UDC 339.13:636.4 DOI 10.62034/2815-5300/2025-v2-i1-006

DETERMINANTS OF THE DEVELOPMENT OF THE WORLD PORK MARKET: EFFICIENT SCALE OF PRODUCTION AS A CONDITION FOR ACCESS TO LEADING IMPORTERS

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ABSTRACT. The article analyzes the causes of the long-term decline in Ukraine's pig herd and the rise in pork imports through the lens of organizational–managerial models and an integrated value chain (primary production, feed production, veterinary services, breeding/genetics, processing and packaging), where synchronization among links and transparent rules of interaction are pivotal. It is shown that the global pork market is highly concentrated: exports are controlled by a narrow group of countries integrated with suppliers of soybeans and corn and underpinned by intergovernmental agreements and long-term contracts that scale up feed production and industrial pig farming. The paper identifies Ukraine's dysfunctions: the crowding out of small and medium producers and the concentration of herds in large enterprises which—under constrained supply—increases the efficiency and profitability of market leaders via higher selling prices, but simultaneously reduces pork affordability for low- and middle-income households. It is argued that for land-scarce countries the decisive factor of competitiveness is the manageability of feed flows within the "feed-to-fork" value chain and the development of logistics infrastructure (ports, grain elevators and storage facilities, transport corridors). The study reviews scholarly approaches: domestic and international literature offers divergent interpretations of competitiveness from technological optimism to the need for systemic transformation while empirical evidence (low food exports per hectare) points to structural weaknesses. Methodologically, the paper applies a systems approach, monographic analysis, and statistical grouping of 96 countries using FAO data to reveal regularities between the scale of economies, land endowment, and export outcomes. It concludes that building durable advantages on the global pork market requires long-term feed contracts, institutional alignment among chain participants, logistics development, and compliance with contemporary environmental and social requirements, which simultaneously improves domestic food accessibility.

Keywords: pork, scale of production, competitiveness, market infrastructure, foreign investment.

INTRODUCTION

Problem statement. Since the beginning of independence, Ukraine has shown a steady trend of decreasing pig population and increasing pork imports. In order to adequately diagnose the causes and find solutions, it is advisable to consider the problem through the prism of organizational

and management models of countries that have achieved success in production and stable provision of quality livestock products to the population. Enterprises capable of generating growing added value are built as chains built on expertise, data and standardized value creation processes in which primary production, organized feed production, veterinary support, breeding and genetic selection, processing and packaging function in a coordinated manner. Synchrony between links and transparent rules of interaction are key.

The world pork market is characterized by a high concentration: exports are controlled by a limited number of countries integrated with several feed suppliers (primarily soybeans and corn), which have favorable natural and climatic conditions. Interstate agreements and long contracts ensure large-scale feed production in exporting countries and correspondingly large-scale industrial pig production in importing countries of these resources.

In Ukraine, there is a displacement of small and medium-sized producers and a concentration of livestock in large enterprises. With limited supply, this market structure increases the efficiency of large players due to rising selling prices and profitability, but at the same time narrows the availability of pork for low- and middle-income households.

For low-land-supply countries, effective management of feed resource flows within the pigmeat value chain becomes a crucial factor for competitiveness. Policy and business strategy priorities should focus on the development of logistics infrastructure (ports, elevator and storage capacity, transport corridors), long feed contracts and institutional alignment of chain actors. This setting allows you to increase the scale of production, reduce feed costs –, the main item of the cost price –, and form sustainable competitive advantages in the global pork market, while increasing domestic food availability.

Analysis of recent research and publications. Analysis of recent research and publications. Even during the peace period, Ukraine faced numerous organizational and managerial dysfunctions, the ignoring of which led, in particular, to a long-term reduction in the number of animals. An indicative marker of structural inefficiency is Ukraine's position in terms of food exports per 1 hectare of arable land: in 2021, the country ranked 107th in the world ranking.

Against the background of these empirical data, excellent interpretations of the potential of competitiveness can be traced in the literature. Yes, G.V. Havryushenko emphasizes the presence of competitive advantages in Ukraine on the world food markets and predicts their further strengthening due to the spread of resource- and energy-saving technologies [1]. The team of authors T. IN. Hrynko, T.Z. Gviniashvili, I.S. Hamerska also claims that Ukraine is already the world leader in the market of agricultural products [2].

