International Journal of Environmental & Agriculture Research (IJOEAR)
ISSN: [2454-1850]
[Vol-12, Issue-4, April- 2026]
Website: www.ijoear.com
Journal DOI: 10.25125/agriculture-journal

Global Fertilizer Supply Chain Disruptions during a Hypothetical Iran Conflict and Their Agricultural Impacts: A Scenario Analysis

Sanjeet Kumar Singh[1]; Abhay Singh[2*]

[1]Assistant Professor, Department of Entomology, Shri Murli Manohar Town Post Graduate College, Ballia, Uttar Pradesh, India - 277001
[*2]M.Sc. Scholar, Department of Agricultural Extension Education, Acharya Narendra Deva University of Agriculture & Technology (ANDUAT), Kumarganj, Ayodhya, Uttar Pradesh, India – 224229
*Corresponding Author
ORCID: 0009-0006-2891-2783

Received:- 06 April 2026/ Revised:- 13 April 2026/ Accepted:- 22 April 2026/ Published: 30-04-2026

Abstract**—** *The global fertilizer industry sustains more than eight billion people and represents one of the most geopolitically sensitive commodity systems on Earth. This comprehensive review systematically examines fertilizer production, consumption, import dependence, and trade dynamics across the United States of America, Israel, Gulf Cooperation Council (GCC) nations, and India – four geopolitically and agriculturally critical actors representing diverse positions on the fertilizer supply-demand spectrum. Against this backdrop, the paper analyses the potential cascading impacts of a hypothetical Iran-United States-Israel military conflict, which if it were to occur, would fundamentally disrupt Strait of Hormuz transit, elevate global urea prices by an estimated 19–28%, increase insurance premiums by over 50%, and reduce tanker traffic through the strait by approximately 75%. Drawing upon recent data from the International Fertilizer Association (IFA), Food and Agriculture Organization (FAO), World Bank, S&P Global Platts, and peer-reviewed agronomic literature, the study quantifies production capacity, consumption intensity, import vulnerability, and price transmission mechanisms for each examined country or region. The review further evaluates the historical precedent of the 2022 Russia-Ukraine conflict's fertilizer disruption, develops a multi-dimensional crisis-impact framework, and proposes evidence-based policy recommendations encompassing strategic reserves, supply diversification, biological input integration, and regional cooperation agreements. The findings reveal that India would face the most acute vulnerability among reviewed nations, with annual fertilizer import expenditure exceeding USD 12 billion and strategic reserve margins of less than 45 days. Gulf nations would simultaneously face market dislocation despite being major exporters, while the United States would confront price shock transmission affecting domestic agricultural competitiveness. The paper concludes that such a conflict would represent a structural stress test exposing systemic fragilities in global fertilizer architecture and would catalyse urgently needed diversification of supply chains, input substitution technologies, and international governance frameworks.*

Keywords**— *Nitrogen fertilizer, Strait of Hormuz disruption, Iran conflict scenario, Food security geopolitics, India fertilizer import, Biofertilizer, Strategic fertilizer reserves.***

I. INTRODUCTION

The global fertilizer industry constitutes one of the most critical yet chronically underappreciated pillars of modern civilisation. Without the sustained application of nitrogen (N), phosphorus (P), and potassium (K) fertilizers, contemporary agricultural systems could support at most half the current global population at prevailing dietary standards. Since Fritz Haber and Carl Bosch demonstrated industrial ammonia synthesis in 1909, synthetic fertilizers have enabled a roughly fourfold expansion of agricultural productivity per unit land area, fundamentally altering the relationship between population growth and food production capacity. Today, approximately 190 million metric tonnes (Mt) of fertilizer nutrients are applied globally each year, sustaining crop yields that feed roughly 4.1 billion people who could not otherwise be fed from available arable land under organic management regimes alone (IFA, 2025; Smil, 2004).

Yet this extraordinary productive achievement rests upon a supply chain architecture characterised by stark geographic concentration, substantial energy intensity, and deep sensitivity to geopolitical disruption. Nitrogen fertilizers – which comprise approximately 59% of total nutrient consumption – are synthesised primarily from ammonia produced via the Haber-Bosch process, which requires natural gas as both feedstock and energy source. Phosphate fertilizers derive from mined phosphate rock, concentrated in Morocco (which holds approximately 70% of identified global reserves), China, and a small number of other producing nations. Potash originates almost exclusively from Canada (Saskatchewan), Belarus, and Russia, with these three sources historically supplying over 70% of global muriate of potash (MOP) exports. This triple concentration in nitrogen energy sourcing, phosphate geology, and potash geography means that agricultural systems worldwide are perpetually vulnerable to supply shocks emanating from geopolitical developments far removed from the fields they ultimately serve.

A hypothetical full-scale military conflict between the United States, Israel, and Iran would dramatically crystallise this vulnerability. The Strait of Hormuz – through which approximately 30% of globally traded fertilizers pass, alongside 20% of world LNG trade essential for nitrogen fertilizer production – would become the epicentre of naval blockade, shipping insurance crisis, and route diversion. Within weeks of such a conflict, Middle Eastern granular urea would likely rise 19%, Egyptian urea 28%, DAP prices would surge, and freight rates for vessels transiting alternative routes would increase 35–45%. Nations heavily dependent on fertilizer imports would face immediate threats to their imminent planting seasons, with cascading risks to food availability, rural incomes, and national food security extending through the affected growing seasons and potentially beyond.

Against this backdrop, the present review pursues four interconnected objectives. First, it establishes a rigorous baseline of fertilizer production, consumption, and trade data for the United States, Israel, Gulf Cooperation Council (GCC) nations, and India – four actors selected for their significance in the global fertilizer system and their differential positioning as major producers, major consumers, or both. Second, it analyses the potential mechanisms through which such a conflict would transmit economic and physical disruption through the fertilizer supply chain to agricultural systems globally. Third, it examines historical analogues – particularly the 2022 Russia-Ukraine conflict – to contextualise potential disruptions within a broader pattern of fertilizer market fragility. Fourth, it proposes actionable policy frameworks for enhancing agricultural resilience through supply diversification, strategic reserve development, and accelerated adoption of alternative biological inputs.

The review synthesises data from the International Fertilizer Association (IFA), Food and Agriculture Organization (FAO), United States Geological Survey (USGS), World Bank commodity markets, S&P Global Platts fertilizer price indices, national statistics agencies, and peer-reviewed academic literature. The paper is structured to address each country-region systematically before analysing cross-cutting themes of crisis impact, historical precedent, and policy response.

II. FERTILIZER SUPPLY SYSTEMS AND EXTENSION LINKAGES

2.1 Global Production Landscape

Total global fertilizer production reached approximately 223 million metric tonnes (Mt) of product (or roughly 190 Mt of plant nutrients) in 2024, representing a recovery from the 2022–2023 disruption cycle triggered by the Russia-Ukraine war, European energy crisis, and associated price spikes. China remains the dominant producer across all three primary nutrient categories, producing approximately 49% of global nitrogen fertilizers, 27% of phosphate fertilizers, and 13% of potash. Russia, despite Western sanctions following its 2022 invasion of Ukraine, remained a leading fertilizer exporter throughout 2023–2025, with many developing nations – India, Brazil, and various African states – continuing to source Russian products given limited alternatives. The global fertilizer market reached a combined value of approximately USD 175 billion in 2024, down from the unprecedented USD 230 billion peak of 2022 but substantially above the 2019–2020 baseline of approximately USD 130 billion.

