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Innovative approaches to standardisation in forest commodity science: Trends and prospects

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Abstract. It is important to create a regulatory environment for the integration of digital technologies into standardisation procedures. The aim of the study was to examine the possibilities for harmonising the Ukrainian regulatory framework with international requirements, identify barriers to the introduction of innovations, and outline the prospects for the development of the industry until 2030. The study used methods of comparative analysis of regulatory documents, content analysis of publications, analytical and descriptive methods. Both Ukrainian (DSTU) and international standards (ISO, FSC, PEFC) regulating the requirements for the quality, safety and environmental friendliness of forest products were considered. The study revealed modern innovative approaches to standardisation in forest commodity science, among which digital technologies, blockchain systems, artificial intelligence algorithms and remote monitoring tools played a key role. Based on the analysis of foreign experience (Germany, Canada, Sweden) and Ukrainian practice, the effectiveness of digital platforms for compliance control, online certification systems, the use of drones and satellite monitoring has been proven. It has been determined that leading countries have already implemented integrated ecosystems that combine standards, intelligent algorithms, and certification chains. In Ukraine, electronic product coding and the creation of databases of certified sites have been initiated, but further development is hampered by underfunding, fragmented policies and a

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lack of personnel. Areas for improvement have been proposed: attracting international technical assistance, developing public-private partnerships and updating educational programmes. Particular attention is paid to the need to form a single unified system for the evaluation of forest products in accordance with international trade requirements. The results of this study can serve as a basis for strategic decisions in the field of modernisation of the Ukrainian standardisation system

Keywords: forest products; FSC certification; digital technologies; sustainable development; quality control; innovations in forestry

Introduction

In the US (United States), the Forest Service, which is part of the Department of Agriculture (USDA Forest Service, n.d.), is rolling out artificial intelligence and digital monitoring technologies within its Forest Products Modernisation program. They're really focusing on automating timber quality assessment to cut down on subjective decision-making. On top of that, the system aims to ensure our regulations can be updated quickly via digital platforms. K. Klaric *et al.* (2023) showed that an increase in FSC certificates has a positive effect on Croatian timber exports, strengthening the industry's standing in the international market. The authors highlighted that having these certificates also builds trust with foreign partners, especially under free trade agreements. This research underscored certification's role in boosting competitiveness. However, as E. Lombardo *et al.* (2021) noted, the main drivers for adopting FSC and PEFC certification are often market pressure and companies wanting to be seen as environmentally responsible. Moral, legal, and institutional factors tend to be secondary, although they could play a significant role in further developing voluntary certification. J. Chen *et al.* (2020) argued in their study that it makes sense to harmonise FSC and PEFC standards at the ISO level, creating one global mechanism to simplify requirements and lower costs. They proved that synchronising certification procedures makes it easier for producers to access the market and reduces the expense of going through double procedures. The authors concluded that this kind of standard consolidation helps create a unified digital environment across supply chains.

Forest certification is increasingly seen not just as a quality control mechanism, but also as a tool for environmental marketing. A systematic review of blockchain technology use in the forestry sector by Z. He & P. Turner (2022) confirmed this innovative architecture's significant potential for improving the reliability and immutability of data in certification processes. Their proposed concepts have formed the basis for practical recommendations on how to integrate blockchain systems into Ukraine's electronic timber origin registries. K. Fernholz *et al.* (2021) pointed out that a significant portion of certified areas worldwide undergo dual certification (both FSC and PEFC simultaneously), which shows a drive for international recognition between systems. They noted that this duplication adds an extra burden on forestry enterprises but also opens up access to a wider range of markets. Their report also stressed the need for digitally integrating FSC and PEFC databases to avoid duplication.