Along with this, the works devoted to the tools of strategic management outline a wide list of measures to increase competitiveness at the enterprise level. In particular, in the dissertation of A.O. Sitkovskaya has been provided with a set of such measures [3, p. 332], however, there is no completed organizational design of an entity capable of implementing them in an integrated manner. Part of the research reduces the explanation of competitiveness to one dominant factor: O.V. Bilyk links the growth reserves of foreign economic competitiveness primarily to export prices [4], and V.V. Nechyporenko believes that only a radical transformation at the economic level will ensure high competitive positions [5], however, without revealing the systemic mechanism of such transformation. G.S. Fedoseeva proposes a list of measures for the formation of competitive advantages (positioning the country's image, simplifying access to foreign markets, attracting foreign investments) [6, p. 341].

In foreign literature (B. Matkovski, S. Zekić, D. ijokić) highlights the lack of a generally accepted approach to measuring competitiveness at the macro level and emphasizes the need to take into account trade legislation, increase the share of value added and ensure profitability of production [7].

A separate cluster of studies links competitiveness prospects with integration projects, particularly within the Chinese «One Belt – One Road» initiative. In this context, the multiplicative effect of investments in market infrastructure (ports, road and rail corridors, storage facilities, etc.) is considered, potentially accelerating export activity and regional development.

Ukrainian scientists T.O. Ostashko and V.K. Olefir singles out the possibilities of attracting Chinese investments primarily in infrastructure and agricultural projects [8,9]. At the same time, the results of research by scientists of Chinese universities V. Yerohin, Li Diao, Peiran Du on the Central Asian countries demonstrate not only the potential benefits for agriculture, but also the risks of excessive concentration of foreign land control and the import of labor, which can provoke social tensions [10]. This highlights the ambivalence of the exogenously investment model: combining infrastructural benefits with institutional and social risks.

Empirical works confirm the gravitational pattern: the intensity of trade between countries increases directly in proportion to their «economic mass». Over the past decades, most states have concluded both multilateral agreements within the WTO and numerous regional arrangements [11], which has contributed to the formation of trade clusters of – groups of countries with increased internal exchange intensity [12]. In such institutional conditions, exports increase especially quickly when the importer simultaneously invests in the exporter's logistics infrastructure (ports, transport corridors, elevator and warehouse capacities), increasing throughput and reducing transaction costs.

Most clearly, interdependence is manifested in the agri-food value chain of pork: alongside the movement of the final product, there is an intense cross-border movement of critical feed – primarily soybeans and corn. It is the dynamics and manageability of these flows that significantly determine the scale of production and the cost of production, and therefore the competitiveness of participants on world markets.

The purpose of the article is to identify and systematize the key determinants of the development of the global pork market and justify the threshold «of the effective scale of production», the achievement of which is a necessary condition for entering the markets and maintaining contracts with leading importers.

The theoretical and methodological basis of the conducted research was the methods of the systemic approach – of a comprehensive vision of the system of export-import relations at the global level depending on the wealth of countries. The monographic method was used to analyze the results of scientists' research on the environment in which the competitiveness of countries in certain segments of the global market is formed, and statistical grouping – for establishing patterns of trade relationship depending on a number of indicators of the size (scale) of the economies of certain groups of countries.

PRESENTATION OF THE MAIN RESEARCH MATERIAL

The scale of the agrarian business of the countries of the world in the planetary dimension is due to natural and climatic conditions, environmental restrictions, available labor resources, difficulties in transporting resources and food, rivalry between national economies of different capacities, including the agrarian sector, adopted development strategies, political activity, institutional development, legal perfection of laws, etc. In this environment, economically stronger countries behave more aggressively in competition and adapt to the market, which takes into account the problems of population employment, environmental protection and production efficiency. Other countries, to varying degrees, are forced to adapt to the existing state with a much worse production structure, which does not sufficiently correspond to natural and climatic conditions, with the dominance of economic tasks over environmental and especially social ones. For a generalized confirmation of the above, we selected from the FAO database 96 countries, each with more than 300,000 hectares of arable land, and consumed the most pork per inhabitant. These countries account for more than 91% of the amount of exports of agricultural products, including 99% of pork, and gross domestic product (GDP) and almost 86% of export volumes in the national economy of all countries of the world (Table 1).

