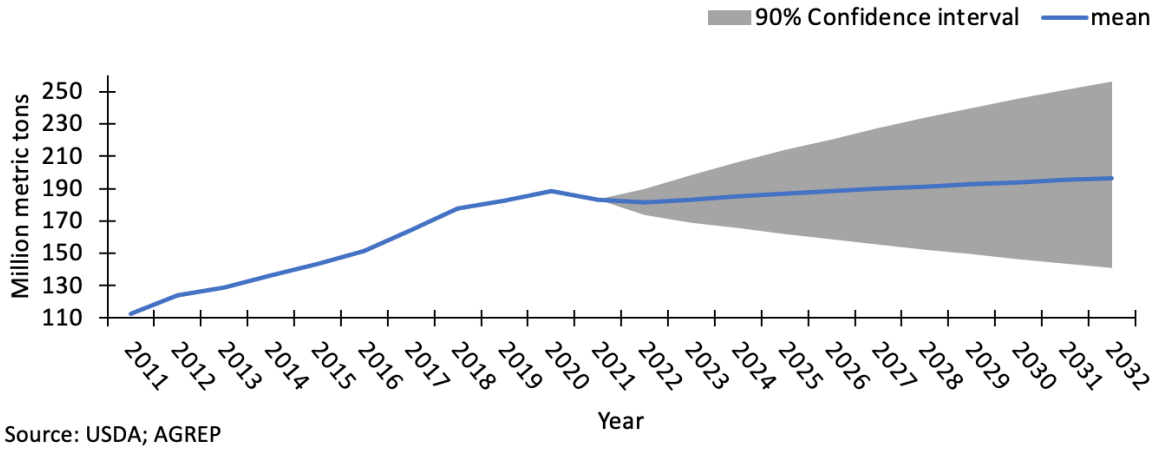


Fig. 20. Stochastic projection of global rice exports in the next decade. The gray-shaded area indicates the 90% confidence interval area based on stochastic projections for the period between 2021 to 2032.

productivity gains from increasing input use will increase but at a decreasing rate. We project that the rice yield will grow 0.75% a year, and the area will decrease slightly by 0.12% annually but should maintain a 0.64% average annual increase in production over the next decade. Despite this projected slowdown in production growth, we expect India to remain the largest rice exporter worldwide. Suppose India manages to keep the growth observed in the last two decades (e.g., via increasing adoption of hybrid rice and irrigation). In that case, we can expect that the international rice market will find an equilibrium at much lower prices than our projections suggest, which will have strong implications for the patterns of production and consumption worldwide.

Price Gaps Between Asian and Western Hemisphere Rice

Historically, LG rice exports from the Western Hemisphere (e.g., the U.S. and Mercosur) have been priced higher than most LG rice originating from Asia. To illustrate, Fig. 23 shows that the nominal and relative premium for long grain rice from the U.S. relative to Thailand has varied widely but, in general, trended downward from 1982 until the rice market crisis of 2007/2008, when the international market price of Thai 100%B rice tripled from $335/mt to over $1,000/mt (Dawe and Slayton, 2010). The price premium remained nearly zero and even reversed in 2012 when Thailand launched its ambitious rice-pledging program, resulting in higher Thai rice prices and lower export competitiveness. The price premium for U.S. long-grain rice has increased significantly since 2015, reaching $231/mt in 2021, and is projected to reach $305/mt in the 2022 marketing year. We forecast that the gap will decrease steadily in the next decade but remain above $150/mt.

One of the main reasons supporting the price gap between Western Hemisphere and Asian rice is the level of trade integration in the former and the fact that most rice trade remains regional and benefits from a preferential trade policy treatment. Another reason for the price gap often cited anecdotally by rice

