

FERTILISER COSTS UNDER CBAM: IMPACT ON THE COST STRUCTURE OF FAMILY FARMS IN LITHUANIA

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Abstract

The CBAM on mineral fertilisers imported from third countries is putting financial pressure on Lithuanian family farms. This research aims to understand the principles of CBAM implementation and to determine how the CBAM on imported mineral fertilisers would change the cost structure of Lithuanian farms. The study employed analysis, systematization, and comparison, and utilized a logical-scenario-based simulation method for the empirical analysis of Lithuanian family farms. The results of the empirical research revealed that financial pressure varies depending on the size of Lithuanian family farms. The CBAM obligation resulted in the greatest increase in costs for family farms in classes 3–6 in 2026, with costs increasing by between 10.72% and 12.73%.

Keywords: Carbon Border Adjustment Mechanism (CBAM), Farm Cost Structure, Family Farms, Mineral Fertilisers, Scenario Modelling.

JEL Codes: F18, Q12, Q56.

Introduction

In the European Union (EU), the Carbon Border Adjustment Mechanism (CBAM) was introduced in 2023 for a transitional period, during which importers were only required to report the amount of CO₂ emissions associated with imported CBAM goods: steel, cement, aluminium, fertilisers, electricity, and hydrogen. A financial obligation was introduced in 2026, meaning that certificates on CO₂ emissions must be purchased for CBAM goods imported into the EU. This could be interpreted as an indirect environmental tax on goods (Regulation (EU) 2023/956, 2023; Martinez, 2025; Crisci et al., 2026).

The CBAM will affect various industrial sectors, but it will also be of particular importance to the agricultural sector, where small and medium-sized family farms are the most vulnerable. Although the impact will currently be limited to the taxation of fertilisers, the list of CBAM goods may expand in the future due to rising pollution in the agricultural sector. By 2030, EU institutions plan to expand the scope to additional products, including

agricultural goods (e.g., grains, animal products, rice, plant-based fibers, vegetable oils, etc.), while implementing reporting and offset mechanisms in line with the EU's climate and trade objectives (Martinez, 2025; Matthews, 2022).

Today, fertilisers account for a significant proportion of the costs incurred by crop farms, and this subsequently impacts livestock farms through increased feed costs. Therefore, the application of the CBAM to fertilisers used in agriculture is particularly relevant. In January 2026, the European Commission considered the possibility of temporarily suspending the application of the CBAM, but no decision was reached. The current decision is to temporarily exempt imports of nitrogen fertilisers from customs duties, while the CBAM remains in effect (Council of the EU, 2026).

It remains unclear how the CBAM will affect the family farms, as the geopolitical situation alone caused prices for certain fertilisers to rise by 30–40% in March 2026 (George & Strohecker, 2026). Various scientific studies (Wilson, 2026; Pieralli et

al., 2025; Fournier Gabela et al., 2024; Bux et al., 2024) highlight the relevance of this issue, indicating that such regulation in the future could significantly impact the financial stability of EU family farms, increase the prices of agricultural products, and alter trade flows with third countries.

Unfortunately, the existing research is still fragmented, making it difficult to assess how the CBAM will affect the financial stability of EU family farms and how this will impact countries at the national level. This allows us to formulate the **research question** – how to assess changes in fertiliser costs under the CBAM, taking into account the carbon dioxide (CO₂) emissions from imported fertilisers.

The aim of this research is to use data modelling to assess the impact of applying the CBAM to fertilisers on the cost structure of Lithuanian family farms, providing initial insights into the situation of these farms.

To achieve the aim, the following **research objectives** were set:

1. To explain the concept of CBAM and its role in agriculture from a theoretical perspective.
2. Analyse previous research on the application of the CBAM to fertilisers, identifying fertiliser emission factors in different countries.
3. Design an empirical research methodology to model the impact of the CBAM on the expenditure of family farms when importing fertilisers from third countries into the EU and test it using Lithuanian family farms as a case study.

In the authors' opinion, the results of the present empirical research are significant from both scientific and practical perspectives. Firstly, family farms should familiarise themselves with the CBAM application and its potential impact on their cost structure, as this could encourage them to explore alternatives when transitioning to more sustainable farming practices. Secondly, policymakers should take note of scientific discussion in the field of CBAM application, as the transition to more sustainable farming practices, especially on less fertile land, can be unprofitable for family farms. This makes it impossible for them to survive in some specific areas without using fertilisers. Thirdly, from a scientific perspective,

further research is necessary to measure the impact of CBAM implementation and to identify the most effective modelling methods. This is important not only for family farms, but also for food prices and the entire EU economy. However, the extent of this impact has not yet been clearly determined.

Research methods

The literature review was conducted using general research methods, including analysis, systematisation, and comparison. The research methodology is based on logical-inductive methods following analysis of previous empirical research. For the present empirical research, scenario-based simulation was used to identify and model several scenarios using crop family farms in Lithuania data from Farm Sustainability Data Network (FSDN), fertiliser import data from EU trade statistics in Access2Markets database, and fertiliser emission factors from secondary data sources. The results were interpreted using logical analysis and comparison with previous studies.

Literature review

Concept of CBAM in the context of agriculture

The application of the CBAM in the EU covers six industrial sectors – steel, cement, aluminium, fertilisers, electricity, and hydrogen (Regulation (EU) 2023/956, 2023; Martinez, 2025; Crisci et al., 2026). However, given the context of the present research, the primarily on the analysis of research related to agriculture. We used keywords such as “CBAM+fertiliser trade”, “CBAM+Agriculture”, and “CBAM+agri-food sector” for the research search. Taking into account that the CBAM regulation was adopted in 2023 and the financial period began in 2026, most of the previous studies analysed covered the 2023–2026 period.