It can be seen from Table 1 that the countries of the three groups have practically the same land supply – 0.19-0.23 ha of arable land. However, large-scale countries (1st group) have reached 4-11 times the level of GDP per 1 hectare of arable land and have advantages in exports both in the national economy and in the food market, which is the result of the realization of a global advantage in choosing the most effective trading partners in resource and logistics terms. The countries of the

first group exported on the basis of 1 hectare of arable land, 514 USD more food compared to the 2nd group and 1.3 thousand USD – with the 3rd group. If we consider the indicators by subgroups, then the following regularity – was noted in every second subgroup with low land supply (0.08-0.13 ha of arable land), the value of exports per 1 ha of arable land in the crop production industries is much higher (except grain) than in the first subgroup with a high level of land supply (0.29-0.45 ha). Low-land countries specialize in the production of intensive, more labor-intensive and income-generating crops – vegetables, fruits, nuts, etc.

Table 1. Grouping of the countries of the world by the size of the gross domestic product and land security and their impact on the results of export activity, 2022

Indicators	Groups by GDP per country, billion US dollars									Also, Ukraine
	More then 300			40-300			Less then 40			
	Subgroups by level of arable land per 1 inhabitant, ha									
	Over 0.17 ha	Less then 0.17 ha	total	Over 0.17 ha	Less then 0.17 ha	total	Over 0.17 ha	Less then 0.17 ha	total	
Number of countries in the group	13	19	32	18	15	33	19	12	31	1
There is arable land per 1 inhabitant, ha	0.45	0.08	0.19	0.42	0.08	0.22	0.29	0.12	0.23	0.80
Share of arable land in the total area, %	55.7	20.2	75.9	13.3	3.9	17.2	5.6	1.3	6.9	3.4
The average level of GDP per country is 1 billion US dollars	3210	2248	2639	183	190	186	32	19	27	161
Share in groups to total, %:										
GDP	45.6	46.7	92.4	3.6	3.1	6.7	0.7	0.3	0.9	0.18
export of agricultural products	45.8	37.4	83.2	8.1	5.9	14.0	2.1	0.7	2.8	1.3
export by national economy	29.7	59.3	88.9	6.1	3.4	9.5	1.2	0.4	1.5	0.21
Accounts for 1 hectare of arable land, US dollars:										
GDP	35.0	16.6	22.5	10.9	6.3	8.2	3.3	2.3	2.9	3.9
added value of the agricultural sector	1.57	10.16	3.86	1.24	5.13	2.13	1.28	2.47	1.51	0.40
export of agricultural products per 1 hectare of arable land – total, including:	1502	3383	2003	1115	2756	1489	675	971	731	708
meat – total	201.0	256.2	215.7	113.7	229.3	140.1	63.0	7.1	52.4	29.1
from it: beef	85.8	79.7	84.2	35.7	102.8	51.0	53.4	1.7	43.7	2.2
Pork	41.9	79.0	51.8	35.8	18.8	31.9	3.3	1.4	2.9	0.1
other meat, dollar	73.3	97.5	79.8	42.2	107.7	57.1	6.3	4.0	5.9	26.8

Source: *FAO database.*

For example, in the second subgroup of the first group, vegetables, fruits, nuts and citrus fruits in the structure of cultivated areas and plantations occupy 29.7%, while in the first subgroup (0.45 hectares of arable land per inhabitant) – 3.8%. In Ukraine, this group of labor-intensive and high-income crops accounts for only 1.9%, and accordingly, according to existing trends, employment in agriculture will decrease by 63% in 2030 compared to 1992 [13]. In the animal husbandry of the countries under analysis, this pattern, especially in pig and poultry farming, is broken by the globally developed resource markets, and primarily by – feed. However, in general, in the first group of countries, export volumes significantly exceed them in the second, and even more so – in the third group of countries. However, this is a de facto slice of the export results of countries with different wealth and levels of land security.

Over the period 1992-2022, the arable land supply of the world population decreased by 30 % – to 0.25 ha arable land per 1 inhabitant, and under existing trends – to 0.1 ha in 2050. For feeding in 2050, 9.7 billion inhabitants of the planet, it is necessary, at a minimum, to increase the yield of agricultural crops and the productivity of animals and poultry by 70 %, with a simultaneous

parallel deterioration in climate change [14]. Scientists agreed that meeting this growth in demand is impossible without further proliferation of industrial types of production, especially in livestock industries where economies of scale will be fully exploited and realized [15]. In the movement of large amounts of resources between countries, pork production faces different deterrent system – problems of international feed transport, manure disposal, veterinary costs, greenhouse gas emissions, compliance with the zero deforestation obligation, greenhouse gas emissions, carbon footprint, etc. Here, economic interconnections arise on the food chain, which concern countries with different competitive forces, which shape the world pork market (Table 2).

