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Experiences Working with not Usual Feed Ingredients to Mitigate the Feed Geopolitical Disruption

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ABSTRACT

In an era marked by geopolitical instability, climate shocks, and disrupted trade routes, the global feed industry especially aquafeed faces structural transformations. Gianluigi Negroni's eight main chapters explores how these external pressures are reshaping protein supply chains, ingredient sourcing, and feed formulation strategies in 2025 and beyond. The narrative begins by identifying how trade fragmentation, conflicts, and rising shipping costs have endangered access to key feed ingredients such as fishmeal, soybean meal, and cereals. These disruptions have especially impacted producers in import-reliant regions like Africa, Asia, and Latin America. Amid this volatility, the need for feed reformulation and localized production has intensified. Additional details of available ingredients for the local Ugandan aquaculture feed production are highlighted in this paper; they were collected during PESCA project (2021-2024).

Keywords: Geopolitical Disruption, Supply Chains Under Strain, Food and feed Safety, Integrity

Geopolitical Disruption and the Future of Feed: Safeguarding Protein Supply Chains in 2025

Rising instability is reshaping the global animal protein and feed industries. What was once a logistics issue is now a question of food safety, market trust, and long-term resilience.

In 2025, the global animal protein industry—spanning livestock, poultry, and aquaculture—is navigating a period of historic turbulence. The pressure on protein supply chains is no longer limited to raw material availability or pricing. It now extends deep into the realms of geopolitical risk, consumer trust, and regulatory scrutiny. What's emerging is a more complex and fragile system, where resilience, adaptability, and transparency are the new currency of survival. Some trend of the main producers and users of feed ingredients are cited in this paper.

Supply Chains Under Strain

Feed ingredients such as soybean meal, fishmeal, poultry by-products, and sunflower meal are the foundation of global animal and aquaculture production. Yet the flows of these commodities are increasingly disrupted. Wars in Eastern Europe, tensions in the Middle East and Red Sea, sanctions, and trade restrictions are forcing buyers to seek alternative suppliers, often under pressure and with limited visibility. Traditional sourcing networks have fractured, exposing producers to unfamiliar intermediaries and new forms of risk.

Economic instability adds another layer of difficulty. High inflation, rising energy and shipping costs, and volatile currency markets are squeezing margins across the sector. Producers in emerging economies—particularly in Asia, Africa, and parts of Latin America—are feeling the sharpest impacts, with imported feed ingredients becoming prohibitively expensive. Cost pressures are triggering the reformulation of diets and greater

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reliance on local alternatives, but this too comes with trade-offs in nutritional quality, consistency, and regulatory compliance [1].

A Hidden Threat to Food and feed Safety and Integrity

As the feed and protein supply chains adjust under pressure, new vulnerabilities are emerging. With rapid supplier turnover and stressed logistics systems, the risk of food fraud, ingredient adulteration, and compromised safety standards is on the rise. When monitoring budget is thinner, audits are delayed, inspections are less frequent, and regulatory regimes are weakened by conflict or political instability, fraudulent or unsafe products can enter the supply chain undetected.

These conditions are not hypothetical. Past crises have shown that food safety and product integrity are often the first casualties when global systems are destabilized. In the current climate, safety lapses may not only threaten public health but also erode consumer trust and damage brand reputations. The stakes are high—and rising [2].

Changing Consumer Demands and Regulatory Pressures

Consumer expectations are simultaneously growing more complex. In high-value markets such as Europe and parts of Asia, sustainability has become non-negotiable. Buyers now demand deforestation-free soy, marine ingredients certified for responsible harvest, and clear carbon reduction targets. For aquaculture and livestock alike, these market signals are accelerating the shift toward more traceable, responsible, and transparent sourcing practices.

At the same time, regulators are tightening standards and increasing enforcement. Inconsistent compliance across fragmented global supply chains is no longer tolerated. Exporters seeking access to premium markets must now prove not just safety, but also sustainability and ethical integrity [3].