In Ukraine, there's growing research on harmonising national standards with international ones. S.M. Bondarenko & A.V. Kopa (2017) highlighted the necessity of adapting FSC, PEFC, and ISO certification systems to the conditions of national forestry. The authors noted that successful implementation of international standards is only possible if the management and infrastructure base is modernised. They also pointed to the lack of trained personnel in certification auditing as a systemic problem. N. Marchenko *et al.* (2017) analysed the specifics of implementing harmonised DSTU EN standards for coniferous

timber, pointing out structural differences in classification approaches and quality requirements. Specifically, the authors emphasised the inconsistency between national technical specifications and European grading criteria. Their work highlighted the need to unify methods for assessing the physical and mechanical characteristics of timber.

P.H. Khomiuk *et al.* (2021) investigated the evolution of stand mensuration regulations and changes in roundwood grade classification according to new requirements. Their results indicate an improvement in the timber assessment system, particularly through its division into four quality classes and the differentiation of firewood by purpose. The researchers noted the need to implement digital tools for recording mensuration indicators to improve accounting accuracy. They propose updating methodological approaches in line with European practices of laser scanning and GIS technologies.

The aim of this study was to analyse contemporary innovative approaches to the standardisation of forest products, assess their effectiveness, and determine the possibilities for their implementation in Ukrainian practice. To achieve this aim, the following tasks were set:

- to analyse the current national and international standards in the field of forest commodity science;
- to identify the main problems that hinder effective standardisation in Ukraine;
- to formulate recommendations for improving the standardisation system in Ukraine, taking into account international requirements and industry specifics.

Materials and Methods

The study was conducted in 2023-2024, taking into account the experience of four countries: Ukraine, Canada, Germany, and Sweden. The geographical coverage was determined based on the relevance of digital technologies in the standardisation of forest products and the level of implementation of international certification systems.

The methodological basis was provided by analytical, descriptive and comparative methods.

The analysis covered State standards of Ukraine (DSTU 2152-93, 1993; DSTU 2980-95, 1995; DSTU 3404-96, 1996; DSTU EN 1309-1:2001, 2001; ISO 14001:2015, 2015; DSTU EN 1309-3, 2018), and international standards (FSC Standards, n.d.; ISO 38200:2018, 2018; Standards and implementation, 2023), in particular technical requirements for classification, measurement, certification and environmental management. The provisions of standards regarding the physical and mechanical characteristics of wood, criteria for sustainable forest management, requirements for transparency of product origin and conformity assessment procedures were evaluated. Particular attention was paid to the harmonisation of national standards with international ones, as well as to the assessment of the role of digital tools – blockchain technologies, remote sensing systems, drone monitoring and IoT solutions – in ensuring transparency and improving the effectiveness of standards.

The study used publications from scientific journal databases and reports of international organisations – The German National Forest Inventory (n.d.), FSC Standards (n.d.), FSC (n.d.), Forest Bioeconomy Cluster (n.d.), Precision forestry (n.d.), Law of Ukraine No. 1315-VII (2014), ISO 38200:2018 (2018) та Standards and implementation (2023).

Results and Discussion

In a general scientific context, the term “standardisation” is interpreted as activities aimed at establishing, implementing and applying rules for regulating various types of activities in specific areas that meet modern technical, economic and social requirements. According to Law of Ukraine No. 1315-VII (2014), standardisation is “an activity that consists of establishing provisions for general and repeated application in current or future activities in order to achieve an optimal degree of order in a particular field.” The main objectives of standardisation in the field of forest products

are to ensure stable quality, safety and compliance with environmental requirements. It allows for the unification of approaches to product evaluation, ensures traceability of origin and creates a unified system of technical requirements that are understandable to both the manufacturer and the consumer. In modern conditions, particular attention is paid to sustainable forest management standards, which, in addition to technical characteristics, also take into account social and environmental aspects.

In forest product commodity science, standardisation serves not only as a technical regulation, but also as a mechanism for ensuring the transparency of supply chains and the legality of wood origin. It creates a basis for objective evaluation of the quality of raw materials and finished products, determining their compliance with consumer and market requirements. According to the results of research by K. Klaric *et al.* (2023), certification based on international standards, in particular FSC, directly influences the competitiveness of forestry enterprises in the international market.

