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VALUE CHAINS IN RAW MATERIALS, HIGH-TECH AND AGRICULTURAL PRODUCTS. INTERNATIONAL, EUROPEAN AND ROMANIAN PERSPECTIVES

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Abstract

This article explores the complexities and opportunities of agricultural value chains from international, European, and Romanian perspectives. Highlighting the importance of efficient value chain management, the exploration examines first the situation at the global level in the countries with a high economic development: USA, China, Germany, Japan and India, as a reflection on how global and regional policies impact agricultural production and distribution. Market dynamics of raw materials and high tech products and services in terms of export, import and trade balance was analyzed in the EU in the interval 2012-2022, based on Eurostat data, emphasizing its role in shaping value chains. The European lens focuses on the Common Agricultural Policy (CAP) and its implications for member states. The Romanian context highlights local challenges and strategies for integrating into broader value chains. From a methodological point of view, there were used various methods and procedures among which the main ones have been: descriptive context of the literature, trend dynamics in raw materials and high tech-products and services in terms of regression equation and R square, fixed basis index for showing the growth rate on the studied period, comparison method, illustrations in tabulated results and suggestive graphics. By analyzing case studies and current trends, the current research provide insights for enhancing economic efficiency, sustainability, and competitiveness in the agricultural sectors.

Key words**:** *agriculture, value chains, global markets, European Union, Romania, agribusiness, supply chain management, sustainability, digitalization*

INTRODUCTION

Value chain is a common term in business management, and was first defined by Porter in 1985 "as a multitude of activities that a company caries out in order to deliver products and services to the final consumer" [17, 22].

The concept of value chain is widely recognized as a strategic development framework at global level. Various definitions of the network of relationships within a value chain are found in the literature, allowing for discussions on sectoral or technological value chains [14]. Other authors considered that: "Value chain is an operational model for the sustainable development through economic advantages. It is a way in producing, marketing, buying and selling different products by providing integrated capital, access to various networks,

markets, innovations, knowledge and technologies".

It shows the long way of a product from its conception till its delivery to final consumer and then its recycling after use. In agriculture, it shows how from a natural resource a product arrives from "farm to fork" [3, 4, 5].

Theoretical sources distinguish between different levels of value chains.

These include an industry value-added chain at the micro-level [17], an industry value chain at the meso-level [10], a global value chain at the macro-level and a technological value chain that integrates the micro and medium levels. Unique insights into value creation processes are offered by each of these perspectives.

Both the micro and medium levels are items combined in the technological value chain framework, which suppose the involvement of the value chain of specific technologies and their interactions with other sectors.

This type of value chain has been explored in various studies along the years.

Strategic initiatives are useful for the companies' value chains, which have to redesign production involving logistics capabilities, marketing, sales, and service.

The role of value chains has to be better understood and new business models have to be created for assuring a more sustainable development [1].

The huge volume of information transmitted to consumers have contributed to the change of their purchasing habits and to a higher flexibility in manufacturing systems so that the producing industry is able to achieve a large variety of products to better satisfy consumer needs [20, 21].

The era of the digital economy involves the appearance of new technologies such as Big Data, Internet of Things, Cloud Computing, and Artificial Intelligence which offer support for global economic development [15].

This results in the creation of the concept of the "Big Data Value Chain," which is composed of a series of steps to generate value and meaningful insights from data.

The Big Data Value Chain encompasses the end-to-end process of data management, from data acquisition and storage to data processing, analysis, and the generation of actionable intelligence.

This holistic approach enables organizations to derive maximum value from the vast amounts of data being generated in the digital economy, allowing them to make more informed decisions, optimize operations, and drive innovation across various sectors. "The advances in Big Data and Big Data Value Chain, using clear processes for aggregation and exploitation of data, have given rise to what is called data monetization. Data monetization concept consists of using data from an organization to generate profit. It may be selling the data directly for cash, or relying on that data to create value indirectly." [9].

In agriculture, among the top high-tech innovations, wireless irrigation tools as well as the drones designing the crop mapping are not novelties any more [16].

In the developing countries, the strategy to develop an efficient value chain have to start with the identification of the major constraints such as: restrains to market access, weak infrastructures, lack of resources and institutional gaps. Then, it is need "to find solutions to add value, to create horizontal and vertical chain-network and value chain governance mechanisms" [18].