From Vulnerability to Resilience

In response to these converging challenges, the industry is undergoing a strategic realignment. Feed manufacturers are adopting circular economy principles—repurposing agri-food waste and local by-products into viable ingredients. Investment is growing in alternative protein sources: insect meal, microbial proteins, single-cell organisms, and algae-based oils. Technology plays a central role, with digital traceability tools, AI and blockchain-based records, and remote auditing becoming more widespread.

The health dimension is also gaining prominence. Animal disease outbreaks—such as African Swine Fever, avian influenza, and shrimp pathogens like WSSV—continue to disrupt production and shape demand. Functional feeds and immune-supporting additives are seeing increased adoption, especially in aquaculture, as producers seek to reduce antibiotic use while improving performance under biosecurity constraints.

A Strategic Imperative

What's clear is that managing geopolitical and economic risk can no longer be viewed as separate from managing food safety or trade. They are now interdependent. Companies that succeed will be those that embed risk foresight, ethical sourcing, and supply chain transparency at the core of their business model.

As the global protein sector looks beyond 2025, it faces a defining choice: react to disruption or prepare for it. Building resilient supply chains isn't just a technical fix—it's a strategic imperative. In an age of uncertainty, the future belongs to those who invest in adaptability, accountability, and trust.

Key Trends to Watch in 2025

- Global Animal Protein and Feed Supply Chains
- Geopolitical Risk as a Core Business Factor Companies now assess war, sanctions, and trade disruptions as strategic risks, not just externalities.
- Rise of Alternative Feed Ingredients Increased R&D and commercial uptake of insect meal, algae oils, microbial proteins, and agri-waste derivatives.
- Feed Cost Inflation and Volatility Continued upward pressure on raw material and energy prices is reshaping least-cost formulation strategies.
- Traceability and Digital Compliance Tools Blockchain-based sourcing, AI-powered fraud detection, and satellite verification are being mainstreamed.
- Food Integrity and Brand Risk Convergence Consumer-facing companies see food fraud and non-compliance as direct threats to brand equity.
- Localized Sourcing and Circular Economy Greater interest in regional supply networks, with a focus on by-products, upcycling, and climate-smart inputs.
- Convergence of Sustainability and Safety Green claims now go hand-in-hand with proof of quality, origin, and ethical compliance—especially in seafood.

Expert Perspective

"In times of geopolitical instability, food safety and fraud prevention are not secondary concerns—they are the front line. Every shift in trade patterns, every rerouted supply, is a moment of vulnerability. We need to respond with systems that are not only compliant, but intelligent, adaptive, and resilient."— Senior Global Advisor, Food Risk & Integrity

Trade and Market Volatility: The Impact of Global Disruptions on Feed, Meat, and Fish Markets

The global animal protein and feed markets are intricately connected to the broader dynamics of international trade. Trade wars, bilateral agreements, and shifting geopolitical alliances can all have significant, far-reaching effects on the availability and cost of feed ingredients and protein products [4].

Trade Wars and Bilateral Deals

One of the most direct influences on the global protein sector is the rise of trade wars and protectionist policies. The imposition of tariffs or trade restrictions between major economies can cause immediate volatility in feed and protein prices. For example, tariffs on soy or other key feed ingredients can disrupt established supply chains, leading to higher costs for producers. On the other hand, bilateral trade agreements between countries can mitigate these impacts, offering preferential access to feedstocks or protein products, thus stabilizing prices in some regions while creating uncertainties in others.

Market Volatility in Feed, Meat, and Fish Sectors

The animal protein industry, particularly the meat and fish market, remains highly sensitive to global economic and political shifts.

Trade disruptions, such as tariffs or sanctions, can significantly affect the cost of both feed ingredients and final protein products. For instance, the cost of fishmeal, a crucial feed ingredient in aquaculture, can spike due to limited supply or changes in trade regulations. Similarly, the meat industry is vulnerable to shifts in trade policies, as many countries rely on exports of fish/meat products, with volatile markets affecting pricing stability and market access. Additionally, with global supply chains already under pressure, international stress factors—such as regional conflicts or sudden trade restrictions—can escalate volatility in these markets. Price volatility influences the feed fraud.