Standardisation also plays a decisive role in foreign trade, as compliance with international standards is often a prerequisite for entering European and global markets. In addition, standards ensure transparency and reliability in certification, allowing stakeholders – from consumers to

regulatory authorities – to obtain verified information about the quality, environmental friendliness and safety of products (Pavlishchuk *et al.*, 2022).

According to S. Pezdevšek Malovrh *et al.* (2019), FSC certification has a positive impact not only on export opportunities but also on domestic sustainable forest management practices, especially in the public sector. It contributes to the resolution of social and environmental issues, improves working conditions and the safety of loggers, and raises environmental awareness in the industry. At the global level, as noted by M. Bösch (2025), the spread of FSC and PEFC certification is closely linked to the quality of governance, the level of economic development and the foreign trade orientation of the forestry sector. The author also points out that countries with more active environmental organisations have higher levels of FSC certification, while PEFC is more common where this pressure is lower.

In the field of forest products in Ukraine, both national standards (DSTU) are applied, which regulate the requirements for the quality, safety and environmental friendliness of timber in accordance with the state regulatory framework, and international standards – ISO, FSC and PEFC, which ensure that products comply with global requirements for sustainable development, transparency of origin, environmental management and competitiveness in global markets (Table 1).

Table 1. Comparative characteristics of national and international standards in the forestry sector

Designation and title of the standard	Summary and characteristics	Geography of application	Functional purpose
DSTU (State standards of Ukraine)	National regulatory documents governing product quality, safety and environmental requirements. Harmonised with European EN standards	Ukraine, in particular state-owned and commercial forestry enterprises	Technical regulation of the quality of round timber, sawn timber, harvesting processes
ISO (International Organisation for Standardisation)	International standards for quality and environmental management; ISO 14001 – environmental management, ISO 38200 – timber supply chain	All countries involved in international trade, international companies, certification bodies	Environmental risk management, traceability of wood origin

Table 1. Continued

Designation and title of the standard	Summary and characteristics	Geography of application	Functional purpose
FSC (Forest Stewardship Council)	Voluntary international forest certification system. Defines the principles of sustainable forest management	Ukraine (over 4.7 million hectares of certified forests), Europe, North America, globally	Forest certification, supply chain control, compliance with environmental and social criteria
PEFC (Programme for the Endorsement of Forest Certification)	Global system for the recognition of national certification programmes. An alternative to FSC with a focus on local initiatives	In Ukraine – since 2021, also in over 50 countries worldwide	Certification of sustainable forest management, support for local standards, compliance with international environmental requirements

Source: developed by the authors based on FSC Standards (n.d.), FSC (n.d.), DSTU 2152-93 (1993), DSTU 2980-95 (1995), DSTU 3404-96 (1996), DSTU EN 1309-1:2001 (2001), ISO 14001:2015 (2015), DSTU EN 1309-3 (2018), ISO 38200:2018 (2018), Standards and implementation (2023)

The application of these standards promotes the integration of the Ukrainian forestry sector into international economic processes and improves the image of Ukrainian timber as a high-quality and responsible resource. The existence of a unified regulatory framework allows companies not only to meet the requirements of the domestic market, but also to enter foreign markets with products certified in accordance with international environmental and technical criteria, which, in turn, builds trust among international partners, promotes the

growth of the industry's investment attractiveness and provides competitive advantages for Ukrainian producers.

Within the framework of the state technical regulation system in Ukraine, there is a set of industry standards covering various stages of forest product circulation – from taxation and harvesting to classification, measurement and determination of wood quality characteristics. These include standards for terms and definitions, measurement methods, volume tables, and systems for classifying and identifying wood defects (Table 2).

