Chapter

International Cooperation for Smart and Sustainable Agriculture

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Abstract

This chapter presents international best practices, realized within Europe, and focuses on cooperation for developing innovation support mechanisms and approaches in the area of smart agriculture. Specific situations are presented and analyzed in detailed regarding the requirements of smart agriculture and the possibilities to implement its percepts. As a consequence, solutions are proposed both in the technical and management domains to help speed up the transition from classical agriculture techniques to technology infused approaches, suitable for the current needs of this sector. Also, policy recommendations are developed based on the scientific findings in alignment with the evolution of the competitive pressures.

Keywords: smart agriculture, international cooperation, Danube region

1. Introduction and state of the art

Economic development sits at the crossroads of two megatrends that are developing fast and are ready to change the way human societies think and act about the future. One of these is sustainable development that attempts to change models, approaches, and cultures to balance the competitive impetuosity with the needs and limitations of the supporting ecosystems, while the other is the digital transformation (a.k.a. the smart revolution) which means fast, independent, and ubiquitous computers and electronic device processing large amounts of data continuously. Although these axes are very visible in manufacturing (e.g., Industry 4.0), automotive, consumer electronics, and even e-government, they are also present to a large extent in the field of agriculture and rural development, and they have an even more clear impact here because many areas of these sectors are a bit left behind in terms of development especially in developing countries. This is also the case in Central and Eastern Europe which came out of the communist period with an outdated agriculture that relied on mechanization and chemical products rather than biosciences and ecologically sound approaches. Moreover, the necessary process of restoring property rights further leads to de-evolution as small landowners had to gain technical and financial proficiency in order to rebecome competitive after a few decades.

This chapter deals with developments in smart agriculture cooperation in Romania and Slovakia, two countries that used to be part of the Eastern Block and faced similar but also specific challenges and which are now finding a new identity as part of the Danube macro-region coordinated and financed by the European Union (EU). The cross-cultural links among west and east along the Danube river are very good premise for establishing cooperation in the area of innovation support to help revitalize the agricultural sector in the 12 countries involved.

Scientifically speaking, smart agriculture is a trendy topic with significant developments being published in the last years. We will focus our next analysis on the situation in Europe, Romania, and Slovakia, addressing some important contributions both in the technical domain and in the economic one (**Table 1**).

Of course, this presentation is not exhaustive due to space limitations and a focus that does not include all the scientific disciplines connected with smart agriculture (e.g., chemistry, materials science, biotechnology, etc.). Its role is to provide an overview of the landscape that hosts the approaches described below in which the authors have been directly involved.

Scientific content	Type of contribution	Geographic scope	Source
Data mining study of 17,700 papers that shows the position of Europe as lagging in precision agriculture research and identifies a progression from topics related to crop management toward sustainability and sensorics	Literature review	Global/Europe, Italy	Pallottino et al. [1]
Investigation of technical approaches to machine learning applications in the areas of crop, livestock, water, and soil management, underlining their importance for future full-scale artificial intelligence deployment	Literature review	Not defined/global	Liakos et al. [2]
State-of-the-art study on the role of big data approaches for the development of smart farming, including closed vs. open access models	Literature review	Not defined/global	Wolfert et al. [3]
Development, testing, and performance review of an online cloud-based platform for small smart farm management	Practical achievement	Romania	Colezea et al. [4]
Case study on image processing of satellite photography for determining land destination and testing of the accuracy of the method	Practical achievement	Romania	Herbei et al. [5]
Solution building for a cyber-physical system that provides real-time monitoring and intervention in supervising potato cultivated fields	Theoretical study	Romania	Rad et al. [6]
Economic and environmental benefits of implementing precision techniques for the use of pesticides in crop management	Theoretical study	Hungary, Romania, EU	Takács-György et al. [7]
Creating dataset maps through data fusion in order to support the scenario-based policy interventions, with possible applications in agriculture	Practical achievement	Slovakia	Pazúr and Bolliger [8]
Algorithmic intercountry parallel investigation of the performances obtained by company processing agricultural products	Empirical study	Czech Republic, Slovakia	Čechura and Malá [9]
Mode of employment, results analysis, and improvement opportunities related to employing precision agriculture solutions	User survey	Five countries in the EU	Barnes et al. [10]

Table 1.
Comparative analysis of sustainable development scenarios.

