FEFAC
Experts in Animal Nutrition

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EU VULNERABILITY FOR THE SOURCING OF ESSENTIAL NUTRITIONAL FEED ADDITIVES

An assessment by FEFAC

Disclaimer: The information hereafter is the result of a vulnerability assessment for access to vitamins and amino acids, performed by FEFAC in spring 2025. These results are based to a large extent on expert data and, while we endeavour to reach a high level of quality and robustness of the data, we make no representations or warranties of any kind, express or implied, about their completeness, accuracy, reliability, suitability or availability. Any reliance you place on these data is therefore strictly at your own risk.

Summary

The 2024-2029 Competitiveness Compass and Clean Industrial Deal place competitive strength and food autonomy and sovereignty at the heart of the Commission's objectives.
The Competitiveness Compass is underpinned by three pillars:

1. Closing the innovation gap with the EU's main competitors;
2. Linking decarbonisation and competitiveness;
3. Reducing dependencies and increasing security.

For already several years, **FEFAC has alerted Public Authorities as regards the high level of dependency of the EU regarding the supply of vitamins** (essential to support animal health and welfare) **and amino acids** (the number one solution to reduce nitrogen emissions and mitigate the EU dependency on imported soya proteins).

FEFAC with the support of its experts performed a vulnerability assessment meant to provide policy makers with elements regarding the current level of vulnerability of the EU feed, livestock & aquaculture sectors regarding access to vitamins and amino acids.

The study was meant to answer among others the following questions:

- How concentrated is the global market of vitamins and amino acids?
- How dependent is the EU on Third Countries, in particular China, for the supply of vitamins and amino acids to EU farm animals?
- Is the EU production capacity sufficient to meet the EU demand for each vitamin and amino acid?
- Can the EU replace imports from high geopolitical risk countries with imports from low and medium risk countries?

<u>The key findings of the study are:</u>

- The **global markets of vitamins and amino acids are highly concentrated** with only 10 producing countries for vitamins (thereof no more than 4 per vitamins) and 11 for amino acids. **China is the only country producing all vitamins and all amino acids** with a global market share ranging from 25% (methionine) to 99% (vitamin H – biotin).
- The **EU feed chain imports 35 to 100% of its vitamins needs and more than 95% of its needs in essential amino acids produced by fermentation.** China is the main supplier to the EU of all vitamins and amino acids and sometimes the exclusive supplier (e.g. vitamins B1, B12 or H).
The EU is fully dependent on its supply of vitamins C, B9 and K3 and more than 75% on vitamins B3, B12 and H.
- **To be autonomous** (i.e. independent from high geopolitical risk countries), **the EU would need to invest in production capacities to meet the EU feed demand** for vitamins B5, B9, B12, C, H and K3 as well as for all amino acids but methionine. For other additives, the EU dependency is not due to a lack of production capacity but a **widening competitiveness deficit of the EU producing industry vs. Third Countries.**
- **Diversification of supply** with low and medium geopolitical risk countries is only an option for vitamins A, B2, B3, B4, B5 and K3.

NB: The study does not take into account the fact that the manufacturing of vitamins by chemical synthesis such as vitamins A and E requires the purchase of a **precursor**, whose production may be also very concentrated in a few countries. **This means that, for these substances, the EU-27 vulnerability is likely to be underestimated in this study.**

FEFAC calls on authorities to consider the supply chain for essential feed additives as critical and to adopt a set of measures to reverse the trend and mitigate the EU vulnerability. The study shows clearly that the primary limiting factor for the EU autonomy in amino acids and vitamins is the competitiveness gap with Third Countries (especially China). Ad-hoc measures are required to help the vitamins and amino acids production industry to compete on equal footing with Third Countries producers, in particular via reduction of costs of production factors. Then, the study shows also that diversification of sourcing may be possible only in a limited number of cases, meaning that the security of supply for many nutritional feed additives will require reshoring production in the EU and like-minded countries (e.g. The UK, Switzerland) which means a supportive industrial policy to allow deploying existing production capacity and investments in new producing capacities if needed (i.e. for vitamins B9, H and K3 and most fermentation amino acids).

Introduction

The 2024-2029 Competitiveness Compass and Clean Industrial Deal place competitive strength and food autonomy and sovereignty at the heart of the Commission's objectives.
The Competitiveness Compass is indeed underpinned by three pillars: i) Closing the innovation gap with the EU's main competitors; ii) Linking decarbonisation and competitiveness; and iii) Reducing dependencies and increasing security.

For already several years, FEFAC alerted Public Authorities as regards the high level of dependency of the EU-27 regarding the supply of vitamins, essential to support animal health and welfare, and amino acids, essential to reduce nitrogen emissions and mitigate the EU-27 dependency for soya proteins. Here are a few facts to illustrate this dependency:

- The EU-27 does not produce any vitamin B9, C, K3 and threonine. it depends on imports from China at 100% for Vitamin B9 and 96% for Vitamin H.
- The EU-27 produces 6% of its needs in Lysine and 0% of the Threonine.
- China represents 60 to 70% in value of all vitamins imported in the EU-27 and 70 to 80% of the volume of amino acids imported in the EU-27.

FEFAC considers this situation as extremely concerning and puts the EU in a situation of extreme vulnerability for several reasons shared with the EU authorities and acknowledged by The European Food Security Crisis preparedness and response Mechanism (EFSCM) in 2024:

- The EU chemical and fermentation industry is facing high production costs (in particular energy and carbohydrates for the fermentation sector) and therefore is not competitive towards third countries. As a consequence, there is little investment in the EU for the production of nutritional feed additives.
- The global demand for vitamins and amino acids increases with the development of efficient livestock & aquaculture production systems and the need to minimize emissions, including nitrogen.
- The whole of the global production of vitamins (including vitamin B4) is made in China (79%), the EU-27 (8%), United Kingdom & Switzerland (5%), South Korea, India, Turkey, Uruguay, the USA and Vietnam (7%). Furthermore, for most vitamins, there are only 2 to 3 producing countries / regions and 4 to 5 producing companies worldwide, thereof no more than 1 in the EU-27.
Any incident affecting a production plant directly impacts on the EU-27 sourcing capacity;
- The health & welfare of animals require that all minimum requirements in vitamins and amino acids are met: any deficiency in one vitamin or one amino acid is sufficient to affect animal health & welfare and therefore the zootechnical performances and the EU sovereignty in products of animal origin, whose importance in healthy diets is increasingly recognised.

