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DOI: <https://www.doi.org/10.53002/166>

VISUALIZATION OF DEVELOPMENT OF AN INTEGRATED ASAFOETIDA (HING) VALUE CHAIN IN AFGHANISTAN FROM CULTIVATION TO EXPORT

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Abstract — This study examines the development of an integrated Asafoetida (Hing) value chain in Afghanistan from cultivation to export using bibliometric analysis and VOSviewer. Metadata from 494,420 Web of Science publications (2020–2025) were analyzed to identify key research themes and relationships. The results highlight strong connections between supply chain management, sustainability, resilience, logistics, quality, digital transformation, and international trade. The findings suggest that integrating cultivation, harvesting, processing, quality control, storage, packaging, transportation, and export activities can improve coordination, product quality, market access, and export competitiveness. Digital technologies can further support traceability, information sharing, forecasting, and supply chain coordination. The analysis also emphasizes the importance of collaboration among farmers, processors, traders, exporters, government institutions, and other value-chain stakeholders. Improving logistics and quality-management practices can reduce inefficiencies and strengthen the reliability of Asafoetida products in international markets. Sustainable production and resilient supply-chain practices can also contribute to rural development and income generation. Therefore, an integrated farm-to-export approach can help create greater economic value and strengthen Afghanistan's position in the international Asafoetida market. The study provides a conceptual basis for developing a sustainable, resilient, and digitally supported Asafoetida value chain in Afghanistan.

Keywords — Asafoetida (Hing); value chain; supply chain management; agriculture; sustainability; logistics; digital transformation; export; Afghanistan.

ВИЗУАЛИЗАЦИЯ РАЗВИТИЯ ИНТЕГРИРОВАННОЙ ЦЕПОЧКИ СОЗДАНИЯ СТОИМОСТИ АСАФЕТИДЫ (ХИНГА) В АФГАНИСТАНЕ: ОТ ВЫРАЩИВАНИЯ ДО ЭКСПОРТА

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Аннотация — В данном исследовании рассматривается развитие интегрированной цепочки создания стоимости асафетиды (хинга) в Афганистане — от выращивания до экспорта — с использованием библиометрического анализа и программного обеспечения VOSviewer. Для выявления основных исследовательских направлений и взаимосвязей были проанализированы метаданные 494 420 публикаций из базы данных Web of Science за период 2020–2025 гг. Результаты демонстрируют тесные взаимосвязи между управлением цепочками поставок, устойчивым

развитием, устойчивостью цепочек поставок к внешним воздействиям, логистикой, качеством, цифровой трансформацией и международной торговлей. Полученные результаты показывают, что интеграция таких видов деятельности, как выращивание, сбор урожая, переработка, контроль качества, хранение, упаковка, транспортировка и экспорт, может способствовать улучшению координации, повышению качества продукции, расширению доступа к рынкам и укреплению экспортной конкурентоспособности.

Цифровые технологии могут дополнительно способствовать обеспечению прослеживаемости продукции, обмену информацией, прогнозированию и координации цепочки поставок. Анализ также подчеркивает важность сотрудничества между фермерами, переработчиками, торговцами, экспортёрами, государственными учреждениями и другими участниками цепочки создания стоимости. Совершенствование логистики и практик управления качеством может снизить неэффективность и повысить надёжность продукции из асафетиды на международных рынках. Устойчивые методы производства и практики формирования устойчивых цепочек поставок также могут способствовать развитию сельских территорий и увеличению доходов населения. Таким образом, интегрированный подход «от фермы до экспорта» может способствовать созданию большей экономической ценности и укреплению позиций Афганистана на международном рынке асафетиды. Исследование формирует концептуальную основу для развития устойчивой, адаптивной и поддерживаемой цифровыми технологиями цепочки создания стоимости асафетиды в Афганистане.

Ключевые слова — асафетида (хинг); цепочка создания стоимости; управление цепочками поставок; сельское хозяйство; устойчивое развитие; логистика; цифровая трансформация; экспорт; Афганистан.