2. Current situation of smart agriculture in Europe

The European Union and to a larger extent all the countries of Europe, as they have strong ties to the union, are searching for a pathway to competitiveness for a long time now. First came the Lisbon Strategy, then the Europe 2020 Strategy, and now the Future of Europe toward 2030 is being discussed. These fundamental guidelines helped maintain Europe on a strong development course in terms of economic growth, social inclusion, and competitiveness through troubling times like the 2008 financial crises and significant structural transformation like Industry 4.0. In all these documents, the issues of environmental accountability and efforts to protect the diversity of European ecosystems have been in the spotlight, constituting a signature trait of the union in the international arena. On the operational plane, sectoral strategies for agriculture and bioeconomy have been developed in the past years that include the concept of "smartness," thus fostering the appearance of smart and precision agriculture policies, funding instruments, technologies, solutions, and implementers. The support for this approach has led to the development of a competitive agricultural sector while at the same time ensuring the protection and safeguarding of the environment. This easily noticeable within the European Innovation Partnership "Agricultural Productivity and Sustainability" initiative acts as an innovation highway between EU's rural development programs and research and development programs and their associated stakeholders [11].

The main goals and directions of intervention of the EU bioeconomy strategy are summed up in **Figure 1**.

The three main axes are targeting sea and oceans, the replacement of fossil fuels and resources with bioresources (i.e., that can be grown), and the food and energy security of European citizens. Agriculture plays an important role as the source for many of the raw materials needed to implement these changes. Also, it is in its turn affected by the need to reduce the water footprint and the usage of fertilizers, while at the same increasing the yields and the quality of agricultural products. There are multiple ramifications to finding solutions relating to these issues, with smart and

Figure 1.
EU's approach to bioeconomy [12] (figure adapted by the authors).

precision agriculture dealing with some of them, while genetic engineering and circular economy are also forces to be reckoned with.

The future common agricultural policy (CAP) 2021–2027 has nine objectives that will reshape the sector within the European Union in the next 7 years (**Figure 2**):

Most of these priorities can benefit from the implementation of smart agriculture-based approaches in terms of sensors and precision guidance of agricultural equipment, Internet of things (IoT), and cloud solutions for infield interventions and ubiquitous computing and big data analytics for optimization and waste reduction in the production and processing stages.

Among the component structures of the Standing Committee on Agricultural Research at European level (SCAR), the strategic working group Agricultural Knowledge and Innovation Systems (AKIS) had been working for almost a decade on developing policy recommendations for supporting innovation frameworks in bioeconomy [14]. These guidelines will become part of the CAP strategic plans addressing the above-mentioned priorities and are expected to further boost the competitiveness of the agricultural sector in Europe.

In most Central and Eastern European countries, the implementation of smart agriculture is still developing, although some interesting solutions (e.g., anti-hail rockets launched based on computerized weather forecasts) are implemented and coexist with traditional farming methods. In our studied case, Slovakia can be considered a good practice for Romania, with important smart agriculture solutions being deployed on a considerable scale. This makes the domain ready for a massive influx of know-how, which can only come from a wide geographical area (e.g., the Danube region) and that will have significant impacts in the early stages of the digital transformation.

Figure 2.
EU's priorities for agriculture [13] (figure adapted by the authors).

Although other European countries are more advanced and have had for decades an industrialized agricultural sector, they are also facing important challenges in implementing smart approaches. As part of the effort to increase the trust of consumers, especially in the new bio- and eco-products as alternatives to the mass production of foodstuff, there is considerable contribution that can be made by the use of smart devices and software to process data and monitor agricultural production and product parameters. Mass implementation of such measures is desired by the customers and can be achieved faster in the new paradigm.

3. The Danube transfer centers network: a collaboration framework

The Danube transfer centers network (DTCN) has been growing strong since 2012 and has been an active participant in the field of technology transfer, innovation support, and transnational cooperation. It stems from a pilot initiative of the government of the state of Baden-Württemberg (federal state of Germany) implemented by Steinbeis Europa Zentrum (SEZ) and Steinbeis-Donau-Zentrum (SDZ) according the Steinbeis model in this domain, which is a success story on a national and European level. Starting with three pilot centers in Nitra, Novi Sad, and Cluj-Napoca, it has expanded through several cycles coordinated by SEZ to include centers in Bucharest (RO), Ruse (BG), Slavonski Hrast/Vukovar (HR), Maribor (SI), Pannon/Györ (HU), and Craiova (RO).

