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CIRCULAR ECONOMY AND AGRICULTURAL SECTOR: POINTS OF CONTACT AND PROSPECTS OF SYMBIOSIS

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The relevance of the research topic is determined by the fact that in the modern agricultural sector in general the development of economic relations is carried out on a linear principle across countries, the motto of which is the triad "get-recycle-utilize". However, in modern conditions, the most relevant is the organization of economic relations in the agricultural sector based on the principle of sustainable use of all components of renewable resources, in this regard, innovative business models are needed that determine how to process what is currently considered waste.

The problem of the study lies in the fact that during the transition of agricultural enterprises to relationships within a circular economy, it is necessary to take into account certain factors that determine both success and risk. This should include technical, logistical, economic, financial and marketing, organizational and spatial, institutional and legal, environmental, social and cultural factors. At the same time, the specific factors for the agricultural sector are innovative conversion technologies, flexible internal and external logistics, joint investments in R&D, price competitiveness, etc.

The purpose of the study is to consider the points of contact and prospects for the symbiosis of the circular economy and the agricultural sector.

In the analysis of the material, comparative research methods were used, the consideration of the research topic was carried out on the basis of an analysis of sources and publications covering the main conceptual foundations of the development of the circular economy and the agro-industrial complex.

The authors concluded that while several success factors are also crucial for closed-loop business models in general, some of them are very specific to those evaluating agricultural waste and by-products.

Keywords: *circular economy; agro-industrial complex; innovative technologies; closed cycle; waste management*

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ЦИРКУЛЯРНАЯ ЭКОНОМИКА И СЕЛЬСКОХОЗЯЙСТВЕННЫЙ СЕКТОР: ТОЧКИ СОПРИКОСНОВЕНИЯ И ПЕРСПЕКТИВЫ СИМБИОЗА

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Актуальность темы исследования определена тем, что в современном сельскохозяйственном секторе развитие экономических отношений в целом по странам осуществляется по линейному принципу, девизом которого выступает триада «получить-переработать-утилизировать». Однако в современных условиях наиболее актуальным выступает организация экономических отношений в секторе АПК на основе принципа устойчивого использования всех составляющих возобновляемых ресурсов, в этой связи необходимы инновационные бизнес-модели, определяющие способы переработки того, что в настоящее время считается отходами.

Проблема исследования заключена в том, что при переходе сельскохозяйственных предприятий к отношениям в рамках циркулярной экономики необходим учет определенных факторов, определяющих, как успех, так и риск. Сюда следует отнести технические, логистические, экономические, финансовые и маркетинговые, организационные и пространственные, институциональные и правовые, экологические, социальные и культурные факторы. При этом, специфическими факторами для сельскохозяйственного сектора являются инновационные конверсионные технологии, гибкая внутренняя и внешняя логистика, совместные инвестиции в НИОКР, ценовая конкурентоспособность и пр.

Цель исследования – рассмотреть точки соприкосновения и перспективы симбиоза циркулярной экономики и сельскохозяйственного сектора.

При анализе материала применялся сравнительный и сопоставительный методы исследования, рассмотрение темы исследования было проведено на основе анализа источников и публикаций, освещающих основные концептуальные основы развития циркулярной экономики и АПК.

Авторы пришли к выводу, что хотя несколько факторов успеха также имеют решающее значение для бизнес-моделей замкнутого цикла в целом, некоторые из них очень специфичны для тех, кто оценивает сельскохозяйственные отходы и побочные продукты.

Ключевые слова: *циркулярная экономика; АПК; инновационные технологии; замкнутый цикл; управление отходами*

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Introduction

Concerns about the limitations of economic growth and the efficient use of all natural resources have arisen for a long time, in connection with which leading scientists around the world have actively begun to call for new approaches to environmental resource management. The closed-cycle economy is currently coming to the fore among such management methods. From the point of view of a closed-loop economy, the continuous flow of technical and biological materials in the circle of values increases, and waste is preferably avoided, reduced, reused and estimated or completely recycled [1].

