United States Department of Agriculture

Economic Research Service

Economic Brief Number 30

November 2020

Economic and Food Security Impacts of Agricultural Input Reduction Under the European Union Green Deal's Farm to Fork and Biodiversity Strategies

Jayson Beckman, Maros Ivanic, Jeremy L. Jelliffe, Felix G. Baquedano, and Sara G. Scott

United States Department of Agriculture

Economic Research Service
www.ers.usda.gov

Recommended citation format for this publication:

Beckman, Jayson, Maros Ivanic, Jeremy L. Jelliffe, Felix G. Baquedano, and Sara G. Scott. November 2020. *Economic and Food Security Impacts of Agricultural Input Reduc-tion Under the European Union Green Deal's Farm to Fork and Biodiversity Strategies*, EB-30, U.S. Department of Agriculture, Economic Research Service.

United States Department of Agriculture

Economic Research Service

Economic Brief Number 30

November 2020

Economic and Food Security Impacts of Agricultural Input Reduction Under the European Union Green Deal's Farm to Fork and Biodiversity Strategies

Jayson Beckman, Maros Ivanic, Jeremy L. Jelliffe, Felix G. Baquedano, and Sara G. Scott

Abstract

The European Commission (EC) unveiled its Farm to Fork and Biodiversity Strategies that would impose restrictions on European Union (EU) agriculture through targeted reductions in the use of land, fertilizers, antimicrobials, and pesticides. The proposal also pledges to use EC trade policies and other international efforts to support this vision of sustainable agri-food systems, suggesting intentions to expand the reach of the policy beyond the EU. To examine the economic implications of the proposal, we performed a range of policy simulations on several of the proposed targets using three progressively broader adoption scenarios of the EC's initiative. Under all these scenarios, we found that the proposed input reductions affect EU farmers by reducing their agricultural production by 7 to 12 percent and diminishing their competitiveness in both domestic and export markets. Moreover, we found that adoption of these strategies would have impacts that stretch beyond the EU, driving up worldwide food prices by 9 (EU only adoption) to 89 percent (global adoption), negatively affecting consumer budgets, and ultimately reducing worldwide societal welfare by $96 billion to $1.1 trillion, depending on how widely other countries adopt the strategies. We estimate that the higher food prices under these scenarios would increase the number of food-insecure people in the world's most vulnerable regions by 22 million (EU only adoption) to 185 million (global adoption).

Keywords: European Union, EU, international trade, global markets, production systems, research and development, R&D, exports, food prices, food security, Farm to Fork, biodiversity, land, fertilizers, pesticides, pest control, antimicrobials, agriculture productivity, commodities, labeling, USDA, U.S. Department of Agriculture, ERS, Economic Research Service.

Acknowledgments

The authors thank Andrew Muhammad (University of Tennessee), Jason Grant (Virginia Polytechnic Institute and State University), Michael Adjemian (University of Georgia); and Utpal Vasavada, Anne Effland, and Philip Jarrell (USDA, Economic Research Service (ERS)) for their reviews and comments. They would also like to acknowledge comments and feedback received during presentations and interagency reviews. Thanks also to ERS editors Grant Wall, Angela Brees, and Elaine Symanski, and Chris Sanguinett (ERS) for design assistance.

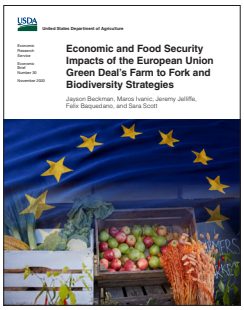
Contents

Errata

On February 23, 2021, the Summary table was revised to correct errors that occurred in data transmission. No other components of the report were affected by the error.

United States Department of Agriculture

A report summary from the Economic Research Service November 2020



Economic and Food Security Impacts of Agricultural Input Reduction Under the European Union Green Deal's Farm to Fork and Biodiversity Strategies

Jayson Beckman, Maros Ivanic, Jeremy L. Jelliffe, Felix G. Baquedano, and Sara G. Scott

What Is the Issue?

The European Commission (EC) has unveiled its Farm to Fork and Biodiversity Strategies that would impose restrictions on European Union (EU) agriculture through targeted reductions in the use of land, fertilizers, antimicrobials, and pesticides. The Farm to Fork and Biodiversity Strategies (European Commission, 2020) and which we refer to as "the Strategies," represents a fundamental shift in EU food and agriculture policy, with correspondingly fundamental implications for the structure and productivity of the EU food and agriculture industry. As the EU is a major agricultural producer and participant in international agricultural trade, this policy shift is likely to affect international markets for agricultural commodities and, consequently, the broader food and agriculture system.

What Did the Study Find?

Our analysis, which examines three adoption scenarios—EU-only, middle (adoption by some countries, and including explicit EU trade restrictions against non-adopters), and global adoption—suggests that the EC's 10-year plan of targeted reductions in the use of land, antimicrobials, fertilizers, and pesticides would lead to a reduction in EU agricultural production and reduce its competitiveness in domestic and export markets. If the plan were adopted beyond the EU, those impacts would also expand with consequences for worldwide welfare and food insecurity. In summary, we found that by 2030:

- The decline in agricultural production in the EU, as shown in the summary table, would range from 7 percent (global adoption) to 12 percent (EU-only). Impacts on production would be smaller worldwide, except in the case of global adoption, when production would decline by 11 percent.
- The decline in agricultural production would tighten the EU food supply, resulting in price increases that impact consumer budgets. Prices and per capita food costs would increase the most for the EU, across each of the three scenarios. However, price and food cost increases would be significant for most regions if Strategies are adopted globally. For the United States, price and food costs would remain relatively unchanged except in the case of global adoption.
- Production declines in the EU and elsewhere would lead to reduced trade, although some regions would benefit depending on changes in import demand. However, if trade is restricted as a result

of the imposition of the proposed measures, the negative impacts are concentrated in regions with the world's most food-insecure populations.

- The declines in production and trade, coupled with the projected increases in food commodity prices, would significantly reduce the EU's gross domestic product (GDP), especially if adoption was limited to the EU. In that case, the EU's decline in GDP would represent 76 percent of the decline in the worldwide GDP. If the Strategies were adopted beyond the EU, however, the EU's share in decline of worldwide GDP would drop to 49 percent in the middle scenario and as low as 12 percent if globally adopted. The effects on the GDP of the United States would be smaller than for the EU and worldwide under all adoption scenarios.

- Food insecurity, measured as the number of people who lack access to a diet of at least 2,100 calories a day, increases significantly in the 76 low- and middle-income countries covered in our analysis due to increases in food commodity prices and declines in income, particularly in Africa. By 2030, the number of food-insecure people in the case of EU-only adoption would increase by an additional 22 million more than projected without the EC's proposed Strategies. The number would climb to 103 million under the middle scenario and 185 million under global adoption.

How Was the Study Conducted?

To examine the prospective market and food security impacts of the EC proposal, we focused on several selected agricultural input reductions specified in the Strategies: reduction of pesticide use by 50 percent, reduction of fertilizer use by 20 percent, reduction of antimicrobial use for livestock by 50 percent, and removal of 10 percent of existing farmland from agricultural use. To capture the potential impacts of not only EU adoption of the Strategies but also "the global transition to sustainable agri-food systems through its trade policies and international cooperation instruments" (European Commission, 2020), we used the three different adoption scenarios noted above.

The first scenario assumes the EU alone implements the Strategies and trade is permitted normally—the EU-only scenario. The second scenario, a "middle scenario," extends the restrictions on agricultural inputs to those EU trade partners who depend on food and agricultural exports to the EU. This scenario simultaneously assumes the EU restricts 50 percent of imports from regions that do not adopt the Strategies to simulate the use of trade policies to support the Strategies. In the third scenario, the "global scenario," the study considers the impacts of the extreme case of global adoption of the Strategies, as suggested by the EC's pledge to support a global transition.

In the first phase of our study, we used a specific Computable General Equilibrium (CGE) model, the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model, to examine the potential market and economywide impacts from the adoption of the Strategies. GTAP-AEZ divides the world into 18 agroecological zones and explicitly accounts for land use by allowing cropland to compete with other land applications. We assumed a medium-run horizon; thus, the results could be interpreted as to impacts that might occur over 8–10 years. To examine potential food security impacts from the adoption of the Strategies, in the second phase of our study, we used the estimated changes in gross domestic product (GDP) and food prices from the CGE model as inputs into the USDA, Economic Research Service's International Food Security Assessment (IFSA) model, which estimates changes in food consumption in developing countries.

Our study was limited to an analysis of agricultural input reductions under the Strategies and does not consider other important aspects of the EC's proposal, for example, increased land in organic production or reductions of food waste and greenhouse gas emissions. In addition, while our results indicate the potential market and food security impacts from the Strategies stemming from proposed input reductions, they do not provide any information about the potential benefits and costs to the environment and human health. Evaluation of environmental and human health (benefits and costs) under the Strategies is subject to ongoing debate. However, estimation of the market impacts of the Strategies can serve as an important tool to assess policy aims.

Summary of the main impacts of the Strategies under the three scenarios[1]

	European Union	United States	Worldwide
Scenario: EU adoption only			
Production (percent change)	-12	0	-1
Prices (percent change)	17	5	9
Imports (percent change)	2	-3	-2
Exports (percent change)	-20	6	
Gross farm income (percent change)	-16	6	2
Increase in food cost (annual per capita change in U.S. dollars)	153	59	51
Increase in food insecurity[2] (millions of people)	na[1]	na	22
GDP (change, in billions of U.S. dollars)	-71	-2	-94
Scenario: middle[3]			
Production (percent change)	-11	0	-4
Prices (percent change)	60	1	21
Imports (percent change)	-10	-7	-9
Exports (percent change)	-10	-2	
Gross farm income (percent change)	8	1	4
Increase in food cost (annual per capita change in U.S. dollars)	651	16	159
Increase in food insecurity (millions of people)	na	na	103
GDP (change, in billions of U.S. dollars)	-186	<-1	-381
Scenario: global adoption			
Production (percent change)	-7	-9	-11
Prices (percent change)	53	62	89
Imports (percent change)	-5	-15	-4
Exports (percent change)	2	3	
Gross farm income (percent change)	15	34	17
Increase in food cost (annual per capita change in U.S. dollars)	602	512	450
Increase in food insecurity (millions of people)	na	na	185
GDP (change, billions of U.S. dollars)	-133	-74	-1,144

Notes: [1]na = not applicable; [2]Food insecurity is estimated for 76 low- and middle-income countries and not the full set of countries in the Global Trade Analysis Project – AgroEcological Zones (GTAP-AEZ) model; [3]In the middle scenario, we assume that trade partners who depend on food and agricultural exports to the EU or that have close colonial ties adopt the Strategies to maintain their trading relationship with the EU. The regions that we assumed adopt the Strategies in this scenario are European Free Trade Association (EFTA) countries (Iceland, Liechtenstein, Norway, and Switzerland); other European countries; Turkey; Ukraine; the Middle East and North Africa; and Africa.

The gross farm income calculation is based on the returns to agriculture from changes in prices and quantities. Those returns are not going to all farmers, but probably those that own land.

Source: USDA, Economic Research Service calculations using the GTAP-AEZ model and USDA, ERS's International Food Security Assessment Model.

[1]Percent change represents a one-time change from the counterfactual values (i.e., no policy change); all annual changes expressed in U.S. dollars represent the impacts evaluated over the period of a year after the changes have occurred.

Economic and Food Security Impacts of the European Union Green Deal's Farm to Fork and Biodiversity Strategies

Introduction

Agricultural productivity gains during the 20th century can be credited with meeting many of the global population's food and fiber needs, and these benefits accrued even as the global population grew. These gains can be largely attributed to public and private investment in agricultural research and development (R&D), spurring innovation in the field by farmers worldwide (Fuglie, 2018; USDA, International Agricultural Productivity Data Set). At the same time, intensive modern agricultural production systems, such as conventional tillage and chemical inputs, are associated with environmental spillovers. Unmitigated environmental spillovers can increase the cost of farming to society. Thus, significant efforts have been made to foster sustainable intensification in modern farming systems, aiming to minimize the environmental footprint while maintaining farm productivity (Garnett et al., 2013).

The European Commission (EC) presented its vision to achieve these goals in its Farm to Fork and Biodiversity Strategies (henceforth referred to as "the Strategies") released in May 2020 under the Commission's larger European Union (EU) Green Deal (European Commission, 2020). The Strategies take a broad approach to promoting sustainability in agriculture in four areas for improvement. These include (1) sustainable food production, (2) sustainable food consumption, (3) sustainable food processing and distribution, and (4) food loss and waste prevention. The Strategies focus on EU agricultural sector stewardship of the environment, as well as food security and human health outcomes, by setting policy targets for 2030. Ultimately, the Strategies' proposal represents a fundamental shift in the EU food and agriculture industry and has, therefore, been the subject of wide debate (Schebesta and Candel, 2020).

In principle, the costs to society from the Strategies must be offset by the prospective gains (e.g., environmental and human health) from implementing such a policy (Bullock and Salhofer, 2003). This paper focuses on the former and considers the impacts of the specific reductions listed in the Strategies (i.e., land, antimicrobials, pesticides, and fertilizer) on agricultural production, food prices, and societal welfare. In the latter case, evaluation (benefits and costs) of environmental and human health under the Strategies is subject to considerable debate. However, estimation of the market impacts of the Strategies can serve as an important tool to assess policy aims. To this end, we are the first to examine the prospective impacts of the Strategies in their current form. Here, we considered the prospective market and food security impacts of agricultural input reductions—(1) sustainable food production—that are clearly specified in the Strategies (figure 1).

Figure 1
European Commission Farm to Fork and Biodiversity Strategies: agricultural input reductions

- Pesticide use by 50 percent;[2]
- Fertilizer use by 20 percent;
- Antimicrobials for livestock by 50 percent;[3]
- Land in agriculture by 10 percent.

In focusing on the Strategies' proposed reductions of agricultural inputs (figure 1), we expect that additional inputs, such as labor, could be used as a replacement. This will have a large impact on agricultural production, relying on shifts to new (or older) practices that require different labor supply and allocation of resources throughout the growing season. A primary constraint to adopting alternatives to chemical inputs is the unavailability of qualified managers and insufficient labor at critical times during the growing season (Bastiaans et al., 2008; Chikowo et al., 2009; Rossi et al., 2012). Furthermore, these methods are largely crop and scale dependent, which means that while some crops may readily transition to alternative production systems that are less chemically dependent, others may face catastrophic decline by doing so. For example, sugar beet farmers in France lobbied successfully for special chemical use to prevent crop losses from pest pressure (Mallet, 2020). Furthermore, agrochemical rates in the environment can be highly localized and driven by crop value, as evidenced by two recent studies (Maggi et al., 2019; Skevas and Oude Lansink, 2020). While the Strategies appear to presume that research and innovation can adequately maintain agricultural productivity through these shifts, considering the factors in play, this may not be feasible under the proposed timeframe.

Accordingly, we assumed that agricultural productivity is essentially fixed during the 8- to 10-year horizon of the Strategies for this analysis. This assumption is based on studies on investment in agricultural research and development (R&D) over recent decades and the technology treadmill effect (Fuglie, 2018; Levins and Cochrane, 1996).[4] The foundation of this treadmill is well-funded R&D; evidence suggests that investments over recent decades are inadequate to maintain current productivity levels. Consequently, this assumption about future technologies and innovation given current R&D stocks is conservative, and without additional investments in R&D, producers face declining productivity in the future. In addition, lags between investments in agricultural R&D and productivity increases are more than two decades (Baldos et al., 2019). Thus, a concern for agricultural markets could be that implementing restrictions on input use will outpace innovation, resulting in regressive food and agricultural production trends and, ultimately, shortages. As the EU is a major agricultural producer and participant in international agricultural trade, these Strategies could affect global markets for agricultural commodities.

[2]The Strategies also specify the reduction of pesticide risk by 50 percent, but the Strategies do not specify the risk criteria—hence, we were unable to include it in our model.

[3]The EU also proposes to reduce antimicrobials in aquaculture by 50 percent, but we do not examine this.

[4]The observed pattern of perpetual adoption of innovative technologies by farmers to maintain productivity over time is referred to as the agricultural technology treadmill effect (Levins and Cochrane, 1996).

Trends in Agricultural Input Use and Food Production

To cultivate crops and other primary agricultural products, farmers use land, labor, capital (in the form of tractors and other machinery),[5] and other inputs such as seed, fertilizer, and pesticides. Trends for selected inputs used on a global scale and in the EU are shown in figure 2(a) for pesticide and fertilizer use, and land in agriculture in figure 2(b) (United Nations, 2020). EU application of fertilizers has remained steady after two decades of declining usage linked to agriculture policy reform (European Commission, 2019). While EU use of fertilizer and pesticides has been relatively stable since 1990, worldwide application increased from 1990-2018, stabilizing around 2010. Land usage in agriculture (figure 2(b)) both worldwide and in the EU decreased at similar rates from the mid-2000s until present.

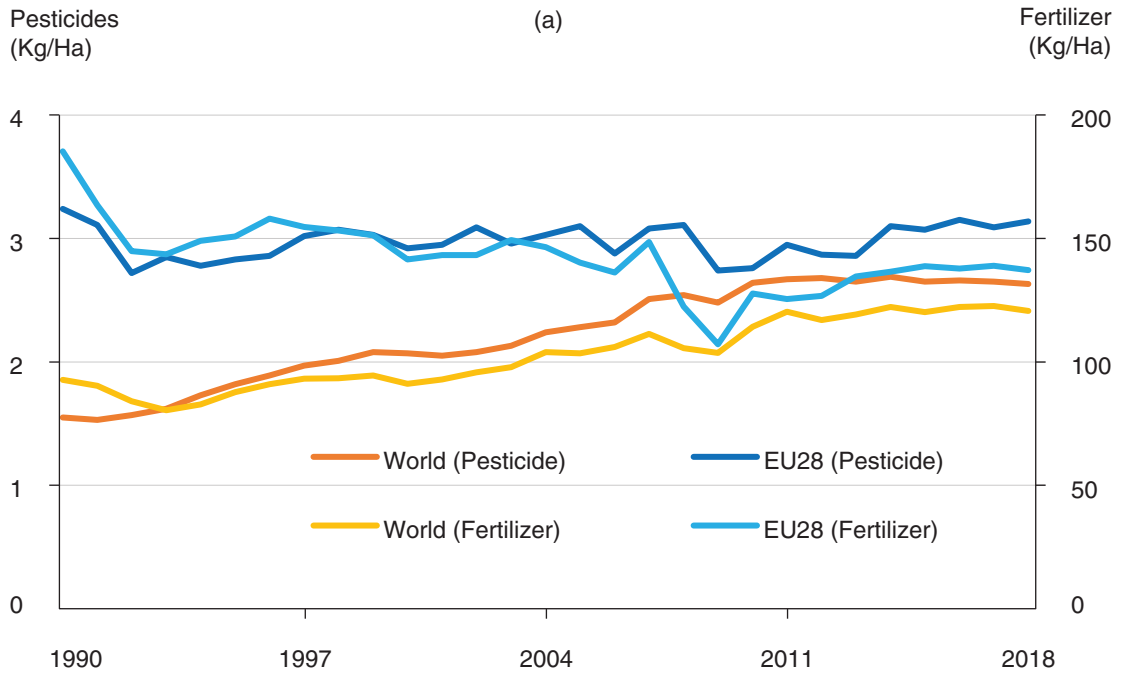
Agricultural production per capita (figure 3), as measured by the United Nations' gross per capita Production Index Number (PIN), declined slightly in the EU from 1990 to 2018, while the measure increased steadily worldwide over the same period (United Nations, 2020).[6] Trends in agricultural production are similar for fertilizer and pesticide use over the period from 1990 to 2018, with slight declines in the EU and general increases worldwide. While input use and food production has increased over the previous quarter-century worldwide, EU levels have been relatively stable over the same period. Thus, a concern is that the Strategies' proposed input reductions (figure 1) will result in corresponding declines in food and agricultural production, as well as impacts to prices, gross farm incomes, trade, food security, and societal welfare.

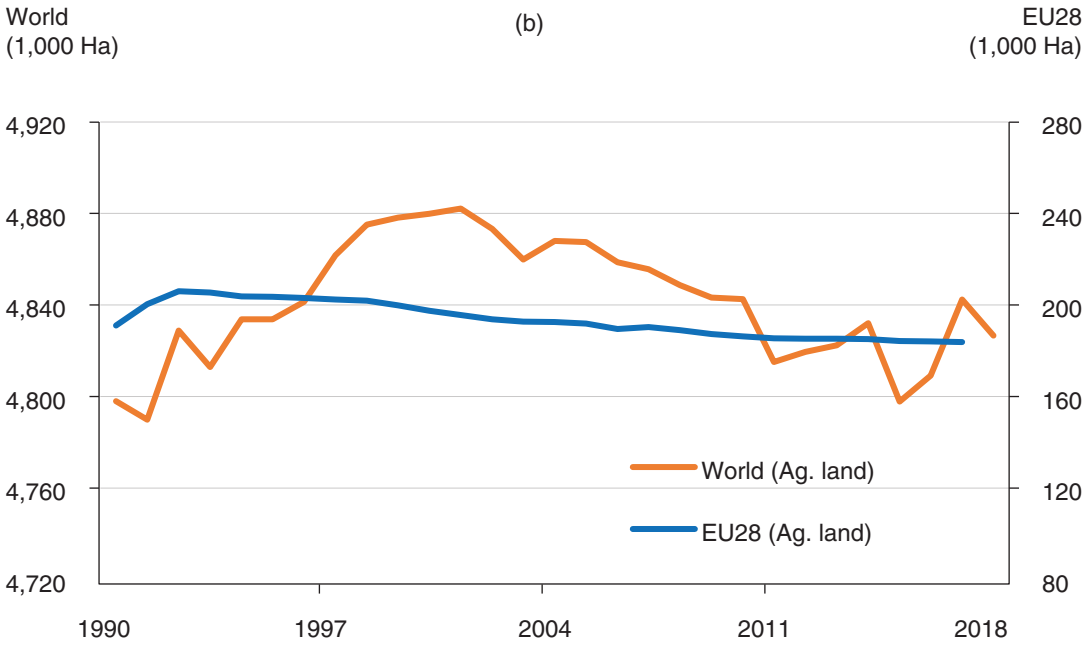
[5]These are often referred to as endowments, as is the case in our computable general equilibrium (CGE) model.

[6]The PIN is indexed to agricultural production levels during the period from 2014-16 (i.e., 2014-16=100).