This very wide presence in the Danube region makes it a good choice for any stakeholders (companies on the one side and research institutions on the other side) to seek assistance in finding partners, solutions, or new project ideas to develop together. The network is predicated on the belief that transnational knowledge transfer is one of the main keys of sustainable development, economic growth, and social inclusion [15] and that the Danube region, due to its dimension and diversity, can be a good practice model for the entire European Union.

The network has developed an important online presence, and the platform www.dtcnetwork.eu hosts both presentation pages for the centers and links to instruments and tools for training, communication, and project management. The most important tool developed in-house by the Danube transfer center (DTC) Cluj-Napoca within the Interreg-DTP project "Made in Danube" is called Danube Transnational Innovation Cooperation (DTIC) and is full online system for partner matching and innovative project development from idea to results. It is available free of charge at this address, http://www.muri.utcluj.ro/tin-etool/index.php?page=login, and is operational for more than 1 year already (see **Figure 3**).

Due to the nature of the Danube region, specifically focused on the river and its related ecosystem, as well as due to the characteristics of the projects undertaken so far in common, the DTCN has developed a focus on eco-responsible innovation with preoccupations for bioeconomy, renewable energy, and international outreach toward the Eastern partnership countries and Western Balkan countries. Agriculture and food production are integral parts of this approach, and the need for smart agriculture solutions has become more noticeable over time, in conferences, bilateral talks, or DTIC platform searches.

DTC Cluj-Napoca, where three of the authors of this chapter are active, has a networked structure in itself and includes offices that activate in four universities in the city of Cluj-Napoca (the technical, the social and natural, the medical, and the agricultural ones), and one university (a comprehensive one) in the city of Sibiu. This creates multiple opportunities for interdisciplinary contacts among scientific disciplines and research areas, including modern agriculture and modern technology. The fourth author leads the Union of Slovak Clusters and is in close contact

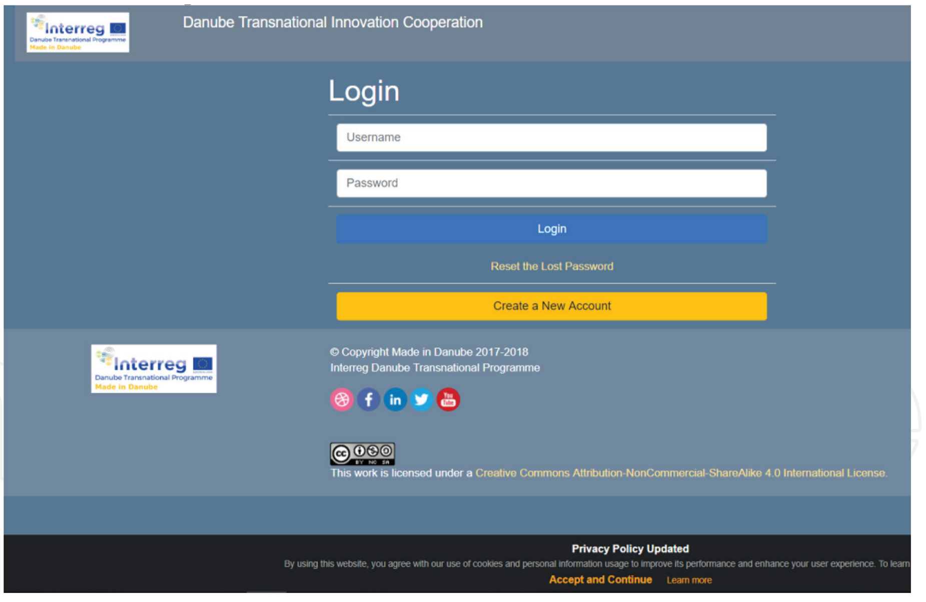

Figure 3.
Login interface of DTIC [16].

in the city of Nitra with the national agricultural university there which also hosts DTC Nitra, thus bringing into the current contribution an international perspective on the same topic.