АУҒАНСТАНДА АСАФЕТИДАНЫҢ (ХИНГТІҢ) ӨСІРҮДЕН ЭКСПОРТҚА ДЕЙІНГІ ИНТЕГРАЦИЯЛАНҒАН ҚҰН ТІЗБЕГІН ДАМУ ТҮРІН ВИЗУАЛИЗАЦИЯЛАУ

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Аңдатпа — Бұл зерттеуде библиометриялық талдау және VOSviewer бағдарламалық құралы арқылы Ауғанстандағы асафетиданың (хингтің) өсіруден бастап экспортқа дейінгі интеграцияланған құн тізбегін дамыту мәселесі қарастырылады. Негізгі зерттеу бағыттары мен олардың өзара байланыстарын анықтау мақсатында 2020–2025 жылдар аралығындағы Web of Science деректер базасындағы 494 420 жарияланымның метадеректері талданды. Нәтижелер жеткізу тізбегін басқару, тұрақты даму, жеткізу тізбегінің тұрақтылығы, логистика, сапа, цифрлық трансформация және халықаралық сауда арасында тығыз байланыстар бар екенін көрсетті. Алынған нәтижелер өсіру, жинау, өңдеу, сапаны бақылау, сақтау, орау, тасымалдау және экспорттау сияқты қызмет түрлерін интеграциялау үйлестіруді жақсартуға, өнім сапасын арттыруға, нарықтарға қолжетімділікті кеңейтуге және экспорттық бәсекеге қабілеттілікті нығайтуға мүмкіндік беретінін көрсетеді.

Цифрлық технологиялар өнімнің қадағалануын қамтамасыз етуге, ақпарат алмасуға, болжам жасауға және жеткізу тізбегін үйлестіруге қосымша қолдау көрсете алады. Талдау сонымен қатар фермерлер, өңдеушілер, саудагерлер, экспорттаушылар, мемлекеттік мекемелер және құн тізбегінің басқа да қатысушылары арасындағы ынтымақтастықтың маңыздылығын көрсетеді. Логистика мен сапаны басқару тәжірибесін жетілдіру тиімсіздікті азайтып, халықаралық нарықтардағы асафетида өнімдерінің сенімділігін арттыруға мүмкіндік береді. Тұрақты өндіріс пен жеткізу тізбегінің орнықтылығын қамтамасыз ететін тәжірибелер ауылдық аумақтардың дамуына және халықтың табысын арттыруға да ықпал ете алады. Сондықтан «фермадан экспортқа дейін» интеграцияланған тәсіл экономикалық құндылықты арттыруға және Ауғанстанның халықаралық асафетида нарығындағы позициясын нығайтуға мүмкіндік береді. Зерттеу Ауғанстанда тұрақты, орнықты және цифрлық технологиялармен қолдау көрсетілетін асафетиданың құн тізбегін дамыту үшін тұжырымдамалық негіз қалыптастырады.

Түйін сөздер — асафетида (хинг); құн тізбегі; жеткізу тізбегін басқару; ауыл шаруашылығы; тұрақты даму; логистика; цифрлық трансформация; экспорт; Ауғанстан.

The development of an integrated asafoetida (hing) value chain is a crucial aspect of improving

agricultural productivity, promoting rural livelihoods, and increasing the export

competitiveness of Afghanistan, where asafoetida is recognized as one of the country's most valuable medicinal and aromatic plant products [1]. Establishing an efficient value chain that connects cultivation, harvesting, processing, quality control, marketing, and export can enhance product quality, reduce post-harvest losses, and create greater economic opportunities for farmers and exporters. Understanding the research landscape in this area is essential for identifying the major themes, research gaps, and emerging directions related to the sustainable development of the asafoetida sector.

This section aims to visualize the scientific literature on the development of an integrated asafoetida (hing) value chain in Afghanistan, from cultivation to export, using VOSviewer software. A bibliometric visualization approach was employed to analyze the co-occurrence of keywords and their relationships, enabling the identification of dominant research clusters, thematic networks, and knowledge trends. The visualization provides a comprehensive overview of the existing research and supports future studies and policy development for strengthening the asafoetida value chain in Afghanistan.

