MODELLING OF ORGANIC PIG PRODUCTION ECONOMIC VIABILITY IN LATVIA

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Abstract. Pig production in Latvia is almost exclusively based on conventional farming that has been rather stagnant over the past years. Organic pork production offers the possibility to utilize the growing organic food consumption trend and align with the sustainable food principles and environmentally friendly farming initiatives accelerated by the Farm to Fork Strategy of the European Green Deal and the EU Taxonomy. Organic farming is classified as an activity meeting the CAP objective towards climate change mitigation and adaption, as well as under normal circumstances is qualified as environmentally sustainable (Taxonomy-aligned). There is a lack of systematic knowledge regarding organic pig market and production in Latvia, therefore the study attempts to fill the gap by examining the market potential of Latvian organic pork, as well as modelling the performance of organic pig production in Latvia. The modelling is carried out by developing and analysing two comparable models of pig production – conventional and organic (1 000 sows, full production cycle). Model inputs also include market analysis, organic pig feeding trials, expert interviews, and consumer survey. Results of the study reveal that the market value of organic food has more than doubled in the EU over the last decade. Experience from Denmark and Germany shows that producer prices of organic pork tend to be more stable than conventional pork prices and on average 2.4 times conventional price level. Demand for organic pork exists in Latvia and can be further increased by improving the availability of organic pork at convenient locations, highlighting its local origin, and raising awareness of its benefits. Demand for organic pork in Latvia is largely influenced by the price. In the medium term, the potential market for organic pork in Latvia has been assessed at 0.67 thousand tonnes annually. Similarly to conventional farming, economic viability of organic pig production depends on the revenue and feed costs ratio.

Keywords: organic, pig production, market potential, economic viability, modelling.

Introduction

Pig production in Latvia is stagnating – the annual production volume of pork has been close to 40 thousand tonnes over the past decade, while the number of pigs and farms is constantly decreasing [1]. Pork is still the most popular among meats consumed in Latvia and only about 60-65% of its consumption can be met by the local production [2].

Latvia's pig sector is almost exclusively based on conventional farming as the number of organic pigs was only 2 972 out of 306 821 of total swine in 2020 [3]. In 2020, only about 54 tonnes of organic pork were produced in Latvia that constitute 0.15% of total pork production [1; 4].

Organic, regional, local, direct, unpacked, free from – these are the new consumption trends in the European food market [5]. Overall, sustainability has been one of the mega trends in food, nutrition and health over the past years as highlighted by the market research and analysis company New Nutrition Business [6]. Organic pork production offers the possibility to utilize the growing organic food consumption trend and align with the sustainable food principles and environmentally friendly farming initiatives accelerated by the Farm to Fork Strategy of the European Green Deal and the European Union (EU) Taxonomy [7; 8]. Organic farming is automatically classified as an activity meeting the CAP objective towards climate change mitigation and adaption, as well as under normal circumstances is qualified as environmentally sustainable (Taxonomy-aligned). In its turn, complying with the requirements of the Taxonomy Regulation could be challenging for intensive conventional pig farms [9].

Organic pig production demands higher animal welfare standards than conventional farming, only organically certified feed may be used, and there are also restrictions on the use of medicines. Thus, the application of organic farming methods in pig production requires both investment and new knowledge. To encourage operators to switch to organic pig farming, a clear understanding of the market situation and production costs is critical based on which the economic viability can be examined.

There is a lack of systematic knowledge regarding organic pig market and production in Latvia, therefore the study attempts to fill the gap by examining the market potential of Latvian organic pork, as well as modelling the performance of organic pig production in Latvia.

Materials and methods

The modelling is carried out by developing and analysing two comparable models of pig production – conventional and organic (1 000 breeding sows, full production cycle). Model direct or indirect inputs also include market analysis (including price monitoring), organic pig feeding trials, expert interviews, and consumer survey. The latter was performed within a study in September, 2020. In total, 1 010 responses were obtained that are representative of the population of Latvia. Organic feed trials and in-depth expert interviews were carried out within the European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI) project "Sustainable development of pig breeding based on organic farming and free from antibiotics". Relevant experts were selected among the project partners and the interview results used for the modelling were approved by all project partners.

The models of conventional and organic pig production assume that fattening pigs are sold for pork when animals reach live weight of 110 kg and 130 kg respectively. All key assumptions for each pig production system used in the respective models are presented in Table 1.

Table 1

Key assumptions for the modelled pig production systems

Assumptions*	Conventional	Organic
Breeding sows:		
Mortality rate (annual)	3 %	3 %
Culling rate (selling, annual)	30 %	30 %
Average weight of culled sows, kg	225	225
Average number of piglets born alive per litter	13	11.8
Average number of litter per year	2.3	1.9
Piglets (till weaning):		
Mortality rate (in period)	10 %	15 %
Weight at weaning, kg	8	14
Weaners (up to 30 kg):		
Mortality rate (in period)	3 %	3 %
Gilts (30-120 kg):		
Mortality rate (in period)	0.5 %	0.5 %
Culling rate till 85 kg (selling, in period)	5.0 %	5.0 %
Culling rate 85-120 kg (selling, in period)	13.5 %	13.5 %
Fattening pigs:		
Mortality rate (in period)	0.5 %	0.5 %
Culling rate (selling, in period)	1.0 %	1.0 %
Weight at selling, kg	110	130
Gilts (120-150 kg):**		
Mortality rate (in period)	0.2 %	0.2 %
Culling rate (selling, in period)	11.5 %	11.5 %

* weight refers to live weight

** till insemination

Source: experts' interviews

The projected herd structure for both models presented in Table 2 is derived from the key assumptions for conventional and organic pig production. Maximal number of pig places considers the estimated number of pig places that the farm needs to operate properly, i.e. including a reserve of pig places. The number of pigs in the organic model is lower mainly due lower birth numbers observed in this production system (see Table 1).