Figure 2

Selected agricultural inputs world and European Union 28 from 1990-2018: (a) fertilizer and pesticide, and (b) land in agriculture



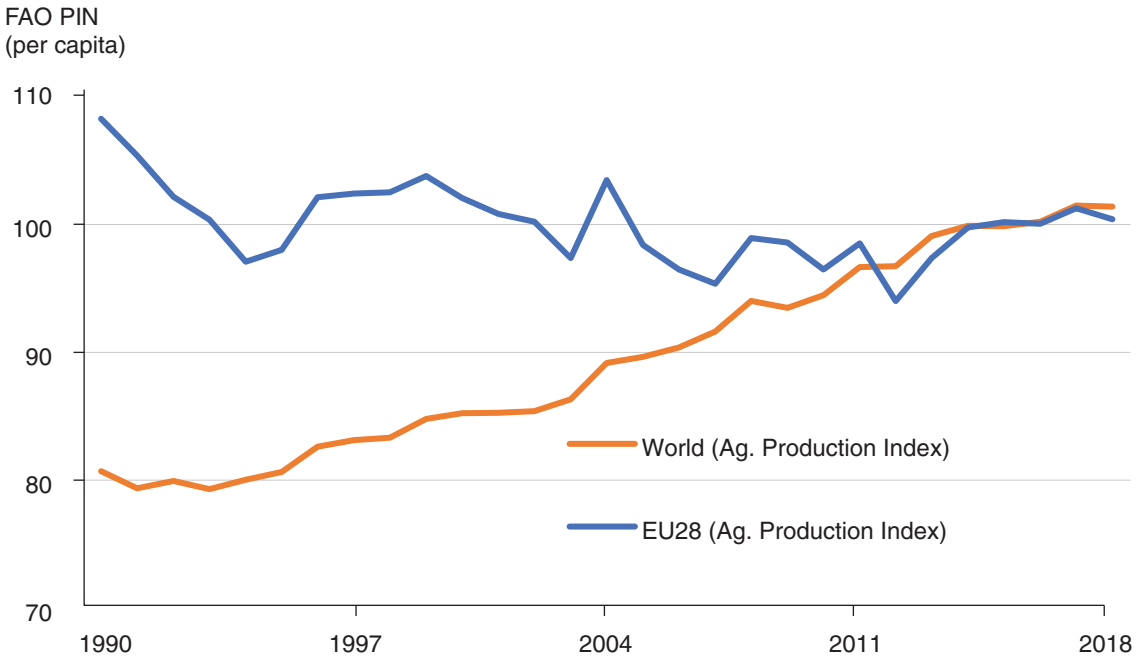


Note: Kg/Ha refers to kilograms per hectare.

Source: United Nations, 2020.

Figure 3

United Nations' Food and Agriculture Organization: Gross per capita production index number, world and European Union 28, 1990-2018



Note: FAO is the Food and Agriculture Organization of the United Nations. Agricultural production is indexed to the period from 2014-16 (i.e., 2014-16 = 100). PIN is the production index number.

Source: United Nations, 2020.

Model and Scenarios

Computable General Equilibrium (CGE) models are often used to evaluate the potential impacts of a policy, as they provide economywide and commodity-specific effects while considering inter-industry linkages. These models are often used to examine policy targets under alternative implementation scenarios, such as regulations, taxation, subsidies, and combinations thereof.[7] A benefit of the CGE model is that it captures the economic effects of regulations related to land being taken out of use. In the first phase of our study, we used a specific CGE model, the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model, which divides the world into 18 agroecological zones and explicitly accounts for land use by allowing cropland to compete with other land applications. We assumed a medium-run horizon; thus, the results could be interpreted as to impacts that occur over 8-10 years. See appendix 1 for the regions and commodities used in the model and our work to update the model to 2020.

For these reasons, CGE models are well-suited to estimate market impacts of the Strategies; however, the Strategies could also lead to changes in international food security as prices for food and other goods rise. To consider potential food security impacts, we then used the estimated changes in gross domestic product (GDP) and food prices from the CGE model as inputs into the USDA, Economic Research Service's (ERS) International Food Security Assessment (IFSA) model, which estimates changes in food consumption in developing countries.

Scenarios

We considered three different implementation scenarios to assess the potential impacts of the policies encompassing EC's intent to "support the global transition to sustainable agri-food systems through its trade policies and international cooperation instruments" with all its partners (European Commission, 2020).

In the first scenario, we assumed the EU alone implements the Strategies and does not impose any restrictions on trade—the EU-only scenario (see box, "Implementing the Scenarios: Methodology"). The second scenario (which we denote as the "middle scenario") extends the restrictions of agricultural inputs to the EU's trade partners who depend on food and agricultural exports to the EU.[8] At the same time, we assumed the EU restricts 50 percent of imports from regions that do not adopt the Strategies. The third scenario, the "global scenario," considers the impacts resulting from global adoption of the Strategies, assuming all regions in the world adopt the reduction in agricultural production inputs listed in figure 1.

[7]Further examples of using CGE models to consider changes in agricultural input use are Bareille and Gohin (2018); Bartelings et al. (2016); Bellora and Bureau (2014); Nadoveza Jelićand Šimurina (2020); and Rendleman et al. (1995).

[8]In the middle scenario, we assume that trade partners who depend on food and agricultural exports to the EU or that have close colonial ties adopt the Strategies to maintain their trading relationship with the EU. The regions that we assumed adopt the Strategies in this scenario are European Free Trade Association (EFTA) countries (Iceland, Liechtenstein, Norway, and Switzerland); other European countries; Turkey; Ukraine; the Middle East & North Africa; and Africa.

The impacts estimated across the scenarios indicate significant price increases for agricultural commodities and decreased GDP in numerous countries.[9] Given these large changes to commodity prices, the final phase of the analysis examines potential impacts on international food security using the IFSA model.

Results

We present results across the three scenarios at the same time to facilitate comparison. Results are first presented for market impacts from the CGE model (production, prices, trade, and economywide impacts), then we present the food security results from the IFSA model.[10]

Implementing the Scenarios: Methodology

To incorporate the impact of the Strategies in the model, all components in figure 1 are conducted simultaneously. They are applied as a reduction in each targeted value across primary agriculture as a whole; e.g., we target a reduction in fertilizer use by 20 percent for all crops. This approach allows the model to solve for the most economically efficient use of the components while still achieving the policy target. To achieve the required reductions in inputs such as fertilizer, pesticide, and antimicrobial use, we introduce a tax on their use, which brings the total use to the lower application level. To achieve a reduction in the available land across 18 agroecological zones (AEZs), we adjust the available area by land type so the returns to each type of land are constant, and the total area is reduced by the 10-percent reduction in land specified in the Strategies. To minimize distortions from policy-related government revenue, we distribute all tax revenue generated by the input taxes back to producers in the form of a uniform tax reduction on farm output. While the model assumes the most economically efficient means to implement the Strategies, real-world application is likely to result in considerable deviation from this efficient implementation.

To properly model the substitution between fertilizers, pesticides, and antimicrobials with land, labor, and capital, we set the elasticity to -0.13 (previously, the elasticity is 0—hence, no substitution), which is half of the value of the substitution between land, labor, and capital (see Dissanayake et al. (2017) for a visual of the Global Trade Analysis Project GTAP-AEZ model production structure). The assumed elasticity is similar to that used for developed countries in Bartelings et al. (2016), which assumes a value of -0.15.

For the middle scenario, the 50 percent reduction in imports is introduced directly in the model. The model then solves for the tariff that would be necessary to restrict trade by that amount—acting as a non-tariff measure (see Beckman and Arita (2017) for more information on these trade barriers). By not completely banning trade, we assume that some farmers in regions that do not adopt the Strategies still produce products that are allowed into the EU (e.g., processed food and animal products). If the reduction in imports was more than 50 percent or completely banned, the market impacts in the middle scenario would be more significant.

[9]As a reviewer points out, the EU proposals lead to large changes estimated by the CGE model, but the model is dependent on parameters that might not be well designed for very large structural transformations that affect production, input substitution, and trade.

[10]See appendix table A-3 for the definition of agriculture in our model.

Impacts on Production

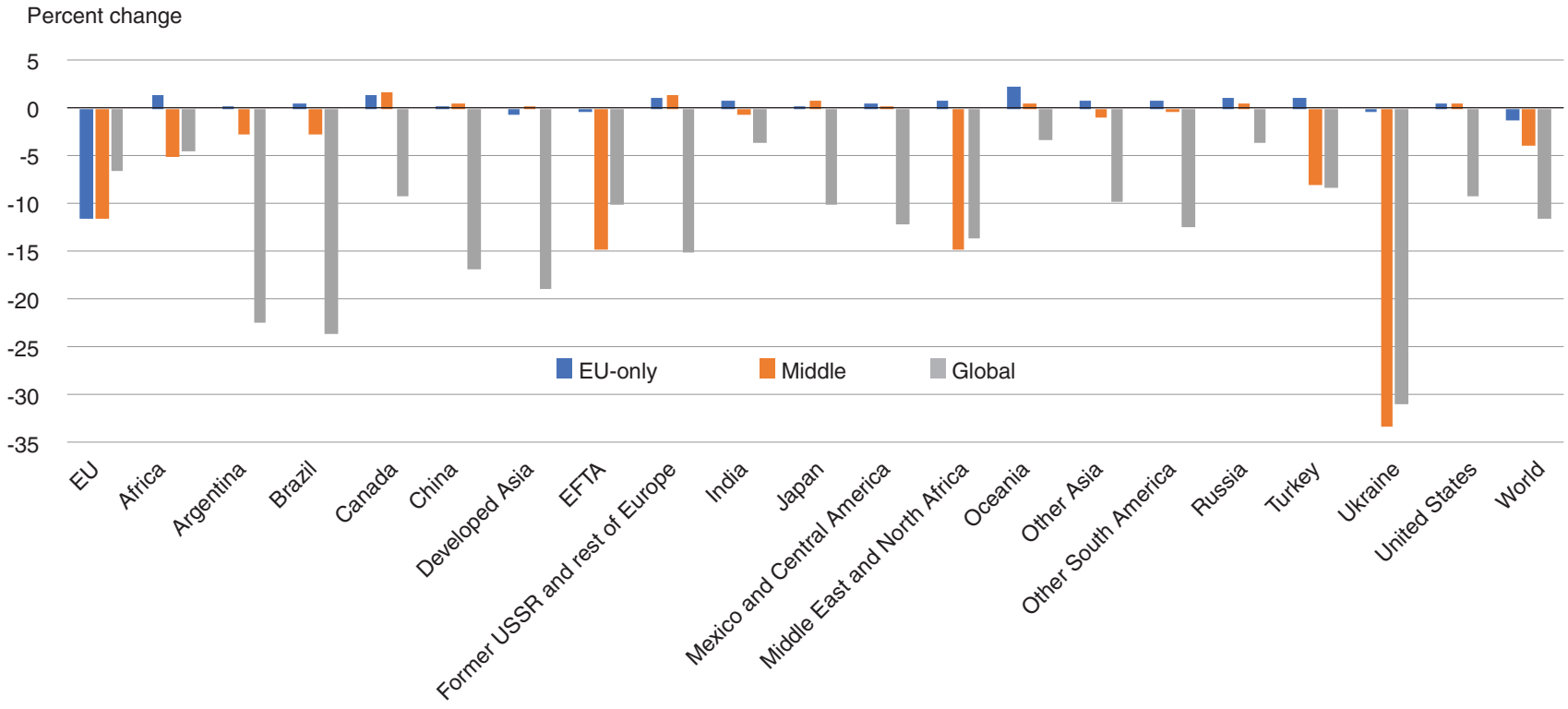
In the EU-only scenario, worldwide agricultural production decreases by 1 percent, precipitated by a decline in agricultural production in the EU of 12 percent. All other regions in our model—none of which impose the production changes required by the Strategies—realize an increase in agricultural production, as they seek to replace the lost EU production (and trade). Results by commodity/region are shown in appendix table B-1. These results show the largest declines in production by product for the EU: oilseeds (61 percent), wheat (49 percent), and other crops (44 percent).[11] The projected decreases in the production volume of EU oilseeds are driven by strong worldwide competition (and EU price increases). For wheat, production decreases are driven by reduced fertilizer and land use (fertilizer and land make up a relatively large proportion of production costs for wheat). For other crops, the decreases result from reduced land use (land makes up 21 percent of production costs—the highest share for any agricultural product category). The two regions in which overall agricultural production declines in this scenario, the European Free Trade Association (EFTA) and Ukraine, are closely tied to agricultural trade with the EU in general. Their agricultural production declines as they are not able to compete with other regions for the rest of the international market. In addition, these regions could have a reduction in agricultural production from cross-commodity effects (land moving out of one commodity to another). Agricultural production in Oceania[12] is projected to increase by the greatest percent (2 percent), as they have increases in the production of oilseeds, sugar, vegetable oil, and wheat. Production volumes of meats increase by the fastest rate in Canada, but because Canada is a relatively small producer, the decline in EU production is filled by a larger international producer, Brazil.

In the middle scenario, worldwide agricultural production declines by 4 percent as regions that adopt the Strategies, along with the EU, also see a decrease in agricultural production. As noted in figure 4, some regions have large production declines. Agricultural production in Ukraine is reduced by 33 percent, with double-digit decreases in production for almost every commodity (appendix table B-2). Production in the Middle East and North Africa region and the EFTA region both decline by 15 percent, again with many commodities undergoing double-digit production losses. In addition to those regional declines, other regions that do not adopt the Strategies also observe decreased agricultural production. However, those changes tend to be smaller than in countries where the Strategies are adopted. This decrease may occur because those regions (Argentina, Brazil, India, other Asia, and other South America) tend to rely more on trade with those adopting the Strategies and, therefore, scale back production as a result of diminished overseas demand. For example, 37 percent of Brazil's agricultural exports were to regions assumed in this scenario as adopting the Strategies, versus only 16 percent of U.S. exports. In the middle scenario, Canada realizes the highest increase in agricultural production, mainly through increased pork production (appendix table B-2).

[11]Other crops include products such as herbs, spices, and cut flowers.

[12]Oceania includes Australia, New Zealand, and the islands in the Pacific.

Figure 4
Changes in agricultural/food output volumes for the three scenarios



Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ model.

Finally, the global scenario leads to the greatest reduction in worldwide agricultural production (11 percent). Figure 4 indicates that total agricultural production volumes would fall in every region, with half of the regions incurring a double-digit decrease. Those regions where total agricultural production volumes would fall by the greatest percentages are Ukraine (from oilseeds production), Argentina (from oilseeds and beef production), and Brazil (from oilseeds production) (appendix table B-3). Most other major agricultural producers incur a decrease in agricultural production, including the United States (9 percent) and China (17 percent). Oceania is the region with the smallest decrease (3 percent), as production of oilseeds and vegetable oil increases, despite a decrease in almost every other commodity.

Impacts on Market Prices

Large-scale reductions in EU agricultural output, as observed in the EU-only scenario, would tighten market availability of agricultural commodities in the EU, leading to increased prices (figure 5). Appendix table B-4 indicates prices increasing across all agricultural commodities in the EU, with most commodity prices climbing by double digits. Agricultural prices increase across all regions (figure 5) due to the increase in EU prices (affecting imports) and an increase in competition for domestically produced goods (i.e., exports). Agricultural prices in Ukraine increase mainly as a result of their close trade with the EU.

The middle scenario highlights differences in prices between those who join the EU's initiative to reduce agricultural inputs targeted in the Strategies and those who do not join. The 6 regions that adopt the Strategies all see an increase in the price of agricultural products by more than 50 percent. In the middle scenario, regions adopting the Strategies have the same increase in prices from the reduction in input use; but they also have higher prices as trade restrictions increase the prices of agricultural products. As a result, prices in these regions are high—most commodities incur a triple-digit increase in these regions (appendix table B-5). In particular, commodities that are primary products (crops) undergo triple-digit increases in response to restrictions under the Strategies in all regions with few minor exceptions. These increases lead to higher prices for meats as well, given that there are higher prices for the feed input (and the decrease in antimicrobial use). Conversely, regions that retain traditional production practices but are constrained in their trade to the EU see little change in prices.

Larger production changes in the global scenario lead to larger changes in prices across all regions, with double-digit increases for total agriculture for all regions and triple-digit increases for many regions. The price of most crops increases by triple digits in every region (appendix table B-6). Figure 5 indicates that the increase in the price of agricultural products is dampened for those regions adopting the Strategies in the middle scenario. However, these regions would still see a larger increase than non-adopters in the scenario. A move toward equalizing agricultural prices worldwide occurs as trade is not hindered under the global scenario; however, prices are the highest in this scenario since all regions are implementing the Strategies.

Impacts on Trade

The decrease in EU agricultural production impacts international trade with a 2-percent decrease across all regions. Although many regions fill some of the lost EU trade, the EU is a major trade market, and their decrease outweighs the gains for the other regions. For the EU, the EU-only scenario would lead to an increase in the volume of agricultural imports in the EU (figure 6) and a decrease in exports (figure 7). The largest expected increase in bilateral EU imports by commodity and source are for other crops (31 percent), wheat (18 percent), and milk (raw) (19 percent) (appendix table B-7). The EU is a major importer of other crops; its largest source is Africa (35 percent of EU imports). Africa's exports to the EU would increase by 103 percent. Canada is the EU's main source of wheat imports in our model (44 percent); Canadian exports of wheat to the EU grow by 177 percent under this scenario. Finally, as the EU imports most of its oilseeds from Brazil and the United States, both of those regions increase exports of oilseeds to the EU. All other regions other than Brazil and Ukraine undergo a decrease in their agricultural imports.

Agricultural exports in the EU-only scenario increase across all non-EU regions in the model, with several regions registering double-digit increases in crop exports (appendix table B-10). India's exports of other crops and wheat grow by 64 and 50 percent; Africa's exports of beef and other crops increase 36 and 37 percent, respectively, and exports of many crops in the former USSR and rest of Europe increase. Other major agricultural exporters such as Argentina, Brazil, and the United States increase exports of crops and their total agricultural exports, but the increase tends to be smaller than other regions as they are not major exporters of other crops.

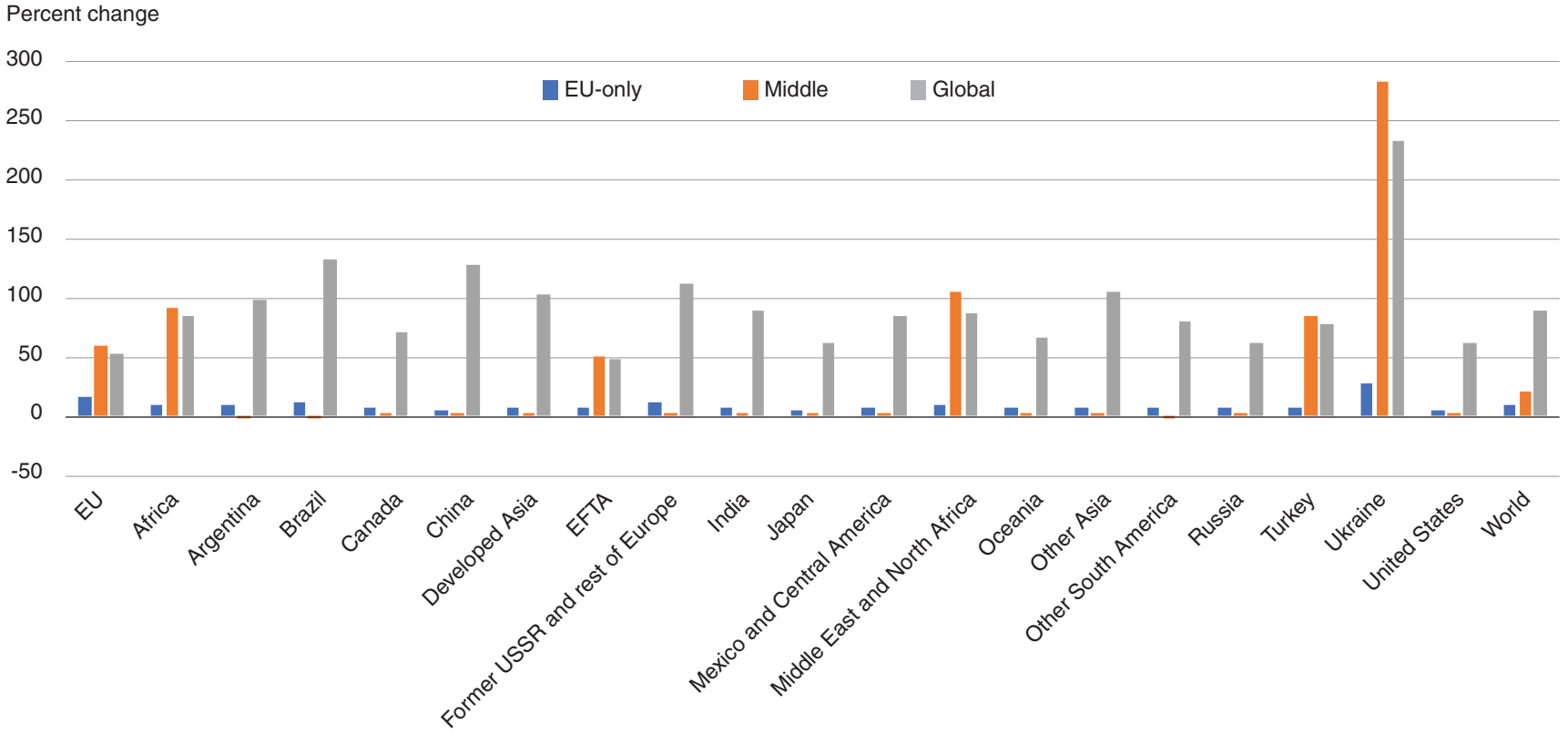
Under the middle scenario, worldwide agricultural trade decreases by 9 percent—the largest decrease across all three scenarios. Imports fall in most regions with double-digit decreases in imports in 9 of the 20 regions (figure 6). Imports in all regions decrease, except Ukraine, which is a major importer of agricultural products from the EU, particularly fruits and vegetables and all meat products (appendix table B-8). Imports in all other regions decrease due to restrictions on exports to the regions adopting the Strategies—the CGE model results indicate that the non-adopting regions also reduce their imports from regions where the Strategies are adopted.

Similar results occur for exports (figure 7), where the reduction in trade to the regions adopting the Strategies is greater than the trade occurring between regions that do not adopt. Canada and Japan are the only regions where agricultural exports increase; Japan is a very small exporter, while Canada benefits from an increase in pork exports (appendix table B-11).

Worldwide, agricultural trade decreases by 4 percent if the Strategies are adopted by every region (global scenario). Changes in production and prices cause changes in the mix of agricultural imports (appendix table B-9). Production for most crops increases in most regions but decreases in 8 of the 20 regions. Similarly, in 10 of the 20 regions, milk and meat imports fall. For total agriculture, imports decrease in most regions. Japan is a major agricultural importer; however, its imports fall by 4 percent. This reduction is mainly because of lower imports of processed agriculture—in particular, vegetable oil. Brazil, a major agricultural exporter, increases overall imports relative to current low levels due to an increase in processed agriculture.