Various action plans have been implemented all over the world (one can mention the PRC Law on the Development of Circular Economy (2008), the EU Action Plan in the Field of Circular Economy (2019), etc.), tools have been developed to support the implementation of the concept in the form of taxes or financial subsidies. A variety of strategies have been developed for different parts of the value chain. However, circular economy as a new concept was rather used as a general term. It should also be noted that the relationship between sustainability, bioeconomy and closed-loop economics has not yet received due attention from the scientific community, despite its relevance in modern conditions.

The realization of a circular economy requires major social changes and reforms of the entire economic system, including production and consumer activities. Firms can become key participants in the transition period if they change their production methods.

For several years, more and more research attention has been paid to sustainable or closed business models aimed at increasing economic growth while minimizing the negative impact on the environment and society. These "new business models" create multiple and common value, that is, not only economic, but also environmental and social [2]. Cyclic business models solve the question of how to create, deliver and fix value with and within closed material cycles, for example, by slowing down, closing and narrowing resource cycles.

Representatives of the agricultural sector are particularly interested in implementing the ideology of a circular economy, since the current habits of food production and consumption are unstable. Every year, about 88 million tons of food

and 700 million tons of agricultural crops are thrown out in the world. For this reason, the closed production cycle in the agricultural sector is highly relevant.

Materials and methods

In the analysis of the material, comparative research methods were used, the consideration of the research topic was carried out on the basis of an analysis of sources and publications covering the main conceptual foundations of the development of the circular economy and the agro-industrial complex.

Results

Definitions of food losses and food waste are determined by different specialists in different ways. According to the Food and Agricultural Organization and the Economic Research Service of the US Department of Agriculture, food losses and waste refer to a decrease in edible food mass.

However, agricultural waste and by-products are usually defined as the remains of plants or animals that are not processed (or not processed further) into food or feed. They are non-food products of agricultural production and processing and include animal waste (manure, animal carcasses), food industry waste, crop waste (for example, corn stalks, drops and discards of fruits and vegetables) and hazardous or even toxic waste [3].

Agricultural waste and by-products often create an environmental and economic burden in the agriculture and primary processing sectors, which can be reinforced by regional specialization in either crop production or animal husbandry. For example, a high concentration of manure leads to "bacterial contamination, high greenhouse gas emissions, and high levels of organic matter and nutrients (e.g. nitrogen)."

However, agricultural waste and by-products can be turned into valuable resources by means of intensified processes of recycling, which leads to the emergence of new value-added products, such as bioenergy, biofertilizers, biomaterials and biomolecules, depending on the volume of biomass [4].

Conversion of residues is crucial to support the separation of economic growth and human well-being from the use of primary resources, as well as to prevent the burden on the earth causing adverse effects on biodiversity and endangering global food security.

However, the cost-effective use of waste is a very complex and interdisciplinary problem that requires knowledge of materials, technologies, the market and socio-economic issues related to additional value enhancement. Although the problems and opportunities of increasing the value of agricultural waste

and by-products were often approached from a technological point of view, for example, using anaerobic digestion, bio-processing or biocatalysis, the socio-economic side was practically ignored.

Research on agricultural waste has been conducted for more than 60 years, mainly in the USA, India and China, but also in Latin America (Brazil and Mexico), as well as in Chile, Colombia, Peru, Trinidad and Tobago and other countries), as well as in Europe with a special focus on the capture and processing of nutrients in the production fields themselves [5].

Spatial clustering of various enterprises is considered as one of the appropriate ways to make possible the estimation of the cost of biomass. Eco-industrial parks have attracted attention thanks to the cooperation between companies aimed at optimizing resource efficiency, which is more often called industrial symbiosis.

Most eco-industrial parks belong to the petrochemical, chemical or belong to different industries; but there are also projects and studies in various regions of the world that focus on cross-estimating the cost of agricultural by-products. Efforts in Research and Technological Development, business modeling, and framework conditions are needed to ensure the complete conversion of all the fresh weight of the harvested crop (food plus agricultural waste) into food and feed, bioenergy and biological products in order to increase the potential of agricultural biomass without affecting land use and plant productivity. Moreover, there is a need to raise awareness of value-enhancing and marketing opportunities in alternative sectors, and there is also a need to encourage consumer acceptance of reusable or products made from waste. For efficient use of agricultural waste and by-products, innovative modernization technologies should be linked to new business models and marketing strategies.

