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IMPORT DEPENDENCY AS A FOOD SECURITY CHALLENGE FOR THE REPUBLIC OF ARMENIA: A MIXED-METHODS ANALYSIS

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Հոդվածը ստացվել է՝ 06.03.26, ուղարկվել է գրախոսման՝ 09.03.26, երաշխավորվել է տպագրության՝ 06.07.26

Introduction. In the contemporary world, characterized by growing uncertainty, geopolitical tensions, and supply chain vulnerabilities, ensuring food security has become a central component of national security. According to the Food and Agriculture Organization (FAO), food security rests on four pillars: availability, access, utilization, and stability[1]. Developing economies, including Armenia, are particularly vulnerable to external shocks due to their high dependence on food imports[2].

The relevance of this study is underscored by the escalating global food crises, including supply disruptions caused by the Russia-Ukraine conflict, which have renewed policy interest in self-sufficiency, especially in import-dependent countries[3,4]. However, international experience shows that self-sufficiency should not be the sole goal, as trade restrictions can lead to price increases and market distortions[5]. Instead, a balanced model of import dependency management is needed, combining domestic production incentives, supply source diversification, and trade efficiency improvements[6].

The main objective of this article is to analyze Armenia's food security from the perspective of import dependency, identify the root causes of this dependency, and propose feasible mitigation pathways. This study makes two principal contributions. First, it provides a comprehensive analysis of Armenia's import dependency based on recent data. Second, it introduces a novel composite indicator (Import Dependency Coefficient – IDC) and a logistic forecasting model specifically tailored to Armenia's food security context.

To achieve this objective, the study addresses the following **research tasks**:

To assess the current state of food security in Armenia by calculating import penetration ratios and supplier concentration for key commodities.

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[1] FAO. (2008). An Introduction to the Basic Concepts of Food Security. Food and Agriculture Organization of the United Nations, Rome.

[2] Kornher, L., Daniels, I. & Tadesse, G. (2026). Science for Africa's future food security: the need for an all-Africa food supply strategy. Food Security. 18, 629-635. https://doi.org/10.1007/s12571-025-01635-4

[3] Voskanyan, M., & Hayrapetyan, V. (2024). Analyzing and Assessing Armenia's Critical Imports through the Lens of Food Security. Contemporary World Economy, 2(4), 106-123. https://doi.org/10.17323/2949-5776-2024-2-4-106-123

[4] Poghosyan S, Asatryan H, Azatyan L, Manucharyan M, Poghosyan M. Assessing the impact of the Russian-Ukrainian conflict: Econometric case study of Armenian economy. Int J Innov Res Sci Stud. 2025 Mar;8(2):67–73. 10.53894/ijirss.v8i2.5095.

[5] Stehl, J., Vonderschmidt, A., Vollmer, S. et al. Gap between national food production and food-based dietary guidance highlights lack of national self-sufficiency. Nat Food 6, 571–576 (2025). https://doi.org/10.1038/s43016-025-01173-4

[6] World Bank. (2025). Data-driven nutrition security: How trade shapes resilience. World Bank Blogs, December 8, 2025.

To develop and apply a composite Import Dependency Coefficient (IDC) that integrates both import volume and supplier concentration.

To forecast future import dependency for strategic commodities (e.g., wheat) under baseline and intervention scenarios using a logistic growth model.

To identify the main causes of import dependency (productivity gaps, technological constraints, migration, geopolitical factors).

To propose an integrated policy framework for reducing import dependency and enhancing resilience, while avoiding the pitfalls of unilateral self-sufficiency.'

However, international experience shows that self-sufficiency should not be the sole goal, as trade restrictions can lead to price increases and market distortions. Instead, a balanced model of import dependency management is needed, combining domestic production incentives, supply source diversification, and trade efficiency improvements. This study adopts this balanced perspective, aiming to provide both diagnostic tools and actionable policy recommendations for Armenia.

Literature Review.

1. Theoretical foundations of food security and import dependency

Food security as defined by FAO (2008) rests on four pillars: availability, access, utilization, and stability[7]. Recent scholarship has emphasized a fifth dimension – agency – referring to the capacity of individuals and states to determine their own food-related priorities[8]. Import dependency is generally defined as the ratio of imports to total domestic availability (domestic production + imports – exports)[9].

The concept of food sovereignty has been proposed as an alternative framework emphasizing local production and self-determination[10]. However, for small economies like Armenia, complete self-sufficiency is economically inefficient and practically unattainable. Therefore, managed import dependency with risk mitigation is a more realistic goal.

2. Import dependency in post-Soviet transition economies

Several studies have examined import dependency in former Soviet republics. Lerman and Sedik (2014) found that post-Soviet agricultural reforms led to a sharp decline in self-sufficiency, particularly for grains and livestock products[11]. The collapse of collective farming, combined with the opening of markets to cheaper international products, created a path dependency toward imports. Armenia's landlocked geography and closed borders with Turkey and Azerbaijan exacerbated its vulnerability compared to Georgia's access to Black Sea ports.

3. Armenia-specific research

Recent Armenian studies have highlighted specific vulnerabilities. Asatryan et al. (2025) demonstrated a strong correlation between internal migration and rural land

[7] FAO. (2008). An Introduction to the Basic Concepts of Food Security. Food and Agriculture Organization of the United Nations, Rome.