Like imports, agricultural exports by region are also mixed (appendix table B-12). As mentioned, Brazil is a major agricultural exporter, and its exports are estimated to decrease by 45 percent. In particular, Brazil's oilseeds exports decrease by about 50 percent. In this scenario, India's exports increase due mainly to rice exports. Note that Africa has an increase in agricultural exports under all three scenarios; thus, the model likely assumes that African producers adopt and meet the Strategies. This would likely involve a significant investment and transformation of its production practices to follow the policy as written. This is perhaps possible as technological innovations that are compliant with the strategy catch up. However, the initial fixed costs may prove too difficult to overcome in the time frame, considering the unique circumstances applicable to lower income developing countries.

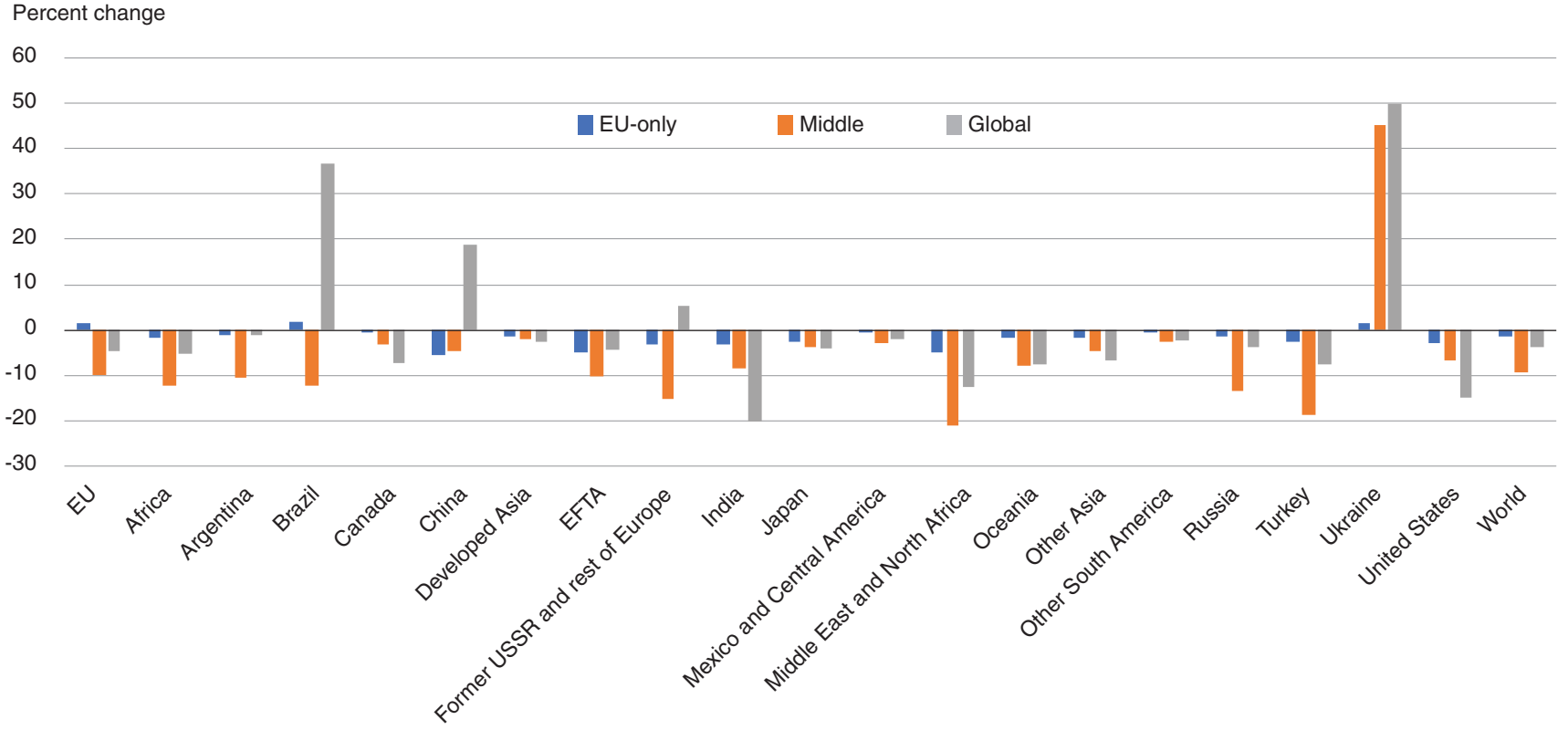
Figure 5
Change in agricultural/food market prices for the three scenarios



Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

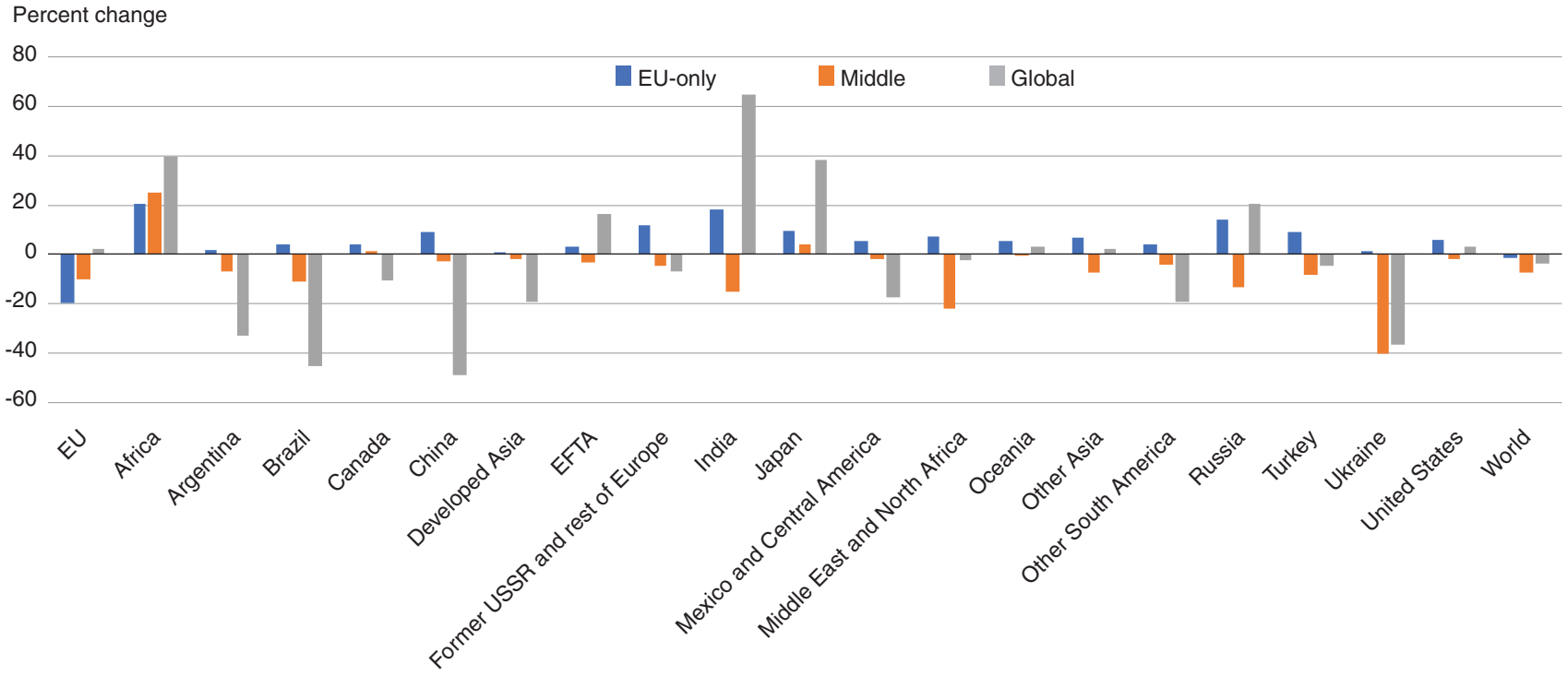
Figure 6
Change in agricultural/food import volumes for the three scenarios



Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Figure 7
Change in agricultural/food export volumes for the three scenarios



Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Economywide Impacts

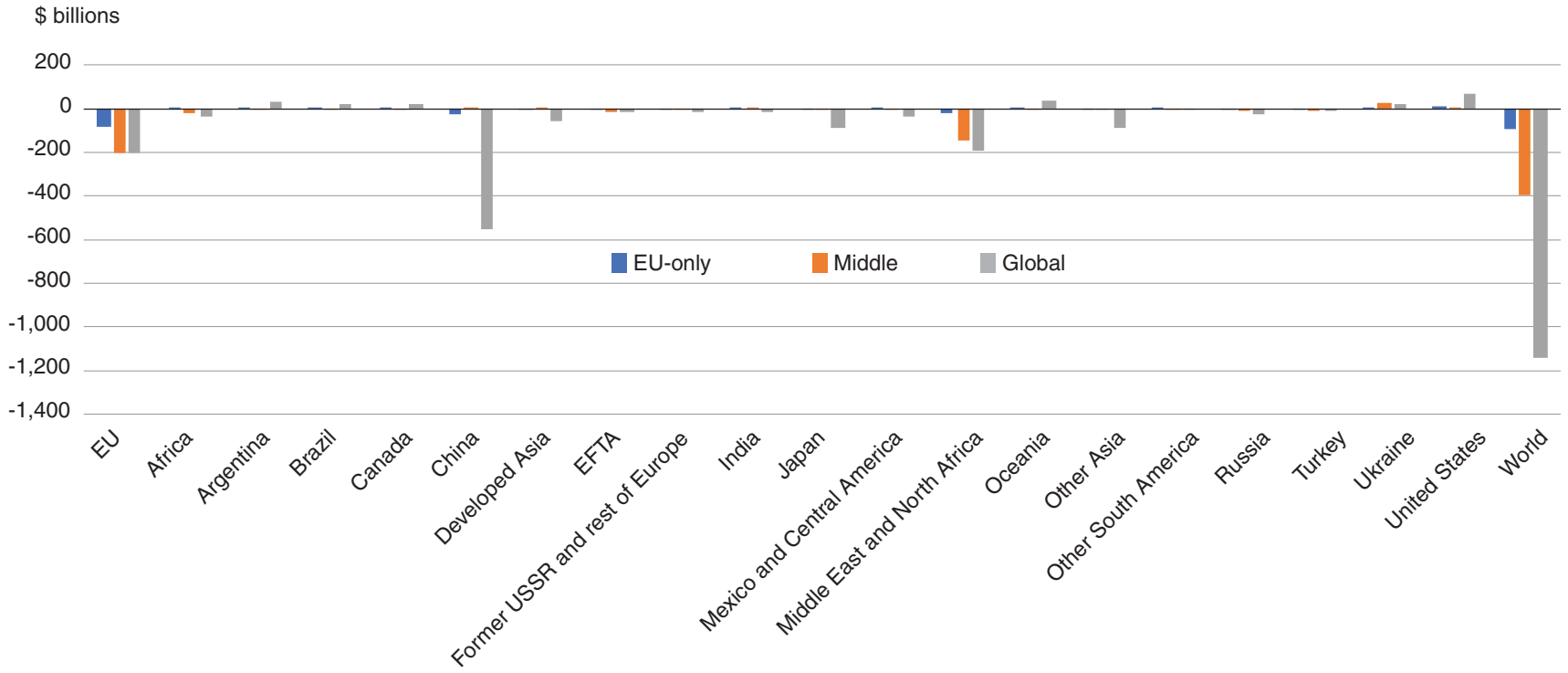
The changes created by the Strategies ultimately lead to economywide changes. This section discusses the impacts on societal welfare, GDP, land use, gross farm income, and food expenditures.

Welfare

Societal welfare, or consumer well-being, is measured in the GTAP model by the equivalent variation (EV) (see box, "Equivalent Variation in the GTAP: A Measurement of Welfare"), which allows for the decomposition of changes in welfare into several activities—allocative efficiency, terms of trade, endowments, and other. Using this measure, welfare would be reduced worldwide by $95.9 billion in the EU-only scenario. As noted in appendix table B-13, most ($80.1 billion) is due to allocative efficiency (AE)—the redistribution of resources from a more productive sector to a less productive one. Figure 8 indicates that the EU is the region with the largest reduction in welfare; $84.2 billion of the total worldwide reduction in welfare originates from the EU, mostly due to AE (67 percent). In addition, the loss of endowments ($14.5 billion) and terms of trade ($10.7 billion) further reduce welfare in the EU (appendix table B-13). Conversely, several regions in the EU-only scenario benefit from an increase in welfare, as they gain from the reduction in the EU terms of trade.

Worldwide welfare is reduced by more in the middle scenario, with a $396 billion decline. The EU again has the largest reduction in welfare at $206 billion. Trade loss in the EU declines by a smaller amount, but the loss in AE is greater in this scenario as more resources are pulled from relatively efficient production. In the EU-only scenario, welfare increases in half of the regions; however, it increases in only five regions in the middle scenario.

Figure 8
Welfare change by region for the three scenarios



Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Considering that the projected impacts are larger under the global adoption scenario, it is not surprising that estimated welfare impacts are also comparatively greater than the other scenarios (figure 8). If these Strategies are adopted globally, welfare falls by $1.1 trillion. Welfare would increase in some regions—these are primarily larger agricultural exporters who gain from higher prices and trade terms. For the EU, although their agricultural production decreases by a smaller scale relative to others under the global scenario, they experience a greater loss in welfare relative to the EU-only scenario. Welfare decreases from endowments and terms of trade, but the reduction in welfare from the AE component is greater under the global scenario than the total welfare change in the EU-only scenario (appendix table B-15). The model also generates details on contributions by commodity to AE. For the EU, AE losses stem mainly from the worldwide trade decline in processed food and pesticides. It is noted that the EU is the world's largest exporter (by value) of pesticides (WTO, 2020). Reducing international demand leads to a reduction in EU exports and the movement of resources out of pesticide production. China realizes the greatest welfare loss worldwide, with large losses in AE and trade terms (appendix table B-15). The reduction in AE is due to the movement of resources out of pesticide use—data from the United Nations (2020) indicate that China uses four times the value of any other country of pesticides in agricultural production. China's terms of trade losses are largely from paying higher prices for agricultural products on the international market.

Equivalent Variation in GTAP: A Measurement of Welfare

The equivalent variation (EV), as used in the Global Trade Analysis Project (GTAP) model, is the change in income at current prices that would have the same impact on consumer welfare as would the change in prices with income unchanged. The results provide a decomposition of the total economywide welfare measure, allocating the change in welfare to four activities (which can be summed to equal total welfare change).

- The first welfare change is allocative efficiency, which involves the redistribution of resources to other sectors. That is, if a policy change occurs, resources such as labor will move based on the relative profitability of each sector. A move from a less efficient to a more efficient sector will generate an increase in welfare based on allocative efficiency.

- The second component involves the terms of trade, which is the relative price of imports in terms of exports for a region. If a region undergoes an increase in the price they receive for their exports on the international market, relative to the price of products that they import, they experience a gain in welfare from terms of trade.

- The third component involves endowments and is the change in total factor productivity calculated as the ratio of aggregate inputs to aggregate outputs.

- The final activity is deemed "other" and largely involves how well a region is able to attract foreign investment based on the profitability of a region given the change in scenario.

Welfare is different from gross domestic product (GDP), as noted in Dynan and Sheiner (2018), as it is primarily a calculation of consumer well-being, while GDP measures production and investment.

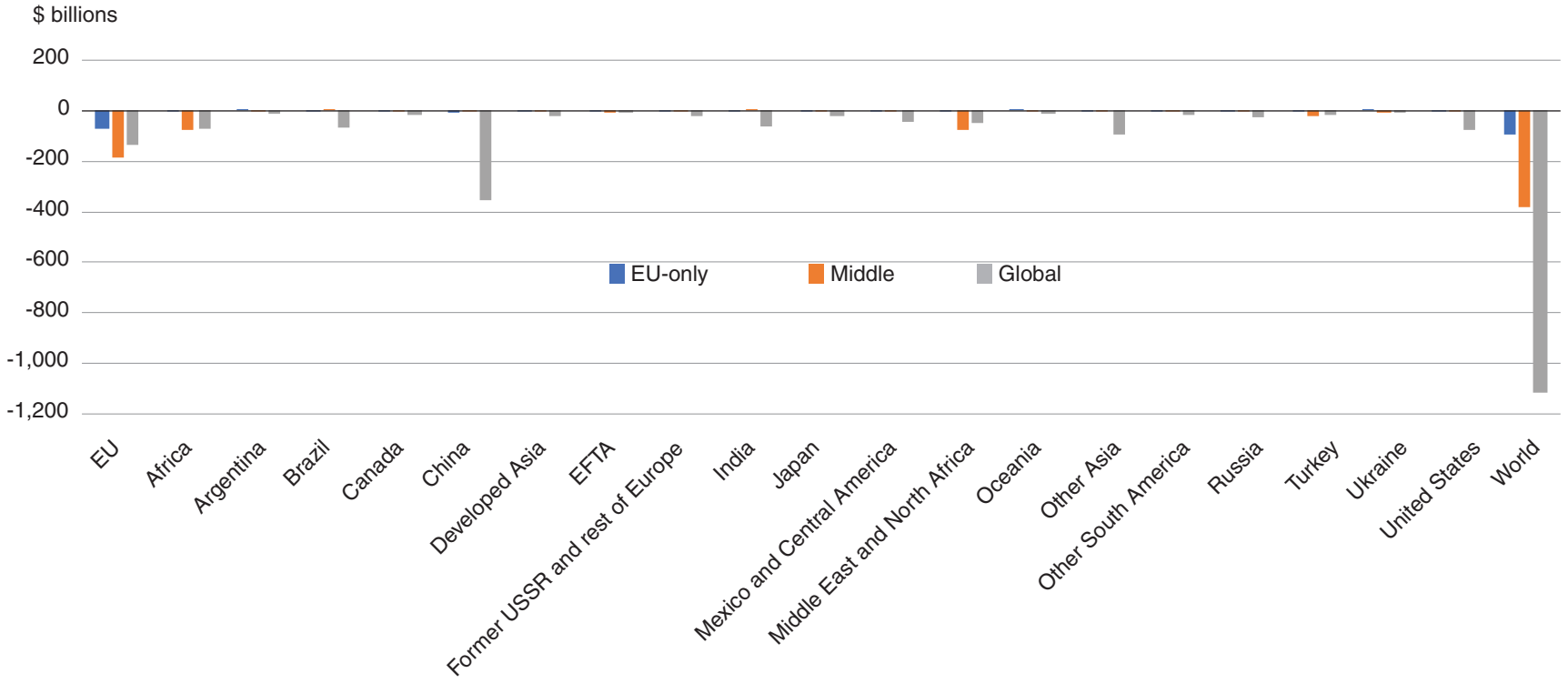
GDP

Figure 9 presents information on changes in real GDP (GDP adjusted for inflation). For the EU-only implementation of the Strategies, GDP increases in only two regions, Argentina and Ukraine. Most regions, like the EU, incur decreases in GDP. The EU undergoes the largest decrease in GDP at 0.3 percent, which based on actual GDP leads to a decrease of $71 billion.

Under the middle scenario, larger decreases occur to both EU and worldwide GDP. EU GDP decreases by 0.8 percent, or $186 billion, based on actual GDP. In this scenario, however, regions where agriculture plays a more important role in the economy experience larger GDP decreases if they adopt the Strategies than does the EU. Those regions tend to be the developing regions (note that the EFTA, a developed region with a relatively high share of the economy in agriculture, has a smaller decrease in GDP than the EU). For example, Ukraine has a reduction in GDP of 6.2 percent, and Africa has a 3.7-percent reduction. Worldwide GDP decreases by 0.4 percent.

The impacts to real GDP are also much larger under the global scenario (figure 9). In the EU-only scenario, worldwide real GDP decreases by 0.1 percent; however, if these Strategies are implemented globally, real GDP would decrease worldwide by over 1 percent ($1.1 trillion). In certain regions dependent upon agricultural exports, projected impacts are relatively large. In Ukraine, GDP decreases by nearly 6 percent; in Africa, it decreases by 3 percent; and in Brazil, by almost 3 percent. The EU also sees a larger decrease in GDP under the global scenario as compared to when they implement the Strategies on their own; as the largest exporter of pesticides, a reduction in international demand leads to a reduction in GDP.

Figure 9
Change in GDP for the three scenarios



Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association. GDP = gross domestic product.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Land use

One measure prescribed by the EC calls for the removal of 10 percent of existing farmland from production (figure 1). The class of land use (forestry, cropland, and pastureland) from which that area is removed is determined within our model. Under the EU-only scenario, the EU reduction in land use is mostly cropland, an outcome caused by reducing pesticide and fertilizer use—and a subsequent decline in production (appendix table B-16). In addition, pastureland is more affected than forestry because of the reduction in antimicrobials, which reduces the number of live animals that use that type of land. In most other regions, cropland increases with a concurrent reduction in other land uses, as agricultural production increases in those regions.

Under the middle scenario, more regions reduce their overall land use, with the EU again reducing cropland. Other regions implementing the Strategies also see a reduction in cropland (appendix table B-17). In most regions, overall land use decreases by more than 10 percent.

Finally, under the global scenario, land use is reduced across all regions (appendix table B-18). In many regions, cropland use decreases by greater than 10 percent--beyond what the EC first proposed in the Strategies. Generally, this is because the decrease in crop production tends to be greater than 10 percent—as a result of the larger than 10-percent decrease in fertilizer and pesticide use.[13]

Gross farm income

We also estimate the change in gross farm income based on the returns to agriculture from changes in prices and quantities (Beckman et al., 2018).[14] In the EU-only scenario, gross farm income in the EU falls by 16 percent, as decreased productivity prevents farmers from benefiting from higher prices (table 1). Gross farm income increases in all other regions, led by a 26-percent increase in the EFTA region from increased agricultural exports to the EU. Thus, farmers worldwide benefit from higher prices and a decrease in EU production, but food consumers instead pay those higher prices.

Results for the middle scenario indicate that more regions see overall decreases in gross farm income (Oceania, Argentina, Brazil, other South America,[15] and Russia) since price increases are relatively muted in these regions. Conversely, gross farm income rises in regions that adopt the Strategies due to the large resulting increase in agricultural prices.

In the global scenario, gross farm income decreases in only two regions, China and Brazil, which are also two of the regions in which agricultural production falls. Gross farm income increases in all other regions with some large increases, particularly EFTA and developed Asia,[16] where producers can take advantage of higher prices that result from the worldwide decline in production. Note that

[13]Given that this result occurs, the model essentially is treating inputs into production as complements more than substitutes.

[14]Our measure of gross farm income represents aggregate returns on all factors employed in agriculture (primary and processing), such as rents to landowners, wages to laborers, and dividends to capital owners. Because the aggregate ownership of resources need not correspond to the typical ownership by individual farmers (e.g., some farmers may lease land or hire off-farm labor), this measure does not reflect the changes in total net incomes that producers may experience through implementation of the Strategies. This would be especially true for those farmers who do not own land, the resource whose return is expected to increase most substantially.

