

# Risks to global food security triggered by the Russian invasion of Ukraine

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*Crossborder climate change impacts and systemic risks in Europe and beyond*  
Potsdam, Germany  
2023-10-17

# War in Ukraine | a threat to global food security

- 24<sup>th</sup> February 2022: Russian full-scale invasion of Ukraine

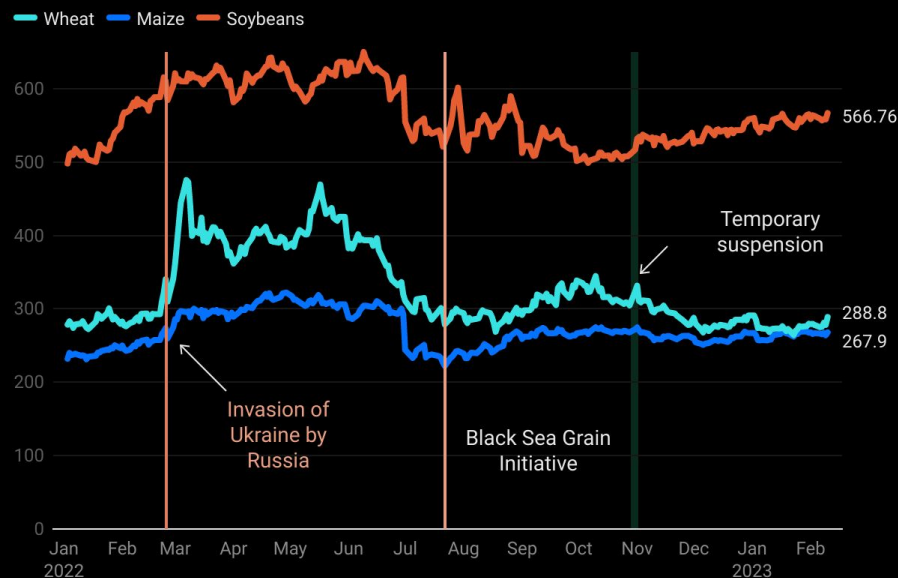


# War in Ukraine | a threat to global food security

- 24<sup>th</sup> February 2022: Russian full-scale invasion of Ukraine
- First half 2022: increase of crop prices above preceding 2007/08 and 2010/11 crises
- Later: normalization of prices

## Wheat, maize and soybean price evolution

USD per metric ton



Future prices (+30 days) quoted in Chicago

Chart: David Laborde and Joseph Glauber • Source: CBOT

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→ Compensation of reduced Ukrainian crop production by other countries

Change in global wheat exports, 2022/23 versus 2021/22

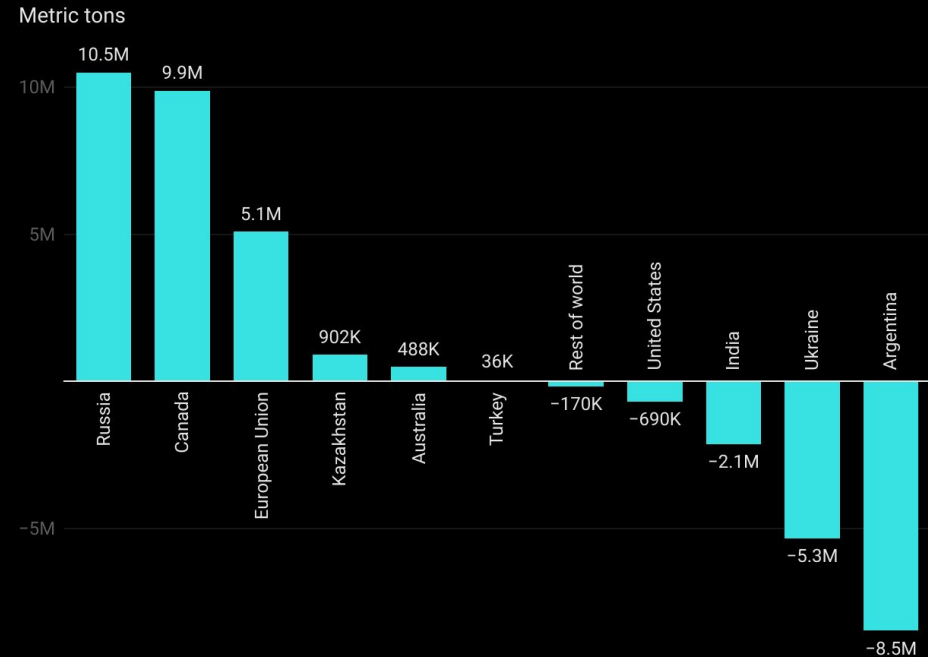


Chart: Joseph Glauber • Source: USDA/FAS PSD database February 8, 2023

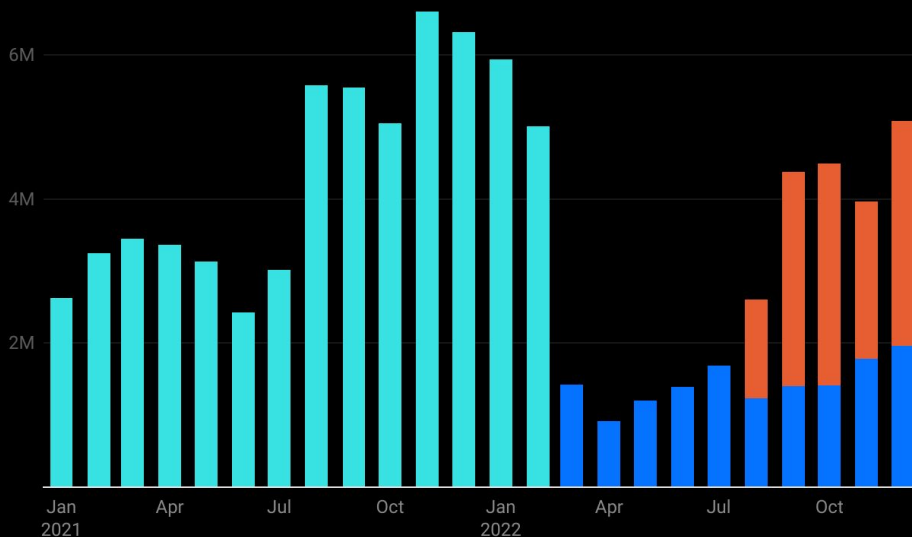
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  - Enabling (fairly) free trade of agricultural commodities

## Ukraine grain exports

Metric tons

■ Pre-war ■ Solidarity lanes ■ Black Sea Grain Initiative



Wheat, maize and barley exports. Solidarity lanes reflect grain not exported through Black Sea Grains Initiative.

Chart: Joseph Glauber • Source: COMTRADE (through Oct) Ukraine Ministry of Agriculture (Nov-Dec)

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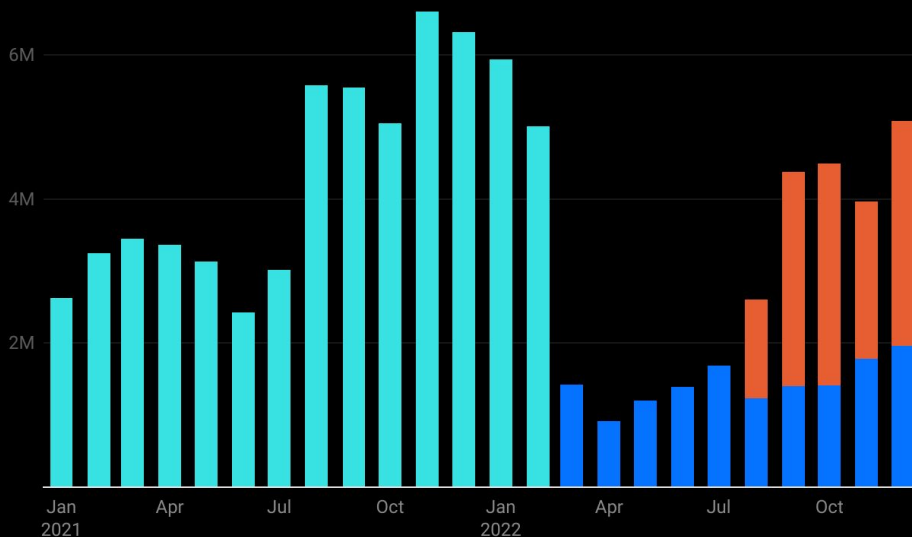
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**What if not?**

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# Our study setup

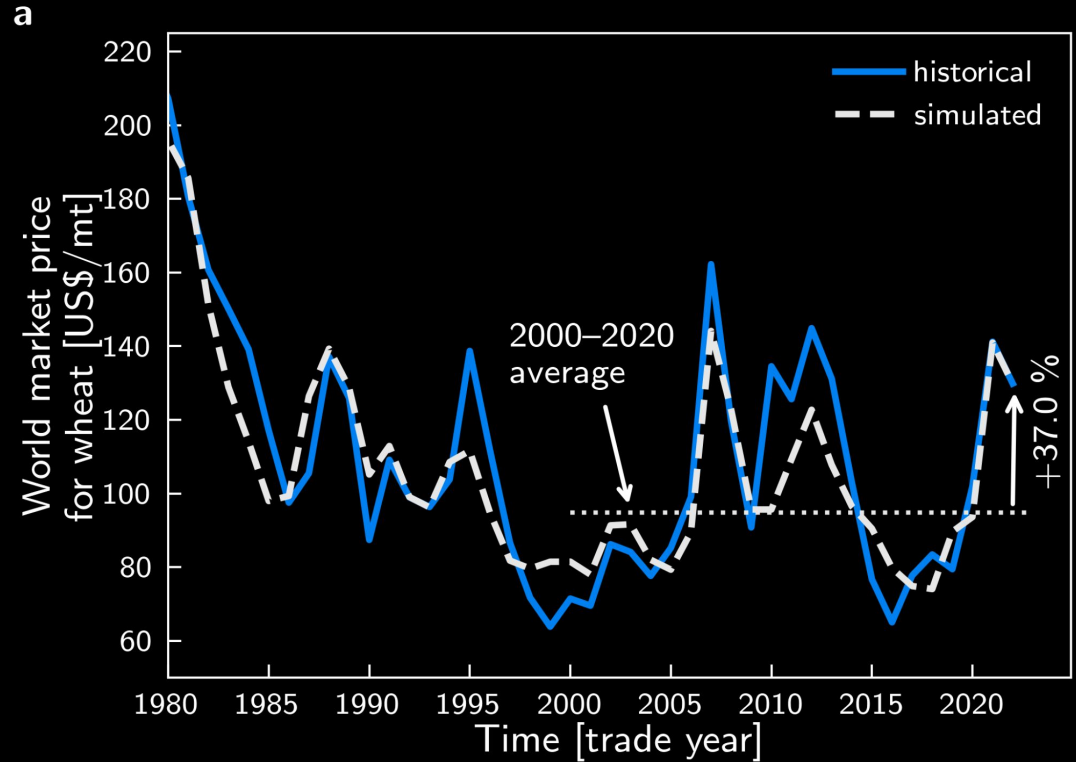
*Stabilizing international wheat prices through international cooperation after the Russian invasion of Ukraine*  
Kuhla K, Puma MJ, Otto C (under review)

Effects of (i) international measures, (ii) additional historical stressors, and (iii) potential coping strategies on **global wheat price** and **national wheat supply**

