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To cite this article: L Shabalina *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **937** 022080

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Innovative development of the meat industry in BRICS for the environment improvement

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Abstract. Global trends in food provision indicate the consumption of meat is increasing. The world's population will reach 9.8 billion people by 2050, this leads to the predominance and growth of livestock rates over crop production in developed countries, where livestock products account for up to 60% of the gross agricultural product, as a result, that will facilitate the environment and climate change. Developing an alternative protein becomes the only remedy, since traditional production is unable to meet the growing demand for meat as almost 70% of total agricultural land is already occupied by traditional farming. Accounted facts prove the necessity in innovative development of meat industry in BRICS countries. The analysis of meat consumption in BRICS countries in 1995-2020 was carried out. It is determined over the past twenty-five years, the average per capita consumption of meat has increased by 1.8 times, while 25% of the world's population lives in the studied countries. The negative impact of livestock breeding on the environment was revealed, explained by the high consumption of water and land resources as well as methane emissions into the atmosphere. BRICS meat industry innovative development based on alternative protein is argued and proven.

1. Statement of the problem and its connection with important scientific and practical problems

According to UN experts by 2050 the world's population will grow to 9.8 billion people [1], which will increase the consumption of meat products and their prices, thereby increasing the threat to the food security of countries. It should be noted that the production of protein-containing food products of animal origin requires the highest level of resources and time expenditures. For instance, production of 1 kg veal requires up to 25 kg grain, 15 thousand liters of water and 300 m² of land, while for growing of 1 kg wheat needs only 1,000 liters of water and 3 m² of land. It is obvious without the use of innovative developments in the meat industry, it is impossible to satisfy the increasing demand for meat by a significant part of the population of the BRICS countries, which will lead to the inaccessibility of products in question for majority of citizens. In connection with circumstances mentioned, it is advisable to analyze the prospects for the innovations in the field of the meat industry based on the development of an alternative protein, which will contribute to solving both the solution of food security issues in the BRICS countries and the improvement of the environmental situation.

2. Analysis of recent research and publications

The process of regulation and control of global food security is performed by various international organizations.



The World Food and Agriculture Organization (FAO) regulates food issues, assessing the security and availability of food at the international level; International Food Policy Research Institute bears responsibility for policy making for sustainable food security; The International Fund for Agricultural Development (IFAD) controls the allocation of financial resources aimed to increase food production and improve the nutritional status of the poor population groups. The issues of economic growth and development of countries are coordinated by the Organization for Economic Cooperation and Development (OECD). Progressing in the field of patenting is carried out by the World Intellectual Property Organization (WIPO) and European Patent Organization (EPO). The scientific works of J. Schumpeter, B. Twiss, B. Sandur, N. Chukhrai, V. Tkachenko and others are also devoted to the study of the problems of theoretical and methodological aspects of ensuring innovative development in the field of food security. Innovations in the food industry are addressed in the scientific researches by I.V. Vasilieva, A.A. Krasnov, I.N. Lukiyanchuk and T.A. Kobzarenko. The development and formulation of artificial meat was carried out by A.N. Nesmeyanov, N.M. Derkanosova, L.A. Veretov, E.O. Chugunova and others.

3. Presentation of the main research material

Nutrition is one of the key factors in human health and longevity. According to the World Health Organization (WHO), the state of human health by 15% depends on the organization of health care in the state, the same is due to genetic predisposition, while 70% is determined by lifestyle and nutrition. Foodstuffs provide the human body with the energy necessary to undergo vital processes in it, the cost of labor and physical activity.