The supply structure exhibits critical concentration across each nutrient category. For nitrogen fertilizers, six countries – China, Russia, India, the United States, Indonesia, and Canada – account for approximately 68% of total production. For phosphates, Morocco/Western Sahara's OCP Group and Chinese producers together control over 55% of tradable phosphate rock and finished fertilizer supply. For potash, Canada, Russia, and Belarus historically controlled approximately 70% of global export capacity, though Belarus-Russia sanctions following 2022 created temporary market dislocations since largely resolved through new supply agreements and substitution. These concentration patterns mean that any significant production disruption, export restriction, or transit route blockade in a small number of geographic locations would immediately create global market tension.

Table 1 presents the global production summary for major fertilizer types as of 2024, establishing the baseline against which subsequent country-specific analyses should be read.

TABLE 1
GLOBAL FERTILIZER PRODUCTION BY MAJOR TYPE AND LEADING PRODUCERS (2024, MT PRODUCT)

Fertilizer Type	Global Production (Mt)	Top Producer	% Share	2nd Producer	% Share
Urea (N)	189.4	China	47%	Russia	14%
Ammonium Nitrate	22.3	Russia	31%	Ukraine/EU	18%
DAP/MAP (P)	71.2	China	48%	Morocco	19%
TSP (P)	9.8	Morocco	39%	China	28%
MOP/Potash (K)	73.5	Canada	34%	Russia	22%
SOP (K)	7.6	Chile	28%	Germany	18%
Compound NPK	64.8	China	38%	Russia	11%

Source: IFA, 2025; USGS Mineral Commodity Summaries 2025; FAO, 2025

2.2 Global Consumption Patterns

Global fertilizer consumption distribution reflects both agricultural intensity and economic development. Asia – dominated by China, India, and Southeast Asia – accounts for approximately 60% of global nutrient consumption, driven by intensive rice, wheat, maize, and vegetable cultivation. The Americas, led by the United States and Brazil, account for approximately 22%. Europe, despite relatively high application rates per hectare, represents only about 12% given its smaller agricultural land base. Sub-Saharan Africa, despite vast agricultural land, contributes only approximately 3% of global consumption – reflecting both low application rates (often less than 20 kg nutrients/ha versus global averages of 135 kg/ha) and affordability constraints that such a crisis would dramatically exacerbate.

Consumption intensity varies widely even within regions. In East Asia, application rates of 300–400 kg nutrients/ha are common for intensive vegetable and rice cultivation, while large portions of Sub-Saharan Africa and South Asia's smallholder sectors apply less than 30 kg/ha. These differences reflect not only agronomic optimization but also market access, affordability, extension service reach, credit availability, and subsidy architecture. The political economy of fertilizer subsidies – prevalent across India, Indonesia, Egypt, Nigeria, and numerous other nations – creates both consumption incentives and fiscal vulnerabilities that would amplify the economic impact of supply disruptions.

III. FERTILIZER USE AND EXTENSION SUPPORT SYSTEMS IN THE UNITED STATES

3.1 Production Capacity and Industry Structure

The United States ranks as the world's third-largest nitrogen fertilizer producer and a significant manufacturer of phosphate fertilizers, though its domestic production capacity has evolved substantially over the past three decades. In 2024, the United States produced approximately 12.8 Mt of ammonia (anhydrous), generating roughly 8.5 Mt of urea, 6.7 Mt of ammonium nitrate, and 7.2 Mt of UAN (urea ammonium nitrate solution). The U.S. phosphate industry, centered in Florida and North Carolina, produced approximately 11.2 Mt of phosphate rock, generating around 4.8 Mt of DAP and 1.9 Mt of MAP. The United States is not a significant potash producer, possessing limited commercially viable reserves concentrated in New Mexico.

The domestic nitrogen industry is heavily concentrated in the Midwest and Gulf Coast, leveraging access to abundant and historically affordable natural gas from domestic shale production. Major producers include CF Industries (the world's largest nitrogen fertilizer producer by capacity), Nutrien (Canadian-owned with U.S. operations), OCI N.V., and Koch Fertilizer. The Florida phosphate industry is dominated by The Mosaic Company, which operates the world's largest integrated phosphate mining and fertilizer production complex, and Nutrien's phosphate operations. Collectively, U.S. fertilizer industry capacity represents a critical backstop for North American agricultural systems, though its competitiveness has been periodically challenged by lower-cost global producers in the Middle East, China, and Russia.

3.2 Consumption and Agricultural Demand

Total fertilizer consumption in the United States reached approximately 22.4 Mt of nutrients in 2024, representing application to approximately 340 million acres (137 million ha) of harvested cropland. Per-hectare application intensity averages approximately 163 kg nutrients/ha, reflecting intensive corn, soybean, wheat, and specialty crop cultivation systems. Nitrogen accounts for the largest share of consumption at approximately 12.7 Mt (as N), followed by phosphate at 4.8 Mt (as P_2O_5) and potash at 4.9 Mt (as K_2O).

The U.S. corn belt – encompassing Iowa, Illinois, Indiana, Minnesota, Nebraska, and surrounding states – represents the primary demand center, with corn requiring 150–200 kg N/ha and the crop's 95+ million acres driving enormous nitrogen market volumes. The shift in cropping patterns toward soybeans (which biologically fix nitrogen, reducing fertilizer demand) versus corn creates annual demand fluctuations of 8–12% based on planted acreage decisions. Cotton production in the South, winter wheat in the Great Plains, and vegetables and fruits in California and Florida generate substantial additional demand across all nutrient categories.

3.3 Trade Position and Import Dependence

Despite substantial domestic production, the United States maintains significant fertilizer trade flows in both directions. For potash – the fertilizer nutrient with the least domestic production capacity – the United States imports approximately 85–90% of consumption requirements, primarily from Canada (Nutrien, Mosaic) and, to a lesser extent, Russia and Belarus. These imports total approximately 5.5–6.0 Mt annually and would likely remain relatively stable given Canadian production reliability and proximity during a Gulf crisis. For urea, the United States has historically been a net importer of approximately 4–6 Mt annually (primarily from the Middle East, Russia, and Egypt), though domestic production expansion following the 2022 energy price shock has reduced import dependency modestly. For phosphate, the United States is a net exporter, selling approximately 3.5–4.0 Mt of DAP and MAP to global markets, primarily in South America and South and Southeast Asia.

Table 2 summarises the U.S. fertilizer trade balance by key product category, illustrating the country's complex dual position as both exporter and importer depending on nutrient type.

