

**TECHNICAL AND TECHNOLOGICAL PECULIARITIES OF MEAT INDUSTRY
DEVELOPMENT IN THE COURSE OF BASIC ECONOMIC TRENDS OF
INNOVATIVE DEVELOPMENT OF FOOD INDUSTRY IN UKRAINE**

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Abstract: *The actual state and prospects of innovative activity in food, in particular meat, industry are considered. The innovative potential of the food industry in Ukraine is shown to grow more dynamically than that of other sectors of domestic industrial production and an urgent need to implement innovative measures aimed at modernizing technologies and equipment of food production is proven. It is substantiated that financially and technically reasonable innovative activity can and should sufficiently improve the current economic state of the meat industry in Ukraine. Meat industry is the most attractive in terms of return on investment and profitability of innovations among the sub-branches of food industry. The actual directions of innovative activity in the meat industry, as well as the probable ways of development of innovations in the short term, are described.*

Key words: *food industry, meat industry, meat, innovations, innovative potential, innovative activity, meat processing technologies, meat production equipment.*

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A necessary prerequisite for the achievement of proper competitiveness of domestic products in both Ukrainian and international markets, as well as an important factor in the sustainable development of the national economy, is the innovative nature of industrial development. Now the innovative potential of the food industry in Ukraine is growing more dynamically than that of other sectors of domestic industrial production. Unlike high-tech products, for which the Ukrainian market is mostly operated by foreign producers, most part of food products, both by volume and nomenclature, is made from domestic raw materials at the industrial capacities within Ukraine. The overwhelming development of agro-industrial production, including that of foods, can hardly be considered a positive macroeconomic trend, but it stimulates practical interest of investors to participate in innovative projects,

their payback period being quite reasonable. So, the conjuncture is quite positive in the sense of intensification of innovation activity in the food and processing industry [1].

There are numerous legal acts regulating the legal and normative basis for the implementation of innovations in Ukraine, the main directions of the said activity, the rights and responsibilities of the appropriate stakeholders etc. The Law of Ukraine "On Investment Activity" [2] defines it as an activity aimed at the use and commercialization of scientific research and development and, as such, leading to the launch of new competitive goods and services on the market. In particular, the innovations are newly created (applied) and (or) advanced competitive technologies, products or services, and the innovative product is defined as the result of research and (or) development, the said result meeting the requirements established by norms in force [2].

The tasks defined in the medium-term plan of priority actions of the Government until 2020 and approved by the Decree of Cabinet of Ministers of Ukraine No. 275-r of April 3, 2017 [3], also focus on the fact that today Ukraine's economy mostly supplies raw materials, its produce being traditional industrial and agrarian goods of low added value. It is deplorably but it has to be stated that the technological gap between Ukraine and the developed countries has been deepening constantly, and one of the main problems of Ukraine's development is an inefficient state policy in the sphere of innovations in the production sector of the economy, this causing lack of incentives for the development of start-ups and innovative business, the lack of models for state support for the development of innovations and the outflow of highly qualified personnel in all spheres of economic activity. The consequences of this also are: limited access to financing in the early stages of innovation development, the low level of interconnection between business, universities and academic institutions, the low level of technology transfer, discrepancy between the educational content and contemporary market needs. In addition, the state system of legal protection of intellectual property is not able to ensure the development of intellectual property as the basis of the innovative economy of Ukraine. The science intensity of Ukraine's gross domestic product did not exceed 0.3% in 2016, while in the EU and China this parameter was about 2%. In general, this situation is characterized by the indicators adduced in Table 1.

*Table 1***Principal parameters of innovative development in Ukraine**

Parameters	2011	2012	2013	2014	2015	2016
Science intensity of domestic product, %	0.74	0.75	0.70	0.65	0.61	0.3
Global innovation index, place	60	63	71	63	64	56

Source: State Statistic Service of Ukraine, World Bank, ITU, GII

Among other priority areas of investment activity defined by the Law of Ukraine "On Priority Areas of Investment Activity in Ukraine" [4], for the period of 2011-2021, the technological renewal and development of the agro-industrial complex are also mentioned. This approach reflects the worldwide trend to focus scientists' efforts towards addressing important food safety issues and improving the quality of food, as well as health care, public welfare and securing consumers' needs [5].

The latest advances in biotechnology, nanotechnology and technology of storage of food raw materials and food products can be widely applied in the food industry. At the same time, it is necessary to reach compliance with regulatory requirements and to establish effective contacts with all involved parties possessing the necessary and relevant information. All the said factors in their totality, determine a completely outlined paradigm for new challenges in the development of the food industry [6]. Research and transfer of technologies in the agro-food sector are in the process of gradual transition to innovative systems aimed at enhancing the dynamism in the relations between market operators and state institutions working in the field of production and development of technologies that fully meet the requirements of producers, consumers, retailers, suppliers, generators of new knowledge, creators of innovations, etc. in order to ensure the development of this sector and to oppose global challenges these providing proper approaches to solving problems of education, poverty, social instability, unemployment, insufficient productivity, competitiveness and stability, lack of long-term investments, accessibility and introduction of modern information technologies [7].