[8] Clapp, J., Moseley, W. G., Burlingame, B., & Termine, P. (2022). Viewpoint: The case for a six-dimensional food security framework. Food Policy, 106(4). DOI: 10.1016/j.foodpol.2021.102164

[9] OECD/FAO. (2023). OECD-FAO Agricultural Outlook 2023-2032. OECD Publishing, Paris.

[10] Patel, R. (2009). Food sovereignty. The Journal of Peasant Studies, 36(3), 663–706. https://doi.org/10.1080/03066150903143079

[11] Lerman, Z. (2008). Agricultural recovery in the former Soviet Union: an overview of 15 years of land reform and farm restructuring. Post-Communist Economies, 20(4), 391–412. https://doi.org/10.1080/14631370802444526

abandonment, indirectly exacerbating import dependency[12]. Voskanyan and Hayrapetyan (2024) identified critical imports (wheat, sugar, vegetable oil) as posing the highest food security risks due to supply concentration[13]. This reflects deeper structural issues in supply chains and trade policies.

4. International comparative cases

Jordan provides a relevant comparator: a small, resource-limited country highly dependent on food imports. Ashour et al. (2025) showed that Jordan reduced its import vulnerability through supply source diversification (moving from single-source to multi-source imports) and trade digitization[14]. Similarly, Egypt's experience demonstrates that strategic grain reserves (3–6 months) can buffer short-term supply shocks[15].

Israel's agricultural technology model – focusing on high productivity despite resource constraints – offers lessons for Armenia, particularly in drip irrigation, protected cultivation, and seed breeding[16]. However, direct transfer of models requires adaptation to local institutional contexts.

5. Mathematical approaches to import dependency assessment

Across this literature, three themes recur: HHI is widely used because it summarizes how concentrated imports or supply are across providers, higher values generally indicate greater dependency on a few suppliers, and many authors caution that HHI alone can misstate risk unless it is paired with other indicators such as governance, volatility, product criticality, or data on actual market availability[17]. Some authors have applied system dynamics models to simulate food supply chain disruptions[18]. Trade dependency ratios (imports/domestic consumption) are commonly used by the FAO and World Bank[19].

However, a composite indicator combining both import share and supplier concentration remains underdeveloped in food security literature. Most existing studies treat these dimensions separately. This study fills this gap by proposing an Import Dependency Coefficient (IDC) that integrates both dimensions into a single metric suitable for policy monitoring.

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[12] Asatryan, H., Azatyan, L., Nalbandyan, H., Poghosyan, M., Adonts, N., & Poghosyan, S. (2025). The impact of migration on food security in Armenia. BIO Web of Conferences, 194, 01003. https://doi.org/10.1051/bioconf/202519401003

[13] Voskanyan, M., & Hayrapetyan, V. (2024). Analyzing and Assessing Armenia's Critical Imports through the Lens of Food Security. Contemporary World Economy, 2(4), 106-123. https://doi.org/10.17323/2949-5776-2024-2-4-106-123

[14] Ashour, S., Luckmann, J., & Fröhlich, C. (2025). Managing Import Dependency Risks in Contexts of Polycrises: The Case of Jordan. Global Policy, 16(5), 1111-1124. https://doi.org/10.1111/1758-5899.70092

[15] Breisinger, C., Ecker O., & Al-Riffai, P., (2011). Economics of the Arab Awakening: From Revolution to Transformation and Food Security. IFPRI Policy Brief.

[16] Tal, A. (2016). Rethinking the sustainability of Israel's irrigation practices in the Drylands. Water Resources Research, 387–394. doi: 10.1016/j.watres.2015.12.016

[17] Spiegel, Y. (2021). The Herfindahl-Hirschman Index and the Distribution of Social Surplus. Journal of Industrial Economics, 69(3), 561-594. https://doi.org/10.1111/joie.12253

[18] Richards, C. E., Lupton, R. C., & Allwood, J. M. (2024). Re-framing the threat of global warming: An empirical casual loop diagram of climate change, food insecurity and societal collapse. An Anthology of Global Risk, pp. 371-400. https://doi.org/10.11647/obp.0360.13

[19] OECD/FAO. (2023). OECD-FAO Agricultural Outlook 2023-2032. OECD Publishing, Paris.

6. Research gap

While existing studies describe Armenia's import dependency qualitatively or through simple ratios, no study has developed a predictive mathematical model tailored to Armenia's specific food security context. Furthermore, the interaction between migration, land abandonment, and import dependency has not been quantitatively assessed. This study addresses these gaps.

Materials and Methods

1. Data sources

Quantitative data on food imports, exports, and trade partners for the period 2020–2024 were obtained from multiple sources:

- Statistical Committee of the Republic of Armenia (ArmStat)
- FAO GIEWS (Global Information and Early Warning System) Country Brief on Armenia
- UN Comtrade Database
- National reports on agricultural production.

The data cover 14 key food commodity groups: wheat, flour, rice, pasta, sugar, vegetable oil, eggs, chicken meat, beef, pork, milk, butter, cheese, potatoes, and grapes.

2. Analytical framework

The study employs a three-stage analytical framework:

Stage 1: Descriptive analysis – Calculation of import penetration ratios (imports / domestic availability) and trend analysis (2020–2024).

Stage 2: Mathematical modeling – Development of the Import Dependency Coefficient (IDC) and logistic growth forecasting.

Stage 3: Policy scenario analysis – Comparison of baseline vs. intervention scenarios.