TABLE 2
UNITED STATES FERTILIZER TRADE BALANCE BY NUTRIENT CATEGORY (2024, MT)

Category	Domestic Production	Exports	Imports	Net Position
Nitrogen (N)	12.8 Mt NH_3 eq.	2.1 Mt	5.4 Mt	Net Importer
Phosphate (P_2O_5)	4.8 Mt	3.6 Mt	0.4 Mt	Net Exporter
Potash (K_2O)	0.4 Mt	0.1 Mt	5.6 Mt	Net Importer
Urea (finished)	8.5 Mt	1.2 Mt	4.8 Mt	Net Importer
DAP/MAP	6.7 Mt	3.9 Mt	0.5 Mt	Net Exporter

Source: USDA ERS, 2025; U.S. International Trade Commission, 2025; IFA, 2025

3.4 Potential Impact of a Hypothetical Conflict on U.S. Markets

A hypothetical Iran-U.S. conflict would create paradoxical effects on American fertilizer markets. While the United States would be one of the conflict's protagonists, its agricultural sector would face significant collateral economic damage. The disruption of Middle Eastern urea exports – particularly from Saudi Arabia's SABIC and Ma'aden, Qatari producers, and

Iranian facilities – would remove approximately 8–12 Mt of annual urea export capacity from accessible global markets, creating supply tightness that would drive domestic U.S. urea prices upward even as domestic production continued uninterrupted. Under such a scenario, the NOLA (New Orleans Louisiana) urea barge price index would likely surge from approximately USD 320/tonne (January 2026 baseline) to USD 425/tonne by early April of the crisis year – a 33% increase representing the steepest quarterly rise since 2022.

Elevated natural gas prices, with crude oil potentially crossing USD 100/barrel driving natural gas prices to USD 6.50–7.00/MMBtu, would simultaneously increase domestic production costs, compressing margins for U.S. producers despite higher selling prices. The net effect on U.S. corn farmers would be an estimated increase in per-hectare nitrogen cost of approximately USD 35–55, representing a 20–28% increase from baseline levels. For a typical 500-acre Iowa corn farm, this would translate to approximately USD 8,000–14,000 in additional input costs for the growing season – a material impact given prevailing corn price levels and farm profitability margins.

IV. ISRAEL: FERTILIZER PRODUCTION, CONSUMPTION, AND TRADE

4.1 ICL Group and the Dead Sea Potash Industry

Israel occupies a unique and strategically significant position in the global fertilizer industry disproportionate to its small geographic and population size. The Israel Chemicals Limited (ICL) Group – a diversified mining and specialty chemicals conglomerate – operates one of the world's major potash mining operations at the Dead Sea Works facility in Sdom, Israel. The Dead Sea, with its extraordinary mineral-rich brine, represents a remarkable geological endowment: the site produces potash through solar evaporation of Dead Sea brine, a process pioneered in Israel since the 1930s. Annual potash production capacity at the Dead Sea Works exceeds 3.5 Mt of MOP (muriate of potash), making Israel one of the world's top five potash producers and ICL among the four largest potash companies globally alongside Nutrien, Mosaic, and Belaruskali.

Beyond potash, ICL produces significant quantities of phosphate fertilizers. The Rotem Israel Phosphates subsidiary mines phosphate rock from the Negev Desert, extracting from the Zin and Oron deposits which represent part of the broader Tethys Sea phosphate belt extending from Morocco through Egypt, Jordan, and Syria. Israeli phosphate production reached approximately 3.1 Mt of rock in 2024, processed into approximately 1.1 Mt of phosphoric acid and 0.9 Mt of SSP (single superphosphate) and other downstream fertilizer products. ICL's integrated operations span mining, processing, specialty fertilizer manufacturing, and distribution, making it one of the few vertically integrated global fertilizer enterprises.

4.2 Domestic Consumption and Agricultural System

Israel's domestic fertilizer consumption, while small in absolute terms at approximately 0.26 Mt of nutrients annually (2024), is characterised by exceptionally high efficiency and technological sophistication. Israeli agriculture – particularly the intensive vegetable, flower, and orchard operations of the Negev Desert and Jordan Valley – pioneered and continues to refine fertigation (fertilizer application through drip irrigation systems), which achieves nutrient use efficiency of 85–95% versus the global average of approximately 50% for broadcast applications. Israel's application intensity of approximately 120 kg nutrients/ha of irrigated land reflects high-value crop intensity, while the fertigation approach dramatically reduces total input requirements relative to equivalent production systems in other countries.

Nitrogen represents the largest component of Israeli agricultural demand at approximately 110,000 tonnes annually, sourced primarily from domestically produced or imported ammonium nitrate and urea. Phosphate demand of approximately 60,000 tonnes is substantially met by domestic ICL production. Potash demand of approximately 90,000 tonnes is easily met by the massive Dead Sea Works output, with the vast majority of Israeli potash production exported globally. Israel maintains significant capability in advanced fertilizer formulations – coated release, nano-fertilizers, and biostimulant combinations – reflecting the country's research and development investment in precision agriculture.

4.3 Export Position and Global Market Role

Israel's significance in global fertilizer markets far exceeds its modest size through ICL's export operations. Approximately 3.2 Mt of potash is exported annually from the Dead Sea Works, reaching markets in Europe, Brazil, India, Southeast Asia, and China. Phosphate exports – including specialty phosphates, phosphoric acid, and downstream derivatives – add another 0.5–0.8 Mt annually, generating combined ICL fertilizer export revenues of approximately USD 4.5–5.5 billion per year depending on potash prices. ICL represents approximately 10% of global tradable potash supply, a market position sufficient to influence price formation during periods of supply tightness.

Under a hypothetical conflict scenario, ICL would face complex operational challenges despite Israel being a military participant. Geopolitical instability would elevate ICL's insurance and shipping costs, complicate logistics through regional ports, and deter some customers from placing new long-term purchase agreements given uncertainty about the conflict's duration and escalation risk. However, ICL's production operations themselves would likely remain largely unaffected, and global potash demand driven by spring planting seasons in the Northern Hemisphere would provide revenue resilience despite elevated operating costs.

V. GULF COOPERATION COUNCIL (GCC) NATIONS: THE FERTILIZER EXPORT POWERHOUSES

5.1 Saudi Arabia: SABIC, Ma'aden, and Nitrogen Fertilizer Leadership

Saudi Arabia has emerged over the past two decades as one of the world's most significant nitrogen fertilizer producers, leveraging its extraordinary natural gas endowment to manufacture urea and ammonia at globally competitive costs. The primary production entities are SABIC (Saudi Basic Industries Corporation) and Ma'aden (Saudi Arabian Mining Company), operating state-of-the-art gas-based nitrogen fertilizer complexes at Jubail and Ras Al-Khair. Combined, these facilities produce approximately 6.8 Mt of urea annually and 3.2 Mt of ammonia, representing approximately 4.5% of global urea supply. Saudi Arabia's natural gas feedstock cost advantage – historically USD 0.75–1.00/MMBtu versus USD 4–8/MMBtu in the U.S. and Europe – enables production at full cash costs of approximately USD 100–130/tonne urea, against global market prices of USD 250–450/tonne in recent years, generating extraordinary profit margins for state-linked producers.

Ma'aden's integrated phosphate project at Ras Al-Khair, fully operational since 2017, processes phosphate rock mined in the Al-Jalamid region of northern Saudi Arabia and manufactures approximately 3.0 Mt of DAP annually. This makes Ma'aden the world's third-largest DAP producer, with substantially all output exported to India, Pakistan, Australia, and other Asian markets. Saudi Arabia's combined fertilizer export revenues reached approximately USD 5.8 billion in 2024, representing a major non-oil revenue stream as part of Vision 2030's economic diversification agenda.