According to FAO, agricultural value chains have not only an economic impact, but also social and environmental effects which have to be known regarding their trends and challenges in order to find out policy options [7, 8].

In this context, this article investigates and presents the possibilities within agricultural value chains, taking a comprehensive view from international, European, and Romanian standpoints. Emphasizing the significance of effective value chain management, the exploration reveals how global and regional policies influence agricultural production and distribution. The international segment presented regards countries as China, USA, Japan, India, the EU segment regards all 27 countries taking as driven force Germany and Romania as emerging country that adapts at global conditions regarding the agriculture sustainability, value chain management,

adopting circular economy and digitalization in all the processes.
The article also presents the trade for raw materials contributing at high-tech goods and services production.

MATERIALS AND METHODS

For setting up this study the literature in the field was approached in order to create the scientific information background.
The ideas coming from other authors have been evaluated in a critical logical manner and also the authors own opinions have been sustained.
In the study structure the main ideas are presented in a logical manner emphasizing the core of the problems.
In order to analyse the significance of the value chain as a strategic initiative for companies, we conducted a study using the Scopus and Google Scholar data base where the term 'value chain' appeared in article titles, abstracts, or keywords a total of 29,042 times (as of September 29, 2023).
The focus on sustainability policies within value chains underscores the drive for efficiency across economic, social, and environmental dimensions.
Achieving a balance among these aspects and their interdependencies necessitates the adoption of suitable business models that facilitate the seamless integration of functions, technologies, companies, or industries to support sustainable operations.
In the paper structure there were presented the following aspects:
-Value chain of raw materials;
-Production and trade of high-tech goods and services at international level.
The data were collected from Eurostat data base and graphical and tabled representation have been done for a better understanding.
The data series reflected the dynamics of the main indicators in the period 2013-2022.
The analysis emphasizes the trends in the production and commerce with high-tech goods for main sectors and for agriculture field.

RESULTS AND DISCUSSIONS

Value Chain of Raw Materials

Raw materials have historically served as the backbone of economies and the catalyst for their advancement over centuries. Countries endowed with abundant natural resources have often influenced development trajectories and wielded significant influence in the realm of international relations.
In the contemporary world, it is a challenge to effectively manage available resources by considering the entire lifecycle encompassing their extraction, processing, utilization, and disposal. In the age of the green economy and conscientious business practices, environmental and social considerations are inherently intertwined. Within such a comprehensive framework, the creation of value, its origins, and its beneficiaries all play critical roles.
The mix of economic, environmental, and social interests significantly shapes activities related to exploration, mining, processing, and distribution. This interconnectedness within the value chain, embracing the principles of a circular economy.
The utilization of raw materials across various technologies underpins their development and underscores the significance of raw materials amidst the challenges posed by innovative corporate and field strategies. The diverse array of industries reliant on raw materials are in danger because of low supply of these materials.
The primary sectors - Renewable Energy, Electric Mobility, Defence and Space - that rely on cutting-edge technologies, which are in turn enabled by the utilization of raw materials. Critical raw materials, in particular, hold substantial importance as their procurement becomes a pressing concern, particularly given the increasing demand driven by energy transition initiatives, autonomous vehicles, electric mobility, space exploration, and global militarization trends, with recent events such as those in Ukraine underscoring their significance.
The value chain of raw materials starts with the identification of primary resources, by exploring the environment, extracting the

resources from the Earth surface or from the depths, processing the materials by various industries using high technologies in accordance with the progress in science and techniques.
The raw materials are destined to be transformed into high value products which impose the design and then the implementation in the series production.
The obtained products must be used according to the preference of consumers and reused to continue their life cycle.
Across this long way, there are also obtained wastes which have to be collected and recycled according to the principles of the circular economy. A suggestive representation has been done by [12] as shown below in Table 1.

Table 1. The value chain of the raw materials according to the principles of the circular economy

1	**Exploitation of natural resources**
2	Extraction of natural material resources from mines and Earth surface
3	Processing of raw materials using various technologies
4	Raw materials ready to be transformed into products
6	Designing the products
7	Carrying out the production of the designed goods
8	Use and reuse of the products
9	Collection of used products and wastes
10	Recycling

Source: Adapted based on [12].