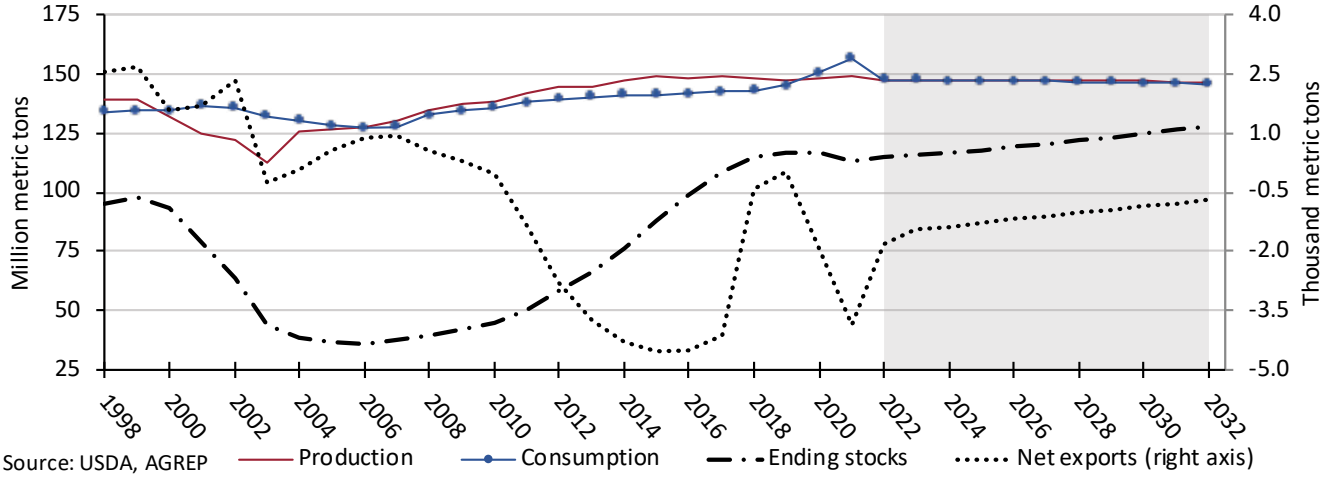


Fig. 21. China rice supply and utilization. The gray-shaded area represents the projected period between 2022 to 2032.

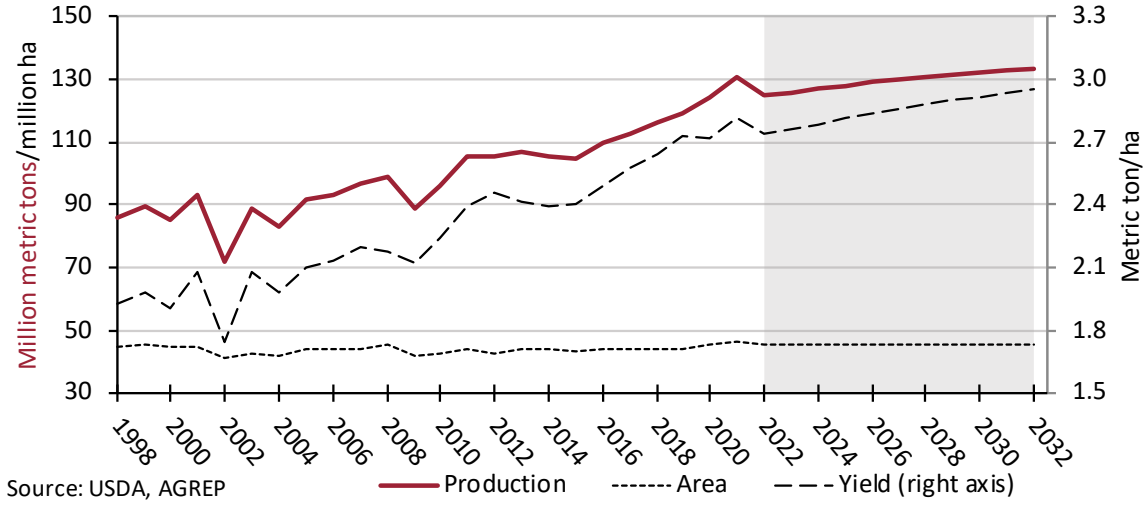


Fig. 22. India's historical and projected rice area, yield, and volume of production. The gray-shaded area represents the projected period between 2022 to 2032.

traders (although not well referenced scientifically) is the difference in quality that results, among other things, from having a more modern milling industry in the Western Hemisphere. We argue that some market and policy developments could reduce the price premium in the coming decade. For instance, trade integration between Western Hemisphere and Asian countries (e.g., Trans-Pacific Partnership) may create a more leveled playing field and improve the competitiveness of Asian rice in key core markets in the Americas. Additionally, upgrades in the rice supply chains across Asia are ongoing, resulting in high-quality rice that can compete well in the most demanding markets.