In the food industry, as well as in other sectors of industrial production, attracting new knowledge, technologies and taking into account new market conditions become key elements of development, however in the case of the food industry, general trends are rarely enough the factors of its global innovation renewal due to the local nature of innovations in the food industry and lack of proper consideration of its characteristic traits. Proper understanding the importance of the food industry for the world market and ensuring the welfare of the consumers requires the most thorough analysis of the problem to be made in order to identify the factors, strategies and initiatives that determine the innovative development of the industry [8, 9].

Concerning the food industry enterprises, it should be noted that about 50% of food and processing enterprises are of advanced technical level, while other enterprises require innovative modernization. In 2016 only 154 innovative products and technologies were introduced at 900 enterprises surveyed. The total amount of expenditures for innovation activity amounted to 2.2 billion UAH or 9% of the total costs spent for the entire industry of Ukraine.

The intensity of innovative activity in the food industry directly depends on the financial condition of enterprises, since more than 70 percent of enterprises implement innovations at their own expense. This reduces the burden on the country's budget but very often the amounts of these funds are not sufficient to meet the requirements of scientific and technological progress. The amount of expenditures for innovation by sources of financing is shown in Table. 2

Table 2

Sources of financing innovative activity in the food industry, thousand UAH

Years	Total expenses	Due to funds				
		own	state budget	foreign investors	loans	other
2012	1566274.9	1411651.3	52.7	0	154198.8	372.1
2013	1700695.3	1477280.1	5.8	137643.6	85765.8	0
2014	2173609.8	1768501.9	0.4	380.0	403218.3	1509.2
2015	1540271.7	1476576.5	5.3	1638.0	61771.9	280.0
2016	2186483.3	1771446.3	-	6525.0	374967.2	33544.8

Source: developed according to the data of State Statistic Service of Ukraine

Unfortunately, the official statistics lacks the data on the value of sales of innovative products by food industry enterprises in 2016 and 2017. Therefore, it is impossible to evaluate the effectiveness of innovation in the food industry. It should be noted that the share of enterprises engaged in innovation activity and implementing innovations for the period of 2015–2016 did not almost changed (Table 3)

Table 3

Implementation of innovations by industrial enterprises, %

Year	Share of enterprises engaged in innovative activity	Share of enterprises implementing innovations	Including			
			Share of enterprises implementing innovative processes	Share of enterprises implementing low-waste, energy efficient technologies	Share of enterprises implementing innovative products	Share of enterprises implementing products new for the market
2012	17.4	19.8	47.1	41.4	50.3	5.2
2013	16.8	18.7	43.3	35.8	53.9	7.8
2014	16.8	13.3	34.3	10.6	50.6	9.1
2015	18.1	16.8	48.5	13.9	56.4	10.9
2016	18.9	17.1	71.4	26.6	74.7	20.8

Source: developed according to the data of State Statistic Service of Ukraine

The activity of intellectual property applicants for innovative products in the food industry is much lower than in other sectors of the economy, but somewhat higher than in agriculture (Table 4).

Table 4

Objects of intellectual property in agriculture and food industry registered by domestic applicants - legal bodies

Objects of intellectual property	2015	2016
1. Applications for inventions:		
– in agriculture, forestry and aquaculture, units / % from total amount in Ukraine	1 / 0.09	1 / 0.08
– in production of foods, beverages and tobacco goods, units / % from total amount in Ukraine	–	3 / 0.25
2. Patents for inventions		
– in agriculture, forestry and aquaculture, units / % from total amount in Ukraine	–	–
– in production of foods, beverages and tobacco goods, units / % from total amount in Ukraine	3 / 0.28	–
3. Applications for utility models		
– in agriculture, forestry and aquaculture, units / % from total amount in Ukraine	15 / 0.28	8 / 0.13
– in production of foods, beverages and tobacco goods, units / % from total amount in Ukraine	22 / 0.42	18 / 0.28
4. Patents for utility models		
– in agriculture, forestry and aquaculture, units / % from total amount in Ukraine	11 / 0.21	16 / 0.27
– in production of foods, beverages and tobacco goods, units / % from total amount in Ukraine	29 / 0.55	14 / 0.23

Source: developed according to the data of State Statistic Service of Ukraine

It should be noted that in 2015 food industry enterprises lost their positions in the implementation of innovative products on the domestic as well as on international markets (Table 5).