[15]As noted in appendix table A-3, other South America includes Chile, Costa Rica, Falkland Islands, French Guiana, Guyana, Panama, Paraguay, South Georgia and the South Sandwich Islands, Suriname, Uruguay, and Venezuela.

[16]As noted in appendix table A-3, developed Asia includes Korea, Singapore, and Taiwan.

model results indicate that the price of labor and capital will increase; however, since land is the only fixed factor (capital and labor are mobile across sectors in the medium-run CGE setup), all extra revenues are assigned to land by the model. This is essentially a demand story—food faces extremely inelastic demand, prices go up when output falls, and land is assigned the extra revenue as the fixed factor.

Table 1
Changes in gross farm income for the three scenarios (percent changes)

	EU-only	Middle	Global
EU	-16.4	7.5	14.6
Africa	3.7	11.3	16.6
Argentina	5.9	-4.7	16.9
Brazil	3.4	-2.3	-5.1
Canada	4.1	1.0	25.0
China	1.0	0.9	-4.6
Developed Asia	9.0	1.9	66.5
EFTA	25.8	131.5	111.9
Former USSR and rest of Europe	6.0	3.5	15.9
India	5.3	0.1	48.2
Japan	1.5	1.3	9.6
Mexico and Central America	6.9	0.1	18.8
Middle East and North Africa	2.6	3.7	4.4
Oceania	5.9	-0.1	27.7
Other Asia	6.7	0.1	35.8
Other South America	4.9	-2.1	15.8
Russia	7.9	-3.4	27.6
Turkey	3.7	16.9	18.1
Ukraine	8.8	14.0	6.1
United States	6.2	0.5	34.2
World	2.0	3.6	17.1

Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association. The gross farm income calculation is based on the returns to agriculture from changes in prices and quantities.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Impacts on Food Expenditures

The final piece of economywide change is annual changes in food expenditures by consumers in each region, calculated as the change in purchases of agricultural products (both domestic and imported) due to the Strategies (table 2). In the EU-only scenario, the average annual food expenditure increases by $51 per capita worldwide. Food expenditures increase the most in the EU, as they are the only region adopting the Strategies.

In the middle scenario, annual food expenditures per capita increase by $159 worldwide, led by large increases in regions that adopt the Strategies. Most regions undergo increases greater than $500

(Africa is the only exception at $413). Annual food expenditures per capita increase by $651 in the EU, but they decrease in several regions that do not adopt the Strategies.

Finally, global adoption of the Strategies leads to an increase in annual food expenditures of $450 per capita. All regions in the model observe a triple-digit increase in food expenditures per capita, with the smallest increase of $214 in India and the highest increase of $919 in developed Asia.

Table 2
Changes in annual food expenditures per capita for the three scenarios (dollars)

	EU Only	Middle	Global
EU	153.2	650.5	601.9
Africa	47.0	412.8	381.7
Argentina	56.0	-14.6	501.3
Brazil	76.0	-7.2	665.0
Canada	86.4	24.0	709.7
China	32.5	6.9	542.0
Developed Asia	78.8	23.5	919.2
European Free Trade Association	131.2	680.3	648.0
Former USSR and rest of Europe	82.5	26.7	660.0
India	19.6	1.2	213.7
Japan	56.0	19.1	767.4
Mexico and Central America	58.3	4.4	546.4
Middle East and North Africa	70.8	673.7	539.6
Oceania	71.8	11.0	484.7
Other Asia	32.0	2.0	341.3
Other South America	61.2	-3.0	582.5
Russia	69.4	13.2	527.4
Turkey	75.9	777.5	704.6
Ukraine	109.6	934.1	760.5
United States	58.6	16.2	512.2
World	50.6	159.3	450.1

Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

As a developed region, the EU has a small number of food-insecure people (i.e., people unable to access 2,100 calories a day). We estimate that the average share of income spent by European consumers on food will increase from 11.1 percent to 13.3 (middle scenario) or 12.9 percent (global scenario) after the Strategies have been adopted. Thus, it is likely that poorer households whose food consumption represents a larger share of total expenditure may see a reduction in their overall purchasing power.

How Food Security Is Assessed: Method and Definitions

The International Food Security Assessment (IFSA) model, as detailed in Baquedano et al. (2020), first generates food insecurity estimates in their current state as a baseline to measure the potential impact of the Strategies on food insecurity.

Each country model comprises a price-independent demand system for each of the four food groups (Muellbauer, 1975). The demand system is calibrated on a 3-year-average of prices and incomes (2017–19), observed consumption levels, a measure of inequality, and income and price elasticities. Demand projections are based on projected prices and incomes; the model implicitly assumes that both the preferences represented by the demand system and the income distributions embedded in the calibration and projections are constant over time.

Impacts on Food Security

Given the impact of significant price increases for agricultural commodities and the decreases of GDP in numerous countries from the Strategies, we would expect impacts on food security in other regions. The final piece of our analysis examines the potential impacts of the Strategies on international food security. We use USDA, ERS's IFSA model (see box, "How Food Security Is Assessed: Method and Definitions") to project food demand for 76 low- and middle- income countries.[17] The country and regional coverage in our analysis of food security impacts reflects the availability of demand estimates in the IFSA model database, which covers a smaller number of countries than the GTAP database. The IFSA model analyzes the gap between projected food demand, which is a function of per capita income and food prices, and a nutritional target of 2,100 calories per capita per day.[18] Food insecurity occurs when estimated per capita food consumption for a consumer at a certain income level falls short of that nutritional target.

Illustrating the impact of the Strategies on international food security, figure 10 shows the increase in the number of food-insecure people from the *status quo* (our baseline) that would occur by 2030 with adoption of the Strategies across the three scenarios. Under the EU-only scenario, food price increases resulting from adoption of the Strategies by the EU increases the number of food-insecure people by 22 million (or 0.5 percentage points in the prevalence of food insecurity). Most of the increase is in Africa and other Asia regions, which see an absolute increase in the number of food-insecure people of 8 million and 10 million, respectively. Moreover, the prevalence of food insecurity increases by 0.4 percentage point and 1 percentage point in Africa and other Asia regions, respectively.

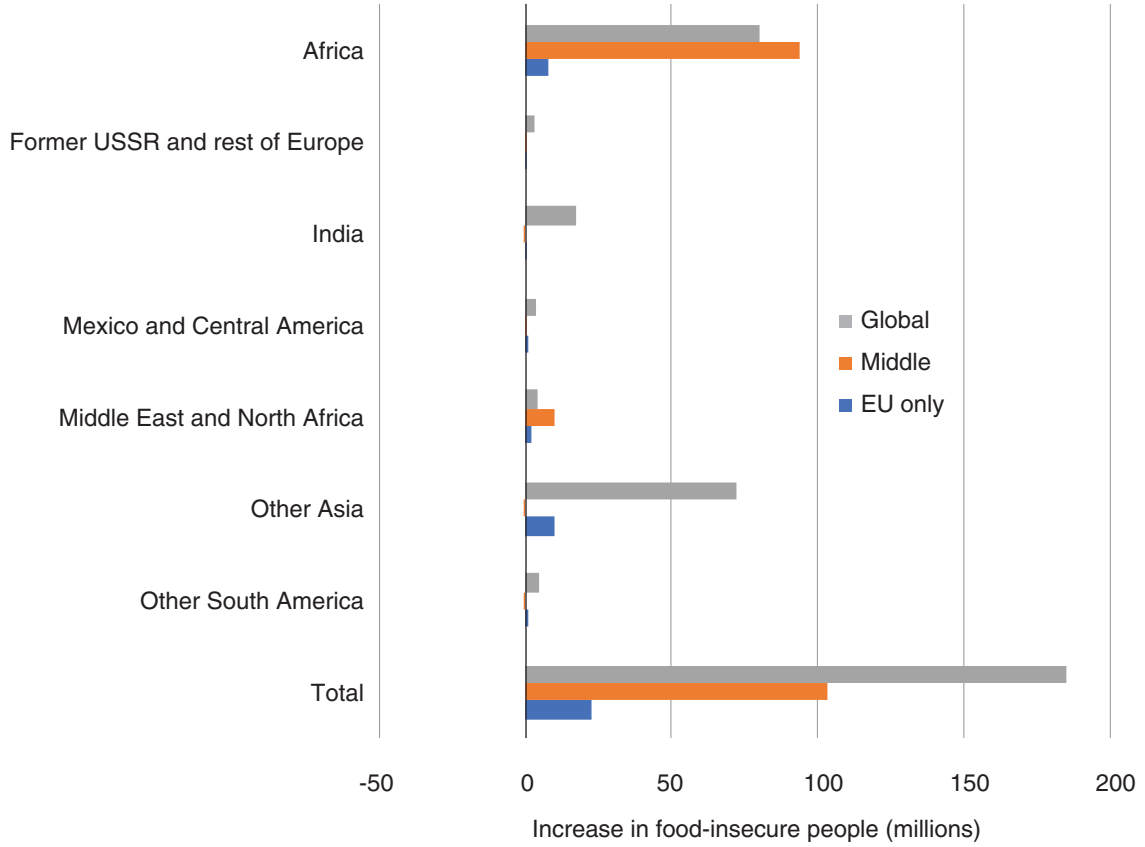
Under the middle scenario, the prevalence of food insecurity increases by 2.2 percentage points. The increase in food insecurity in Africa (94 million) and the Middle East and North Africa (10 million) is due to significant food price increases. In all other regions, the number of food-insecure people in 2030 remains unchanged or marginally declines, reflecting lower price levels as countries in these regions shift away from trading with the EU. When the Strategies are adopted at the global level, the

[17]Twelve in other Asia and India, 7 in Mexico and Central America, 4 in other South America, 8 in the former USSR and rest of Europe, 5 in the Middle East and North Africa, and 39 in Africa.

[18]The 2,100 kcal/per capita/per day threshold is an internationally agreed-upon level set by the United Nations as the recommended dietary energy intake level for a healthy, well-nourished individual (United Nations, 2004).

number of food-insecure people increases to 185 million and the prevalence of food insecurity to 3.9 percentage points. The increase in food security is spread across all regions, but Africa (80 million) and other Asia (72 million) continue to be the most impacted. This is because they could experience the largest increase in commodity prices and the largest GDP declines.

Figure 10
Net increase in food-insecure people by 2030 for the three scenarios



Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies.

Source: USDA, Economic Research Service calculations using the International Food Security Assessment Model.

Conclusions

Based on our analysis, the food and agricultural sustainability measures proposed by the EC in their 10-year plan to reduce the use of traditional agricultural inputs of land, fertilizers, antimicrobials, and pesticides in the EU would lead to a reduction in both EU agricultural production and their competitiveness in export markets. Furthermore, the tightening of the EU food supply would likely result in price increases that affect consumer budgets, reduce food security, and decrease GDPs worldwide. In the three scenarios modeled in this study, the estimated impacts of adopting the EC's Farm to Fork and Biodiversity Strategies include: reduced agricultural output for the regions adopting the Strategies; increased agricultural commodities prices; and decreased GDP and welfare worldwide, with the largest impacts to prices and GDP in the regions adopting the Strategies. Our models find that the more widespread EC's measures limiting usage of agricultural inputs, the more marked these impacts become, with consequences for international food insecurity. Likewise, we find that when trade is restricted as a result of the imposition of the EC's proposed measures, the impacts are concentrated in regions with the world's most food-insecure populations. We also find that EU-specific implications of the Strategies will depend on the degree to which others adopt this or similarly compliant strategies. For example, the EU's share of welfare loss is 88 percent when the EU alone adopts the Strategies but is 18 percent when the Strategies are adopted globally.

Prospective gains to environmental and human health from the Strategies is a subject of ongoing debate. Therefore, we do not include measurement of the associated costs and benefits from the Strategies in this analysis. Furthermore, we exclude some components of the Strategies that could be expected to add to adoption costs due to a lack of detailed information (e.g., animal welfare regulations and organic production). In addition, while the model assumes the most economically efficient means to implement the Strategies, real-world application is likely to result in considerable deviation from efficient implementation. We also note that the changes estimated here are based on large structural policy shocks; as such, further work could be done to investigate the aspects mentioned here.

The framers of the Strategies include incentives for the adoption of new technologies and innovations. Presumably, adopting these technologies will help curb the productivity impacts from the Strategies' input reductions. While details on these aims are not fully defined, they deserve more consideration. Further discourse and refinement of the Strategies can help identify the best path to achieving the overarching aims of this policy of a "fair, healthy, and environmentally friendly food system" (European Commission, 2020). However, the current cutting-edge technologies are likely insufficient to mitigate the production losses and their cascading impacts on the worldwide economy and food security from the magnitude of the Strategies' agricultural inputs reduction targets. The effective treadmill of agricultural technology adoption, along with insufficient research and development (R&D) stocks and spending, poses distinct challenges to generate future productivity growth and feed an expanding population. This leads to concerns over the feasibility of the EC's Strategies over the proposed timeline, as well as consideration of the steps needed to generate a more sustainable food and agriculture system. Ultimately, a robust and resilient food system may benefit from greater investment in innovative agricultural R&D, where sustainability is achieved through perpetual adaptation to new and distinct challenges through science, innovation, and adoption by farmers in their fields throughout the world. Future economic research can evaluate the merits of alternative approaches to generating sustainability outcomes.

References

Baldos, U. L. C., F. G. Viens, T. W. Hertel, and K. O. Fuglie. 2019. "R&D Spending, Knowledge Capital, and Agricultural Productivity Growth: A Bayesian Approach," *American Journal of Agricultural Economics*, (101):291–310.

Baquedano, F., C. Christensen, K. Ajewole, and J. Beckman. 2020. *International food security assessment, 2020-30,* GFA-31, U.S. Department of Agriculture, Economic Research Service, August 2020.

Bareille, F., and A. Gohin. 2020. "Simulating market and environmental impacts of French pesticide policies: a macroeconomic assessment," *Annals of Economics and Statistics* (139):1-28. 2020.

Bartelings, H., A. Kavallari, H. van Meijl, and M. Von Lampe. 2016. "Estimating the impact of fertilizer support policies: A CGE approach." Paper prepared for the 16th annual conference on global economic analysis, Washington, DC, USA. 2016.

Bastiaans, L., R. Paolini, and D. T. Baumann. 2008. "Focus on Ecological Weed Management: What Is Hindering Adoption?" *Weed Research* (48):481–491.

Beckman, J., and S. Arita. 2017. "Modeling the interplay between sanitary and phytosanitary measures and tariff-rate quotas under partial trade liberalization," *American Journal of Agricultural Economics* (99):1078–1095. 2017.

Beckman, J., M. Gopinath, and M. Tsigas. 2018. "The Impacts of Tax Reform on Agricultural Households," *American Journal of Agricultural Economics* (100):1391–1406. 2018.

Beghin, J., B. Meade, and S. Rosen. 2017. "A food demand framework for International Food Security Assessment," *Journal of Policy Modeling* (39):827–842. 2017.

Bellora, C., and C. Bureau. 2014. "The indirect effects of organic farming on trade, land use and GHG emissions," Global Trade Analysis Project, Purdue University, West Lafayette, IN, USA.

Bullock, D. S., and K. Salhofer. 2003. "Judging Agricultural Policies: A Survey," *Agricultural Economics* (28):225–243.

Chikowo, R., V. Faloya, S. Petit, and N. M. Munier-Jolain. 2009. "Integrated Weed Management Systems Allow Reduced Reliance on Herbicides and Long-Term Weed Control," *Agriculture, Ecosystems & Environment* (132):237–242.

Dissanayake, S., J. Asafu-Adjaye, and R. Mahadeva. 2017. "Addressing climate change cause and effect on land cover and land use in South Asia," *Land Use Policy* (67):352–366.

Dynan, K., and L. Sheiner. 2018. "GDP as a Measure of Economic Well-Being," Hutchins Center Working Paper #43, Brookings Institution, Washington, DC, USA.

European Commission. 2019. "Fertilisers in the EU: Prices, trade and use," *EU Agricultural Markets Briefs,* No. 15, European Commission, Brussels, Belgium.

European Commission. 2020. "A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system," *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, COM(2020) 381 final*, European Commission, Brussels, Belgium.

Fouré, J., A. Bénassy-Quéré, & L. Fontagné. 2016. "Modelling the world economy at the 2050 horizon," *The Economics of Transition* (21):617–654.

Fuglie, K. 2018. "R&D Capital, R&D Spillovers, and Productivity Growth in World Agriculture," *Applied Economic Perspectives and Policy* (40):421–444. 2018.

Garnett, T., M. C. Appleby, A. Balmford, I. J. Bateman, T. G. Benton, P. Bloomer, B. Burlingame, et al. 2013. "Sustainable Intensification in Agriculture: Premises and Policies," *Science* (341):33–34.

Levins, R. A., and W. W. Cochrane. 1996. "The Treadmill Revisited," *Land Economics* (72):550.

Maggi, F., F. H. M. Tang, D. la Cecilia, and A. McBratney. 2019. "PEST-CHEMGRIDS, Global Gridded Maps of the Top 20 Crop-Specific Pesticide Application Rates from 2015 to 2025," *Scientific Data* (6):170.

Mallet, Victor. 2020. "Reversal of Pesticide Ban Sparks Criticism of French Government," Financial Times, September 20, 2020.

Muellbauer, J. 1975. "Aggregation, income distribution and consumer demand," *The Review of Economic Studies* (42):525–543.

Nadoveza Jelić, O., and J. Šimurina. 2020. "Evaluating sectoral effects of agricultural nitrogen pollution reduction policy in Croatia within a CGE framework," *Agricultural and Food Economics* (8):9. 2020.

Rendleman, C. M., K. A. Reinert, and J. A. Tobey. 1995. "Market-based systems for reducing chemical use in agriculture in the United States," *Environmental & Resource Economics* (5):51–70. 1995.

Reuters. 2020. "EU should end imports made with banned pesticides: farm chief," Reuters, July 2, 2020.

Rossi, V., T. Caffi, and F. Salinari. 2012. "Helping Farmers Face the Increasing Complexity of Decision-Making for Crop Protection," *Phytopathologia Mediterranea* (51):457–479.

Schebesta, H., and J. J. L. Candel. 2020. "Game-changing potential of the EU's Farm to Fork Strategy," *Nature Food* (1):586–588.

Skevas, I., and A. Oude Lansink. 2020. "Dynamic Inefficiency and Spatial Spillovers in Dutch Dairy Farming," *Journal of Agricultural Economics* (71):742-759.

Thome, K., M. Smith, and K. Daugherty. 2019. *International food security assessment, 2019-29,* GFA-30, U.S. Department of Agriculture, Economic Research Service, August 2019.

United Nations. 2004. “Human energy requirements: Report of a Joint FAO/WHO/UNU Expert Consultation”, Food and Agriculture Organization, Rome, Italy. 2004.

United Nations. 2020. “FAOSTAT,” Food and Agriculture Organization, Rome, Italy.

USDA, Economic Research Service. International Macroeconomic Data Set, available on the USDA Economic Research Service International Macroeconomic dataset web page.

USDA, Economic Research Service. International Agricultural Productivity Data Set, available on the USDA Economic Research Service International Agricultural Productivity dataset web page.

WTO. “International Trade Statistics,” World Trade Organization, Geneva, Switzerland.

Appendix 1

The latest Global Trade Analysis Project (GTAP) database is set to 2014. Given that the EU Strategies are in reference to changes from 2020, we updated the database using inputs to the model for GDP, population, labor, capital, and productivity (appendix table A-1).

Appendix Table A-1
Shocks to update the CGE model (percent changes)

	Population	Labor	Capital	GDP	Productivity
Africa	15.3	19.1	32.6	15.9	13.7
Argentina	5.6	6.0	24.3	9.9	8.1
Brazil	4.5	6.7	22.8	-0.3	7.6
Canada	4.5	2.2	17.4	11.8	9.5
China	2.4	-0.2	56.5	45.7	33.0
Developed Asia	3.0	4.9	33.8	16.5	15.3
EFTA	5.1	4.0	16.2	10.3	6.4
European Union	1.0	-1.7	12.2	13.6	8.6
Former USSR and rest of Europe	4.4	4.4	31.8	19.6	20.2
India	7.3	10.5	35.6	53.0	20.6
Japan	-1.3	-2.4	10.7	7.0	8.0
Mexico and Central America	6.3	10.9	25.0	14.4	7.5
Middle East and North Africa	11.5	10.2	27.2	17.0	2.4
Oceania	7.4	7.2	18.5	16.8	10.5
Other Asia	6.8	10.4	30.3	35.3	10.4
Other South America	6.6	9.1	25.3	-10.3	6.4
Russia	-0.5	-4.8	22.8	3.9	27.6
Turkey	4.6	9.0	33.7	30.1	14.4
Ukraine	-2.3	-6.7	17.7	4.3	41.7
United States	4.7	3.0	15.5	15.4	5.6

Note: CGE refers to the computable general equilibrium model. GDP is gross domestic product. EFTA refers to the European Free Trade Association.

Source: Population and GDP are from USDA, Economic Research Service (International Macroeconomic Data Set) and labor, capital, and productivity are from Foure et al. (2016).

The GTAP database has 65 sectors and 141 regions, which can be aggregated into broader categories. There are 20 agricultural commodities in the database which are kept mostly disaggregated in this simulation (appendix table A-2). However, commodities vital to this work (fertilizers, pesticides, and antimicrobials) are aggregated into larger sectors in the original GTAP database. To model these properly, we split these from their aggregated sector (known as "chemicals"). There are 141 regions in the model. We aggregated the EU countries together, and we kept major agricultural producers disaggregated. Finally, we also kept regions that are dependent on trade with the EU disaggregated. In total, our model has 20 regions, noted in appendix table A-3.