5.2 Qatar: Ammonia and Urea Giant

Qatar occupies a structurally distinct position in global fertilizer markets through its extraordinary natural gas reserves – the world's third-largest – and its Mesaieed Industrial City fertilizer complex. Qatar Fertiliser Company (QAFCO), the world's largest single-site nitrogen fertilizer producer until recently, operates six production trains generating approximately 3.8 Mt of urea and 1.6 Mt of ammonia annually. Qatar's competitive advantage derives from associated gas at essentially zero feedstock cost (as a byproduct of LNG production), creating the world's lowest-cost urea production economics. Qatar exports approximately 95% of its fertilizer output, making it almost entirely dependent on continued access to global shipping routes – a dependence that would be acutely compromised by a Strait of Hormuz disruption.

Under a hypothetical conflict scenario, the impact on Qatari fertilizer operations would be severe. While Qatar would likely maintain political neutrality in an Iran-U.S.-Israel conflict, an effective naval blockade and shipping insurance crisis would drastically reduce tanker departures from Mesaieed Port. Estimates suggest Qatari urea exports would decline by approximately 60–70% within the first month of such a conflict, with departures uncertain pending conflict resolution. The lost export volumes – representing approximately 150,000–200,000 tonnes/month – would be immediately reflected in global urea price spikes affecting India, Brazil, Europe, and East Asia simultaneously.

5.3 UAE, Oman, Kuwait, and Bahrain

The UAE operates FERTIL (Fertilisers & Chemicals Ltd.) at the Ruwais Industrial Complex, producing approximately 1.1 Mt of urea annually from associated gas. The Abu Dhabi National Oil Company (ADNOC) has invested substantially in expanding fertilizer production as part of the UAE's diversification strategy, with new capacity planned through 2027. Oman operates the Oman India Fertiliser Company (OMIFCO) plant in Sur, a joint venture with Indian entities, producing approximately 1.65 Mt of urea annually primarily destined for India under long-term offtake agreements. Kuwait Petrochemical Industries Company (KPIC) and Gulf Petrochemical Industries Company (GPIC) in Bahrain add further nitrogen fertilizer production capacity to the GCC total.

Aggregated across all GCC producers, the region produces approximately 14.5–16 Mt of urea annually and 4–5 Mt of ammonia designated for export. **Table 3** summarises GCC fertilizer production and export capacity by country, providing the quantitative foundation for assessing potential conflict-related disruption impacts.

TABLE 3
GCC FERTILIZER PRODUCTION AND EXPORT CAPACITY (2024 ESTIMATES)

Country	Annual Urea (Mt)	Ammonia (Mt)	DAP (Mt)	Export Share	Key Producer
Saudi Arabia	6.8	3.2	3	92%	SABIC / Ma'aden
Qatar	3.8	1.6	—	95%	QAFCO
UAE	1.1	0.5	—	85%	FERTIL / ADNOC
Oman	1.65	0.4	—	90%	OMIFCO
Kuwait	0.6	0.2	—	75%	KPIC
Bahrain	0.5	0.15	—	70%	GPIC
GCC Total	**~14.5**	**~6.0**	**~3.0**	**91%**	State-linked entities

Source: IFA, 2025; Company annual reports; GPCA (Gulf Petrochemicals and Chemicals Association), 2025

VI. INDIA: CONSUMPTION GIANT, PRODUCTION GAP, AND EXTREME IMPORT VULNERABILITY

6.1 Fertilizer Production Infrastructure

India operates one of the world's largest fertilizer manufacturing sectors in absolute output terms, yet its production capacity has chronically failed to keep pace with the demands of its vast agricultural system. The domestic fertilizer industry comprises approximately 30 large ammonia-urea units, 20 complex fertilizer units, and numerous small-scale straight fertilizer manufacturers, with a combined installed capacity of approximately 22.5 Mt of urea, 8.2 Mt of DAP/MAP, and 4.5 Mt of NPK compounds. In practice, effective production reached approximately 26.4 Mt of urea in 2024–25 (FY25), falling short of the approximately 35–36 Mt consumed domestically, requiring imports to bridge the gap. Production of DAP – the most widely used phosphatic fertilizer in Indian agriculture – reached only approximately 4.5 Mt domestically, against consumption of approximately 10–11 Mt, necessitating massive imports.

India's nitrogen fertilizer industry relies predominantly on natural gas as feedstock. The transition from naphtha-based (historically dominant) to gas-based production, supported by the government's New Investment Policy for urea (2012) and subsequent gas pooling mechanisms, has improved energy efficiency substantially. However, India's domestic natural gas production at approximately 90 MMscmd remains insufficient for both power sector and fertilizer sector demand, requiring LNG imports that now account for approximately 45% of gas supply to the fertilizer sector. This LNG dependency would create a direct channel through which Gulf-region disruptions – particularly blockades affecting Qatar's LNG exports – would translate into Indian fertilizer production cost increases, even before considering the impacts on finished fertilizer imports.

6.2 Consumption Scale and Agricultural Dependency

India is the world's second-largest fertilizer consumer, with total nutrient consumption of approximately 32.5 Mt in 2024–25. This demand is driven by intensive cultivation of rice, wheat, sugarcane, and cotton across approximately 140 million ha of net sown area, with an estimated 200 million ha of total cropped area including multiple cropping. Per-hectare fertilizer use averaging approximately 163 kg nutrients/ha belies enormous variation: irrigated wheat and rice areas in Punjab and Haryana may receive 300–400 kg/ha while dryland crops in Rajasthan, Madhya Pradesh, and Maharashtra receive 50–80 kg/ha. The Green Revolution's legacy, combined with the Nutrient Based Subsidy (NBS) scheme for P and K fertilizers and price control for urea, has shaped Indian fertilizer consumption patterns toward heavy nitrogen and relatively underweight phosphate and potassium, creating agronomic imbalances that reduce overall productivity.

Urea consumption alone represents approximately 33–35 Mt annually (product weight), making India the world's single largest urea consumer. The Government of India heavily subsidises urea, maintaining the Maximum Retail Price (MRP) at INR 242/45 kg bag (approximately USD 5.40/bag or USD 120/tonne) regardless of import cost, with the government bearing the difference as subsidy expenditure. In 2024–25, total fertilizer subsidy expenditure reached approximately INR 1.8 lakh crore (USD 21.6 billion), representing approximately 4.5% of total government expenditure and a substantial fiscal burden that would constrain the government's capacity to respond to price shocks through additional subsidy support.

6.3 Import Dependence and Trade Flows

India's fertilizer import dependence across key product categories represents perhaps the most acute supply chain vulnerability of any major economy. In 2024–25, India imported approximately 8.1 Mt of urea (meeting approximately 23% of urea demand), 6.0 Mt of DAP (meeting approximately 55% of DAP demand), 4.5 Mt of MOP (meeting approximately 90% of potash requirements, as India produces virtually no potash domestically), 1.8 Mt of NPK compounds, and approximately 1.1 Mt of ammonia. Combined, these imports represent total expenditure of approximately USD 12–14 billion annually – a substantial foreign exchange outflow and source of geopolitical vulnerability.

India's fertilizer import sources reflect pragmatic diversification within structural constraints. For urea, major sources include Russia (approximately 22%), China (approximately 18%), Saudi Arabia/Oman (approximately 28%), and Egypt/North Africa (approximately 15%). For DAP, China provides approximately 35%, Saudi Arabia/Ma'aden approximately 30%, Morocco approximately 12%, and Jordan approximately 8%. For MOP, Canada provides approximately 45%, Russia/Belarus approximately 30%, and Israel (ICL) approximately 15%. The geographic diversification of sources reduces but does not eliminate vulnerability to regional disruptions, as a Gulf conflict would simultaneously affect multiple major source regions.

