

Implementation of circular economy technologies in the agricultural and industrial complex of the Russian Arctic

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Abstract. The paper presents the results of the study of the content and capabilities of Circular Economy (CE), its technologies and tools that increase the economic and environmental efficiency of limited resources. The paper uses the example of the Russian Arctic and its agricultural and industrial complex, which has its own features, ranging from providing raw materials and the necessary semi-finished products, feed to the manufacturing industry for which agricultural products are the main source of raw materials. The authors present the key CE technologies allowing achieving a set of goals of Russian Arctic zone development. The comparison with international experience, namely that of Egypt, is of a particular importance. The main results obtained by the authors in the study include trend assessment in the development of the Russian Arctic and its land territories with agricultural and industrial complex based on reindeer herding as a traditional type of economic activity of the North indigenous peoples. Comparative analysis of sedentary and nomadic reindeer herding was carried out. A CE model was built using the example of agricultural enterprise "Smart Herd" and other participants in the agricultural and industrial complex, ensuring the transition from a linear business model to a cyclical one.

1 Introduction

According to experts, by the 2050s, a growing scale of negative consequences of necessary resource shortage for humanity to meet its complex needs will reach a critical level for the entire global community, and the relevance of introducing technologies that allow solving this problem in a complex and in a short time is growing. The Circular Economy (CE) represents the most demanded system of knowledge, technologies and methods for minimizing recyclable tails from production and consumption, which is widely used worldwide. Introduction of new technologies, particularly in territories that are strategically

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important or vulnerable for national economic system, should be carried out on the initiative with maximum support and government control.

The land area of the Russian Arctic, as well as similar territories of other countries (US, Canada), are traditionally considered to be subsidized from the point of view of state role in their development and financial management. This statement is explained both by natural and climatic factors that objectively limit the introduction of all available technologies, including in agricultural activities. Moreover, remoteness from megacities and low concentration of human resources and financial institutions make CE technologies introduction unprofitable without state support and control.

However, for the indigenous North peoples, for other citizens permanently residing in these territories or participating in labor migration processes such as construction, trade and agriculture, a Unified state standard of quality of life should be available in terms of safety, environmental protection. The standard is to be determined not only by Russian national and federal legal norms, but also encompass the UN Sustainable Development Goals (SDGs) in general, which Russia implements in the system of national indicators through the system of National Projects.

2 Materials and methods

To achieve the goal of the study, which consists in substantiating the content and conditions for CE technologies introduction into the activities of key stakeholders of agricultural and industrial complex of the Russian Arctic, materials from official sources were studied. They include the orders of the Government of the Russian Federation on the handling of food waste, minimizing emissions into the atmosphere, federal project "Circular Economy", national project "Ecology", strategic documents for the development of the Russian Arctic, updated in 2020-2022, etc. The study also comprises analytical data that reveal the content of the applied CE technologies, features of their production and implementation, resulting effects for resources and goods involved in additional processing procedures, safety improvement of consumption and storage, etc.

To conduct a comparative analysis and assess the so-called maturity of the circular economy in terms of the scale of the technologies introduced and the effects obtained, the material on the research topic for the Arab Republic of Egypt was also studied. The country choice can be explained by its territory possessing similar zones of increased complexity for agricultural activities and comparable urgent problem of waste management in production and consumption.

The research methods applied in this study include traditional methodology of economic analysis, including modeling, analogy, and factor analysis, as well as methods of statistical and strategic analysis (comparison, dynamics and planning).

3 Results

Considering the land territory of the Russian Arctic as an object for the CE technologies application in demand according to expected results, the authors have noted the following features of the territory development reflected in strategic planning documents and territory management guidelines:

- poorly developed transport and social infrastructure against the backdrop of extreme natural and climatic conditions and exceptionally low population density;
- high negative consequences of external factors impact on ecosystem of this mega-region due to high vulnerability and weak resilient stability, which

makes any CE technology highly demanded especially taking into account other previously agreed conditions (small population, climate, transport and social infrastructure);

- strong negative susceptibility to climate change impact on flora and fauna of the region, taking into account their state and traditionally applied technologies for involvement in economic circulation and removal from the habitat, etc. This is exacerbated by the high resource intensity of economic activity and considerable dependence on a number of resources from other Russian regions that do not belong to the Arctic zone. Another problem negatively affecting the regional ecosystem is regular for the last decade's one-sided support by investors of only one type of economic activity in this territory which is mining with the aim of exporting to other industrial regions for processing, refining or export.