The study will answer in particular the following questions:

- **How concentrated is the global market of vitamins and amino acids?**
- **How dependent is the EU-27 from Third Countries, in particular China, for its supply in vitamins and amino acids?**
- **Is the EU-27 production capacity sufficient to meet the EU-27 demand for each vitamin and amino acid?**
- **Can the EU-27 diversify its sourcing from low and medium geopolitical risk countries, in particular in case of a worst-case scenario combining a rupture of supply from high geopolitical risk countries and a closure of EU-27 production plant due to industrial accident?**

As public data are scarce, most of the figures used in this study have been collected from private sources and will be made available to authorities only. Aggregated / processed data were reviewed and validated by the FEFAC Task Force on Feed Additives Vulnerability.

FEFAC encourages EU authorities to build upon this study to perform their own market analysis with a view to design an effective and targeted strategy to secure EU strategic autonomy for the sourcing of feed vitamins and amino acids.

1. Scope and purpose of the vulnerability study

The mission of the feed industry is to deliver to animals feed that meet their nutritional needs while at the same time optimising the targeted zootechnical performance under the different production system (extensive, intensive, organic, etc.), maintaining animal welfare and health and minimizing the environmental impact of livestock farming and aquaculture. To achieve this, the feed manufacturer combines different feed ingredients (so-called feed materials) whether unprocessed crops, or co-products of food/biofuels processing or feed materials from mineral or animal origin. The mixture obtained is in general deficient in certain essential nutrients such as vitamins, trace-elements or imbalanced in essential amino acids. The feed manufacturer makes use of such nutritional additives to optimize the diet composition.

Vitamins play a crucial role in the livestock & aquaculture sectors by supporting animal health, productivity, reproduction and welfare. Vitamins intervene at different levels: growth and bone development for vitamin A, D, and E, energy metabolism and nervous system functions for B-complex vitamins (e.g., B1, B2, B6, B12), reproduction for vitamin E, embryonic development and fertility for Vitamin A, antioxidant functions enhancing the immune response and reducing disease susceptibility for Vitamin C, A, and E. Deficiencies in vitamins can lead to blindness and poor coat condition for vitamin A, rickets in young animals and osteomalacia in adults for vitamin D3, etc. Farm animals cannot synthesize all vitamins in sufficient quantities, and cannot find in their basic diet the minimum amounts of vitamins to cover their needs. This is in particular the case in intensive farming systems where animal performance requires a high health status, exempt of any nutritional deficiency. However, this is not limited to highly performing animals and supplementation with all vitamins is permitted in organic livestock production and aquaculture, limited to A, D and E for ruminants. Indeed, ruminants can synthesize some B-vitamins via microbial action in the rumen, while non-ruminants (e.g., poultry, pigs) rely more on dietary sources. Vitamins' supplementation is therefore indispensable in livestock production and aquaculture and inadequate vitamin nutrition affects animal welfare, increases exposure to disease incidence and leads incidentally to productivity losses.

Amino acids are key component of proteins. For monogastrics, essential amino acids (like lysine, methionine, threonine, tryptophan or valine) cannot be produced by the animal's body and must therefore come from the diet. If even one essential amino acid is missing, it can limit protein synthesis entirely (this is known as the "limiting amino acid" concept). To minimise the risk of deficiency, the feed formulator must secure that the diet contains the minimum quantity of each essential amino acids to meet the animal's requirements, which are different across species. However, this used to mean putting more proteins in the diet than necessary, thus resulting in extra emissions of nitrogen in the environment. To avoid this, the feed formulator will set a maximum amount of crude protein in the feed formulation matrices and add as necessary depending on the feed composition, any missing amino acid in the form of feed additives. Usually, the one amino acid missing the most is lysine, so-called "first limiting amino acid". The following limiting amino acids are by order of importance methionine, threonine and tryptophan and valine. The addition of amino acids in diets is not only a means to reduce environmental emissions of nitrogen (nitrates, nitrous oxide, ammonia) but also to lower the demand for protein rich feed materials such as soya. It is estimated in the EU-27 that the current level of supplementation of feed with amino acids allows reducing by 3 mio. T the imports of soyabean meal in the EU-27 per year.

The scope of this study is limited to vitamins and amino acids, for which the EU-27 is dependent on third countries. The additives in scope are therefore:

Vitamins	Amino acids
• Vitamin A (retinol) • Vitamin B1 (thiamine) • Vitamin B2 (riboflavin) • Vitamin B3 (niacin/nicotinic acid) • Vitamin B4 (choline chloride) • Vitamin B5 (pantothenic acid) • Vitamin B6 (pyridoxin) • Vitamin B9 (folic acid) • Vitamin B12 (cyanocobalamin) • Vitamin C (ascorbic acid) • Vitamin D3 (cholecalciferol) • Vitamin E (tocopherol) • Vitamin H (biotin) • Vitamin K3 (menadione)	• Lysine • Methionine • Threonine • Valine • Tryptophan

NB: Although, from a geopolitical point of view, Switzerland, United Kingdom and Turkey are traditional preferential trade partners of the EU-27, these countries are not bound by solidarity agreements with the EU and therefore are not considered differently from other non-EU low-risk countries.

2. Methodology

2.1. Selected indicators

The EU Commission Staff Working Document SWD(2021)352 final[1] identifies 3 indicators for a vulnerability assessment, defined on the basis of trade data (in value) and reflecting three characteristics of vulnerability:

Concentration: meant to illustrate whether current imports originate from a limited number of origins or not (so-called Herfindahl-Hirschman Index (HHI))

Importance in EU-27 supply: meant to illustrate how dependent the EU-27 is from imports from Third Countries to meet its need

Importance in demand: meant to illustrate whether imports from Third Countries may be substituted by EU-27 production (taking into account EU-27 exports).

These indicators however do not take into account additional elements that impact on vulnerability, such as the production and production capacity in and outside the EU-27 or the actual consumption.