Besides establishing innovation and technology transfer relations among their stakeholders, the DTCs in the network also undertake activities on a local scale or collaborate with each other on larger projects, usually with European or Danubian profile. Among the main activities on the network level, we can mention the following:

- Cooperating in European research, development, and innovation projects funded by EU's framework programs
- Cooperating in transnational framework and policy development projects financed by EU's interregional programs
- Participating in associations, clusters, and networks with thematic and sectoral characteristics in other countries than the host one
- Maintaining a consistent image, a common or aligned web, and social media presence to project the scope of the collaboration
- Organization or participation in common to relevant events in the macro-region: the annual forum, brokerage events, conference, workshops, etc.
- Exchange of good practices, experts, and know-how in the form of visits, trainings, bilateral projects, and development of specific competence centers in line with smart specialization strategies and needs

All these elements contribute to developing a stronger network that is also oriented toward territorial and content-wise expansion to match the true development potential of the Danube region, which is judged by all those involved to be considerable and with a long-time halo. In this respect, there are also many challenges to face in the present and the future. Some of those identified so far are presented below:

- Distinct cultural approaches to international cooperation and the inclusion in the region of EU and non-EU countries, with different relations to the so-called European project and obvious language differences
- Large economic, infrastructure, and development disparities which bring about significant differences in terms of needs, interests, and preoccupations regarding research and innovation of all stakeholders
- A "digital divide" with high penetration and low speeds in the West and low penetration and high speeds in the East
- Differences in legal and accounting systems that make collaboration difficult and time-consuming, especially in bureaucratic grants and projects

4. The "Made in Danube" project approach

The "Made in Danube" project (full name "transnational cooperation to transform knowledge into marketable products and services for the Danubian sustainable society of tomorrow") is currently being implemented (time frame 2017–2019) with financing from the Interreg-Danube transnational Program (project code DTP1-1-072-1.1) and involves seven of the DTCs active in the Danube region, being focalized on supporting the development of bioeconomy in this area of the continent through innovation and technology transfer policies and instruments. The outputs and results of the project reflect the contributions of the partners toward researching and supporting this emerging economic sector, with demonstrators proposed on three directions, each in a different country [17]:

- Smart and innovative precision farming—implemented in Nitra, Slovakia
- Competence Center in Wood Sector—implemented in Vukovar, Croatia
- Biofuels—implemented in Novi Sad, Serbia

The project has a total of six workpackages (**Figure 4**), with the Technical University of Cluj-Napoca being in charge of the one aimed at developing new tools in instruments and the Union of Slovak Cluster contributing to the pilot local action plan implementation in Nitra that deals with innovative precision farming, in partnerhsip with the Slovak University of Agriculture [18]. Thus, these two entities have expanded their collaboration on the topic of smart agriculture that started within the DTCN, with the DTIC platform (developed by TUCN) playing an important role in the activities carried out as part of the Slovakian pilot initiative.

The project aims to bring together all relevant actors working in bioeconomy in the macro-region (companies—especially small- and medium-sized ones, professional networks, universities, research institutes, nongovernmental organizations, public authorities at local and national levels, experts, and the general public) and to perform the scanning and cross-referencing of strategies, policies, and other programmatic documents to contribute in the future the better alignment of interests and initiatives. The web platform, the direct technology transfer instruments, and the training materials represent the main vehicle through which changes are being designed in line with state-of-the-art concepts and approaches related to innovation, before being deployed through the localized demonstrators and proposed as solutions on regional level to decisionmakers.