Similar CBAM regulations are being implemented not only in the EU, but also in other countries, such as Canada (Atagher, 2023) and the United Kingdom (Aylett et al., 2024). However, there is a lack of in-depth international discussion on the topic. A literature analysis indicated that the research is fragmented. Some research on CBAM

has focused on the international fertiliser trade (Crisci et al., 2025; Bux et al., 2024; Atagher, 2023), food consumption (Kuiper et al., 2023), challenges in the agricultural sector (Del Federico & Giorgi, 2024; Santeramo & Jelliffe, 2024; Matthews, 2022), sustainable agricultural development

(Kuzmanović, 2023) and the EU-Africa agricultural food supply (Häberli et al., 2025; Bassi et al., 2024).

A systematic review of the scientific literature was conducted to identify the main conceptual approaches to CBAM (see Table 1).

Table 1. Concept of CBAM

Author	Concept
Crisci et al. (2026)	As part of the EU Green Deal, CBAM is closely related to the EU's goal of achieving climate neutrality by 2050. CBAM requires EU importers of goods from six industries to purchase certificates based on the CO ₂ emissions of the imported goods, which are priced according to the EU Emissions Trading System (ETS).
Bux et al. (2024)	CBAM could be defined as a carbon tax, which is the financial cost of importing CBAM goods. The CBAM assessment depends on the CO ₂ emissions associated with the imported goods, which are calculated using a world weighted average (WWA) emission factor.
Del Federico & Giorgi (2024)	One of the goals of CBAM is to ensure the fair competitiveness of EU producers, taking into account foreign producers who produce cheaper goods using unsustainable methods. The CBAM is linked to “mitigating climate change, neutralising commercial competitive advantages for polluters, strengthening climate leadership and raising resources for public finance”. The CBAM must encourage foreign countries to design their own CO ₂ tax.
Santeramo & Jelliffe (2024)	The EU CBAM is described as a policy linked to reducing CO ₂ emissions through a carbon tax. The CBAM, which is linked to the ETS, aims to boost the competitiveness of green or greener imports from other countries.

**Source: compiled by authors.*

As shown in Table 1, the main conceptual approaches suggest that the CBAM is primarily a policy tool aimed at reducing global CO₂ emissions (Crisci et al., 2026; Santeramo & Jelliffe, 2024). CBAM is often interpreted as a carbon tax, which is linked to extra costs for imported goods (Bux et al., 2024; Del Federico & Giorgi, 2024). The amount of the additional costs under the CBAM depends on the CO₂ emission factor of the imported goods and the ETS price (Crisci et al., 2026; Bux et al., 2024; Santeramo & Jelliffe, 2024).

This means that CBAM supports the import of goods into the EU that are manufactured using sustainable methods, while creating trade barriers for products that are manufactured in an unsustainable way (Santeramo & Jelliffe, 2024). The second goal of CBAM is to ensure that EU producers remain competitive despite their more sustainable production methods. The idea is to make less competitive, unsustainable producers outside the EU less competitive (Santeramo & Jelliffe, 2024; Del Federico & Giorgi, 2024).

In the context of agriculture, various studies (Del Federico and Giorgi, 2024; Atagher, 2023), the CBAM has been criticized for rising fertiliser prices, declining agricultural output, insufficient support for family farms to adapt, and a lack of subsidies and support for fertiliser producers' infrastructure (for CO₂ capture and storage facilities, or incentives to use “green hydrogen” or nuclear energy in production). Researchers (Bux et al., 2024) emphasize that the application of the CBAM is necessary, but microeconomic and macroeconomic variables such as fertiliser production costs, raw material availability, and local environmental policies are currently insufficiently assessed. Some of the risks are related to discriminatory applications of the CBAM and the consequences of pricing indirect emissions (Atagher, 2023). A significant portion of fertilisers imported into the EU comes from Africa, so the application of the CBAM will result in higher fertiliser prices in the EU, which will reduce the competitiveness of EU agriculture (Häberli et al., 2025; Bassi et al., 2024).

Positive aspects of CBAM have been identified in other scientific studies (Crisci et al., 2025), and it has been suggested that environmental policy can be transformed by CBAM in interaction with international trade, thereby strengthening sustainable agriculture, while a broader global decarbonisation movement is simultaneously promoted. Another researcher (Atagher, 2023) identified CBAM as the center of the triangle – international trade, environmental protection, and food safety.

Crisci et al. (2025) highlight that, in order to mitigate existing issues, it is essential to open up opportunities for ecological and bio-based farming practices, and revenues collected through the CBAM must be allocated to supporting the development of alternative bio-based fertilisers.

In the first phase, the inclusion of fertilisers in CBAM goods is viewed as a compromise solution (Del Federico and Giorgi, 2024). Today, the debate is ongoing regarding the future expansion of the list of CBAM goods to include agricultural and food products, as the agricultural sector is identified as one of the largest polluters (Del Federico and Giorgi, 2024; Santeramo and Jelliffe, 2024; Matthews, 2022). However, researchers (Del Federico and Giorgi, 2024) note that in the long term, by including agriculture as one of the polluting sectors, CBAM will have a positive impact on consumer behaviour: (1) an understanding of the impact of dietary habits on CO₂ emissions; (2) land degradation, and other environmental consequences; and (3) an understanding of an eco-friendly food culture.