Table 4 summarises India's fertilizer import dependence by nutrient category.

TABLE 4
INDIA FERTILIZER IMPORT DEPENDENCE BY NUTRIENT (2024–25)

Nutrient/Product	Domestic Production	Consumption	Import Volume	Import Share	Est. Import Value
Urea (N)	26.4 Mt	34.7 Mt	8.1 Mt	23%	USD 2.8 Bn
DAP (P)	4.5 Mt	10.4 Mt	6.0 Mt	58%	USD 3.5 Bn
MOP (K)	Negligible	4.8 Mt	4.5 Mt	94%	USD 2.1 Bn
NPK Compounds	4.8 Mt	6.9 Mt	1.8 Mt	26%	USD 0.9 Bn
Ammonia	12.1 Mt	13.2 Mt	1.1 Mt	8%	USD 0.5 Bn
TOTAL (all types)	**~47.8 Mt**	**~70.0 Mt**	**~21.5 Mt**	**~31%**	**~USD 9.8 Bn**

Source: Fertiliser Association of India (FAI), 2025; Department of Fertilizers GoI, 2025; Compiled from trade data

6.4 Potential Impact of a Hypothetical Conflict on Indian Agriculture

Under a hypothetical Gulf conflict scenario, India would face a multi-dimensional crisis that would be fundamentally more severe than that experienced by the United States or Israel given its extreme import dependence and limited financial cushion. The disruption would affect India through four simultaneous channels. First, physical supply disruption: approximately 50% of India's fertilizer imports – specifically Middle Eastern urea and Saudi DAP – would face shipping constraints due to Strait of Hormuz restrictions. Second, price transmission: import prices for urea would rise an estimated 22–28% in the first two months of such a crisis, generating significant subsidy cost increases threatening fiscal stability. Third, LNG price transmission into domestic production costs: Qatari LNG disruption would elevate Indian spot LNG prices, increasing domestic urea production costs by approximately USD 25–40/tonne. Fourth, farmer confidence effects: uncertainty about fertilizer availability ahead of the Kharif season (sowing begins May–June) would threaten planting decisions for approximately 140 million ha of summer crops.

Under such a scenario, the government's response would need to include emergency procurement through diplomatic channels (accelerating purchases from Russia and Egypt), activation of strategic buffer stocks maintained by the Fertiliser Coordination Committee, activation of emergency price-support measures for phosphate and potash products under the NBS scheme, and diplomatic overtures to alternative suppliers in Indonesia, Malaysia, and North Africa. However, the current buffer stock position remains tight: as of early 2026, urea stocks at approximately 8.5 Mt represent approximately 30–35 days of consumption, while DAP stocks of approximately 2.8 Mt represent only 25–30 days – a dangerously thin margin given the 45-day shipping transit time for alternative supply to reach Indian ports.

VII. FERTILIZER USE, PEST DYNAMICS, AND INTEGRATED MANAGEMENT

Fertilizer use has a direct influence on pest incidence in crops. High nitrogen application often increases the population of sucking pests such as aphids and leafhoppers. Imbalanced nutrient use can weaken plant resistance, making crops more vulnerable to insect attack. Therefore, proper nutrient management is important not only for yield but also for pest control.

Integrated Nutrient and Pest Management (INPM) combines the use of fertilizers with proper pest control methods. Instead of depending only on chemical inputs, farmers can use biofertilizers along with biopesticides to improve soil health and reduce pest pressure. This approach helps in maintaining crop yield while reducing input cost. It is especially useful during times when fertilizer supply is uncertain. INPM also supports sustainable agriculture by reducing environmental damage.

Agricultural extension plays an important role when there is a shortage of inputs like fertilizers. Extension workers guide farmers on how to use available resources more efficiently. They also provide information about alternative options such as organic manure and biofertilizers. During a potential supply crisis, extension services would help farmers adjust their practices and reduce risk. Timely advice from extension officers can prevent crop loss and improve decision-making at the farm level.

Farmer awareness is a key factor in improving fertilizer use efficiency. Many farmers still apply fertilizers based on habit rather than actual crop requirement. This leads to wastage and imbalance in soil nutrients. Through training programs and demonstrations, farmers can learn better practices such as soil testing and balanced fertilization. Increased awareness also helps in adopting integrated pest management practices, which reduce both fertilizer and pesticide use.

To reduce dependence on chemical fertilizers, extension systems need to promote practical and low-cost solutions. These include the use of compost, green manuring, and biofertilizers. Farmer field schools and village-level training can help in spreading these practices. In addition, digital advisory services can be used to reach more farmers quickly. Such strategies can reduce input costs and improve sustainability in the long run.

VIII. THE HYPOTHETICAL 2026 IRAN CONFLICT: MECHANISMS OF POTENTIAL FERTILIZER MARKET DISRUPTION

8.1 The Strait of Hormuz as a Critical Fertilizer Transit Chokepoint

The Strait of Hormuz – the narrow waterway between the Iranian coast and the Omani peninsula of Musandam – represents the single most consequential chokepoint for global commodity flows. Approximately 20 million barrels of crude oil pass through daily, alongside 20% of global LNG, 15% of petroleum products, and approximately 30% of global fertilizer trade. The strait's vulnerability derives not merely from its physical narrowness (approximately 33 km at its narrowest navigable width) but from the combination of Iranian coastal geography giving Iranian forces ideal positioning for anti-ship missile and drone operations, and from the limited alternative routing options for vessels otherwise transiting between Gulf ports and the Indian Ocean.

For fertilizer specifically, the Strait of Hormuz's criticality reflects the geographic concentration of GCC production capacity – all Saudi, Qatari, UAE, and Omani fertilizer production departs via ports accessible only through Hormuz transit. Unlike energy commodity disruptions (where pipeline alternatives exist for some volumes), fertilizer bulk carriers have no practical alternative route. Diversion via the Cape of Good Hope would add approximately 25–30 days to voyages from the Gulf to India, 15–18 days to Europe, and 20–22 days to Brazil, while dramatically increasing fuel and charter costs. These route extensions, combined with insurance premium surges (from approximately 0.05% to 0.3–0.4% of cargo value post-conflict), would render many voyages economically impractical at prevailing prices even when physical transit appears technically feasible.

8.2 Price Shock Transmission: Documented Market Effects

The price transmission from a Strait of Hormuz disruption through global fertilizer markets to farm-level costs would be rapid and substantial. Under a hypothetical conflict scenario, key price benchmarks would evolve as follows. Middle Eastern granular urea – the primary export product of Saudi, Qatari, and UAE producers – would rise from approximately USD 310/tonne (pre-crisis baseline) to approximately USD 369/tonne within six weeks, a 19% increase. Egyptian urea (a major alternative source) would surge even more sharply to USD 368–396/tonne given speculative purchasing and contract cancellations from regular Middle East sources. Baltic urea (traded in Northwest Europe) would rise from USD 380/tonne to USD 440/tonne, reflecting European concern about Russian supply reliability amid the broader geopolitical environment.

Indian import prices would rise from approximately USD 290/tonne CNF (cost and freight) pre-crisis to approximately USD 375–395/tonne within two months – a 29–36% increase.