Table 2. Classification of national standards regulating activities in the forestry sector

Standard designation	Name of standard	Purpose of the standard
DSTU 3404-96	Forestry. Terms and definitions	Terms and definitions of basic concepts in forestry
DSTU 2980-95	Forest cultures. Terms and definitions	Terms related to forest cultures, seed production, nurseries
DSTU 2152-93	Wood defects and processing defects. Terms and definitions	Terms related to wood defects and processing defects
DSTU EN 1309-1:2001	Method of measuring dimensions. Part 1. Sawn timber	Methods for measuring the dimensions of sawn timber
DSTU EN 1309-3	Measurement methods. Part 3. Biological damage	Methods for measuring the characteristics of biological damage

Source: developed by the authors based on DSTU 2152-93 (1993), DSTU 2980-95 (1995), DSTU 3404-96 (1996), DSTU EN 1309-1:2001 (2001), DSTU EN 1309-3 (2018)

Intensive globalisation and the growing role of international environmental initiatives are leading to the gradual alignment of forest products with global standards and sustainable development principles. International markets are increasingly demanding not only product quality and safety, but also transparency of origin, environmental responsibility of producers and compliance with social criteria. The Paris Climate Agreement and the European Green Deal, which set strategic guidelines for countries seeking to integrate into the European market, have a significant impact on environmental policy in the field of forest use (FSC, n.d.). In this context, there is a growing need not only for the implementation of internationally recognised standards (in particular FSC and ISO 14001), but also for the digital transformation of the forestry sector (Exploring the impact of the Paris Agreement..., 2024). At the same time, a study by J. Stubenrauch *et al.* (2022) emphasised that large-scale forest restoration in line with climate goals could have a reverse effect on forest ecosystems, in particular due to the threat to biodiversity posed by the creation of homogeneous forest plantations. Rapid growth in production volumes, the need to ensure timber traceability and minimise the human factor in inspections are driving the active use of automated solutions. Modern tools – in particular GPS monitoring systems, drone photography, satellite sensing and blockchain – enable operational control, accurate recording of raw material quality parameters and ensure the consistency and reliability of data in supply chains (Stopfer *et al.*, 2024). All this not only increases management efficiency, but also ensures that forest products comply with certification requirements, transparency of inspections and access to markets with high environmental standards.

However, despite the active development of international standards, the lack of uniform technical requirements for forest products in different countries remains a significant problem. Discrepancies in wood grade classification, documentation requirements, environmental criteria,

or certification procedures complicate export and import operations and create an additional burden on producers. This is particularly relevant for countries with economies in transition, which are forced to adapt their national standards to ISO, FSC or PEFC standards, requiring significant financial, technical and organisational resources. The lack of a harmonised evaluation system complicates the process of international recognition of certificates, reducing the competitiveness of products and slowing down their promotion on world markets. In this regard, there is a growing need to unify approaches to standardisation both at the level of regional unions (EU) and within bilateral trade agreements.

Traditional regulatory approaches are being replaced by digital solutions, including electronic certification, remote monitoring, blockchain systems and artificial intelligence. This approach ensures comprehensive traceability of raw materials, increases the accuracy of inspections, reduces the risk of fraud and optimises management decisions. The use of digital platforms in the forestry sector is already actively practised in many countries, including Germany and Canada, where electronic certification systems are integrated into national databases for managing timber supply chains (Chain of custody certification, n.d.). Ukraine is also implementing similar solutions through initiatives of the State Forest Resources Agency, including the use of QR coding of products and the creation of electronic registers of certified areas (State Forest Resources Agency of Ukraine, 2024).

Blockchain plays a special role in strengthening trust in certified products, as it allows for the storage of an unalterable chronology of data on the origin of timber, logistics, processing and final circulation. As part of the FSC Blockchain Pilot project, as well as through independent initiatives in EU countries, blockchain is being used as a technology that eliminates gaps in supply chain transparency and guarantees the accuracy of information at every stage (FSC, n.d.). At the same time, remote monitoring based on satellite images and drones is becoming increasingly

widespread in forestry. Systems such as Starling were already being used around the world to monitor deforestation and forest inventory (Monitor deforestation..., n.d.), while in Ukraine, drones were helping to record changes in areas where ground monitoring was difficult.