Table 2. Volumes of export-import operations between the main producers and consumers of pork, average for 2020-2022

Indicator	Pigmeat exporting countries					Total by countries of the world
	EU	USA	Canada	Brazil	% to total	
Production of pork, tons	23037	12552	2281	4856	36.3	117600
Number of exports, thousand tons	10103	2652	1371	1293	92.9	16597
Export growth rate, 2023 % to						
1961	1,042	1,073	1,179	1,065		1,048
1992	1,037	1,096	1,121	1,051		1,045
2000	1,028	1,065	1,105	1,035		1,036
Export value, million dollars	29180	6716	3353	2518	92.5	45167
Export of pork to countries, thousand tons*):						
EU	5657	0.78	0.47	0.37	99.3	5698
China mainland	2388	714	355	502	91.0	4350
Japan	129	330	210	18	65.5	1048
Mexico	12.9	808	143	0.00	99.4	969
Republic of Korea	237	158	49	6.7	90.5	498
USA	75.6	0	304	15.9	89.4	442
United Kingdom	363	0.74	0.060	0.037	100.0	364
Total for these countries, thousand tons	8862	2012	1061	543	93.3	13368
to all exports, %	87.7	75.9	77.4	42.0	80.9	80.5

**Pig meat and edible offal (codes 1035, 1036, 1038)*

Source: *FAO database: https://www.fao.org/faostat/en/#data/TM*

Attention is drawn to the fact that only four participants in the pork market account for 92.9% of the world volume of its exports. In turn, only 6 individual countries and EU countries import 93.3% of pork volumes from these exporting countries and occupy 80.5% of world import volumes. Moreover, the pork market to EU countries is practically inaccessible – they trade with each other (99.3%), and other countries account for only 0.7% of the volume of exports to the EU. In all these exporting countries, the average annual growth rate of pork exports in 2023 compared to 1961 exceeds 4%, while in Ukraine, with meager volumes compared to 1992, the annual rate of decline in pork exports was 6%.

On the other hand, the achievements of these exporting countries are not only related to the scale of production, but also to the high efficiency of pig farming, which is the result of a combination of achievements in animal breeding and the breeding of new meat genotypes and their standardized feeding. The use of soybeans in the production of compound feed contributed to this push for efficiency heights, as an ingredient whose amino acid profile complements the amino acid profiles of other main grain ingredients and primarily corn. Therefore, countries with a shortage of land and a large population become the main importers of soybeans and/or their processed products and corn (tables 3, 4).

On the soybean market, two features of Brazil's – monopoly in exports, which occupies more than 50%, and China's monopoly in imports of –, which occupies almost 60% of its global volumes, are noted. In the soybean seed exporting countries, where 7.5% of the world's population

lives, the plowing rate of their territory is 11.8% and 1 inhabitant accounts for 0.42 ha of arable land, while in the largest importing countries – respectively 39.8%, 15.4% and 0.12 ha. Over the past 30 years, China has increased the import of soybeans from several tens of thousands of tons to 100 million tons (2023) due to land scarcity, land degradation, and water scarcity, which, along with the growth of the population and its income, is accompanied by an increase in the consumption of livestock products.

Table 3. Volumes of export-import operations between the main producers and consumers of soybean seeds, average for 2020-2022

Indicator	Soybean seed exporting countries					Total by countries of the world
	Brazil	USA	Argentina	Paraguay	% to total	
Production, thousand tons	125970	117491	46286	8927	78.7	379522
Number of exports, thousand tons	82672	58318	5280	5074	92.2	164138
Export value, million dollars	37956	29288	2500	2116	91.3	78705
Export of soybean seeds to the main importing countries, thousand tons:						
China, mainland	53999	30806	4612	0	93.6	95523
EU	7749	4711	0	41.9	77.0	16233
Mexico	686	5256	0	0	95.9	6194
Argentina	202	1.46	0	3793	91.0	4392
Egypt	217	3400	390	9.2	94.5	4249
A group of 7 importers*)	6461	8139	0	0	534	18800
Total for main importers	69316	52313	5002	3844	89.7	145391
% to the entire export	83.8	89.7	94.7	75.8	86.2	88.6