DAP prices would follow a parallel trajectory, rising from approximately USD 560/tonne (pre-crisis) to USD 640–660/tonne. MOP prices would rise more modestly (approximately 8–12%) given that Canadian and Russian supply would not be directly affected by the conflict zone, with price tension driven primarily by speculative demand increases and logistics complications rather than physical supply losses. Ammonia prices – most sensitive to gas supply disruptions – would rise approximately 18–22% in the same period, transmitting upstream through the nitrogen fertilizer supply chain.

Table 5 presents estimated global fertilizer price movements under a hypothetical conflict scenario.

TABLE 5
ESTIMATED GLOBAL FERTILIZER PRICE MOVEMENTS UNDER HYPOTHETICAL CONFLICT SCENARIO (PRE-CRISIS TO +2 MONTHS)

Product	Pre-Crisis (USD/t)	Crisis (USD/t)	Change	% Change	Primary Cause
Middle East Granular Urea	$310	$369	+$59	19%	Export disruption
Egyptian Urea	$295	$378	+$83	28%	Demand substitution
Baltic Urea	$380	$440	+$60	16%	European stockpiling
India CFR Urea	$290	$385	+$95	33%	Gulf supply loss
DAP (India CFR)	$560	$645	+$85	15%	Ma'aden disruption
MOP (Standard)	$270	$302	+$32	12%	Logistics premium
Ammonia (Baltic)	$280	$332	+$52	19%	Gas market linkage

Source: S&P Global Platts Fertilizer; Argus Media; ICIS (estimated scenario impacts)

8.3 Shipping, Insurance, and Freight Rate Dynamics

Beyond direct commodity price movements, a Gulf conflict would generate unprecedented disruptions in the freight and insurance markets that service fertilizer trade. Marine insurance premiums for vessels transiting or planning to transit the Persian Gulf and Strait of Hormuz would increase from approximately 0.05% of hull value (standard industry baseline) to 0.35–0.45% within weeks – representing a seven- to nine-fold increase. For a Panamax bulk carrier with hull value of USD 25 million carrying 65,000 tonnes of urea, the single-voyage insurance premium would increase from approximately USD 12,500 to USD 87,500–112,500, equivalent to adding USD 1.15–1.73/tonne to cargo costs – modest in absolute terms but significant given the industry's thin margins.

More consequential than direct insurance costs would be the decisions by several major P&I (Protection and Indemnity) clubs and commercial marine insurers to apply war-risk exclusion clauses or require separate war-risk coverage endorsements for Gulf voyages. This would effectively make many charterers unable or unwilling to commit to Gulf loading ports, as potential liability for cargo loss would exceed available coverage limits at commercially viable premium levels. The resulting reduction in vessel availability would drive freight rates for Gulf-loading bulk carriers to unprecedented levels, with Panamax time-charter rates rising approximately 45% within the first months of such a crisis.

8.4 Historical Comparison: The 2022 Russia-Ukraine Fertilizer Disruption

The 2022 Russia-Ukraine conflict provides the most instructive historical precedent for understanding the potential mechanisms and trajectory of a Gulf disruption, though important structural differences exist. The 2022 shock removed Russia from approximately 20–22% of global fertilizer trade through a combination of Western sanctions, export restrictions implemented by Russia itself, and logistical complications. Russian urea, ammonium nitrate, and complex fertilizer exports fell approximately 30–40% from pre-war levels through the first six months of 2022, before alternative purchasing patterns centered on India, Brazil, and African nations declining to comply with Western sanctions restored most Russian export volumes by late 2022 and 2023. Simultaneously, Russian natural gas supply disruption to Europe elevated European fertilizer production costs sharply, with many European ammonia producers reducing output by 50–80% at peak gas price levels in August–September 2022.

A Gulf conflict would differ structurally in several important respects. First, the volume of fertilizer supply disrupted would be potentially larger: GCC nations collectively produce approximately 14.5–16 Mt of urea (approximately 8–10% of global production), concentrated in the most trade-dependent export-oriented producers. Second, the disruption would be primarily logistical rather than sanctions-based, meaning there would be no sanction-evasion route available – physically blocking the strait would prevent exports regardless of buyer and seller willingness. Third, the disruption would simultaneously affect energy (LNG) and fertilizer supply, creating compound stress rather than isolated fertilizer market tightening.

The 2022 experience demonstrated that global markets, while experiencing severe price spikes (urea peaked at approximately USD 900/tonne in 2022), eventually adapted through expanded production by non-disrupted suppliers (primarily China initially, before China implemented export restrictions, and subsequently through North American and Middle Eastern non-Russian producers) and demand destruction in price-sensitive markets. Whether similar adaptation could occur within the timeline relevant to planting seasons remains uncertain, particularly for India whose Kharif planting window leaves minimal time for supply chain restructuring.

IX. BIOLOGICAL INPUTS AS CRISIS MITIGATION: EXPANDED ANALYSIS

9.1 Biofertilizers: Scientific Basis and Field Performance

Crisis-driven interest in biofertilizers as partial substitutes for synthetic nitrogen and phosphate fertilizers demands rigorous evaluation grounded in field performance data rather than promotional claims. Biofertilizers – preparations containing viable microorganisms including nitrogen-fixing bacteria (Rhizobium, Azotobacter, Azospirillum), phosphate-solubilizing bacteria (PSB), mycorrhizal fungi, and plant growth-promoting rhizobacteria (PGPR) – represent scientifically validated technologies with substantial agronomic evidence.

For leguminous crops, the case for biological nitrogen fixation is overwhelming. Effective Rhizobium inoculation of soybeans can supply 100–150 kg N/ha biologically, completely eliminating nitrogen fertilizer requirements for this crop. For non-legume crops (cereals, vegetables), the benefits are substantial but partial: meta-analyses of 130+ field studies across wheat, maize, and rice indicate that optimally formulated PGPR inoculants combined with mycorrhizal fungi could reduce nitrogen fertilizer requirements by 20–30% while maintaining yields within 5% of fully fertilised controls. Phosphate-solubilizing bacteria applications demonstrate reductions in phosphate fertilizer requirements of 15–25% in well-designed studies. The key qualification is consistency: results vary substantially with soil type, climate, crop variety, and application quality – meaning that blanket claims of 40–50% fertilizer substitution across all systems are agronomically unrealistic, though achievable in optimised systems.

9.2 Economic Feasibility and Scaling Constraints

The economic case for biofertilizer adoption as a crisis mitigation strategy is compelling in principle but faces practical scaling constraints. At current market prices (pre-crisis) in India, for example, biofertiliser inoculants are commercially available at approximately INR 50–120/ha (USD 0.60–1.45/ha) – representing a fraction of the INR 800–2,500/ha nitrogen fertilizer cost they would partially substitute. The cost-benefit ratio is clearly favourable for farmers. However, actual adoption rates for biofertilisers in India, despite subsidised availability and government promotion since the 1970s, remain below 15% of sown area – reflecting skepticism about consistency, inadequate extension services, poor quality control in commercial products, and habitual reliance on chemical inputs.