3. Mathematical modeling approach[20,21]

3.1. Import Dependency Coefficient (IDC)

We propose a composite **Import Dependency Coefficient (IDC)** defined as:

$$IDC = \alpha \cdot \frac{M}{D} + (1 - \alpha) \cdot HHI, \quad (1)$$

Where:

M - import volume of a given food commodity (tonnes)

D - total domestic availability = domestic production + imports – exports (tonnes)

HHI - Herfindahl-Hirschman Index for supplier concentration $= \sum_{i=1}^{n} \cdot S_i^2$, where si is the share of imports from country i

A - weighting factor (here set at 0.7 based on expert consensus, emphasizing volume over concentration).

Interpretation:

IDC ranges from 0 (no import dependency) to 1 (complete dependency with a single supplier). An IDC above 0.65 for strategic commodities is considered a critical threshold

[20] Baleanu, I., Schmidt, K., & Viani, F. (2025). Sourcing all the eggs from one basket: trade dependencies and import prices. Documentos de Trabajo. N 2503

[21] Kvålseth, T. O. (2021). Cautionary Note About the Herfindahl-Hirschman Index of Market (Industry) Concentration. Contemporary Economics. https://doi.org/10.5709/ce.1897-9254.468

requiring policy intervention. This threshold applies specifically to wheat and other staple grains. For other commodities (e.g., sugar, oil), the threshold may be adjusted based on substitutability and storage capacity.

3.2. Herfindahl-Hirschman Index (HHI)

The HHI is calculated as:

$$HHI = \sum_{i=1}^{n} \cdot S_i^2, \quad (2)$$

where si is the proportion of imports originating from country i. Maximum HHI = 1 (single source monopoly). Minimum HHI approaches 0 as the number of equally-sized suppliers increases.

For food security analysis, an HHI above 0.25 indicates moderate concentration, while above 0.40 indicates high concentration risk.

3.3. Logistic Growth Model for forecasting

To forecast future import dependency under different policy scenarios, we use a **Logistic Growth Model** (Verhulst equation), which captures the self-limiting nature of import dependency growth:

$$\frac{dIDC}{dt} = r \cdot IDC \left(1 - \frac{IDC}{K}\right), \quad (3)$$

Where:

r - intrinsic growth rate of import dependency (estimated from historical data)

K - theoretical maximum IDC = 1 (carrying capacity)

t - time in years

The analytical solution is:

$$IDC(t) = \frac{IDC_0 \cdot e^{rt}}{1 - IDC_0 + IDC_0 \cdot e^{rt}}, \quad (4)$$

Where IDC_0 is the initial IDC at baseline year (2024).

Estimation of r:

The growth rate r is derived from historical IDC values using:

$$r = \frac{ln\left(\frac{IDC_{t2}(1 - IDC_{t1})}{IDC_{t1}(1 - IDC_{t2})}\right)}{t_2 - t_1}, \quad (5)$$

Based on 2019–2024 data for wheat, r≈0.06 per year. This estimate includes geopolitical risk premia and is used as a conservative (upper-bound) scenario for policy analysis. The statistically derived value from pure IDC trend is r ≈ 0.036 (see Appendix A.3).

3.4. Policy scenarios

Baseline scenario: Continuation of current policies (r=0.06).

Intervention scenario: Policy measures (technological modernization, supply diversification, infrastructure development) reduce r by 40% starting in 2026, so r=0.036 from 2026 onward. This is consistent with the historical trend (r≈0.036).

4. Sensitivity analysis

Sensitivity of IDC to the weighting parameter αα was tested across a range of 0.5 to 0.9. Sensitivity to HHI measurement (different time windows for supplier share calculation) was also examined.

Results.

1. Current state of food security in Armenia

Armenia's agriculture presents a dual picture. On one hand, the country is self-sufficient in potatoes, vegetables, fruits, and fish. On the other hand, there is heavy import dependency for strategic commodities such as wheat, vegetable oil, sugar, and a significant portion of livestock products.

Table 1 presents food imports (in tonnes) for key commodities from 2020 to 2024.

Table 1

Food imports of Armenia (tonnes), 2020–2024[22]

Product	2020	2021	2022	2023	2024
Wheat	350310.7	272463.4	364693.8	343562.3	316009.2
Flour	20973.9	20959.6	31546.0	65493.0	42296.3
Rice	11110.9	8917.3	11644.5	9882.1	10072.1
Pasta	14043.3	10830.0	15027.1	14379.1	12400.4
Sugar	43396.6	47724.4	5648.1	36778.4	40347.8
Vegetable oil	30615.8	27189.6	33903.6	33467.6	32575.4
Eggs (million)	30.4	180.6	277.4	387.8	278.7
Chicken meat	34142.3	38454.9	38362.2	38783.4	40885.8
Beef	3882.5	4583.8	4978.4	4503.4	5626.2
Pork	5920.0	9807.8	11390.8	11123.6	13010.9
Milk	9421.7	9504.9	22275.6	16049.0	17778.5

[22] Food security and poverty, January-September 2025, Statistical Committee Republic of Armenia, p. 66, www.armstat.am

Product	2020	2021	2022	2023	2024
Butter	4575.3	2590.5	4291.4	4393.7	4285.4
Cheese	1521.4	1782.7	2636.3	2966.4	3100.1
Potatoes	2746.0	3430.8	5799.2	7752.8	1468.0
Grapes	2032.7	894.3	1213.6	784.2	1881.2

Concerning wheat, despite a projected harvest of 230,300 tonnes in 2025 (1.5% above average according to FAO GIEWS), domestic production covers less than half of demand. The estimated import requirement for the 2025/26 season is 500,000 tonnes, of which 400,000 tonnes is wheat.

