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GLOBAL TRANSFORMATION TRENDS OF ENSURING FOOD SECURITY OF STATES AGAINST GLOBAL THREATS

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Abstract. The *purpose* of the paper is to investigate global transformation trends of ensuring food security of states against global threats. Our focus is to confirm that global threats influence the process of agri-food transformation and the selection of policy responses. *Methodology.* The research is based on comparison, logical synthesis methods, as well as economic analysis through cross-tab analysis, cluster analysis and PLS-SEM modelling of selected questionnaire results of 195 food security experts from 52 countries. The datasets used for PLS-SEM model are Likert scale type, other questions are multi-choice questions. *Results* of the survey showed that global threats significantly shape the configuration of policy responses and transformation pathways, but the strength of influence depend on the nature and depth of the threat. *Practical implications.* Global threats – particularly geopolitical and environmental – are the primary drivers shaping food security as a multidimensional problem, influencing diverse expert perceptions, steering transformation pathways toward integrated sustainability, technology, governance and hybrid models. and, as evidenced by both cross-analysis and PLS-SEM results, framing policy priorities for food-security investment instruments. *Value / originality.* The novelty of the research is that the questionnaire was constructed in way to validate selected theoretical food security frameworks and transformation trends to obtain theoretically-sound results that can be used to improve global and international policy responses on food security.

Keywords: global transformation trends, food security, global threats, transformation, agri-food systems, policy responses, questionnaire analysis, Russia's war against Ukraine, climate change, natural disasters, 4 Betters, cluster analysis, crosstab analysis, PLS-SEM, resilience, sustainability, technologies, governance.

JEL Classification: F01, F52, Q18, Q54, C38, C83

1. Introduction

Since 2000 we can observe that global food security threats have been more impactful on the process of agri-food transformation. Russia's war against Ukraine, climate change, Covid-19, natural disasters, financial crisis (2007-8), energy crisis, trade restrictions and refugee crisis (2014) – all have triggered specific policy responses and created additional pressure on agri-food systems transformation. It has been internationally recognized that shocks and policy choices in agri-food sector can have macrocritical consequences (Diaz-Bonilla,2015). The FAO assessed $3.26 trillion in agricultural losses due to natural disasters over the past 30 years, with annual damages increasing from $64 billion in the 1990s to $144 bln recently (FAO,2025). Under RDNA 5, the damage and losses of Ukraine's agriculture and irrigation sectors due to the war since 2022 is assessed at $92 bln and recovery needs (10 years) – at $67.8 bln (World Bank, 2025). In turn, climate change intensifies risks and disrupts food security, disproportionately affecting vulnerable populations while increasing pressure on natural resources and agrifood systems. Thus, most countries are off track to achieve the 2030 SDG targets related to food security (FAO et al, 2025).

The aim of the article is to investigate global transformation trends of ensuring food security of states against global threats. To achieve this aim, the following **objectives** are set: 1) to provide overview of global trends of agri-food systems transformation; 2) to analyze modern status quo of transformation tends of ensuring food security; and 3) to identify the impact of global threats on current transformation pathways on the basis of the results of food security experts questionnaire.

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The empirical analysis is based on selected questions of the questionnaire of 195 food security experts with limited sample of 63 responses for Q28. The analysis is centered on Q35 that suggests selected transformation pathways for increasing food security of states and Q12 that structures perceptions of global threats to food security (Likert scale). The analysis is done through descriptive statistics and cross-tabulation techniques. To examine the relationship between perceived global threats and selected transformation responses, each Q12 global threat (Likert scale data) was dichotomized into high importance (scores 4-5) and low-to-moderate importance (scores 1-3). Cross-tabulation analysis was conducted by comparing the proportion of respondents selecting high against low global threats and difference recorded under: reasons of global FS problem (Q4), ways to ensure FS (Q6), Top 4 Betters pillars (Q36).

Further analysis was performed to build a PLS-SEM model in SmartPLS4 programme to investigate how global food security factors, risks, and threats influence the types of investment support for strengthening food security at the national level.