- Storyline approach
- World market price hikes (affordability dimension of food security)
  - Trade With Storage (TWIST) model [Schewe et al., ERL, 2017]
  - Annual supply-demand model to quantitatively describe price and storage movements at individual agricultural world markets
- National impaired supply (availability dimension of food security)
  - Food Shock Cascade (FSC) model [Puma et al., ERL, 2015]
  - Analysis of static wheat trade network

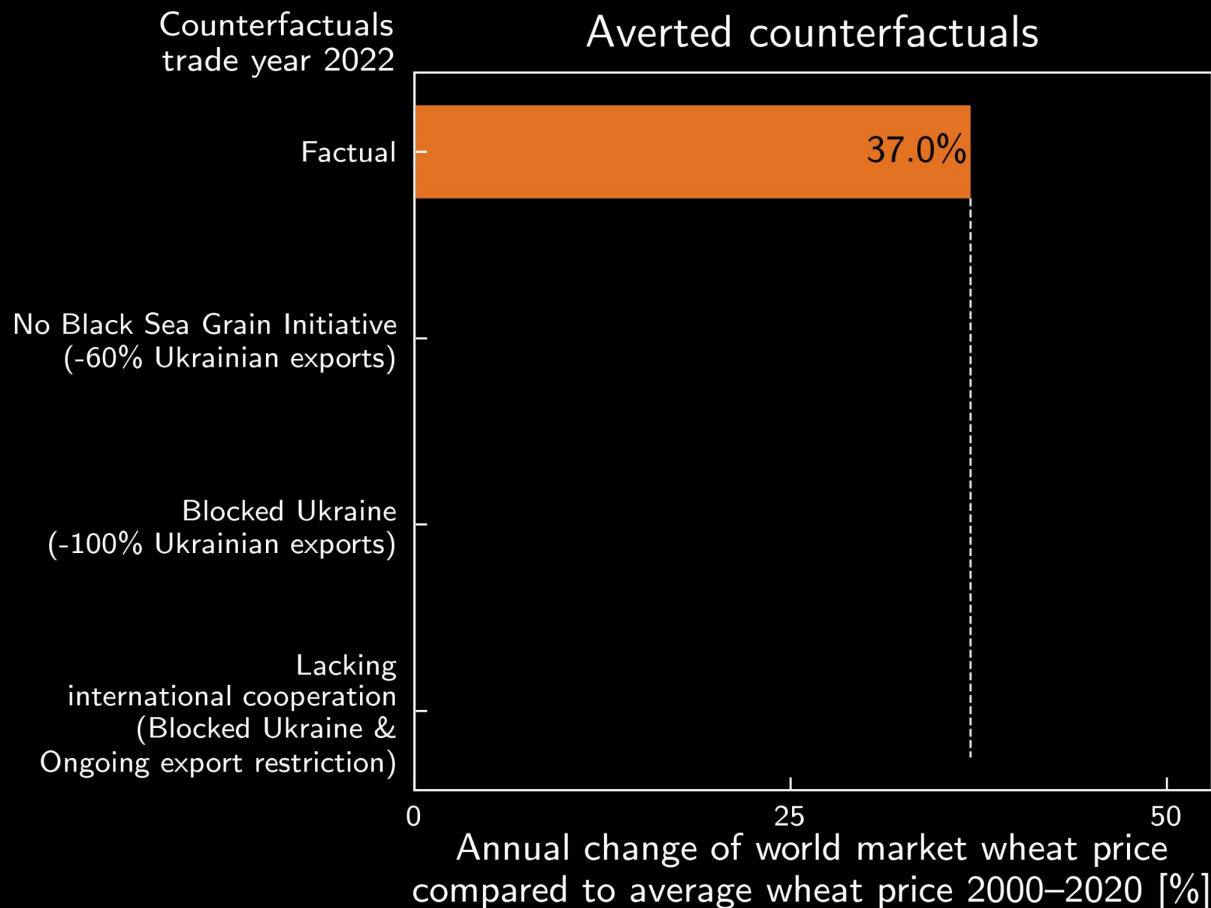
# Factual scenario

- Good reproducing of annual world market wheat price
- **+37%** annual wheat price for trade year 2022 (July 2022 – June 2023) compared to 2000–2020 average

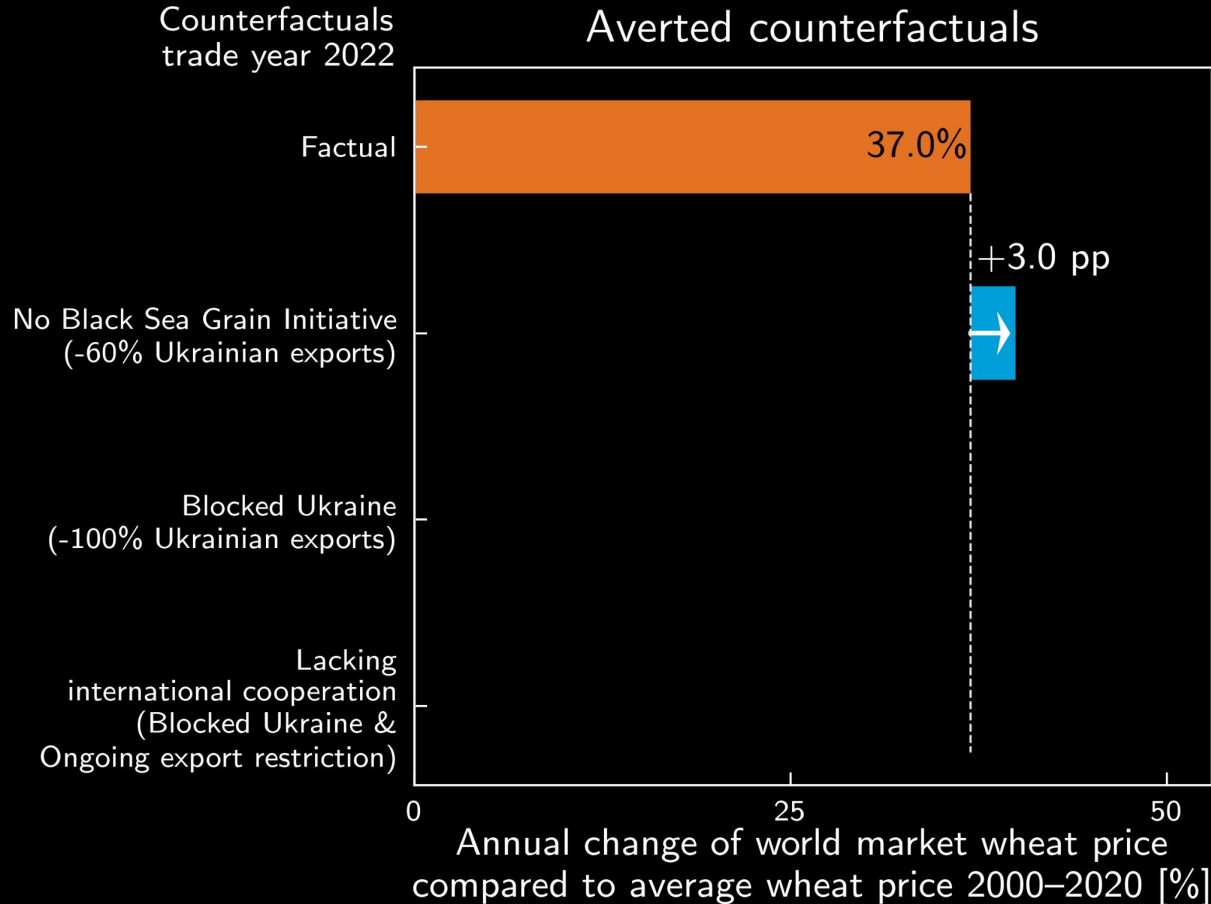




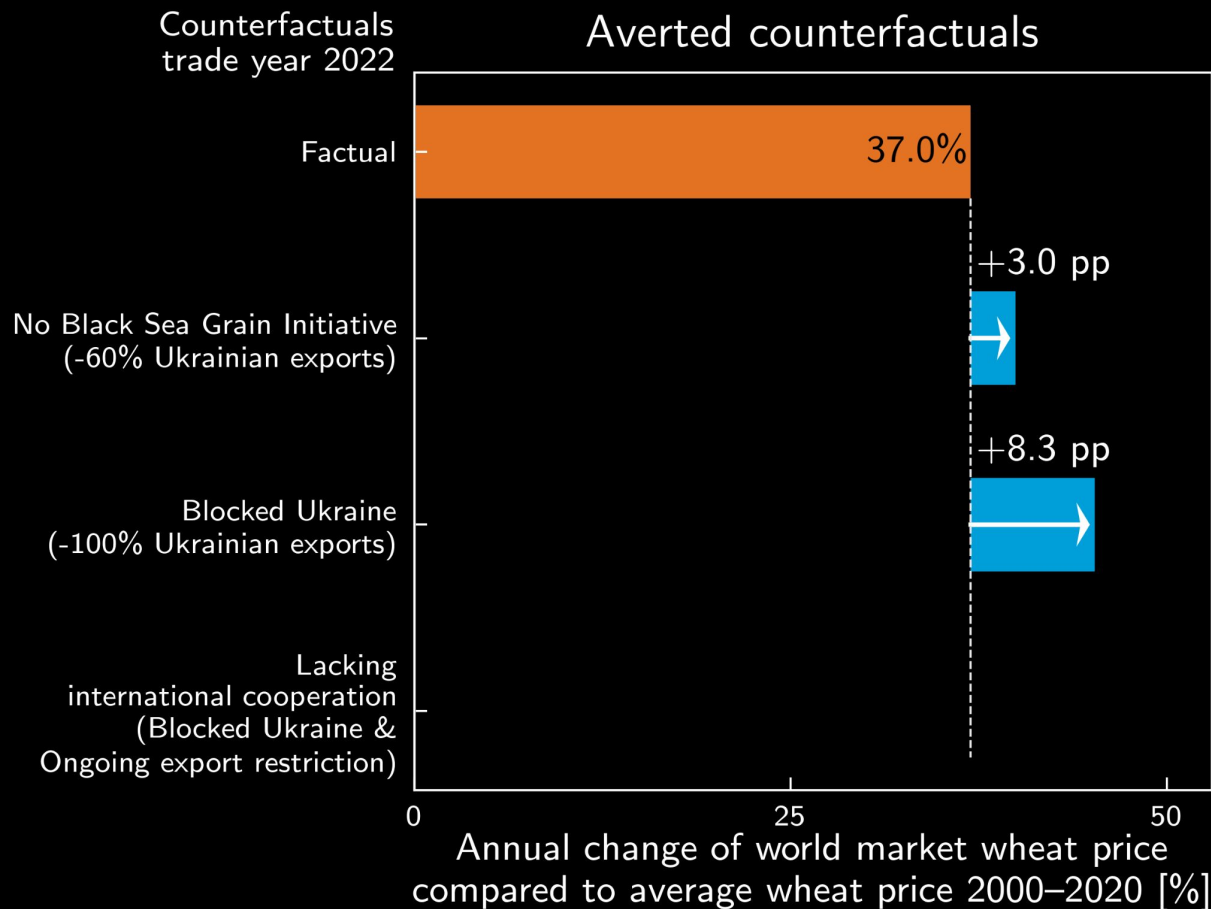
# International cooperation averted worse crisis