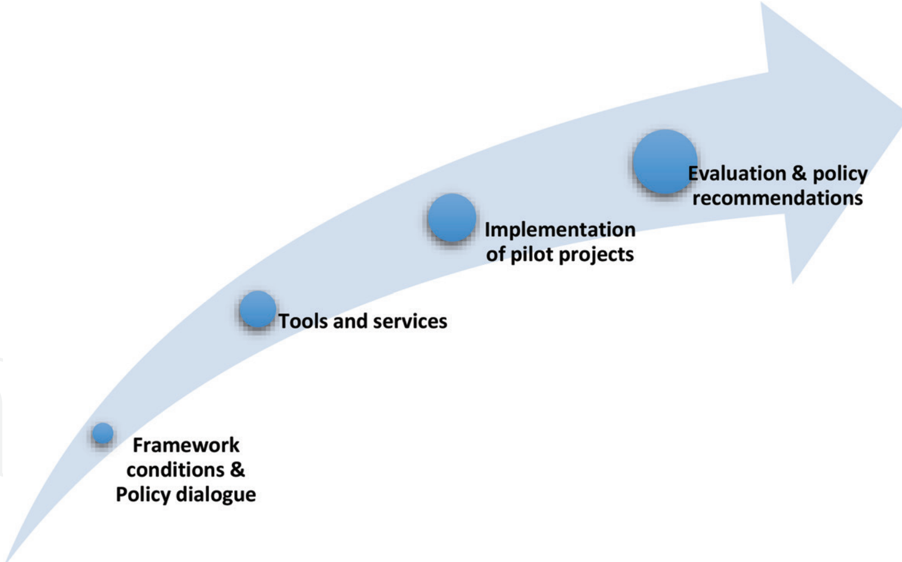

Figure 4.
Logical structure of "Made in Danube" activities [18].

5. Some results in smart agriculture

This section presents two contributions in which international cooperation, established with the help of the previously mentioned instruments, has contributed to better and faster smart solutions to be implemented in the farming sector.

The first project deals with developing a new type of tractor for a Romanian manufacturing company based on agricultural expertise from Slovakia and Internet of things expertise from Hungary. The main development themes set by the company for the new product lines dealt with the following topics:

- Following in a manned and semi-unmanned fashion precise working trajectories to ensure better yields
- A climate smart device with a lower carbon footprint than current tractors existing on the market
- Real-time data collection of information regarding soil and weather conditions to adapt the operations to the work conditions
- Ability to work under difficult conditions with ease

The product development process has followed a combined model, using elements of stage-gate and quality function deployment, with the documentation for production approaching finalization. **Figure 5** presents a summary of the deployment of requirements to product characteristics, identifying along the way the main subassemblies in relation to the agreed upon technical specification.

The chassis design and the fitting of the engine and powertrain were undertaken in Romania, the mobile sensor configuration and connectivity was designed in Hungary, and the adaptation of the device to agricultural best practices was achieved in Slovakia. This collaboration has been undertaken based on a cooperation agreement, with the three involved organizations sharing costs and risks in the same percentage as future sales of the product, should it be successful in the promising market [19]. The intellectual property rights have been mapped out from the beginning, and common authorship patents will be filed for the innovative elements.

The second project deals with a multinational team of scientist and experts from the Danube region and also from the UK and the USA involved in developing a total preventive maintenance model for automated screw conveyors used in grain silos. The product combines a mechanical structure with automation and sensorics that permit to start and stop according to the quantity and flow of the product that it has to transport. It is used for loading and unloading operations, in relation with trucks and human operators and, to a larger extent, in internal transport operations of the silos in order to achieve the rotation of stock and treatment operations upon the grains and for optimizing loads and usage of the storage spaces that form the facility.

The equipment operates mostly automatic, with manual control possible in case of override situations. Both the mechanical and the automation components require