Furthermore, these indicators are based on official trade data in value and therefore lack the level of granularity needed to tackle essential additives individually. In addition, they do not consider the economic vulnerability, i.e. the potential negative economic impact on the profitability of the EU livestock, aquaculture and feed chains. Finally, they do not allow evaluating the potential for mitigation of vulnerability via diversification of supply and do not take into account the geopolitical and logistical risks. For the purpose of this study, the following indicators were used.

2.1.1. Geopolitical vulnerability

Risk weighed concentration of dependency

This indicator is meant to illustrate how concentrate the supply is in terms of supplying countries. The indicator chosen is the Herfindahl-Hirschman indicator, calculated either on values or on volumes, depending on available trade data and taking into account the risk profile of the supplying country (political relation with the EU-27, logistical risk - see 2.1.3).

Risk weighed concentration:

$$\sum_{i=1}^{n} (S_i * RFi)^2)$$

where RFi is a qualifier of the risk presented by the country of origin, Si is the share of the Third Country i in EU-27 imports and n is the number of producing countries supplying the EU-27.
An HHI index below 0,4 is regarded as low risk, medium between 0,4 and 0,6, high between 0,6 and 0,8 and very high between 0,8 and 1 (1 corresponding to a monopoly). By default, in case the breakdown of imports per country of origin is not available, an equal share of imports among the producing Third Countries will be used as a proxy.

[1] 2021: EU Commission - Strategic dependencies and capacities Working Document SWD(2021)352 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2021:352:FIN

Self-sufficiency

This indicator is meant to define how much of the EU-27 consumption could be met by EU-27 production if there would be no export to Third Countries. This indicator does not take into account trade flows (imports and exports) and does not correctly capture the notion of dependency upon Third Countries and therefore must be interpreted with care.

Self sufficiency:

$$\frac{\text{EU-27 production for feed use}}{\text{EU-27 feed use}}$$

This indirect way to illustrate the EU-27 dependency upon Third Countries was preferred in absence of import data for certain vitamins and amino acids.

Autonomy potential

The purpose of this indicator is to evaluate the possibility for EU-27 producers to meet the whole of the EU-27 feed demand when making full use of their production capacity and directing the whole of the production to the internal feed market.

Autonomy potential:

$$\frac{\text{EU-27 production capacity any use}}{\text{EU-27 feed use}}$$

When interpreting this indicator, attention should be paid to the fact that other outlets (food, cosmetics and pharmaceutical use) are usually given priority and therefore it is unlikely that the whole of the production is directed to feed. Furthermore, a number of Third Countries rely on the EU-27 for their own supply and it is also unlikely that the EU will stop exporting.

Diversification capacity

The purpose of this indicator is to evaluate what the possibility is for the EU-27 to replace imports from at-risk countries by imports from low and medium risk countries. For medium risk, a margin of security is taken by considering that only half of the surplus of production capacity could be available to produce for the EU-27. An indicator below 100% means that the EU-27 would have no choice but to buy from high-risk countries.

Diversification capacity:

$$\frac{\sum_{i=1}^{n} ((PC_i - P_i * RFi)}{ImpRC}$$

Where PCi is the production capacity any use of the country i, Pi is the production for any use of country i, RFi is the risk factor for country i (0 for high-risk, 0.5 for medium risks and 1 for low-risk countries) and ImpRC is imports from high geopolitical risk countries.

Overall Geopolitical Vulnerability Score

The purpose here is to define an overall score combining the results of the 4 indicators, by attributing a score from 1 to 9 to each indicator on a linear basis to obtain an overall score from 1 to 9 (1 being the lowest vulnerability and 9 the highest). Each indicator carries the same weight in the overall score.

Values	Score for Risk Weighed Concentration	Values (%)	Score for Self-sufficiency Autonomy Potential & Diversification Capacity
<0.2	1	<20	9
0.2≤ <0.3	2	20≤ <40	8
0.3≤ <0.4	3	40≤ <60	7
0.4≤ <0.5	4	60≤ <80	6
0.5≤ <0.6	5	80≤ <100	5
0.6≤ <0.7	6	100≤ <120	4
0.7≤ <0.8	7	120≤ <140	3
0.8≤ <0.9	8	140≤ <160	2
≥0.9	9	≥160	1

2.1.2. Economic vulnerability

Economic vulnerability score
This indicator is meant to evaluate the economic risk in case of shortage in a vitamin or an amino acid. This is obtained by a combination of an evaluation of the essentiality of the substance (i.e. whether it is possible to reduce or replace the substance in the diet of an animal without compromising animal health, welfare and zootechnical performance) and the economic impact on feeding costs of a potential price increase due to a shortage at EU / global level.

Economic vulnerability score: **Essentiality * Importance in feed production cost**

The essentiality is scored on a scale from 1 (non-essential) to 3 (essential). The share in feed production costs is scored on a scale from 1 (share of feed costs < 1%) to 3 (> 5%).

Additive	Share of feed vs. non-feed use	Essentiality	Share in feed costs
Vitamin A	83%	3	1
Vitamin B1	55%	3	1
Vitamin B2	66%	3	1
Vitamin B3	78%	3	1
Vitamin B4	94%	2	1
Vitamin B5	80%	3	1
Vitamin B6	70%	3	1
Vitamin B9	85%	3	1
Vitamin B12	30%	3	1
Vitamin C	8%	1	1
Vitamin D3	75%	3	1
Vitamin E	70%	3	1
Vitamin H	70%	3	1
Vitamin K3	95%	3	1
Lysine	>95%	3	2
Methionine	>95%	3	2
Tryptophan	>95%	2	1
Valine	>95%	2	1
Threonine	>95%	2	2