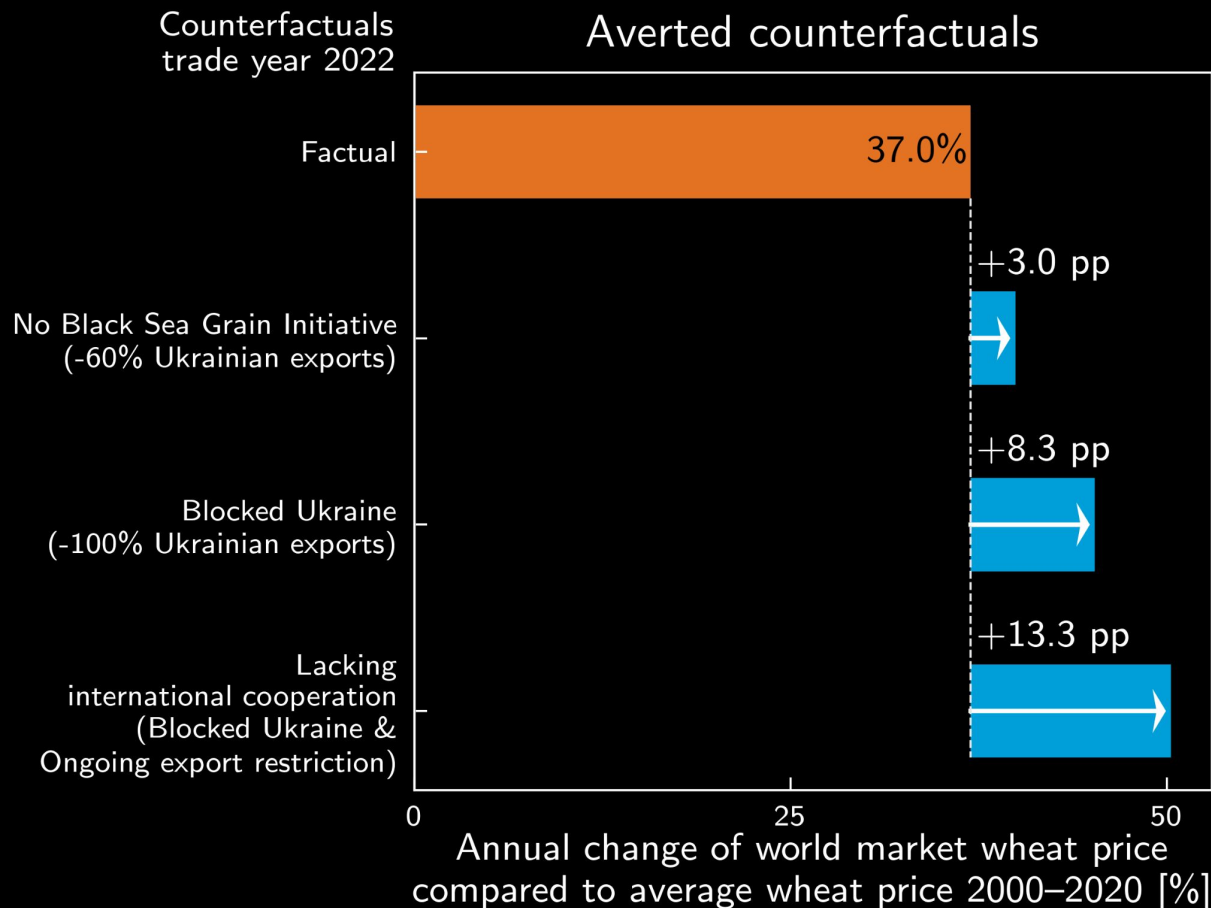
# International cooperation averted worse crisis



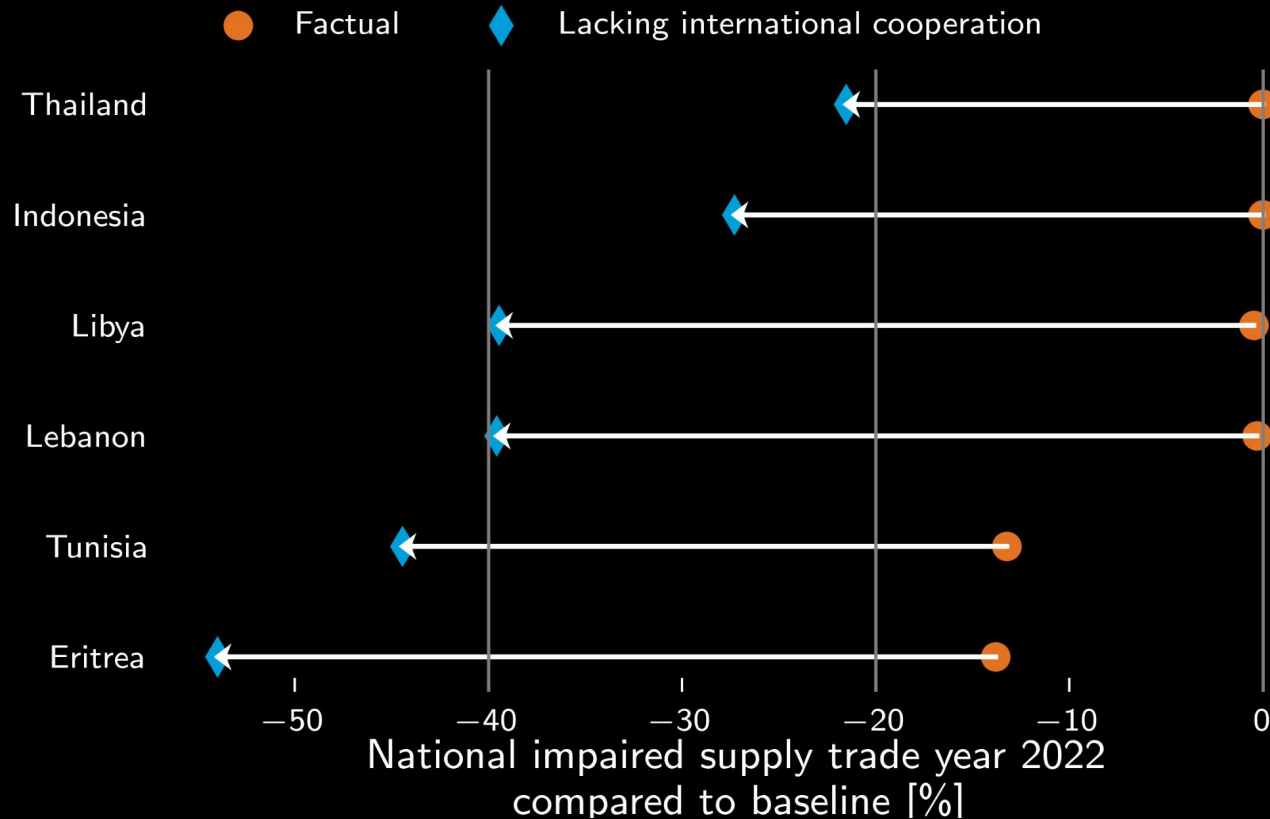
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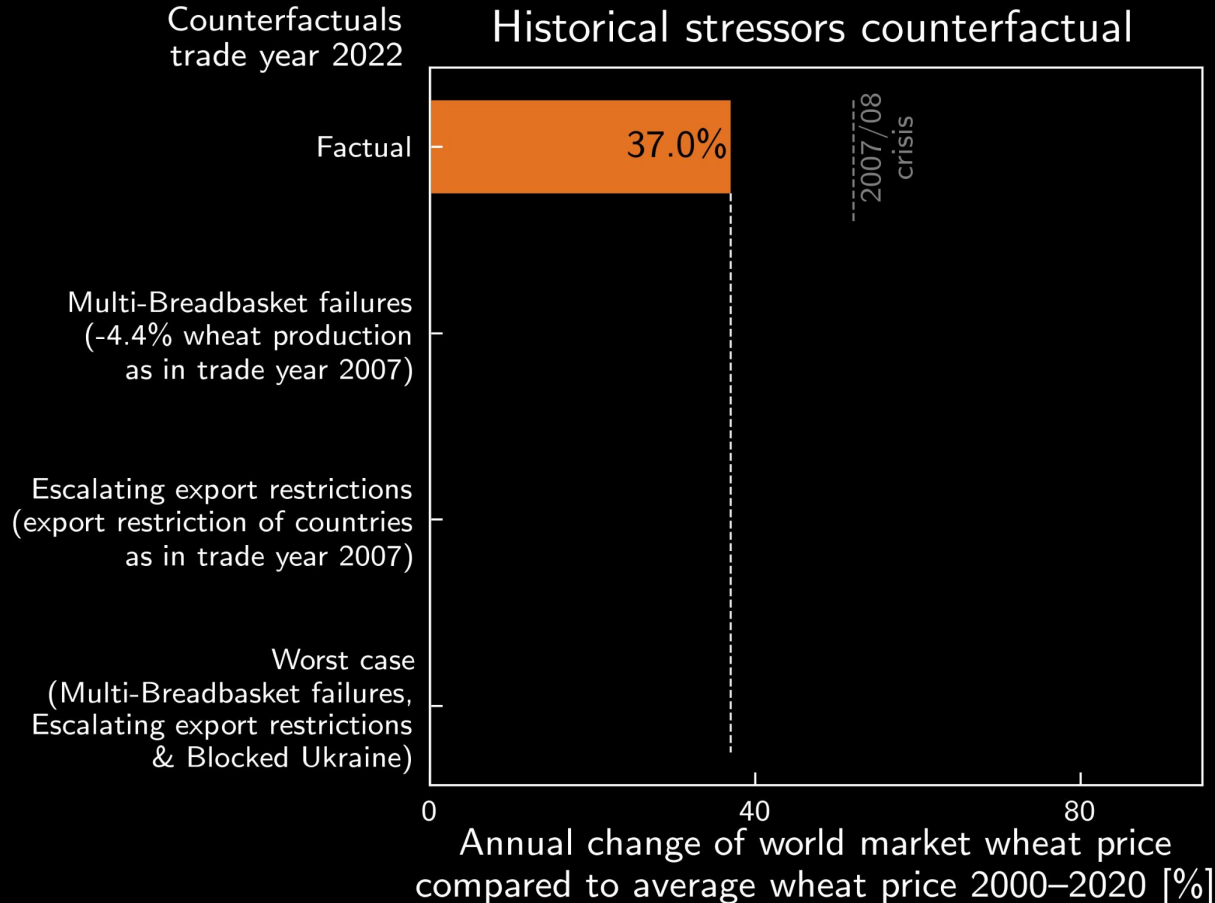


# International cooperation averted worse crisis



Could it have been worse?