2. Global Transformation Trends of Food Security

Economic literature defines 3 major global transformation trends of ensuring food security of states, namely, *technology* (von Braun et al., 2023; Novak, 2023), *sustainability* (Nguyen, 2018; Herrero et al., 2020) and *governance* (Resnick et al., 2023; Swinnen et al., 2025; Jaspars et al., 2024). Overall, global transformation trends aim to build resilient food systems (de Steenhuijsen Piters et al, 2021; Fanzo, 2023). And global threats are the reason of transformation of food security policy responses (Paudel et al., 2023; Raga, 2022; Saccone, 2025).

The questionnaire included multiple-response questions addressing perceived reasons of global FS problem (Q4), ways to ensure FS (Q6), Top 4 Betters pillars (Q36) and Top 4 accelerators of agri-food transformation (Q37), and policy priorities for resilience (Q28) as structured against 4 transformation clusters (defined on Q35). Given the non-Likert and multi-select nature of the data (except Q12), the analysis employs descriptive statistics and cross-tabulation techniques. Under Q35 (See Fig. 1) respondents most frequently identify multiple transformation pathways to increase food security (91% total), followed by regenerative agriculture (63%), localization of food value chains (58%), circular economy (52%) and digitalization (49%). Next step was cluster analysis. Based on the theoretical generalization, 9 categories were grouped into 3 groups – Sustainability, Technology and Governance. The grouped responses of respondents were summed up for each of the 3 areas. Finally, cluster membership was determined by the highest sum of points for the respondent's responses within the 3 areas. In the event of a coincidence – the same number of points – then the responses were grouped into Hybrid. Responses from the Other category were not taken into account to simplify the analysis. As a result, 4 clusters were formed: Cluster 1– Sustainability – 31 responses, 16% of total; Cluster 2 – Technology – 46 responses, 24% of total; Cluster 3 – Governance – 26 responses, 13% of total; Cluster 4– Hybrid – 92 responses, 47% of total.

The comparison of Q35 transformation clusters with Q4 top reasons of existing global food security problem in Table 1 demonstrates a consistent perception of food security as a **multi-dimensional systemic problem**, rather than a purely production-related issue. The Q4 response categories were aligned with HLPE 2020 6 food security dimensions (Availability, Access, Utilization, Stability, Sustainability, Agency). Both Q35 and Q4 questions are multiple-choice selection. Across the total sample, Access (67%) and Stability (66%) clearly dominate, indicating that respondents primarily associate food insecurity with economic constraints and supply chain disruptions, while Sustainability (59%) and Agency (47%) reflect structural environmental pressures and unequal power relations. Both Q35 and Q4 questions are multiple-choice selection. At the cluster level, SUSTAINABILITY reflects a socio-ecological framing with higher importance for Sustainability, but still as closely linked to Access. TECHNOLOGY adopts a system-efficiency perspective, uniquely incorporating Availability, thus emphasizing production capacity alongside Access, Stability and Sustainability. GOVERNANCE demonstrates an institutional and power-oriented focus, where Stability and Agency become more prominent. In contrast, HYBRID cluster is most integrated approach, simultaneously combining Access, Stability, Sustainability, and Agency, indicating recognition of interconnected economic, environmental, and political dimensions of food security problem at global level.

Overall, the results suggest that transformation pathways are closely linked to how stakeholders diagnose food security, with a clear shift from food availability toward a complex paradigm centered on access, stability, and agency.

The comparison of Q35 transformation clusters with Q6 top ways to ensure food security in Table 2 reflects same 4 priorities observed at total level – agri-food production (73%), investments in technologies and innovation (69%), government regulations (66%) and international trade (51%) with the varying importance against 4 clusters. This confirms a balanced but production- and innovation-driven transformation model. Both Q35 and Q6 questions are multiple-choice selection. At the cluster level, SUSTAINABILITY focuses mainly on producer support, regulations