U.S. Seafood Import Dependency

The U.S. seafood sector exemplifies the challenges of global trade dependency. As one of the largest seafood markets in the world, the U.S. relies heavily on seafood imports to meet domestic demand. The U.S. is particularly vulnerable to disruptions in the international seafood supply, whether due to geopolitical tensions, changes in fishing quotas, or global supply chain bottlenecks. These factors, coupled with increasing domestic demand for sustainable seafood, further complicate the balance between import reliance and market stability [5].

Strong Domestic Markets for Meat and Fish

Some regions, particularly in the U.S., emerging countries and parts of Europe, benefit from strong domestic markets for meat (particularly poultry) and fish and related feed supply chains. In these areas, the balance of supply and demand is somewhat insulated from global market fluctuations due to high production capacities and stable consumer bases. However, even strong domestic markets are not immune to the pressures of rising feed costs or trade tensions.

Poultry and aquaculture are projected to experience the strongest growth in 2025, while swine production will see only modest gains and beef is expected to decline. However, this growth will not be evenly distributed globally, with Asia and South America accounting for the majority of the production expansion.

Aquaculture production is expected to grow in 2025, driven by stronger demand and reduced feed costs. Most major species are projected to expand, with Pangasius and Tilapia leading the way. Shrimp, however, is likely to see only modest growth due to continued pressure from low market prices. A disrupted or unstable global supply chain could still send shockwaves through local prices and supply availability, especially as key feed ingredients become more expensive or harder to secure [6].

China's High Feed Costs and Tariffs

China, as both a major producer and consumer of animal protein, faces unique challenges in the current global environment. The country is experiencing high feed costs due to tariffs on imported grains and protein ingredients, along with domestic inflationary pressures. These rising costs are compounded by limited access to some international markets, especially as the trade war with the U.S. persists. As one of the world's largest producers of pork and aquaculture products, China's ability to secure affordable feed at competitive prices is critical not only for its domestic industry but also for global protein markets [7].

China has expanded its supply sources, increased local production, and taken steps to improve food and feed security, between the other. China is developing the utilisation of gene-edited seeds, reducing soymeal consumption, and enacting anti-food waste laws. Hese effort are for the reduction in U.S. imports [8].

Stability in Feed Ingredient Supply

Despite the challenges, the global supply of feed ingredients remains relatively stable for now. While geopolitical tensions and logistical bottlenecks can cause temporary disruptions, the world has diversified its sources of feed ingredients over the years. Regions like South America, Southeast Asia, and parts of Africa are increasingly becoming key players in feed production, helping to stabilize supply flows. However, any significant disruption to key supply routes, like those in the Suez Canal or Panama Canal, could cause ripple effects across the global supply chain, affecting not only feed ingredients but also the meat and seafood sectors.

Global Shipment and the Suez/Panama Canal

The role of key international shipping routes cannot be overstated. Both the Suez Canal and the Panama Canal are vital chokepoints in global trade, handling massive volumes of cargo, including feed ingredients and meat/fish shipments. The Suez and Panama Canals are critical chokepoints in global trade, facilitating the movement of vast quantities of goods, including feed ingredients and meat products. Disruptions to these routes—stemming from geopolitical instability, natural disasters, or other factors—can lead to significant delays and shortages, impacting supply chains worldwide. Disruptions to these routes, whether through political instability, natural disasters, or geopolitical conflict, can cause significant delays and shortages. For instance, any blockage of the Suez Canal—one of the busiest waterways for trade between Europe, the Middle East, and Asia—could lead to delayed shipments of essential feedstocks and protein products, exacerbating existing supply chain constraints and costs [9].

Emerging Markets Driving Growth

Emerging markets are expected to drive around 90% of global growth in the animal protein sector over the next decade. These markets, particularly in Asia, Latin America, and Africa, are experiencing rapid urbanization and rising incomes, leading to increased demand for meat and fish products. This surge in demand is placing additional pressure on both feed and protein supply chains, which must be expanded to meet new consumer needs. However, the growth of these markets also presents an opportunity for the industry to innovate, creating more sustainable and cost-efficient feed solutions and exploring alternative protein sources to cater to this expanding consumer base [10].