**This includes: Thailand, Japan, Turkey, Indonesia, Italy, Bangladesh, Pakistan*
***Source:** FAO database: https://www.fao.org/faostat/en/#data/TM*

According to FAO data, China occupied only 6-12% of global pork production 60 years ago, and in 2022-2023 – more than 45%. Moreover, the pork market in China, as the largest producer of pork and importer of soybeans, will continue to develop at a high pace. This will be facilitated by the further expansion of the increase in the production of soybeans and corn in Brazil, which is guaranteed by the presence of Chinese investments in the Brazilian soybean commodity chain, in particular in the construction of warehouse, transport and port infrastructure [16; 17]. The expansion of soybean production in Brazil at a high rate also solved the problems of social development of the territories, employment of the rural population in this exporting country [18]. Note that global production of products with sustainable global demand (cattle, soybeans and palm oil) accounts for 40% of tropical deforestation between 2000 and 2010. The halting of these processes has been linked through improvements in multilateral trade within the WTO [19]. According to the Brazilian Ministry of Agriculture, Livestock and Food (MAPA), by the 2033/34 season, soybean acreage will increase to 57.6 million hectares (by 25.1%) and exports alone will reach 157.6 million tons, or 71% of global sales. According to MAPA's forecast, corn production in 2034 will reach 153 million tons, and corn exports may increase to 58 million tons (in the US – to 63.5 million tons). This growth will be due mainly to the harvest of «safrinya» – of the second harvest of corn after the harvest of soybeans [20]. According to forecast data from the United States Department of Agriculture (USDA), China will import 140.4 million tons [21] or 63.3% of the world's soybean volumes in 2034. That is, such maximum possible volumes of trade between the two countries will have too much effect on the world market of both soybeans and pork.

The relentless rate of growth in the use of soybean meal in pig and poultry feeding is due to the achievement of high efficiency in soybean production in South America, where No-till (zero cultivation or direct sowing) technologies have been introduced in which land is not cultivated and surface plant residues remain on the surface of fields, providing large-scale environmental benefits (reducing soil erosion, preventing sediment runoff into water bodies, etc). The main feature of this

– technology is also the introduction of transgenic varieties of glyphosate-resistant crops (GR crops), which are introduced in the areas of soybeans and corn after germination, which has caused significant changes in weed control around the world. [22]. At the same time, the yield of soybeans increases, operating costs decrease, and the total net profit of the farm increases compared to conventional tillage. It is in the countries of South America that the highest share of areas under No-till technologies with glyphosate-resistant varieties – above 90% is used, for example, in Brazil, the USA, Argentina [22]. Such technologies in these countries have resulted in reduced losses from soil erosion by up to 50-90 %, reduced production costs by up to 40-60 % and increased farm incomes by 50-80 % [23]. In Brazil, the zero-treating technologies of soybeans of early GM– varieties, in addition to economic and ecological effects, contributed to the cultivation of a second crop of – corn in the same field. As a result, the area under maize of the first harvest (spring/summer season) began to decline sharply, and the area under the second harvest (summer/autumn season) after harvesting soybeans – grew, causing the production volumes of the last maize harvest to become 2.2 times the volumes of the first [24]. It is the application of GM seeds that underlies the successful application of zero cultivation and double sowing in the same field of soybeans and corn for one year [25], and accordingly, as a derivative, effective industrial technologies in pig farming. On the other hand, the efficiency of the industrial pig industry depends on the development, in addition to soybeans, of the corn industry (Table. 4).

Table 2. Volumes of export-import operations between the main producers and consumers of corn, average for 2020-2022

Indicator	Corn-exporting countries					Total by countries of the world
	USA	Argentina	Brazil	Ukraine	% to total	
Production, thousand tons	362219	59320	100667	32862	47.3	1173910
Number of exports, thousand tons	60159	36401	32750	25890	77.7	199749
Export value, million dollars	15906	7896	7435	5577	72.9	50475
The level of plowing of the territory, %	15,4	15,5	6,5	54,6	13,0	9,9
Corn exports to the main importing countries, thousand tons:						
EU	258	138	16	10265	28.9	36959
China, mainland	13951	0	396	6682	98.0	21453
-Mexico [138]	15693	24.5	1129	0	99.7	16903
-Japan [110]	10288	640	3628	36.5	95.5	15272
-Republic of Korea [117]	2538	4200	2009	822	88.0	10869
-Vietnam [237]	249	6622	2164	65	83.7	10867
A group of 7 other importers*)	5611	15002	11659	3738	94.9	37931
Total for main importers	48587	26626	21002	21609	78.4	150253
% to the entire export	80.8	73.1	64.1	83.5	75.9	75.2