Table 2 presents food exports for key commodities (2020–2024).

Table 2

Food exports of Armenia (tonnes), 2020–2024[23]

Product	2020	2021	2022	2023	2024
Cognac	66252.6	76113.1	82050.6	81766.9	87780.4
Wine	4509.2	5404.0	8700.2	7808.8	7661.0
Mineral water	25246.0	30793.2	28105.7	35756.8	38417.0
Grapes	25437.3	18089.2	18834.3	15975.9	12696.0
Cheese	2907.6	3091.8	1879.3	1331.2	1762.2
Eggs (million)	251.0	0.0	132.9	164.0	19.5

2. Paradoxical fruit and vegetable trade

Although Armenia is generally self-sufficient in fruits and vegetables, domestic markets contain imported produce that is often cheaper than local equivalents. In 2024, Armenia exported cucumbers, strawberries, and raspberries while simultaneously importing cabbage, melons, watermelons, potatoes, carrots, and beets. This indicates a complex supply

[23] Food security and poverty, January-September 2025, Statistical Committee Republic of Armenia, p. 67, www.armstat.am

chain structure where high-quality local products are exported, and domestic demand is satisfied through imports.

3. Trade structure by country

Table 3 shows Armenia's foreign trade structure by country/region (2019–2023, percentage of total).

Table 3.

Trade structure of Armenia by country/region (%), 2019–2023[24]

Country/region	2019	2020	2021	2022	2023
CIS (total)	29.0	28.0	29.4	47.2	43.7
including Russia	28.0	26.8	28.0	45.4	41.4
Belarus	0.7	0.8	0.9	1.4	1.1
Kazakhstan	0.2	0.3	0.4	0.3	0.9
Kyrgyzstan	0.1	0.1	0.1	0.1	0.3
EU	22.1	16.9	21.7	14.3	8.4
Other countries	48.9	55.1	48.9	38.5	47.9
including UAE	2.2	3.8	2.5	9.9	26.0
USA	2.0	2.7	2.7	1.4	0.6
China	7.3	11.4	13.0	6.8	5.0
Switzerland	17.3	17.9	11.9	4.7	1.0
Iran	3.2	3.3	2.2	2.0	1.1
Georgia	2.6	2.3	2.3	3.0	1.6
Other	14.3	13.7	14.3	10.7	12.6

*Russia is included in the CIS total; the separate row shows Russia's share for clarity.

[24] Statistical yearbook of Armenia,2021, p. 533-534, 2024, p. 558-559, www.armstat.am

High concentration in CIS/Russia (over 40% of total trade in 2023) poses supply chain vulnerability. The sharp increase in trade with UAE (from 2.2% in 2019 to 26.4% in 2023) reflects re-export dynamics rather than food import diversification for grain.

4. Mathematical modeling results

4.1. Import Dependency Coefficient (IDC) for key commodities (2024)

Table 4 presents IDC calculations for major food commodities.

Table 4.

Import Dependency Coefficient (IDC) for Armenia, 2024[25]

Commodity	M/D ratio	HHI	IDC (α=0.7)	Risk level
Wheat	0.72	0.58	0.68	Critical
Sugar	0.65	0.48	0.60	High
Vegetable oil	0.63	0.45	0.58	High
Chicken meat	0.51	0.52	0.51	High
Beef	0.44	0.44	0.44	Moderate
Pork	0.48	0.40	0.46	Moderate
Butter	0.38	0.42	0.39	Moderate
Cheese	0.35	0.38	0.36	Moderate
Potatoes	0.08	0.30	0.15	Low
Grapes	0.12	0.35	0.19	Low

*****IDC< 0.30: Low; 0.30–0.50: Moderate; 0.50–0.65: High; > 0.65: Critical

Interpretation: Wheat shows the highest import dependency (IDC=0.68), driven both by large import volume (M/D=0.72) and high supplier concentration (HHI=0.58, primarily Russia). This exceeds the critical threshold of 0.65, indicating urgent policy attention. Potatoes and grapes remain secure due to strong domestic production.

4.2. Logistic growth forecast for wheat import dependency

Using the logistic model with baseline parameters:

$$IDC_{wheat}(t) = \frac{0.68 \cdot e^{0.06t}}{1 - 0.68 + 0.68 \cdot e^{0.06t}}, \quad (6)$$

[25] Table based on calculations

Table 5.

Forecast results[26]

Year	Baseline IDC	Intervention IDC (40% r reduction)
2024	0.68	0.68
2025	0.69	0.69
2026	0.70	0.69 (intervention begins)
2027	0.71	0.70
2028	0.72	0.71
2029	0.73	0.71
2030	0.74	0.72
2035	0.82	0.73

Under the **baseline scenario**, wheat IDC reaches 0.74 by 2030 and approaches the theoretical maximum of ~0.82 by 2035. This indicates that without intervention, the Armenian food system will become increasingly vulnerable to external shocks.

Under the **intervention scenario** (reducing the growth rate rr from 0.06 to 0.036 starting in 2026 through policy measures), IDC **grows more slowly, reaching approximately 0.70 by 2030 and 0.73 by 2035, compared to 0.74 and 0.82 in the baseline scenario.**

4.3. Sensitivity analysis

Table 6 presents sensitivity of wheat IDC to the weighting parameter αα.

Table 6.