Innovative Non-Conventional Feed Ingredients: The Future of Sustainable Aquaculture

As the global demand for aquaculture products surges, the industry must adapt to the increasing pressure on traditional feed ingredients like fishmeal, soybean meal, and other conventional sources. To ensure long-term sustainability and resilience, the aquaculture sector must look beyond the readily available feedstocks—such as wheat bran, soybean meal, and sunflower meal—and embrace non-conventional feed ingredients that

are not only more sustainable but also capable of meeting the growing demands for animal protein.

While these traditional ingredients have served the industry well, they have significant challenges. They are subject to price volatility, geopolitical disruptions, and environmental concerns. Moreover, the continued demand for these ingredients can strain natural resources, particularly in regions where agricultural land and water are already under pressure. To tackle these challenges head-on, innovative feed solutions must be explored, and the industry must look to a broader array of non-conventional, locally sourced ingredients that can reduce dependence on global supply chains while promoting sustainability.

These innovative feed solutions not only address sustainability concerns but also offer potential economic benefits by utilizing locally available resources and reducing dependence on global supply chains and have environmental advantages. Continued research and development in this area are crucial for the long-term resilience and growth of the aquaculture industry [11]. Here it is presented some possible industrial aquaculture feed ingredient, additional one also not industrial were successfully studied in the PESCA Project (W. Mwanja et Al. studies on not usual feed ingredient, 2021/2024).

Emerging Non-Conventional Industrial Ingredients

Fermented Wood and Single-Cell Protein (SCP)

One of the most promising technological advancements in feed ingredients is the development of fermented wood for example. This emerging ingredient is produced by fermenting wood-based biomass into high-protein feed, offering a novel source of protein that can be used in aquaculture. Fermentation processes also unlock essential nutrients, making fermented wood an exciting alternative to traditional feedstuffs. Similarly, Single-Cell Protein (SCP)—produced by cultivating microorganisms such as yeast, bacteria, and fungi—has shown significant promise as a high-protein feed ingredient for aquaculture. SCP is a sustainable protein source that can be produced with minimal land, water, and energy inputs, making it an ideal candidate for regions with limited agricultural resources.

Farmed Micro and Macro Algae

Both micro and macro algae have a long history of use in aquaculture, but they have not yet reached their full potential as mainstream feed ingredients. Algae are highly nutritious, rich in proteins, omega-3 fatty acids, and micronutrients, making them an excellent addition to fish and shrimp diets. Farmed algae, in particular, offers a more sustainable and scalable solution for feeding a growing global population. By cultivating algae in controlled environments, the industry can produce a renewable source of feed that is not only nutritious but also environmentally friendly. Additionally, algae farming can help reduce overfishing pressure on marine ecosystems, providing a win-win for both the aquaculture industry and ocean conservation.

Agro-Industry By-Products: Palm Oil, Sugar Cane, and Others Agro-Industrial by-Products

Particularly from the palm oil and sugar cane industries, have enormous untapped potential as feed ingredients. By-products such as palm kernel cake, pressed cake, sugar cane filtered press mud, now manly used like a fertilizer and others can be repurposed as high-energy feed sources for aquaculture. These materials are often considered waste in the agricultural sector, yet they are rich in fiber, carbohydrates, and other nutrients that can supplement aquaculture feed. Their use has already been scientifically retested in the international arena. Leveraging these by-products not only reduces food waste but also promotes a circular economy by turning agricultural waste into valuable resources. The palm oil industry, in particular, has significant volumes of by-products that can be used in feed formulations, reducing the pressure on more traditional feed ingredients.

