

# Indication of industrial safety of sugar production in Russia

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**Abstract.** In modern conditions of political confrontation and economic sanctions, ensuring national security is becoming a priority direction of state policy, not only in the long term, but also in the short term. The purpose of this study is to develop methodological support for assessing the level of industrial safety, which makes it possible to identify latent threats that reduce its level at each stage of the sugar beet business cycle. To achieve this goal, the structural and logical relationships of food independence, food security, industrial safety of sugar beet production were substantiated. The priority importance of industrial safety is proved for the economic development of business entities, ensuring the balance of their business interests and the formation of harmonious business relations, which make it possible to reduce the level of unused and underutilized opportunities. Using the example of the main stages of the beet-sugar business cycle - selection, seed production, beet growing, sugar production, sale (consumption) - a method for indicating industrial safety has been developed, which provides for the implementation of five stages and the implementation of an analytical complex consisting of nine indicators and six indicators. The proposed indicators at each stage of the sugar beet business cycle link the potential, actual and optimal level of indicators and make it possible to assess the balance of business relations and the level of industrial safety. The results of the indication can be used to analyze the actual state of the business cycle as a whole or its individual stages.

## 1 Introduction

In the Russian Federation, the priority directions are the development of industrial organizations, the results of which in the form of final products make it possible to directly or indirectly meet the needs of related industries and the population in food [1]. This aspect of the state economic policy applies to many domestic food industries, including sugar, the parameters of balanced business relations of which with stakeholders are inextricably linked with the supply of raw materials. In addition, particular attention is focused on the

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possibilities of ensuring food security and independence, objectively related to import substitution [2].

Taking into account the above, it is of practical interest to provide a methodological support for a business analysis of the safety of functioning and development of the sugar beet complex in Russia as a whole, including the identification of unproductively interacting industrial and agricultural elements, which, of course, will make it possible to expediently redistribute resources to ensure food independence. In the indicated direction, we have developed and recommended for use a methodological approach to indicating the level of industrial (sugar production) safety, based on the procedures for analyzing the balance of business relations in raw materials and their processing in order to obtain food products - sugar and by-products.