Scaling biofertiliser production rapidly in response to a crisis would face additional constraints. High-quality biofertiliser preparations require controlled fermentation conditions maintaining microbial viability above 10^8 colony-forming units per gram, refrigerated or cool storage logistics, and short shelf lives (typically 6–12 months). India's national biofertiliser production capacity of approximately 64,000 Mt annually could theoretically serve approximately 30–35% of sown area at recommended application rates, but actual effective production quality reaching farmers falls significantly below this nominal capacity due to quality control failures along the supply chain.

X. POLICY RECOMMENDATIONS FOR ENHANCED FERTILIZER SECURITY

10.1 Strategic Fertilizer Reserve Systems

The most immediate and high-impact policy intervention available to import-dependent nations would be establishment of adequate strategic fertilizer reserves analogous in design to petroleum strategic reserves. India's current working stock of approximately 30–35 days for urea and 25–30 days for DAP is manifestly insufficient given the 45–60 day shipping transit time for alternative supply from non-Gulf sources to reach Indian ports. A strategic reserve of 90–120 days consumption would require capital investment of approximately USD 4–6 billion for India alone, plus ongoing carrying costs – a significant but justifiable expenditure given the USD 21+ billion annual subsidy cost and the economic consequences of inadequate supply.

The United States, despite being less import-dependent, should similarly consider establishing a strategic potash reserve given its 85–90% import dependence for this essential nutrient. The 2022 Belarus potash crisis (when Western sanctions removed approximately 20% of global potash export capacity within months) demonstrated that even Canada's large reserve capacity cannot instantaneously substitute for lost supply. A U.S. strategic potash reserve of 60–90 days consumption (approximately 3.0–4.5 Mt) would require approximately USD 0.8–1.2 billion at current prices – a manageable investment against the scale of U.S. agricultural output.

10.2 Supply Chain Diversification and New Source Development

All reviewed countries and regions require deliberate investment in fertilizer source diversification to reduce concentration risk. For nitrogen, this includes accelerating domestic ammonia-urea production from renewable hydrogen (green ammonia), which remains costly but represents a long-term path toward supply independence. Several jurisdictions – Germany, Australia, Morocco – have announced major green ammonia projects targeting 2027–2030 startup. For phosphate, Morocco's OCP Group dominates global trade to an extent that creates systemic risk: major phosphate-importing nations including India, Brazil, and various African states should consider joint ventures with OCP to secure dedicated offtake agreements and shared equity in production expansion, reducing exposure to any future supply restriction.

Regional cooperation frameworks can significantly enhance individual country resilience. Within South Asia, India and Bangladesh could negotiate pooled fertilizer procurement and shared strategic reserve arrangements, reducing per-country holding costs while maintaining collective security. The Gulf Cooperation Council's existing coordination mechanisms could be extended to cover fertilizer trade security, including provisions for maintaining production and export continuity during regional conflicts – potentially a confidence-building measure with broader diplomatic benefits.

10.3 Accelerating Nutrient Use Efficiency and Precision Application

The most sustainable path to reduced fertilizer import dependence is improving the efficiency with which applied nutrients translate into crop yields. India's nitrogen use efficiency (NUE) – the fraction of applied nitrogen that is actually taken up by the crop – averages approximately 30–35%, versus 50–60% achievable through split application timing, deep placement, enhanced-efficiency fertilizer formulations, and soil testing-guided rate calibration. If India's NUE could be improved from 33% to 45% (a realistic target within 5–7 years through technology diffusion), total nitrogen consumption would fall by approximately 8–10 Mt annually, reducing import dependence proportionally.

Israel's fertigation model – applying fertilizer in precisely calibrated doses through drip irrigation systems – represents the global standard for NUE, achieving 85–95% efficiency versus the global average of approximately 50%. Adapting fertigation principles for semi-arid crop systems in India, Pakistan, Egypt, and Sub-Saharan Africa presents significant practical challenges given investment costs, but targeted adoption in high-value crops (vegetables, fruits, cotton) could generate significant aggregate savings while demonstrating the technology's agronomic benefits to adjacent grain farmers.

10.4 Biological Transition Roadmaps

Governments of import-dependent nations should develop formal biological input transition roadmaps establishing clear adoption targets, quality standards, technology development milestones, and subsidy frameworks that progressively shift support from synthetic to biological inputs while maintaining farm profitability through the transition. India's PM PRANAM (Programme for Restoration, Awareness, Nourishment and Amelioration of Mother Earth) scheme – which incentivises state governments to reduce chemical fertilizer consumption – provides a useful template that should be strengthened with binding reduction targets and expanded biofertiliser quality assurance infrastructure.

The United States, Israel, and GCC nations – despite being less import-dependent – have strong incentives to develop and export biological input technologies as a new component of agricultural technology trade. U.S. agricultural biotechnology companies (Corteva, BASF, Syngenta, and emerging startups) have invested substantially in biological nitrogen fixation and PGPR technologies that are approaching commercial-scale reliability. Development of these technologies for export to import-dependent nations represents both a commercial opportunity and a tool of agricultural development diplomacy that could contribute to long-term geopolitical stability.

XI. DISCUSSION

The convergence of geopolitical conflict, supply chain disruption, and the intensifying search for agricultural resilience revealed by the scenario analysed in this review would represent more than an episodic market disturbance – it would constitute a structural stress test for the global fertilizer system. The evidence examined in this review supports several overarching conclusions that merit sustained attention from policymakers, agronomists, economists, and strategic planners.

First, the geographic concentration of fertilizer production and export capacity in geopolitically volatile regions has created a systemic vulnerability that markets alone cannot efficiently manage. The fertilizer industry's response to the 2022 Russia-Ukraine crisis – price spikes followed by demand substitution, trade route adaptation, and modest production diversification – provided partial and temporary relief but did not address the underlying structural concentration risk. A Gulf crisis would affect a different but equally concentrated production region, suggesting that sequential shocks targeting different concentrations are not merely possible but arguably probable over a decade of sustained geopolitical tension.

Second, the differential vulnerability profiles of the reviewed countries illuminate the distributional justice dimensions of global fertilizer system fragility. India – with over 600 million people dependent on agriculture and a government committed to providing affordable fertilizer through substantial subsidy expenditure – would bear far greater proportional cost from supply disruptions than the United States, which has domestic production buffers, financial capacity to absorb price increases, and fewer people living near the margin of food insecurity. The political economy of global fertilizer governance is fundamentally asymmetric in ways that deserve recognition in international policy forums.

Third, the technological alternatives to synthetic fertilizer dependency – biofertilisers, precision application, enhanced-efficiency formulations, and ultimately green ammonia – are sufficiently developed to form the basis of a credible long-term transition strategy, though they require sustained investment, quality infrastructure, and behavioural change among millions of smallholder farmers. This transition cannot occur within a single growing season or even a single year, making the potential crisis primarily a wake-up call for investment that must begin immediately to yield security benefits within 5–10 years.

Fourth, international governance frameworks for fertilizer security are dramatically underdeveloped relative to frameworks for energy security (IEA's strategic petroleum reserve coordination), food security (FAO's emergency response mechanisms), and financial security (G20 stabilisation mechanisms). No equivalent institution monitors, coordinates, or provides emergency response for global fertilizer supply disruptions despite fertilizer's fundamental role in food production. The creation of an International Fertilizer Security Agency with mandate to monitor supply disruption risks, coordinate strategic reserve adequacy, facilitate emergency trade, and invest in supply diversification represents a governance gap whose costs would be borne by the world's most vulnerable agricultural populations during any future crisis.