International trade and production of high-tech goods and services in the EU

The EU is among the major economic player in the international market, besides USA and China.
Its policies are focused on a continuous sustainable development for keeping its high position in the market.
At the EU level, the marketed production of high-tech products increased from €275 billion in 2012 to €355 billion in 2022 (Table 2).
In 2022, high-tech products accounted for 16% of the total imports into the European Union from countries outside the EU.
These imports encompassed a wide range of advanced technological goods such as electronics, machinery, pharmaceuticals, aerospace technology, and software.
Similarly, high-tech products comprised 17% of the total exports from the European Union to countries outside the EU during the same year.
This indicates that the EU is a significant exporter of high-tech products, showcasing its strength in innovation and technological capabilities in various industries.
Regarding these sectors the evolution is positive for all of them, the increase in production of high-tech at global level, as well as at the EU level for this type of the goods and services.
The highest growth rate in the analyzed period was registered by pharmacy products (+54.9%), scientific instruments (+52%) and armament (+150%).
Important increases were also noticed in case of electric machinery (+37.5%), aerospace (+24.2%), electronics communications (+24%).
However, two economic sectors registered a diminished production, like in case of computers and office machines (-12.8%) and non-electrical machinery (-4.4%).
The balance of trade in high-tech products reflects the EU's participation in the global marketplace for advanced technologies and highlights the importance of these products in driving both imports and exports for the region (Table 3).
The data show that in the studied interval the imports value increased by 90.6%, the value of exports by +71.7%, and the trade balance passed from a positive value to a negative one in the last three years, 2020-2022, registering Euro Billion - 36.1.
In 2022, the export value accounted for Euro Billion 445.3 compared to Euro Billion 259.1 in 2012.
In the same year, the import value accounted for Euro Billion 481.3 compared to Euro Billion 252.4 in the year 2012.
The total trade value, increased from Euro Billion 511.7 in 2012 to Euro Billion 926.6, meaning a surplus by +81%.
The EU trade in high-tech products in the period 2012-2022 is shown in Fig. 1.

Table 2. EU total sold production of high-tech products by sector, 2012-2022

Econ sector	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2022/ 2012 %
Electronics communications	75	63	61	65	65	72	75	77	69	79	93	124.0
Scientific instruments	48	49	50	54	55	57	60	63	58	66	73	152.0
Pharmacy	51	52	51	58	59	62	79	85	97	76	79	154.9
Aerospace	33	42	45	43	50	54	45	51	36	40	41	124.2
Non electrical machinery	23	22	22	24	22	23	23	21	16	19	22	95.6
Computers and office machines	19	15	15	15	20	16	22	19	16	14	16	84.2
Chemistry	16	15	16	16	16	15	15	13	14	15	16	100.0
Electrical machinery	8	8	7	8	8	9	10	9	9	10	11	137.5
Armament	2	3	2	2	3	3	3	4	4	4	5	250.0
Total	275	270	271	286	301	311	332	342	320	322	355	129.0

Source: Eurostat, 2024, Sold production, exports and imports, https://ec.europa.eu/eurostat/databrowser/view/DS-056120/legacyMultiFreq/table?lang=en, Accessed on May 10, 2024 [5].

Table 3. The export, import, trade balance value and total trade value in the EU, in the interval 2012-2022 (Euro Billion)

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2022/ 2012 %**
Imports	252.4	243.2	249.1	294.1	301.1	331.7	347.7	364.4	346.5	393.5	481.3	190.6
Exports	259.2	260.4	266.5	301.0	307.7	332.2	348.0	381.6	341.9	384.8	445.3	171.7
Balance	+6.8	+17.2	+17.4	+6.9	+6.7	+0.5	+0.3	+17.2	-4.6	-8.7	-36.1	-530
Total Trade	511.7	503.5	515.6	595.1	608.8	663.9	695.7	746.0	688.5	778.3	926.6	181.0

Source: Eurostat, Comext data base [6].