Discussion

A business model is a conceptual tool that allows you to understand how a company does business. It describes the logic of the firm, how it works, and creates value for stakeholders. The literature presents a business model consisting of nine building blocks related to the main business elements [6]:

1) value creation (key activities, resources, partners);

2) value proposition and delivery (products and services offered to specific customer segments through customer relationships and sales channels);

3) obtaining value (cost structure and revenue of the company). This model offers a useful approach to understand and analyze the details of an organization's current business model, as well as to support its innovation process throughout the value chain in order to generate value.

A circular business model can be considered as a subcategory of business models. However, unlike the classical business model, it is mainly aimed not at economic indicators, but rather at the efficient use of resources while maintaining good financial health and, consequently, the long-term viability of the firm.

A common characteristic of all closed-loop business models is the reduction of energy, water and materials consumption, as well as the recycling or reassessment of waste generated in the business. This requires reorganization processes and new strategies, which may consist in slowing down, closing or narrowing resource cycles. The researchers emphasize the collaborative nature of circular business models that require collaboration, communication and coordination with a wide range of participants and stakeholders. Consequently, closed-loop business models are associated with sustainable business models, since they are aimed at creating economic and environmental and, to a lesser extent, social value, assume the presence of multiple stakeholders and have a long-term perspective [7].

Also, various studies have examined the critical success or risk factors of closed business models. The factors that allow or hinder innovation in sustainable business models in other sectors are also presented. In particular, one group of researchers, using institutional theory and a systematic approach to innovation, identified three types of external barriers to innovation of sustainable business models: regulatory, market and financial barriers, along with behavioral and social barriers. They criticized the fact that research on innovative business models usually focuses on the internal activities of the firm, although the institutional environment can have an important impact on this activity.

Also, some authors identified obstacles in the implementation of business models. For example, consumers' rejection of products created on the basis of waste, the lack of willingness of businesses to invest in uncertain and risky environmental innovations, the lack of an industry legal framework, etc.

Another group of authors focuses on the internal factors of a firm's success and therefore uses a change management approach. They have shown that the key success factors for the transition to sustainability business models are collaboration, continuous innovation, clear description and vision, profitability, commitment to sustainability and external events such as consumer trends or food crises. In addition, researchers have identified factors that promote and hinder circular SMEs, including lack of support from the supply and demand network, insufficient capital for investment, and sometimes lack of government support, technical know-how or administrative burden [8].

In the literature, the barriers of four different closed-loop business models based on the 4R concept of "reduction, reuse, recovery, recycling" have been

compared. Internal obstacles were the lack of knowledge and technology, organizational and financial structures, and external obstacles were related to the supply chain, markets and institutions (for example, policies, standards). In addition, the structure of drivers and barriers for circular economy enterprises in various industries was developed and seven main categories were proposed: environmental, economic, social, institutional, technological and information, supply chains and organizational [9].

In general, there is a wide variety and complementarity of initiatives that increase the value of agricultural waste and by-products.

The main goals of different enterprises differ. While some initiatives are aimed at directly and locally adding value to agricultural by-products through anaerobic digestion processes, others are aiming for a more diversified application of bio-processing plants for agri-food and other industries.

There is also a wide range of assessed agricultural waste and by-products, such as pig, horse or chicken manure, various fruit and vegetable residues, wood chips, olive oilcake, sugar beet and wheat by-products, slaughterhouse waste. In addition, the processes and technologies of value enhancement vary, ranging, for example, from natural transformation with the help of fly-larvae or composting, traditional distilleries, anaerobic digestion to highly specialized and patented technological processes. Enterprises also are targeted at various markets, including, for example, agriculture, chemicals, cosmetics and pharmaceuticals, energy, construction, transport, textiles or (packaging) materials sectors.