Appendix Table A-2
Sectoral aggregation

Name	Description	GTAP sector code
Paddy rice[1]	Paddy rice	Paddy rice (pdr)
Wheat[1]	Wheat	Wheat (wht)
Coarse grains[1]	Cereal grains	Cereal grains nec (gro)
Fruits and vegetables[1]	Fruits and vegetables*	Vegetables, fruit, nuts (v_f)
Nuts[1]	Nuts*	Vegetables, fruit, nuts (v_f)
Oilseeds[1]	Oilseeds	Oil seeds (osd)
Sugar[1]	Sugar	Sugar cane, sugar beet (c_b)
Other crops[1]	Other crops	Plant-based fibers (pfb), Crops nec (ocr)
Cattle[1]	Cattle	Bovine cattle, sheep and goats (ctl)
Hogs[1]	Hogs*	Animal products nec (oap)
Other animals[1]	Other live animals*	Animal products nec (oap), Wool, silk-worm cocoons (wol)
Milk[1]	Raw milk	Raw milk (rmk)
Natural resources	Natural resources	Forestry (frs), Fishing (fsh)
Energy/mines	Energy and mining activities	Coal (coa), Oil (oil), Gas (gas), Minerals nec (oxt), Petroleum, coal products (p_c), Mineral products nec (nmm), Ferrous metals (i_s), Electricity (ely), Gas manufacture, distribution (gdt)
Beef[1]	Beef	Bovine meat products (cmt)
Pork[1]	Pork*	Meat products nec (omt)
Other meat[1]	Poultry and other meat*	Meat products nec (omt)
Vegetable oil[1]	Vegetable oil and fats	Vegetable oils and fats (vol)
Milk products[1]	Milk products	Dairy products (mil)
Processed rice[1]	Processed rice	Processed rice (pcr)
Sugar[1]	Sugar	Sugar (sgr)
Processed foods[1]	Processed foods, beverages and tobacco	Food products nec (ofd), Beverages and tobacco products (b_t)
Labor manu	Labor intensive manufacturing	Textiles (tex), Wearing apparel (wap), Leather products (lea), Wood products (lum), Paper products, publishing (ppp)
Other chemicals	Other chemical products*	Chemical products (chm)
Fertilizers	Fertilizers*	Chemical products (chm)
Pesticides	Pesticides*	Chemical products (chm)
Capital manu	Capital intensive manufacturing	Basic pharmaceutical products (bph), Rubber and plastic products (rpp), Metals nec (nfm), Metal products (fmp), Computer, electronic and optic (ele), Electrical equipment (eeq), Machinery and equipment nec (ome), Motor vehicles and parts (mvh), Transport equipment nec (otn), Manufactures nec (omf)
Services	Services	Water (wtr), Construction (cns), Trade (trd), Accommodation, Food and servic (afs), Transport nec (otp), Water transport (wtp), Air transport (atp), Warehousing and support activi (whs), Communication (cmn), Financial services nec (ofi), Insurance (ins), Real estate activities (rsa), Business services nec (obs), Recreational and other service (ros), Public Administration and defe (osg), Education (edu), Human health and social work a (hht), Dwellings (dwe)

Note: [1] indicates a sector we consider as agriculture. * indicates a sector that has been disaggregated. Nec means not elsewhere classified.

Source: USDA, Economic Research Service using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table A-3
Regional aggregation

Country/region	Included Global Trade Analysis Project (GTAP) country/regions
EU	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Guadeloupe, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Martinique, Netherlands, Poland, Portugal, Reunion, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom
Africa*	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo DR-Kinshasa, Congo-Brazzaville, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome/Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe
Argentina	Argentina
Brazil	Brazil
Canada	Canada
China	China, Hong Kong
Developed Asia	Singapore, South Korea, Taiwan
EFTA*	Iceland, Liechtenstein, Norway, Switzerland
Former USSR and Rest of Europe	Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia/Herzegovina, Faroe Islands, Georgia, Gibraltar, Kazakhstan, Kyrgyzstan, Macedonia, Moldova, Monaco, San Marino, Serbia and Montenegro, Tajikistan, Turkmenistan, Uzbekistan
India	India
Japan	Japan
Mexico and Central America	Anguilla, Antigua/Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Cayman Islands, Colombia, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Greenland, Grenada, Guatemala, Haiti, Honduras, Jamaica, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Peru, Puerto Rico, Saint Kitts/Nevis, Saint Lucia, Saint Pierre/Miquelon, Saint Vincent/Grenadines, Trinidad and Tobago, Turks/Caicos, Virgin Islands British, Virgin Islands U.S.
Middle East and North Africa*	Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Occupied Palestine, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, Yemen
Oceania	American Samoa, Antarctica, Australia, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia Federated States, Nauru, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, Palau, Papua New Guinea, Saint Helena, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna
Other Asia	Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Burma, Cambodia, Indonesia, Laos, Macau, Malaysia, Maldives, Mongolia, Nepal, North Korea, Pakistan, Philippines, Sri Lanka, Thailand, Timor Leste, Vietnam
Other South America	Chile, Costa Rica, Falkland Islands (Malvinas), French Guiana, Guyana, Panama, Paraguay, Suriname, Uruguay, Venezuela
Russia	Russian Federation
Turkey*	Turkey
Ukraine*	Ukraine
United States	United States of America

*Note: * indicates a region which we assume adopts the Strategies in the middle scenario. EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-1

Production changes from EU-only scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	-13.2	-0.9	18.1	-1.2	0.8	-0.3	-0.6	-7.8	-0.5	1.2	-0.4	-2.3	-2.8	-0.9	-1.2	-0.4	-4.1	0.6	-5.5	2.5
Wheat	-48.5	0.8	7	-3	18.6	0.8	5.8	18.2	12.7	0.9	9.4	12	15.4	8.5	8.4	-1.8	14.9	16.5	10.2	15.6
Coarse grains	-20	-0.4	4.5	1.3	1.1	0.4	3.9	5.7	1.1	0.2	6	1.1	1.5	-1.9	0.5	3.1	3.6	2.9	7.6	-0.2
Fruits and vegetables	-5.2	-0.2	0	-1.1	-6.1	-0.1	-0.5	-2.4	-0.8	0	0.2	-1.8	-0.5	-2	-0.9	0.3	-2.7	-0.4	-3.1	0.9
Nuts	-9.2	0	-1.4	-2.7	-4.8	0.7	-0.2	-7.2	-2.4	3.3	0.7	-2.9	-1.3	-3.8	0	-0.3	-6.2	-2.7	-10.4	0.1
Oil seeds	-60.7	5.4	-0.5	0	-6.2	2.8	2.3	2.4	6	2.4	13.5	2.9	4.2	37.3	2.8	3.4	6.8	10.2	-2.7	2.7
Sugar crops	-20.5	0.9	0.3	-2.3	-0.7	-0.3	8.4	0.8	1.8	1.1	0.2	-0.1	-0.1	4.6	-0.4	3.8	2.3	5.1	0.6	1.8
Other crops	-44	13	3.2	14.1	10.9	4.1	15.6	3.4	5.7	4.7	5	13.3	2.3	-4.4	6.9	6	5.6	4.5	48.8	6.8
Cattle	-14.8	0.9	0.3	0.9	3.1	0.3	-1.2	-0.2	-0.1	2.1	2.6	-0.1	1.9	2	-0.5	0.4	0.8	0.9	1.7	-0.2
Hogs	-8.4	0.4	0.4	2.8	2.2	-0.2	-0.3	-0.5	-0.3	-0.2	1.4	-0.4	-0.3	0.1	0.3	0.2	-0.1	1	0.9	0.2
Other animals	-18.9	2.1	2.1	3	12	1.2	0.6	7.6	1	0.2	2.2	0.4	-0.1	0.8	1.2	2.4	1	1.4	0.2	2.6
Milk	-11.6	1	0.4	-0.5	0	1.4	0.4	-0.4	0.1	-0.3	0.2	0.3	0.8	1.1	0.9	0.5	-0.4	-0.1	1.4	-0.2
Forestry	5.6	-0.8	-2.5	-1.4	-1.5	-0.1	-0.5	-7.7	-3.3	-0.7	0.2	-1.3	-1.8	-3.5	-0.6	-0.5	-2.7	-2.3	-14.1	-1.6
Energy, mining	1.1	-1.2	-1.3	-1.1	-0.5	0.1	0.1	0.6	-0.3	-0.4	0	-0.3	0.1	-1.2	0.2	-0.2	-0.2	-0.4	-3.5	-0.3
Beef	-13.5	0.5	0.3	0.7	1	3.4	-1.3	-2.5	0	4.2	1.6	-0.5	-0.1	0.9	-0.6	1.1	0.2	0.1	0.7	-1
Pork	-6.9	1.9	-0.2	4	5.4	-0.2	1.6	-1.2	1.5	2.5	4.7	-0.2	8.1	3.4	0.3	0.5	2.3	7.3	-2	1
Other meat	-12.5	1	-0.3	5.8	2	1.4	-0.2	1.8	-1	-0.2	0.5	-0.5	-0.3	1.7	3.4	0.1	2	-0.6	-2.1	0.4
Vegetable oil	-16.2	8.5	-3.7	-1.2	-5.5	-0.4	-1.4	0	-4.6	1.6	5.7	-0.3	2.6	39.8	3.8	7.2	7.5	-2.6	-15.1	-0.3
Milk products	-10.6	3.2	0.5	-0.3	0	2	0.7	-0.3	0.3	0.2	0.5	0.3	1	1	1.2	0.7	2.9	0	0.7	0.1
Processed rice	-4.3	-3.3	1.7	-0.6	0.5	-0.3	-0.7	-19.3	-0.8	1.4	-0.5	-1.8	-5.4	-0.3	-1.3	-0.8	-6.8	-4.7	-2.1	10.4
Sugar	-16.3	2.7	0.4	-2.6	4.9	-0.3	15.8	-1.2	-3	1.6	-0.3	0	-1.4	7.8	-0.3	1.9	-0.9	2.9	-3.6	1.9
Processed food	-4.5	0.1	0.2	-1.1	0.7	-0.2	-1.9	-0.2	-0.3	-1	-0.5	-0.3	-1.7	0.9	0	-0.2	-0.6	-0.2	-1.8	0
Labor intensive manufactures	3	-2.4	-1.1	-1.2	-1.1	-0.7	1.2	0	-3.4	-1.5	1	-0.5	-1.6	-0.5	-2.9	0	-2.7	-1.4	-7.9	0.2
Other chemicals	1.3	-2.6	-2	-2.2	-1	-0.6	0.7	-0.6	-0.8	-1.1	0.4	-0.5	0.4	-1.9	-0.5	-0.5	-0.1	-0.8	-4.4	-0.5
Fertilizers	-5.9	-1.8	-0.9	-0.6	-0.9	-0.3	0.5	-1	-0.5	-0.3	0.3	-0.5	0.1	-1.2	0.1	-0.9	0.2	-0.8	-3	-0.3
Pesticides	-16.1	-2.1	-1.1	-0.2	-1.2	-0.3	0.6	-14.9	-0.8	-2.1	-1.1	-0.5	-7.3	-2.1	-0.2	-0.9	-0.2	-1.2	-1.3	-1.7
Capital intensive manufacturing	1.7	-3.4	-3.2	-1.1	-1.4	0.1	0	-0.2	-2.4	-1.1	-0.1	-0.8	-0.3	-1.9	-0.5	-1	-0.6	-1.1	-5.2	-0.7
Services	0.2	-0.2	0.3	0.1	0.1	-0.1	-0.1	0	0	0	0	0.1	-0.2	0.1	0	0	0	0	1.3	0.1

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-2

Production changes from Farm to Fork regions adoption of Strategies (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	69.5	-2.5	-1.4	-0.6	0.6	0	-0.3	-9	0.9	-3.9	0.1	-0.1	-9.2	-3.6	-2.2	-1	-11.1	-9.4	-50.9	-2
Wheat	-24.7	-85.1	3.1	0.2	-13.6	0.2	0.3	0.4	-8.2	-1.1	-2.3	-3.3	16	-6.1	0.1	-0.3	-22.6	81.5	6.2	-5.7
Coarse grains	-17.2	-12.5	-13.4	-5	1.7	1	7.7	-9.4	0.5	-0.8	3.7	0.3	-1.1	7.2	-0.1	-0.3	-4.9	-2	-29.4	1.6
Fruits and vegetables	7.4	-9.6	1.1	-1.2	-2	0.3	0.1	-43.1	5.2	0.1	0.5	-1	-18.7	-1.1	0.6	-3.2	9.9	-19.9	-35.9	-0.7
Nuts	78	-39.8	-4.4	3.7	17.5	3.1	11.2	-61.2	-8.5	11.7	8.1	4.3	-15.3	15.9	12.8	-4.8	18.9	-36.6	-82.6	-2.8
Oil seeds	-37.8	22.6	-4.7	-2.2	-0.4	-0.9	0.1	-3.6	-7.1	-0.2	2.6	-1.4	13.4	-11.1	-2.9	-6.8	-1.8	44	-56.5	-3.9
Sugar crops	-18.2	-4.6	-0.2	-5.6	0.5	-0.2	-0.1	-31	0.6	-3	1.6	-1.1	-12.7	0.9	-0.6	0.5	3.3	12.8	-23.7	0.3
Other crops	-20.6	-1.3	0.7	-0.6	8.6	1.9	2.8	12.9	1.3	1.9	3	1.4	-25.2	12.4	3.4	3.7	15.1	-49.8	368.8	4.6
Cattle	-11.7	-5	-0.8	-1.6	1.7	0.1	-0.8	-24.1	0.3	-0.9	-0.6	0.3	-13	-2.4	-0.1	-0.6	0.2	-9.8	-23.4	-0.1
Hogs	-11.4	-7.6	0.3	-4.9	2.6	0.4	0.6	-18.8	1.1	0	2.2	0.3	-11	2	-0.1	0.5	-0.5	2.3	-31.8	0.6
Other animals	-12.3	-13.1	0.9	-4.7	7.6	1	1.4	-16.1	1.5	0	2.9	0	-11.9	10.6	0.3	1.1	-0.3	-12	-44.5	2.8
Milk	-12	-11.6	0.8	0	0.9	1.1	1.2	-26	1	0	0.7	0.6	-22.2	1.4	0.7	0.5	-0.7	-15.4	-23.7	0.7
Forestry	-4.4	-8.9	2.7	1	1.2	0.7	1	-20.1	3.3	0.3	0.9	0.9	-15.2	1.2	0.9	1.3	1.4	-13.5	-20	1.3
Energy, mining	0.4	0	0.4	0.3	-1	-0.7	-0.8	1.9	-0.7	-0.6	-1	-1	3.1	-1.2	-1	-0.8	-0.2	1.5	-13.7	-0.8
Beef	-11.7	-3.2	-1.3	-1.7	0.3	-0.7	-1.1	-27.7	-0.3	-8.7	-1	-0.2	-3.6	-3.1	-0.5	-1.6	-0.5	-10.7	-10.2	-0.3
Pork	-13.3	-5.8	0.3	7.7	8.9	0.5	3.9	-18.4	5.7	7.2	7.7	2.1	2.1	10	1.1	2.6	0.8	-45.2	-83.5	2.4
Other meat	-8.2	-4.1	0.5	-11.4	2	1.6	0.2	-20.7	1.6	0.1	-0.6	0	1.4	0.2	-1.9	-0.1	0.2	-14.6	-80.3	0.1
Vegetable oil	-14.8	84.7	-9.8	-6.3	8.2	0	-2	-8.8	-2.6	-0.5	1.8	-1.2	17.8	-9.6	-7.2	-4.6	-2.9	1.5	-75	-1.7
Milk products	-7.2	-9.7	0.8	-0.1	0.9	1.5	1.3	-25.7	2	0	0.9	0.8	-26.8	1.7	1.3	0.8	3	-14.2	-19.9	0.8
Processed rice	118.2	37.2	-3.2	-0.8	0.4	0	-0.6	119.8	-1.7	-5	0	-0.3	0.7	-5.6	-2.7	-3.2	-1.3	-19.7	58.4	-7.1
Sugar	-16.1	4.6	0.4	-8.1	-0.8	-0.6	-0.3	-42.4	-9.1	-4	1.4	-1.7	-12.4	0.7	-0.9	-0.6	-1.4	11.9	-24.7	0.3
Processed food	-11.1	-6.4	-0.6	-1	3.2	0.3	0	-6.2	2.9	-0.6	0.8	0.5	-21.9	1.3	0.4	0.7	3.4	-10.9	-27.4	0.7
Labor intensive manufactures	0.2	-17.9	1.3	1.6	0.3	1	1.3	0.3	1.3	1.6	0.4	0.7	-20.5	0.7	1.6	1.3	0.8	-11.2	-25.4	0.4
Other chemicals	-1.3	-11.6	2.3	1.2	0.3	-0.5	0.6	-6	0.9	0.6	0	0.1	2.7	0.4	0.4	0.5	1.8	-2.7	-22.9	-0.2
Fertilizers	-10.2	-24.9	-4.3	-2.4	-1.5	-0.1	0.1	-9	-1.3	-0.2	0.3	-0.6	-2.9	0.2	-0.4	-1.9	-3.4	-14.5	-32.4	-1
Pesticides	-27.5	-48	-3.4	-2.5	-2.4	-2.3	0.1	-27.6	-4.5	-11.1	-3.2	-1.4	-24.8	-1.3	-1	-1.8	-19.7	-30.3	-54.5	-4.5
Capital intensive manufacturing	1.2	-10.9	2.4	1.1	-0.2	-0.5	-0.1	1.3	-0.5	0.2	-0.5	0.1	4.7	0.4	0.3	0.7	0.9	1.6	-20.3	-0.3
Services	0.1	0.4	0	0.1	0.1	0.1	0	0.1	-0.1	0.1	0.1	0.1	-1.3	0.1	0.1	0.1	0	0.4	10.2	0.1

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-3

Production changes from global scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	48.4	-8.5	241.6	-15.1	7.7	-15.8	-16.3	7.1	-11.3	10	-16.9	-36	-26.7	15.5	-20.7	-15.2	-46.8	-16.5	-49.1	24.4
Wheat	-33.5	-93.1	55.3	-55.2	-25	-32.9	-21.8	-11.1	16.8	-20.7	-33.8	27.9	9.4	-12	43	-77.1	6.7	54.3	-16	3.2
Coarse grains	-13.7	-10.9	0.1	-14.4	-22.8	-12.4	-4.1	-7.6	-29	-10.3	0.8	-0.6	-6.9	-36.3	-4.8	-4	-4.9	-1.7	-25.1	-26.4
Fruits and vegetables	27	-6.4	-13.9	-19.4	-34.8	-16.3	-23.8	-40	-15.5	-3.7	-15.1	-33.8	-12.9	-1.6	-9.5	-4.6	-28	-14.1	-34.1	13.1
Nuts	72.1	18.1	-27.4	-36.9	-30.3	-24.6	-55.7	-59.9	-27.8	27.3	-51.9	-40.1	-8.3	-19.7	-22.7	-17.6	-53.1	-34.5	-81.9	-4.2
Oil seeds	-43.4	51.7	-51.6	-44.6	-38.9	-34.2	-3.6	-10.4	-47.6	-0.6	24.4	9.1	24.5	184	1.9	-60	19.6	53.2	-49.3	-22
Sugar crops	-15.1	-6.8	-6.7	-28.8	-4.4	-31.7	128.2	-29.7	-42.2	-3.4	-21.2	-9.8	-13.5	45.2	-20.1	6.4	-12.6	10	-23	16.1
Other crops	-26.7	-17.5	0.3	-20.1	88.3	-26.8	61.8	10	5	10.2	-33.8	6.9	-29.1	-63.7	-2.1	-22.1	-20.9	-63.6	319.8	41.6
Cattle	-10.8	-5.6	-16	-14.3	-3.9	-5.1	-17.8	-22	-16.2	6.2	3.7	-13.5	-12.3	-3.5	-16.6	-18.4	-0.8	-9.4	-23.4	-20.6
Hogs	-8.3	-8.5	-11.8	-16.8	1.5	-11.8	-13.8	-18.6	-12.2	-4.2	-6.9	-11.2	-9.8	-12.4	-6.8	-11	-5.9	-10.7	-31.6	-9.1
Other animals	-6	-11.1	-20.8	-18.4	27.4	-11.9	-12.1	-19.6	-13.9	-3.3	-3.1	-11.9	-10.3	-47.3	-6.5	-9.9	-4.6	-11.2	-44.2	-3.8
Milk	-7	-11.3	-12.5	-23.7	-16.9	-12.4	-16.1	-23.8	-16.9	-7.3	-10.6	-14.2	-17.9	-30.8	-14.2	-14.8	-11.6	-14.5	-24.3	-19.1
Forestry	1.3	-8.1	-3.7	1	-5.3	-6	-9.5	-6.8	-3.8	-9.4	0	-3.6	-11.4	-16.2	-5.7	-1.8	-5	-9.8	1.5	-6.5
Energy, mining	-3.4	-2.9	-7.2	1.4	-4.4	6	-0.4	-0.7	1.2	-2.5	-0.7	-0.9	1.3	-8.6	3.9	1.4	-1.3	-3.3	-11.2	-3.4
Beef	-12.4	-3.8	-18.1	-17.3	-2.8	7.2	-17.9	-26.1	-17	22	3.3	-12.1	-5.5	-13.7	-15.2	-18.1	-0.6	-10.1	-12.6	-21.2
Pork	-8.9	-7.1	-5.7	-18.5	9.9	-12	-10.5	-18.1	-19.6	-16.5	-7.8	-14.7	6.8	-8.7	-5.5	-14.5	15.4	-48.4	-80.5	-9.3
Other meat	-6.4	-6.9	-9.8	-17.9	11.8	-14.8	-10.7	-21	-19.3	-6.2	-3.1	-11.5	-4.1	-6.7	-3.1	-12.6	17.7	-15.3	-76.7	-7.7
Vegetable oil	0.5	93.2	-76.6	-34.9	-46.7	-32.6	-31.8	13.2	-73.2	-1.5	57.3	-13.2	33.9	406.6	6	32.4	41.4	-18	-52	-28.5
Milk products	0.7	-8.9	-12.9	-20.2	-15.6	-11	-15.9	-23.3	-19.1	-3.6	-6.9	-14.5	-21.5	-40.9	-19.1	-16.9	10.1	-13.2	-19.5	-16
Processed rice	65.6	-13	25.9	-6.2	7.5	-15.6	-16.2	32.6	33.7	13.4	-17.3	-22.7	-44.6	35.7	-22	-16.5	-48.3	-44.1	17.3	169.1
Sugar	-11.2	-0.7	-4.6	-35.9	36.5	-50.2	257.8	-39.6	-72.3	-1.1	-18	-10.8	-16.8	101.4	-23	1.9	-13.6	11.9	-16.8	16.4
Processed food	-5.9	-5.3	-3.2	-20.5	-1.1	-14.4	-27	2.5	-13.6	-20.2	-10	-7.7	-18.8	6.3	-7.1	-10.7	-10	-9.4	-17.1	-4.5
Labor intensive manufactures	14.7	-6.5	-3.7	7	3.9	-13.8	20.2	12.2	-8.7	-10	16	5.2	-3.9	5.5	-20.3	12.7	0.5	4.1	-4.8	5.3
Other chemicals	1.2	-8.4	-4.9	-13.2	-2.1	-8.6	10.9	-0.8	7.4	-4.3	8.7	1.7	12.5	-11.2	2	0.7	8.7	-1	-13.5	-2
Fertilizers	-11.3	-22.8	-22.4	-22.7	-17.6	-21.8	-1.4	-12.3	-8.6	-19.1	-5	-11.7	-1.5	-23.7	-14	-14.1	-5.6	-16	-28.1	-15.8
Pesticides	-35.9	-44.1	-50.9	-50.5	-45.1	-48.1	-17.6	-39.3	-46.9	-39.4	-23.9	-35.6	-28.6	-45.5	-30.7	-40.3	-42.8	-38.8	-53.3	-37
Capital intensive manufacturing	-3.9	-13	-17.2	-2.3	-7.6	8.9	-0.5	-3	-6.2	-6.1	-0.9	0	3.5	-9.8	2	-2.6	-0.4	-3.1	-14.9	-5.3
Services	0.3	0.2	3.3	1.9	1.3	-1.2	-0.3	0.5	0.9	0.2	0.1	0.6	-0.9	1.3	0.3	0.2	0.2	0.1	8.6	0.7