Summary and Conclusion

Rice is a crucial global staple and the cornerstone of food security programs worldwide, and it remains one of the most regulated global staple foods. Hence, understanding the future behavior of the global rice market is of utmost importance from a food security point of view, as well as from an economic perspective, since rice is the main source of income for millions of rice farmers and agents worldwide. This report outlines the main findings from the 2022–2032 baseline projections of the global rice market outlook developed by the Arkansas Global Rice Economics Program.

Based on the results from model simulations, over the next decade, the overall rice story is that global production and consumption will continue to grow strong, with a marginal deficit developing by the end of the projected period.

At the regional level, most of the nominal growth in production and consumption is expected to happen in Asia, but Africa is projected to become more relevant from a production and consumption point of view in the next decade. Africa is projected to account for the vast majority of the growth in imports in the next decade, surpassing Asia as the largest rice importer in 2030–2032.

At the country level, rice production is projected to decrease in China, Japan, and South Korea and grow the most in Tanzania, Thailand, Nigeria, and Cambodia relative to the production level observed in 2019–2021. On the other hand, total rice consumption is projected to decline in China, Japan, and South Korea and increase strongly in the African nations of Egypt, Tanzania, Madagascar, and Nigeria, as well as in Pakistan and Peru.

These differential changes in production and consumption across countries will push global rice trade to new records. India will continue to be a leader on the export side, while Thailand is projected to secure its place as the second-largest rice exporter. Rice exports will continue to be highly concentrated among the top-5 largest exporters. Myanmar is projected to replace the U.S. as the fifth-largest rice exporter by the end of the next decade.

The global rice market has many factors that could alter its projected path. Among the key factors to keep an eye on in the future because of their potential impact on the global rice market, we highlight the following three: (1) China's rice stock management, (2) India's yield and overall production trend, and (3) the price gap between Asian and American LG rice. In the short term, the behavior of the rice market and the entire global economy depends largely on the evolution of the conflict in Ukraine.

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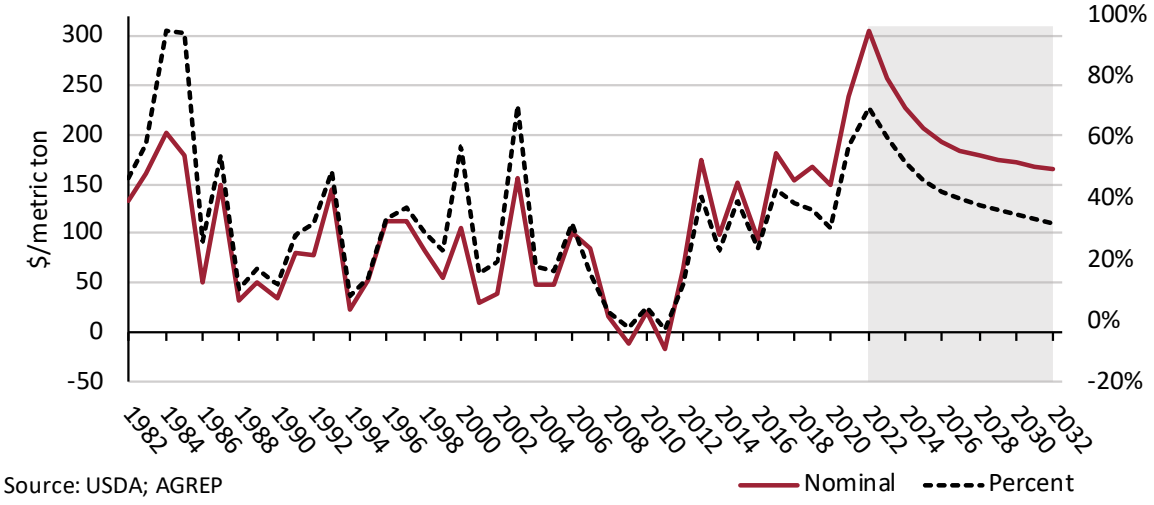

Fig. 23. Price gap between Thai 100%B and U.S. #2 long grain rice (percent = price gap/price Thai 100%B). The gray-shaded area represents the projected period between 2022 to 2032.