# Historical stressors



# Historical stressors

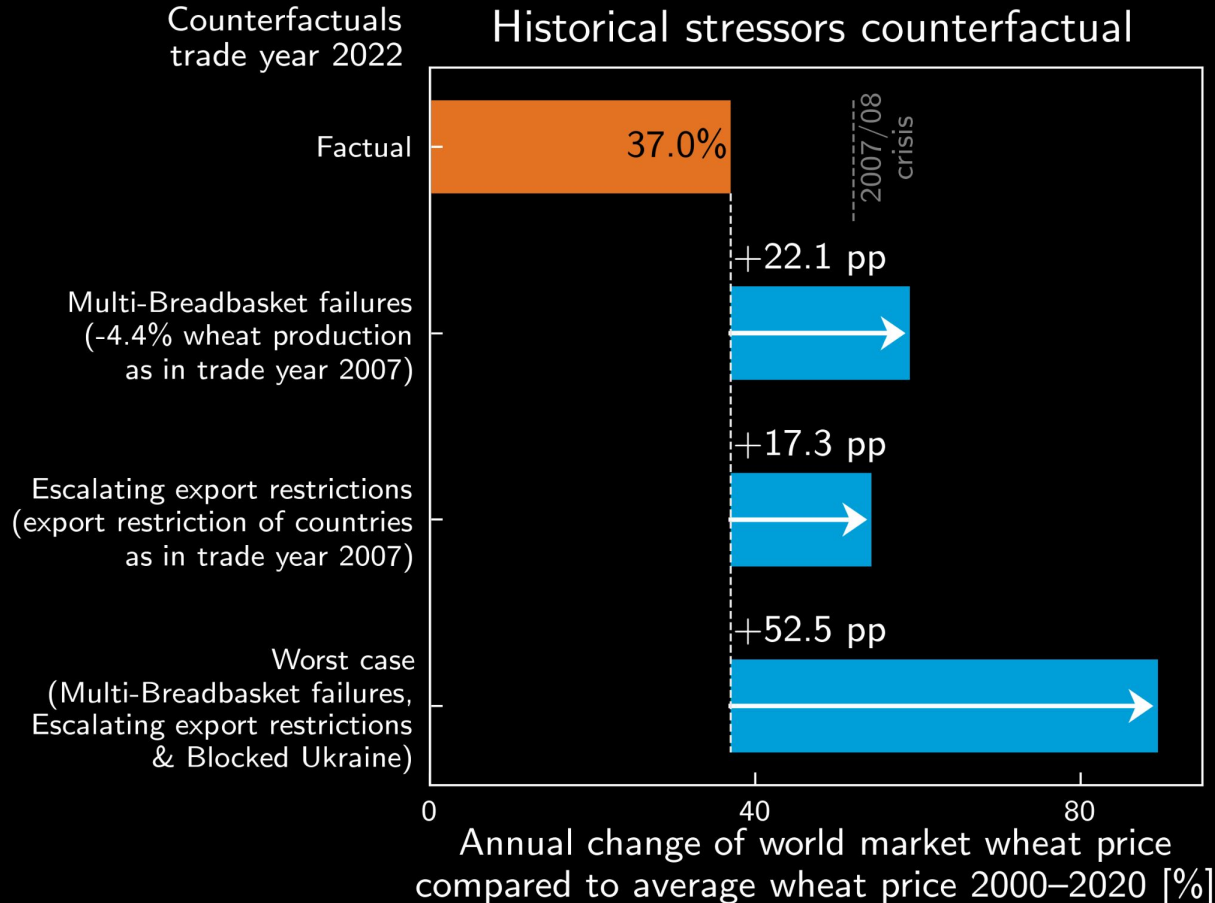




# Historical stressors

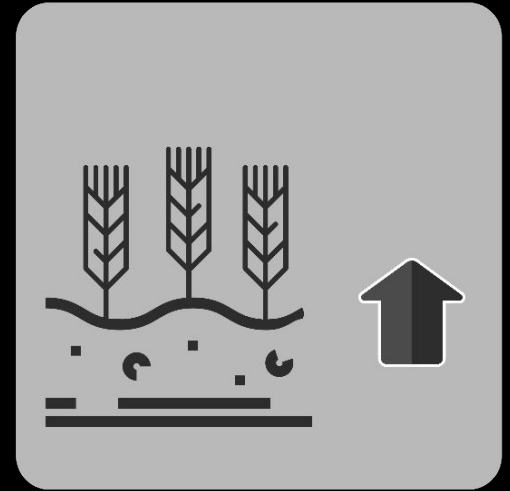
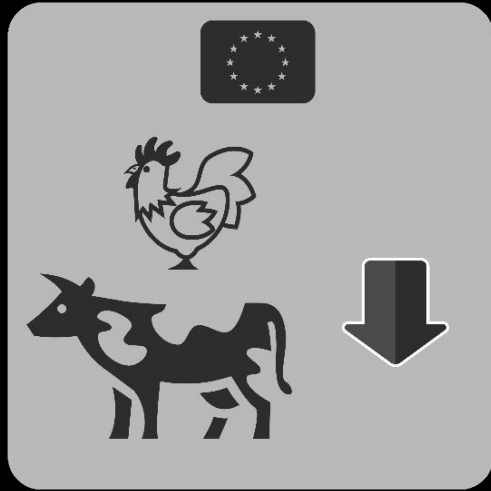


# Historical stressors



What more could we  
have done?

# Short-term coping measures



# Moderate short-term coping measures

Counterfactuals  
trade year 2022

Counterfactual policy measures

Factual

37.0%



–30% feed consumption  
in EU



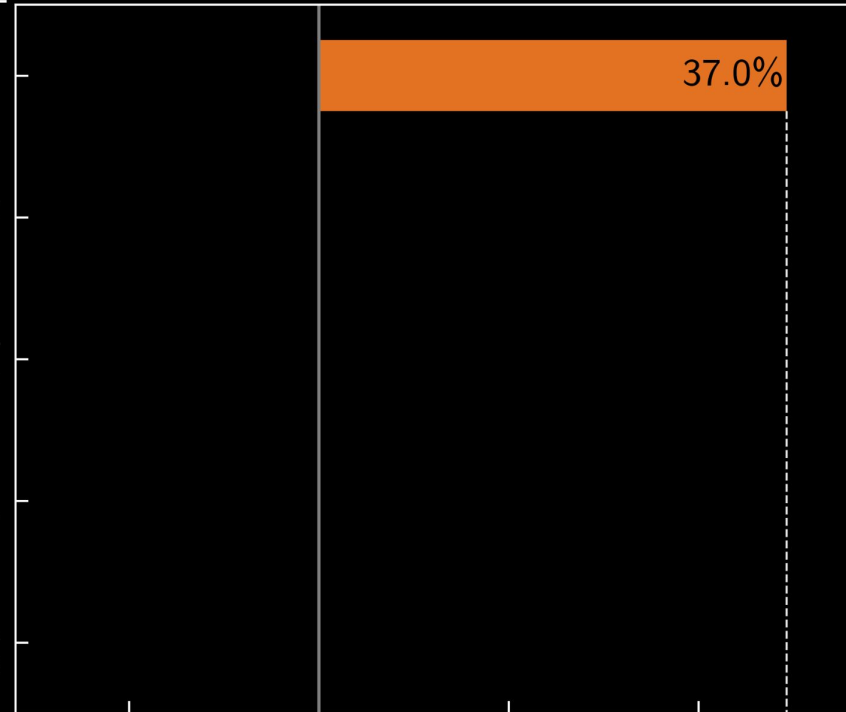
–1.5% stocks for  
G7 & China



+3% production  
of major producer



Combined moderate  
coping strategies



Annual change of world market wheat price  
compared to average wheat price 2000–2020 [%]

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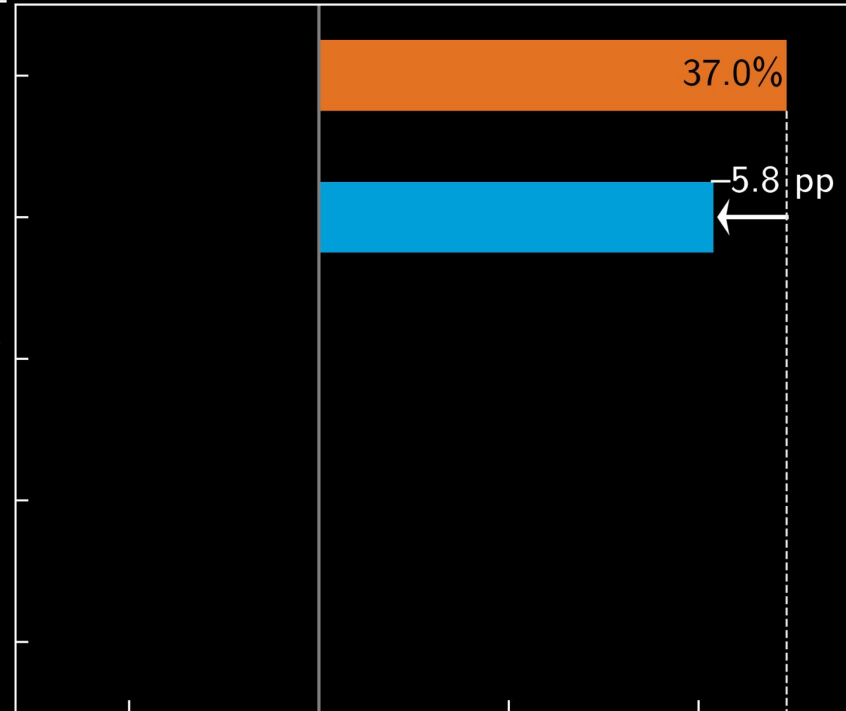


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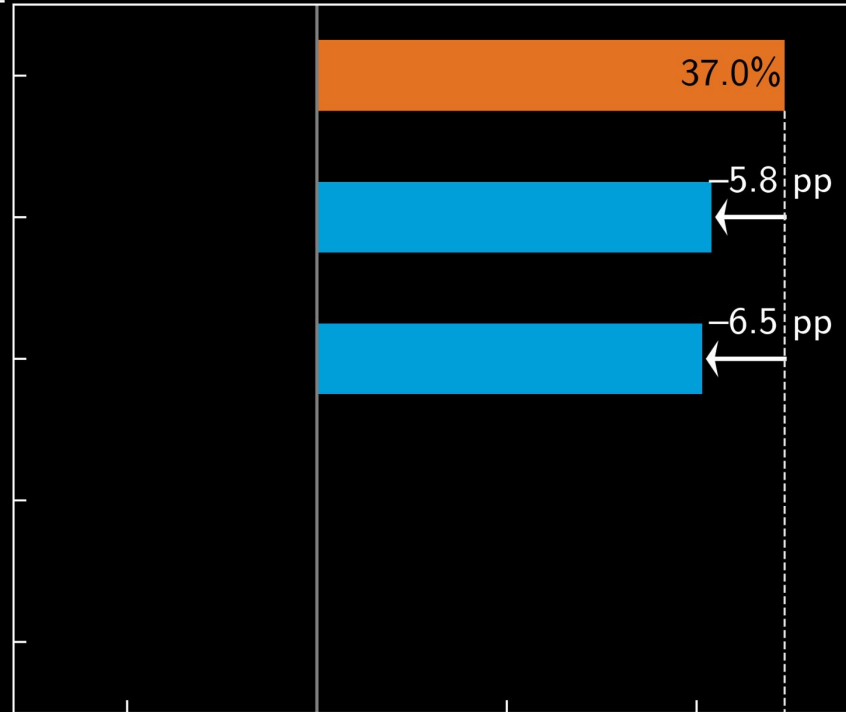