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-4

Market price changes from EU-only scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	29.5	11.6	11.1	27.4	14.5	10.4	14.3	19	23.3	11	11.9	28.5	14.6	30.7	14.7	17.8	30.6	17	67.7	20.1
Wheat	71	46.2	17.2	23.5	27.2	19.6	14.9	34	21.9	17.3	14.9	22	16.3	24	11.8	36	27.3	13.7	32.1	22.3
Coarse grains	96.3	15.6	20.5	22.2	41	13.6	13.1	36.2	47.4	12.5	14.8	21.1	15.8	34.7	13.3	23.3	26	16.9	42.1	33
Fruits and vegetables	15.7	9.6	17.8	25.7	19.2	8.9	15.6	24.5	16.4	6.4	12.4	21.4	11.5	15.6	11.9	15.2	28.9	18.2	61.6	12.2
Nuts	14.9	9.8	17.2	25.4	19.5	9	14.6	22.4	15.7	8.4	12.3	21	11.5	15.2	12	14.9	26.7	17.8	58.8	11.9
Oil seeds	93.3	10.7	18.9	25.4	27.1	10.2	13.1	28.4	30.5	12.2	10.3	18.7	10.9	17.7	14.9	29.6	24.1	13.2	35.7	21.3
Sugar crops	107.8	23.4	21.2	25.9	23.6	12.7	14.1	28.8	38.7	11.7	31.1	18.8	16.4	17.2	13.1	10.2	30	16	73.4	18.3
Other crops	73.8	22.3	15.6	21.6	15.3	11.3	13.7	32.9	17	11.5	12.5	20.6	19.8	24.6	15.1	21.4	25	29.5	24	15.5
Cattle	53.1	4.6	7.4	5.6	6.8	2.2	8.1	13.5	8.8	6.9	4.2	7.2	6.6	6.8	6.7	5.7	4.6	3.7	33.3	6.9
Hogs	19.8	4.4	4.5	4	1.8	1.8	3.2	4.9	4.4	2.9	1.8	3.2	4.3	7.7	2.8	2.6	3.6	3.2	26	1.9
Other animals	19.6	4.4	4.5	4.1	1.8	1.8	3.2	5	4.5	2.8	1.8	3.2	4.3	7.2	2.7	2.6	3.6	3.2	26	1.9
Milk	40.9	10.6	9.7	11.1	7.7	3.6	11.6	15	8.2	3.3	5.5	8.6	7.2	13	7.9	8.2	3.8	4.9	35.2	8.1
Forestry	-8.9	5.1	6.9	6.2	4.3	1.2	2.2	2.9	3.2	4.9	1.6	5.5	2.8	6.5	2.8	4.1	7.9	5.5	7.9	5.5
Energy, mining	-0.4	0.1	0.8	0.4	0.2	-0.2	0	-0.2	0	0.2	0	0.1	-0.1	0.2	-0.1	0	0	0.1	0.9	0.2
Beef	17.1	2.3	5.8	3.6	3.2	1.1	4.5	7.1	4.9	2.4	2.1	4	3.6	4.3	3.4	3.4	1.7	2.8	9.4	3.9
Pork	9.5	2.7	3.7	2.2	1.6	1.4	2.2	3.7	3.1	2.7	1.5	2.3	2.6	2.8	1.6	2.3	1	2.9	15.2	1.6
Other meat	9.5	2.7	3.7	2.1	1.6	1.4	2.2	3.8	3.1	2.7	1.5	2.3	2.2	2.8	1.6	2.3	1	2.9	15.2	1.6
Vegetable oil	15.2	4.2	13.4	11.8	13.6	9.4	9.2	9.6	15.2	6.6	3.6	9.9	6.9	3.7	7.4	6.7	6.5	9.7	14.8	10.8
Milk products	11.6	3.3	4.7	4.9	3.5	2.1	4.2	4.3	4	2.1	1.5	3.4	5.2	6.2	4.3	3.6	1.2	2.8	9.4	3.5
Processed rice	6.4	8.9	4.5	8.8	3.5	8	12.7	13	7.1	4.1	10.7	12.5	12.8	6.3	11.2	9.5	15.3	14.2	7.7	3.6
Sugar	20.1	7.4	6.6	12.8	2.5	12.6	2.6	16.5	17.6	5.4	4.7	7	10.3	2.7	7.1	5.3	11	4.6	21.4	3.5
Processed food	6.6	4.1	4	8.8	2.6	3.1	6.1	3.9	4.8	6.9	2.3	3.2	6.3	2.3	3.3	3.9	4.6	4.5	7.2	2
Labor intensive manufactures	-0.5	1.8	1.9	1.3	1	0.8	0.3	0	1.1	1.4	0.1	0.8	0.9	1	1.3	0.6	1.5	0.6	1.9	0.5
Other chemicals	-0.2	0.8	1	1.4	0.4	0.5	0	0.1	0.2	0.4	0	0.4	0	0.8	0.2	0.4	0	0.1	0.8	0.3
Fertilizers	-0.2	0.8	1	1.4	0.4	0.5	0	0.1	0.2	0.4	0	0.4	0	0.8	0.2	0.4	0	0.1	0.8	0.3
Pesticides	-0.2	0.8	1	1.4	0.4	0.5	0	0.1	0.2	0.4	0	0.4	0	0.8	0.2	0.4	0	0.1	0.8	0.3
Capital intensive manufacturing	-0.5	0.8	1.2	0.7	0.3	-0.1	0	-0.1	0.4	0.4	0	0.2	0	0.5	0.1	0.2	0.1	0.1	1	0.3
Services	-0.5	0.9	1.4	0.7	0.4	-0.1	0	-0.1	0.2	0.5	0	0.3	0.1	0.6	0.1	0.3	0.2	0.2	1.8	0.3

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-5

Market price changes from middle scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	175.7	130	-2.6	-1.7	2.4	0.7	1.3	149.7	8.6	-1.1	0.7	0	206.2	-0.7	-1	-2.2	-4.7	196.8	682.7	0.1
Wheat	321.1	562.2	-3.1	-1.8	-0.6	0.6	1.6	281.5	0.3	-0.3	0.4	-1.4	194	-1.4	0.4	-1.3	-7.8	140.4	288.5	-0.4
Coarse grains	401.5	177.2	-5.1	-2.3	0.3	0.8	3.4	325.8	1.6	-0.2	1.3	0	214	0.3	-0.2	-1.7	-3.7	191	400.1	0.5
Fruits and vegetables	95.8	98.1	-3	-1.8	0.1	0.8	1.2	247	3.1	0.1	0.7	-0.2	150.1	-0.4	0.1	-2.3	-1	207.3	617.4	0.2
Nuts	104.1	90.2	-3.9	-1.3	1.6	1.2	3.8	235.4	0.7	3.4	1.2	0.9	151.2	1.3	4.3	-2.6	0.4	204.5	595.4	0
Oil seeds	395.7	104.1	-3.8	-2	0.2	0.5	0.8	297.3	0.8	0	1	-0.3	136.3	-1.9	-1.4	-2.7	-2.8	138.6	351.1	-0.2
Sugar crops	440.9	261	-3.7	-2.6	0.2	0.6	2.4	291.9	1.9	-0.8	0.7	-0.5	181.5	-0.2	-0.3	-1.3	-2.2	176.1	744.1	0.4
Other crops	302.9	242.2	-3.5	-1.8	1.9	1	1.9	202.7	2.2	0.4	0.9	0.3	272.7	0.9	1.3	-0.8	4.5	343.3	176.2	1.1
Cattle	77.3	51.7	-3.1	-1.6	1	1	1.4	94	2.6	-0.3	1	0.5	63.5	-0.7	0	-1.2	0.8	68.4	452.7	0.5
Hogs	43.1	53.3	-1.1	-0.7	0.6	0.6	1.7	44.1	1.5	0.2	0.9	0.4	49.9	0.3	0.5	0	1.7	45.1	336.9	0.5
Other animals	43.1	53.2	-1.1	-0.7	0.7	0.6	1.8	44.1	1.5	0.2	0.9	0.4	49.7	0.8	0.5	0	1.7	45	336.8	0.5
Milk	63.7	162	-2.3	-1	0.9	1.6	3.2	126.2	3.4	0.2	1.1	0.7	70.6	0.8	1.3	-0.4	1	107.4	453.3	0.7
Forestry	15.4	27.1	1.3	-0.6	2.5	1.2	2.2	27.8	5.5	0.7	2.3	1.1	27.7	2.6	0.9	0.8	3.9	36.9	18.8	2.1
Energy, mining	-0.5	-0.6	-0.4	-0.4	0	0.2	-0.2	-0.8	-0.2	-0.1	0	0	-1	-0.1	-0.1	-0.1	-0.3	-0.8	3.9	0.2
Beef	28.8	18.5	-2.3	-1.1	0.7	0.7	1.3	43.9	1.9	0.3	0.8	0.5	28.1	-0.3	0.1	-0.6	0.4	38.8	106.1	0.6
Pork	22.9	26.2	-1.2	-0.5	0.5	0.6	1.2	27.1	1.7	0.3	0.8	0.4	25.6	0.4	0.4	0	1	38.7	190.3	0.5
Other meat	23	26.2	-1.2	-0.5	0.5	0.6	1.2	27.1	1.7	0.3	0.8	0.4	24	0.3	0.3	0	1	38.3	190.3	0.5
Vegetable oil	104.6	36.8	-2.8	-1	0.5	0.5	1.4	89.4	2.6	0.3	0.9	0.1	76.7	0.5	-0.4	-0.4	0	93.6	138.1	0.2
Milk products	21.2	32.1	-1.3	-0.7	0.6	1	1.6	34.3	1.8	0.4	0.7	0.4	51	0.5	0.8	-0.1	0.3	47.9	107.8	0.6
Processed rice	40.1	98.2	-1.1	-0.8	0.8	0.6	1.3	80.8	2.8	-0.3	0.7	0.3	161.8	0.1	-0.7	-0.9	2.2	160.2	71.1	0.3
Sugar	86.7	75.9	-1.4	-1.4	0.6	0.6	0.7	146.2	3.9	-0.3	0.7	0	110.2	0.2	-0.1	-0.5	2	48.4	152.1	0.5
Processed food	33.5	36.7	-1	-0.9	0.8	0.6	2.7	26.3	1.7	0.1	0.8	0.3	69.8	0.4	0.4	0	1.1	48	63.9	0.6
Labor intensive manufactures	0.9	10.5	-0.6	-0.4	0.6	0.5	0.4	0.7	0.7	0.2	0.4	0.3	8.8	0.3	0.4	0.1	0.6	4.4	6.6	0.5
Other chemicals	0.5	3.1	-0.5	-0.4	0.2	0.4	0.1	1.3	0	0	0.2	0.2	-0.7	0.2	0.1	0.1	-0.3	0.5	5.1	0.3
Fertilizers	0.5	3.1	-0.5	-0.4	0.2	0.4	0.1	1.3	0	0	0.2	0.2	-0.7	0.2	0.1	0.1	-0.3	0.5	5.1	0.3
Pesticides	0.5	3.1	-0.5	-0.4	0.2	0.4	0.1	1.3	0	0	0.2	0.2	-0.7	0.2	0.1	0.1	-0.3	0.5	5.1	0.3
Capital intensive manufacturing	-0.2	2.6	-0.5	-0.4	0.3	0.3	0.2	-0.2	0.1	0.1	0.3	0.2	-1.2	0.1	0.1	0	-0.2	-0.5	4.5	0.4
Services	-0.2	1.5	-0.6	-0.5	0.3	0.4	0.3	-0.5	0.1	0.1	0.4	0.2	-0.2	0.2	0.1	0.1	-0.2	-0.1	10.8	0.4

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-6

Market price changes from global scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	146.3	120.8	116.1	311.5	131.6	269.2	263.9	165.2	165.5	142.2	245.8	346.5	169.5	337.7	212.5	206.3	293.5	172.8	563.3	231.4
Wheat	260.5	495.6	185.9	262.9	248.7	513.3	210.6	239.4	202.9	241.7	261.3	191.6	161.4	242.7	126.3	451.6	216.6	122.6	231.4	232.1
Coarse grains	327	163.4	230.9	246	384.1	359.2	200.7	284.2	530.6	170.3	277	236	177.8	378.6	165.9	262.9	238.1	169.2	330.4	395.8
Fruits and vegetables	84.7	94.2	194.9	288.8	191.1	225.6	286.2	218.2	166.1	76.4	255.7	250.9	126.4	164	161.1	171.7	285.5	184	509.2	136.8
Nuts	90.2	99.7	190.7	286	192.8	222.1	260.8	206.3	160.7	94.9	250.8	248.8	127.5	160.4	152.4	167.4	267.9	180.7	490	132.7
Oil seeds	319.8	104.3	219.2	279.2	256.4	240.3	187.6	257.3	313.4	158	173.9	195.2	116	150.3	187.1	355.8	219.9	125.4	290.5	240.3
Sugar crops	357.3	240.6	244.8	285.4	229.8	331.3	141.8	257.6	421.9	153	652.8	201.1	153.4	161.6	177.6	108.5	295.3	155.9	614.7	204.1
Other crops	246.8	218.7	165	220.4	148.1	267.6	162.3	175.6	159.9	139	246.2	188.6	225.9	258.7	174.2	233.4	203.9	297.6	141.4	160.4
Cattle	90.2	53.6	87.1	76.7	80.6	34.7	86	94.2	86.7	74.5	61.6	95.2	58.5	64.8	75.2	83.8	49.4	71.1	395.9	92
Hogs	43	52.7	66.5	67.6	26.7	44.8	40.4	47.3	54.7	36	28.1	47.4	44.9	82.9	41.5	42.1	35.3	43.1	291.9	32.9
Other animals	43	52.4	63.8	67.4	26.8	44.8	39.2	47.3	54.5	35.1	28.1	47.4	44.9	75.7	41.2	42.1	35.3	43.1	291.8	32.9
Milk	76.1	168.2	130.1	206.6	97.1	60.3	105.8	136.4	98.7	51.1	92.4	138.3	71.6	130.9	117.8	136.1	45.3	113	394.7	108.7
Forestry	23.6	35.5	26	11.4	35.5	8.6	21.3	29.9	19.9	52.2	15	23.7	24.9	40.4	20.5	23.1	37.6	38.9	18.7	36.4
Energy, mining	0.9	-0.3	4.2	-1.1	1.2	-4.8	-0.5	0.2	-0.4	0.5	-0.2	0.4	-0.8	0.7	-2.2	-0.6	0.2	0.7	3.2	2
Beef	33.3	20.3	66.5	45.7	37.4	16	49.4	44.9	42.6	25.1	28.8	48.8	25.8	40	37.5	47.2	16.6	39.2	93.5	50.2
Pork	23.7	26.6	40	29.3	18.6	30	26.9	28.8	29.6	33.3	22.9	30.5	22.9	26.7	22.1	33.4	8.2	35.4	164.9	23.8
Other meat	23.7	26.6	40	29.3	18.6	30	26.9	28.7	29.6	33.3	22.9	30.5	21.7	26.8	22.1	33.4	8.2	35.9	164.9	23.8
Vegetable oil	78.7	37.2	152.5	124.7	131.4	189	113.1	70.2	138.6	83.2	39.5	104.2	64.8	33.2	89.3	76.4	59.3	87.8	114.1	119.6
Milk products	25.4	34.9	56.6	82.7	42.1	34.8	39.1	37.3	40.7	25.5	22.3	49.7	46.3	61.1	57.8	53.2	10.4	47.8	93.8	45.5
Processed rice	35.1	90.3	42.7	94.6	32.1	184.9	232.6	70	49.6	50.6	219.8	143.6	127.9	66.4	161.4	110.2	146.2	139.7	60.2	39.1
Sugar	71.4	71.1	69.2	136.7	24.2	326.8	31.8	128	166.9	69.5	76.5	73.5	92.3	23.4	95.5	55.2	103.1	42.5	124.7	38.7
Processed food	28.9	33.1	36.9	91.9	24.4	66.1	69	23.9	42.3	90.4	29.1	32.4	54.4	20.3	37.4	40	41	41	51.9	22.4
Labor intensive manufactures	3.4	12.3	12.7	3.7	7.9	14.7	4	2.4	9.7	13.7	1.9	5.8	8.4	6.6	14.3	3.8	8.2	6	8	4.6
Other chemicals	2.2	4.4	5.6	10.1	3.4	8.2	0.9	2.7	1	3.3	0.8	2.6	-0.1	6.3	1.9	3.1	0.3	2.3	4.8	3.6
Fertilizers	2.2	4.4	5.6	10.1	3.4	8.2	0.9	2.7	1	3.3	0.8	2.6	-0.1	6.3	1.9	3.1	0.3	2.3	4.9	3.6
Pesticides	2.2	4.4	5.6	10.1	3.4	8.2	0.9	2.7	1	3.3	0.8	2.6	-0.1	6.3	1.9	3.1	0.3	2.3	4.9	3.6
Capital intensive manufacturing	1.5	3.6	6.1	1.1	2.3	-2.6	0.2	1.2	1.9	2.7	0.4	0.9	-0.4	3.1	-0.3	0.8	0.8	1.4	3.9	2.8
Services	1.8	3	7.8	-0.4	3.1	-4.1	1.3	0.9	0.2	2.6	0.6	1.3	0.4	3.9	-0.5	0.8	1.7	2.3	8.9	3.5

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-7

Import volume changes from EU-only scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	31.5	3.3	-1.3	161.1	9.3	-73.9	-29.3	6.7	37	-5.8	-43.9	11.9	1.9	174.8	9.1	3.5	85.3	-7.9	564.9	36.5
Wheat	18.4	-1.7	-13.7	1.7	10.4	-95.2	-9.1	-21.3	-0.7	-16.3	-1	-1.3	-18.3	4.2	-6.3	0.8	34.2	-9.7	-19	-5.5
Coarse grains	3.8	-1.5	-1.7	-0.5	2.4	-9	-0.7	-16.6	-7.6	-5	-0.6	-1.7	-4.9	-1.1	-1.7	0.3	-14.7	-5.3	-7.8	-4.1
Fruits and vegetables	-0.5	0.2	1	4.3	1	-5.7	-0.8	2.6	0.3	-3.9	-2.2	3.3	-1.4	2.7	1.2	0.4	5.6	1.4	19.1	-1.8
Nuts	-1.7	0.9	1.5	3	1	-4.5	-0.6	0.3	-0.1	-1.3	-0.3	2	-0.4	1.9	0.1	0.5	1.8	0.7	11.1	0.4
Oil seeds	6.6	-0.5	-3.8	-0.9	2.2	-3	-3.7	-0.2	-10.8	-0.5	0	-1.2	-3.5	15	-3.1	5.9	6	-5	-31.6	-0.7
Sugar crops	1	9.2	7.1	8.1	5.3	-54.4	5.9	-15.8	-75.4	-16.6	-45.9	-1.7	-46.4	-16.1	-6.1	-38.5	-65.2	-52.6	-73	4.8
Other crops	31.4	0.8	-6.4	-3.4	-1.2	-15.5	-1.3	-9.4	-16.5	-8.4	-6.3	2	-7.3	0.2	-2.9	-1.8	0.3	0	0.2	-2.7
Cattle	8.3	2.3	-3.5	-3.6	-11.6	-4.1	-4	-44.7	-19.4	-16.3	-9.6	-10.2	-10	-4.8	2.6	3.6	-9.8	-29.3	-59	-7.3
Hogs	-6.1	2.1	3.2	2.8	5.2	-0.1	-3.5	-6.7	-15.6	1.8	-2.6	1.3	2	4.8	0.6	0.6	-10.4	-0.4	-7.3	0.3
Other animals	-3.5	-3.3	-0.2	-0.6	-3.5	-5.1	-0.3	-6.9	-9.5	-1.9	-1.3	-0.4	-4.3	4.7	-2.2	-1.7	-6.4	-3.3	0	-2.6
Milk	18.8	-74.6	-60.4	-24.1	-39.1	-11.2	-11.2	-49.9	-39.6	-46.3	-33.5	-72	-33.2	-25.7	-64.8	-70.8	-19.8	-42.2	-79.6	-48.4
Forestry	-4.7	4.9	8.9	3.3	-0.2	-3.2	-0.5	10.5	2.1	1.6	-2	5.4	2.6	5.1	-0.6	2.5	7.2	4.1	4.7	2.8
Energy, mining	0.3	-0.5	1.3	-0.2	-0.3	-0.5	0.1	0.2	-0.2	0.1	0	-0.2	-0.1	0	-0.2	-0.4	-0.2	-0.2	1.5	0.1
Beef	-1.9	-5.7	-22.9	-3	-1.7	-5.9	-0.5	-10.5	-13.9	-11.2	-3.1	-0.8	-0.4	-2.1	0.1	-1.5	-6.2	-7.6	6.2	-1.8
Pork	-4.1	-10.7	4.1	-12.5	-2.1	-16.1	-11.6	-18.2	-7.7	-5.8	-4.8	0.9	-2	-7.4	-14.2	-3.8	-4.4	0.5	8.7	-6.9
Other meat	-3.6	-5.5	-1.9	-14.4	-0.8	-8.9	-1.5	-9.4	-1.3	-7.6	-0.8	0.8	-1.8	-3.6	-6	-1	-4	0.8	11.9	-5.5
Vegetable oil	-2	-1.9	8.5	-1	0.6	-4.2	-1.2	-3.1	-0.2	-4	-4.6	-1.1	-2.6	-2.4	-0.8	-1.3	-6.3	1	2.6	-1.7
Milk products	-6.1	-14.3	-9	-6.6	-12.5	-13.4	-7.3	-21.8	-8.5	-19.9	-11.6	-6.3	-9.6	-8.4	-8.3	-3.8	-10.6	-19.9	-3.3	-20.4
Processed rice	-1.6	1.5	-2.8	2.9	-0.8	-5.9	4.8	0.7	-0.4	-3.7	12.3	10.9	4.2	0.9	6	4.3	6.3	3	1.2	-2.3
Sugar	-3.1	-0.9	-3.2	13.6	-4	2.2	-1.7	-9.7	-0.2	-6.6	-1.1	3.2	-2	-4.3	-0.4	-2.6	-2.5	-4.6	11.7	-1.9
Processed food	-2.5	-1.1	-1.2	3.8	-0.9	-2.3	0	-3.7	-1.3	2.3	-2.3	-0.6	-0.5	-1.8	-0.7	-0.6	-1.5	-1.6	2	-2.8
Labor intensive manufactures	-0.3	2	3.1	1.4	0.4	0.5	-0.4	0.5	0	1.8	-1.1	0.2	0.2	0.8	-0.4	-0.2	1.2	0	-0.1	-0.6
Other chemicals	0.4	0	0.8	1.8	-0.4	0.9	0.1	-0.2	-0.5	-0.4	-0.2	-0.2	-0.2	0.7	-0.4	-0.1	-0.1	-0.5	-2.5	0.3
Fertilizers	-8.6	0.7	1.4	0.5	0.7	1.1	-0.1	-0.8	0.2	0.1	-0.2	-0.2	0	0	-0.3	0.3	-0.3	-0.1	0.2	0.3
Pesticides	-33.8	0.2	0.8	0.3	0.5	0.7	0.1	-0.4	0.1	-0.1	0	-0.1	0	-0.2	-0.1	0.2	-0.1	-0.1	0.1	0.2
Capital intensive manufacturing	0.2	1	1.9	1.5	0	-0.1	0	0.1	0.3	0.9	0.2	0.1	0	1	-0.1	0.2	0.5	0.2	1.4	0.8
Services	-0.5	1.7	3.2	1.4	1	-0.2	0.1	0.2	0.5	1	0.1	0.7	0	1.4	0.3	0.6	0.6	0.3	5	0.9