Table 5

Sales of innovatively active industrial food enterprises in the period of 2012 – 2015

Parameter	2012	2013	2014	2015	
The volume of sold innovative products in the food industry, billion UAH	4.6	7.3	6.3	4.9	
The distribution of volumes of innovative products sold by the level of novelty, billion UAH / percent of the volume of innovative products sold	the product was new to the market	1.6/ 33.9	1.7/ 23.5	0.8 / 13.0	0.9/ 18.0
	the products were new only for the enterprise	30.5/ 66.1	5.6/ 76.5	5.5 / 87.0	4.0 / 82.0
The volume of innovative products sold outside Ukraine, billion UAH	0.4	1.2	0.6	0.7	
Share of sold innovative products in the total volume of industrial products sold, %	2.5	3.5	8.8	1.3	
The share of sold innovative products outside Ukraine in the total volume of innovative products sold, %	8.5	15.9	26.6	15.0	

Developed according to [10]

The coefficient of the anticipation of growth in the volume of sales of the food industry over the growth of expenditures during the period under review ranged from 0.7 to 1.5, that is, the trend was not constant (Table 6), showing the low efficiency of using funds to finance innovative activities and indicating the lack of effective mechanism of management of innovative development at food industry enterprises, the said mechanism would be able to provide a positive result in the long term. At the same time, in 2015 its value increased and reached above 1, which indicates a positive trend.

In 2015, according to the assessment of innovative activity of the principal industrial sectors using 10 indicators [11], for the category of economic activity "Production of food products, beverages and tobacco products", the group of enterprises that implemented innovation processes consisted of 80

units (indicator 1), 23 enterprises introduced low-waste, resource-saving technologies (indicator 2), 93 enterprises introduced innovative products (indicator 3), expenditures for internal research (indicator 4) amounted to 82.821 million UAH, expenditures for external research (indicator 5) – 3.5 million UAH, expenditures for new machines, equipment and software (indicator 6) – 1328.441 million UAH, expenditures for other external knowledge (indicator 7) – 1.172 million UAH, other expenditures (indicator 8) – 124.339 million UAH, the volume of innovative products sold in the domestic market (indicator 9) reached 4142.935 million UAH, in the international market (indicator 10) – 731.599 million UAH. According to the results of cluster analysis of innovative activity of the principal industrial sectors performed in [11], the food industry is characterized by the “high” level of innovative activity.

Table 6

Anticipating growth in the volume of sold products over the growth of expenditures of food industry enterprises

Parameter	2012	2013	2014	2015
Volume of the products of food industry sold, million UAH	4614295.9	7275705.7	6293927.3	4874534.3
Rate of growth of the volumes of products sold,%	-	157.7	86.5	77.4
Total expenditures, million UAH	1566274.9	1700695.3	2173609.8	1540271.7
Rate of growth of total expenditures, %	-	108.6	127.8	70.9
Coefficient of the anticipation of growth in the volume of sales of the food industry over the growth of expenditures	-	1.5	0.7	1.1

Developed according to [10]

Meat industry has traditionally been one of the most developed areas of the food and processing industry in Ukraine. Taking into account the traditional diet of the Ukrainians together with the existing structure of the domestic agro-industrial complex in the economic, geographical and historical context, the production of meat and meat products has been and remains one of the priority directions of ensuring food security of Ukraine. It is impossible not to note the difficulties which the economic activity of meat processing enterprises encounters nowadays. Among these difficulties are the insufficiency of high-quality raw materials, the lack of a balanced logistics system, the permanent increase in energy prices, increased competition from imported products, the lack of effective strategic management of enterprises. The lack of effective means to solve problems in the functioning and development of the meat industry leads to a reduction in the volume of production with a significant increase in its cost [12, 13].

The financially and technically supported innovative activity can and should improve the current economic state of the meat industry in Ukraine. Studies show [14] that the meat industry, along with butter and fat production, is the most attractive in terms of return on investment and profitability of innovation. Innovative activity in the meat industry is not only economically expedient, but critically necessary, and it is important to promote the fullest involvement of domestic producers in this activity. Unfortunately, the vast majority of equipment for slaughter, primary processing of livestock, and for the production of meat products is of foreign origin and imported to Ukraine, so the small enterprises are mainly equipped with restored meat processing equipment from EU. In this respect, it is impossible to consider as positive the actual trend of the predominant development of large engineering companies specializing in integrated services including supplies of foreign technologies and specialized technological equipment, mainly represented by the reconditioned machines [15]. However, the Ukrainian machine-building enterprises can manufacture equipment for the primary processing of animals/poultry together with some machines for meat processing and production of meat products. However, it should be recognized that the domestic equipment is much inferior to the best foreign samples in sense of its weight, reliability, longevity, the technical level of control systems, etc. Analysis of the needs of meat industry enterprises in specialized technological equipment and the capabilities of domestic machine-building enterprises make it possible to say that

the prospect of domestic machine-building for meat production consists in determining specific segments of equipment of medium technical complexity (for example, meat mincers), which should be enhanced to secure own niche in the domestic machine-building market and to acquire excess to the markets of other countries. Rotating bowl cutters, flow cutters, vacuum sausage fillers, automatic brine injectors and other technically complicated machines are yet expedient to be imported until the domestic machine-building enterprises reach a competitive level of quality and technical perfection of the said machines [12].