All of the above confirms the demand for CE technologies in the Arctic zone, but in conformity with the specific model, all stakeholders have to develop individual approach to solving the issues:

- From the state and local government's perspective, CE technologies should be clearly identified and their introduction results should be precisely specified. Furthermore, subsequent control over the implementation and obtaining the planned effects (budget investments efficiency) is to be conducted.
- From inhabitants of these territories perspective, it is necessary to develop a certain level of responsibility, consumption culture, processing and recycling of solid municipal waste.
- From the perspective of entrepreneurs, according to the authors N. S. Osintsev, A. N. Osintsev [7], organizations involved in agricultural activity, its maintenance by agricultural and industrial complex or new technical services and innovations, a systematic approach should be introduced to technologies and methods implemented, as well as responsible investment practices, corporate governance, quality and safety control.

According to official statistics, multiple increases in cargo transportation facilities via the Northern Sea Route area (from 4 million tons per year in 2014 to 31.5 million tons in 2019) is an important trend. Not only natural factors, such as increased navigation traffic when average temperature grows, are reasons for such changes, but also the active icebreakers construction including by China which is interested in participating in exploring and developing of the Arctic in accordance with the White Paper "China's Policy in the Arctic".

4 Discussion

According to the Strategy for the Russian Arctic development and Ensuring National Security for the Period up to 2035, Table 1 shows the comparison results of some key economic indicators growth in general and with support of Russian state budget.

The GRP growth shows an increase of 24% indicating rising minerals extraction. At the same time, the authors study the Russian Arctic land areas which, in accordance with the Decree of the President of the Russian Federation of May 2, 2014. No. 296 "On the land territories of the Russian Arctic", include the the Murmansk region, the Nenets, Chukotka, Yamalo-Nenets autonomous regions, Vorkuta municipality (Komi Republic), a number of territories (districts) of the Republic of Sakha (Yakutia), the Krasnoyarsk Territory, the

Arkhangelsk region and the lands, islands located in the Arctic Ocean. In this study, data on the change in the share of section A of the OKVED "Agriculture" of these territories will be presented. The data cover the constituent entities of the Russian Federation in which the share of northern reindeer husbandry is traditionally the highest. Given that since 2016, this section has included agriculture, forestry, hunting, fishing and fish farming, we can only observe a general trend towards a decrease or increase in contribution of this type of activity to the regional economy. The results for all 4 constituent entities of the Russian Federation are different, depending on growth in other activities particularly mining. If we include manufacturing in the agricultural and industrial complex, one should pay attention to presence of a growth correlation in these types of economic activity. However, there are cases of increase and decrease depending on the development level, presence of local agricultural products processing technology, practice of exporting them abroad or to other Russian regions for further processing.

Table 1. Indicators of Changes in Main Areas of Economic Development of the Russian Arctic, 2014 and 2019.

Analysis Indicator	2014	2019	Change, in %
1. Cargo Transportation Volumes through the Northern Sea Route, million tons	4.0	31.5	increase by 6.9 times
2. GRP share of the Arctic in total GRP of the constituent entities of the Russian Federation, %	5.0	6.2	increase by 24.0%
3. Russian Budget Funding Share in the total volume of investments in fixed assets in the Arctic zone, %	5.5	7.6	increase by 38.2%
4.1. Share of the Agriculture Section of OKVED in the gross value added of the Yamalo-Nenets Autonomous District (UFD)	0.1	0.1	0
4.2. Share of Manufacturing Activity Section	1.7	4.7	increase by 176.5%
5.1. Share of Agriculture Section of OKVED in the gross value added of the Nenets Autonomous District (NWFD)	1.1	0.3	decline by 72.7%
5.2. Share of the Manufacturing Section	0.3	0.2	decline by 33.3%
6.1. Share of the Agriculture Section of OKVED in the gross value added of the Republic of Sakha (Yakutia) (FEFD)	2.3	1.4	decline by 39.1%
6.2. Share of the Manufacturing Section	1.6	1.1	decline by 31.3%
7.1. Share of the Agriculture Section of OKVED in the gross value added of the Chukotka Autonomous District (FEFD)	2.2	3.4	increase by 54.5%
7.2. Share of the Manufacturing Section	0.2	0.3	increase by 50.0%