**This includes: Egypt, Iran, Colombia, Algeria, Malaysia, Saudi Arabia, Peru*
***Source:** FAO database: https://www.fao.org/faostat/en/#data/TM*

The corn market is practically different from the pork and soybean markets. Here, the four main countries export 78% of all world corn volumes, while exporters of pork and soybeans – are over 92%. And another feature of –, there is no importer on the corn market that would occupy more than 40% of world import volumes. According to forecasts, the same exporters will dominate by 2034: Brazil – 72.6 million tons (30%), the United States – 69.2 (29%), Argentina – 44.9 (19%) and Ukraine – 24.2 million tons (10%) [21], which will total 88% of world corn exports. The growth of corn exports from Ukraine was facilitated by the trade agreement signed in 2012 with China, which had previously had problems in trade with one of the powerful corn producers – USA [26]. However, such leadership of Ukraine in production and almost 80% of its exports cannot be perceived as a positive trend for such reasons as the largest in the world in terms of plowing of the country's territory, for more than 65% of the saturation of crop rotation with intensive erosion-dangerous crops for the available 30% of eroded and 63% of agricultural land with a steepness of

slopes over 10, including 22 % – with a steepness of more than 30, where environmental requirements are intensive (corn, sugar beet, sunflower, etc.) erosion-hazardous crops should be absent. Under existing trends in reducing animal numbers and increasing the share of cereals and oilseeds in crop rotations, by 2030 the surplus of straw, sunflower stalks, and maize will reach almost 200 million tons (5.5 million tons of nutrients) worth UAH 210 billion, which are exported as pellets or burned in the field [13]. Scientists of the NSC «IGA named after O. N. Sokolovsky» established that the plowing of the total territory of Ukraine cannot exceed 40 % (actually – 54%) and the share of arable land from the total area of agricultural land – up to 50 % (actually – 78%). That is, from the total area of arable land, at least 10 million hectares should be removed from intensive exploitation [27, c. 309].

With low rents and the introduction of labor-saving technologies, agricultural holdings maintain and create a competitive environment for themselves and work with profits [26]. The main result of the activity of agricultural holdings – is a sharp reduction in the employment of the rural population and the practical creation of a social desert. Such agricultural holdings dominate and control the entire food chain of export-oriented monocultures (wheat, corn and oil crops) from the supply of technological resources to the sale of final products on the markets.

Ukraine achieved a sufficient scale of production of only corn and sunflower oil, which allowed it to gain a foothold in certain segments of world markets. But at the same time, as we can see, the ecologically permissible limits of – were violated, the highest level of agricultural use of the country's territory in the world, and the social factor of the triad – in rural areas was not taken into account, under such specialization, almost all its residents became unemployed and landless. In Ukraine, in large and vertically integrated corporate agribusiness (agroholdings), the share of leased agricultural land reached 97% of the land out of 27 million hectares, which was transferred to 6.9 million Ukrainians in the form of land shares (shares) [28] with the as yet unknown prospect of their return to the owners of shares, who must enter the land market precisely as these land owners. As for the economic component of the harmonious development of the country, under the existing trend of grain and oil specialization until 2030 (not taking into account the impact of the war), the export of agricultural products and their processing products will increase to a maximum of 32 billion US dollars or to 1 thousand US dollars per 1 hectare of arable land with growing processes of humus mineralization, soil erosion and its washing away [13]. Today (average for 2021-2023), according to these forecast indicators, Ukraine ranks 21st (by volume) and 98th (per 1 hectare of arable land) among the countries of the world, respectively, in exports. Ukraine has two options for its condition for the future: (1) agree with grain and oil specialization and with the final disappearance of the settlement network in rural areas; (2) develop a rural development strategy where plans to address economic, social and environmental problems by individual region would be taken into account and developed. We should immediately note that China is investing in the development of infrastructure in – trading partner countries, where there is a much large potential for expanding arable land within the limits of the permissible development of new land for agricultural use. Therefore, investors can come last to much smaller exporters and already with exhaustive land potential, like Ukraine, where the entire territory of the country is ecologically dangerous.