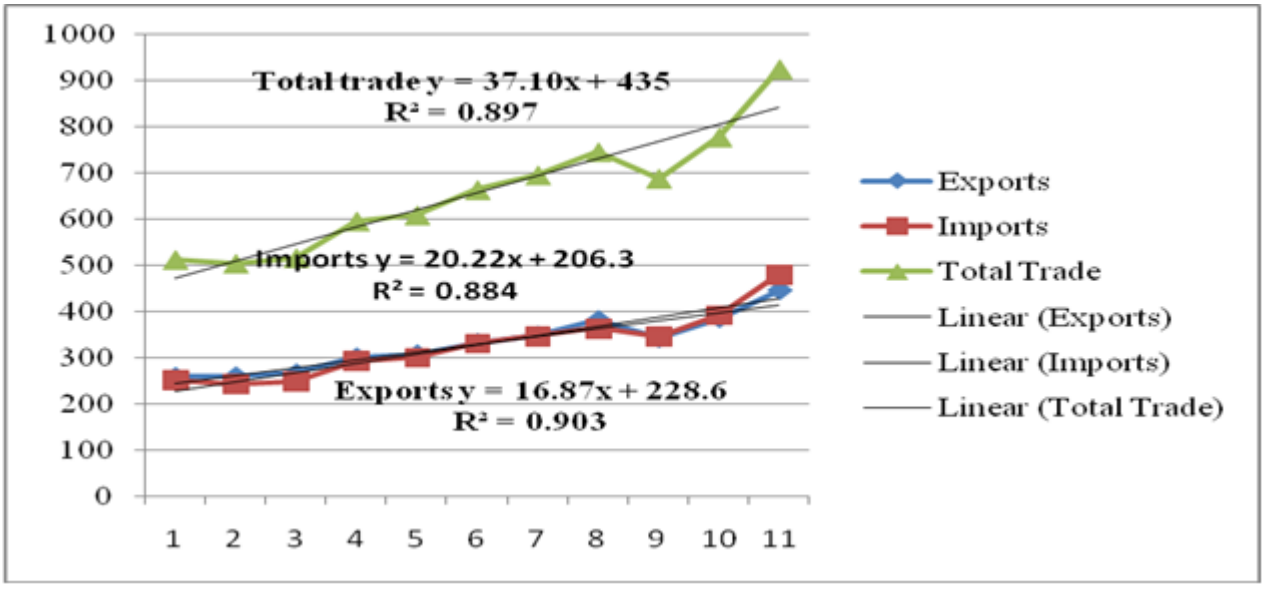

Fig. 1. The EU trade: Exports, Imports, Total trade in high-tech products in the period 2012-2022 (Euro Billion)
Source: Own design and calculation based on Eurostat, Comext data base [6].

Raw materials and high-level goods and services in non-EU countries

The situation is shown in Table 4.

We may easily notice that the both raw materials and high-tech products and services increased in the interval 2013-2022 both in the USA and in Germany.

Moreover, the high-tech products and services have a triple value compared to raw materials

highlighting the value added created in the production process.

Table 4. Exports of raw materials and high-level goods and services in USA, CHINA and GERMANY (in trillions of USD)

	usa export of raw materials	usa export of high-level goods and services	china export of raw materials	china export of high-level goods and services	germany export of raw materials	germany export of high-level goods and services	japan export of raw materials	japan export of high-level goods and services	india export of raw materials	india export of high-level goods and services
2012	0.54	1.48	0.72	1.50	0.58	1.18	0.11	0.65	0.23	0.28
2013	0.56	1.41	0.75	1.46	0.61	1.16	0.12	0.62	0.25	0.29
2014	0.56	1.46	0.79	1.58	0.62	1.24	0.13	0.64	0.27	0.3
2015	0.45	1.34	0.71	1.56	0.53	1.31	0.11	0.61	0.24	0.29
2016	0.41	1.30	0.63	1.47	0.49	1.30	0.1	0.6	0.23	0.28
2017	0.46	1.39	0.66	1.60	0.51	1.46	0.11	0.63	0.25	0.3
2018	0.52	1.57	0.75	1.75	0.53	1.52	0.12	0.67	0.28	0.32
2019	0.46	1.53	0.71	1.79	0.47	1.53	0.11	0.68	0.26	0.33
2020	0.37	1.32	0.66	1.93	0.39	1.42	0.09	0.65	0.22	0.31
2021	0.52	1.68	0.80	2.56	0.47	1.50	0.1	0.68	0.25	0.34
2022	0.63	1.88	0.87	2.72	0.50	1.61	0.11	0.7	0.28	0.37

Source: Authors' own concept based on the data from World Bank's WDI database [23] and UN Comtrade database [19].