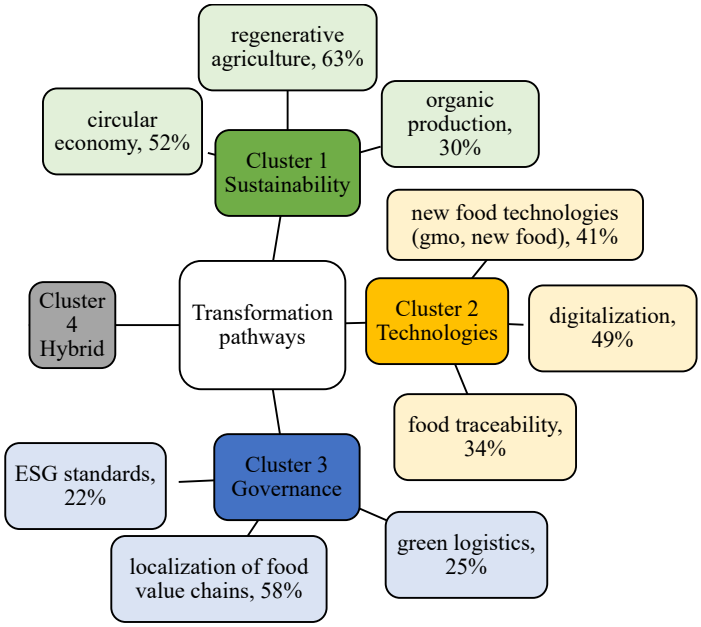

Figure 1. Clusters of transformation pathways based on Q35 responses

Source: made by author

Table 1

Transformation clusters vs Top 4 reasons of global food security (FS) problem

Cluster	Top 4 reasons of global FS problem, 195 responses			
TOTAL	Access, 67%	Stability, 66%	Sustainability, 59%	Agency, 47%
SUSTAINABILITY	Access, 12%	Sustainability, 11%	Stability, 9%	Agency, 6%
TECHNOLOGY	Access, 16%	Stability, 16%	Sustainability, 15%	Availability, 8%
GOVERNANCE	Stability, 8%	Access, 7%	Agency, 7%	Sustainability, 7%
HYBRID	Stability,34%	Access, 32%	Sustainability,26%	Agency, 26%

Source: made by author

and investments, with less emphasis on trade, which reflects the high role of institutional and ecological governance needed to build sustainable food systems. TECHNOLOGY prioritizes innovation and technological development, supported by production and international trade. GOVERNANCE relies mostly on government regulations and producer support policy. HYBRID cluster mixes several approaches together, combining production, innovation, and regulation in a more integrated way.

Overall, we confirm that ways to ensure food security are not uniform and can be structured into 4 transformation pathways, aligning with research evidence (Swinnen et al., 2025) that food system transformation requires coordination of approaches through investments, governance, and innovations rather than isolated policy responses.

The comparison of Q35 transformation clusters with Q36 4 Betters pillars of agri-food transformation demonstrates a differentiated alignment between transformation pathways and perceived outcome priorities. Q36 is limited choice question (max 4 answers), Q35 is multiple-choice selection. Q36 responses were developed to validate FAO 4 Betters programming concept (2022–2031)[1] that covers Better production, Better environment, Better nutrition and Better life. It should be noted that Better life category did not qualify to Top 4. The respondents were provided with three additional categories (Better governance, Better resilience and Better health), leading to high prioritization of Better governance in their responses (Table 3). At the total level, respondents emphasize Better production (76%), Better governance (72%), Better environment (58%) and Better health (51%), indicating a nexus of technologies, policy, biosphere and food safety priorities. At the cluster level, SUSTAINABILITY cluster is primarily associated with Better environment, while still incorporating production, governance, and nutrition, reflecting a socio-ecological prioritization. TECHNOLOGY is centered

[1] Food and Agriculture Organization of the United Nations. (2023). FAO strategic priorities for food safety within the FAO Strategic Framework 2022–2031. https://doi.org/10.4060/cc4040en