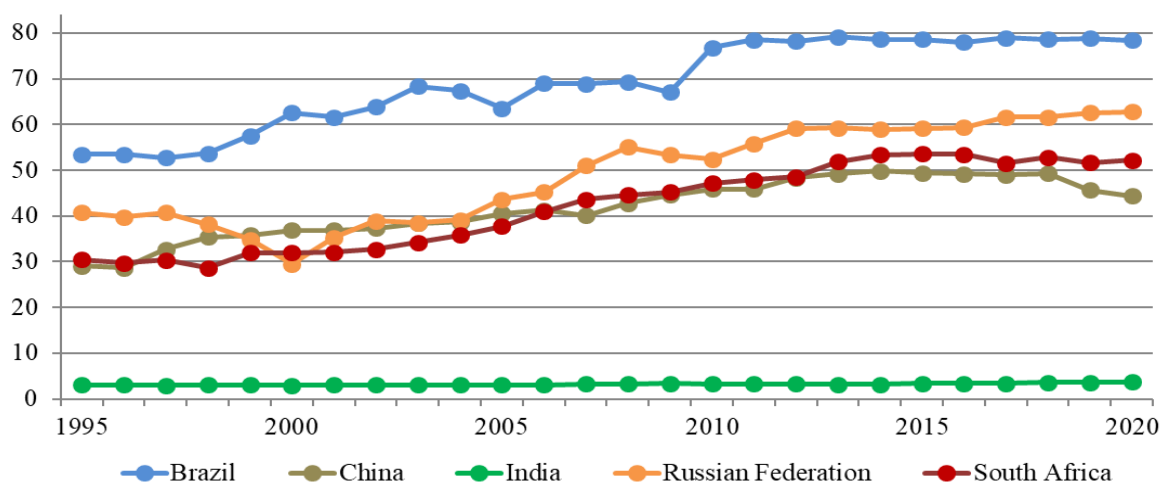


Figure 1. Average per capita meat consumption, kg / year 1995 – 2020.

Note: compiled by the authors based on data: [2]

It should be noted that animal protein is an essential part of the food intake, the consumption of which is mandatory at any age. At the same time, the growing population and its well-being have an impact on the growth of meat consumption. As an example, in the BRICS countries over the past twenty-five years the average per capita meat consumption has grown by 1.8 times (Figure 1). It should also be emphasized that in the world as a whole, the increase occurred by 20%. According to experts from the US Food and Drug Administration, in the next 40 years, the demand for meat in the world will double. As noted by O.V. Polyanskaya, almost 70% of the world's agricultural land is already occupied by livestock, and traditional production will not be able to meet the growing demand for meat, which will provoke hyperactivity of price increases, making it even more inaccessible to the majority of the population [3].

The current status of the world food problem is characterized not only by insufficient food production, but also by extremely uneven distribution and consumption between different countries and regions of the world. Moreover, more than 60% of the population is nourished unsatisfactorily in terms of getting enough of the necessary nutrients (protein, fat, vitamins, minerals). Comparison of the meat consumption level in each of the BRICS countries and GDP per capita confirms the thesis “the richer the country, the higher the level of meat consumption” (Table 1).

Table 1. Consumption of meat in the BRICS countries and GDP per capita.

Year	Brazil		Russian Federation		India		China		South Africa	
	consumption, kg / year	GDP, \$ /person	consumption, kg / year	GDP, \$ /person	consumption, kg / year	GDP, \$ /person	consumption, kg / year	GDP, \$ /person	consumption, kg / year	GDP, \$ /person
1995	53,5	4748	40,7	2665	3,0	373	29,1	609	30,5	3751
1997	52,7	5282	40,8	2737	3,0	415	32,8	781	30,3	3549
2000	62,6	3749	29,5	1771	3,0	443	36,8	959	31,9	3032
2003	68,4	3070	38,5	2975	3,1	546	38,4	1288	34,2	3751
2006	69,0	5886	45,2	6920	3,1	806	41,3	2099	41,0	5602
2009	67,1	8597	53,4	8562	3,4	1101	44,6	3832	45,2	5862
2012	78,2	12370	59,2	15420	3,3	1443	48,3	6316	48,5	7501
2015	78,7	8814	59,2	9313	3,3	1605	49,4	8066	53,5	5734
2017	79,0	9925	61,6	10720	3,4	1981	49,0	8879	51,5	6131
2019	78,9	8717	62,6	11585	3,6	2099	45,7	10216	51,6	6001
2020	78,5	8955	62,8	11305	3,7	2338	44,4	10872	52,2	6193
Rate of increase 2020/19 95, %	47	89	54	324	21	527	53	1685	71	65

Note: compiled by the authors based on the data: [2], [4].