On the other hand, the application of the CBAM to agricultural products may have negative effects, such as increased production costs, and therefore, these indirect costs should be offset by CBAM revenues (Matthews, 2022). The practical application of the CBAM to agricultural products raises concerns regarding the complexity of the supply chain, as it would require assessing, for example, where the cattle were raised, what they were fed, slaughter age, and other characteristics, which would complicate the calculation of CO₂ emissions (Matthews, 2022). Including agriculture in the CBAM is a complex task due to its specific

nature and gaps in the application of the CBAM (Kuzmanović, 2023). The CBAM has also been criticized for taxing only imports, even though the aim is to maintain the competitiveness of EU agriculture, while exports are not included in the scope of the CBAM (Matthews, 2022). On the other hand, if implemented properly and in cooperation with trading partners, the CBAM would serve not only as a CO₂ tax mechanism but also as a global catalyst for decarbonization and agricultural resilience (Crisci et al., 2025).

The theoretical foundation of CBAM for fertilisers

Studies on the application of the CBAM to fertiliser import have been conducted by researchers such as Crisci et al. (2026), Pieralli et al. (2025), Bux et al. (2024), and Atagher (2023). Other researchers and various studies (Shin et al., 2026; Vidovic et al., 2023; EBD, 2023) have focused on emissions from the production of nitrogen fertiliser (the majority used) or, in some cases, nitrogen combined with phosphorus and potassium (known as NPK), all of which are relevant in the context of the CBAM.

It should be noted that the application of the CBAM to fertilisers has been subject to exemptions due to geopolitical challenges and rising prices. The CBAM is calculated based on CO₂ emissions, which should be reported by the manufacturer (Crisci et al., 2026; Bux et al., 2024; Santeramo & Jelliffe, 2024). When this information is unavailable, the CBAM's default emission values are applied (Regulation (EU) 2023/956, 2023). Starting in 2026, the CO₂ emission values for CBAM goods will increase significantly (10–20–30% in 2026–2028) to encourage the reporting of actual emissions, but the fertiliser sector is an exception: its default values will increase by only about 1% per year, taking into account the specific nature of agriculture (International Carbon Action Partnership, 2026).

Nitrogen fertilisers account for the largest share of all fertilisers used on EU farms (Agri-food Data Portal, 2026). According to Access2Market data, approximately 29% of fertiliser imports to the EU in 2025 came from Egypt, around 22% from Russia, around 13% from China and around 10%

from Algeria. Fertiliser imports from other countries account for very small quantities, ranging from 0% to 5%. The situation with NPK fertilisers imported into the EU is a little different. According to Access2Market data, mineral or chemical fertilisers containing two or three of the fertilising elements nitrogen, phosphorus and potassium (HS 3105) were imported from Russia (33%), Morocco (30%) and Norway (12%) in 2025. In the context of the present research, therefore, this section focused primarily on analysing secondary source data to determine the CO₂ emission factor for mineral fertiliser production in Egypt, Russia, China, and Algeria.

The CO₂ intensity of mineral fertiliser production depends directly on the energy source used: the more carbon-intensive the electricity (e.g., from coal), the higher the emissions, while production using renewable or nuclear sources allows for an extremely low or nearly zero CO₂ footprint (Shin et al., 2026). In the case of CBAM,

the CO₂ emission factor is calculated based on direct emissions (Scope 1), which are driven by fertiliser production processes and energy-related sources (e.g., natural gas), as well as indirect emissions (Scope 2), which are usually grid electricity (Shin et al., 2026; Bux et al., 2024; EBD, 2023). However, in certain cases, the sum of upstream emissions (Scope 3) may also be included. This is known as embedded CO₂ in raw materials under CBAM, but only in the case of complex goods (Shin et al., 2026; EBD, 2023). Life Cycle Assessment (LCA) is closely related to the inclusion of Scope 3 emissions, which is why CO₂ emission levels are much higher than when using Scope 1 and Scope 2 (Shin et al., 2026). Therefore, based on the results of various studies and research (Shin et al., 2026; Bux et al., 2024; Vidovic et al., 2023; EBD, 2023), the CO₂ emission factor varies within the same country due to differences in calculation methods and mineral fertiliser production processes (see table 2).

Table 2. CO₂ emission factors for mineral fertilisers in selected countries

Country	CO ₂ emission factor (tCO _{2e} /t of goods)	Comments	Source
Egypt (EG)	0.89–2.52	The calculations were performed for ammonia (Scope 1 and 2) and urea, nitric acid and ammonium nitrate (Scope 1, 2 and 3).	EBD (2023)
	0.88–2.08	The calculations were performed for ammonia, urea, ammonium nitrate, and NPK fertilisers.	Bux et al. (2024)
	6.23	An LCA assessment was used for the production of ammonia.	Shin et al. (2026)
	0.70	Natural gas and electricity are used for the production of ammonia.	
	0.66–2.786	Various fertiliser mixes, in which nitrogen fertilisers dominate (HS 3102*).	Vidovic et al. (2023)
Russia (RU)	1.12–2.60	The calculations were performed for ammonia, urea, ammonium nitrate, and NPK fertilisers.	Bux et al. (2024)
	4.7	An LCA assessment was used for the production of ammonia.	Shin et al. (2026)
	0.59	Natural gas and electricity are used for the production of ammonia.	
	0.67–4.26	Various fertiliser mixes, in which nitrogen fertilisers dominate (HS 3102*).	Vidovic et al. (2023)
China (CN)	1.43–3.88	The calculations were performed for ammonia, urea, ammonium nitrate, and NPK fertilisers.	Bux et al. (2024)
	6.67	An LCA assessment was used for the production of ammonia.	Shin et al. (2026)
	0.81	Natural gas and electricity are used for the production of ammonia.	
	1.15–4.61	Various fertiliser mixes, in which nitrogen fertilisers dominate (HS 3102*).	Vidovic et al. (2023)
	6.35	An LCA assessment was used for the production of ammonia.	Shin et al. (2026)

Algeria (DZ)	0.81	Natural gas and electricity are used for the production of ammonia.	
	0.65–2.79	Various fertiliser mixes, in which nitrogen fertilisers dominate (HS 3102*)	Vidovic et al. (2023)

*Source: compiled by authors.