Table 2
Transformation clusters vs Top 4 ways to ensure FS

Cluster	Top 4 ways to ensure FS, 195 responses			
TOTAL	agri-food production support. 73%	investments in technologies and innovation, 69%	government regulations, 66%	international trade, 51%
SUSTAINABILITY	agri-food production support, 11%	government regulations, 11%	investments in technologies and innovation, 10%	international trade, 7%
TECHNOLOGY	investments in technologies and innovation, 18%	agri-food production support, 17%	international trade, 15%	government regulations, 14%
GOVERNANCE	government regulations, 9%	agri-food production support, 9%	investments in technologies and innovation, 8%	international trade, 6%
HYBRID	agri-food production support, 36%	investments in technologies and innovation, 32%	government regulations, 32%	international trade, 23%

Source: made by author

on Better production and governance, expanding to Better life and Better resilience that indicates a broader system-efficiency perspective. GOVERNANCE is led by Better governance, with complementary links to better production, life, nutrition, health, and resilience, suggesting a coordination-oriented approach. While HYBRID cluster integrates Better production, governance, environment, and health that gives balanced systemic perspective.

Overall, the results confirm that transformation clusters correspond to distinct configurations of 4 Betters conceptual framework, ranging from specialized (environmental, technological, institutional) to fully integrated (hybrid) models of agri-food system transformation.

The analysis of Q35 transformation clusters in relation to Q37 top 4 accelerators of agri-food transformation is aligned with conceptual framework of agri-food systems transformation accelerators that proves new technologies alone are not enough to ensure the transformation process (Herrero, 2020). Q37 is limited choice question (max 4), Q35 is multiple-choice selection. Q37 categories of data monitoring and gender &youth mainstreaming did not qualify into top 4 selection. At the total level, as presented in Table 4, respondents identify innovation (79%), technologies (75%), education (69%), and multi-stakeholder (MS) dialogue (57%) as major accelerators, reflecting both technical system components and social-institutional dimensions of agri-food transformation. Specifically, technologies correspond directly to changes in system components (technologies, infrastructure), while education relates to the development of skills and capabilities. At the same time, MS dialogue captures governance processes, and innovation spans both technological advancement and the reconfiguration of policies, markets, and institutional arrangements.

At the cluster level, SUSTAINABILITY reflects a more specialized configuration, combining technologies and innovation with system-oriented elements such as integrated food–energy systems and education; TECHNOLOGY demonstrates a balanced and system-driven perspective, integrating technologies, innovation, education, and MS dialogue; GOVERNANCE prioritizes innovation alongside education and MS dialogue, with technologies ranking 4th place; HYBRID presents the most comprehensive configuration, covering innovation, technologies,

Table 3
Transformation clusters vs 4 Betters pillars of agri-food transformation

Cluster	4 Betters pillars, 195 responses					
TOTAL	Better production, 76%	Better governance, 72%	Better environment, 58%	Better health, 51%		
SUSTAINABILITY	Better environment, 12%	Better production, 10%	Better governance, 10%	Better nutrition, 9%		
TECHNOLOGY	Better production, 19%	Better governance, 17%	Better life, 14%	Better environment, 12%	Better resilience, 12%	
GOVERNANCE	Better governance, 11%	Better production, 10%	Better life, 7%	Better nutrition, 6%	Better health, 6%	Better resilience, 6%
HYBRID	Better production, 37%	Better governance, 33%	Better environment, 29%	Better health, 26%		

Source: made by author

Table 4
Transformation clusters vs Top 4 accelerators of agri-food transformation

Cluster	4 accelerators, 195 responses			
TOTAL	innovation, 79%	technologies, 75%	education, 69%	MS dialogue, 57%
SUSTAINABILITY	technologies, 11%	innovation, 11%	integrated food – energy systems, 10%	education, 10%
TECHNOLOGY	technologies, 20%	innovation,18%	education, 17%	MS dialogue, 13%
GOVERNANCE	innovation, 10%	education, 9%	MS dialogue, 9%	technologies, 8%
HYBRID	innovation, 41%	technologies,35%	education, 32%	MS dialogue, 27%

Source: made by author

education, and MS dialogue, thus reflecting a fully integrated approach to accelerating transformation. Overall, we can confirm that while core accelerators are shared across clusters, the transformation pathways depend on how technological components interact with social and institutional factors. Thus, the analysis results empirically support the proposition that agri-food systems transformation is a systemic and political process requiring not only technological upgrades but also alignment of values, policies, governance, and stakeholder coordination.