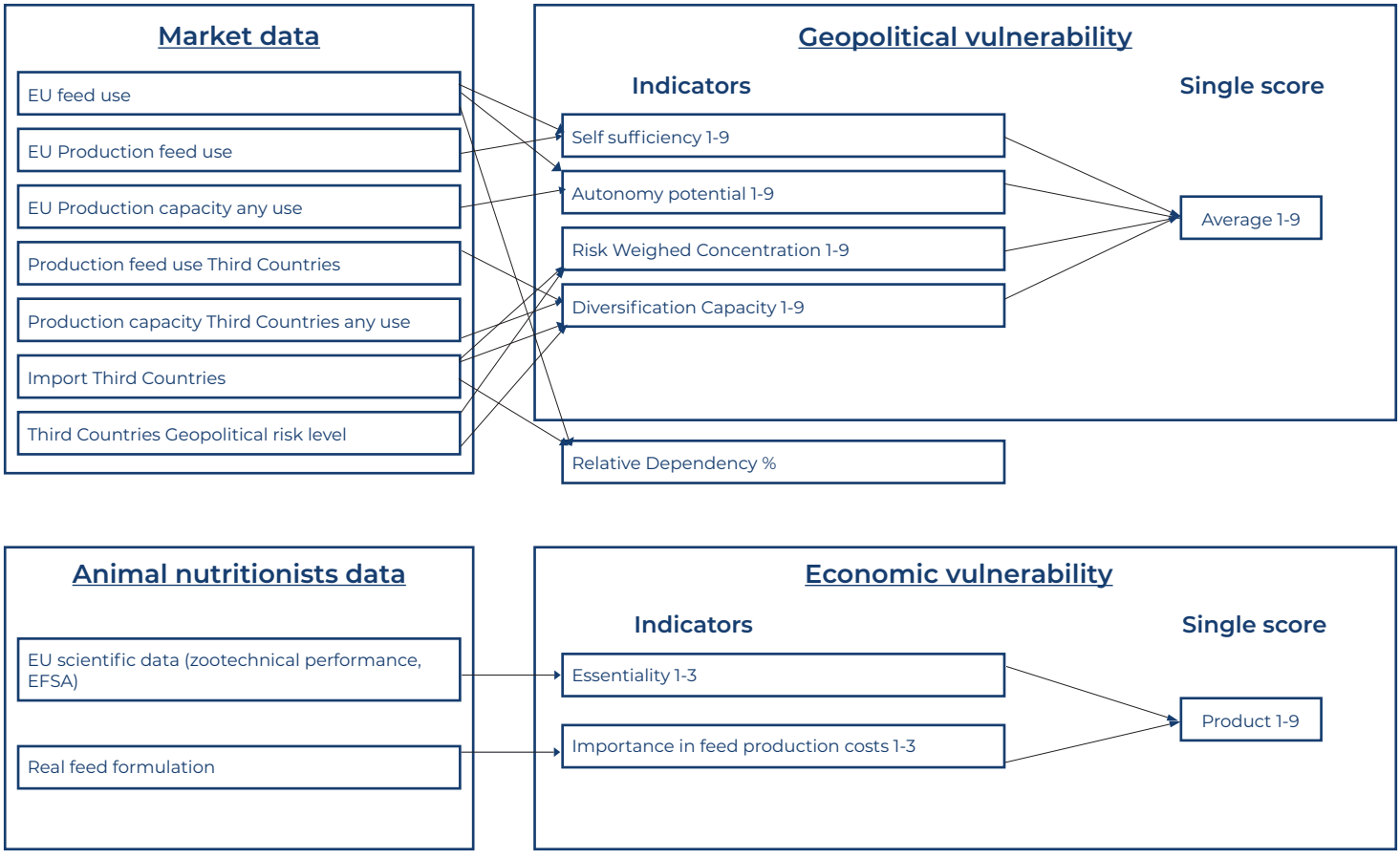
2.1.3. Relative dependency

The purpose of this indicator is to evaluate how much of what is used in the EU-27 is imported from Third Countries whatever the usage.

Relative dependency: $\frac{\text{imports any use}}{\text{consumption any use}}$

This indicator may be reported per individual Third Country. For vitamins for which only trade data in value can be used because of different concentrations of vitamins in the preparations and without differentiation in the usage made of imports, the qualifier "relative" means that this indicator does not take into account the fact that, for certain substances, the dependency is also due to the fact that part of the EU-27 production is exported. In other words, the EU-27 may look apparently self-sufficient, but in fact relatively highly dependent on Third Countries for its supply because it exports a significant part of its production to Third Countries. For this reason, this indicator may not be considered as a geopolitical vulnerability indicator per se and is reported separately.

Overview of indicators used for vulnerability assessment



2.2.Collected data and parameters

There is no public data on consumption production, or production capacity for vitamins and amino acids. The only publicly available market data are trade data from Eurostat. To be able to generate the indicators, FEFAC created a Task Force on Feed Additives Vulnerability, with company experts in feed additives suppliers, traders of micro-ingredients, premixtures manufacturers and feed formulators. The data were collected anonymously, consolidated by the Secretariat and shared for validation with experts in ranges to comply with antitrust rules. Bilateral interviews with individual experts were also conducted during the period March to June 2025.

The suitability of the collected data for the determination of the vulnerability indicators is limited by a number of factors:

- They are based on expert views and may not always be supported by robust in-house market analysis.
- Trade data are based on CN Codes for individual vitamins. It is assumed that part of the imports might have been made under CN Codes for preparation for feed use (23099096);
- The export data have not been considered here. Part of the vitamins used in the EU-27 is actually exported in the form of premixtures and compound feed to Third Countries, in particular mediterranean countries and Africa;
- Most expert data do not differentiate between feed and other usages. The data for country (EU-27 and Third Countries) specific production for feed use and feed use are obtained by applying a ratio feed vs. non feed for all countries. It can be expected that the ratio is different across countries. However, in absence of detailed data, the same ratio was applied to all countries.
- Some provitamins e.g. (betaine or inositol) are excluded from the scope of the study since data were not of sufficient quality to allow calculating indicators in a sufficiently reliable way.
- The use of amino acids other than lysine, methionine, threonine, tryptophan and valine is only occasional and therefore access to market data of sufficient quality was not possible.
  They have been also put aside. The situation is different for histidine, which is essential in fish farming and systematically added to diets. However, it could be concluded from interviews that the supply from low and medium geopolitical risk countries is more than sufficient to cover the EU-27 needs, which remains low.

When detailed import data are not available, the following proxies are used to estimate the imports from high geopolitical countries:

- Vitamins B9 and K3: ImpRC = EU consumption (no production in the EU and large domination of China on the global market)
- Vitamin B5 and D3 and tryptophan: ImpRC = EU consumption – EU production (large domination of China on the global market – limited exports to Third Countries)
- Vitamin B3: ImpRC = 1/3 of EU consumption (no production in the EU and China represents 1/3 of global production)

The qualification of essentiality of the different feed additives was agreed unanimously by the expert formulators. Regarding the risk factors for the different supplying Third Countries, the following parameters were taken into account: political stability, potential for market disruption due to intergovernmental trade disputes, logistical bottlenecks (e.g. Suez Chanel) and existence of a Trade Agreement. This leads to the following risk classification of all countries producing amino acids or vitamins.