The size of GDP is indicated in current prices

Although meat is a concentrated source of nutrients, it increases the risk of chronic diseases stimulation such as cancer and cardiovascular disease. For example, the results of a study published in the International Journal of Cancer [5] indicate an increased risk of woman breast cancer. In the course of the study, scientists monitored the health of 42 thousand respondents in the period of 7.6 years, who often ate red meat. Thus, the risk of developing breast cancer was 23% higher for those who ate pork and beef. A study of the red meat effect on human health was conducted by the American College of Physicians (ACP), covering more than 120,000 subjects, suggests red meat increases the risk of cardiovascular disease [6]. A serving of unprocessed red meat in a daily diet has been shown to increase the risk of premature death by 13%, cardiovascular disease by 18% and cancer by 10%, while for processed meat it is 20%, 21% and 16%, respectively.

The current trend to increased consumption of animal protein has a major impact on the land and water use, as the expansion of agriculture has become one of the most significant anthropogenic impacts on the environment. According to the Food and Agriculture Organization of the United Nations (FAO), the total area of agricultural lands in the world has grown by 10% over the past fifty

years, and the area of arable agricultural lands by 15%. At the same time, the area of plowed lands increased by 10%, and the territory that gives a constant harvest (2-3 times per year) - by more than 86%. The irrigated lands have grown over this period by 106% and amounted to more than 331 million hectares. Lands used at the constant basis as meadows and pastures expanded by 8% [7].

It should be noted that the land area of the planet is slightly more than 13 billion hectares, where agricultural land occupies only 37.7% (4900 million hectares) of the total land area, of which about 32% is industrially cultivated as arable land (1585 million hectares). More specifically industrially cultivated lands are understood to be under the jurisdiction of farmers and organizations engaged in agriculture as the main activity. This type of land does not include gardens and household plots, the area of which is about 1 billion hectares, while the rest of the land is splitted on pastures and meadows, which occupy 25.5% of the land area (3315 million hectares). Figure 2 presents data on the amount of land required for use in the production of one kilogram of meat. The data indicate that an increase of the world's population will lead to the depletion of the world's land resources, which results in the need for innovative development of the meat industry, one of which is the alternative protein.

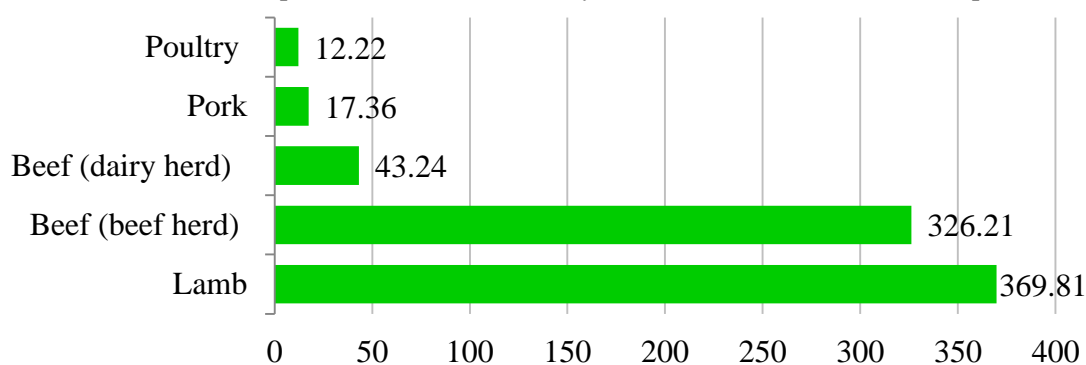


Figure 2. Land use per kg of food, m² [8].

It should be emphasized that the development of animal husbandry is one of the reasons for climate change, since the production of animal protein consumes a significant amount of water and at the same time releases greenhouse gases into the atmosphere. According to experts, animal husbandry provides 39% of all methane emissions and 5% of carbon dioxide, while cows are the most harmful source of animal protein for the environment. According to FAO, about 1.5 billion cows live worldwide, which are directly or indirectly associated with the emission of 18% of all greenhouse gases, that causes much more damage to the environment than all transport in the world collectively. Also, as a result of the production and transportation of meat, the transportation of feed and the arrangement of pastures for cows, fuel is burned, which in complex gives 9% of the world's carbon dioxide emissions. So, for example, for the production of one meat cutlet, you need about 1200 liters of water and 4 m² of land [9].