Source: compiled by authors according to the According to the Strategy for the Russian Arctic development and Ensuring National Security for the Period up to 2035, Rosstat data "Industry structure of the gross value added of the constituent entities of the Russian Federation in 2014 and 2019." [8]

The Circular Economy concept, opposed to the Linear Economy, is aimed at extending economic and consumer life of goods as well as of resources. The CE revises the understanding of production or consumer waste, demand for technologies allowing obtaining

the expected effects in saving resources and minimizing non-recyclable waste and used goods. It should be clarified that the so-called Cyclical Economy can be applied for such types of activities where resources and results are material, except for formation of consumer behavior models that correspond to goals and tools of the cyclical economy.

The trends accompanying the development and implementation of the CE technologies include: minimizing CO₂ emissions, introducing business models with most energy-intensive production and maximum waste recycling. Using the example of reindeer husbandry, based on an article by scientists from Salekhard K. A. Laishev, A. A. Yuzhakov, T. M. Romanenko [3], the trend is clearly demonstrated by production of dietary infant food and recycling of food waste as animal feed, the use of blood and deer antlers for medicines production.

There is an increase in the processing waste cycles from primary production as raw materials (assets) for the next production cycle. The minimization of the so-called "tails" takes place as they are already subject to disposal due to inability of the existing technology to include them into next processing cycle. There are three ways to achieve these results (taking into account the results of the authors' previous work [1]):

- the production cycle is completely closed in a single chain of processing materials and restoring goods (repair, modernization) with control over the allowable loss as newly obtained materials after processing, clarifying that the number of recycling rounds is limited;
- the production cycle is maximally narrowed in conformity with current technological and innovative level of development by reducing the share of materials used. Digital technologies and digital transformation of business processes in this respect are an important condition for building a cyclic rather than a linear production model;
- slowing down (and even shortening) the production cycle in terms of maximum possible time extension and an increase in the consumers of one good, boosting the demand for repair services and all the main types of sharing economy.

5 Conclusion

The application of CE technologies in the Russian Arctic allows achieving necessary results in agricultural and industrial economic activities. The CE technologies have the following prospects:

- In order to increase economic efficiency of northern reindeer breeding and form a closed production cycle with minimal waste, a gradual transition from nomadic reindeer breeding to fenced (sedentary) is proposed (in an article by authors from Yakutsk [10]). The fenced method enables construction of permanent in their location production facilities and creation of necessary business conditions for the entire range of finished products. Furthermore, we expect an increase in controllability of animal herds and reduction of losses from diseases, shortage of food supply, etc.
- In addition to fenced (sedentary) reindeer husbandry transition, it is necessary to consider "Smart Herd" (an example of an author's article - N. M. Suray, M. G. Kudinova, E. Uvarova, E. I. Zhidkikh [9]) introduction technologies for individual monitoring of each species, obtaining maximum return in weight, processed products with minimal non-recyclable residues, moreover, legal regulations and standards should be adopted in quality, sanitary and epidemiology.

We agree with the opinion of the authors of the article [4] that such changes will increase sedentary lifestyle practice in young indigenous population, as well as attractiveness for entrepreneurs to take up a new animal husbandry method.

Growing dependency on conditions, cost and diversity of feed supplies, while abandoning natural nomadic habitat, increases the role of producers of such feed for reindeer, taking into account their traditional diet. The planning of logistics, accommodation and communication between participants should be supported by the state to ensure the stability of the fodder supply of farms, taking into account territorial distribution and planning. The research of Yakut scientists [11] reflects the opinion that full-fledged profitable processing of livestock products using the example of reindeer breeding is associated with the introduction of modern technologies that provide the required quality, shelf life, assortment variety. Furthermore, stable distribution chains are beneficial for producers, consumers and intermediaries. The most suitable option is association with a large agricultural holding as a part of its strategic development and gaining competitive advantages in the oligopolistic market.