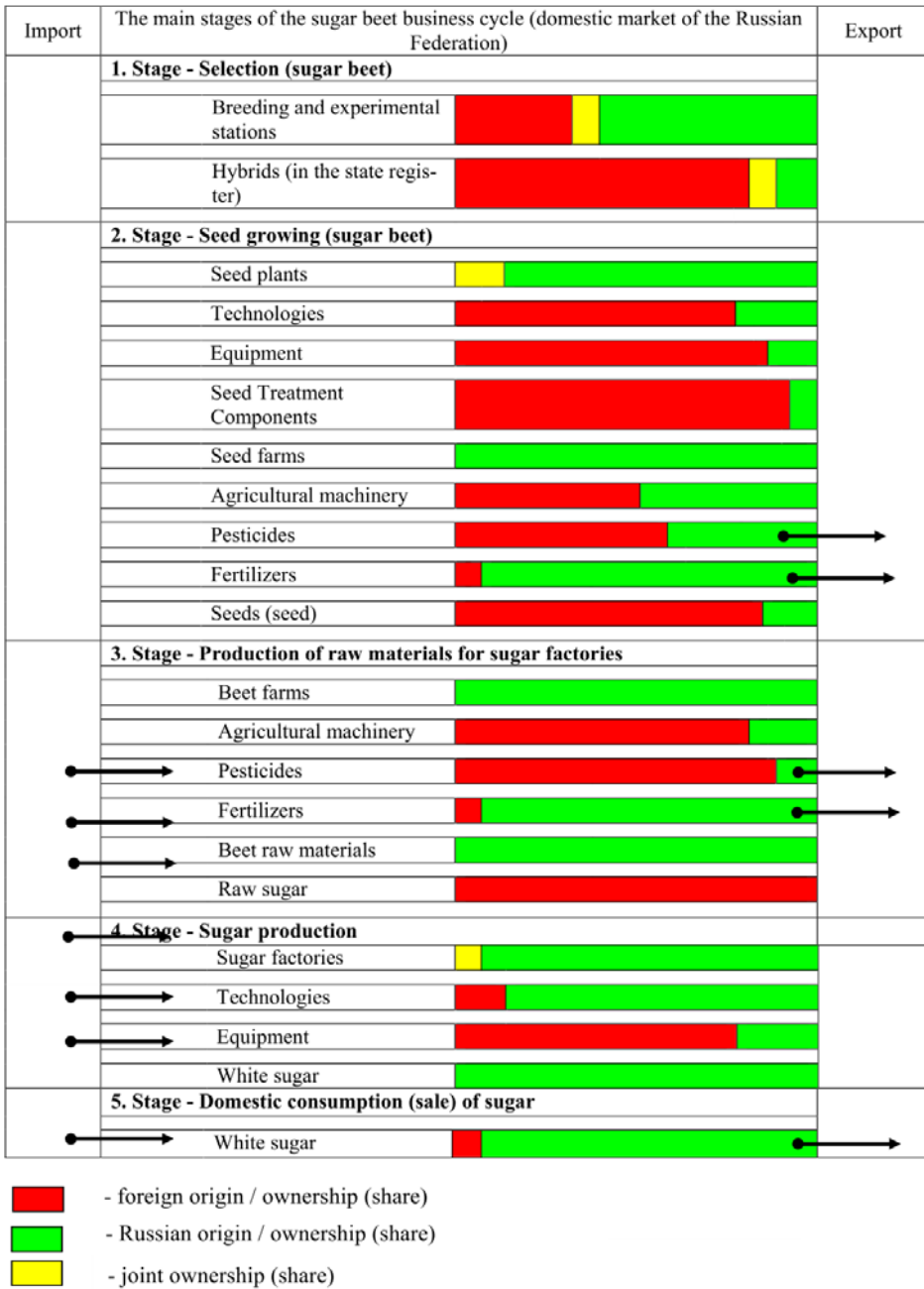
## **2 Materials and Methods**

The systemic essence of the proposed approach lies in the detailing of the beet-sugar business cycle, where each stage (an element of the beet-sugar complex) corresponds to a certain indicator, which makes it possible to judge the orientation of each element towards achieving the overall ultimate goal of ensuring food independence [3].

Figure 1 shows that the goal of business relations between the participants of the beet-sugar complex is to ensure industrial safety, the optimal level of which automatically ensures the country's food independence. The level of industrial safety is determined considering the influence of internal (unused and underutilized opportunities) and external (differential components) factors, food independence is determined by the level of industrial safety and the import of white granulated sugar. The depend component characterizes raw materials and other components of foreign origin used in beet sugar production, as well as depend sugar, and at various stages of the sugar beet business cycle manifests itself in various forms [4].

Influencing industrial safety at the corresponding stages of the sugar beet business cycle, the depend component does not directly affect the food independence of the country, since products manufactured in the territory of the Russian Federation using imported raw materials and components are considered domestic.

For the beet sugar complex in modern conditions, the question of the presence of unused and underutilized opportunities and methods of their indication at various stages of the beet sugar business cycle is relevant; underutilized opportunities are of particular importance, since they are of a non-obvious nature.



**Fig. 1.** Parameters of business relations of subjects of the sugar beet business cycle.

Underutilized opportunities should be understood as such a level of business relations when there is a negative deviation of the results of the economic activities of the associated participants from the potential ones, taking into account the established criteria of normative indicators.

### 3 Results and Discussion

The proposed analytical complex for indicating the level of industrial safety includes 15 indicators (Table 1, Figure 2), characterizing the corresponding stages of the sugar beet business cycle [5,6,7]:

indicators 1.1-1.3 - the possible (potential) level of achievement of production results by mobilizing all resources and the implementation of all opportunities.

indicators 2.1-2.3 - indicators of the balance of business relations (deviations of the actual level of indicators from the potential).

indicators 3.1-3.3 - achieved results in the conditions of existing business relations.

indicators 4.1-4.3 - industrial safety indicators (deviations of the actual level of indicators from the optimal).

indicators 5.1-5.3 are the optimal level required to ensure industrial safety and food independence of the country in accordance with the Strategy for the Development of the Food and Processing Industry of the Russian Federation for the period up to 2030.

Analytical iterations to indicate the level of industrial safety and assess its impact on food independence are built in the reverse order compared to the sequence of implementation of the stages of the business cycle. The proposed approach is conditioned by the logic of the performed evaluation procedures based on the knowledge of the required volume of sugar production, which is the product of the last stage of the business cycle.