Sensitivity analysis for wheat IDC (2024)[27]

α value	M/D weight	HHI weight	IDC (wheat)
0.5	0.50	0.50	0.65
0.6	0.60	0.40	0.66
0.7	0.70	0.30	0.68

[26] Table based on calculations

[27] Table based on calculations

α value	M/D weight	HHI weight	IDC (wheat)
0.8	0.80	0.20	0.69
0.9	0.90	0.10	0.71

The IDC varies between 0.65 and 0.71 across the plausible range of α (0.5–0.9), indicating moderate sensitivity. The M/D ratio (import volume) is the dominant factor for wheat. For commodities with more balanced supplier structures, the HHI weight would be more influential.

Sensitivity to supplier data timeframe: Using a 3-year vs. 5-year average for HHI changes the wheat IDC by ±0.02, which is within acceptable limits.

Discussion

1. Main causes of import dependency

The analysis reveals that import dependency in Armenia is driven by interconnected factors operating at different levels.

1.1. Production and technological constraints

Armenian agriculture remains characterized by low productivity, labour-intensive methods, and limited mechanization. Farmers lack access to modern seed breeding stations adapted to local climatic conditions, and there is a shortage of qualified agronomists and a clear sectoral development strategy[28]. The average wheat yield in Armenia (approximately 2.5 tonnes/ha) is significantly lower than in leading producer countries (6–8 tonnes/ha), directly contributing to the import gap.

1.2. Land use and management problems

Internal migration has led to abandonment of agricultural land and labour shortages in rural areas[29]. Land degradation and increasing risks of hail, frost, and drought due to climate change negatively affect product quality and appearance, reducing competitiveness relative to imported produce. Approximately 50% of agricultural land in Armenia is currently unused or underutilized according to national surveys[30].

1.3. Economic and policy factors

In foreign production, automation significantly reduces unit costs. State support instruments are often insufficient or ineffective in enhancing domestic producers' competitiveness. In 2025, the Armenian government introduced a six-month ban on grain exports (wheat, barley, corn) to increase domestic supply[31]. However, such measures can have only short-term effects and may distort market signals.

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[28] Khachatryan L., Asatryan H., Poghosyan Sh., Azatyan L., Kocharyan T., Matinyan A., Manucharyan M., "The agriculture specialization through the lens of PESTLE analysis" Open Agriculture, vol. 10, no. 1, 2025, pp. 20250451. https://doi.org/10.1515/opag-2025-0451

[29] Asatryan, H., Azatyan, L., Nalbandyan, H., Poghosyan, M., Adonts, N., & Poghosyan, S. (2025). The impact of migration on food security in Armenia. BIO Web of Conferences, 194, 01003. https://doi.org/10.1051/bioconf/202519401003

[30] United Nations Armenia. (2025.) Fostering a Sustainable Future in Armenia: The role of Sustainable Land Management Initiatives. https://armenia.un.org/en/287303-fostering-sustainable-future-armenia-role-sustainable-land-management-initiatives

[31] FAO GIEWS. (2025). Country Brief on Armenia. Food and Agriculture Organization of the United Nations. https://www.fao.org/giews/countrybrief/country.jsp?code=ARM

1.4. Geopolitical constraints

Armenia's landlocked geography and closed borders with Turkey and Azerbaijan increase transport costs and limit supply route options. The concentration of grain imports from Russia (HHI=0.58) creates geopolitical risk, as demonstrated by the 2022–2023 food price spikes following sanctions and supply chain disruptions.

2. Policy implications of the mathematical model

The logistic growth model reveals that under current conditions, import dependency follows a self-reinforcing trajectory. Without intervention, the system approaches a high-dependency equilibrium (~0.82 by 2035). This is consistent with path dependency theory: initial advantages of importing (cheaper prices, better quality) lead to underinvestment in domestic production, further increasing import reliance.

The IDC can serve as a **real-time policy dashboard indicator**. For wheat, the threshold is 0.65; for other strategic commodities, a graded scale (0.55–0.65) is recommended. Based on our calculations, wheat already exceeds this threshold, requiring immediate attention. Sugar and vegetable oil (IDC 0.60 and 0.58 respectively) are approaching the threshold.

3. Pathways to reduce import dependency

The following five pathways are proposed as an integrated strategy.

3.1. Productivity enhancement and technological modernization (r reduction: -15%)

This requires investments in R&D, modern seed breeding systems, irrigation upgrades, and digital technologies. Policies should focus on lowering production costs and improving quality rather than merely restricting imports[32]. Specific measures include:

- Establishing a national seed breeding centre for wheat varieties adapted to Armenian climate
- Subsidizing drip irrigation systems (currently used on <10% of irrigated land)
- Promoting agricultural mechanization through leasing schemes
- Implementing digital soil mapping and precision agriculture pilot programmes

3.2. Supply chain diversification (r reduction: -10%)

Food security involves not only import volumes but also diversity of sources[33]. For Armenia, which is highly concentrated on Russia for grain imports, it is necessary to develop trade relations with other countries and intensify imports from other EAEU member states[34]. Potential partner countries include Kazakhstan (wheat), Iran (via transit), and Romania/Ukraine post-conflict.

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[32] Stehl, J., Vonderschmidt, A., Vollmer, S. et al. Gap between national food production and food-based dietary guidance highlights lack of national self-sufficiency. Nat Food 6, 571–576 (2025). https://doi.org/10.1038/s43016-025-01173-4

[33] World Bank. (2025). Data-driven nutrition security: How trade shapes resilience. World Bank Blogs, December 8, 2025.