The dynamics in raw materials trade (export) in the non-EU countries for USA, China, Japan, Germany and India, are shown in Fig. 2.

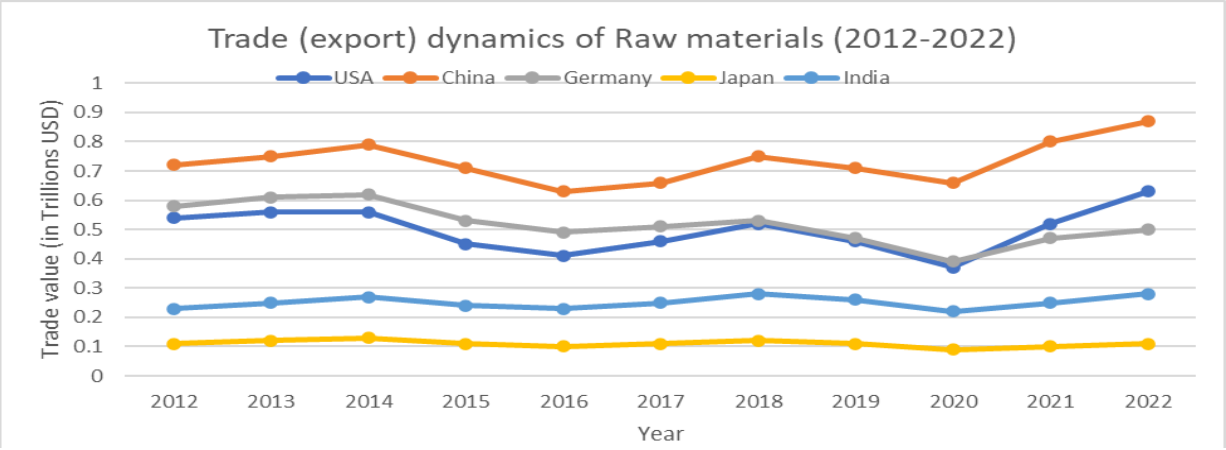

Fig. 2. Trade (export) dynamics of Raw materials in non-EU countries, 2012-2022 (USD Trillion)
Source: Authors' own concept based on the data from World Bank's WDI database [23] and UN Comtrade database [19].