We exported metadata from 494,420 publications from the Web of Science (WoS) database using the following query: "TITLE:(\"asafoetida\" OR \"asafetida\" OR \"hing\" OR \"Ferula asafoetida\" OR \"Ferula assa-foetida\" OR \"Ferula foetida\" OR \"asafoetida resin\" or \"value chain\" OR \"value-chain\" OR \"agricultural value chain\" OR \"agrifood value chain\" OR \"supply chain\" OR \"supply-chain\" OR \"commodity chain\" OR \"value chain development\" OR \"cultivation\" OR \"cultivation practices\" OR \"production\" OR \"agricultural production\" OR \"farming\" OR \"harvesting\" OR \"processing\" OR \"post-harvest\" OR \"postharvest\" OR \"storage\" OR \"marketing\" OR \"commercialization\" OR \"market access\" OR \"trade\" OR \"export\" OR \"exports\" OR \"international trade\" OR \"export development\" OR \"Afghanistan\" OR \"Afghan\"), timespan: 2020–2025. Indexes: SCI - EXPANDED, SSCI, CPCI - S, ESCI. The construction of a network of co-occurrence of keywords and their clustering was carried out using the VOSviewer 1.6.15 program [2].

The minimum occurrence of keywords selected for consideration was four. The total number of keywords in the 494,420 publications considered (Authors and Keywords Plus generated by WoS) is 4002. The number of keywords that appear at least 4 times is 369, and further analysis was carried out on them.

To reduce the number of clusters into which keywords (KW) are aggregated, an additional restriction has been introduced: at least 100 KW per cluster.

Table 1 presents the bibliometric visualization of the development of an integrated Asafoetida (Hing) value chain in Afghanistan, highlighting the interconnected research areas from cultivation and production to processing, marketing, and export. The visualization was generated using VOSviewer to identify key themes, keyword co-occurrence, and relationships within the scientific literature.

Table 1- 40 most frequently occurring keywords in a sample of 494,420 metadata

Key word	N-kw	Key word	N-kw	Key word	N-kw	Key word	N-kw
manag ement	171	integrat ion	55	collab oratio n	35	strategi es	29
impact	155	resilien ce	54	suppl y chain integr ation	35	big data analyti cs	24
perfor mance	147	firm perfor mance	54	design	35	scale develo pment	23
supply chain	157	dynami c capabil ities	48	coordi nation	34	supply chain agility	23
sustain ability	69	capabil ities	41	techn ology	33	agility	23
supply chain resilie nce	68	logistic s	41	infor matio n- techn ology	31	resourc e-based view	22
frame work	66	anteced ents	40	comp etitive advan tage	31	modera ting role	22
model	63	quality	40	infor matio n	31	industr y	22
supply chain manag ement	63	strateg y	39	risk	30	operati onal perfor mance	21
innova tion	59	supply chain perfor mance	37	block chain	30	mediati ng role	19

Notes: keyword is the name of the term; N-kw is the occurrence of the term.

The dominant keywords are related to the topic, its management, impact, performance, supply chain, sustainability, supply chain resilience, framework, model, supply chain management, innovation, integration, resilience, firm performance, dynamic capabilities, capabilities, logistics, antecedents, quality, strategy, and supply chain performance.