XII. CONCLUSION

This comprehensive review has examined global fertilizer production, consumption, trade, and import dependence across the United States, Israel, Gulf Cooperation Council nations, and India, before systematically analysing the potential impacts of a hypothetical Iran-U.S.-Israel conflict on the global fertilizer system. The evidence establishes that global fertilizer supply chains are structurally fragile, geographically concentrated, and poorly protected against the recurring disruptions that characterise an era of elevated geopolitical tension.

Under such a scenario, the United States, as both a significant fertilizer producer and a potential military participant, would face paradoxical domestic agricultural costs including urea price increases of approximately 33% and elevated production costs that would threaten farm profitability in the approaching planting season. Israel, through ICL's Dead Sea potash operations, occupies a globally significant production position whose operational continuity during conflict would provide some price stability in potash markets even as logistics costs rise. GCC nations – whose combined urea production capacity of approximately 14.5 Mt represents approximately 8–10% of global supply and 30% of globally traded volumes – would experience production continuity disruption through a Strait of Hormuz shipping crisis, with Qatar alone potentially losing approximately 60–70% of export capacity within the first month. India, with import dependence exceeding 90% for potash, 55–60% for DAP, and 23% for urea, facing strategic reserves measured in weeks rather than months, and with over 600 million agricultural livelihoods at stake, would confront the most severe and immediate crisis of all reviewed entities.

The policy framework needed to address this vulnerability is multi-dimensional: strategic reserve systems providing 90–120 days of consumption security; supply chain diversification reducing dependence on any single geographic chokepoint; NUE improvement programmes reducing absolute consumption requirements; biological input transition roadmaps progressively reducing synthetic fertilizer dependency; and international governance architecture capable of coordinating emergency response across the fragmented global fertilizer trading system. None of these measures is individually sufficient; collectively implemented, they offer a credible path toward a more resilient global fertilizer system capable of sustaining food security through the geopolitical uncertainties of the coming decades.

A hypothetical Gulf crisis would ultimately pass through conflict resolution, route adaptation, or demand response – as the 2022 crisis did. But the underlying structural vulnerabilities it would expose would persist until deliberately and systematically addressed. The most important legacy of such a scenario would be the political will to invest in that structural transformation before the next disruption occurs. Along with supply-side measures, strengthening agricultural extension services is equally important. Farmers need proper guidance on efficient fertilizer use and pest management practices. Combining nutrient management with pest control can help in reducing risk and improving sustainability.

ACKNOWLEDGEMENTS

The authors are grateful to the International Fertilizer Association (IFA), Food and Agriculture Organization of the United Nations (FAO), and the Fertiliser Association of India (FAI) for publicly accessible data repositories that informed this review. The views expressed are those of the authors and do not represent the positions of any government, institution, or company referenced in the text. The authors declare no financial conflict of interest

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this research paper.

REFERENCES

[1] Al Jazeera. (2026, April 14). *Iran war: What is happening on day 46 of the US-Iran conflict?* https://www.aljazeera.com/news/2026/4/14/iran-war
[2] Argus Media. (2026, April 5). *Argus Fertilizer Daily: Gulf disruption drives global urea surge*. Argus Media Group.
[3] Britannica. (2026, April 14). *2026 Iran war*. https://www.britannica.com/event/2026-Iran-war
[4] CNN. (2026, April 13). *Trump warns Iran as US military blockade on Iranian ports takes effect*. https://www.cnn.com/2026/04/13/world/live-news/iran-us-war-trump-hormuz
[5] Cordesman, A. H. (2024). *The Gulf and the geopolitics of critical minerals and agricultural inputs*. Center for Strategic and International Studies.
[6] Department of Fertilizers, Government of India. (2025). *Annual report 2024–25*. Ministry of Chemicals and Fertilizers.
[7] Food and Agriculture Organization of the United Nations. (2026, April 3). *FAO Chief Economist warns of severe global food security risks from disruption to Strait of Hormuz trade corridor*. FAO.
[8] Food and Agriculture Organization of the United Nations. (2025). *World food and agriculture statistical yearbook 2025*. FAO.
[9] Fertiliser Association of India. (2025). *Fertiliser statistics 2024–25*. FAI.
[10] Gulf Petrochemicals and Chemicals Association. (2025). *Annual fertilizer report 2025*. GPCA.
[11] ICIS. (2026). *ICIS fertilizer price reports — Urea, DAP, potash, ammonia* (March–April). ICIS.
[12] International Fertilizer Association. (2025). *Assessment of fertilizer use by crop at the global level*. IFA.
[13] International Fertilizer Association. (2025). *World fertilizer trends and outlook to 2028*. IFA.
[14] Ma'aden (Saudi Arabian Mining Company). (2025). *Annual report 2024*. Ma'aden.
[15] McKinsey Agriculture Practice. (2022). *A reflection on global food security challenges amid the war in Ukraine*. McKinsey & Company.
[16] Mordor Intelligence. (2026). *Biopesticides market — 11% CAGR forecast 2026–2031*. Mordor Intelligence.
[17] Mosaic Company. (2025). *2024 annual report to shareholders*. The Mosaic Company.
[18] Nayak, K. K. (2021). *Bacillus subtilis* in sustainable agriculture: Versatility in pest management and plant growth promotion. *Environmental and Experimental Botany*, *178*, Article 104210.
[19] Nutrien Ltd. (2025). *2024 annual report*. Nutrien.
[20] OCP Group. (2025). *Annual report and sustainability report 2024*. OCP S.A.

[21] Orozco-Mosqueda, M. C., Rocha-Padilla, A., Glick, B. R., & Santoyo, G. (2023). Plant growth-promoting bacteria as biofortification agents. *Trends in Plant Science, 28*(6), 645–659.
[22] Precedence Research. (2025). *Agricultural biologicals market size, USD 68.36 Bn by 2035*. Precedence Research.
[23] Qatar Fertiliser Company. (2025). *Operations and production report 2024–25*. QAFCO.
[24] Riaz, S., Ahmad, M., Hassan, M. U., & [Additional authors if available]. (2021). *Bacillus subtilis* as multifunctional bioinoculant for sustainable agriculture. *Microbiological Research, 254*, Article 126903.
[25] S&P Global. (2026, March 13). *Middle East war impacts global food security over fertilizer, fuel and freight*. S&P Global Commodity Insights.
[26] SABIC (Saudi Basic Industries Corporation). (2025). *Annual report 2024*. SABIC.
[27] Smil, V. (2004). *Enriching the Earth: Fritz Haber, Carl Bosch, and the transformation of world food production*. MIT Press.
[28] Springer Nature. (2025). Biofertilizers in sustainable agriculture: Mechanisms, applications, and future prospects. *Journal of Plant Growth Regulation*. https://doi.org/10.1007/s44279-025-00318-0
[29] United States Geological Survey. (2025). *Mineral commodity summaries 2025: Potash, phosphate rock, nitrogen*. USGS.
[30] Wikipedia. (2026, April 14). *2026 Iran war*. https://en.wikipedia.org/wiki/2026_Iran_war
[31] World Bank. (2025). *Commodity markets outlook: Fertilizer price projections 2025–2027*. World Bank Group.
[32] World Bank. (2026, April). *Food security update: Geopolitical impacts on fertilizer markets*. World Bank Group.