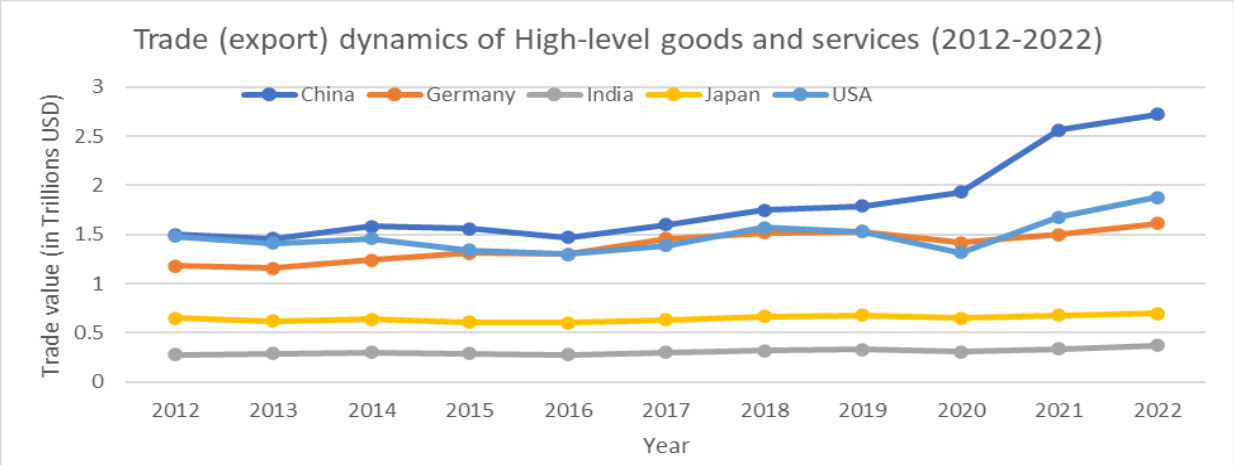

Fig. 3. Trade dynamics of High-level goods and services in non-EU countries, 2012-2022 (USD trillion)
Source: Authors' own concept based on the data from World Bank's WDI database [23] and UN Comtrade database [19]

In Fig. 3 it is presented the dynamics in high-tech goods and services trade (export) for the same countries included in the category in the non-EU countries.

The data from Table 4 and Fig. 2 and 3 show us the situation of each non-EU country in the trade with raw materials and high-level products and services.

United States: while the US maintains a significant volume of raw material exports, its export growth in high-level goods and services has been more pronounced, showcasing a shift towards a more knowledge-based economy and technologically advanced sectors.

China: has experienced the most substantial growth in both raw material and high-level goods and services exports, demonstrating its increasing dominance in global trade and its growing capacity for manufacturing and innovation.

Germany: trade patterns show a balanced approach, with a relatively stable volume of raw material exports and a steady growth in high-level goods and services. This underscores the country's established strength in manufacturing and engineering, while also highlighting its increasing focus on higher-value exports.

Japan: export profile is similar to Germany's, with a consistent level of raw material exports and a gradual increase in high-level goods and services. This suggests a focus on technological innovation and advanced manufacturing, mirroring Germany's strategy.

India: India's export trends indicate a developing economy with growing capabilities. While both raw material and high-level goods and services exports have increased, the growth in high-level goods and services has been more notable in recent years. This suggests a shift towards more value-added sectors as India's economy matures.

The analysis of these trends indicates that China has seen the most remarkable growth in exports, particularly in high-level goods and services, solidifying its position as a global trade powerhouse.

Romania's value chains

In Romania, the economy has traditionally been oriented towards sectors that involve processing raw materials, such as the agricultural sector, the mining sector, the metallurgical industry, or the textile industry. These sectors have been important for the economy, but in recent years, the country has started to diversify its economy and shift towards high-tech products and services.

Raw materials have played and continue to play a significant role in the Romanian economy, as the country has various natural resources, such as fertile land for agriculture, mineral resources (such as natural gas, coal, oil, metals), rich forests, etc. The traditional sectors based on these raw materials have contributed to Romania's economic history and have been important for exports.

On the other hand, the high-tech sector has experienced significant growth in recent years in Romania. This sector includes products and services based on advanced technologies, such as IT, software, electronics, telecommunications, research and development, artificial intelligence, technology consulting services, etc. Companies in this sector bring innovation, added value, and economic growth opportunities.

Romania has started to become a leading name in the IT industry and technology services in Eastern Europe, with an increasing number of high-tech companies and startups making their presence felt in the global market. Investments in education, research, and innovation have contributed to the development of this sector and to transforming Romania into a technological hub in the region.

Therefore, Romania is in a transition process from an economy based on raw materials to one focused on high-tech products and services, also circular economy, seeking to leverage its potential in the technology field and to adapt to the requirements of a digital and globalized economy.

Value chains in agriculture

The agriculture sector and all the structural changes in the latest period, that involves the introduction of the digitalization and technology in this field.

The 3 directions to study the value chains in

agriculture identified in the latest period are:
(1) The trend of the global trade and value chains –this has an important role in shaping the value chains in agriculture, impacting production, distribution, and market access worldwide.
(2) Technology and innovation - have revolutionized agricultural value chains, improving efficiency, sustainability, and product quality.
(3) Market dynamics and consumer demand - Understanding consumer demand and market dynamics is essential for developing robust agricultural value chains that meet global market needs.
In agriculture, value chain is a sum of activities along the stages in which a raw material is transformed in its final form ready to be consumed and then to be disposed after use, reflecting the value added at each stage.
Agricultural production requires a long range of stages depending on crop type and animal species, genetic material and its productive potential, farms inputs (seeds, fertilizers, pesticides, fuels etc), farmer's knowledge, training level and experience, production technologies, post-harvest activities (collection, transportation, storage, grading, cooling, packing), industrial processing, storage, transport, finance, and feedback from beneficiaries [2].
Therefore, in agriculture, value chain consists of the following parts: input supply, production, primary processing, secondary processing, distribution and retailing.
The detailed activities suitable for each part or phase are shown in Table 5.