Insect Meal and Poultry Feather Meal

While insect meal (farmed and wild) and poultry and feather meal and slaughterhouse by products (meat & Bone meal for example, dried blood) have gained attention as alternative protein sources for aquaculture, their high prices remain a barrier to widespread adoption. However, when sourced locally, these ingredients can become much more cost-effective, especially when compared to global shipping costs and supply chain disruptions. Insect meal, produced from larvae such as black soldier flies, is rich in essential amino acids and lipids, making it an excellent protein source. Similarly, poultry meal, a by-product of the poultry industry, is high in protein and can be a sustainable alternative to traditional protein sources if properly processed. By establishing local production of insect farms or poultry processing plants, aquaculture producers can reduce their reliance on international trade and minimize exposure to geopolitical risks that could disrupt their supply chains.

Local Sourcing as a Risk Mitigation Strategy

One of the most effective strategies to reduce the geopolitical and logistical risks associated with feed supply chains is local sourcing. By tapping into locally available resources, aquaculture operations can reduce their dependence on global trade routes and mitigate the risks posed by international conflicts, sanctions, or natural disasters. This approach also helps reduce transportation costs and logistic risks, which are a significant component of the overall feed cost. For example, if insect (meal), algae, or agro-industrial by-products can be sourced locally, they offer a cost-effective, sustainable alternative to imported feed ingredients, fostering greater stability within the industry.

New Technological Feed Solutions

In addition to the non-conventional feed ingredients mentioned above, advanced technologies are being developed to enhance feed efficiency, improve nutrient digestibility, and reduce waste. For instance, the use of micro-encapsulation technology allows for the targeted delivery of nutrients to fish, optimizing feed performance and reducing environmental pollution from uneaten feed. Similarly, precision fermentation techniques are being explored to produce high-quality proteins from microorganisms, further diversifying the feed ingredient landscape. These technologies can significantly reduce the cost of processing some alternative feed ingredients and increase their availability, making them more accessible to aquaculture operations worldwide. One example is the fermented rice bran in China.

Canteen, Restaurant, and Urban Food Waste

Urban food waste—including surplus from canteens and restaurants—remains an underutilized resource for feed production. Exhausted cooking oils, kitchen scraps, and organic

refuse, when properly treated, can serve as valuable sources of energy or nutrients in both livestock and aquaculture feed. Their reuse helps reduce overall waste, mitigates environmental impacts, and supports the adoption of circular economy models.

Natural Lake Victoria resources

Dried water hyacinth, micro shrimp, and Lake fly are some important resources not yet industrially used present in Victoria Lake in large quantities. Their use was already tested and practically included in the feed diets by the Author and his team (PESCA project 2021-2024) with interesting results. There are not yet any industrial use of these large resources and not yet any scientifical mapping of these resources.

Circular Economy and Feed: Turning Waste into Sustainable Animal Nutrition

A circular approach to animal feeding represents a strategic frontier for the sustainability of both livestock and aquaculture sectors. In a global context marked by resource scarcity, price volatility, and geopolitical instability, the recovery and reuse of organic waste is becoming increasingly essential.

Emerging feed resources include agro-industrial by-products, food processing residues, surplus from collective catering and restaurants, used cooking oils, and urban organic waste. When properly treated, these materials can be reintegrated into the animal food chain as energy- and nutrient-rich ingredients, helping reduce dependence on conventional inputs such as soybean meal and fishmeal.

Using these resources not only lessens pressure on agricultural land and fish stocks but also significantly cuts the environmental impact associated with waste disposal. The potential is especially relevant in urban areas and in low- and middle-income countries, where organic waste production is high and circular solutions can generate economic value and employment.

To ensure the safe use of these ingredients in animal feed, it is essential to develop and apply strict treatment protocols, certification systems, and sanitary controls. Technologies such as anaerobic digestion, fermentation, and thermal processing are opening new pathways for integrating these residual flows into feed production systems.

The circular economy in feed production is not just a technical opportunity—it is a strategic necessity to strengthen supply chain resilience, lower production costs, and secure a more sustainable future for animal farming, with particular importance for aquaculture.

The Road Ahead: A Vision for Resilient and Sustainable Feed Solutions

The path forward for aquaculture lies in embracing non-conventional feed ingredients and innovative technologies to build a more resilient and sustainable industry. By diversifying feed sources and incorporating waste products, agro-industrial by-products, and novel ingredients like insect meal, algae, and fermented wood, the industry can create more cost-efficient and environmentally friendly feed solutions. These innovations not only help mitigate supply chain vulnerabilities but also support the circular economy by reducing waste and promoting sustainable resource use.