The analysis of Q35 transformation clusters in relation to Q28 agri-food policy priorities for resilience (identified by respondents in a country of policy implementation) shows clear differences in resilience priorities between clusters (see Table 5). At the overall level, respondents prioritize increasing agriculture productivity (65%), maximizing use of innovative technologies (65%), maximizing resource efficiency (63%) and minimizing value chains disruptions (52%). Other question categories are less than 50% of total responses and did not qualify to Top 4, including to minimize further agriculture land areas increase to conserve forests and environment; and to minimize fertilizers use.

At the cluster level, SUSTAINABILITY follows a similar structure but in a more evenly distributed way, without a strong dominant priority. TECHNOLOGY cluster emphasizes efficiency and innovative technologies, combined with productivity improvements and minimization of disruptions, reflecting a system-performance perspective. GOVERNANCE focuses on resource efficiency alongside more specific measures such as emissions reduction, increased production of processed food and agri-productivity, thus, indicating a more targeted approach. HYBRID cluster presents the most integrated model, combining innovative technologies, productivity, efficiency, and value chain stability in a comprehensive way. Overall, the clusters show that resilience priorities vary from more focused (sustainability, governance) to more integrated and systemic approaches (technology, hybrid). The results are in line with Exposure-Resilience-Vulnerability model that emphasizes resilience – particularly through effective governance and system capacity – playing a key role in mitigating the negative cascading effects of global threats (Raga et al., 2022).

The results of clustering of Q12 global threats indicate that global food security threats are perceived differently across 4 transformation clusters, with clear patterns in what is considered high threat (where scores above 4 are considered high, 3.5-4 as moderate, and below 3.5 as low), see Table 6.

Across all clusters, Russia's war against Ukraine and climate change are consistently assessed as high threats, reflecting a shared recognition of geopolitical and environmental shocks as the most critical drivers of food system instability. In addition, natural disasters are also perceived as a high threat by TOTAL, SUSTAINABILITY, GOVERNANCE, and HYBRID

Table 5
Transformation clusters vs Top 4 agri-food policy priorities for resilience

Cluster	Top 4 resilience priorities, 63 responses			
TOTAL	increase agriculture productivity, 65%	max use of innovative technologies, 65%	max resource efficiency, 63%	min value chains disruptions, 52%
SUSTAINABILITY	increase agriculture productivity, 14%	max use of innovative technologies, 13%	max resource efficiency, 11%	min value chains disruptions, 10%
TECHNOLOGY	max resource efficiency, 22%	max use of innovative technologies, 22%	increase agriculture productivity, 21%	min value chains disruptions, 17%
GOVERNANCE	max resource efficiency, 5%	decrease emissions, 3%	increase production of processed agri-food products, 3%	increase agriculture productivity, 3%
HYBRID	max use of innovative technologies, 29%	increase agriculture productivity, 27%	max resource efficiency, 25%	min value chains disruptions, 25%

Source: made by author

Table 6
Global threats vs Transformation clusters

High threat	TOTAL	SUSTAINABILITY	TECHNOLOGY	GOVERNANCE	HYBRID
Russia's war against Ukraine (2022-...)	high	high	high	high	high
pandemics (Covid-19)	moderate	moderate	high	moderate	moderate
financial crisis (2007-8)	moderate	moderate	moderate	moderate	moderate
natural disasters	high	high	moderate	high	high
refugee crisis 2014	low	low	low	low	low
climate change	high	high	high	high	high
energy crisis	moderate	moderate	moderate	moderate	moderate
trade wars	moderate	moderate	moderate	moderate	moderate

Source: made by author

clusters, while TECHNOLOGY cluster evaluates them as moderate vulnerability to environmental risks. Other threats – including pandemics (Covid-19), financial crisis (2007-8), energy crisis, and trade wars – are generally assessed as moderate, while refugee crisis is consistently perceived as low. Overall, the clustering results demonstrate strong convergence around key high-impact threats, with only minor variation across clusters, confirming a broadly shared understanding of the most critical threats to global food security.