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APPENDIX

Table A1. Projected production and consumption by country.

Country	Production			Consumption		
	2019–2021	2030–2032	Change	2019–2021	2030–2032	Change
	1000 metric tons					
East Asia & Pacific						
Australia	280	664	9.0%	340	459	3.0%
Brunei	1	1	0.0%	25	30	1.7%
Cambodia	5,750	7,078	2.1%	4,250	4,896	1.4%
China	148,007	146,629	-0.1%	150,628	145,952	-0.3%
Hong Kong				304	360	1.7%
Indonesia	34,533	36,108	0.4%	35,567	36,864	0.4%
Japan	7,615	7,232	-0.5%	8,233	7,556	-0.9%
Laos	1,817	2,587	3.6%	1,842	2,151	1.6%
Malaysia	1,802	2,097	1.5%	2,900	3,042	0.5%
Myanmar	12,534	12,317	-0.2%	10,433	11,324	0.8%
Philippines	12,294	13,566	1.0%	14,717	17,175	1.6%
Singapore				381	352	-0.8%
South Korea	3,711	3,492	-0.6%	4,017	3,646	-1.0%
Taiwan	1,227	1,194	-0.3%	1,133	1,155	0.2%
Thailand	18,799	22,440	1.8%	12,600	13,269	0.5%
Vietnam	27,142	29,822	0.9%	21,400	22,436	0.5%
South Asia						
Bangladesh	35,433	38,810	0.9%	36,100	39,681	1.0%
India	124,510	136,630	0.9%	104,756	111,528	0.6%
Pakistan	8,316	8,949	0.7%	3,583	4,859	3.1%
Sri Lanka	3,110	3,711	1.8%	3,283	3,570	0.8%
Middle East & North Africa						
Egypt	3,733	4,324	1.5%	4,217	4,989	1.7%
Iran	1,964	2,191	1.1%	3,150	3,813	1.9%
Iraq	301	335	1.1%	1,510	2,150	3.6%
Saudi Arabia				1,317	1,690	2.5%
Sub-Saharan Africa						
Cameroon	209	375	6.0%	800	1,165	3.8%
Cote d'Ivoire	1,088	1,511	3.3%	2,467	3,999	5.0%
ECOWAS 7[a]	890	1,084	2.0%	3,159	5,329	5.4%
Ghana	686	833	1.9%	1,583	2,124	3.0%
Guinea	1,848	2,674	3.8%	2,475	3,378	3.2%
Kenya	81	140	5.6%	708	1,323	6.4%
Liberia	172	251	3.9%	490	746	4.3%
Madagascar	2,740	3,104	1.3%	3,280	4,123	2.3%
Malawi	83	77	-0.7%	98	139	3.6%
Mali	1,868	2,331	2.2%	2,392	3,263	3.2%
Mozambique	213	416	6.9%	863	1,474	5.5%

Continued

Table A1. Projected production and consumption by country, *continued*.