At the same time, modern technologies for the production of animal protein are characterized by its high cost in relation to the production of fodder for livestock and poultry. According to “Our World in Data”, the amount of feed required to produce one kilogram of meat varies from 3 to 25 kg dry, depending on the type and breed of farm animals (Figure 3).

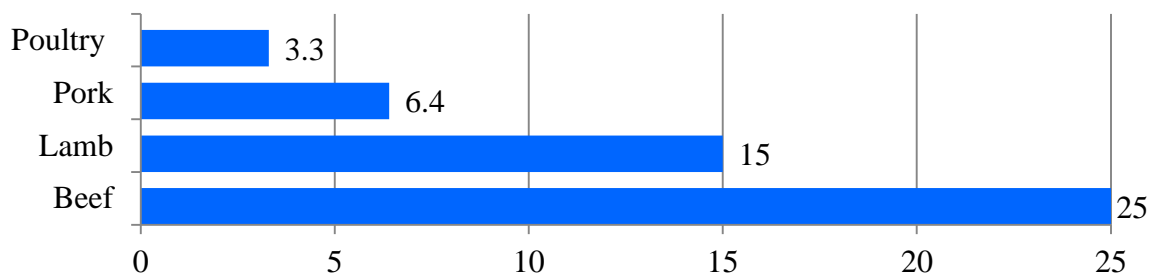


Figure 3. Feed costs for the production of 1 kg meat [10].

The main raw materials for the production of feed for farm animals are grain crops. In this regard, it is advisable to consider the share of the harvested crop that goes to the production of the fodder base. This indicator is calculated after adjusting for trade and does not take into account personal consumption by the population and industrial use (for example, for the production of biofuels) (Figure 4).

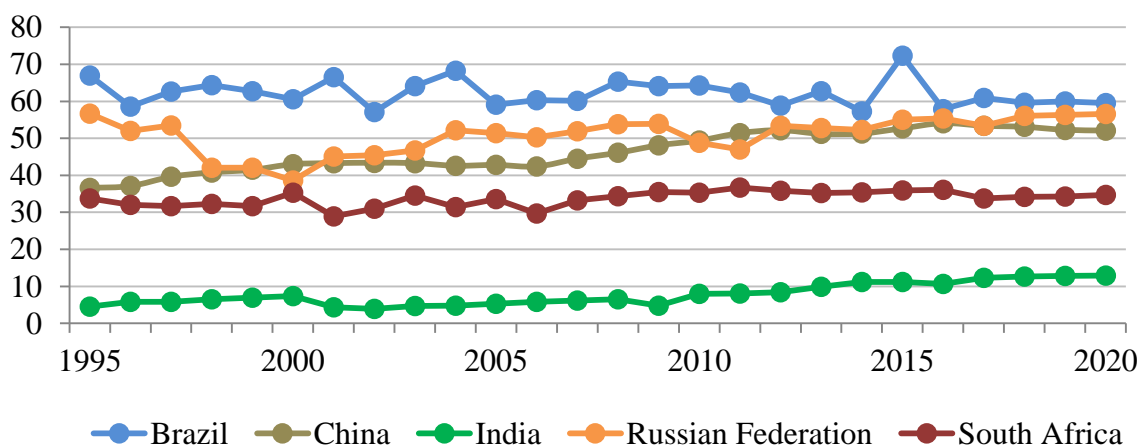


Figure 4. The share of crops used for the production of fodder for farm animals in the BRICS countries.

Note: compiled by the authors based on the data: [10]

It should be noted that according to the methodology of FAO experts [11], the condition of food security of the state is assessed by the volume of grain reserves, which should account at least 17% of total state consumption. When comparing the cost of feed for farm animals in the BRICS countries with the world average, which in fact remains practically unchanged over the study period, it comprises about 40%, means, significant risks in ensuring access to food for the population of the countries of the integration association are detected. Thus, the level of grain consumption for feed for farm animals in Brazil, Russia and China in 2020 amounted to 59%, 56% and 52%, respectively, then taking into account the minimum recommended reserves for consumption by the population, no more than 30% of the harvested crop remains. This value of the indicator cannot be considered sufficient, taking into account the fact that the share of the studied countries accounts for almost 25% of the world's population. At the same time, breeding livestock accounts for only 18% of the world's calories and 37% of protein.