3. Global Threats and Agri-Food Systems Transformation

The comparison of Q12 global threats with Q4 top reasons of existing global food security problem in Table 7 reveals strong associations primarily where differences exceed 15%, notably between Russia's war against Ukraine and Stability pillar (36%), as well as natural disasters and Availability (30%), indicating a clear linkage between geopolitical and environmental shocks and supply chain disruptions. Also, strong relationships are observed between financial crisis and Agency (26%) and climate change and Agency (25%), highlighting the importance of power structures and governance factors impact on food security under systemic global threats.

The comparison of Q12 global threats with Q6 top ways to ensure food security is presented in Table 8.

The analysis demonstrates strong associations particularly for Russia's war against Ukraine, which is strongly linked to international humanitarian assistance (28%), change of diets ('nudges') (27%), and food assistance (24%), indicating a clear shift toward emergency and behavioural response measures. Similarly, strong relationships appear between financial crisis and agri-food production support (23%), climate change and investments in technologies & innovation (21%), and natural disasters and food assistance (20%), highlighting that different types of global threats trigger distinct but targeted policy response priorities.

The comparison of Q12 global threats with Q36 4 Betters pillars of agri-food transformation (Better life is not included, as no positive relation recorded) in Table 9 indicate strong associations primarily for climate change that is strongly linked to Better environment (37%), indicating a clear alignment between environmental threats and sustainability-oriented transformation outcomes. Another

Table 7
Global threats vs reasons of global FS problem

High threat	Availability	Access	Utilization	Stability	Sustainability	Agency
Russia's war against Ukraine (2022-...)	11%	7%	13%	**36%**		3%
pandemics (Covid-19)	4%	8%		15%	**17%**	5%
financial crisis (2007-8)	8%	13%	11%		8%	**26%**
natural disasters	**30%**	15%	21%	14%	6%	14%
refugee crisis 2014	**20%**		17%	4%		
climate change	14%	14%	21%	7%	10%	**25%**
energy crisis	1%		3%		8%	**13%**
trade wars	11%	4%				

Source: made by author

Table 8
Global threats vs ways to ensure FS

High threat	government regulations	international trade	food assistance	agri-food production support	investments in technologies & innovation	change of 'nudges' (diets)	international humanitarian assistance
Russia's war against Ukraine (2022-...)	11%	13%	24%	19%	15%	**27%**	**28%**
pandemics (Covid-19)	9%	10%		18%	**19%**	6%	3%
financial crisis(2007-8)	22%	5%	15%	**23%**	13%	21%	13%
natural disasters	18%	19%	**20%**	17%	9%	10%	9%
refugee crisis 2014	9%		**21%**	16%	2%	18%	10%
climate change	1%	18%	20%	20%	21%	**23%**	12%
energy crisis	17%		10%	6%	9%	13%	
trade wars	7%	**15%**	9%	7%	4%	2%	6%

Source: made by author

strong relationship is identified for Russia's war against Ukraine that is associated with Better resilience (20%) and Better governance (18%), highlighting the emphasis on institutional capacity and system buffering in response to geopolitical shocks. Overall, the findings confirm that global threats significantly shape the configuration of policy responses and transformation pathways, but the strength and direction of this influence depend on the nature and systemic depth of the shock.

4. PLS-SEM model

In order to build a PLS-SEM model in SmartPLS4 programme to understand the impact of global FS factors, risks, and threats on selection and direction of investment support aimed at strengthening food security at the national level we analyze Q12 global threats and Q10, Q11 and Q22 responses, as briefly presented in Table 10.