As for the success and risk factors that have affected the business over time, there is a large number of different factors, both internal to the business model and external to the business ecosystem, which can be grouped into five categories. This

1) technical and logistical (for example, innovative or proven technologies, optimal internal and external logistics);

2) economic, financial and marketing (for example, economies of scale for clusters, joint investments or financial support, price competitiveness of biological products);

3) organizational and spatial (for example, successful cooperation, geographical proximity, sufficient space for effective infrastructure);

4) institutional and legal (for example, state subsidies) [10].

The researchers note that for businesses evaluating agricultural waste, there are success and risk factors that are common and crucial to sustainable or closed business-models in other sectors, as shown in recent literature. These factors are related to high (initial) investment costs, technical uncertainties, the need for

state support, especially at the initial stage of business development, difficulties associated with regional regulations and complex legislative requirements.

The transition to a sustainable or closed business model is generally considered a difficult task, and there is no unique solution to overcome obstacles. Therefore, experts call for the implementation of "opened business-models" or "open innovations", encouraging companies to open their business model, as well as use external resources and ideas as input data for innovation.

At the same time, a special role is assigned to closed-loop business models. The implementation of such models often requires innovative biological-oriented products, technologies to provide new, but complex ways of transformation, etc. In addition, efficient and flexible internal and external logistics and large storage capacities are needed, since agricultural resources are voluminous and heterogeneous, their input quality varies, can deteriorate rapidly, and seasonality leads to changes in quantity and quality over time.

Also stimulating factors are economies of scale (for clusters such as bio-processing plants and agroparks, but also for biogas plants), taking into account the biological diversity of resources, as well as strong innovative public-private partnerships or even triple helix partnerships that promote technological innovation, with joint investments in R&D.

At the same time, a high risk is the general lack of competitiveness of new biological products compared to fossil fuel products that dominate existing markets, especially due to often immature and still experimental processes, as well as due to the rather complex characteristics of biomass.

Another risk is related to competition between different markets for the same agricultural by-products. Thus, investments, profits, risks and benefits should be clearly defined with all stakeholders implementing a closed-loop business model, both private and public. It is also necessary to avoid resistance from residents of nearby villages due to potential disturbing factors such as noise or odors, for example, produced by biogas plants or stored manure.

The public perception of "green products and processes" contributes to business development, in particular, the fact that they can be produced locally and use natural functions. All factors that reduce the impact on the environment also have a positive impact if they are controlled separately. However, negative trade-offs may arise if viewed from a broader perspective, for example, from an acceptability or aesthetic point of view, as in the case of biogas plants installed in landscapes.

The success of closed-loop business models for increasing the cost of agriculture and by-products depends both on the elements of the internal busi-

ness model and on the external business ecosystem, which sets the boundary conditions for successful business operations. While macro-environment conditions should only be assessed by individual enterprises, micro-environment conditions can be controlled and influenced by them. They depend on context, which means that business concepts that are successful in one context may fail in another. Therefore, it is very important to have a good understanding of local and (international) contextual factors and their evolution (for example, subsidies that change over time), legislative measures and restrictions.

The research results of individual specialists also show that the transition from linear chains to a closed-loop economy in the agricultural sector has allowed individual business models to develop towards more dynamic and integrated business models with a high degree of interaction between all participants (i.e., government partners, companies, research institutes and other stakeholders). For all parties involved, the process of implementing a business model requires open and flexible management and transparent communication while respecting each other's positions. Overall, there seems to be a positive attitude, as much more success than risk factors have been mentioned.

Conclusion

Thus, it can be concluded that while several success factors are also crucial for closed-loop business models in general, some of them are very specific to those evaluating agricultural waste and by-products. These factors are innovative conversion technologies, flexible internal and external logistics, joint investments in research and development, price competitiveness for biological products, partnership with research organizations, availability of space, subsidies, rules for handling agricultural waste, involvement of local stakeholders and adoption of production processes based on biomaterials.

New, more dynamic and integrated business models make it possible to process agricultural waste in the places where it is generated. In addition, it contributes to public-private partnerships, including even citizens as consumers of local products who will participate in the assessment of agricultural waste and by-products.

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