Table 5. The main parts of the value chain in agriculture

No.	Part	Details
1	Input supply	Seeds, fertilizers, pesticides, machinery, fuel etc
2	Production	Crops growing and raising animals
3	First processing	Cleaning, sorting, grading, and packaging agricultural products
4	Second processing	Transforming raw materials into products suitable for consumption
5	Distribution	Transportation of the products to wholesalers, retailers or consumers
6	Retailing	Selling products to consumers

Source: Own conception.

The sector of agriculture has its specificity and the value chain has to be approached in a different way than in other economic fields.
First, the farmers need to assure the farm inputs, which means: seeds of high quality, preferable certified seeds with a high genetic potential, fertilizers for strengthening soil productivity, pesticides for plant protection against various pests and diseases, machinery for making the agricultural works etc.
Secondly, the farmers apply the specific technologies in crop production and in animal production, adapted to the soil and climate conditions, varieties and hybrids, animal species, categories, breeds and cross-breds etc
Thirdly, the agricultural products are supposed to various processing technologies depending on the purpose to attain the final product. For instance, in the field of vegetable growing, the products must be cleaned, sorted, graded and packaged. In the field of dairy farms, milk is milked by milking machines in the parlours, transported in the milk tanks where it is stored at a low temperature (4^0 C), and then collected by the dairies, after testing milk quality according to the standards.
Then, the raw materials have to be transformed into consumable products. In general, at the farm level, this is not possible in the most of farms. But in the integrated farms it is possible to process the raw materials. For instance, in a vinery, it is possible to transform grapes in must and wine, in a dairy farm it is possible to process milk in cheese, butter and ice-cream.
After these steps, the marketing and distribution of the products means to apply the shortest ways as the product to reach the consumers. Taking into account that the majority of the agricultural products are perishable, they have to arrive at the consumer in the shortest period of time. Direct deliveries are preferred, except some cases when the products are delivered to wholesalers and retailers. During the Covid-19 pandemic, direct deliveries of agricultural products to consumers have started to be successfully extended. In this way, the farmers could create a panel of consumers who prefer their products. Taking into account the climate change effects, the practice of monoculture

and the intensive use of fertilizers and pesticides in agriculture is not suitable anymore because this affect biodiversity, soil health, intensify pollution and increase the risk in food systems. To develop a sustainable agriculture, it is needed to pass to crop diversification and to assure an efficient crop rotation [18]. In food industry, things look to be more complicated in accordance with HCCP and many processing standards.

For in dairy industry, the value chain involves: milk production in dairy farms, milk collection, reception of raw milk, analysis of milk quality, pasteurization process, regulation of fat content, processing in various dairy products (butter, sour cream, cheese, yoghourt, ice-cream etc), storage, distribution, retailing (supermarkets, restaurants, hotels and export) [11].

[13] developed a study case which showed how could be created value added in peas chain for sustaining production destined for export.

Leaving from these steps in value chain the main influence factors are policies, sustainability and standardization.

A comparison of the three levels of our analysis International, European and national (Romania) is presented in Table 6.

Table 6. Comparative analysis regarding value chain

Level	**Policy**	**Sustainability and environmental impact**	**Standards and certifications**
International	Efficient international trade, agriculture and innovation policies	Transportation of the goods	Adhering to international standards and certifications for agriculture
European	Alignment of all the members	Sustainable farming, Biodiversity protection	Adhering to European standards and certifications for agriculture
National (Romania)	Investment Policy, Export policy – both for agriculture	Sustainable practices	Adhering to European standards and certifications for agriculture

Source: Authors' own concept.