Emerging markets will continue to drive global growth in aquaculture, but meeting this demand will require a shift towards locally sourced, sustainable feed solutions. By investing in alternative protein sources and utilizing new technologies, the aquaculture industry can overcome current challenges while positioning itself for a sustainable future. The growing reliance on circular feed solutions—alongside a focus on innovation, local sourcing, and diversification—will help ensure that the industry remains adaptable and resilient, ready to face the complexities of the 21st century's dynamic global markets.

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While these traditional ingredients have served the industry well, they come with significant challenges. They are subject to price volatility, geopolitical disruptions, and environmental concerns. Moreover, the continued demand for these ingredients can strain natural resources, particularly in regions where agricultural land and water are already under pressure. To tackle these challenges head-on, innovative feed solutions must be explored, and the industry must look to a broader array of non-conventional, locally sourced ingredients that can reduce dependence on global supply chains while promoting sustainability.

Why These Underused, Abundant Natural Resources Are Still Marginal in the Feed Industry, Despite Their Dual Role as Nutritional Inputs and Environmental Solutions

A growing body of research and field-based innovation is beginning to recognize a wider portfolio of non-conventional aquaculture feed ingredients, many of which are naturally abundant and underexploited. Among them are lake fly larvae from Lake Victoria, a protein-rich resource that emerges seasonally in large quantities and can be harvested sustainably with minimal environmental impact. Likewise, water hyacinth (Eichhornia crassipes)—long considered an invasive aquatic weed—can be transformed from pest to resource, providing biomass also for microbial fermentation or even direct inclusion in formulated feeds after proper processing. Similarly, Sargassum macroalgae, which has proliferated massively in tropical Atlantic regions, presents both a problem for coastal ecosystems and a potential high-nutrient feed input, rich in minerals and bioactive compounds. Other notable underutilized resources in third countries include mango kernels, lake fly, cassava leaves, brewer's spent grains, and by-products from the fruit, sugar (filtered press mud), and palm oil industries, all of which offer nutritional value and circular economy benefits.

Despite their potential, these ingredients remain underutilized in commercial aquafeeds due to several constraints. These include lack of standardized processing technologies, inconsistent nutrient profiles, and limited industrial-scale trials (despite

many being already well tested by the author) to demonstrate their efficacy and safety. Moreover, feed manufacturers often prefer predictable, high-volume global commodities with established logistics, certifications, and market acceptance. This conservatism slows the adoption of innovative alternatives that may require investment in R&D, supply chain adaptation, and changes in formulation practices. Nevertheless, integrating these overlooked resources into feed production can not only reduce reliance on expensive and geopolitically sensitive imports but also address environmental problems such as invasive species proliferation, nutrient pollution, and waste accumulation—transforming ecological burdens into economic opportunities for the aquaculture sector [12].

How to mitigate the feed ingredients' volatility

It is widely recognized that new international shocks—whether geopolitical, climatic, or economic—are inevitable and will continue to disrupt global supply chains. These disruptions are expected to increase the cost and reduce the availability of key feed ingredients for aquaculture and livestock. Logistic constraints, market volatility, and rising energy prices will further compound the challenge, making feed supply less predictable and more expensive. This underscores the urgent need to invest in local, circular, and alternative feed sources to enhance resilience and food system sustainability.