Note: *HS 3102 – Harmonised System for the classification of goods. The 3102 group includes mineral or chemical fertilisers containing nitrogen.

Table 2 analyses the four countries from which the EU imports the largest proportion of nitrogen fertilisers. As can be seen, CO₂ intensity varies significantly depending on the mineral fertiliser production method and calculation methodology. Therefore, when selecting a future fertiliser supplier and assessing the potential impact of the CBAM, it is important to consider whether the CO₂ emissions methodology aligns with the EU's established methodology, as well as the country of origin and production method of the fertilisers. When analysing individual EU member states and fertiliser imports, it should be noted that the main suppliers may vary, as presented in Table 2.

Research methodology and data

Lithuania case study

According to data from Eurostat (2026), the consumption of nitrogen fertiliser in Lithuanian agriculture increased from 162 thousand tonnes in 2014 to 187.5 thousand tonnes in 2021. Meanwhile, the consumption of phosphorus fertiliser in Lithuanian agriculture decreased from 19.4 thousand tonnes in 2014 to 16.3 thousand tonnes in 2024 (Eurostat, 2026). Potassium is usually excluded from agri-environmental analyses because environmental pressures are driven mainly by nitrogen and phosphorus losses.

A significant increase in nitrogen fertiliser consumption was observed during the 2019–2021 COVID-19 pandemic period, with an average consumption of 183.9 thousand tonnes. Later, nitrogen fertiliser consumption in Lithuania decreased significantly, reaching 124.9 thousand tonnes in 2024. During the COVID-19 pandemic, the European Green Deal measures were still in the

early stages of implementation, indicating that family farms in Lithuania were not subject to strict rules on the use of nitrogen fertilisers. During the unstable period of 2019–2021, market, supply chain, and geopolitical instability (including disruptions at the Belarusian border) encouraged Lithuanian farms to aim for higher yields and make more efficient use of available land, which contributed to more intensive fertilization.

Based on the Agri-food data portal¹, the nitrogen fertiliser used on field-crop farms in Lithuania in 2023 was 121 kg/ha. Additionally, it can be seen that the use of fertiliser differs according to the economic size of the family farm in Lithuania. Micro (class 1) and small (class 2) family farms used 23.8 kg/ha of nitrogen fertiliser, making them more sustainable, while medium-small (class 3) sized family farms used 52.4 kg/ha. Meanwhile, medium-large (class 4) sized family farms used 86.4 kg/ha of fertiliser, while larger (class 5) and very large (class 6) farms used 136.6 kg/ha. This reflects higher outputs resulting from the unsustainable use of fertilisers. This also demonstrates that the financial impact of CBAM will affect different family farms in different ways.

Based on the Agri-food Data Portal¹, Lithuanian family farms used on average 22.8 kg of phosphorus (P) and 21.7 kg of potassium (K) per hectare in 2023. Nutrient use increased with farm size: micro and small family farms applied around 4.2 kg P/ha and 3.9 kg K/ha, medium-small and medium-large farms used approximately 11.3 kg P/ha and 11.5 kg K/ha, while large and very large family farms used about 31.1 kg P/ha and 30.6 kg K/ha. The statistics further confirm that larger family farms apply higher rates of phosphorus and potassium fertilisers, following the same pattern

¹ Fertiliser use and costs in EU farms. Available online: <https://agridata.ec.europa.eu/extensions/FertiliserReport/FertiliserReport.html>

observed for nitrogen fertiliser use, with nutrient application increasing consistently as farm size expands.

Access2Market database² showed that the main source of imports of nitrogen fertiliser (HS3102) was Uzbekistan, accounting for around 40% of Lithuania's total fertiliser imports in 2025, with around 257.4 thousand tonnes. The second and third largest trading partners in 2025 were China and Russia, with imports of around 181.3 thousand tonnes (28%) and 170.2 thousand tonnes (27%), respectively. It should be mentioned that the situation in the nitrogen fertiliser import market changed in 2025 due to sanctions against Russia in the context of the war between Russia and Ukraine. Looking back to 2023–2024, the size of Russian nitrogen fertiliser imports was around 30% (120.6 thousand tonnes in 2024 and 128.8 thousand tonnes in 2023). In 2023, a significant proportion was imported from the United States (119.2 thousand tonnes), accounting for around 27% of the total imports. However, in 2024–2025, the United States was an insignificant partner, with fertiliser imports accounting for less than one per cent. To summarize the statistical data, it can be concluded that the main trading partners for nitrogen fertiliser imports are Uzbekistan, Russia, and China. Based on 2025 data, imports from these three countries account for 95%, which means that only 5% of nitrogen fertilisers were imported from other countries.

Based on Access2Market data³, Morocco was the dominant supplier of NPK fertilisers (HS 3105) to Lithuania during 2023–2025, accounting for approximately 60% of total imports. The share of imports from Uzbekistan increased from around 18% in 2023–2024 to 26% in 2025, while Kazakhstan's share rose from about 7% in 2023 to approximately 10% in 2024–2025. This indicates a gradual diversification of Lithuania's NPK fertiliser import structure, although Morocco remains the principal supplier.