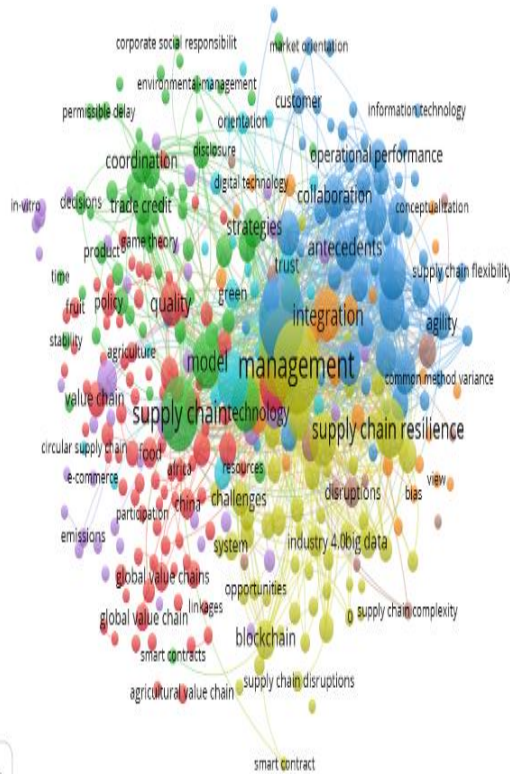


Figure 1- Keyword Co-Occurrence Network
Visualization: 369 Most Frequent Terms in 494,420
Publications

If we consider separately the keywords of the authors themselves, then with a total number of 2,756KW, 157KW occur at least four times, while the total number of keywords plus (Keywords Plus) generated by the WoS platform is 1,548KW and those encountered more than four times are 221KW.

Table 2 - Comparison of the 30 most common keywords used by publication authors and WoS platform keywords

Author Keywords	N-kw	Keywords Plus	N-kw
supply chain	101	trade credit	16
supply chain resilience	68	artificial intelligence	14
supply chain management	63	performance	14
supply chain performance	37	supply chain digitalization	13
sustainability	37	firm performance	12
supply chain integration	35	international trade	12
resilience	27	industry 4.0	11
value chain	26	logistics	11
blockchain	23	digital supply chain	11
supply chain agility	23	information sharing	10
supply chains	23	sustainable development	10
supply chain finance	20	green supply chain management	10
supply chain collaboration	17	collaboration	9
risk management	16	manufacturing	9
digital transformation	16	literature review	9

Table 2 presents the result of a comparison of the 30 most common keywords of publication authors and keywords of the WoS platform. It shows that authors often use more general terms to classify their publications: supply chain, supply chain resilience, supply chain management, supply chain performance, blockchain, sustainability, supply chain integration, resilience, supply chain agility, supply chain collaboration, artificial intelligence, supply chains, risk management, digital transformation, and performance.

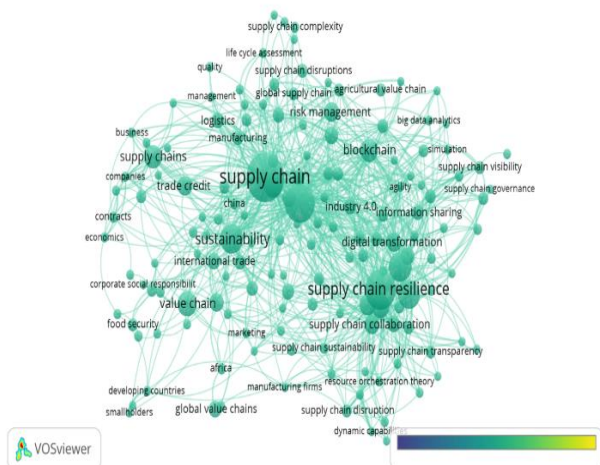


Figure 2- Overlay Visualization of 30 Most Common Keywords: Author-Assigned vs. WoS-Generated Terms

The Web of Science (WoS) platform also generates a list of “Keywords Plus” based on the analysis of the full texts of publications. These terms often describe the topic from a broader perspective than the authors' original keywords. In this case, the dominant terms include: impact, management, performance, framework, dynamic capabilities, firm performance, integration, innovation, model, antecedents, capabilities, information-technology, strategy, collaboration, sustainability, competitive advantage, resilience, technology, logistics, information, which collectively provide a deeper insight into the implementation of the themes addressed by the authors' keywords [3].