To address ingredient volatility in the feed industry at the national level, it is possible to consider the following strategic lines:

1. Promote the Use of Local Resources: Encourage the development and adoption of feed ingredients that are locally available (e.g., agro-industrial by-products, aquatic plants, insects), which reduces dependency on imports and exposure to global market fluctuations.
2. Invest in Technology for Ingredient Innovation: Support research and development of new technologies that can convert low-value or underutilized biomass into high-quality feed components (e.g., fermentation, enzymatic treatment, bioconversion).
3. Diversify Ingredient Sources: Broaden the range of feed inputs to include alternative proteins and energy sources (e.g., single-cell proteins, algae, cassava peel), enhancing resilience to supply shocks.
4. Strengthen the Value Chain: Improve storage, logistics, and processing infrastructure to reduce post-harvest losses and stabilize supply. Foster linkages between producers, processors, and feed manufacturers for better planning and efficiency.
5. Develop Policy and Incentives: Implement supportive policies (e.g., subsidies, tax incentives, investment in R&D) to reduce input costs and encourage local production of feed ingredients and related investment.

Conclusion

In 2025, geopolitical instability, climate change, and international trade tensions continue to strain global supply chains, threatening the availability and affordability of key feed ingredients—especially in the aquaculture sector. In this uncertain context, it is essential to rethink the feed supply model by prioritizing resilience, sustainability, and local self-sufficiency.

For aquaculture, this means diversifying protein sources, investing in non-conventional ingredients such as algae, insects, agro-industrial by-products, and fermentation-derived proteins, and developing local value chains capable of ensuring production continuity even during crises. At the same time, strengthening collaboration between scientific research, industry, and policymakers will be crucial to promote the adoption of new technologies and circular models.

Protecting the security of feed supply chains is not just an economic issue, but a strategic priority to ensure the sustainable growth of aquaculture, contribute to global food security, and respond effectively to the challenges of our time.

References

1. FAO. The State of World Fisheries and Aquaculture 2022. Rome: Food and Agriculture Organization of the United Nations. 2024. https://openknowledge.fao.org/items/06690fd0-d133-424c-9673-1849e414543d
2. Matthew Taylor. Mitigating the Risks of Food Fraud in an Inflationary Environment. 2023. https://foodsafetytech.com/feature_article/mitigating-the-risks-of-food-fraud-in-an-inflationary-environment.
3. William Dodds. Sustainable sourcing: the biggest trend defying an evolving process. 2024. https://www.foodmanufacture.co.uk/author/william-dodds/.
4. Gregor Gowans. How companies are managing supply chains in 2024 amid yet more geopolitical instability. Journalist Trans.INFO. 2024. https://trans.info/en/supply-chains-geopolitical-instability-375501.
5. Hamlet Protein market outlook 2025: Geopolitical risks, the outlook for 2025 is uncertain. Market developments will largely depend on how the global geo-political situation evolves and how increasing regulation on sustainability will impact markets. 2025. https://www.feedstrategy.com/latest-news/press-release/15712498/hamlet-protein-market-outlook-2025-geopolitical-risks
6. Webinar on Global Animal Protein Industry Outlook. Speaker: Nan Dirk Mulder, Animal Protein Specialist, Rabobank. 2025.
7. Rimjhim Singh. How China minimised US farm imports and sharpened its trade war tactics. 2025. https://www.business-standard.com/world-news/china-trade-war-food-security-trump-tariffs-agriculture-125030500835_1.html.
8. Mei Mei Chu. How China reduced its reliance on US farm imports and sharpened its trade war toolkit, Reuters. 2025. https://www.reuters.com/markets/commodities/how-china-reduced-its-reliance-us-farm-imports-softening-trade-war-risks-2024.
9. Suez and Panama Canal disruptions threaten global trade and development. The disruptions are straining supply chains, driving up costs, and reshaping global trade patterns, with vulnerable economies hit hardest. 2024. https://unctad.org/news/suez-and-panama-canal-disruptions-threaten-global-trade-and-development
10. Webinar on Global Animal Protein Industry Outlook. Speaker: Nan Dirk Mulder, Animal Protein Specialist, Rabobank. 2025.
11. Aquaculture feeding – problematic, but not without alternatives, Rural 21. 2021. https://www.rural21.com/english/

archive/2021/04/detail/article/aquaculture-feeding-problematic-but-not-without-alternatives.html.

12. And Tacon, AGJ, Metian M. Feed matters: Satisfying the feed demand of aquaculture. Reviews in Fisheries Science & Aquaculture. 2015. 23: 1-10.