Low	Medium	High
Switzerland	India	China
United Kingdom	Singapore	Russia
Japan	Indonesia	Belarus
South Korea	Malaysia	
Brazil	USA	
Turkey	Uruguay	
	Vietnam	

2.3. Results

Considering the gaps in the collected data, not all indicators could be calculated for all feed additives. Table 1 and Chart 1 provide an overview of the calculated indicators per substance. Detailed results per additive are available to public authorities in the form of fact sheets.

2.3.1. Economic Vulterability

Very Low Score <= 1	Low 1 < Score <= 3	Medium 3 < Score <= 5	High 5 < Score <= 7	Very high Score > 7
Vitamin C	All other vitamins Valine, Tryptophan	Threonine	Lysine, Methionine	

In terms of economic vulnerability, the inclusion rates of vitamins in the final diet are low and, despite prices generally in the range of one to twenty thousand euros per kg, their contribution to the price of the final feed is less than 0.1%. However, taken altogether, vitamins may represent up to 1% of the feed costs. For lysine, methionine and threonine, the contribution to feed costs is between 1 and 5%, meaning that any big variation in price can affect the profitability of livestock farming and aquaculture.

The economic vulnerability is not only linked to the price of the additive but also on the impact on the livestock and aquaculture sectors in case it would not be present in sufficient quantities. For vitamins, the indirect costs result from a lower zootechnical performance and possibly a need for veterinary treatment in case of severe deficiency. For amino acids, the impact is in terms of indirect costs of emissions of nitrogen in the environment. For the EU trade balance, it is also the cost of purchasing from Third Countries the products of animal origin we would not produce. For the EU consumers, the lower output of animal products may trigger food inflation.
For these reasons, the essentiality parameter was integrated in the equation.

2.3.2. Geopolitical vulnerability

Very Low Score <= 1	Low 1 < Score <= 3	Medium 3 < Score <= 5	High 5 < Score <= 7	Very high Score > 7
	Vitamin A and B2 Methionine	Vitamin B3	Vitamins B1, B4, B5, B6, B12, C, D3, E and K3 Lysine, Tryptophan	Vitamins B9 and H, Valine and Threonine

Vitamins

With the exception of vitamin A and vitamin B2, the EU-27 produces less for feed use than its needs. The production of vitamins is concentrated in a very limited number of countries (see Table 2). The totality of the global production of vitamins is divided over in China, the EU-27, United Kingdom, Switzerland, South Korea, India, Turkey and Uruguay. Furthermore, for most vitamins, there are only 2 to 3 producing countries / regions and 4 to 5 producing companies. Whenever data on imports per country are available, the calculated HHI indicator always exceeds the threshold of concerns of 0.40 and is often in the area of high or very high concern, when for example China is the only supplier on the global market (next to the EU-27). There is no situation where China has a full monopoly of the production worldwide but it holds more than 94% of the production of vitamins C, B12, B9 and even 99% of the production of vitamin H (see Chart 2).
In terms of value, China represents on average over the last 5 years 60% of the EU-27 imports of vitamins.

For several Vitamins (B1, B6 and D3 in particular), the EU-27 does not make use of its full capacity and could in theory supply enough of these vitamins to cover the feed demand.
However, the EU is often, for Third Countries, the only alternative to China and the EU policy does not foresee for the time being that the EU producers of vitamins shall serve the internal market as a matter of priority. As a consequence of the concentration of the production in a limited number of countries and the domination of China, the opportunities for the EU-27 to diversify its supply are extremely limited. For vitamins B3, B4, B5 and K3, significant production capacities outside China are not exploited and could constitute options to mitigate vulnerability.

Amino acids

The landscape for amino acids is somehow better, with a higher number of countries involved in production: China, the EU-27, the USA, Brazil, Indonesia, Malaysia, Japan, South Korea, Singapore, Russia and Belarus (see Table 2). The two latter being subject to trade sanctions, they do not play a direct role in the EU vulnerability regarding access to amino acids. As for vitamins, China is the most important producer of amino acids worldwide (see Chart 3).

The production of methionine is quite evenly spread out globally, whereas for other amino acids it is very much concentrated in China and other Asian countries, with some production in Brazil and the USA as well. This may be explained by the fact that methionine is produced by chemical synthesis, which requires heavy investments and a long period before the production can start. Other amino acids are produced by fermentation and can benefit in countries like China or the USA from access to feedstock (carbohydrate) than in the EU-27. 80% on average of EU-27 imports of lysine, valine, tryptophan and threonine originate from China.

The competitiveness of EU-27 methionine production, although apparently good, is also challenged by the widening gap in production costs (energy) with Third Countries and recent investments in new production capacities in Asia, especially China, suggest that the global picture of the methionine market will change in disfavour of the EU-27. The present relative autonomy of the EU-27 may look differently in 4 years' time if no measure is taken to keep production in the EU-27.

Table 1: Overview of the vulnerability scores for each indicator for each additive in scope.

Additive	Economic vulnerability score	Geopolitical Vulnerability score					Relative dependency (%)	
		Risk weighed concentration (HHI)	Self-sufficiency	Autonomy potential	Diversification capacity	Overall Score	to Third Countries	to China
Vitamin A	3	7	3	1	1	3	50	40
Vitamin B1	3	9	7	1	9	6,5	65	65
Vitamin B2	3	5	3	1	1	3	60	15
Vitamin B3	3	4	9	1	1	3,8	n/a	n/a
Vitamin B4	2	7	5	1	4	6	35	25
Vitamin B5	3	7	8	7	4	6,5	n/a	n/a
Vitamin B6	3	9	8	1	9	6,75	n/a	n/a
Vitamin B9	3	9	9	9	8	8,8	100	90
Vitamin B12	3	9	8	1	9	6,75	75	75
Vitamin C	1	7	9	9	2	6,75	100	75
Vitamin D3	3	9	6	1	8	6	n/a	n/a
Vitamin E	3	6	7	3	7	5,8	n/a	n/a
Vitamin H	3	9	9	9	9	9	95	95
Vitamin K3	3	8	9	9	1	6,8	100	n/a
Lysine	6	6	9	8	4	6,75	95	65
Methionine	6	6	2	1	1	2,5	10	6
Threonine	4	9	9	9	9	9	100	100
Tryptophan	2	5	7	6	1	6,25	55	>20
Valine	2	9	8	8	5	7,5	60	>55