Challenges and opportunities in agricultural value chains

I. Economic challenges – are related to market fluctuations and price volatility, present significant economic challenges in agricultural value chains, impacting profitability and financial stability; Access to finance and credit that is the key to invest in agriculture; Trade barriers and tariffs that create increased transaction costs within agricultural value chains; Economic opportunities thorough diversification of products and markets.

II. Technological advancements

Adoption of precision agriculture - The adoption of precision agriculture technologies presents opportunities for increased efficiency and productivity in agricultural value chains, contributing to sustainable practices.

Innovations in agri-tech - Continuous innovations in agri-tech offer opportunities to enhance production, processing, and distribution capabilities within agricultural value chains, fostering competitiveness.

Challenges in technology adoption - Challenges in technology adoption, such as high initial costs and limited digital infrastructure, hinder the realization of technological opportunities within agricultural value chains.

Potential of blockchain and IoT -The potential of blockchain and IoT presents opportunities for improved traceability and transparency in agricultural value chains, addressing consumer demand for quality and sustainability.

III. Sustainability and Resilience – refers to environmental sustainability, resilience to climate change, social sustainability and circular economy.

IV. Policy and Regulatory Frameworks - Government support and subsidies; Compliance with food safety standards; Policy coherence and alignment; Trade agreements and geopolitical influences.

V. Supply chain management.

Figure 4 highlights the phases of the supply chain management.

Fig. 4. Supply chain management

Source: Authors' own concept.

Future trends in agricultural value chains

Integration of IoT and AI in agricultural processes

-*IoT and AI technologies* are being integrated into various agricultural processes to enable data-driven decision-making, optimizing resource utilization and increasing yields.

-*Utilizing big data for predictive analytics* - The use of big data allows for predictive analytics, helping farmers and agribusinesses to anticipate market trends, manage risks, and optimize supply chain logistics.

-*Blockchain for transparency and traceability* - Blockchain technology is increasingly used to create transparent and traceable supply chains, enhancing consumer trust and ensuring the authenticity of agricultural products.

-*Precision agriculture for enhanced efficiency* - Precision agriculture techniques, such as GPS-guided machinery and drone technology, are revolutionizing farming practices, leading to more efficient use of resources and reduced environmental impact.

-*Robotics and automation in farming* - The adoption of robotics and automation in farming operations is increasing, leading to improved efficiency, reduced labor costs, and enhanced productivity in agricultural value chains.

-*Biotechnology and genetic engineering* - Biotechnological advancements and genetic engineering are reshaping agricultural production, offering solutions for pest resistance, improved crop quality, and higher yields.

-*Vertical farming and urban agriculture* - Vertical farming and urban agriculture initiatives are gaining momentum, leveraging advanced technologies to produce food in urban environments, reducing transportation costs and environmental impact.

-*Remote sensing and satellite imagery* -The use of remote sensing and satellite imagery provides valuable insights for monitoring crop health, detecting pests, and optimizing resource allocation in agricultural value chains.

Blockchain Applications in Agricultural Value Chains

Traceability platforms: consumers can scan a QR code and see the journey of their food product. This increased transparency can build trust with consumers and potentially lead to higher demand for Romanian agricultural products.

-*Smart contracts*: automate payments and other processes based on predetermined conditions. This can eliminate unnecessary paperwork and administrative burdens for Romanian farmers, allowing them to focus on core agricultural activities.

-*Microfinance:* facilitate access to financing for smallholder farmers in Romania.

This can help them overcome the challenge of limited access to traditional financial institutions and empower them to invest in improvements for their farms

CONCLUSIONS

The aspects discussed in the scientific paper are the result of many studies from technical and economic point of view and reveals the problems and the advances in trade with raw materials and high- tech products.

Collaborations between different sectors, such as agriculture, technology, and finance, are driving innovation for sustainable solutions, addressing challenges related to food security and environmental sustainability.

Public-private partnerships are playing a key role in driving agricultural development, facilitating investments in infrastructure, research, and capacity building to enhance the efficiency of value chains.

Knowledge exchange and capacity building initiatives are fostering innovation and skill development within agricultural value chains, empowering stakeholders to adapt to evolving market trends and technological advancements.

Initiatives aimed at supporting smallholder farmers and rural communities are essential for fostering inclusive growth within agricultural value chains, promoting economic development and social well-being.

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