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-8

Import volume changes from middle scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	158.5	24	-49.2	-4.6	-43.1	-31.1	-60	16.6	18.9	-65.3	-62.8	0.5	105.7	-45.7	-7.6	-3.3	-67.4	8.4	5,446.9	-54.6
Wheat	18.5	45.1	-45.4	-1.7	-23.1	3.7	-0.6	-4.4	11.2	-12	0.8	-1.6	-53.1	0.1	0.3	-0.2	-40.9	-54.8	29.1	-0.3
Coarse grains	-4.6	-9.7	-17.9	-4.3	0.3	-8.9	6.5	-12.1	-22.4	-16.3	0.6	-0.2	-39.8	-13.2	0.5	0.2	-46.3	-33.8	-11.3	-8.1
Fruits and vegetables	-0.4	3.9	-8.3	-9.3	-0.2	-0.5	-2.1	45.5	-24.3	-11	-1.7	-3.4	7.7	-5.5	-3.8	-6.5	-18.7	33.8	168.7	-0.5
Nuts	3.6	4	-4.9	-12.2	-3.1	-16.4	-1.6	1.1	-19.2	-30.1	-1.2	-2.3	-15.6	-1.7	-26.4	-4.8	-4.6	23.8	64.7	-7.2
Oil seeds	10	12.3	-12	-7.3	3.3	0.7	2.9	26	-27	-57.8	0.9	-1.2	-16.3	-11.4	-10.8	-3.4	-10.5	-14.2	-40.8	-3.5
Sugar crops	-2.7	-6.8	-21.1	-23.6	-2.7	-51.8	-1.6	-29.9	-72.4	-30.6	-18.9	-17	-81.7	-27.5	-17.6	-60.8	-80.5	-79.4	70.1	-10.4
Other crops	8.2	-7.1	-16.5	-45.2	-2.3	-6.9	-1.1	-28.7	-35.2	-29.5	-3	-6.1	-14	-3.2	-12.8	-3.3	1.9	2.6	-14.7	-5.4
Cattle	10.5	28.5	-13.2	-11	-12	-1.9	-6.9	-8.7	-28	-37.2	-10.1	-9.4	-1.5	-14	0.3	-1.6	-12	15.9	875.5	-6.6
Hogs	-7.9	-13.5	-0.9	-4	4.3	-0.1	-6	-17.2	-31.4	-0.4	-3.1	0.4	-20	8.1	-0.8	0.2	-18.9	-50	375.9	0.3
Other animals	-9.7	-3.5	-5.2	-7.9	-4.4	-6.2	-0.3	-15.5	-21	-7.6	-1.3	-1.4	-9.2	-2	-3.3	-1.2	-11	-8.9	241.4	-3.3
Milk	-25.5	275.8	-45.2	-20.3	-34.1	-11.1	-13.5	83.7	-26.2	-39.9	-28.1	-36.8	-23.9	-24	-36.8	-40.2	-23.7	42.7	2,167.5	-37.8
Forestry	-5.8	18.4	-6	-3.1	1.3	-5.3	-1.8	8.2	-14.8	-2.7	-1.5	-6.7	4.6	-1.3	-5.5	-11.9	-14.8	22	9.8	-2.3
Energy, mining	0	-1.6	-0.5	0	-0.5	1.3	0	-0.6	-0.4	0.7	0.3	-0.4	-0.7	-0.1	0.2	-0.5	-1.3	0.1	9.2	0.6
Beef	-12.9	-25.5	-35.7	-5.9	1.9	1.4	2.5	7.9	-19	-20.6	1.1	-0.9	-32.1	-3.1	-0.7	1	-0.9	-2.9	220.9	1.2
Pork	-9.9	-5.8	-6.1	-27.5	-2.8	-20.7	-18.9	-1.8	-20.2	-16.1	-6.3	-1.3	-13.8	-17.6	-24.1	-6.3	-2.3	-9.1	310.4	-10.3
Other meat	-10.3	-14.2	-16.1	-25.8	-0.5	-9.7	-0.4	-6	-11.3	-19.8	1.8	-1.3	-32	-8.7	-9.6	0.9	-2.3	-21.6	828.8	-6.6
Vegetable oil	-14.6	-19.2	-13.7	-21.9	-2	-2.7	0.6	-10.6	-8.1	-9.1	-1.9	-0.5	-31.2	-1.9	-0.8	-0.9	-19.8	-35.8	-8	-5.2
Milk products	-8.4	6.6	-20.9	-5.3	-18.6	-8.6	-6.4	12.7	-21	-34.9	-9.1	-5.1	22.9	-12.2	-6.5	-0.9	-15	41.1	430.1	-27.9
Processed rice	-4.4	-34.2	-5.4	-0.9	1.5	2.9	2	7.5	-0.4	-12.3	1.5	0.6	-9.8	0.9	-1	-1	3.4	30.5	-22.5	0.2
Sugar	-14.6	-20.4	-18.4	-15.1	2.2	2	-0.2	-9.2	0.3	-0.1	-3.4	-1.9	-16.4	-9.3	-1.1	-0.1	1.4	-48.1	71.6	-1.5
Processed food	-12.7	-9.1	-7.2	-12.1	-4.6	-9.1	-4.1	-20.5	-13.2	-10.7	-6	-4.8	2.3	-8.4	-4.2	-5.1	-16.4	0.7	9.7	-8.6
Labor intensive manufactures	-0.8	14.4	-2.2	-2.3	0	0.1	0.1	-1	-0.6	-1.6	-0.2	-0.2	7.3	-0.6	0.5	-0.5	-0.9	2.7	2.2	-0.5
Other chemicals	-0.6	-1.5	-0.7	-1	-0.2	0.6	0	-1.7	-0.3	0.2	-0.3	-0.2	-3.1	0	0.1	0	-1.3	-2.5	-14.2	0
Fertilizers	-9.7	-17	-6.2	-0.9	-2.4	1.2	0.2	-9.7	1	-0.4	0.5	-0.5	-19.3	0.7	-0.7	-2.6	-2.9	-19.4	-18.3	0.6
Pesticides	-34.5	-48.6	-6.4	-1.8	-3.5	0.8	0.2	-31.8	1.1	-0.6	0.4	-0.5	-48.2	0.3	-0.7	-3	-1.6	-43.9	-49.5	-0.1
Capital intensive manufacturing	0	0.8	-0.5	-0.6	0.2	0.5	0.2	0.1	0.2	0.2	0.5	0.3	-2.1	0.2	0.2	0.3	-0.4	-1	4.2	0.8
Services	-0.5	3	-1.5	-0.9	0.4	0.6	0.4	-1.1	-0.1	0.2	0.7	0.3	-2	0.1	0.1	0.1	-0.5	-0.3	32.1	0.7

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-9

Import volume changes from global scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	67.4	6.8	-22.8	2,010.5	4	689.2	838.3	32.2	60.9	43.3	578.9	190.9	53.7	2,245.3	77.1	39.5	700	-22	3,569.5	490.2
Wheat	22.1	27.2	41.1	22.4	144.2	854.7	-24.1	10.9	19.4	94.7	-7.7	-18.3	-42.2	26.1	-49.9	27.3	82	-54.8	31.3	-2.8
Coarse grains	-1.3	-15	-26.6	-13.9	1	-12.4	-28.3	-3.8	23.3	-34.3	-9.8	-28	-28.2	20.6	-19.3	-6.5	-17.6	-22.7	-11.7	17.3
Fruits and vegetables	-1.9	1.8	7.6	44.2	5.2	46.2	80.9	39.9	26.2	-41.9	69.4	42.5	0.9	21.9	-4.2	-1.1	49.1	15.3	136	-24.4
Nuts	-2.5	3.6	12.7	18	5	36.5	21.5	-2.3	5.2	-11.3	15.7	26.1	-5.8	5.2	9.5	5	9.5	2.6	55.6	-4
Oil seeds	17.7	9.9	-60.8	-32.5	-9.6	-14.3	-27.7	12.9	-19.3	50	2.7	-25.1	-32.5	62.2	-12.2	46.7	22.7	-31.9	-9.3	-9.4
Sugar crops	8.3	2.7	8.3	-1.1	11.8	21.2	1.1	-21.7	20.6	-50.6	460.2	-26.7	-76.2	-31	-41.2	-81.8	-30.4	-72.1	92.5	-11.1
Other crops	17.2	12.9	-34.7	22.6	-11.5	75.5	-6.6	-14.2	-34.2	-49.6	31.8	8.7	7.7	6.5	-10.8	20.6	-9	18.9	-12.3	-13.2
Cattle	13.8	28.7	-10.7	-4.5	-13.5	-11.7	3.8	-14.9	35.9	15.9	-9	5.5	-4.7	72	37	28.3	5.3	18.6	644.3	-12.9
Hogs	-5.1	0.7	6.6	11	2.4	3.3	-3.7	-14.3	7.4	-9.9	-14.4	2.9	-7.1	-18.2	-4.8	3.7	-4.6	-2.6	309.1	-1
Other animals	-6.4	1.3	11.2	16.6	-12.2	-9.7	-1.2	-10.9	3.4	-17.1	-12.2	4.6	-8.9	42	-9.9	-6.9	-4.8	-2.6	201.9	-15
Milk	-8.2	342.4	138.4	92	13.1	-20.2	37.7	106.9	32.8	-53.1	15.7	162.5	-14.3	80.2	103.8	146.5	-21.2	92	1,695.3	69
Forestry	-3	10.8	3.7	-13.5	1.2	-29.2	2.2	0.8	-13.1	36.5	-14.4	-6.3	-5	20.3	-12.4	-6.3	14.2	21.4	4.7	5.2
Energy, mining	-0.9	-2.3	7.2	-5.1	-3.3	-8	0.9	-1.3	-1.2	-0.2	0.5	-1.1	-1.3	-0.5	-0.4	-1.5	1	-0.7	6.7	2.2
Beef	-10.3	-24.4	109.1	8.4	-22.6	-48.4	1.1	6.9	17	-27.1	-24.8	-3.9	-23	-9.3	8.3	-10.8	-55.7	12.5	200	9.5
Pork	-8.4	-1.1	40.3	4	-18.6	9.1	2.9	3.6	12.4	15	-6.6	12.7	-11.6	0.6	-11.6	15.1	-41.4	-2.1	271.8	1
Other meat	-9.3	-2.4	48.1	0.6	-17.6	2.7	-1.8	-1.4	3.6	25.3	-12.9	11.6	-21.1	-3.3	-13.3	1.3	-46.5	31.8	699.4	-8.7
Vegetable oil	-11.9	-26.8	93.1	43.4	1.4	206.2	-9.6	-9.6	2.5	-21.4	-55.7	-14.7	-28	-29.8	-13.1	-24.3	-39.6	2.4	3.3	6.6
Milk products	-6	0.2	42.8	79.4	1.5	-23.3	-16.3	9.7	37.7	-20.1	-44.1	4.7	5.6	31.5	19.2	-11.2	-49.9	22.4	342.2	17.9
Processed rice	-9.8	-5	-62.3	23.7	-31.8	31.3	136.8	0.8	-21	-50.4	435.6	123.8	29	-7.8	91.3	41.9	35.8	22.1	-13.7	-42.3
Sugar	-9.8	-20.3	16.8	175.6	-49.6	547.6	-13.6	-2.3	-0.7	-49.7	35.5	30.1	-17.1	-37	6.9	-35.3	-29.4	-45	45.4	-17
Processed food	-9.9	-7.3	-14.8	48.6	-9.9	25	5.6	-15.5	-4.5	54.9	-19.6	-3.9	1.4	-16.5	-10	-3.8	-3.9	2.4	9.2	-19.9
Labor intensive manufactures	-2.1	0	18.4	-15.3	-1.2	18.6	-6	-2.8	-2.6	8.6	-16.6	-1.2	-4.7	-6.3	-4.4	-10.7	-3.8	-2.6	3.8	-12.1
Other chemicals	-0.2	-2.7	0.5	9.8	-2.2	15.6	1.6	-1.7	-3	-4.1	-3.2	-1.9	-3.2	1.7	-3	-2.2	-3.7	-0.5	-10	0.6
Fertilizers	-8.8	-17.8	-14.1	-6.2	-12.2	-2.6	-5.5	-6.2	-18.2	-17.8	-15	-19	-20.1	-12.5	-20	-22.6	-22.8	-18.7	-18.4	-10.9
Pesticides	-34	-49.1	-47.6	-24.2	-43.2	-38.7	-22.2	-29.9	-48.6	-41.7	-39.8	-47.2	-48.4	-36.1	-45	-49	-50.9	-43.9	-49.7	-25.1
Capital intensive manufacturing	0.5	3.1	11.6	-0.9	0.8	-7.3	0.9	-1.1	0	6.1	3.8	1.3	-1.9	5.8	0.6	-1.7	1.6	1.2	4.9	8.2
Services	0.7	2.8	14.6	-2	3.7	-10.8	0.3	-0.7	-1.8	2	-0.9	0.1	-3.2	6	-3.9	-0.9	0.7	0.9	22.9	5.3

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-10

Export volume changes from EU-only scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	-82.2	63.6	159	-6.4	484.7	8.3	21.8	-10.1	-9.5	21	74.9	-1.1	18.6	-13.2	12.2	10.4	-3.6	41.7	-10	6
Wheat	-82.4	7.6	21	7.9	21	13.3	83.2	-6.8	58.2	50.4	58	84	245.7	11.4	554.4	-2.2	21.4	1,042.3	11.5	20.8
Coarse grains	-34.2	23.3	7.5	4.6	2.5	18.2	28.5	1.5	15.5	11	19.4	22.2	34.3	-3.6	11.9	16	13.3	61.7	8.3	0.7
Fruits and vegetables	-5.3	9.5	0.5	-2.5	-7.3	7.8	1.1	-10.2	2.5	17.7	3.7	-2.9	6.8	-5.9	-0.3	1.1	-8	0.2	-11.6	1.5
Nuts	-9.5	0.6	-1.9	-6.2	-9.5	6.8	0.7	-9.6	-3.3	8.6	1.6	-5	-0.9	-4.8	1.3	-0.1	-9.2	-4	-12.5	0.4
Oil seeds	-84.6	57.5	7.7	0.6	-6.6	35.4	25	9.4	18.7	47.5	74.4	21.8	119.1	71.7	16	3.2	24.7	98.5	6.3	4.4
Sugar crops	-54.4	143	111.6	35.4	78.6	91.2	246.4	118.5	102.8	127.6	10.8	146.1	349.1	159.6	305.3	1,060.7	200.7	658.6	9.7	9.8
Other crops	-84.7	37	22.3	30.3	17.8	27.1	31.1	6.9	40.1	64.1	28.7	33.8	38.8	-4.8	47.2	23.5	9.2	22	51.4	13.7
Cattle	-28.7	21.2	19.5	9.8	8.3	25.3	3.4	43.1	24.8	6.9	85.4	5.3	23.1	7.8	16	11.6	15	48.3	2.7	32.1
Hogs	-9.3	2.4	1.6	3	2.2	10.8	-0.6	33.8	22.5	16.6	5	7	-6.3	-6.1	2.3	28.2	43.1	9	-2.7	3.7
Other animals	-34.6	13.7	8.6	8.4	27.3	22.8	6.5	27	20.7	22.9	17	17.4	14.2	1.2	16.6	23	26.6	19.5	-3.8	21.5
Milk	-157	24.4	26	12.8	56.1	139.9	22.6	10.6	39.5	120.8	67.2	23.5	77.6	16.1	26.4	24.2	203.2	50.3	-2.2	37.9
Forestry	13	-7	-22.6	-16.2	-4	2.9	1.6	-16	-12.6	-6.5	2.8	-9.7	-9.1	-8	0.2	-1.5	-13.4	-14.4	-26.6	-6.2
Energy, mining	2.6	-1.2	-5.8	-3	-1	1.5	0.1	0.9	-0.5	-2.1	-0.1	-0.7	0.3	-1.7	0.8	-0.3	-0.4	-0.7	-7.2	-1.4
Beef	-28	36.3	6	5.5	4.9	84.9	-1.5	6.6	-1.1	6.1	16.6	0.5	45.4	1.9	9.4	8.1	67.2	42.2	-2.4	1.3
Pork	-14.2	13.6	2.9	8.3	12.7	14.8	17.5	23	-0.7	5.6	25.1	7	12.7	13	17	7.2	53.6	8.2	-4.7	10.6
Other meat	-20.7	11.1	-2.9	9.9	7	10.2	3.7	15.5	-2.9	-0.2	11.9	6.7	6.5	8.2	23.7	6.8	37	-0.2	-5	6.1
Vegetable oil	-22.8	29.6	-3.9	-0.7	-7.7	2.6	-0.6	2.8	-4.1	13.5	82	2.6	11.5	91.3	6.4	19.9	21.4	-4.2	-15.3	-0.8
Milk products	-20.5	21	4	3.9	17.5	28.4	9.2	19.6	5.2	39.9	45.5	10.5	9.8	1.8	8.7	7.9	59.7	20	-4.1	12
Processed rice	-4.8	-7.3	13.8	-3.8	23.3	2.3	-1.2	-34.7	0.5	13.5	0.3	-7.1	-10.8	-0.8	-3.7	-3.6	-9.5	-10.4	-5.6	23.4
Sugar	-27.2	16	7.5	-5	35.9	0.8	72.6	-9.7	-3.6	18.9	12.7	4.5	0.5	37.5	1.2	19.4	7.3	54.5	-19.1	19.6
Processed food	-5.8	1.4	1.3	-4.7	1.7	2.4	-3.5	1.4	0.7	-2.5	4.3	1.1	-2.5	4	1.5	0.2	-0.5	1.6	-4.4	4.9
Labor intensive manufactures	5.2	-6.9	-7.6	-5.6	-1.9	-1.6	2.5	1.5	-5.1	-4.9	4	-0.9	-3.4	-2.4	-4.4	-0.2	-6.5	-2.5	-10.3	0.6
Other chemicals	1.6	-3.9	-4.2	-5.9	-1.2	-1.8	0.8	-0.6	-0.8	-1.8	0.8	-0.8	0.7	-3.6	-0.5	-1.2	0	-0.8	-4.7	-1
Fertilizers	-3.2	-2.4	-3.6	-4.6	-1	-1.3	0.7	-1	-0.5	-1.3	0.8	-1.8	0.2	-3.2	-0.2	-2	0.3	-2.4	-4.4	-0.6
Pesticides	-15.1	-2.7	-3	-4.4	-1.4	-1.5	0.5	-15	-2.8	-2.7	-3.4	-1	-9.4	-3.3	-0.3	-1.7	-0.5	-1.9	-9.1	-2.9
Capital intensive manufacturing	2.4	-5.8	-6.5	-4.5	-1.8	0.4	0	-0.1	-3.6	-3	-0.3	-1.1	-0.5	-3.7	-0.7	-1.9	-1.5	-1.6	-7.2	-2
Services	1.4	-3.3	-4.9	-2.8	-1.5	0.2	-0.3	-0.1	-1	-1.8	-0.3	-1.2	-0.6	-2.4	-0.5	-1.2	-1	-1	-5.2	-1.4