The field to implement innovations in the meat industry is extremely wide. Here are some possible directions for innovative renovation of enterprises and facilities fulfilling slaughtering, primary processing of animals and the production of meat products:

- introduction of modern technologies for slaughtering farm animals and appropriate technical equipment, based on the current concept of humane treatment of them;
- equipping of industrial poultry enterprises with automatic high-performance lines for complex processing of poultry – from the slaughtering to dividing carcasses into retail cuts;
- use of robotics for slaughter and primary processing of animals in order to replace workers in heavy and dangerous technological operations;
- use of barrier packaging materials, as well as modified gas atmospheres, introduction of "smart packaging";
- introduction of environmentally friendly (biodegradable, edible, etc.) packages to reduce the burden on the environment;
- a radical change in the concept of the use of vegetable raw materials in meat and meat containing products – from just reduction in the cost of production through the addition of cheap ingredients to the purposeful enrichment of products with plant fibers, valuable essential oils, etc. in order to provide products of functional and therapeutic properties, technical and technological provision of an appropriate replacement of traditional spices with new aromatic materials;
- meat processing with the use of effective biotechnological methods, including injection of whole-muscle products with protein-fat products of animal origin (meat-in-meat technology), limiting the caloric content of sausages by replacing fat with analogues based on animal and plant jellies, using a variety of bacterial preparations to achieve the desired tenderness of meat products and to intensify their production;
- introduction of technologies for the production of "convenient foods" of full or high culinary readiness;
- improving the quality and safety of minced meat products by softly separating meat and bone raw materials from slaughter animals and poultry rather than mechanically deboning them, which causes unduly significant content of bone inclusions in the meats processed;
- technical and technological support of processing of organic animal raw materials into organic products to be in great demand among domestic and foreign consumers;
- ensuring the production of meat products of baby, infant and geriatric assortment, including the design of appropriate formulations and the improvement of technological processes of fine grinding, emulsification, heat treatment etc.

All the above-mentioned areas of innovation development seek actively, or have already found, their embodiment in the domestic practice of meat production. However, while solving today's problems, prospects should not also be forgotten. The full-scale European integration of Ukraine and the ever-increasing involvement of our country in the global food market require a proper reorientation of the efforts of the domestic scientific and technical potential addressing important but local issues of the development of agro-industrial production to the comprehensive solution of economic, technical and technological problems. It is necessary to be if not ahead, then at least in the wake of modern lines of scientific research in the field of food science. For example, the European Union financed fundamental research on the use of insects as food raw materials, which is now a huge unused protein source of worldwide importance [16, 17]. Local specialists in the food industry should overcome an understandable skepticism about this area of research in order to join it and scientifically prove the technologies for producing products from such raw materials, methods for monitoring safety

indicators and the quality of products manufactured etc. This also applies to numerous unconventional animal raw materials – for example, meats of various hydrobionts, amphibians and cheropterians. Soon the development of experimental and industrial biotechnologies of synthetic meat with the involvement of the cultivation of appropriate tissues in vitro and 3D printing methods, is rather to be expected [18, 19]. The feasibility of processing a variety of animal raw materials, the use of which for the production of protein animal feed is impossible for veterinary safety reasons, into energy materials and fuel should also be carefully considered, such technologies having already been developed [20]. They are very promising from the point of view of rational use of biomaterials and reduction of the burden on the environment, however, the economic feasibility of introducing these technologies should be duly justified and calculated.

Thus, the conjuncture is quite positive in the sense of intensification of innovative activity in food, in particular meat, industry. Now the innovative potential of the food industry in Ukraine is growing more dynamically than in other sectors of domestic industrial production. Innovative measures are now an urgent necessity, since only 50 percent of food and processing enterprises are technically and technologically correspond to the current world level.

Meat industry has traditionally been one of the most developed areas of the food industry in Ukraine. Properly financially provided and technically buttressed innovative activities can and should significantly improve the current economic state of the meat industry in Ukraine. Meat industry is the most attractive among other sectors of food production in terms of return on investment and profitability of innovations. The field to implement innovations in the food industry is extremely broad. Here are some directions of innovative renewal of meat industry enterprises: use of robotics for slaughter and primary processing of animals; use of barrier and environmentally friendly packaging materials, as well as modified gas atmospheres, introduction of "smart packages"; technology of production of "convenient foods". However, solving today's problems, we should not forget about the prospects and be ready, in the economic and technical sense, to implement innovations, which food scientists and technologists are working on today.

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