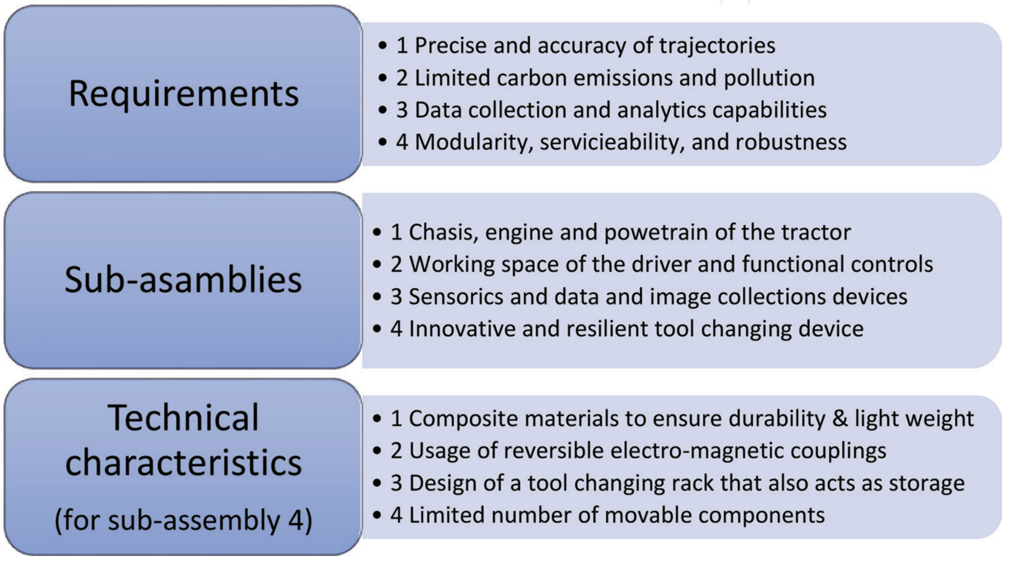

Figure 5.
Establishing the main smart tractor components.

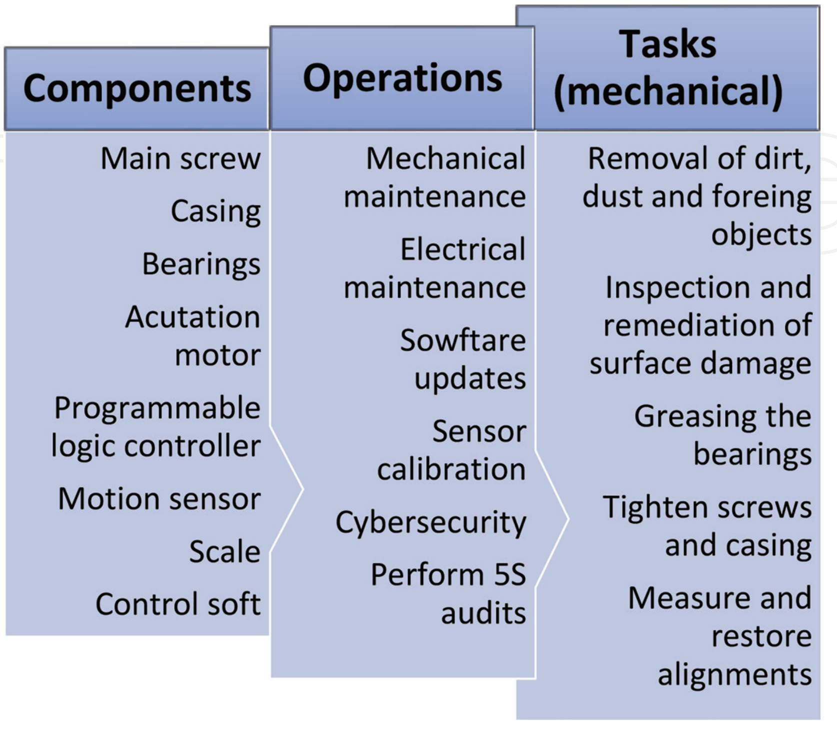

Figure 6.
Total preventive maintenance for an automated screw conveyor.

considerable preventive maintenance in order to remain in an operating condition inside the environment of the silos, which is characterized by high amounts of dust, large variation of temperature with the outside weather, and possible blockages when grains enter the conveyor components and get lodged. The total preventive maintenance (TPM) model is applied with the help of two maintenance teams. A maintenance program is applied through software, based on a risk management algorithm that determines the components most prone to breakdown, taking into account complexity and history of operation. The software permits the grouping and scheduling of operations and the recording of maintenance dates, including tasks performed and situations encountered in the field, as well as the generation of material list for supplementing the consumables and materials stock (measuring devices, bearings, controllers, plugs, grease, paint, etc.).

By implementing the smart conveyor instead of the classical version and by applying the total maintenance program on a silo with six conveyors (one for input and output from the building and five internal ones for moving and transporting the grains), the savings have been recorded to be over 6.5% of the total revenue per year, with a payback period of less than 3 years but an estimated active life (with proper maintenance) of cca. 15 years. **Figure 6** presents the main elements that can be incorporated in the total preventive maintenance strategy.