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-11

Export volume changes from middle scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	118.3	173.4	9.8	5.3	-20	-10.3	-9.1	-23	-34.1	-6.5	-7.3	27.2	-86.1	20.7	13	9.8	-48.1	-27.3	-100	-9
Wheat	-29.9	-95.8	11.7	10.8	-15.9	-42.8	-20	-11	-30.1	-16.7	-24.2	-41.3	867.5	-8.9	-24.3	-5.3	-32.6	5,851.9	8.9	-8.1
Coarse grains	-18.5	20	-20.1	-12.8	0.8	7.1	-5.6	-21.1	-9.2	-9.5	-7.8	-2.6	61.6	7.8	4.1	-4.4	-31.6	113.1	-29.3	3.9
Fruits and vegetables	20.7	4.4	2.3	-34	-4.4	3	-1	-91.4	41.3	-15.9	-0.7	-3.4	-37.2	-6.7	-0.5	-8.4	-3.3	-75.6	-99.3	-5.4
Nuts	88	-54.2	-18.5	8.5	20.9	4.4	31.9	-70.3	-21.9	-18.7	36.6	9.7	-34.6	22.9	7.6	-7.3	28.6	-61.3	-98	-9
Oil seeds	-49.1	282.2	8.3	-0.2	-4.5	-20	12.9	-36.4	-32.9	-14.4	-17.9	-8.6	723.2	-22.8	4.1	-7.9	-30.2	401.8	-43.8	-5.8
Sugar crops	-40.6	174.2	23.5	23.5	10.8	1.6	11.8	74.1	-2.7	21.8	7.3	16.6	988.6	24.9	4.7	4.9	200.9	1,789.9	-96.6	7.4
Other crops	-30.5	19.9	23.7	-3.4	10.4	3.6	4.1	211.2	-7.8	9.7	12.2	1.2	-15.7	16	-3.4	9.3	13.3	-77.7	385.5	2.7
Cattle	1.9	22.1	1.5	-10.3	4.7	0.3	-4.5	-54.8	-13.1	-35.5	-22.6	5	-10.1	-2.7	-7.3	-2.1	17	-48.9	-98.4	-10.7
Hogs	-7.1	37.3	-0.2	-1.1	2.4	-7.3	-10.6	-40.2	110.9	-8	1.1	-7.4	-42.3	5.7	2.9	-20.7	159.9	60.1	-99.8	5.4
Other animals	-14.9	-52.4	2.7	-0.1	13.6	-6.1	5.7	-8.5	0.3	-13.4	11.6	-8.4	-29.6	15.3	4.1	6.2	-5.3	-7.1	-99.7	18.8
Milk	-1	-97.3	49.7	50.2	40.8	18.8	24.3	-92.3	7.7	45.8	37.2	27.3	-36.5	39.2	22.6	33.5	10.8	-86.2	-100	27.4
Forestry	-6.2	-46.4	29.2	21.8	4.3	13.8	9	-32.5	20.4	28.6	6.3	14	-29	2.5	8.9	7.4	3.7	-42.7	-21.2	7.5
Energy, mining	0.9	1.5	1.6	0.4	-2.1	-5.2	-1.5	2.8	-1.2	-2.8	-3.3	-2.6	5.1	-2.3	-2.9	-1.9	-0.7	3.5	-30.6	-3.5
Beef	-7.4	90.7	-15.1	-10	-3.7	-27.2	-10.5	-67	-15.5	-12.6	-5	-3.9	0.1	-4.9	-29.1	-8.6	-21	-56	-99.2	-4.4
Pork	-21.5	-9.5	15.8	16.1	20.1	27.9	1.2	-12	2.4	10.5	4.6	26	-3	32.6	27.2	26.5	43	-52.2	-100	17
Other meat	-6.4	-11.9	3.9	-19.6	6.2	-1.1	5.6	-36.7	-5.2	-7.6	6.2	-6.9	35.8	-5.4	-19.9	-0.5	11	-50.3	-99.9	0
Vegetable oil	-14.5	290.6	-11	-23.2	10.1	-4.9	-11	22.4	-19.7	-18	-6.8	-7.2	49.6	-26.1	-12	-16.5	-15.9	-5.1	-77.6	-10.5
Milk products	-1.2	-24.5	4.3	-9.9	10.1	-4.7	0.1	-60.2	11.2	-9.8	8.8	8	-53.6	2.2	-2.2	6	32.6	-63.5	-98.8	3.5
Processed rice	229	237.2	-25.4	-24.9	-11	-16.7	-19.4	330.9	-10.8	-42.7	-25.9	-18.4	19.2	-26.6	-28	-18.6	-1.2	86.3	78.6	-17.9
Sugar	-6.2	24.6	1.2	-21.8	-6.1	-7.4	-3.9	-76.2	-16.4	-41.9	-7	-10.2	-3.2	-1	-6.4	-13.8	-43.9	308.4	-93.7	-2.4
Processed food	-12.1	-13.1	-4.2	-14.6	6	-3	-2.5	-1.2	-7.7	-7.6	4.5	0	-45.3	1.4	-2.2	0.2	5.8	-18.1	-65	-2.3
Labor intensive manufactures	0.8	-43	8.6	8.1	0.3	3	2.9	1.4	2	6.1	2.3	2.1	-39.1	2.9	2.9	3.9	2.8	-19.1	-30.8	1.8
Other chemicals	-1.6	-15.7	4.2	3.9	0.4	-1.2	0.7	-6.5	1.2	1.1	0	0.3	5.3	0.4	0.6	1.2	2.1	-2.3	-25.6	-0.7
Fertilizers	-9.1	-27.1	1.3	0.3	-0.8	-3.8	-2.2	-8.7	-2.3	-3.9	-0.7	-2.1	1.9	-1	-0.8	-1.9	-3.5	-15.4	-34.6	-2.6
Pesticides	-27.8	-49.7	1.8	-1.7	-2.3	-19.2	-0.3	-27.6	-31	-16.2	-9.2	-2.7	-22.9	-3.5	-1.7	-2.3	-29.5	-28.6	-29.5	-7.9
Capital intensive manufacturing	1.8	-16.9	4.8	3.7	-0.4	-1.5	-0.3	1.8	-0.7	0.1	-1.2	0	9.7	0.4	0.2	1	1.8	3.1	-27.6	-1.6
Services	0.7	-5.1	2.5	1.9	-0.8	-1.2	-0.9	1.8	-0.2	-0.3	-1.2	-0.6	0.9	-0.3	-0.3	-0.1	0.6	0.5	-26.8	-1.3

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-12

Export volume changes from global scenario (percent change)

	EU	Africa	Argentina	Brazil	Canada	China	Developed Asia	EFTA	Former USSR and rest of Europe	India	Japan	Mexico and Central America	Middle East and North Africa	Oceania	Other Asia	Other South America	Russia	Turkey	Ukraine	United States
Rice	252.1	756.7	2,109.3	-85.2	9,319.2	-84.6	-43.7	948.1	249.5	538.1	69.2	-97.2	65.8	-89.2	-62.3	98.3	-93.5	179.1	-100	66.3
Wheat	-47.5	-99.2	172.1	-57.3	-26.5	-99.6	89.9	-15.8	146	-51.5	-46.6	177.9	620.8	-17.7	2,575.7	-99.1	13.8	3,427.7	-16.1	1.4
Coarse grains	-13.5	83.2	15.7	-3.9	-33.9	-38.8	105.9	-12.3	-69.6	37.3	19.9	57.4	92.2	-38.2	86.4	23.6	14.5	193.1	-24.6	-40.3
Fruits and vegetables	55.1	69.6	-35.9	-83.9	-39.8	-47	-59.2	-62.7	-13.3	223.7	-56.9	-60.9	10.3	-0.6	15.6	-1.5	-85.9	-43.3	-96.3	31.6
Nuts	81.5	34	-49.2	-78.3	-48.6	-64.3	-69.8	-69.2	-33.9	84.9	-69.4	-69.7	22.1	-28.5	-22.2	-18.5	-76.1	-51.1	-96.7	-7.2
Oil seeds	-58.1	575.1	8.9	-49.9	-37.7	-26.7	59.3	-25.7	-62.5	169.5	171.5	73.6	526.4	363.8	41.4	-78.2	14.2	551.7	-48.9	-21
Sugar crops	-37.3	92.4	62.3	-39.1	74.6	-42	1,438.9	51.2	-63.7	291.1	-98.6	241	864.1	382.9	507.2	2,980.5	104.2	1,096.4	-96.1	36.9
Other crops	-42.7	-24.4	75.7	-30.6	159	-68.4	133.1	111.9	117.9	236.5	-58.3	35.9	-34.3	-71.6	66.1	-33.7	-19.9	-80.7	335.9	96.6
Cattle	6.9	14.6	-24.8	35.7	-6.5	97.9	-27.9	-31	-20.4	-42	52.5	-27.2	3	30	-1.7	-2.1	19.5	10	-94.7	-24
Hogs	-3.2	-11.3	-59	-16.3	5.1	-4.7	-4.3	-4.4	-41	11.5	50	-7.6	-23.6	-68.8	10.7	2.9	21.6	3.2	-99.5	16.1
Other animals	-0.6	-27.5	-54.4	-51.8	70.4	-11.6	0.3	-20.2	-35.4	24.7	54.9	-19.3	-6.7	-66.1	3	0	28.3	0.7	-99.5	36.5
Milk	22.7	-94.4	-82.9	-97.9	-46	156.4	-62.7	-86.4	-49.7	262.7	-38.3	-86.6	47	-83.4	-74.2	-85.7	393.4	-71.4	-99.9	-64.5
Forestry	1.4	-31.6	-7.5	55.5	-29.8	51.4	5.2	-11	21.2	-52.9	23.3	8.2	0.4	-39.7	16.5	2.6	-38.9	-25.1	9.7	-30
Energy, mining	-8.4	-2.3	-31	5.6	-8.5	43.8	-4.4	-1.3	2.1	-8.8	-6.6	-3.5	1.9	-13.6	11	1.9	-3.5	-9.1	-26	-15.4
Beef	-7.4	91.2	-80.7	-46.2	13.7	194.3	-61.3	-44	-47.1	33.5	37.4	-35.5	48.9	-15.6	-27.6	-46.6	197.5	-30.3	-94.3	-42.8
Pork	-5	-9.2	-62.6	-31.3	28.4	-32.3	-17.8	-15.3	-47.7	-47.4	14.6	-41	13.3	-19.3	15.8	-49.7	218.7	-49.6	-99.9	-1.1
Other meat	-1.3	-11.4	-55.9	-25.8	41.8	-31.7	-13.4	-30.6	-43.1	-45.9	17.6	-33.1	21	-16.5	10.9	-44	254.7	-52.2	-99.9	8.8
Vegetable oil	12.3	304	-82.8	-63.7	-59	-92.7	-50	66.6	-81.1	54.9	771.9	-10.9	138.9	919.8	14.5	86.4	127.9	-3.1	-52.4	-47.3
Milk products	24.1	-7.3	-41.3	-79.9	-11.6	16.9	-4.1	-30.9	-54.8	141.4	141.2	-33.1	-35.3	-62.4	-51.6	-30.6	273.7	-41.6	-93.7	-16
Processed rice	110.3	2.5	218	-15.2	487.8	-73.6	-88.2	91.5	140	162.7	-86.8	-68.7	-69.4	137.5	-66.5	-49.5	-82	-80.7	23.1	382.8
Sugar	1.8	9.6	21.2	-64	260.9	-98.6	1,233.2	-68	-81.3	60.5	32	4.8	-11.2	494.4	-32.4	44	-51.3	279.9	-50.9	209.1
Processed food	0.9	-3.2	-2.7	-71	9.6	-50.6	-51.4	19.7	-18.3	-70.5	21.4	-6.7	-34.2	36.8	-7.5	-17.4	-11	-13.8	-32.1	27.6
Labor intensive manufactures	25.8	-17.2	-24.2	36	6.9	-31.4	41.2	36.8	-13.4	-29.1	61.7	18.9	-4	19.8	-31.1	35.4	2.7	8.9	-1.5	26.2
Other chemicals	1.9	-9.6	-11.4	-32.8	-1.8	-27.7	14.2	-0.6	11.4	-3.8	15	4.1	19	-18.1	6.2	1.9	13.5	-0.3	-14.1	-3.5
Fertilizers	-11.6	-24.7	-29.7	-46.8	-16.2	-38	-6.6	-12.2	-4.5	-19.2	-0.8	-14.3	3.1	-32.5	-9.5	-16.3	-3.6	-18	-28.1	-18.1
Pesticides	-37.7	-46.6	-50.8	-63.6	-31.6	-57.4	-32	-39.5	-43.3	-42.3	-30.4	-39.9	-29.2	-47.1	-36.6	-42.2	-42	-45.7	-53.8	-43.1
Capital intensive manufacturing	-5.6	-20.3	-33.1	-2	-10.3	26.5	-0.5	-4.5	-8.5	-15.2	-1.5	0.4	7.6	-18.6	4	-3.3	-1.4	-4.8	-20.9	-15.5
Services	-1.5	-6.1	-20.8	6.3	-6.2	19.1	-0.4	1.3	3.5	-4.5	1.2	-0.3	3.1	-9.6	6.6	1.8	-1.4	-4.3	-19.6	-7.8

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-13

Welfare changes from EU-only scenario (billions of U.S. dollars, over a period of a year)

	Allocative efficiency	Endowments	Terms of trade	Other	Total
EU	-56.8	-14.5	-10.7	-2.3	-84.2
Africa	-0.7	0.0	4.8	0.0	4.1
Argentina	0.1	0.0	4.3	-0.1	4.3
Brazil	-1.5	0.0	9.3	0.0	7.8
Canada	-0.4	0.0	4.6	-0.2	4.1
China	-6.8	0.0	-22.3	4.7	-24.4
Developed Asia	-0.9	0.0	-5.4	1.5	-4.8
EFTA	-1.2	0.0	-2.0	0.8	-2.4
Former USSR and rest of Europe	-0.6	0.0	0.6	-0.1	0.0
India	-0.9	0.0	5.6	-0.4	4.3
Japan	-1.4	0.0	-6.0	0.0	-7.4
Mexico and Central America	-0.9	-0.1	1.7	-0.1	0.6
Middle East and North Africa	-2.0	0.0	-17.6	1.0	-18.5
Oceania	0.1	0.0	6.3	0.0	6.5
Other Asia	-1.9	0.1	1.1	-0.2	-0.9
Other South America	-0.2	0.0	1.0	0.1	0.9
Russia	-1.6	0.0	0.3	0.9	-0.4
Turkey	-0.8	0.0	0.7	-0.3	-0.5
Ukraine	0.2	0.0	4.3	0.0	4.4
United States	-2.0	0.0	17.9	-5.1	10.8

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-14

Welfare changes from middle scenario (billions of U.S. dollars, over a period of a year)

	Allocative efficiency	Endowments	Terms of trade	Other	Total
EU	-172.6	-14.2	-17.5	-1.6	-205.9
Africa	-68.7	-11.5	59.2	0.0	-20.9
Argentina	-0.3	0.0	-1.9	0.4	-1.8
Brazil	0.3	0.0	-5.4	2.4	-2.7
Canada	-0.3	0.0	-0.8	-0.7	-1.7
China	0.0	0.0	-5.0	10.5	5.5
Developed Asia	-0.3	0.0	-3.8	4.9	0.8
EFTA	-6.3	-2.8	-10.5	2.6	-17.0
Former USSR and rest of Europe	-0.9	0.0	-2.5	-0.9	-4.3
India	0.6	0.0	2.7	-2.8	0.5
Japan	-1.5	0.0	0.4	0.4	-0.7
Mexico and Central America	-0.9	0.0	-0.8	-0.5	-2.3
Middle East and North Africa	-70.7	-4.2	-75.0	1.5	-148.4
Oceania	-0.1	0.0	-2.0	0.3	-1.8
Other Asia	-0.9	0.0	-2.2	-1.0	-4.1
Other South America	-0.2	0.0	-2.2	1.2	-1.1
Russia	-1.9	0.0	-12.2	4.2	-9.8
Turkey	-18.0	-1.2	11.0	-0.2	-8.4
Ukraine	-10.3	-0.5	39.6	-0.4	28.4
United States	-0.1	0.0	20.7	-20.5	0.2

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-15

Welfare changes from global scenario (billions of U.S. dollars, over a period of a year)

	Allocative efficiency	Endowments	Terms of trade	Other	Total
EU	-119.1	-14.4	-54.9	-14.9	-203.4
Africa	-59.9	-11.9	36.6	0.4	-34.9
Argentina	-11.7	-1.2	45.2	-0.7	31.7
Brazil	-63.6	-3.6	83.6	4.4	20.8
Canada	-13.3	-1.4	35.6	-2.1	18.8
China	-326.4	-32.7	-238.0	44.5	-552.6
Developed Asia	-17.4	-2.2	-47.8	10.2	-57.2
EFTA	-3.8	-2.7	-15.4	4.6	-17.4
Former USSR and rest of Europe	-17.2	-2.8	5.0	-1.1	-16.1
India	-33.2	-30.1	56.5	-6.7	-13.5
Japan	-21.2	-1.4	-63.1	-0.9	-86.6
Mexico and Central America	-38.2	-6.1	7.4	-1.9	-38.7
Middle East and North Africa	-44.6	-4.0	-150.5	8.5	-190.6
Oceania	-11.9	-2.0	53.6	-0.7	39.1
Other Asia	-67.4	-26.0	7.5	-3.8	-89.6
Other South America	-15.0	-2.2	9.3	1.3	-6.6
Russia	-22.3	-3.0	-6.4	7.3	-24.4
Turkey	-13.5	-1.2	5.6	-2.5	-11.6
Ukraine	-8.8	-0.5	30.6	0.0	21.3
United States	-65.1	-8.8	185.8	-44.6	67.3

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-16

Land use changes from EU-only scenario (percent change)

	Forestry	Cropland	Pastureland
EU	9.8	-10.5	-6.1
Africa	-2.1	1.0	-2.5
Argentina	-0.9	1.5	-3.1
Brazil	-2.0	0.3	-0.7
Canada	-0.3	4.6	4.4
China	-0.1	0.9	-0.2
Developed Asia	-2.9	0.5	-1.6
EFTA	-14.7	-0.5	-0.8
Former USSR and rest of Europe	-1.8	0.5	-2.1
India	-5.4	1.5	-12.0
Japan	-0.3	0.0	0.9
Mexico and Central America	-2.3	-0.3	-1.2
Middle East and North Africa	-5.0	1.5	-0.2
Oceania	-3.5	10.1	-5.2
Other Asia	-0.9	-0.7	0.8
Other South America	1.1	1.8	-0.8
Russia	-3.6	3.3	1.7
Turkey	0.1	1.9	-2.4
Ukraine	-3.0	4.2	0.0
United States	-5.1	1.4	-2.4

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-17

Land use changes from middle scenario (percent change)

	Forestry	Cropland	Pastureland
EU	-7.8	-6.8	-11.0
Africa	-12.5	-9.8	-13.5
Argentina	2.3	-1.0	0.1
Brazil	0.6	-0.9	-0.3
Canada	0.3	-0.9	0.3
China	0.2	-0.1	0.0
Developed Asia	0.0	0.0	-0.5
EFTA	-31.8	-20.7	-27.1
Former USSR and rest of Europe	0.8	0.1	-0.1
India	0.9	-0.1	0.5
Japan	0.1	-0.1	-0.4
Mexico and Central America	0.3	-0.3	-0.1
Middle East and North Africa	-25.7	-10.1	-9.5
Oceania	1.3	-0.5	0.0
Other Asia	0.3	-0.3	0.0
Other South America	0.6	-1.1	-0.1
Russia	0.5	-0.6	-0.5
Turkey	-9.2	-3.3	-22.6
Ukraine	-7.4	-9.3	-16.5
United States	0.4	-0.3	-0.1

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model.

Appendix Table B-18

Land use changes from global scenario (percent change)

	Forestry	Cropland	Pastureland
EU	-3.2	-3.7	-10.2
Africa	-10.9	-7.9	-13.7
Argentina	-16.0	-11.0	-15.4
Brazil	0.3	-22.3	-8.5
Canada	-8.0	-23.8	-17.9
China	-6.0	-22.8	-6.0
Developed Asia	-28.0	-15.5	-20.6
EFTA	-13.9	-20.5	-27.0
Former USSR and rest of Europe	-6.9	-11.1	-18.4
India	1.3	-11.0	-3.8
Japan	-8.6	-10.5	-8.6
Mexico and Central America	-11.3	-13.0	-18.6
Middle East and North Africa	-21.5	-9.4	-11.6
Oceania	-17.1	37.1	-44.3
Other Asia	-8.2	-15.9	-15.9
Other South America	1.3	-27.2	-14.5
Russia	-13.0	-2.8	-11.9
Turkey	-7.3	-5.8	-21.1
Ukraine	2.0	-16.3	-12.9
United States	-26.9	-8.9	-34.8

Note: EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ) model

Appendix Table B-19

Food security changes across the three scenarios

		Share of the population food-insecure		Difference from Baseline		Number of people food-insecure		Difference from Baseline		Total population	
		2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
		(percent)		(percent)				(millions)			
Africa	baseline	29.4	18.8			431.5	342.2			1,466	1,816
	Farm to Fork (EU)	29.4	19.3	-0.1	0.4	430.6	350.1	-0.9	7.9	1,466	1,816
	Farm to Fork (Middle Scenario)	30.3	24.0	0.8	5.2	443.6	436.2	12.1	94.0	1,466	1,816
	Farm to Fork (Global)	30.2	23.3	0.8	4.4	443.0	422.5	11.5	80.3	1,466	1,816
Former USSR and rest of Europe	baseline	30.2	13.8			7.9	3.8			26	27
	Farm to Fork (EU)	30.7	15.9	0.5	2.1	8.0	4.3	0.1	0.6	26	27
	Farm to Fork (Middle Scenario)	30.2	13.9	0.0	0.1	7.9	3.8	0.0	0.0	26	27
	Farm to Fork (Global)	33.0	24.2	2.8	10.4	8.6	6.6	0.7	2.8	26	27
India	baseline	14.0	1.1			185.1	15.7			1,326	1,461
	Farm to Fork (EU)	14.0	1.1	0.1	0.01	186.2	15.9	1.2	0.2	1,326	1,461
	Farm to Fork (Middle Scenario)	13.9	1.1	0	0	184.9	15.5	-0.1	-0.2	1,326	1,461
	Farm to Fork (Global)	14.8	2.3	0.8	1.2	195.6	33.1	10.6	17.4	1,326	1,461
Mexico and Central America	baseline	30.2	18.7			19.1	13.2			63	70
	Farm to Fork (EU)	30.3	19.8	0.2	1.1	19.2	13.9	0.1	0.8	63	70
	Farm to Fork (Middle Scenario)	30.2	18.7	0.0	0.0	19.1	13.2	0.0	0.0	63	70
	Farm to Fork (Global)	31.2	23.8	1.0	5.1	19.8	16.7	0.6	3.6	63	70
Middle East and North Africa	baseline	25.3	18.2			38.2	32.1			151	176
	Farm to Fork (EU)	25.5	19.4	0.1	1.2	38.4	34.2	0.2	2.0	151	176
	Farm to Fork (Middle Scenario)	26.2	23.8	0.8	5.6	39.5	41.9	1.3	9.8	151	76
	Farm to Fork (Global)	26.1	20.6	0.7	2.4	39.3	36.4	1.1	4.3	151	176
Other Asia	baseline	23.2	9.4			217.0	96.3			935	1,026
	Farm to Fork (EU)	23.3	10.4	0.1	1.0	217.8	106.4	0.8	10.1	935	1,026
	Farm to Fork (Middle Scenario)	23.2	9.3	0	0	216.9	95.8	-0.1	-0.5	935	1,026
	Farm to Fork (Global)	24.8	16.4	1.6	7.0	231.8	168.3	14.8	72.0	935	1,026
Other South America	baseline	19.9	8.5			21.8	10.2			110	119
	Farm to Fork (EU)	20.0	9.2	0.1	0.7	21.9	11.0	0.1	0.8	110	119
	Farm to Fork (Middle Scenario)	19.9	8.5	0.0	0.0	21.8	10.1	0.0	0.0	110	119
	Farm to Fork (Global)	20.8	12.3	0.8	3.7	22.7	14.7	0.9	4.5	110	119
Total	baseline	22.6	10.9			920.6	513.4			4,076	4,696
	Farm to Fork (EU)	22.6	11.4	0.0	0.5	922.2	535.8	1.5	22.4	4,076	4,696
	Farm to Fork (Middle Scenario)	22.9	13.1	0.3	2.2	933.8	616.5	13.1	103.1	4,076	4,696
	Farm to Fork (Global)	23.6	14.9	1.0	3.9	960.9	698.4	40.3	185.0	4,076	4,696

Note: Food security estimates are for 76 low- and middle-income countries and do not include China, high-income countries in Asia, and Mexico.

Source: USDA, Economic Research Service calculations using the International Food Security Assessment Model.