Table 2: Overview of where amino acids and vitamins are produced worldwide and respective market share (%)

Additive	China	EU-27	Switzerland	UK	Turkey	Russia	Belarus	USA	Brazil	Uruguay	Japan	South Korea	Malaysia	Singapore	Indonesia	India	Vietnam
Vit A	42	31	27														
Vit B1	89	11															
Vit B2	47	26										27					
Vit B3	33	<1	32													35	
Vit B4	82	11					3									3	1
Vit B5	82	7		11				3									
Vit B6	94	6															
Vit B9	94		5													1	
Vit B12	94	6															
Vit C	94			6													
Vit D3	83	14														3	
Vit E	59	10	31														
Vit H	99	1															
Vit K3	79				11					10							
Lysine	78	1				3	1	11	4			2			1		
Methion-ine	26	23				1		19			12		5	15			
Tryptoph-an	31	6				2	1	9	11						41		
Valine	84	4				1		15	2			1			8		
Threonine	92						2	5	1								

Chart 1: EU-27 vulnerability for essential nutritional feed additives in 2023

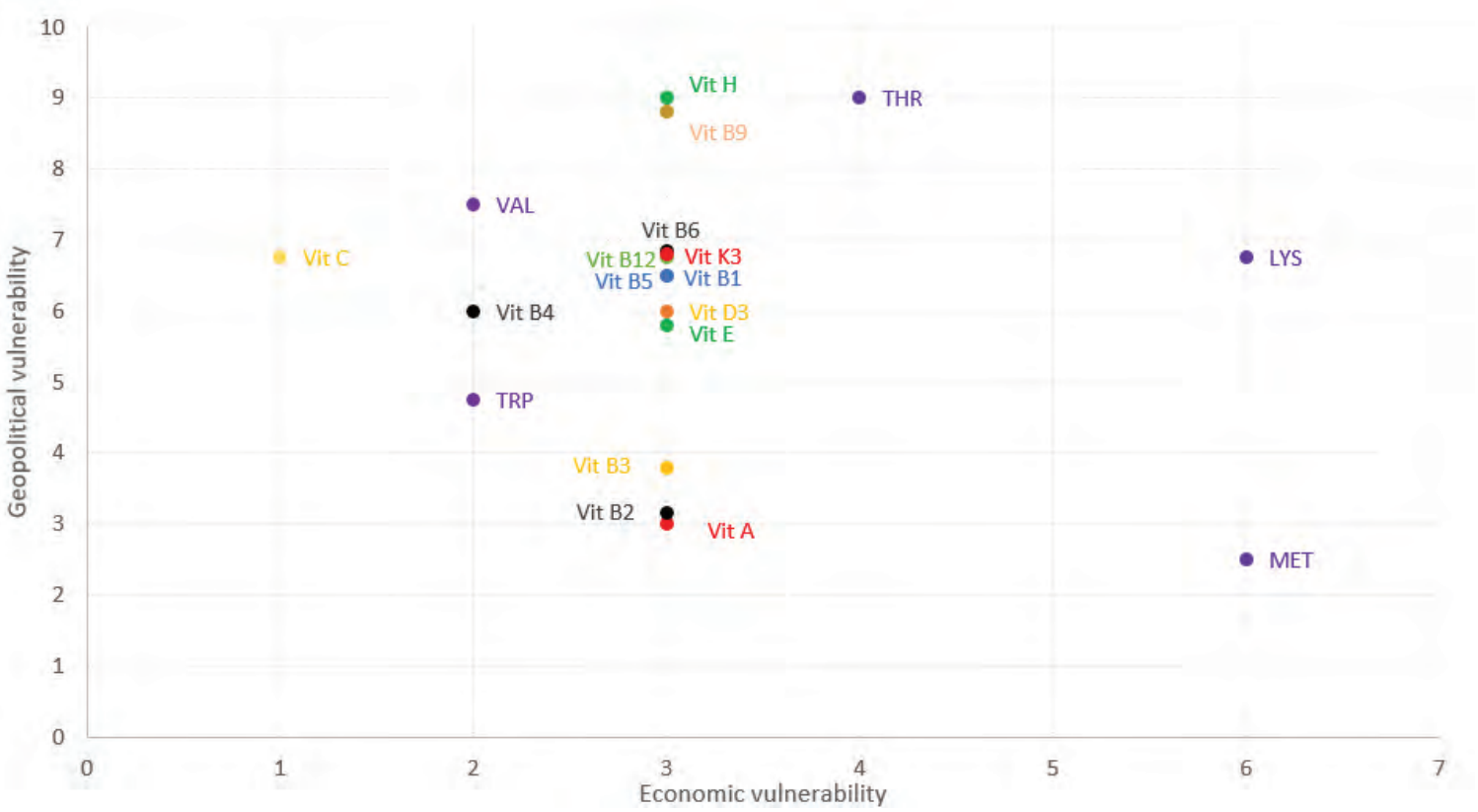


Chart 2: Breakdown of global production of vitamins per countries in 2023

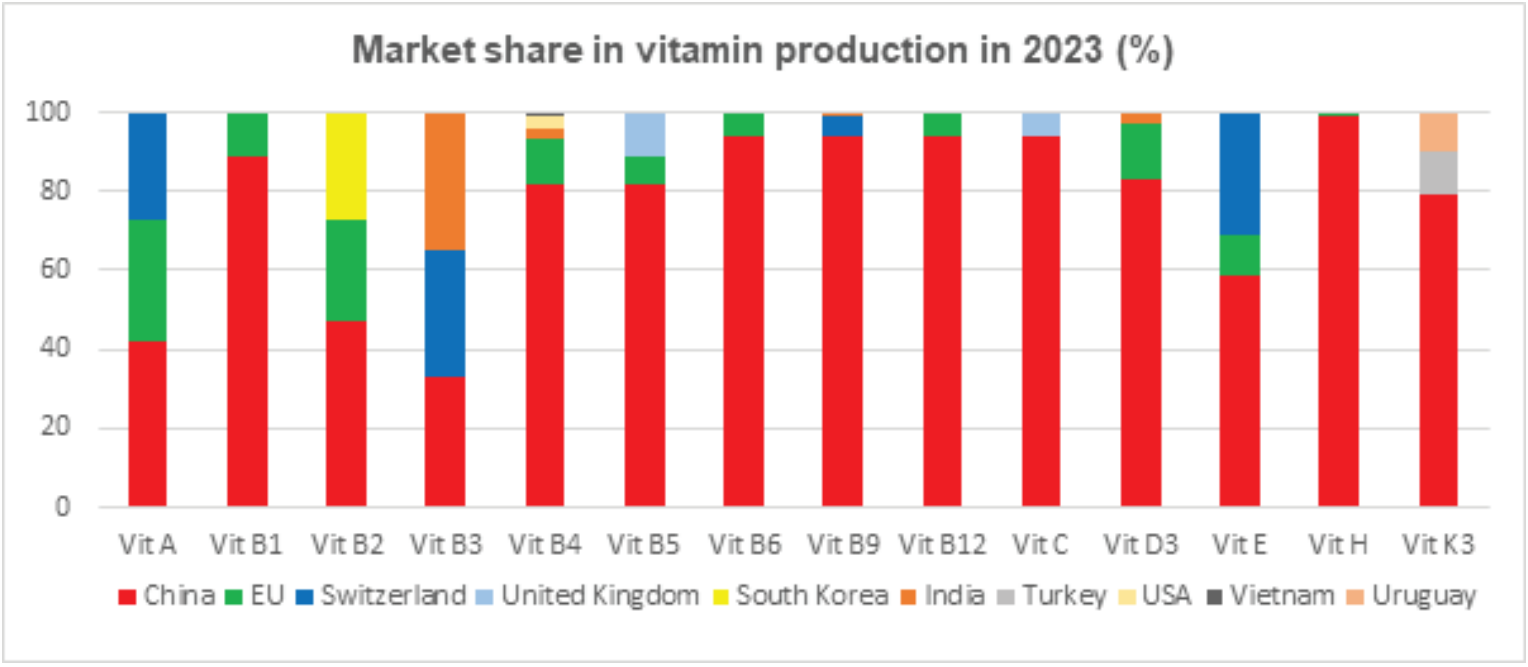
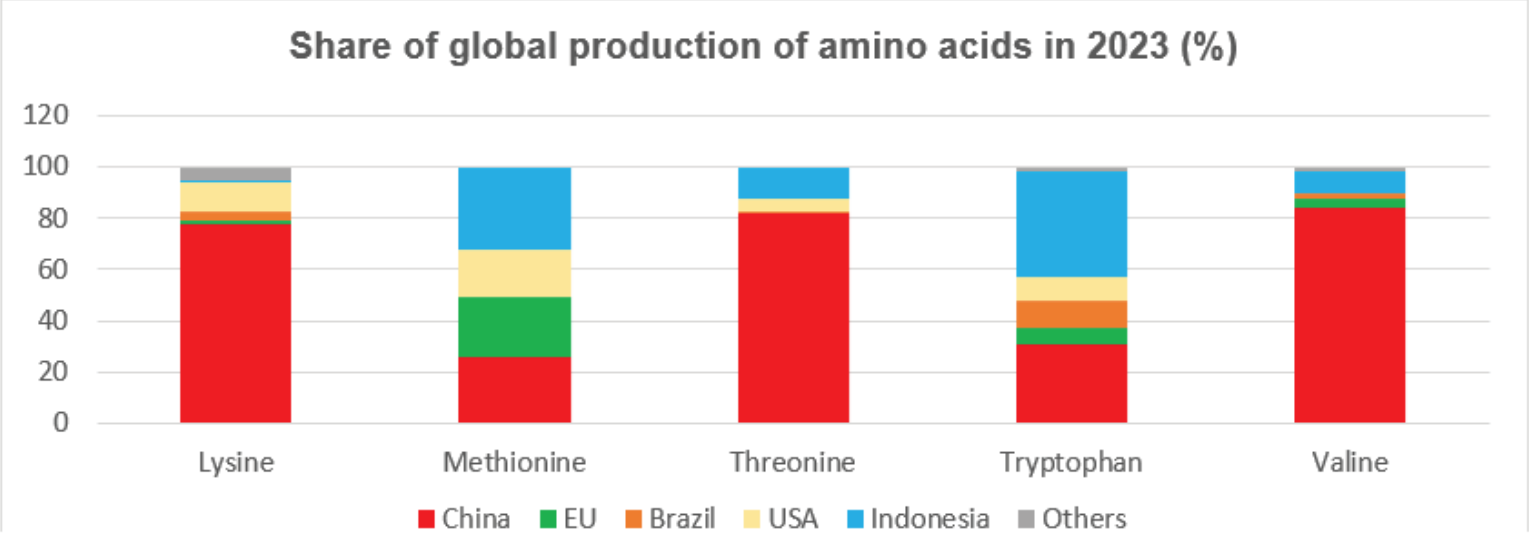


Chart 3: Breakdown of global production of amino acids per countries in 2023



2.3.3. Limitations of the exercise

For the economic vulnerability, a rough evaluation is performed, taking into account an average inclusion rate in final feed. However, the inclusion rates and essentiality might be different across species and therefore certain species may be impacted differently. A clear example is vitamin C, which is not essential to many species except fish.

The market of vitamins and, to a lesser extent, amino acids, is subject to extreme price volatility, due in particular to the low number of players. This may result in huge year-to-year variations regarding the actual production in the different countries and consequently on trade.
Most of the data reported in this study are from 2023, which may be representative for certain additives but not for others. For this reason, it is not easy to identify clear trends regarding market development. Having said that, investments in new production capacities worldwide occurs primarily in Asia and in particular China (lysine, valine, tryptophan, vitamin A), meaning an even higher omnipresence of China on the global market.

Access to the EU-27 market requires for products produced by fermentation a micro-organism specific authorisation as feed additive. Any delay in delivery of authorisations determines the ability of a manufacturer to serve the EU-27 feed market.