In PLS-SEM model at Fig.3, global environment factors (Q10,factor_) and global risks (Q11,risk_)

Table 9
Global threats vs 4 Betters pillars of agri-food transformation

High threat	Better nutrition	Better environment	Better health	Better production	Better governance	Better resilience
Russia's war against Ukraine (2022-...)	4%				18%	20%
pandemics (Covid-19)	10%			9%	3%	1%
financial crisis (2007-8)		9%				
natural disasters		14%				
refugee crisis 2014			19%			
climate change	8%	37%				
energy crisis		7%	6%	5%		
trade wars		10%		1%		

Source: made by author

Table 10
Decoding table for data for PLS-SEM (Q10, Q11, Q22)

Q10	Global FS environment factor	Q11	Global FS risk	Q22	Investment support to strengthen FS
volatility	factor_1	environmental degradation	risk_1	Loans	support_1
interdependence	factor_2	military conflicts	risk_2	Equity investment	support_2
fragmentation	factor_3	poverty and inequality	risk_3	Debt securities	support_3
integration	factor_4	commodity markets volatility	risk_4	Blended finance	support_4
deglobalization	factor_5	migration	risk_5	Grants	support_5
liberalization	factor_6	supply chains disruption	risk_6	Matching grants	support_6
stability (geopolitical)	factor_7	energy deficit	risk_7	Insurance opportunities	support_7
protectionism	factor_8	logistics bottlenecks	risk_8	Infrastructure investment	support_8
				Start-up seed funding	support_9