According to the Access2Market database³, during the 2025 period, Lithuania imported 31.09

million tonnes of nitrogen fertilisers (58.9% of which came from third countries and 41.1% from the EU) and exported 30.58 million tonnes (two-thirds of which went to EU markets). This means that only about 0.51 million tonnes of mineral fertilisers actually remain in the domestic market – that is, the amount that is not re-exported. Therefore, based on the trade balance, it can be concluded that the fertilisers consumed in the Lithuanian market are almost entirely imported, as the surplus of imports over exports accounts for the entire quantity available for domestic consumption.

In a broader context, the EU's dependence on imports of mineral nitrogen fertilisers reached 45% in 2022 (Matthews, 2025). The situation in Lithuania is in line with the overall EU trend – an increasing reliance on imports to meet fertiliser demand. This suggests that Lithuania, as part of the EU, could use 55% of the fertiliser produced in the EU, with the remaining 45% needing to be imported. As the FSDN database does not contain detailed farm-level information on the origin of nitrogen (N), phosphorus (P) and potassium (K) fertilisers, a uniform import-dependence parameter was applied across all fertiliser categories. This approach ensures comparability between fertiliser groups and enables an assessment of the sensitivity of family farms to potential increases in fertiliser costs due to CBAM under a harmonised scenario framework. Therefore, it is assumed that a Lithuanian family farm using mineral fertilisers would see the cost increase resulting from the CBAM affect 45% of the fertilisers it uses.

Research methodology

This empirical research uses historical, aggregate data on Lithuanian crop family farms from the Farm Sustainability Data Network (FSDN) Public Database for the period 2019–2023. The dataset includes information on the quantity of fertiliser, fertiliser costs, and total inputs (Table 3).

² EU trade statistics (excluding United Kingdom). Available online: <https://trade.ec.europa.eu/access-to-markets/en/statistics?reporter>

³ EU trade statistics (excluding United Kingdom). Available online: <https://trade.ec.europa.eu/access-to-markets/en/statistics?reporter>

Table 3. Selected variables of family farms in Lithuania

Variable	Code of FSDN Public Database
Total Inputs (TC), EUR/farm	SE270 for each farm size 1-6
Fertilisers costs (F), EUR/farm	SE295
Used Nitrogen fertiliser (N), q/farm	SE296
Used Phosphorus fertiliser (P), q/farm	SE297
Used Potassium fertiliser (K), q/farm	SE298
Arable land (L), ha/farm	SE026

**Source: compiled by authors.*

The average family farm level structure that was observed in 2014–2023 is used as a static baseline for the 2026 assessment period in the empirical research. This assumption reflects a constant-structure scenario, where farm size, crop composition, and fertiliser use patterns remain unchanged. The purpose is not to forecast family farm development but to evaluate how CBAM would affect farms if the current production structure persisted.

Nitrogen fertiliser consumption is extracted as the primary input relevant for CBAM calculations. Due to the lack of detailed import statistics by nutrient type, the model applies a

uniform import share of 45% for nitrogen (N), phosphorus (P), and potassium (K) fertilisers (Matthews, 2025). This assumption ensures internal consistency across fertiliser groups and reflects the average share of imported mineral fertilisers in total national consumption.

Additional contextual data on the structure of fertiliser imports from the Access2Market database was used to identify countries exporting fertiliser to the EU and to assess their share of the market. To model CBAM costs, CO₂ value, CBAM benchmark and price variables were used, based on the sources provided in Table 4.

Table 4. Selected variables for calculating CBAM costs

Variable	Explanation	Source
Default value of Nitrogen fertilisers (DV_N _{country}), value	Nitrogen fertilisers are traded internationally as mixed products under HS 3102. The analysis applies the average default emission factor assigned to this code. The average value is calculated separately for each exporting country, ensuring that country-specific default factors are preserved within the HS 3102 product category.	Default values based on Implementing Regulation (EU) 2025/2621 published on 17 December 2025, version of 13 February 2026
Default value of Phosphorus fertilisers (DV_P _{country}), value	Phosphorus and potassium fertilisers, including all compound NPK formulations, fall under HS code 3105, which encompasses mineral or chemical fertilisers containing two or three primary nutrients (N, P, K). Due to the mixed nature of these products, production-specific emission intensities cannot be distinguished. Therefore, the model applies the HS 3105 default emission factor, computed as a country-specific average for each fertiliser-exporting country, preserving cross-country differences in default CBAM values.	
Default value of Potassium fertilisers (DV_K _{country}), value		
CBAM benchmark values of Nitrogen fertilisers (BV_N _i), value	The CBAM benchmark for nitrogen fertilisers classified under HS 3102 is calculated as the average CBAM benchmark factor assigned to this product category, reflecting the aggregated default value applicable to HS 3102.	CBAM benchmark values based on Implementing Regulation (EU) 2025/2620 published on 22 December 2025, version of 13 February 2026
CBAM benchmark values of Phosphorus fertilisers (BV_P _i), value	The CBAM benchmark for fertilisers classified under HS 3105 is likewise determined as the average CBAM benchmark factor for this product category, reflecting the aggregated default value applicable to HS 3105.	
CBAM benchmark values of Potassium fertilisers (BV_K _i), value		
CBAM factor (CBAM _{factor-t}), coefficient	The CBAM factor is assumed to increase gradually over the implementation period, reaching 2.5% in 2026, 5% in 2027, and 10% in 2028.	CBAM factor referred to in Article 10a(1a) of

		Directive 2003/87/EC
CBAM certificates price ($CBAM_{price-t}$)	Future CBAM certificate prices are approximated using a simplified ETS price trajectory, reflecting recent market levels and long-term tightening of the EU ETS. For 2026 Q1 confirmed 75,36 EUR/tCO ₂ . The model applies possible averages as 80 EUR/tCO ₂ in 2026, 90 EUR/tCO ₂ in 2027, and 100 EUR/tCO ₂ in 2028, which is consistent with historical ETS price volatility and medium-term market expectations.	Price of CBAM certificates ⁴ EU carbon permit ⁵

*Source: compiled by authors.