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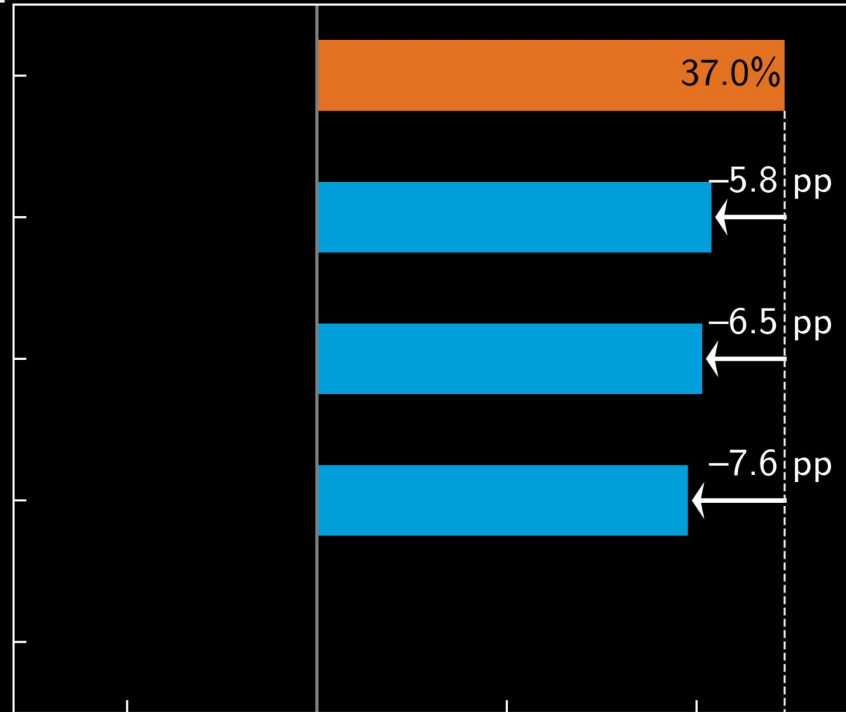


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Counterfactual policy measures



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# Moderate short-term coping measures

Counterfactuals  
trade year 2022

Factual



–30% feed consumption  
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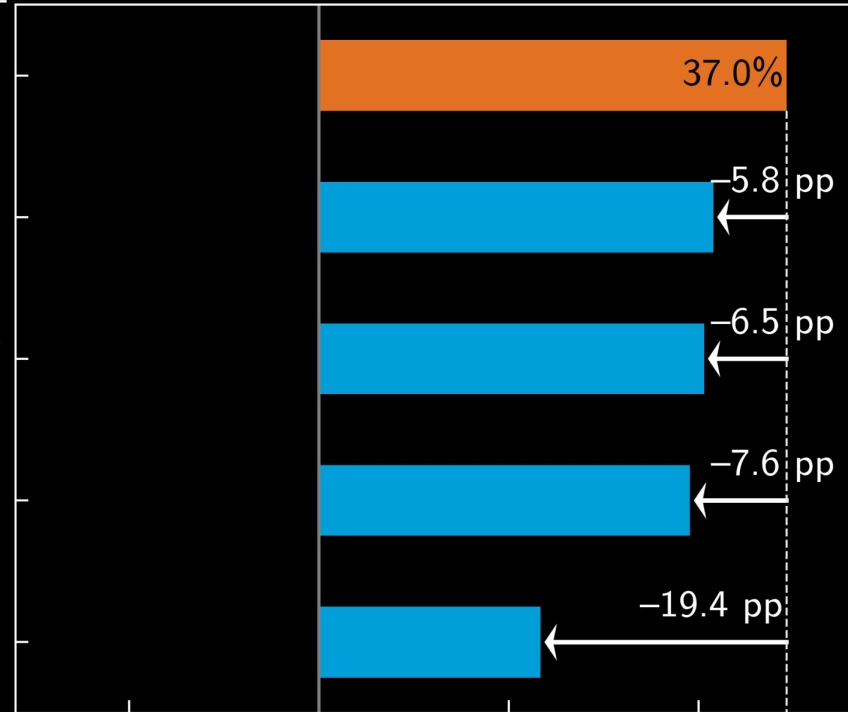


+3% production  
of major producer



Combined moderate  
coping strategies

Counterfactual policy measures



Annual change of world market wheat price  
compared to average wheat price 2000–2020 [%]

# Rigorous short-term coping measures

Counterfactuals  
trade year 2022

Factual



–30% feed consumption  
globally



–7.6% stocks for  
G7 & China

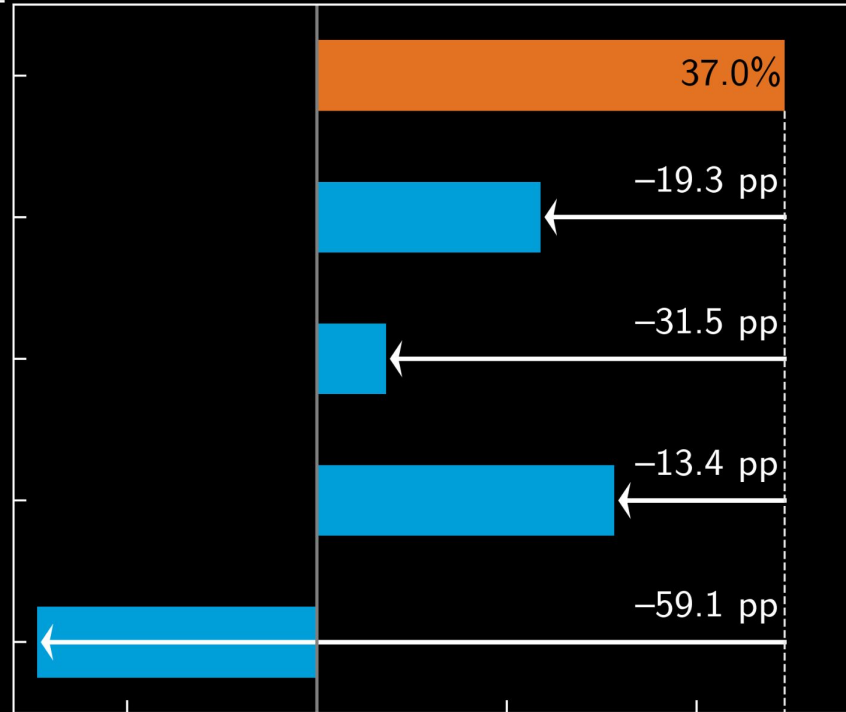


+3% global production



Combined rigorous  
coping strategies

Counterfactual policy measures



Annual change of world market wheat price  
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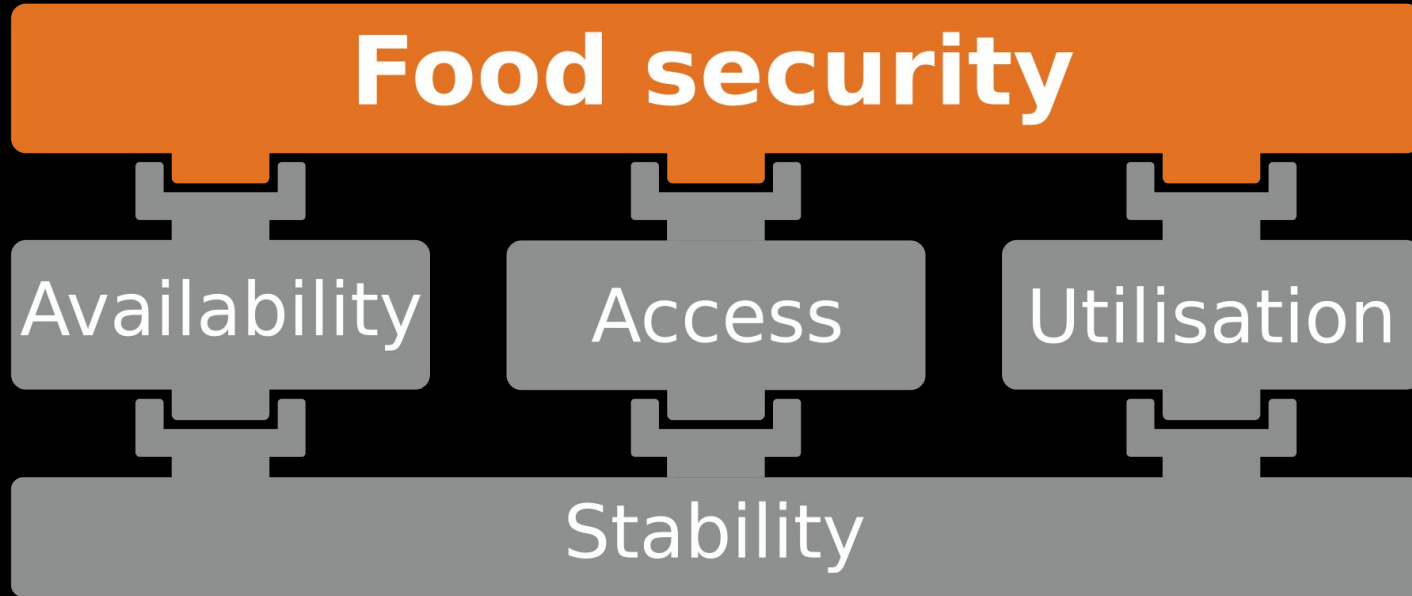
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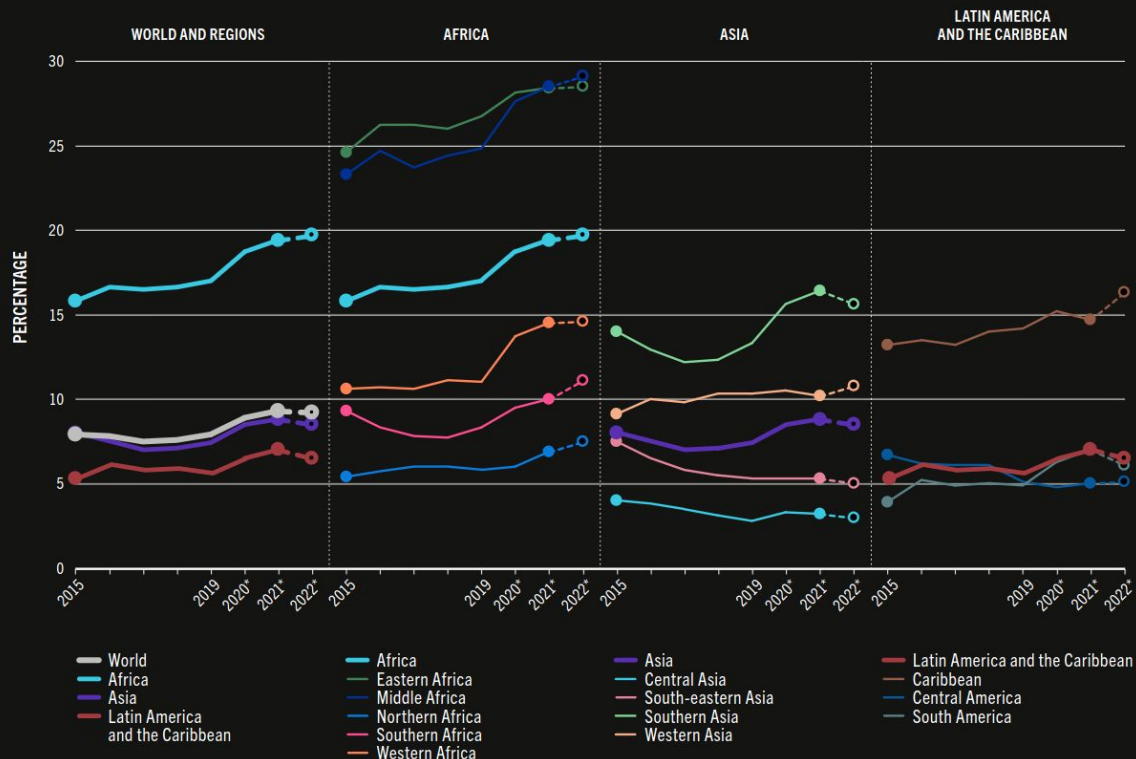
# Additional Slides