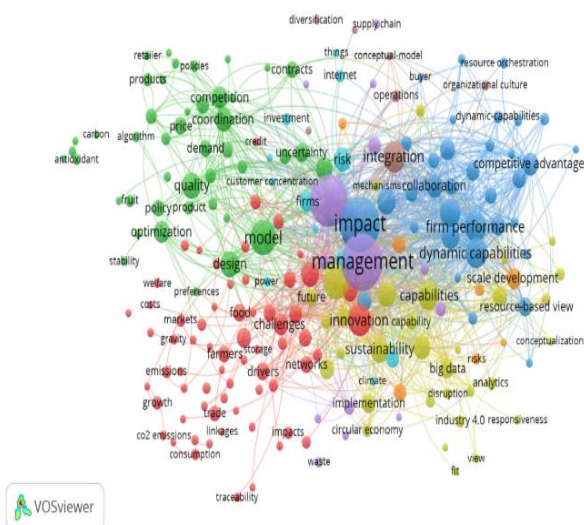


Figure 3- Keywords Plus Co-Occurrence Network
Visualization: 221 Most Frequent in 494,420 Publications

This is also reflected in the clustering of author keywords, WoS platform keywords and the sum of these keywords. Clustering is based on the co occurrence of keywords in a publication; the clustering algorithm is described in detail in the VOSviewer 1.6.15 user manual. Identification of the dominant keywords in each cluster allows us to reduce bias in the further collection of scientific publications on a narrower issue, for example, to compile a systematic review. A well-known problem of narrow specialists: they see their topic well, overestimate the importance of key terms close to them and tend to underestimate other people's topics. At the same time, a significant part of innovations is implemented at the intersection of research areas.

This study provides a comprehensive bibliometric analysis of the research landscape surrounding the development of an integrated Asafoetida (Hing) value chain, with particular attention to the interconnected stages of cultivation, production, harvesting, processing, quality management, marketing, logistics, and export. The development of such an integrated value chain is particularly important for Afghanistan because Asafoetida is an important exportable agricultural commodity and can contribute to rural livelihoods, agricultural income, and international trade. Existing research on Hing production in Afghanistan also identifies important challenges for producers, including limited processing equipment, insufficient market access, inadequate extension support, and high input costs [4]. These challenges demonstrate the need to examine Asafoetida not only as an agricultural product but as an integrated value chain involving farmers, processors, traders, logistics providers, exporters, and international markets.

The present analysis used metadata from 494,420 publications retrieved from the Web of Science database for the period 2020–2025. The search strategy incorporated a broad range of terms associated with *Asafoetida*, *Ferula* species, Hing, cultivation, agricultural production, harvesting, processing, post-harvest management, storage, marketing, commercialization, market access, trade, exports, supply chains, value chains, and Afghanistan. VOSviewer was used to construct keyword co-occurrence networks and identify the major thematic relationships within the research landscape. The analysis initially identified 4,002 keywords, of which 369 occurred at least four times and were subsequently included in the analysis. [5]

The results demonstrate that the literature surrounding the development of agricultural and supply-chain systems is highly interconnected. The most frequently occurring terms identified in the study include management, impact, supply chain, performance, sustainability, supply chain resilience, framework, model, supply chain management, innovation, integration, resilience, firm performance, dynamic capabilities, logistics, quality, strategy, and supply chain performance. These findings suggest that the development of an integrated Asafoetida value chain should be approached from a multidimensional perspective rather than being limited to cultivation and production.

The strong occurrence of supply chain, supply chain management, supply chain resilience, logistics, and supply chain performance is particularly relevant to Afghanistan's Asafoetida sector. An integrated value chain requires coordination among producers, collectors, processors, wholesalers, exporters, transport providers, and foreign buyers. Without effective coordination, value can be lost at different stages through inefficient harvesting, inadequate processing, poor storage, weak information sharing, transportation constraints, or limited market access. Therefore, strengthening supply-chain integration can help connect agricultural production with processing and international markets and can potentially improve the overall economic value generated by Asafoetida.

The importance of supply-chain integration is also supported by the broader literature, which increasingly considers supply chains as interconnected systems involving coordination, information sharing, resilience, technology, and sustainability. Bibliometric research on sustainable supply chains demonstrates that major research clusters include sustainability, technological innovation, performance and competitive advantage, sustainable business models, and supply-chain risks [6]. This supports the findings of the present study, where integration, resilience, innovation, technology, sustainability, and performance appear as interconnected research themes.