The modelling approach links historical fertiliser use with scenario-specific emission intensities to estimate potential CBAM costs. Historical data are used to determine total fertiliser consumption, after which an assumed share is allocated to imported fertilisers. A single scenario based on default emission values is applied to estimate the CBAM certificate requirements for imported fertilisers.

Imported fertilisers are assigned the CBAM default emission values applicable to HS codes 3102 and 3105. These default values are used as regulatory benchmarks when verified emission data are unavailable and provide the basis for calculating the embedded emissions and the corresponding CBAM certificate requirements (1).

$$CBAM_{certificates-t} = \left(N_{import-t} \times \left(DV_{N_{country}} - (BV_{N_t} - CBAM_{factor-t}) \right) \right) + \left(P_{import-t} \times \left(DV_{P_{country}} - (BV_{P_t} - CBAM_{factor-t}) \right) \right) + \left(K_{import-t} \times \left(DV_{K_{country}} - (BV_{K_t} - CBAM_{factor-t}) \right) \right) \quad (1)$$

The estimated CBAM costs (2) is calculated by multiplying the required number of CBAM certificates by the applicable CBAM certificate price, which is linked to the assumed EU ETS allowance price.

$$CBAM_COSTS_t = CBAM_{certificates-t} \times CBAM_{price-t} \quad (2)$$

This scenario is calculated using the data presented in Tables 3 and 4 and applying Equations (1) and (2). Therefore, the estimated number of CBAM certificates and the associated CBAM costs should be interpreted as illustrative values based on the assumptions and data used in this research.

The main limitations of this study are related to data constraints (historical FSDN data), modelling assumptions (static farm structure and constant production patterns), and CBAM-specific uncertainty factors, including the use of default emission values and scenario-based fertiliser import assumptions.

Research results and discussion

For the empirical analysis of nitrogen (N) fertilisers, the HS 3102 fertiliser category was applied (see the explanation in Table 4). The collected data revealed that Uzbekistan, China, and Russia were the main suppliers, accounting for 95.39% of total Lithuania imports in 2025. Phosphorus (P) and potassium (K) fertilisers are most imported as compound fertiliser blends; therefore, the HS 3105 fertiliser category was applied (see the explanation in Table 4). The main import partners in this category differ and include Uzbekistan, Morocco, and Kazakhstan, which together accounted for 96.41% of total imports in 2025. Figure 1 presents the share of imports originating from these countries. This share rate was therefore used as the basis for the 2026 scenario modelling.

⁴ Price of CBAM certificates. Available online: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism/price-cbam-certificates_en

⁵ EU Carbon Permits. Available online: <https://tradingeconomics.com/commodity/carbon>

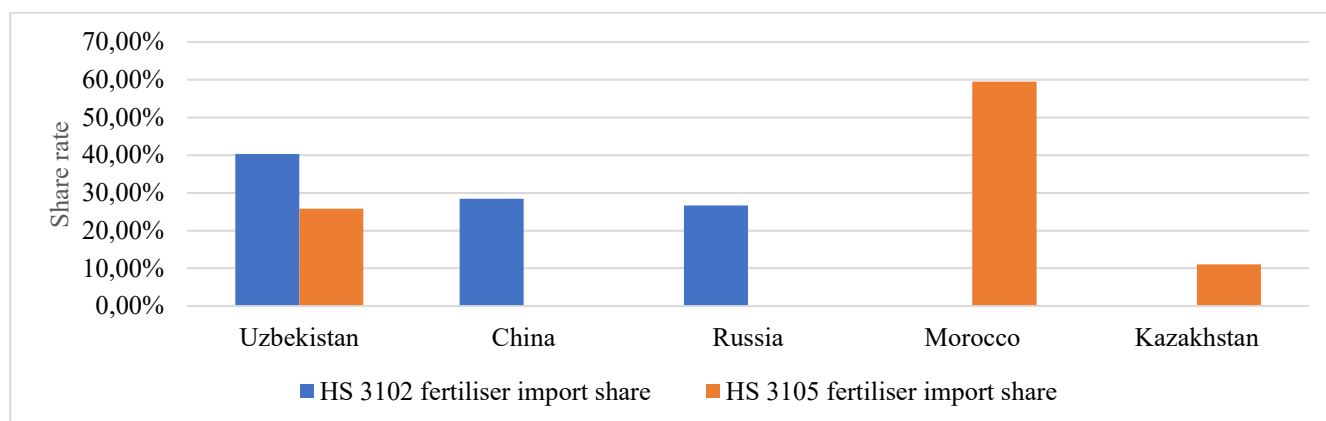


Figure 1. Share of Lithuania fertiliser imports by main trade partner for HS 3102 and HS 3105 in 2025

**Source: compiled by the authors based on Access2Markets trade data.*

Based on calculations performed under the defined research methodology scenario, the results indicate that the total cost of fertiliser on family farms could increase by between 34.12% and 54.29%, assuming that family farms use 45%

imported fertiliser from third countries. Figure 2 presents the average fertiliser costs per hectare across different family farm size classes and illustrates the change in these fertilisers costs after incorporating CBAM-related costs.