# Food security dimensions



# World hunger regionally

**FIGURE 2** PROGRESS WAS MADE TOWARDS REDUCING HUNGER IN MOST SUBREGIONS IN ASIA AND IN LATIN AMERICA, BUT HUNGER IS STILL ON THE RISE IN WESTERN ASIA, THE CARIBBEAN AND ALL SUBREGIONS OF AFRICA

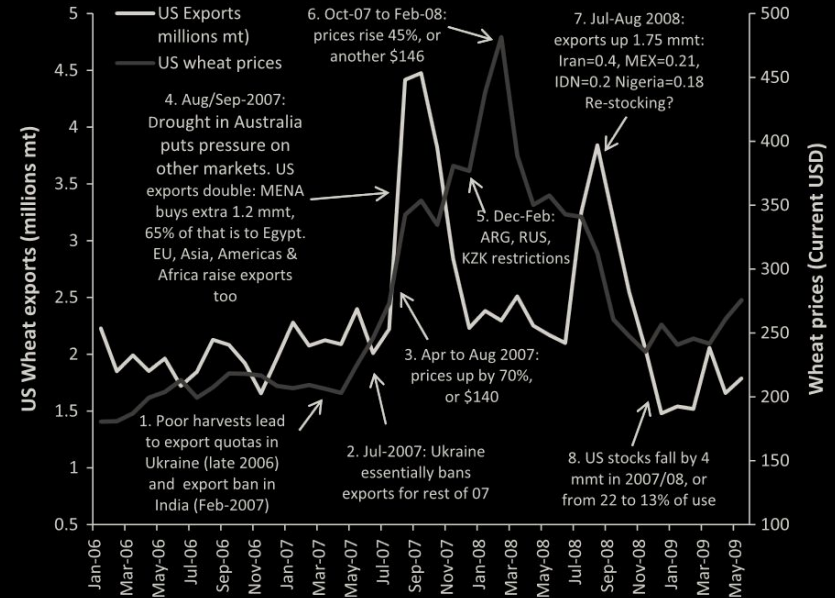


[Source: State of Food Security 2023 FAO]

# The World Food Price Crises in 2007/08 and 2010/11

- Compounding bad harvests in several main production regions
  - tension on global crop markets (in addition to several adverse long-term drivers)
- Resulting market uncertainties
  - escalating export restrictions
- Massive surge of food price at world markets

## Wheat word market price hikes

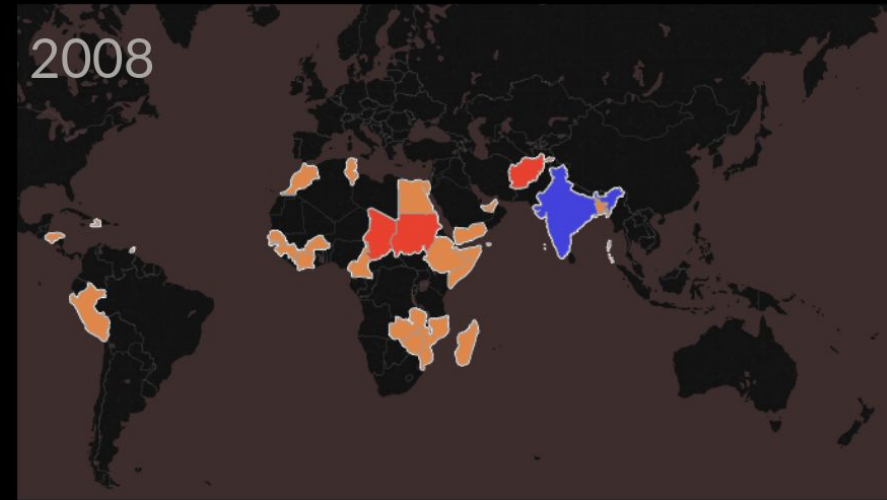


[Headey et al., Food Policy, **36** (2), 2011]

# The World Food Price Crises in 2007/08 and 2010/11

- Compounding bad harvests in several main production regions
  - tension on global crop markets (in addition to several adverse long-term drivers)
- Resulting market uncertainties
  - escalating export restrictions
- Massive surge of food price at world markets
  - 63-80 million (2007/08) and 44 million (2010/11) additional people pushed into food insecurity [Word Bank]
  - Food riots in many import-dependent developing countries

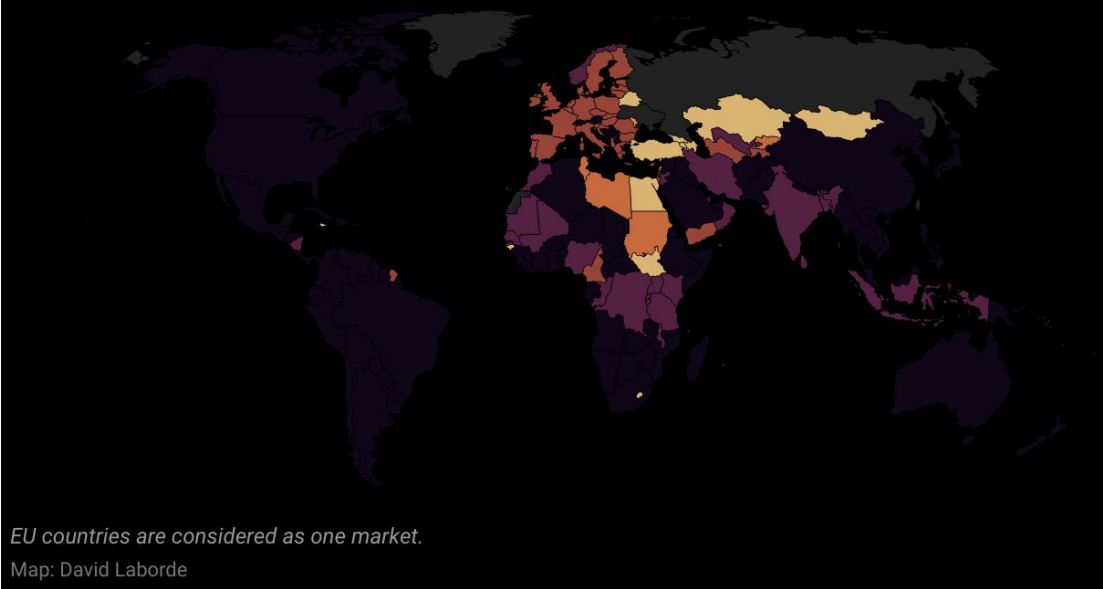
- Riots motivated by price inflation
- Riots motivated by severe shortages
- Both



[World Bank, Food Price Crisis Observatory]



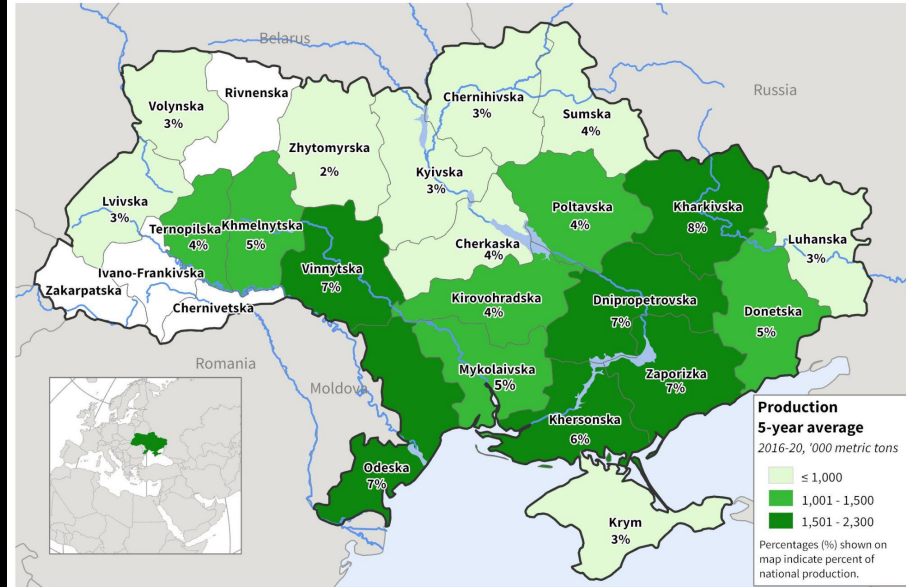
## Share of the Russian Federation & Ukraine in imported calories



*EU countries are considered as one market.*

Map: David Laborde

## Ukraine: Wheat Production

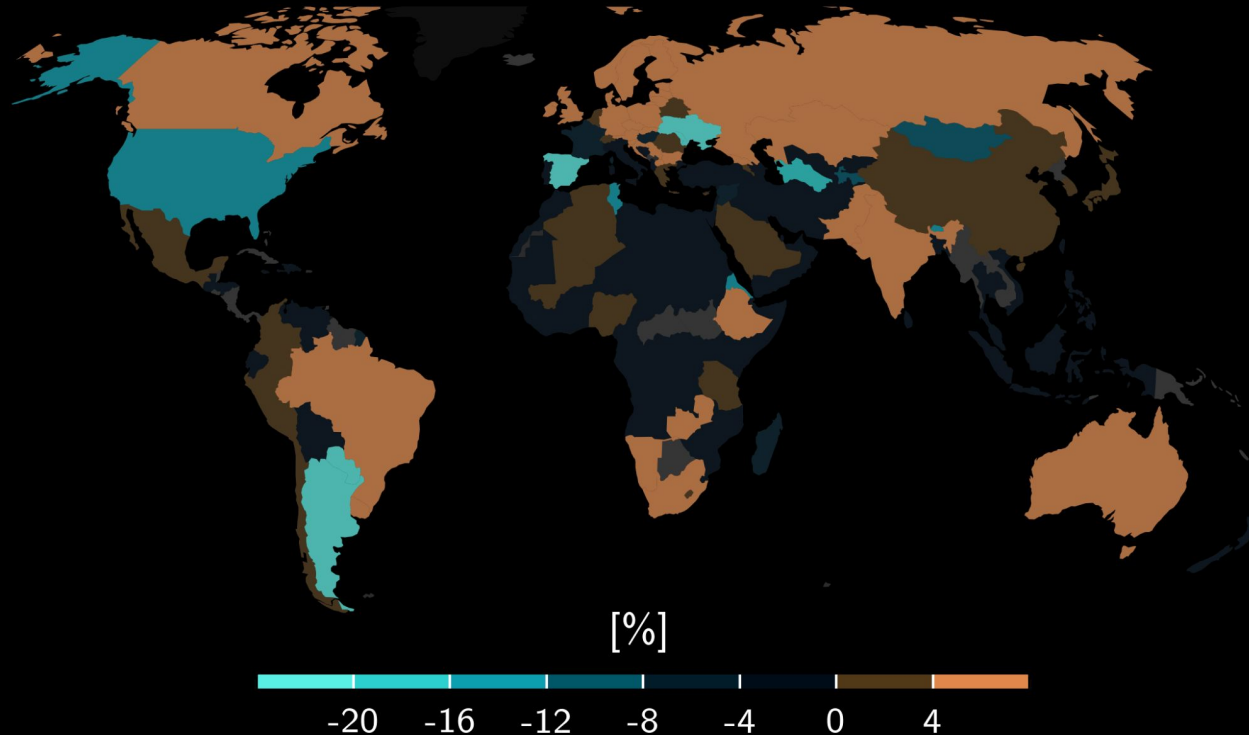


**USDA** Foreign Agricultural Service  
U.S. DEPARTMENT OF AGRICULTURE

Source: State Statistics Service of Ukraine (Rosstat for Crimea Oblast)  
Average Wheat Production 2016-2020