We have identified the appropriate levels of indicators characterizing the industrial safety of sugar production [8,9]:

optimal - characterizes the required volume of production in accordance with the approved doctrines, strategies and development programs, ensuring the country's food independence.

potential - characterizes the possible volume of production due to the mobilization of all resources and the implementation of all possibilities. This level is characterized by a latent manifestation of the depend component, including in the following forms: the presence of foreign experimental stations on the territory of the Russian Federation; seed plants on the territory of the Russian Federation are owned by foreign companies (or jointly owned); almost all seed factories use foreign technologies and equipment; a significant share of imported agricultural machinery; a significant proportion of sugar factories use imported equipment;

actual - characterizes the achieved volume of production. This level is characterized by a clear manifestation of the depend component in the following forms: a significantly larger number of foreign breeding hybrids (compared to domestic ones) are included in the state register of breeding achievements; import of seeds of foreign selection; imported hybrids in most cases have the best quality characteristics; seed factories on the territory of the Russian Federation, owned by foreign companies, practically do not prepare domestic seeds for sowing; processing of imported raw sugar.

Balanced business relations of the associated participants in the sugar beet business cycle, ensuring industrial safety, should be recognized only as those, as a result of which:

- the optimal profitability of the conjugation of the economic activities of the participants is achieved;

- the potential opportunities of associated participants in economic activity are realized;

- the results of the business cycle participants correspond to the priority directions of the state food policy.

- the required level of industrial safety is provided, considering the demographic situation in the country.

Let's consider the content of each of the stages of the proposed methodology.

Stage 1. The level of food security is estimated, which characterizes the share of sugar produced on the territory of the Russian Federation and ensuring the satisfaction of the physiological needs of the population. The total volume of consumed sugar is made up of imported and manufactured products in the country. In accordance with the Food Security Doctrine, the share of the latter should be at least 80% [10,11]. In Russia, the share of imports of white sugar is traditionally insignificant and does not exceed 5-6%, while the influence of depend components poses a significant threat to the country's food independence [12,13].

**Table 1.** Logical structure of analytical iterations of industrial safety indication in sugar beet production.

Potential level of indicators affecting the balance of business relations	Business relationship balance indicator	Actual level of indicators affecting industrial safety	Industrial safety indicator	Optimal indicator level
1	2=3-1	3	4=3-5	5
1.1 $\frac{M_{seed.cap.} \cdot (A_{seed.s.} \cdot B_{seed})_n}{V_{seed.req.}} * 100\%$	2.1	3.1 $\frac{V_{seed.dom.c} \left( \frac{Y}{P} \cdot B_{sug} \right)_f}{V_{seed.req} \left( \frac{Y}{P} \cdot B_{sug} \right)_n} * 100\%$	4.1	5.1 not less than 80 %
1.2 $\frac{MIN (K_{prov.m.}, K_{prov.a})}{K_{prov.a}}$	2.2	3.2 $\frac{(V_{seed.dom.} * B_{sug})_s}{V_{sug.req.} * B_{sug}} * 100\%$	4.2	5.2 not less than 80 %
1.3 $\frac{M_{sug.cap.} \cdot (A_{sug.s.} \cdot B_{sug})_{nopm}}{V_{sug.req.}} * 100\%$	2.3	3.3 $\frac{V_{seed.req.}}{V_{sug.req.}} * 100\%$	4.3	5.3 not less than 80 %

Where:  $I_{21}, I_{22}, I_{23}$  – indicators of a balanced business relationship;  
 $I_{41}, I_{42}, I_{43}$  – industrial safety indicators (breeding and seed growing, beet growing, sugar production, respectively);

$M_{seed.cap.}, M_{sug.cap.}$  - design capacity of seed and sugar factories in the Russian Federation (using capacity by 95%), t / day.;

$K_{prov.m.}, K_{prov.a}$  - provision with agricultural machinery (beet-harvesting), sown areas (with beet-compaction no more than 25%), %;

$T_{beet}, T_{sug}$  - the duration of the production season of seed and sugar factories, days.;

$B_{seed}, B_{sug}$  - output of finished products of seed, sugar factories, %;

$V_{sug.req.}$  - the required amount of sugar to meet the physiological needs of the population, thousand tons;;

$V_{seed.req.}, V_{beet.req.}$  - required volume of seeds and sugar beet, taking into account  $V_{sug.req.}$ , t, thousand t;

$V_{seed.dom.c}$  - volume of sugar beet seeds produced using only domestic components, t;