6. Connecting smart agriculture, bioeconomy, and sustainable development

In this chapter, we will present the analysis undertaken by the authors to determine possible contributions to sustainable development coming from modern approaches to smart agriculture and bioeconomy, based on the description of best practices in the Danube region. For this purpose, the well-known 17 sustainable development goals (SDG) proposed by the United Nations [20] are used as a reference frame. A qualitative description is presented in **Table 2**, and a quantitative approach, based on the binational expertise from Slovakia and Romania captured

UN SDG [20]	No change	Smart agriculture	Full bioeconomy
Goal 1: No poverty	Current economic models still have high levels of poverty and scarcity of resources	Subsistence farming in developing economies will become more productive	Considerable impact across agriculture, manufacturing, recycling, and energy production
Goal 2: Zero hunger	Hunger is still present in many locations on the globe due to economic and political factors	Better yields will drive market prices down and will ensure better access to food	More abundant and more nutritious food will become available
Goal 3: Good health and well-being	Existing development models cannot keep up with population growth and increasing needs	The need for chemical fertilizers and industrial farming techniques will be reduced	Besides agriculture and food production, cosmetics and pharmaceuticals can benefit from bioeconomy
Goal 4: Quality education	Education is not given enough priority especially in terms of accessibility	Some improvements can come about but are rather limited	Considerable research and innovation are needed, and education will have to change to meet demands

UN SDG [20]	No change	Smart agriculture	Full bioeconomy
Goal 5: Gender equality	The gender imbalance is changing slowly	There will be no additional contribution in this respect	More improvements should happen consistently
Goal 6: Clean water and sanitation	Industry, agriculture, and transportation contribute to massive water quality problems	Agricultural runoff and resource usage will significantly decrease, improving water quality	All economic sectors will produce less waste, pollution, and runoff that affect water resources
Goal 7: Affordable and clean energy	Fossil fuels play a major role in meeting the energy demands for economic development	Precision farming will generate more biomass and can also correlate with wind-/wave-based energy	There will be extra energy conservation by reusing processed materials and improving biomass yields
Goal 8: Decent work and economic growth	Economic growth is slow and worker salaries tend to not be sufficient for decent living	People in the agricultural sector can move onto services or other advanced sectors	Bioeconomy requires renewed industries for horizontal and vertical integration
Goal 9: Industry, innovation, and infrastructure	Current trends can be maintained, with a broad and diverse focus of innovation efforts	Agriculture and supporting domains will gain an innovation boost to implement precision farms	Implementing bioeconomy will require considerable R&D effort in fundamental and applied sciences
Goal 10: Reduced inequality	Income inequality among countries and inside countries is widespread	Some minor improvement will ensue due to the commoditization of food	Considerable entrepreneurship and innovation opportunities are to be expected
Goal 11: Sustainable cities and communities	There are considerable difficulties in ensuring a balanced social and economic development	Rural communities will become smaller and more technologically advanced, while cities will receive better products	Additional connections within and among communities will be necessary to ensure new value chains
Goal 12: Responsible consumption and production	Current consumption patterns are unbalanced and affecting ecological balances	An important component will be improved/reduced—food and bioresources (e.g., fodder, raw materials)	In a bioeconomy model, most materials and components are recycled and reused
Goal 13: Climate action	There are severe climate consequences to the current economic and industrial development	The contribution of agriculture to climate change will be reduced through process optimization	Bioeconomy is one of the keys to addressing climate change, but other policy and technology measures are also needed
Goal 14: Life below water	The health of the world oceans is severely affected by pollution and biodiversity reduction	Smart agriculture will reduce the ecological footprint upon ocean waters	Agriculture and manufacturing have less impact, but transport and overfishing remain
Goal 15: Life on land	The economic situation is still difficult for many countries and everyday life is affected for their people	Improvements will take place in terms of food quality and availability, but job opportunities in agriculture will be reduced	Quality of life under bioeconomy is improved in all relevant areas: nutrition, health, future prospects, etc.

UN SDG [20]	No change	Smart agriculture	Full bioeconomy
Goal 16: Peace and justice strong institutions	The UN and democratic states are working toward this goal, but many changes are still needed	There is a limited connection between better food and work options and institutional development	Changing economic balances and lifting countries out of poverty should improve peace prospects
Goal 17: Partnerships to achieve the goals	There are common efforts and cooperation initiatives being implemented	The impact on international cooperation is limited due to the constrains of the sector	New companies, regions and countries will develop in new directions, improving relations

Table 2.
Comparative analysis of sustainable development scenarios.