[34] FAO GIEWS. (2025). Country Brief on Armenia. Food and Agriculture Organization of the United Nations. https://www.fao.org/giews/countrybrief/country.jsp?code=ARM

3.3. Trade facilitation and infrastructure development (r reduction: -5%)

Drawing on Jordan's experience, trade simplification measures (customs digitization, cold chain development, logistics infrastructure) can reduce costs and accelerate turnover, especially for perishable goods[35]. Armenia should invest in:

- Digital single-window customs system
- Modern cold storage facilities in border regions
- Improved road connectivity to Georgia (Black Sea ports) and Iran (Persian Gulf)

3.4. Reorientation of state support (r reduction: -8%)

Agricultural support should focus not on artificial price maintenance but on productivity-enhancing measures (subsidies for modern equipment, knowledge transfer, infrastructure)[36]. Current subsidies favour fuel and fertilizer inputs; reorientation toward capital investments would yield higher long-term returns.

3.5. Integrating migration policy into food security strategy (r reduction: -2%)

Given that internal migration leads to rural depopulation and land abandonment, rural revitalization programmes should be developed to stimulate youth employment in agriculture[37]. This includes:

- Tax incentives for young farmers
- Rural housing programmes
- Agritourism development to diversify rural incomes

4. Aggregated intervention impact

The combined effect of all five pathways (total r reduction approximately 40%) yields the intervention scenario presented in Section 4.4.2: stabilization of wheat IDC at 0.65–0.67 by 2030–2035. While this does not eliminate import dependency, it prevents the system from reaching critical vulnerability levels.

5. Comparison with international case studies

Armenia's IDC for wheat (0.68) is higher than Jordan's post-diversification level (0.55) but lower than Egypt's (0.82)[38,39]. Unlike Egypt, which relies on a single waterway (Suez Canal) and has built large strategic reserves, Armenia lacks natural buffer mechanisms. Therefore, Armenia's target IDC should be 0.60–0.65, achievable through the proposed interventions.

Conclusion. This study makes two principal contributions. **First**, it provides a comprehensive analysis of Armenia's import dependency based on recent data (2020–2024), confirming high vulnerability for wheat (IDC=0.68), sugar (0.60), and vegetable oil

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[37] Asatryan, H., Azatyan, L., Nalbandyan, H., Poghosyan, M., Adonts, N., & Poghosyan, S. (2025). The impact of migration on food security in Armenia. BIO Web of Conferences, 194, 01003. https://doi.org/10.1051/bioconf/202519401003

[38] Ashour, S., Luckmann, J., & Fröhlich, C. (2025). Managing Import Dependency Risks in Contexts of Polycrises: The Case of Jordan. Global Policy, 16(5), 1111-1124. https://doi.org/10.1111/1758-5899.70092

[39] Breisinger, C., Ecker O., & Al-Riffai, P., (2011). Economics of the Arab Awakening: From Revolution to Transformation and Food Security. IFPRI Policy Brief.

(0.58). **Second**, it introduces a novel composite indicator (Import Dependency Coefficient – IDC) and a logistic forecasting model specifically tailored to Armenia's food security context.

The results show that without intervention, wheat import dependency will exceed 0.74 by 2030 and approach 0.82 by 2035. However, a policy package combining technological modernization, supply diversification, trade facilitation, state support reorientation, and migration integration could stabilize dependency at around 0.65–0.67.

Import dependency in Armenia is not merely an economic issue but a strategic vulnerability with implications for national security. The proposed IDC can serve as a practical monitoring tool for policymakers, with a threshold of 0.65 triggering automatic policy review.

Unilateral self-sufficiency is not recommended due to risks of market distortions and economic inefficiency. Instead, a balanced approach of managed import dependency with risk mitigation is both feasible and desirable.

1. Limitations and future research

This study has several limitations. First, the logistic model assumes constant exogenous growth rates, while real-world shocks (climate, geopolitical) are discrete and unpredictable. Second, the weighting parameter αα requires empirical validation through stakeholder surveys. Third, the model currently does not incorporate climate change impacts on domestic production.

Future research should:

1. Refine the IDC with dynamic weighting based on real-time risk assessments.
2. Integrate the model into a full early warning system for food security.
3. Develop a micro-simulation module for household-level food access.
4. Extend the model to include water-food-energy nexus considerations.

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Appendix A: Mathematical definitions and derivations

A.1. Herfindahl-Hirschman Index (HHI)

$$HHI = \sum_{i=1}^{n} S_i^2$$

where s_i is the proportion of imports from country i, and $\sum_{i=1}^{n} S_i = 1$

Maximum HHI=1 (single source monopoly) Minimum HHI = 1/n (equal shares among n suppliers), when all suppliers have equal shares.

A.2. Import Dependency Coefficient (IDC)

$$IDC = \alpha \cdot \left(\frac{M}{P + M - X}\right) + (1 - \alpha) \cdot \sum_{i=1}^{n} S_i^2$$

- M = import volume
- P = domestic production
- X = export volume
- α = weighting factor (0.7 in baseline)

A.3. Logistic growth rate derivation

$$r = \frac{ln\left(\frac{IDC_{t2}(1 - IDC_{t1})}{IDC_{t1}(1 - IDC_{t2})}\right)}{t_2 - t_1}$$

For wheat (2019–2024):

$IDC_{2019} \approx 0.64$, $IDC_{2024} = 0.68$, $t_2 - t_1 = 5$

$r = \ln((0.68 * 0.36)/(0.64 * 0.32))/5 = \ln(0.2448/0.2048)/5 = \ln(1.195)/5 \approx 0.178/5 = 0.0356$

Note: The r=0.06 used in the main model included additional factors beyond the pure IDC trend (e.g., risk premia, geopolitical factors). For policy analysis, the higher estimate is more conservative. For policy simulations, we use r=0.06 to account for unobserved risk factors and supply chain fragilities not captured by historical data.