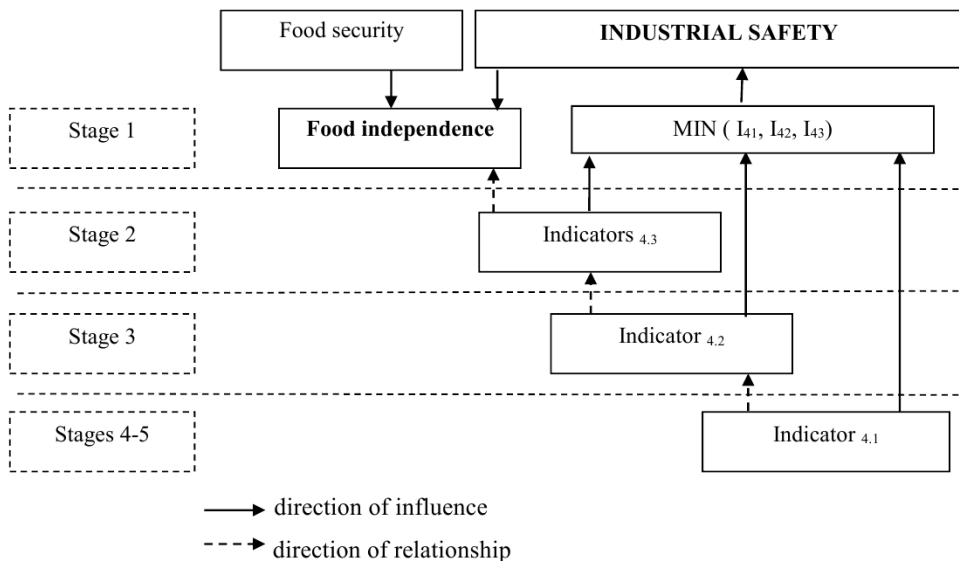
$Y$  - sugar beet yield, t / he;

$P$  - seed consumption per 1 he, kg;

$A_{sug.s.}$  - sown area suitable for the cultivation of sugar beet, thousand hectares;

$A_{sug.dom}$  - sowing areas, areas sown with seeds of domestic selection, thousand hectares;

$V_{sug.beet.}$  - sugar produced from sugar beet, thousand tons.



**Fig. 2.** Volume of the online education market in Russia, 2016-2020 in billion rubles.

Stage 2. The level of indicator 5.3 is determined, which characterizes the minimum required share of sugar produced from sugar beet. In accordance with the Doctrine of Food Security, the value of the indicator was adopted by us at the level of 80%.

At this stage, the following indicators are calculated:

indicator 1.3 is the ratio of the potential volume of beet sugar that can be produced at sugar factories in Russia, taking into account their design capacity, to the required volume ( $V_{sug.req.}$ );

indicator 3.3 - the ratio of the actual volume of beet sugar produced at sugar factories in Russia to the required volume;

indicator 2.3 = (p.3.3-p.1.3). The indicator characterizes the level of underutilized opportunities (production capacities of sugar factories), its values can vary in the range from (-100%) to 0%;

indicator 4.3 = (p.3.3-p.5.3). The indicator characterizes the impact of the level of industrial safety at the stage of beet sugar production on food independence. Its values can vary in the range (-80; 20).

Stage 3. The level of indicator 5.2 is determined, which characterizes the minimum required share of sugar beets grown from domestic varieties and hybrids. In accordance with the Food Security Doctrine, the value of the indicator was adopted by us at the level of 80%.

At this stage, the following indicators are calculated:

indicator 1.2 - takes the value of the lower of two indicators: provision of agricultural machinery ( $K_{prov.m.}$ ) and the provision of sown areas, calculated taking into account the required volume of sugar beet seeds for sowing ( $K_{prov.a}$ );

indicator 3.2 is the ratio of the actual volume of sugar beet grown on the territory of Russia from seeds of domestic selection, considering the required volume. This ratio is adjusted considering the achieved level of sugar yield.

indicator 2.2 = (p.3.2-p.1.2). The indicator characterizes the level of underutilized opportunities (sown areas and provision of agricultural machinery), its values can vary in the range from (-100%) to 0%;

indicator 4.2 = (p.3.2-p.5.2). The indicator characterizes the impact of the level of industrial safety at the stage of growing beet raw materials on food independence. Its values can vary in the range (-80; 20).

Stage 4-5. This stage combines two stages, selection and seed production, since the presence in the state register of at least one variety / hybrid of domestic selection hypothetically can give reason to consider it possible to provide 100% of agricultural producers with the required volume of seed. However, in practice, the number of breeding achievements indicates only the development of science, and not the results of its commercialization.

At this stage, the level of indicator 5.1 is determined, which characterizes the minimum necessary share of domestic selection of sugar beet seeds prepared at seed factories in Russia. In accordance with the Food Security Doctrine, the value of the indicator was adopted by us at the level of 80%. The use of imported disinfectants and similar components is not taken into account due to the lack of domestic analogues, for example, preparations of the carbofuran group.