Fayez Wazani et al. [7] also demonstrated the importance of digitalization in production processes at JSC “Qarmet” within the framework of Industry 4.0. Their research emphasized automated process control, real-time monitoring, automatic detection of production defects, and the application of digital technologies to improve product quality and production performance. Although that study focused on an industrial production environment, its

findings are relevant to the proposed Asafoetida value chain because digital technologies can similarly support information sharing, quality monitoring, traceability, inventory management, production planning, and coordination among participants in an agricultural value chain.

Digital transformation represents an important emerging direction in the present research landscape. Among the author-assigned keywords, digital transformation, artificial intelligence, blockchain, supply chain digitalization, and supply chain collaboration appear as important themes, while Keywords Plus includes information technology, technology, and digital-related concepts. This suggests that future development of the Asafoetida sector could benefit from digital platforms that connect farmers with processors, traders, exporters, and international buyers.

For Afghanistan, digitalization could provide several practical opportunities. A digital value-chain platform could allow farmers to access information about cultivation practices, harvesting schedules, quality requirements, market prices, buyers, and export requirements. Processors and exporters could use digital records to monitor quantities, quality characteristics, processing activities, storage conditions, and shipments. Such systems could also improve transparency between producers and buyers and reduce information asymmetries that may disadvantage small-scale farmers.

The appearance of blockchain and information sharing among the identified research themes is also significant. Blockchain-based systems could potentially support product traceability by recording information about cultivation locations, harvesting, processing, quality inspection, packaging, and export transactions. For a product such as Asafoetida, where product quality and authenticity can influence international market acceptance, improved traceability could contribute to greater buyer confidence and market transparency.

Another important dimension is quality management. The keyword analysis identifies quality as a significant theme, with quality appearing 40 times among the dominant Keywords Plus terms. Quality management is particularly important for Asafoetida because the product passes through several stages between cultivation and final export. Variations in harvesting methods, drying, processing, storage, packaging, and handling can influence the final quality of the product. Therefore, establishing consistent quality-control procedures

throughout the value chain is essential for improving market competitiveness.

Fayez Wazani et al. [8] examined data-driven decision-making within Quality Management Systems based on ISO 9001:2015 and highlighted the importance of statistical analysis for objective process assessment, timely detection of deviations, reduction of process variability, and improvement of management decisions. These findings are relevant to the Asafoetida value chain because data-driven quality management can potentially be applied to production volumes, product quality, processing performance, storage conditions, market demand, and export performance. Consequently, systematic collection and analysis of value-chain data could support more reliable decisions by farmers, processors, exporters, and policymakers.

The research landscape also emphasizes sustainability and resilience. Sustainability appears 69 times among the dominant Keywords Plus terms, while supply-chain resilience appears 68 times. These themes are especially relevant to Afghanistan because agricultural value chains may face multiple risks, including climatic variability, production uncertainty, transportation constraints, market fluctuations, limited infrastructure, and disruptions in domestic and international trade.

A resilient Asafoetida value chain should therefore be capable of responding to disruptions while maintaining the flow of products and information from producers to international buyers. Research on sustainable supply-chain resilience shows that sustainability, supply-chain management, sustainable development, and risk management are closely interconnected themes in the contemporary literature [9]. For the Afghan Asafoetida sector, improving resilience could involve diversifying buyers and export markets, strengthening storage capacity, improving transportation and logistics, developing reliable processing facilities, and increasing access to market information.

Logistics is another important theme identified in the analysis, appearing among the dominant Keywords Plus terms. Logistics is critical because Asafoetida must move through several geographical and organizational stages before reaching international markets. Inefficient transportation, inadequate storage, poor packaging, and delays can reduce product quality and increase transaction costs. Developing an integrated logistics system connecting production areas with processing facilities, domestic markets, border points, and

international buyers could therefore improve the efficiency of the overall value chain.

The role of logistics is closely connected with supply-chain agility and collaboration, which also appear among the major author-assigned keywords. Effective collaboration among farmers, processors, traders, exporters, government agencies, financial institutions, and logistics providers can improve information exchange and facilitate faster responses to changes in demand and market conditions. In the Asafoetida sector, stronger collaboration could also help smallholder farmers obtain better access to processing facilities and international markets.