Criteria / New Concepts	1 Stay the course - No change	2 Smart and precision farming	3 Full scale circular bio-economy	Importance
2 GOAL 1: No Poverty	-	+	++	5,0%
3 GOAL 2: Zero Hunger	-	+	++	10,0%
4 GOAL 3: Good Health and Well-being	O	+	++	5,0%
5 GOAL 4: Quality Education	O	O	+	10,0%
6 GOAL 5: Gender Equality	O	O	O	5,0%
7 GOAL 6: Clean Water and Sanitation	--	+	++	5,0%
8 GOAL 7: Affordable and Clean Energy	-	O	+	5,0%
9 GOAL 8: Decent Work and Economic Growth	O	+	++	5,0%
10 GOAL 9: Industry, Innovation and Infrastructure	+	+	++	5,0%
11 GOAL 10: Reduced Inequality	-	O	+	5,0%
12 GOAL 11: Sustainable Cities and Communities	-	O	++	5,0%
13 GOAL 12: Responsible Consumption and Production	--	+	++	5,0%
14 GOAL 13: Climate Action	--	O	+	10,0%
15 GOAL 14: Life Below Water	--	-	+	5,0%
16 GOAL 15: Life on Land	O	+	++	5,0%
17 GOAL 16: Peace and Justice Strong Institutions	+	+	++	5,0%
18 GOAL 17: Partnerships to achieve the Goal	+	+	++	5,0%
Positive Effects	3	10	16	
Negative Effects	9	1	0	
Neutral Effects	5	6	1	
Net Effect	-6	9	16	
Positive Priorization	5,0%	18,3%	71,7%	
Negative Priorization	-35,0%	-1,7%	0,0%	
Net Effect	-30,0%	16,7%	71,7%	

Figure 7.
Weighted comparison of scenarios—Pugh's method.

with the help of the Pugh method implemented in the Qualica QFD software, is displayed in **Figure 7**. Three scenarios are analyzed in parallel for a time frame of 11 years (2019–2030), with respect to the contribution in realizing the SGD: staying the current course with no significant change (basal scenario), implementation of smart agriculture/precision farming (realistic scenario), and full-scale implementation of bioeconomy including biotechnologies and bio-based industries (optimistic scenario).

This analysis served as basis for the implementation of a selection methodology known as Pugh's method that assigns weights to criteria (in our case the SDG) and ranks the alternatives based on neutral, negative, and positive effects. All the goals received a 5% importance rating, except three considered priorities that received 10% (hunger elimination, quality education, and climate action). The results are presented below:

As it can be noticed, the current course has a slow positive progression, the implementation of smart agriculture contributes significantly, but a full bioeconomy approach on a world-wide scale would be much more effective.

7. Conclusions

There is a significant potential for developing and implementing smart agriculture solutions in the Danube region, both in terms of policies and scientific contributions, and the elements presented in this chapter constitute building blocks of a proper ecosystem for this. Agriculture has historically been a strong sector for both Romania and Slovakia, and there are national policies as well as private initiatives attempting to recapture this competitive advantage in the form of smart devices, technologies, or projects. There is a good and diverse capability for developing this domain (strong IT sector, developed universities in the technical and life sciences areas, fast Internet, and good penetration of technology in rural areas), and we believe cooperation frameworks, like the Danube Transfer Centers Network and the Interreg-Danube projects, can contribute to transforming this capability through proper policies and instruments into concrete results. This is even more timely in the present with increasing discussion about possible food crises in the future, as well as an increasing focus on finding biological and ecological solutions for supporting a circular and sustainable industry, like growing fuels, construction materials, and ingredients specific to the pharmaceuticals and cosmetics.

The international and transnational dimensions of cooperation in this sector come to complement the economic driving axis, because smaller countries that are cooperating in macro-regional (i.e., Danube region) or supranational (i.e., the European Union) contexts have improved chances of being competitive and developing fast in the current setting of a globalized economy. As proposed in the chapter, smart farming is only the first step in implementing a full-scale bioeconomy approach and should be undertaken soon to help change the status quo.

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