At this stage, the following indicators are calculated:

indicator 1.1 - the ratio of the potential volume of sugar beet seeds, which can be prepared at seed factories in Russia, taking into account their design capacity, to their required volume ( $V_{seed.req.}$ );

indicator 3.1 - the ratio of the actual volume of sugar beet seeds, prepared at seed factories in Russia, to the required one. This ratio is adjusted taking into account the actually achieved indicators of yield, seed consumption, sugar yield;

indicator 2.1 = (p.3.1-p.2.1). The indicator characterizes the level of underutilized opportunities (capacities of sugar refineries), its values can vary in the range from (-100%) to 0%.

indicator 4.1 = (p.3.1-p.5.1). The indicator characterizes the impact of the level of industrial safety at the stage of selection and seed production on food independence. Its values can vary in the range (-80; 20).

Imbalance in business relationships, characterized by indicators I21, I22, I23, and, as a result, chronically unrealizable opportunities at one of the stages of the sugar beet-growing business cycle lead either to stagnation of economic activity at the next stage, or to the implementation of compensatory measures, including those leading to an increase in the

share of diplomatic components. The level of industrial safety is determined by the smallest value of the relevant indicators and an indication of opportunities at each stage of the sugar beet business cycle provides timely identification of threats to its reduction (I41, I42, I43).

Ensuring food independence of Russia and industrial safety, including sugar production, as well as business analysis of the values of the corresponding indicators and indicators are inextricably linked with the normative level of the physiological needs of the population. We propose to determine the required amount of sugar to meet the needs of the population ( $V_{sug.req.}$ ) not only on the basis of its size and growth / decrease in physiological needs, which is the primary task of the entire beet-sugar business cycle, but also taking into account its qualitative composition. In Russia, the number of diabetic patients, for whom sugar consumption is not physiologically necessary, is officially increasing annually, and the average age of diabetic patients is decreasing [14].

When determining the degree of imbalance of actions between the associated participants of two successively connected stages of the sugar beet business cycle, it is necessary to consider the indirect impact on the results of their business relations with other participants [15]. In addition, one should take into account the fact that in the sugar beet complex economic relations are not related to the participants of the first and third stages of the business cycle, that is, each of them directly interacts only with the subjects producing sugar beets.

## 5 Conclusion

The indicative approach in modern conditions is recognized as one of the most significant methods for assessing economic processes, including import substitution in domestic food production [16]. The proposed "Methodology for indicating industrial safety" allows at each separate stage of the sugar beet business cycle:

- quantify the degree of non-use and underutilization of production opportunities;
- to judge the balance of business relations of related participants in economic activity;
- determine the degree of influence of the achieved results of business relations on the level of industrial safety.

A detailed consideration of the analytical toolkit is due to the practical need for constant monitoring and adjustment of a number of indicators used in calculating the required volume of sugar, sugar beets, seeds, pesticides, agricultural machinery. In particular:

- rational norms of food consumption. From 1998 to the present, the sugar consumption rate has changed several times and has decreased from 39 kg to 8 kg per year;

- the number of patients with diabetes mellitus. The share of the population of the Russian Federation with diabetes mellitus is increasing every year. According to official data at the beginning of 2020, their number amounted to 5.1 million people, according to unofficial statistics, the figures are twice as high;

- yield and sugar content of sugar beet. In the state register of breeding achievements of 324 varieties and hybrids, only 23% are domestic. The annual registration of new hybrids and their production use have a significant impact on the level of results and industrial safety;

- the duration of the production season. Modern hybrids are able not only to provide an increase in the gross sugar harvest from 1 hectare, but to provide an opportunity to increase the season of sugar beet processing. So, if 20 years ago, when designing, the optimal duration of sap extraction was 90-95 days, now it is economically feasible - 110-115 days;



- consumption rates of various drugs. The consumption rates of drugs are often not only the result of scientific research, but also of the foreign lobby, therefore, their values also affect the level of industrial safety in a certain way.

The use of the outlined methodological approach to business analysis of industrial safety based on indication procedures in relation to sugar production makes it possible to judge the feasibility of certain areas of development of business relations in the sugar beet complex based on a statement of the level of unused and underutilized opportunities of economic activity of associated economic entities. In this context, a threefold reduction in the rate of sugar consumption will lead to a decrease in government interest in the development of the sugar beet business and to a certain stagnation in the development of business entities.

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