Another important finding is the presence of competitive advantage, innovation, dynamic capabilities, and strategy within the research landscape. These concepts indicate that value-chain development should not focus exclusively on increasing production. Long-term competitiveness depends on the ability of participants to develop capabilities for innovation, quality improvement, market adaptation, technological adoption, and strategic coordination.

For Afghanistan, this means that increasing Asafoetida production alone may not be sufficient to maximize its economic contribution. Greater value can potentially be created by improving processing, packaging, branding, certification, traceability, marketing, and export coordination. Moving from the export of relatively unprocessed raw material toward higher-value processed and standardized products could provide opportunities to increase the economic return to producers and other participants in the value chain.

The comparison between author-assigned keywords and Keywords Plus further confirms the interdisciplinary character of the field. The authors' keywords emphasize supply chain, supply chain resilience, supply chain management, supply chain performance, sustainability, supply chain integration, blockchain, supply chain agility, supply chain collaboration, risk management, digital transformation, and performance. Meanwhile, Keywords Plus emphasizes broader concepts such as management, impact, performance, framework, dynamic capabilities, firm performance, integration, innovation, information technology, strategy, collaboration, sustainability, competitive advantage, resilience, technology, and logistics.

This difference indicates that the development of an Asafoetida value chain should be understood through several complementary perspectives: agricultural production, supply-chain management,

logistics, digitalization, sustainability, quality management, international trade, and strategic management. Integrating these perspectives can provide a stronger conceptual foundation for developing an effective national Asafoetida value-chain model for Afghanistan.

The findings also support the development of a farm-to-export integrated value-chain framework for Asafoetida. Such a framework could consist of several interconnected stages: cultivation and production; harvesting and collection; primary processing; quality control; drying and storage; packaging and branding; domestic transportation; market coordination; export logistics; and international marketing. Digital information systems could operate across these stages to improve traceability, information sharing, forecasting, and coordination.

The results of the bibliometric analysis can also support the development of future research programs and systematic reviews focused specifically on Asafoetida production and value-chain development. The clustering of keywords provides an opportunity to identify research gaps and investigate the relationships between cultivation, processing, supply-chain resilience, sustainability, digitalization, quality, logistics, and export competitiveness. The clustering approach can also help reduce the risk of examining the topic from an overly narrow perspective because innovations frequently emerge at the intersection of different research areas.

Future empirical research should examine the actual conditions of the Asafoetida value chain in Afghanistan. Important areas include the economic performance of farmers, cultivation costs, productivity, harvesting practices, processing capacity, post-harvest losses, storage conditions, transportation costs, market structures, export destinations, international prices, quality requirements, certification, and the distribution of value among different participants. Such research could provide the quantitative evidence necessary for designing an economically viable and sustainable national value-chain model.

Future studies should also investigate how digital technologies can be practically applied within the Afghan Asafoetida sector. Potential applications include mobile-based farmer platforms, digital marketplaces, electronic traceability systems, blockchain-based certification, demand forecasting, geographic information systems, digital payment systems, and data-driven production planning. These technologies could help connect rural producers with

domestic and international markets while improving transparency and reducing information barriers.

Sustainability should remain a central component of this development model. Sustainable cultivation practices, responsible harvesting, efficient resource use, appropriate processing technologies, and improved waste management can help ensure that expansion of Asafoetida production does not create unnecessary environmental pressures. At the same time, social sustainability should be considered through improved rural employment, farmer income, participation of local communities, and equitable distribution of value throughout the chain.

Also these findings demonstrate that the development of an integrated Asafoetida value chain in Afghanistan is a multidisciplinary issue involving agriculture, supply-chain management, logistics, international trade, technology, quality management, sustainability, and strategic management. The dominant research themes identified through VOSviewer—including management, supply chain, performance, sustainability, resilience, innovation, integration, logistics, quality, strategy, and supply-chain performance—provide a useful conceptual foundation for understanding the sector.