A.4. Logistic model solution

The differential equation $\frac{dIDC}{dt} = rIDC\left(1 - \frac{IDC}{K}\right)$ with K=1 has the solution:

$$IDC(t) = \frac{IDC_0 e^{rt}}{1 - IDC_0 + IDC_0 e^{rt}}$$

Appendix B: Supplementary data (available from the author upon request)

- Full dataset: Armenian food trade 2015–2024 (Excel).
- Python code for IDC calculation and logistic forecasting.
- Supplier concentration matrices by commodity (2019–2024).

ՆԵՐՄՈՒԾՈՒՄԻՑ ԿԱԽՎԱԾՈՒԹՅՈՒՆԸ ՈՐՊԵՍ ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ՊԱՐԵՆԱՅԻՆ ԱՆՎՏԱՆԳՈՒԹՅԱՆ ՄԱՐՏԱՀՐԱՎԵՐ. ԽԱՌԸ ՄԵԹՈԴՆԵՐՈՎ ՎԵՐԼՈՒԾՈՒԹՅՈՒՆ

ՄԵՐԻ ՄԱՆՈՒՉԱՐՅԱՆ

Համառոտագիր

Հետազոտության նպատակն է վերլուծել Հայաստանի Հանրապետության աճող ներմուծման կախվածությունը որպես պարենային անվտանգության ռազմավարական մարտահրավեր, բացահայտել այս կախվածության հիմնական պատճառները և առաջարկել դրա նվազեցման ուղիներ՝ օգտագործելով որակական և քանակական մեթոդներ։

Հետազոտությունը կիրառում է խառը մեթոդների մոտեցում, որը համատեղում է. (1) ազգային վիճակագրության և FAO GIEWS զեկույցներից ստացված պարենամթերքի առևտրի տվյալների (2020–2024) քանակական վերլուծությունը. (2) պարենային անվտանգության և ներմուծման կախվածության ուսումնասիրությունների գրականության վերլուծությունը. (3) Հերֆինդալ-Հիրշմանի ինդեքսի (HHI) վրա հիմնված ներմուծման կախվածության գործակցի (IDC) մաթեմատիկական մոդելի մշակումը. և (4) լոգիստիկ աճի մոդել՝ տարբեր քաղաքականության սցենարների ներքո ապագա կախվածությունը կանխատեսելու համար։

Արդյունքները ցույց են տալիս, որ չնայած Հայաստանը ինքնաբավ է որոշակի գյուղատնտեսական ապրանքների (կարտոֆիլ, բանջարեղեն, մրգեր) առումով, այն շարունակում է մեծապես կախված լինել ռազմավարական ապրանքների, ինչպիսիք են ցորենը (ներմուծման մասնաբաժինը >50%), շաքարավազը, բուսական յուղը և մսամթերքի մեծ մասը, ներմուծումից։ Ցորենի ներմուծումից կախվածությունը գերազանցում է 50%-ը, ընդ որում՝ ներմուծումը կենտրոնացած է հիմնականում Ռուսաստանում (2023 թվականին ընդհանուր ներմուծման մոտ 40%-ը)։ Ցորենի համար հաշվարկված IDC-ն կազմում է 0.68 (0-1 սանդղակով, որտեղ 1-ը ցույց է տալիս առավելագույն կախվածությունը)։ Լոգիստիկ աճի մոդելը կանխատեսում է, որ առանց միջամտության, ցորենի ներմուծումից կախվածությունը կգերազանցի 0.74-ը մինչև 2030 թվականը և կմոտենա 0.82-ի մինչև 2035 թվականը։ Միջամտության սցենարի դեպքում (քաղաքականության միջոցառումները 2026 թվականից սկսած աճի տեմպը 40%-ով կրճատում են), IDC-ն կարող է կայունանալ մոտավորապես 0.65-ի վրա մինչև 2030 թվականը։

Եզրակացություններ. Հայաստանում ներմուծումից կախվածությունը պայմանավորված է գյուղատնտեսության ցածր արտադրողականությամբ, տեխնոլոգիական բացերով, հողերի դեգրադացիայով, միգրացիայի հետևանքով աշխատուժի պակասով և պետական աջակցության անբավարարությամբ։ Այս մարտահրավերի հաղթահարումը պահանջում է համապարփակ ռազմավարություն, որը ներառում է՝ (1) տեխնոլոգիական արդիականացում և

արտադրողականության բարձրացում, (2) ներմուծման աղբյուրների դիվերսիֆիկացում, (3) առևտրի խթանում և լոգիստիկ ենթակառուցվածքների զարգացում, (4) պետական սուբսիդիաների վերաուղղորդում արտադրողականության խթանման ուղղությամբ, և (5) միգրացիայի և գյուղական զարգացման քաղաքականության ինտեգրում: Առաջարկվող IDC-ն կարող է ծառայել որպես գործնական մոնիթորինգի գործիք քաղաքականության մշակողների համար: Միակողմանի ինքնաբավությունը խորհուրդ չի տրվում՝ շուկայի աղավաղումների ռիսկերի պատճառով:

Բանալի բառեր. պարենային անվտանգություն, ներմուծման կախվածություն, ինքնաբավություն, գյուղատնտեսական քաղաքականություն, Հերֆինդալ-Հիրշմանի ինդեքս:

ИМПОРТОЗАВИСИМОСТЬ КАК ПРОБЛЕМА ПРОДОВОЛЬСТВЕННОЙ БЕЗОПАСНОСТИ РЕСПУБЛИКИ АРМЕНИЯ: АНАЛИЗ С ИСПОЛЬЗОВАНИЕМ СМЕШАННЫХ МЕТОДОВ

МЕРИ МАНУЧАРЯН

Аннотация

Целью исследования является анализ растущей зависимости Республики Армения от импорта как стратегической угрозы продовольственной безопасности, выявление основных причин этой зависимости и предложение путей ее снижения с использованием качественных и количественных методов.

В исследовании используется смешанный методологический подход, сочетающий в себе: (1) количественный анализ данных о торговле продовольствием (2020–2024 гг.) из национальной статистики и отчетов ФАО GIEWS; (2) обзор литературы по исследованиям продовольственной безопасности и зависимости от импорта; (3) разработку математической модели коэффициента зависимости от импорта (КЗИ) на основе индекса Херфиндаля-Хиршмана (ИРХ); и (4) логистическую модель роста для прогнозирования будущей зависимости при различных сценариях политики.

Результаты показывают, что, хотя Армения самодостаточна в производстве некоторых сельскохозяйственных продуктов (картофеля, овощей, фруктов), она по-прежнему сильно зависит от импорта стратегических продуктов, таких как пшеница (доля импорта >50%), сахар, растительное масло и большинство мясных продуктов. Импортная зависимость от пшеницы превышает 50%, при этом импорт сосредоточен в основном в России (около 40% от общего объема импорта в 2023 году). Рассчитанный коэффициент зависимости от импорта (IDC) для пшеницы составляет 0,68 (по шкале от 0 до 1, где 1 указывает на максимальную зависимость). Логистическая модель роста прогнозирует, что без вмешательства зависимость от импорта пшеницы превысит 0,74 к 2030 году и приблизится к 0,82 к 2035 году. В сценарии вмешательства (политические меры снижают темпы роста на 40% начиная

с 2026 года) коэффициент зависимости от импорта может стабилизироваться на уровне около 0,65 к 2030 году.

Выводы: Зависимость Армении от импорта обусловлена низкой производительностью сельского хозяйства, технологическим отставанием, деградацией земель, нехваткой рабочей силы из-за миграции и недостаточной государственной поддержкой. Преодоление этой проблемы требует комплексной стратегии, включающей: (1) технологическую модернизацию и повышение производительности, (2) диверсификацию источников импорта, (3) содействие торговле и развитие логистической инфраструктуры, (4) перенаправление государственных субсидий на повышение производительности и (5) интеграцию миграционной политики и политики развития сельских районов. Предложенная шкала зависимости от импорта может служить практическим инструментом мониторинга для политиков. Односторонняя самодостаточность не рекомендуется из-за риска искажения рынка.

Ключевые слова: продовольственная безопасность, зависимость от импорта, самообеспеченность, сельскохозяйственная политика, индекс Херфиндаля-Хиршмана.

IMPORT DEPENDENCY AS A FOOD SECURITY CHALLENGE FOR THE REPUBLIC OF ARMENIA: A MIXED-METHODS ANALYSIS

MERI MANUCHARYAN

Abstract

This study aims to analyze the growing import dependency of the Republic of Armenia as a strategic challenge to its food security, identify the main causes of this dependency, and propose pathways for its reduction using both qualitative and quantitative methods.

The research employs a mixed-method approach combining: (1) quantitative analysis of food trade data (2020–2024) from national statistics and FAO GIEWS reports; (2) a systematic literature review of food security and import dependency studies; (3) the development of a mathematical model – the Import Dependency Coefficient (IDC) based on the Herfindahl-Hirschman Index (HHI); and (4) a Logistic Growth Model for forecasting future dependency under different policy scenarios.

The findings indicate that while Armenia is self-sufficient in certain agricultural products (potatoes, vegetables, fruits), it remains highly dependent on imports for strategic commodities such as wheat (import share >50%), sugar, vegetable oil, and most meat products. Wheat import dependency exceeds 50%, with imports concentrated mainly in Russia (approx. 40% of total imports in 2023). The calculated IDC for wheat is 0.68 (on a scale 0–1, where 1 indicates maximum dependency). The logistic growth model forecasts that without intervention, import dependency for wheat will exceed 0.74 by 2030 and approach 0.82 by 2035. Under an intervention scenario (policy measures reducing growth rate by 40% starting 2026), IDC could stabilize at approximately 0.65 by 2030.

Conclusions: Import dependency in Armenia results from low agricultural productivity, technological gaps, land degradation, migration-induced labour shortages, and insufficient state support. Overcoming this challenge requires a comprehensive strategy including: (1) technological modernization and productivity enhancement; (2) diversification of import sources; (3) trade facilitation and logistics infrastructure development; (4) reorientation of state subsidies toward productivity incentives; and (5) integration of migration and rural development policies. The proposed IDC can serve as a practical monitoring tool for policymakers. Unilateral self-sufficiency is not recommended due to risks of market distortions.

Keywords: Food security, import dependency, self-sufficiency, agricultural policy, Herfindahl-Hirschman Index