Country	Production			Consumption		
	2019–2021	2030–2032	Change	2019–2021	2030–2032	Change
	----------1000 metric tons----------					
Nigeria	5,239	6,211	1.7%	7,183	9,665	3.0%
Rwanda	58	68	1.6%	98	239	9.3%
Senegal	873	1,090	2.2%	1,942	2,802	3.7%
Sierra Leone	957	1,419	4.0%	1,363	1,744	2.5%
South Africa				875	973	1.1%
Tanzania	2,376	3,459	3.8%	2,421	3,505	3.8%
Uganda	142	152	0.7%	215	336	4.6%
Zambia	30	39	2.7%	40	97	9.3%
Latin America & Caribbean						
Argentina	843	980	1.5%	502	597	1.8%
Brazil	7,647	7,693	0.1%	7,283	7,301	0.0%
Chile	89	153	5.6%	267	328	2.1%
Colombia	1,850	2,044	1.0%	1,922	2,219	1.4%
Costa Rica	100	94	-0.7%	237	247	0.4%
Cuba	199	230	1.4%	611	736	1.9%
Dominican Republic	637	725	1.3%	635	733	1.4%
Guatemala	18	43	9.0%	144	209	3.8%
Guyana	643	774	1.9%	163	219	3.0%
Haiti	72	83	1.5%	564	683	1.9%
Honduras	58	49	-1.7%	200	297	4.0%
Mexico	186	222	1.8%	957	1,106	1.5%
Nicaragua	270	328	2.0%	378	480	2.4%
Panama	239	284	1.7%	320	397	2.2%
Paraguay	702	966	3.2%	48	89	6.3%
Peru	2,354	2,757	1.6%	2,569	3,044	1.7%
Uruguay	912	970	0.6%	45	64	3.6%
Venezuela	151	246	5.0%	703	1,045	4.0%
North America						
Canada				439	458	0.4%
United States	6,395	6,664	0.4%	4,748	5,035	0.6%
Europe & Central Asia						
Turkey	581	607	0.4%	772	771	0.0%
European Union 27 & UK	1,812	2,181	1.9%	3,431	4,259	2.2%
Rest of the world	9,562	8,239	-1.5%	17,162	21,864	2.5%
World	507,751	541,743	0.7%	503,239	541,553	0.7%

[a] ECOWAS-7 = Benin, Burkina, Gambia, Guinea-Bissau, Niger, Togo, and Cape Verde.

Table A2. Projected volumes of trade by country.

Country	2019–2021	2030–2032	Nominal Change	Country	2019–2021	2030–2032	Nominal Change
	----------	----------	----------	1000 metric tons	----------	----------	----------
Exporters							
Argentina	382	389	7	Myanmar	2,167	3,436	1,269
Australia	109	448	339	Pakistan	4,166	4,116	-50
Brazil	1,156	900	-256	Paraguay	721	881	160
Cambodia	1,633	2,245	611	China	2,300	3,256	955
Egypt	10	5	-5	Thailand	6,633	9,445	2,813
European Union 28	462	546	84	United States	2,856	2,998	142
Guyana	490	554	64	Uruguay	867	906	40
India	18,254	21,717	3,464	Vietnam	6,546	8,378	1,832
Laos	81	480	399	Others	1,649	1,671	21
Total Exports					**50,482**	**62,371**	**11,889**
Importers							
Australia	246	239	-7	Madagascar	541	1,022	481
Bangladesh	907	876	-30	Malaysia	1,190	1,067	-123
Brazil	793	507	-286	Mali	467	936	470
Cameroon	592	793	201	Mexico	788	896	108
Canada	456	458	2	Mozambique	650	1,059	409
Chile	175	177	2	Nicaragua	95	153	58
China	4,255	4,029	-226	Nigeria	2,017	3,433	1,416
Hong Kong	304	360	56	Panama	62	114	52
Colombia	153	222	69	Peru	257	339	81
Costa Rica	159	153	-7	Philippines	2,750	3,631	881
Cote d'Ivoire	1,332	2,546	1,214	Saudi Arabia	1,371	1,692	321
Cuba	412	509	97	Senegal	1,217	1,870	653
ECOWAS 7[a]	2,277	4,248	1,971	Sierra Leone	407	327	-79
Egypt	381	670	289	Singapore	381	352	-30
European Union 27 & UK	2,074	2,531	457	South Africa	993	1,106	113
Ghana	920	1,298	378	South Korea	440	421	-19
Guatemala	125	166	41	Sri Lanka	282	-42	-324
Guinea	790	787	-3	Taiwan	104	100	-4
Haiti	490	601	111	Tanzania	147	174	27
Honduras	147	249	101	Thailand	192	171	-21
Indonesia	650	756	106	Turkey	428	391	-37
Iran	1,107	1,635	528	Uganda	83	194	111
Iraq	1,367	1,827	460	United States	1,156	1,385	229
Japan	682	685	3	Venezuela	588	802	214
Kenya	625	1,197	572	Vietnam	1,233	1,000	-233
Liberia	317	498	181	Others	10,907	11,761	855
Total Imports					**50,482**	**62,371**	**11,889**

[a] ECOWAS-7 = Benin, Burkina, Gambia, Guinea-Bissau, Niger, Togo, and Cape Verde.

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