CONCLUSION

The study demonstrates that developing an integrated Asafoetida value chain can create significant opportunities for Afghanistan's agricultural and export sectors. The bibliometric analysis highlights the importance of supply chain integration, sustainability, resilience, logistics, quality management, digitalization, and international trade. Connecting cultivation, harvesting, processing, quality control, storage, packaging, transportation, and export can improve value creation and market competitiveness. Digital technologies, including blockchain and other traceability systems, can further strengthen coordination, transparency, information sharing, and market access. Effective quality control and standardized processing practices are also essential for meeting international market requirements and improving product value. Stronger cooperation among farmers, processors, traders, exporters, and government institutions can reduce supply-chain fragmentation and improve overall efficiency. Investment in logistics, storage, packaging, and export infrastructure can further reduce post-harvest losses and support reliable international distribution. At the same time, sustainable and resilient

production practices can contribute to rural employment, farmer income, and long-term sector development. Therefore, an integrated and digitally supported farm-to-export model can provide a

stronger foundation for sustainable development, higher product quality, and greater international competitiveness of Afghanistan's Asafoetida sector.

REFERENCES

Journal Articles

- [1] D. Salvatore and W. Janssen, «Strengthening Afghanistan's Asafoetida value chain: Production, processing, and export opportunities», Food and Agriculture Organization of the United Nations (FAO), 2021.
- [2] Z. S. Gelmanova, A. W. Fayeze Wazani, and K. B. Khapasov, «Visualization of the development of a methodology for automated analysis and support of cyberattack investigations using artificial intelligence methods with VOSviewer», In the World of Science and Education, vol. 11, no. 11, pp. 69–74, 2026. Available: <https://zenodo.org/records/18810763>.
- [3] Z. S. Gelmanova, A. W. Fayeze Wazani, and A. A. Denezhkin, «Digital transformation of sales in the telecom sector: Development and implementation of CRM systems using Freedom Mobile as an example; data visualization using VOSviewer», In the World of Science and Education, vol. 11, no. 11, pp. 69–74, 2025. Available: <https://zenodo.org/records/17213853>.
- [4] M. Hussain Khail, B. Jafary, A. F. Sharifi, et al., «Economic analysis of Hing production in Badakhshan Province», ESRJ, vol. 62, no. 2, pp. 10–18, 2024. [Online]. Available: <https://esrj.edu.af/esrj/article/view/27>.
- [5] T. T. T. Duong, Q. L. Tran, and L. C. Hoang, «Sustainable supply chain management: A bibliometric analysis using VOSviewer», Ho Chi Minh City Open University Journal of Science – Economics and Business Administration, vol. 16, no. 8, pp. 57–77, 2025. [Online]. Available: <https://doi.org/10.46223/HCMCOUJS.econ.en.16.8.4583.2026>.
- [6] E. Soeryanto Soegoto, S. Luckyardi, E. N. Hayati, et al., «Bibliometric analysis of green supply chain research using VOSviewer», Journal of Eastern European and Central Asian Research, vol. 9, no. 5, 2022. Available: <https://doi.org/10.15549/jeecar.v9i5.1051>.
- [7] Z. S. Gelmanova, A. W. Fayeze Wazani, A. S. Petrovskaya, and G. S. Shakanova, «Data-driven decision making in quality management systems (ISO 9001:2015): A statistical approach and case studies», In the World of Science and Education, vol. 11, no. 11, pp. 98–103, 2026. Available: <https://doi.org/10.5281/zenodo.20405837>.
- [8] S. Z. H. Syed Jamaludin, M. Mustapa, Z. Mohamad Ramly, and N. Muhammad, «Resilience strategies in sustainable supply chain management: Bibliometric analysis and future research directions», Built Environment Journal, vol. 21, no. 2, pp. 204–223, 2024.

Published Conference Proceedings

- [9] A. Batyrbek, Z. S. Gelmanova, and A. W. Fayeze Wazani, «Measures and procedure for implementation of digitalization of production at JSC «Qarmet»», in 2024 International Conference on Electrical and Computer Engineering Researches (ICECER), IEEE, 2024. Available: <https://doi.org/10.1109/ICECER62944.2024.10920383>.