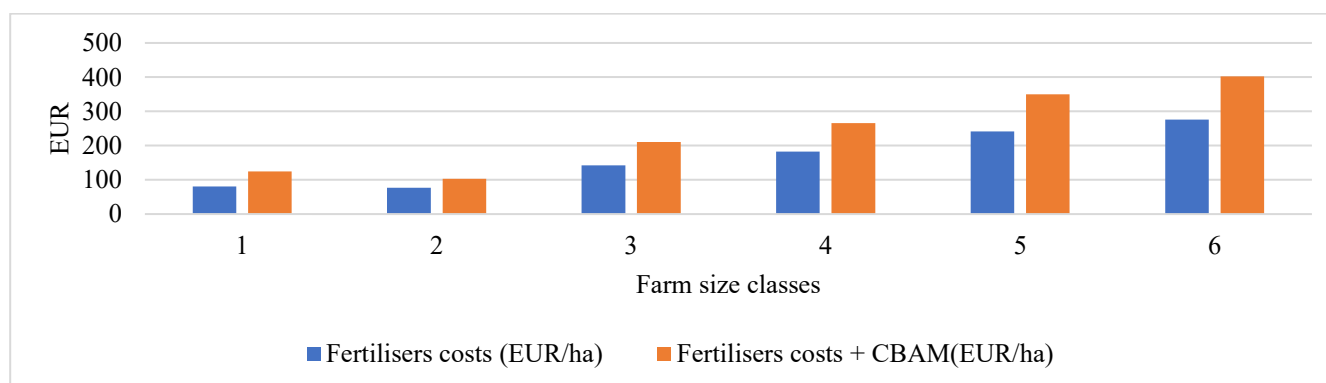


Figure 2. Average fertiliser costs per hectare before and after CBAM

**Source: authors' calculations based on the scenario modelling framework developed in this empirical research.*

In order to evaluate the direct microeconomic consequences of the CBAM for Lithuanian family farms and assess the impact on their cost structure, the structural and economic parameters across the six farm size classes provide a clear baseline for vulnerability. This illustrates how structural input demands translate into direct financial liabilities when the CBAM certificate obligation is introduced in 2026. Based on the simulation results, we divided the farms and their size classes into two distinct groups in our research.

1. The Mid-Scale and Large-Scale Exposure (size classes 3-6)

The most severe cost distortions occur in Classes 3 to 6, where fertiliser costs escalate by between 44.97% and 47.78% (peaking at 47.78% in Class 3). These cost surges lead to an increase in the total cost of farming inputs ranging from 10.72% to 12.73%, with Class 5 experiencing the highest increase at 12.73%. These family farms have high crop yields and require intensive fertiliser inputs. It could be assumed that they lack the supply-chain leverage or buying power to renegotiate logistics

agreements or bypass regional import tariffs directly.

2. The Small-Scale Buffer (size classes 1-2).

In Classes 1 and 2, the financial obligation of the CBAM causes fertiliser costs to increase to varying degrees. Compared to all other family farm size classes, the increase in Class 1 is the highest. Fertiliser costs would rise by 54.29% in Class 1. Meanwhile, fertiliser costs in Class 2 would increase the least, by 34.12%. However, despite these differences, the impact on the overall cost structure of this group is minimal. Due to lower

resource intensity and the impact of the total input structure, the effect on total farm cost is smaller: 5.35% for Class 1 and 4.94% for Class 2. Although overall cost pressure is relatively low compared to larger family farms, operating margins in these segments are narrow. Therefore, even minor cost increases can cause localised liquidity issues.

These changes in the cost structure of family farms are driven by the intensity of fertiliser use. Figure 3 illustrates the intensity of fertiliser use on family farms, alongside the estimated number of CBAM certificates by family farm size.