Improvements in quality control also become possible through the introduction of intelligent systems based on artificial intelligence and the Internet of Things (IoT). Sensors and cameras connected to analytical algorithms automatically monitor the moisture, density and geometric characteristics of wood, enabling efficient sorting and minimising resource losses. In Sweden, Canada and a number of other countries, AI is already being used in the harvesting and processing

stages of wood production to create digital product passports (The future of forestry: High-tech tools leading the way, 2024). The introduction of such systems in Ukraine is a promising step towards modernising standards and improving the quality and market attractiveness of domestic forest products. In the context of the global digitalisation of forestry, countries such as Germany, Canada and Sweden are demonstrating best practices in integrating innovative technologies into the standardisation and management of forest resources. The experience of these countries includes digital platforms, automated control systems and artificial intelligence, which ensure transparency, efficiency and compliance with international standards (Table 3).

Table 3. International practices of digital transformation of the standardisation system in the forest industry		
Country	Digital technologies used	Objective/results of implementation
Germany	Remote sensing systems, PEFC digital audit, national digital databases	Ecosystem assessment, environmental audits, certification transparency
Canada	Online courses on forest management, professional educational platforms	Professional development, implementation of sustainable practices
Sweden	Digital learning platforms, AI forest analysis systems, digital twins	Landscape management, effective training, accurate planning
Ukraine	QR coding, drone monitoring, electronic registers	Transparency of origin, logging control, compliance with standards

Source: developed by the authors based on The German National Forest Inventory (n.d.), Online micro-certificate: Forest management planning (n.d.), Precision forestry (n.d.), Forest Bioeconomy Cluster (n.d.), V. Myroniuk et al. (2024)

In Germany, PEFC Germany (n.d.) certifies forest management in accordance with sustainable management principles, including regular environmental audits. In addition, the Thünen Institute implements a national forest inventory using remote sensing and mathematical modelling, which allows for a comprehensive evaluation of the state of forest ecosystems (The German National Forest Inventory, n.d.).

Canada is notable for its developed system of professional training in forestry. For example, the University of British Columbia offers online courses in forest management planning, which allow specialists to gain up-to-date knowledge

on sustainable development in the forestry sector (Online micro-certificate: Forest management planning, n.d.).

Sweden is actively implementing digital solutions for professional training and upgrading the skills of forestry specialists. Biometria, in collaboration with Xtractor, has developed a digital learning platform that provides effective training for employees in line with modern industry requirements. As part of the Precision Forestry project, which is being implemented jointly with AI Sweden, technologies are being developed for analysing forest areas using artificial intelligence, which contributes to the creation of

digital twins of landscapes for management decisions (Precision forestry, n.d.).

The effective implementation of innovations in the forestry sector largely depends on cooperation between government agencies, businesses and scientific institutions. In Canada, there is the Forest Bioeconomy Cluster (n.d.), which aims to develop innovations in the bioeconomy with the active participation of industry, government and research centres. In Sweden, a similar role is played by the Paper Province association (n.d.), which coordinates joint projects between businesses, universities and regulators to improve the competitiveness and environmental performance of the pulp and paper industry.

Ukraine has the potential to implement modern digital technologies in forestry. In particular, the use of remote sensing and satellite data allows for effective monitoring of forest conditions, detection of illegal logging, and evaluation of the impact of military operations on forest ecosystems. For example, a study published in the journal *Forest Ecology and Management* proposes a national framework for monitoring Ukraine's forest resources using remote sensing, which is an effective tool for spatial assessment of changes in forests (Myroniuk *et al.*, 2024).