# Ukraine crisis: Figure 1

b Factual impaired supply trade year 2022  
compared to baseline



# TWIST Model

$$Q_s(t) = I_p(t) \cdot \delta_{\text{trade}} \cdot \left( \frac{P(t)}{P_{\text{max},p}} \right)^{e_s}, \quad (1)$$

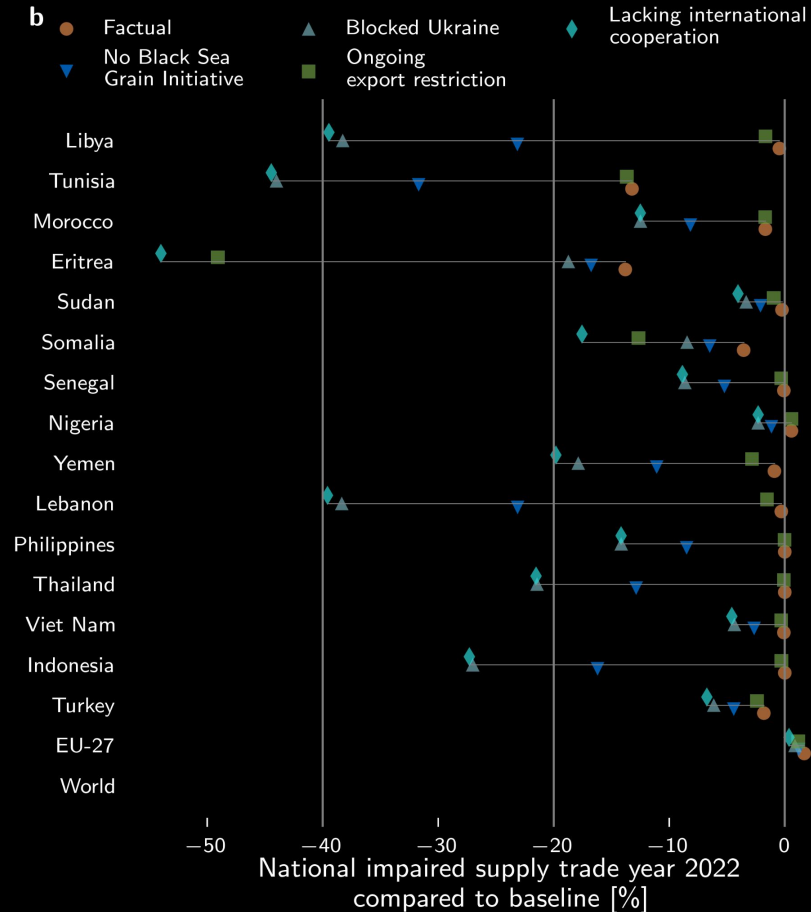
$$Q_d(t) = (\delta_{\text{demand}} \cdot I_{\text{max},c}(t) - I_c(t)) \cdot \left( 1 - \left( \frac{P(t)}{P_{\text{max},c}} \right)^{e_d} \right), \quad (2)$$

$$I_p(t) = I_p(t-1) + H(t) - Q_\chi(t), \quad (3)$$

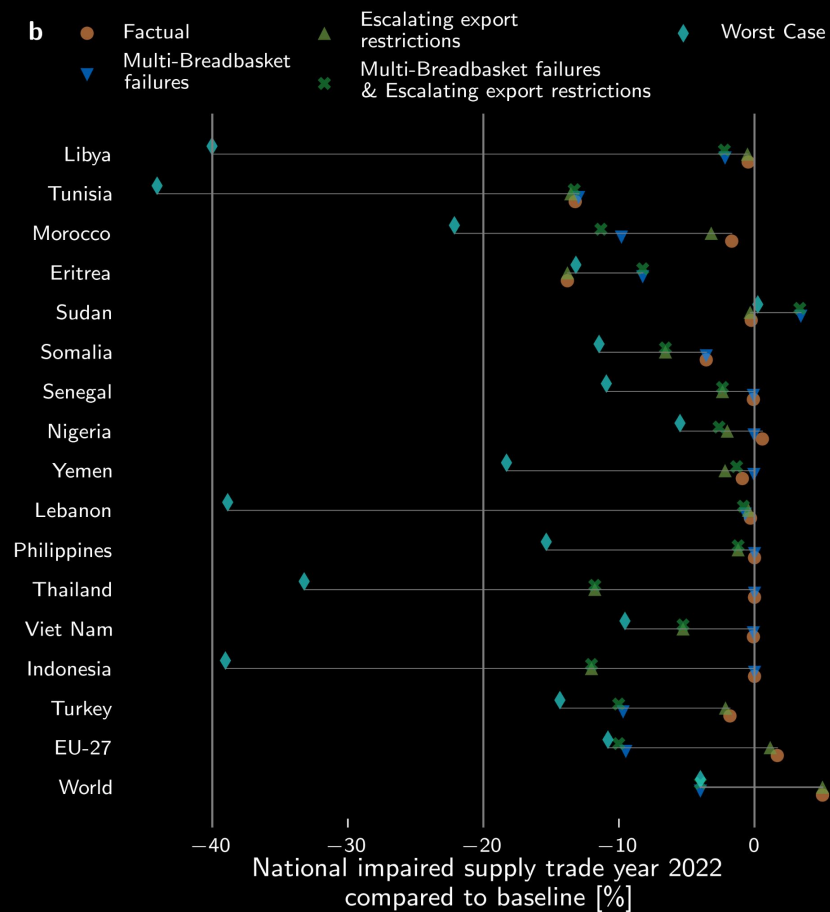
$$I_c(t) = I_c(t-1) + Q_\chi(t) - Q_{\text{out}}(t), \quad (4)$$

$$S_c = H_c + I_c - E_c + R_c \quad (5)$$

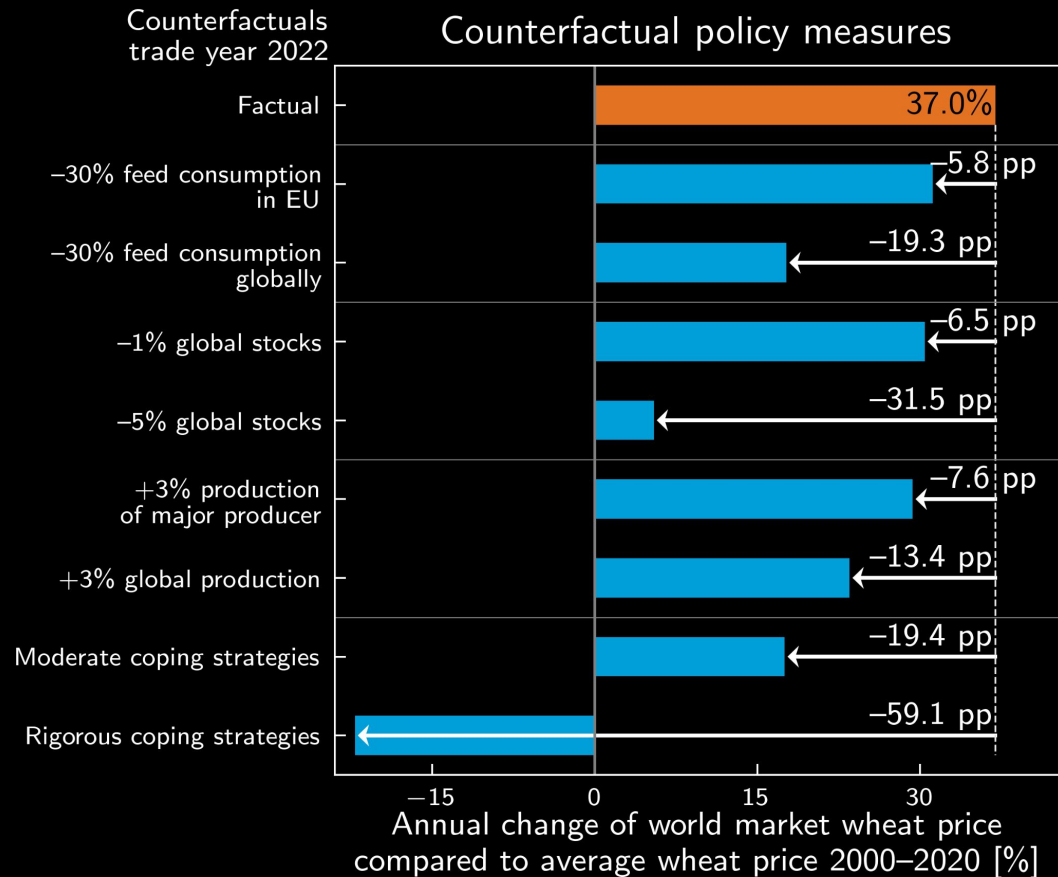
# Ukraine crisis: Figure 2



# Ukraine crisis: Figure 3

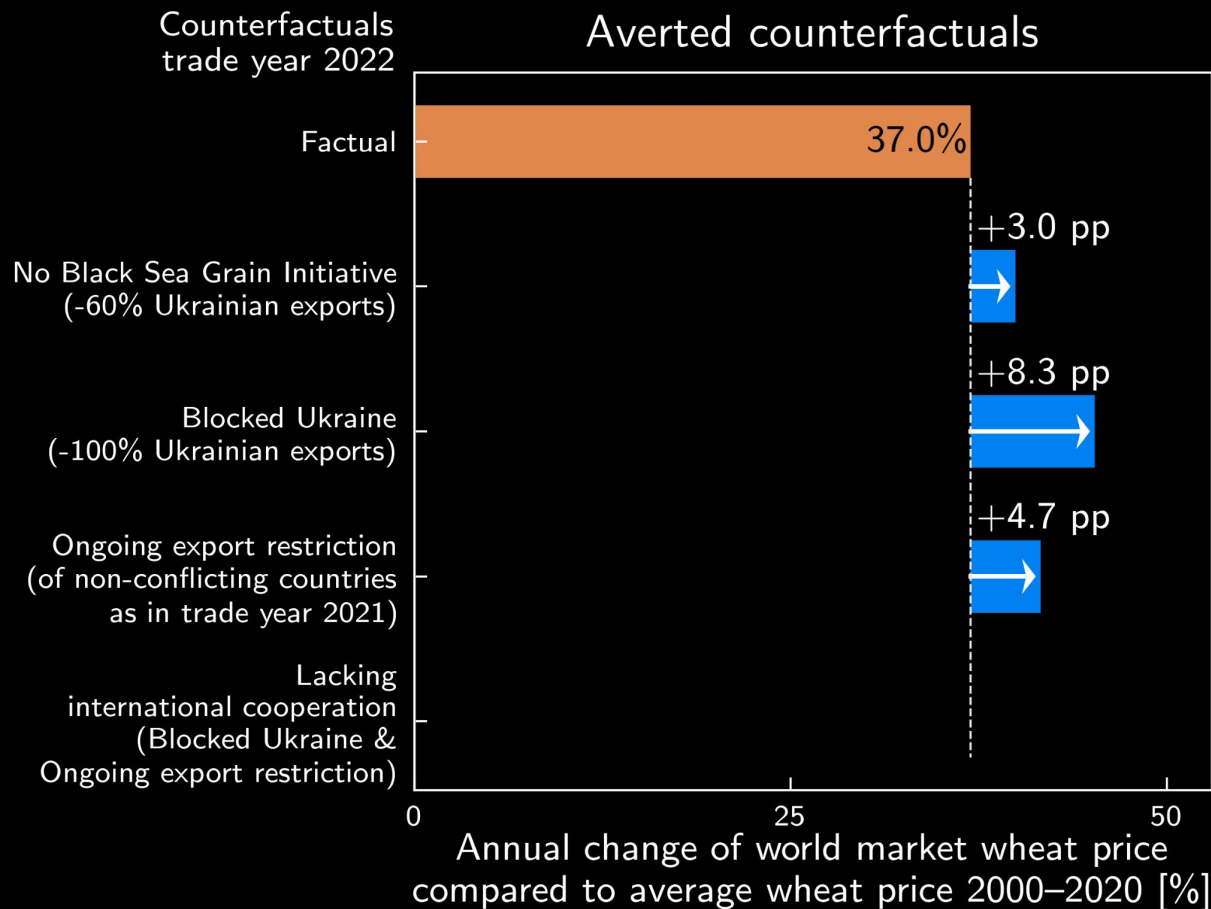


# Ukraine crisis: Figure 4





# Ukraine crisis | international cooperation averted worse crisis



# Zero Hunger in times of compounding crises

- As many as 735 mln people faced hunger in 2022
  - +122 mln compared to 2019
  - reducing hunger in Asia and in Latin America,
  - rising hunger in Western Asia, the Caribbean and all subregions of Africa