Referring to other countries experience in solving issues dual in nature, we observe that they are directly related to the CE expected results in environmental protection and economic performance. They do not restrain, but stimulate social and economic development of the subsidized territories. In the study, we have described Egyptian government practice, business structures and similar activities results in recent years (2016-2022):

- a nationwide systematic approach to municipal solid waste and food residue recycling constitute quite problematic part of waste due to their nature;
- extended producer responsibility for recycling, waste sorting, packaging safety, etc.;
- prioritizing production of durable, recyclable, affordable and easily repairable products, as opposed to mass production models to maximize economies returns due to production scale;
- implementation of quality standards regulation for raw materials, materials, remanufactured goods, product reuse, maintainability, etc.; in the practice of some countries, such standards formalize the CE principles and the requirements for goods; at the international level, ISO standards are developed aimed at providing uniform terminology, conditions and recommendations for converting business models from linear to cyclical, as well as for evaluating the effectiveness of industry's cyclicity.

According to OECD data [2] representing the market shares of cyclical business models by sectors of the economy, there is no information on agricultural activities and agricultural and industrial complex in general. However, in the practice of Russian agricultural enterprises within the same region or municipality, it is common practice to use one fund of machinery and equipment (rent, joint use), production of pet food from local raw materials, etc.

Comparing the Egyptian and Russian accumulated experience in implementing CE technologies in the agricultural and industrial complex of particular territories - the Russian Arctic and the Egyptian agricultural regions, we can draw the following conclusions:

- Egypt's agriculture sector is dominated by small farms using traditional practices that do not meet international standards.
- On 26th of January 2020, The Egypt's Parliament approved a law that regulates national organic agriculture sector and aims at limiting negative effects of traditional farming methods that depend on synthetic chemicals in planting and animal feeding.
- In addition to subsidizing activities of small agricultural producers, Egyptian state policy implements such support measures as:
 - Facilitating obtaining crop loans for farmers and veal for small breeders with soft interest.
 - Digital transformation services for holdings and mechanization of agricultural services.
 - Recording and monitoring the circulation of production requirements: “pesticide seeds – fertilizers – fodder – serums and vaccines – veterinary medicines.”

- The Government of Egypt has embarked on a number of national mega projects that aim at enhancing competitiveness of the economy, creating employment opportunities and attracting foreign and domestic private investments. With work underway by more than 1,000 companies and nearly two million Egyptian workers, these National mega projects are contributing to a new chapter in Egypt's economic progress:
 - The new Suez Canal.
 - The new Suez Canal economic zone.
 - Establishing new cities.
 - Energy development and transformation.
 - New roads and transport infrastructure.
- The role of the Suez Canal and the Northern Sea Route (NSR) is becoming increasingly similar, as the use of the NSR has significantly increased over the months of active navigation and adopted the entire infrastructure of this route in demand for territories of the Arctic zone remote from other countries.
- The use of cyclical business model with a key role of the state in initiating and supporting the initiatives is applied in solving livestock issues. They are typical for agricultural and industrial complex of both countries and represent the most effective way of solving the tasks of increasing efficiency while using limited resources and extending livestock products processing chain to minimal waste, not amenable to reuse or use in other industries as raw materials.

There is another way of sustainable development of the agricultural and industrial complex of the territories difficult or risky for agricultural activity due to climatic factors or remoteness and outflow of population. A field experiment of formation of a unique ecosystem in the Arctic has been conducted since 1988 and represents an alternative direction for agricultural development in the majority of the land territory of the Russian Arctic. We are talking about the Pleistocene park in the Republic of Sakha (Yakutia) [5] where researchers examine settlement impact on an area of 20 sq. km. of large herbivores (reindeer, Yakut horse, elk, steppe bison, bison, musk ox, yak, Kalmyk cow and sheep). The official website of the experiment provides examples of sharing economy practices including crowdfunding; funds raising campaign was aimed at ensuring replenishment of an American bison herd.