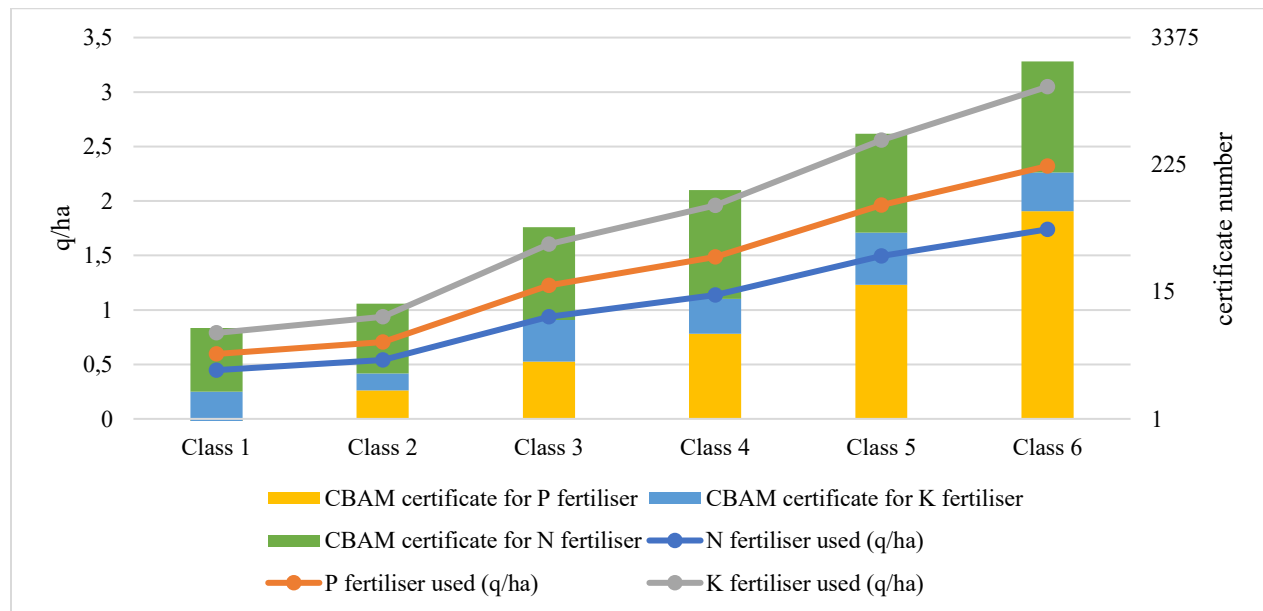


Figure 3. Intensity of fertiliser use and quantity of CBAM certificates

**Source: authors' calculations based on the scenario modelling framework developed in this empirical research.*

As shown in Figure 3, the primary axis shows the application rates of fertilisers (q/ha), while the secondary axis, which is on a logarithmic scale, shows the calculated CBAM certificates by fertiliser group. This empirical study shows that the rate at which fertiliser is applied increases with farm size (see Fig. 3). While small family farms (Classes 1 and 2) are generally considered more sustainable and likely to use fewer fertilisers, financial considerations are also likely to play a role. The larger the family farm (Classes 5 and 6), the more fertiliser is applied per hectare, indicating an effort to maximise yields and profits.

According to our simulation model, the quantity of CBAM certificates for Classes 1–4 would be lower. Here, the cost for Class 1 would increase by seven CBAM certificates, by nearly 12 certificates for Class 2, by about 59 certificates for Class 3 and by about 131 certificates for Class 4. Class 5 would be in the middle, with costs for CBAM increasing by around 436 certificates. Class 6 would be the most impacted by CBAM, with costs increasing by around 2,027 certificates. Accordingly, the volume of fertiliser imports depends directly on decisions regarding fertiliser usage (since EU production is insufficient).

Therefore, larger family farms would bear a greater share of CBAM certificates and the associated tax burden.

There are several possible scenarios for this pressure to decrease in the future. Either new, more innovative fertilisation methods are sought, or there is a shift towards sustainable agriculture, reducing the intensity of fertiliser use and the resulting additional CBAM costs. Third-country markets are also feeling the pressure and shifting towards more sustainable production methods, which reduces the volume of CBAM certificates required and lowers costs for farms. The EU's production of fertilisers is strengthening.

Although this empirical research was conducted on Lithuanian family farms, we believe it provides excellent insights into the impact of the CBAM on all EU family farms. However, it is necessary to examine the impact of the CBAM on family farms in other EU countries, as differences in farm structure and soil fertility may result in different data.

Conclusions

The literature reviewed showed that CBAM is interpreted in different ways, but it is clear that it follows the EU Green Deal policy of promoting more sustainable manufacturing methods worldwide while protecting EU producers. There is still much discussion about the advantages and disadvantages of CBAM and expanding the list of goods covered by CBAM. This is also closely related to agricultural products, particularly with regard to the application of CBAM to fertilisers.

Various studies show that the financial obligations of CBAM for fertilisers could differ significantly. These differences depend on the manufacturing and CO₂ intensity of fertilisers in various third countries. When taking into account the CBAM obligation for EU importers, the country of origin of the fertiliser and the production technology used must be considered. If the technology used for fertilisers is based on renewable energy or nutrients, then CO₂ emissions will be lower, and the CBAM obligation will also be lower compared to gas or coal use.

The suggested empirical research methodology is based on historical data from Lithuanian family farms and sets EU default values for CO₂ intensity, CBAM factors, etc. This allows the expected potential impact of CBAM on fertiliser-related expenditure to be considered, and demonstrates that depending on fertiliser prices, emission intensities, and future CBAM requirements, Lithuanian family farms may face increased production costs.

This empirical research highlights a clear point of friction between environmental policy and the economic realities faced by family farms. If the revenue collected from CBAM certificates is absorbed into general public funds rather than being redirected into target support mechanisms, it could lead to several negative outcomes:

- *The implementation of the CBAM policy encourages inappropriate adaptation by family farms.* Rather than encouraging an orderly transition toward bio-based alternatives, an unmitigated cost (total input) increases of 4.94–12.73% during a period of high geopolitical volatility may force vulnerable family farms to reduce fertiliser application below agronomic optimums. This could potentially affect crop yields and, consequently, regional food security. However, as the current empirical research is based on scenario assumptions, it is impossible to accurately predict the extent of these effects. Further research based on data from actual family farms and CBAM from 2026 onwards will be necessary to evaluate the real impact of fertiliser cost increases induced by CBAM on fertiliser use, agricultural productivity, and food security.

- *The CBAM could lead to greater social exclusion among family farms.* For family farms operating on less fertile soils where a relatively high level of nutrient application is required to maintain production, cost increases related to CBAM may create additional economic pressure. Empirical results showed that fertiliser costs could rise by up to 50% for some family farms, while income could fall by up to 13% for the most affected family farms groups. The assumption is that family farms may reduce fertiliser application rates to lower production costs, which could affect productivity, or

pass on some of the additional costs to consumers in the form of higher agri-food prices. The impact of these adjustments on agricultural production and market outcomes should be evaluated using data from the implementation of CBAM after 2026.

- *The extensive documentation and process requirements of the CBAM may lead to supply chain delays.* The heavy reliance on imports from countries such as Uzbekistan means that, if EU verification channels fail to provide verified emissions figures, fertiliser importers will be

exposed to strict default penalties. In such cases, the fertiliser market could lack the necessary quantity of fertilisers, and due to higher demand, prices could increase further. This highlights the need for transitional public subsidies to help family farms adapt to these new regulations.

This type of research must be expanded in future, particularly once more data has been collected from CBAM declarations. This will make it possible to compare the actual CO₂ emissions generated by fertiliser producers, rather than the impact of the default CO₂ values.

Data availability statement

For this empirical study, the authors used publicly available data. Any data collected by the authors may also be shared upon reasonable request, by contacting the corresponding author.

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