The economic vulnerability is considered only at the last stage of the feed chain.
However, between the feed additive producer and the farmer, vitamins undergo several dilution steps, in particular the dilution in a premixture meant to facilitate a homogeneous mixture of the micro-ingredients in the final feed. In such intermediate products, the contribution of vitamins in the costs of the premixture is up to 1,000 times higher than in the final feed. The competitiveness of the premixture industry on both the EU-27 and the export markets may be affected.

Regarding market data, the trade data on imports are based on Eurostat. The classification of vitamins destined to feed use is not always straightforward and sometimes, imports may occur under different CN codes. The data provided here are based on CN Codes 29362XXX and therefore it may be expected that the actual import flow is underestimated.

For vitamins, and to a lesser extent amino acids, the same manufacturing plants produce for feed, food, healthcare and cosmetics. In absence of official data on the respective market shares, a proxy of the share of feed vs. non-feed use was defined based on expert opinions and applied the same way for data related to production and production capacity in the EU-27 and in Third Countries.
In reality, the shares are likely to be different from one production plant / country to another.
It must be expected that, in case of gap between supply and demand, producers in EU or low geopolitical risk countries will favour the healthcare and food outlet vs. feed.

The HHI indicator for concentration of the EU-27 supply is considering only the concentration at country level. However, the concentration in terms of manufacturing plants is an additional factor of vulnerability. A rupture of supply from one manufacturer, whether resulting from an industrial accident, bankruptcy, … may significantly increase the risk of shortage at global level.
Furthermore, in case such an incident would affect an EU-based company, the overall EU-27 vulnerability would dramatically increase.

Finally, additional restrictions apply for the use of vitamins and amino acids in organic farming in the EU. Amino acids may not be produced by chemical synthesis (which excludes the use of methionine) and fermentation additives may only be produced with non-genetically modified micro-organisms. In reality, this results often in a monopolistic situation as is the case for vitamin B2.

3. DISCUSSION

The EU policy for open strategic autonomy lays on 4 concepts: reduce consumption, recycle, diversify the sourcing and produce more in the EU-27.

3.1. Reduce consumption

The demand for vitamins and amino acids is driven mostly by 4 parameters: the evolution of the livestock population, the improvement of the efficiency of production systems, the societal demand for higher animal welfare standards and less use of veterinary medicines and the increasing environmental standards regarding livestock and aquaculture emissions in the environment. Table 3 provides indications of the impact of these parameters on the future demand for amino acids and vitamins. In short, the demand for vitamins should be mostly affected by the evolution of livestock numbers in the EU, i.e. rather downwards at a steady rate, whereas the demand for amino acids and especially for threonine, valine and tryptophan and some other essential amino acids not covered by this study, is expected to increase with the tightening of legal requirements on environmental emissions of nitrogen which may require supplementation not only for the first and second limiting amino acids, but also more and more for the others.

3.2. Recycling

Vitamins may not be recovered from animals' effluents and amino acids are degraded before being excreted in the form of uric acid. Amino acids may be recovered from animal by-products but the technology is expensive and subject to legal restrictions.

3.3. Diversify the sourcing

The different geopolitical indicators show for vitamins and amino acids a high level of concentration globally and the sourcing from other Third Countries offers a real alternative to China for methionine, lysine, tryptophan and a few vitamins only. Still the EU-27 vulnerability for vitamin B3, C and some other vitamins is mitigated by the fact that they are produced by countries with whom the EU-27 has settled or is about to settle a trade agreement (Switzerland, United Kingdom, Brazil, Turkey, South Korea). On the other hand, the production of vitamins by chemical synthesis requires access to precursors which are produced by a handful of countries, making the prospect of safe diversification of supply dependent on the own vulnerability of the potential supplying country.

3.4. Produce more in the EU-27

Reindustrialization of the EU-27 is a policy priority, in particular for reasons of security of supply. Food security is not an exception here and producing more vitamins and amino acids in the EU-27 is the obvious option to follow. This is not only necessary to mitigate the food security risk but is essential to provide to EU livestock farmers more stability in terms of production costs and secure that consumers get products of animal origin produced in accordance with the EU standards for quality, safety and animal welfare & health. The nature of the instruments to support such a reindustrialization must be the subject to discussion and consultations with all interested parties.

Table 3: Parameters impacting on the future demand for amino acids and vitamins

Parameter	Amino acids		Vitamins	
	+	-	+	-
Evolution of livestock numbers (based on COM outlook 2035) Beef: -7% Dairy cows: -1% Pork: -5% Poultry: +5%		Decrease in pig numbers not compensated by poultry numbers		Less animals overall
Development of organic farming		As long as AA not allowed	Lower efficiency may involve higher demand for those vitamins authorized in organic farming	
Feed efficiency, meaning lower demand for feed for the same number of animals	Potential for improvement in feed efficiency may lay with more balanced AA profile		Neutral (Less feed but possibly with higher levels to meet daily demand)	
Higher pressure on N emissions	Clearly the main driver for increase in demand for AA		Neutral	
Higher requirements on animal welfare / animal health	Balance in amino acids to reduce proteins levels in young piglets and less		Feed for special nutritional purposes based on vitamins (e.g. support weaning)	

4. CONCLUSIONS

Key messages:

- Amino acids and vitamins are essential to preserve animal health and welfare, minimize emissions of nitrogen in the environment, contribute to food security and maintain a profitable livestock production and aquaculture in the EU-27.
- The EU-27 depends on Third Countries and more specifically China and the trend over the last years is to an increasing dependency upon China which continue building production capacities (especially for amino acids) and increases its global market share.
- Mitigating vulnerability requires in most cases reshoring production of amino acids and vitamins in the EU-27 due to limited possibilities to diversify the origins.
- For most vitamins and amino acids, reshoring production in the EU-27 will require helping the industry to regain competitiveness towards Third Countries suppliers.
- For certain vitamins (B9, C, H and K3) and for amino acids, there is also a clear necessity to build additional production capacity in the EU-27.
- Even for substances like vitamins A, B2, B4 and methionine for which the EU-27 is self-sufficient, it is still vulnerable considering that China increases dramatically its production capacity and is putting additional pressure on EU-27 producers.