Analysis of the production of meat products in the BRICS countries in 1995 - 2020 shows that all countries of the integration association have increased the production volume almost in 2 times, occupying a significant share of the meat market in the world. So, while in 1995 BRICS countries together made 34% of global production, then in 2020 made already 40% produced (Figure 5).

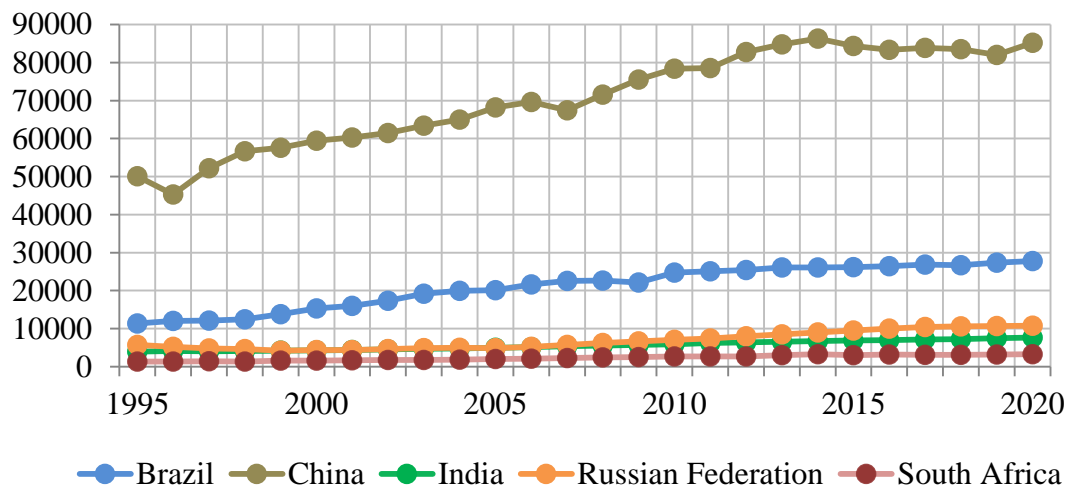


Figure 5. Meat production in the BRICS countries, thousand tons.

Note: compiled by the author based on the data: [2]

The current livestock production capacity will not be able to cover the projected growth in demand for meat products in the coming decades. In this regard, the response of the scientific community to this challenge should be innovations in the meat industry, with the help of which it is possible to prevent the development of a crisis in food supply as well as further deterioration of the ecological situation in the BRICS countries [12]. It should be noted that the concept of artificially grown meat makes it possible to form and regulate the nutritional value of a food products, to give it the desired properties, to create a wide range of functional, therapeutic and prophylactic products, as well as to model new types of meat raw materials in laboratory conditions providing the careful use of natural resources. Serious considerations should be given to the comparative advantages of artificial meat producing:

1. Creation requires 75% less water, 95% less land, 46% less electricity, while producing 87% less greenhouse gases [13,14]. In the United States, it is estimated that a complete rejection of meat in favor of a substitute will lead to the fact that carbon dioxide emissions will be reduced as much as if 12 million cars disappeared from the streets at the same time.
2. A high-quality and safe product is produced, which excludes the possibility of infecting the population with infections transmitted through livestock products.
3. The risks of animal diseases and the ingestion of antibiotics in meat are leveled.
4. The efficiency of the use of agricultural land is increasing.

4. Conclusions and prospects for further research

Based on the foregoing, it can be concluded that the possibilities for the extensive development of traditional animal husbandry have been exhausted, which calls it necessary to develop an alternative sources of animal protein production by the scientific community. Primarily this task is facing the scientists of the BRICS countries, since the integration association plays a key role on the meat market due to significant agricultural territories, population as well as the level of production and consumption of these products. In addition, there is a need to create more efficient, inclusive and resilient food systems, increase natural disasters resilience, prevent threats to the environment and food systems, which will contribute to improving the population quality of life.

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