At the next step, we present the CE model developed by the authors using the example of a modern livestock enterprise in the field of reindeer husbandry with available Smart Herd technologies and further introduction of required CE technologies:

- Simultaneous shift from linear to cyclical business model of other stakeholders in the agricultural and industrial complex of the Arctic is a condition for its successful introduction and functioning. First of all, availability of feed supplies for fenced (sedentary) reindeer husbandry is of crucial importance. It should be adapted to the reindeer diet in natural (nomadic) conditions. It is also important to create conditions for affordable and effective use of modern reproductive technologies for reindeer in sedentary conditions.
- The factor of competitiveness is a component ensuring investment attractiveness and demand for sedentary reindeer husbandry among the indigenous peoples (correlates with the conclusions of the Moscow scientist M. P. Neustroev [6]). Therefore, state support should be directed in general to stimulating settled reindeer husbandry, supporting other participants of the full cycle production chain, maximum processing and infrastructure for safe disposal of non-recyclable "tails". Traditionally, deer meat is in demand among consumers; however, the final cost of finished products in Russian regions is the key issue.

State support and tax incentives will allow expansion of the northern animal husbandry to provide a competitive cost, stable internal and export markets. The economy of scale

should be achieved through the presence of several large agricultural holdings, which, among other things, will be considered as key buyers of raw materials from such farms. State control is aimed at preventing price discrimination and creating unattractive participation in such a megaproject for entrepreneurs, including for North indigenous peoples. To this end, attractiveness of such activities for private investors can considerably be supported by state budget investments and subsidies, financial control and audit.

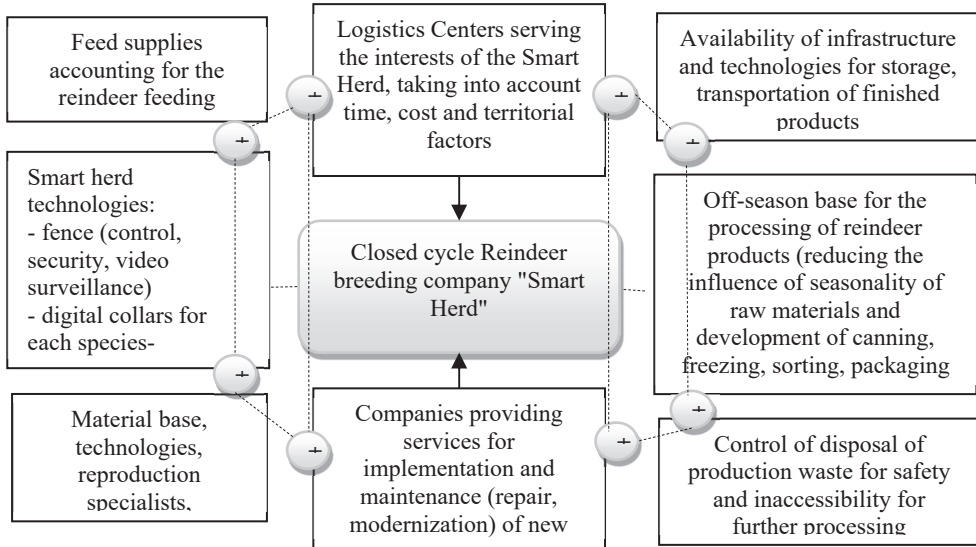


Fig. 1. Cyclic Model of the Reindeer breeding company "Smart Herd" in conditions of Fenced (sedentary) Farming.

CE technologies provide a unique opportunity to overcome reindeer husbandry negative consequences of 1990s. However, their potential is significantly higher than current indicators in terms of livestock and performance of agricultural enterprises and farms. The use of modern technologies and revision of the traditional linear model of reindeer husbandry will make a range of new products of the agricultural and industrial complex of the Russian Arctic in demand as for domestic consumers. The state here is an active stakeholder as it follows the example of "green" purchases for the purpose of forming strategic reserves from reindeer breeding products, including for the contingent of defense forces in this territory of Russia (a similar conclusion is in the study [12]). The agricultural products can be supplied to other countries of Asia, primarily China, for which access to the Northern Sea Route makes it attractive to import such products in large volumes and along the entire assortment chain. The cycle also includes digital platforms, providing the manufacturer and consumer with information about the product and the conditions for its purchase, international e-commerce opportunities which guarantee access to complete information, transparency of conditions and payments security.

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