The main obstacles to innovation in Ukraine's forestry sector are underfunding, bureaucratic procedures and a shortage of qualified specialists. To overcome these problems, it is necessary to intensify state support programmes, attract international grants and develop partnerships between state institutions, scientific institutions and the private sector. In particular, international initiatives such as the Forest Recovery project (Updates on Ukrainian forest status, n.d.), aimed at the restoration and sustainable development of Ukrainian forests, can serve as a platform for the introduction of modern technologies and the exchange of experience.

By 2030, Ukraine is expected to make significant progress in implementing innovative standards in forestry, with the widespread use of artificial intelligence and the Internet of Things

technologies for monitoring and managing forest resources. Another important area will be the integration of blockchain technologies to ensure transparency and traceability of wood origin, which is a key factor for entering international markets with high environmental standards. Participation in international initiatives and adaptation to global environmental requirements will help strengthen Ukraine's position in the global forest products market.

The results of the study confirm the high relevance of introducing innovative approaches to the standardisation of forest products, particularly in terms of harmonising national technical regulations with international standards. This approach is in line with the current scientific paradigm and finds conceptual support in the research of other experts. In the Swedish experience presented by E. Mattsson *et al.* (2024), justifies the introduction of methodological indicators of sustainable forest management that take into account not only technical but also environmental and social criteria. A similar logic can be seen in the current approach, which provides for a comprehensive evaluation of the compliance of forest products with the requirements of sustainable development.

The digital transformation of the forestry industry is seen as a systemic response to the need for greater transparency, efficiency and trust in certification procedures. In this context, Y. Mendel's (2022) conclusions are particularly relevant, as they highlight the expediency of widespread implementation of information technologies to modernise Ukraine's timber industry complex. The results obtained in the current study not only confirm this thesis but also develop it by emphasising the importance of using blockchain platforms, remote monitoring systems and intelligent accounting tools. The study by O.Z. Mykytyn (2015) analyses the state of adaptation of the national certification system to the requirements of the European Union. The author argues that there are significant barriers to harmonisation, particularly in the areas of classification, sorting and methods of assessing wood quality, which are fully

consistent with the analytical conclusions of the current study regarding the need to unify technical procedures and conformity assessment criteria.

V. Makarova *et al.* (2023) examined the impact of digital tools on the effectiveness of foreign economic activity of forestry enterprises. The positive effect of the introduction of ERP systems, electronic auctions and automated supply chains, as documented by the authors, complements the vision in the current study of digital transformation as a strategic vector for the development of the industry. This approach not only increases transparency but also reduces transaction costs and contributes to the formation of a favourable investment climate. Y.I. Hayda (2015) interpreted it as a factor in the formation of the environmental reputation of enterprises, which opens up additional opportunities for integration into international markets. The current study specifies this idea through an empirical analysis of the impact of FSC and PEFC certificates on increasing export potential and trust on the part of international counterparties. The study by F. Ehrlich-Sommer *et al.* (2024) focuses on the development of sensor technologies and artificial intelligence in forest management systems. The current analysis is fully consistent with these provisions: the use of IoT devices and automatic visual control systems is considered an effective tool for improving measurement accuracy, optimising sorting processes and preventing resource losses.

Within the Ukrainian context, A. Deyneka's (2013) analysis is worth noting, as the author identifies critical limitations to implementing FSC certification in Eastern Ukraine. These include staff shortages, low levels of internal control and fragmented regulatory policy. The proposals identified in the current study – the development of electronic registers, strengthening institutional capacity and digital integration of certification data – can be considered practical steps towards overcoming these barriers. During the study of the digital transformation of the forest product standardisation system, the above scientific provisions on the harmonisation

of standards, the introduction of innovations and the improvement of transparency in certification procedures were taken into account.