Source: made by author

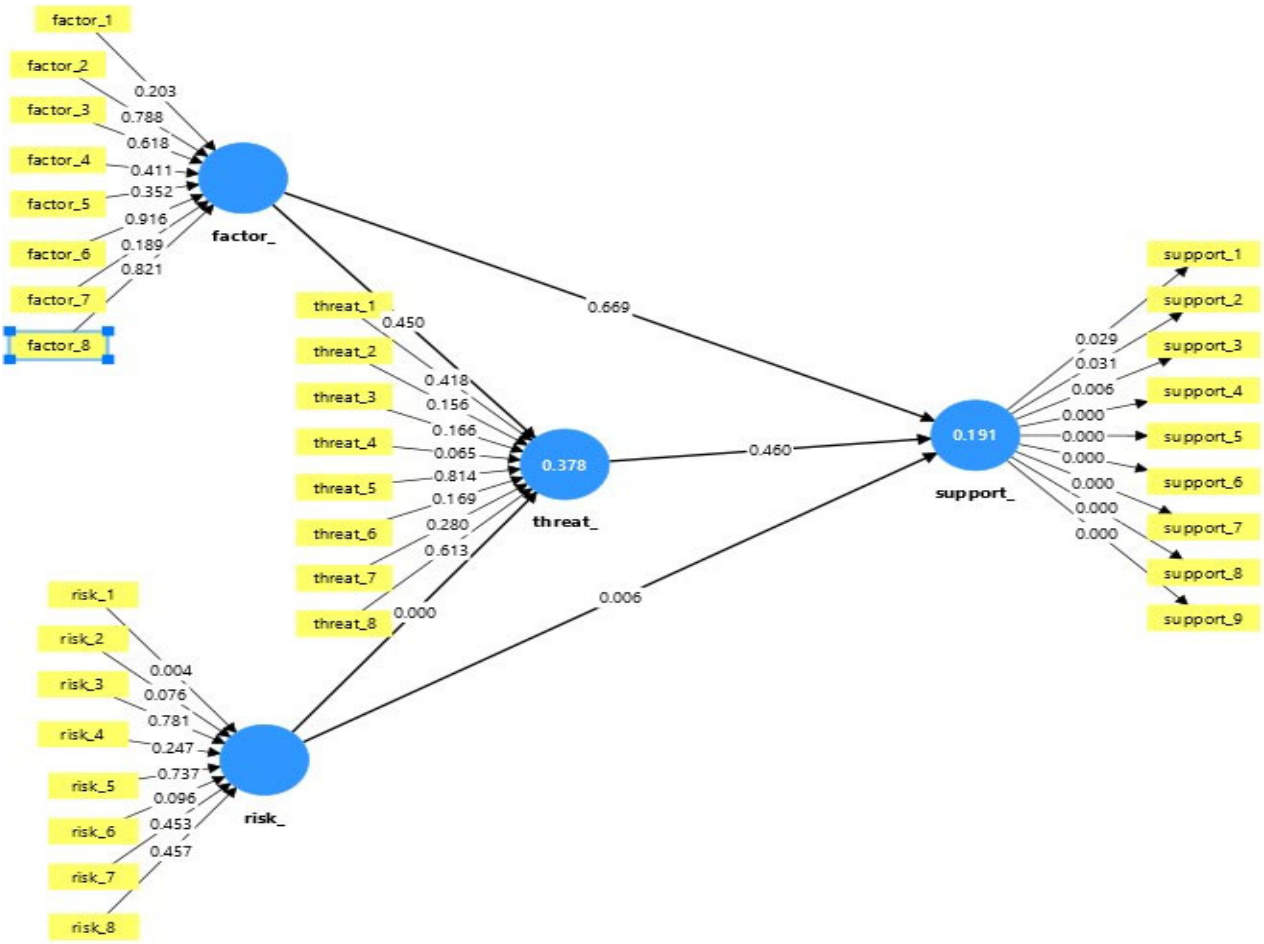

Figure 2. PLS-SEM model (Q10-12, Q22)
Source: made by author

function as exogenous latent variables, global threats (Q12, threat_) operate as a mediating endogenous construct, and policy support for food-security instruments (Q22,support_) is the endogenous dependent variable.

This model demonstrates the highest explanatory power for the dependent construct Q22 (R^2 = 0.191), while also maintaining substantial explanatory power for the mediating construct Q12 (R^2 = 0.378). In this model Q12 (global threats) act as the central strategic channel through which broader conditions shape policy response. In result, the factors of FS global environment and global risks shape the perception of global threats, and this threat context is linked to policy support choices. The findings confirm that global threats provide the strategic policy frame, while global risks are the more immediate mechanism through which support for food-security-strengthening investment instruments is activated.

5. Conclusions

To conclude, we confirm that: (1) food security is a **multi-dimensional systemic problem**; (2) transformation pathways shift from focus food availability toward a complex paradigm centered on access, stability, and governance-related pillars; (3) transformation clusters can be used to transform policy responses more effectively ranging from specialized (environmental, technological, institutional) to fully integrated (hybrid) models of agri-food system transformation; (4) the 4 Betters framework was validated for Better production and Better environment, whereas Better governance and Better health replaced Better life and Better nutrition. Transformation pathways (Q35) were used to classify respondents into distinct transformation clusters: Sustainability, Technology, Governance, and Hybrid. The results of indicate that global food security threats are perceived differently across expert groups. Technology cluster prioritize innovation and production efficiency, while Sustainability emphasizes environmental transformation. Governance cluster highlights institutional and coordination mechanisms. Hybrid perspectives dominate, suggesting that experts tend to combine multiple transformation approaches.

Cross-analysis reveals that major food security threats such as Russia's war against Ukraine, climate change

and natural disasters indicate that geopolitical and environmental shocks have high influence on food security stability, availability, utilization and agency pillars. These threats impact policy priorities being more structured at Better resilience, Better governance and Better environment. The global threats align with the ways of ensuring food security: Russia's war against Ukraine is linked to humanitarian assistance, food assistance, and diets change; financial crisis (2007-8) to agri-food production support; and climate change to diets change, investments in technologies, food assistance, and agri-food production support. The findings of PLS-SEM model confirm that global threats provide strategic policy frame, while global risks are the more immediate mechanism through which support for food-security-strengthening investment instruments is activated. Overall, the findings confirm that global threats significantly shape the configuration of policy responses and transformation pathways, but the strength of this influence depend on the nature and systemic depth of the threat. In line with recent global food policy research, this underscores the need for integrated, multi-dimensional and threat-specific policy frameworks, combining governance, technology, and sustainability approaches to ensure resilient agri-food system transformation. Building resilience comes essential transformation outcome in mitigating the negative effects of global threats.

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