A technological breakthrough in the production of soybeans and corn in South and North America contributed to their production at a much lower cost than in other countries of the world. Therefore, in countries such as Brazil and the USA in 2022, not only is the production cost of these crops much lower, but also production costs in pig farming are about 20% lower than in European countries [29]. Apart from this, in the USA the costs of management, energy, environmental protection and construction of pigsties are much lower than in Europe, and therefore pig farming in the USA compared to the world's main pork producer is a fairly profitable business [30].

In 2020, genetically modified (GM) maize and soybean species underwent biosafety assessments in China [31], which accelerated their commercial cultivation [32; 31]. China first approved the safety of genetically modified wheat to open up the technology to food crops. In 2023. China has increased its approval of genetically modified maize and soybean seeds, which have high

yields and resistance to insects and herbicides. The world's largest buyer of soybeans and corn aims to increase domestic production through high-yielding seeds and reduce grain imports by more than 100 million tons per year [34; 35], which will account for 20% of all world grain exports. It is most likely that the increase in the production of genetically modified soybeans, corn and wheat in China and the refusal of such large volumes from grain imports will make global changes in the structure of world production and employment of the population due to the forced reduction in the production of grain and oil crops in today's exporting countries.

In Europe, only Portugal and Spain have adopted GM crops. At the same time, the need of animal husbandry for protein feed without GMOs was not ensured by its own production in the EU and therefore it is forced to import soybeans and/or soybean meal from their non-main producers – of South and North America, where they are the cheapest. According to estimates by the US Department of Agriculture (USDA) – despite the ban on commercial cultivation –, the share of genetically modified (GMO) soybeans in Ukraine is 50-65% [36] with a US$70/ha effect due to less spraying with herbicides [37]. And when the main players in the soybean and corn market have achieved unparalleled success and occupied almost the entire niche in world markets, the corresponding new Law on State Regulation of GMOs, which was adopted by the Verkhovna Rada of Ukraine on August 23, 2023, will enter into force in Ukraine on September 16, 2026 [38]. In order to achieve competitive advantages, it is necessary not only to keep up with the use of technologies that have given large countries of the world the opportunity to occupy the main export markets. It is still necessary to achieve high results in efficiency and reach large volumes of production. John Shmorgun, CEO of AgroGeneration in Ukraine (60,000 hectares of land), additionally reminds us of this: that the way to a real export state – is to produce on a sufficiently large scale in competition with French farmers (strongly subsidized by the EU) and/or with large plantations in Brazil in the Ukrainian environment of fully integrated conglomerates with a physical size of 300-500 thousand hectares of land («Kernel», «Myronivskyi hliboprodukt», etc.), which work through a complex network of subsidiaries to circumvent the Ukrainian moratorium on the sale of land, and are often registered in places considered tax havens outside the country [37].

CONCLUSIONS

The world pork market is determined not by the volume of arable land, but by the quality of the «triangle of competitiveness»: feed base, technologies, institutions/logistics. The key is the efficient scale of production, but it only works together with low cost, stable batches, biosafety, traceability and ESG requirements. Cheap soybeans and corn (no-till, double crops, GM seeds, advanced logistics) shift costs down and cause a high concentration of exports; Brazil and China set benchmarks for the soy and, indirectly, pig segments. Regulatory monetized environmental and social constraints are increasing; China's import substitution could reshape global feed flows and exporters' margins. The Ukrainian «oil-grain» model gives scale, but is accompanied by environmental risks and employment deformation, and access barriers to premium pork importers remain high without a technological-institutional upgrade. A transition to integrated feed-to-fork clusters, development of logistics, traceability and ESG, reduction of carbon/nitrogen footprint and rural development policy are strategically needed. Only a combination of scale with technology, institutions and eco-balance will provide a long-term advantage.

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Article History:
Received: November 21, 2025 | Revised: December 01, 2025 | Accepted: December 29, 2025 | Published Online: February 08, 2026

Citation: Kalinchyk, M., Rebryna, A., Lavrov, R., & Dushka, V. (2025). DETERMINANTS OF THE DEVELOPMENT OF THE WORLD PORK MARKET: EFFICIENT SCALE OF PRODUCTION AS A CONDITION FOR ACCESS TO LEADING IMPORTERS. *International Interdisciplinary Scientific Journal "Expert", 2*(1), 62–73. https://doi.org/10.62034/2815-5300/2025-v2-i1-006