Number of **children under 5 years with wasting** in 21 food-crisis countries with nutrition data, 2023



# Agenda

Outline the fragility of the global food web

Ukraine crisis:

Study on short-term food security risks due to the Russian invasion



Multi-regional storage model *Agrimate*:

Modeling global & regional food security on sub-annual resolution

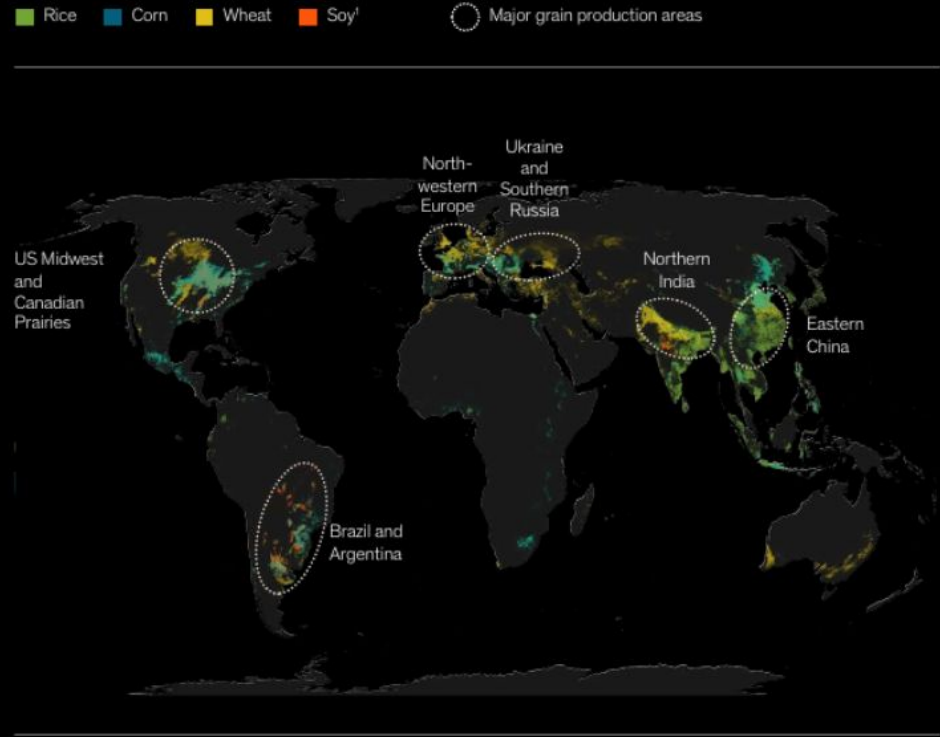


Outlook

# Fragility of the world food web | concentration of production

Concentration of production to few main breadbasket regions

## Major breadbaskets

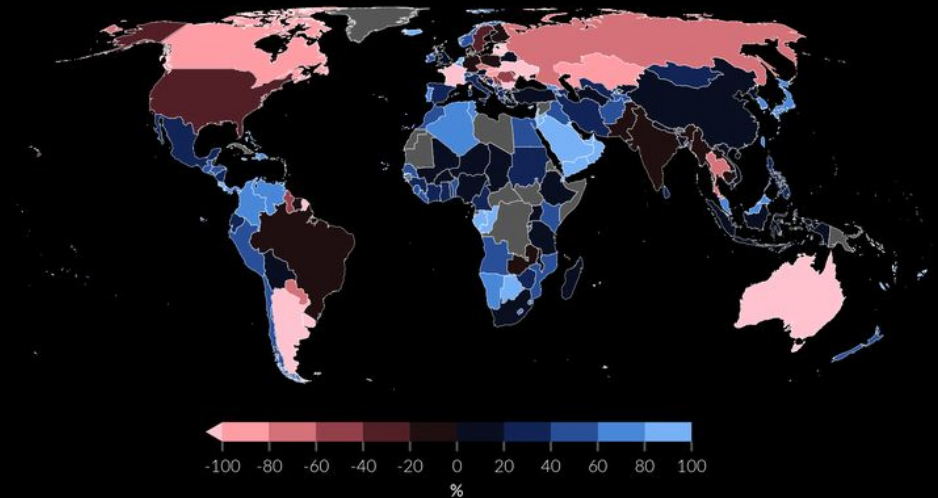


# Fragility of the world food web | trade dependencies

Concentration of production to few main breadbasket regions results in:

- **Import dependencies** of many developing countries render them vulnerable to
  - **Supply failures**  
(lack of food availability)

Cereal import dependency ratio  
(2016–18 average)



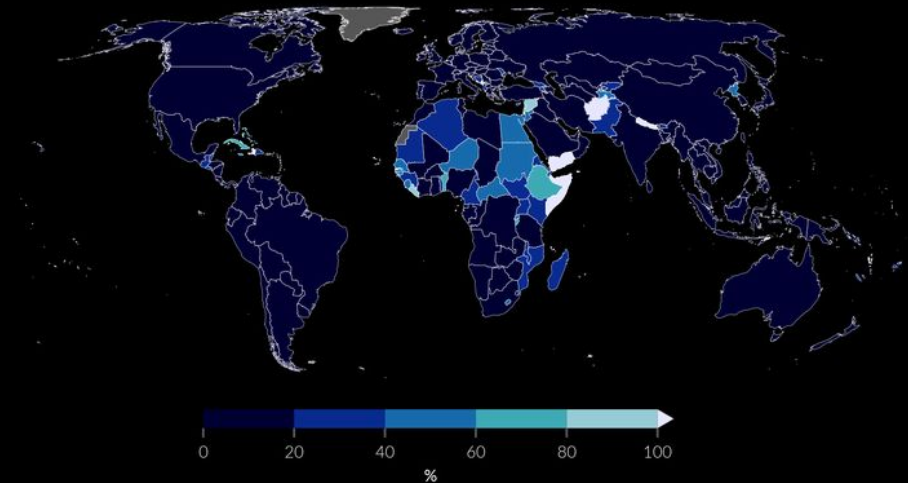
[Source: FAOSTAT]

# Fragility of the world food web | trade dependencies

Concentration of production to few main breadbasket regions results in:

- **Import dependencies** of many developing countries render them vulnerable to
  - **Supply failures**  
(lack of food availability)
  - **World market price hikes**  
(no access to food)

Value of food imports  
to total exports  
(2016–18 average)

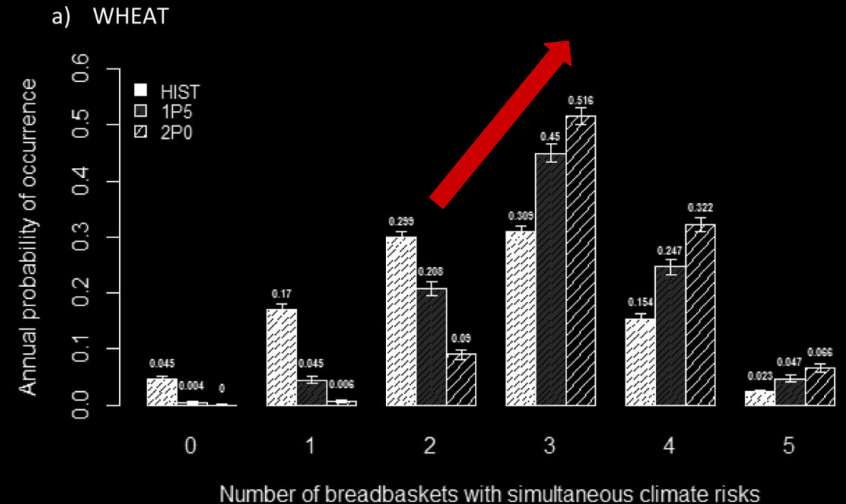


[Source: FAOSTAT]

# Short-term drivers of global food insecurity

- Climate induced crop production variability
  - Risk of (multi-)breadbasket failures
  - Projected to increase under global warming

## Risk of (multi-)breadbasket failures



[Gaupp et al. 2019, Agric. Systems]

# Short-term drivers of global food insecurity

- Climate induced crop production variability
  - Risk of (multi-)breadbasket failures
  - Projected to increase under global warming
- Uncoordinated unilateral policies
  - Export restrictions
  - Precautionary buyings

Export restrictions during  
2007/08 World Food Price Crisis





# Short-term drivers of global food insecurity

- Climate induced crop production variability
  - Risk of (multi-)breadbasket failures
  - Projected to increase under global warming
- Uncoordinated unilateral policies
  - Export restrictions
  - Precautionary buyings
- Armed conflicts
  - Less workforce for agriculture
  - Destroyed infrastructure



# Integrated Food Security Phase Classification (IPC)

Phase	Phase description and priority response objectives
<b>Phase 1</b> None/Minimal	Households are able to meet essential food and non-food needs without engaging in atypical and unsustainable strategies to access food and income. Action required to build resilience and for disaster risk reduction.
<b>Phase 2</b> Stressed	Households have minimally adequate food consumption but are unable to afford some essential non-food expenditures without engaging in stress-coping strategies. Action required for disaster risk reduction and to protect livelihoods.
<b>Phase 3</b> Crisis	Households either: <ul style="list-style-type: none"> <li>• have food consumption gaps that are reflected by high or above-usual acute malnutrition; or</li> <li>• are marginally able to meet minimum food needs but only by depleting essential livelihood assets or through crisis-coping strategies.</li> </ul> <b>URGENT ACTION</b> required to protect livelihoods and reduce food consumption gaps.
<b>Phase 4</b> Emergency	Households either: <ul style="list-style-type: none"> <li>• have large food consumption gaps which are reflected in very high acute malnutrition and excess mortality; or</li> <li>• are able to mitigate large food consumption gaps but only by employing emergency livelihood strategies and asset liquidation.</li> </ul> <b>URGENT ACTION</b> required to save lives and livelihoods.
<b>Phase 5</b> Catastrophe	Households have an extreme lack of food and/or other basic needs even after full employment of coping strategies. Starvation, death, destitution and extremely critical acute malnutrition levels are evident. (For Famine classification, area needs to have extreme critical levels of acute malnutrition and mortality.)* <b>URGENT ACTION</b> required to revert/prevent widespread death and total collapse of livelihoods.