Conclusions

Standardisation in forestry is transforming from a technical regulation tool into a comprehensive mechanism for ensuring quality, traceability of origin and environmental responsibility of products. The adaptation of national standards to international FSC, PEFC and ISO requirements contributes to the integration of the Ukrainian forestry sector into global markets and meets the challenges of sustainable development. Digital transformation tools are particularly important, as they enable real-time compliance monitoring and increase transparency and trust in Ukrainian timber.

The study found that leading countries, including Sweden, Canada and Germany, have already implemented digital forest resource management models based on remote monitoring, artificial intelligence and blockchain technologies. The use of such tools allows for effective control of timber quality, minimisation of the human factor and increased environmental responsibility of producers. At the same time, initiatives on QR coding and the creation of electronic registers have only recently begun in Ukraine, which indicates existing potential but also significant lag. An analysis of the regulatory framework revealed significant gaps, including the non-compliance of national standards with international technical requirements, fragmented assessment methods, and weak integration of environmental criteria. Problems of insufficient funding, a shortage of qualified personnel, and imperfect certification procedures are also confirmed by other studies.

Despite positive examples, such as the introduction of satellite monitoring, QR coding and e-certification, the development of innovation is hampered by limited funding, bureaucracy and a shortage of qualified specialists. To overcome these barriers, it is necessary to expand public-private partnerships, attract international

grants and intensify scientific research in the field of digital standardisation. The use of artificial intelligence, IoT and blockchain to create fully transparent supply chains that meet EU requirements is promising.

The results of the study demonstrate the feasibility of a comprehensive approach to modernising the standardisation of forest products, with an emphasis on digital infrastructure, international cooperation and regulatory harmonisation. Further research in the direction of standard unification, evaluation of the effectiveness of digital tools, and adaptation of international practices to the Ukrainian context is promising. Such a

scientific and practical approach will strengthen Ukraine's position in the certified forest products market by 2030 and ensure the sustainable development of the industry in line with global environmental guidelines.

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Conflict of Interest

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Інноваційні підходи до стандартизації в лісовому товарознавстві: тенденції та перспективи

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Анотація. Актуальним є створення нормативного середовища для інтеграції цифрових технологій у стандартизаційні процедури. Мета дослідження полягала у вивченні можливостей гармонізації української нормативної бази з міжнародними вимогами, виявленні бар'єрів впровадження інновацій та окресленні перспектив розвитку галузі до 2030 року. У межах дослідження застосовано методи порівняльного аналізу нормативних документів, контент-аналіз публікацій, аналітичні й описові методи. Розглянуто як українські – ДСТУ, так і міжнародні стандарти – ISO, FSC, PEFC, що регламентують вимоги до якості, безпеки та екологічності лісової продукції. У результаті проведеного дослідження виявлено сучасні інноваційні підходи до стандартизації в лісовому товарознавстві, серед яких ключове значення мають цифрові технології, блокчейн-системи, алгоритми штучного інтелекту та засоби дистанційного моніторингу. На основі опрацювання зарубіжного досвіду (Німеччина, Канада, Швеція) і української практики доведено ефективність цифрових платформ для контролю відповідності, систем онлайн-сертифікації, використання дронів і супутникового моніторингу. Визначено, що провідні країни вже впровадили інтегровані екосистеми, які поєднують стандарти, інтелектуальні алгоритми та сертифікаційні ланцюги. В Україні ініційовано електронне кодування продукції, створення баз сертифікованих ділянок, але подальший розвиток стримується через недофінансування, фрагментарність політики та нестачу кадрів. Запропоновано напрями удосконалення: залучення міжнародної технічної допомоги, розвиток державно-приватного партнерства, оновлення освітніх програм. Особливу увагу приділено необхідності формування єдиної уніфікованої системи оцінювання лісопродукції відповідно до вимог міжнародної торгівлі. Результати цього дослідження можуть слугувати основою для формування стратегічних рішень у сфері модернізації української системи стандартизації

Ключові слова: лісова продукція; сертифікація FSC; цифрові технології; сталий розвиток; контроль якості; інновації в лісовому господарстві