According to the expert interviews, it is assumed that feeding schemes differ between conventional and organic pig production. The main differences are related to the use of milk replacer (fed only in conventional farming) and starter (fed only in organic farming). Key assumptions for pig feeding applied in the modelling are presented in Table 3.

Table 2

Projected herd structure of the modelled pig production systems

Swine groups	Conventional		Organic	
	Number of pigs	Maximal number of pig places	Number of pigs	Maximal number of pig places
Breeding sows	1 000	1 000	1 000	1 000
Piglets (0-8 kg)	2 294	2 800	2 457	2 999
Weaners (8-30 kg) – for breeding	55	3 932	59	2 983
Weaners (8-30 kg) – for fattening	3 042		2 291	
Gilts (30-120 kg)	131	178	114	154
Fattening pigs (30-110/130 kg)	6 323	6 657	4 938	5 199
Gilts (120-150 kg)	47	63	47	63
Total	**12 891**	**14 630**	**10 905**	**12 398**

Source: experts' interviews

Table 3

Key assumptions about pig feeding (feed consumption) for the modelled pig production systems

Feed type	Conventional	Organic
Breeding sows:		
Feed for lactating sows, kg per year per pig	600	600
Feed for gestating sows, kg per year per pig	500	500
Gilts (120-150 kg):		
Feed for gilts, kg per day per pig	3	3
Piglets (till weaning):		
Milk replacer, kg per period per pig	0.107	-
Prestarter, kg per period per pig	2	10
Weaners (up to 30 kg):		
Prestarter, kg per period per pig	6	1.75
Starter, kg per period per pig	-	6.15
Link, kg per period per pig	22	40.2
Grower, kg per period per pig	8.75	-
Fattening pigs:		
Grower, kg per period per pig	91.25	108
Finisher, kg per period per pig	130	154
Gilts (30-120 kg):		
Grower, kg per period per pig	91.25	108
Finisher, kg per period per pig	167.92	126

Source: organic pig feeding trials and experts' interviews

To assess the economic viability of pig production, EBIT – an indicator showing earnings before interest and taxes – is used in the paper. EBIT is calculated as the difference between revenue (selling of pigs) and costs (feed, veterinary, labour, electricity, etc.), including depreciation. Pig prices (except for fattening pigs) and feed prices in the conventional model are estimated according to the market-based expert interviews (January, 2022). As the prices of conventional fattening pigs have been very volatile, it was decided to apply a break-even price of fattening pigs instead. This approach allows developing the model of conventional pig production that serves as a comparative basis for modelling the economic viability of organic pig production.

Based on the market analysis carried out by the authors, it is assumed that the prices of organic pigs are 2.4 times the level of conventional pig prices. As there is a lack of sufficient market information on organic feed prices, a cautious assumption has been made that organic feed prices are 2.6 times the level

of conventional feed prices. The assumed pig and feed prices used in the models are presented in Table 4.

Table 4

Assumptions about pig and feed prices for the modelled pig production systems

Prices	Conventional	Organic
Pig prices:		
Fattening pigs, EUR per kg live weight	1.62	3.90
Culled fattening pigs and gilts (30-85 kg), EUR per kg live weight	0.70	1.68
Culled gilts (85-120 kg), EUR per kg live weight	1.62	3.90
Culled gilts (120-150 kg), EUR per kg live weight	1.00	2.40
Culled breeding sows, EUR per kg live weight	0.50	1.20
Feed prices:		
Feed for lactating sows, EUR per t	394	1 024
Feed for gestating sows, EUR per t	322	838
Feed for gilts, EUR per t	326	846
Milk replacer, EUR per t	3 250	-
Prestarter, EUR per t	943	2 451
Starter, EUR per t	860*	2 236
Link, EUR per t	429	1 115
Grower, EUR per t	351	913
Finisher, EUR per t	306	794

* reference price only, to estimate organic feed price (starter is not used in the conventional model)
Source: market analysis and experts' interviews

According to the expert interviews, the following assumptions are made about the veterinary costs in the conventional model: for breeding sows and gilts (120-150 kg) – 3.00 EUR per year, and for piglets, weaners, gilts (30-120 kg), fattening pigs – 2.19 EUR per outgoing pig (died, culled, sold). It was assumed that the veterinary costs in the organic model are 80% of the conventional costs. Other key assumptions about operating costs used in the modelling are presented in Table 5.

Table 5

Key assumptions about operating costs for the modelled pig production systems

Resources / costs	Conventional	Organic
Number of workers, in full-time-equivalent (FTE)	16.0	24.0
Remuneration (including social insurance), EUR per FTE per year	30 240	30 240
Biomaterials (insemination), EUR per breeding sow per litter	15	18
Electricity, EUR per year	144 000	144 000
Fuel (heat), EUR per year	56 291	89 590
Water, EUR per year	13 834	16 600
Maintenance, EUR per year	19 200	19 200
Repairs, EUR per year	9 600	9 600
Animal bedding (straw), t per year	10	780
Animal bedding (straw), EUR per t	40	40

Source: experts' interviews

The assumed investment in buildings, machinery and equipment varies from 371 to 473 EUR per m^2 and from 98 to 1 102 EUR per pig respectively, depending on pig categories. The required building space in conventional pig production is assumed ranging from 0.84 to 6.20 m^2 per pig (depending on pig categories). It is also assumed that organic pig production requires 1.9 larger building space than in conventional farming. The total investment costs for conventional and organic production (see Table 6) have been assessed considering the estimated maximal number of pig places (see Table 2).

Table 6

Investment assessment for the modelled pig production systems, EUR

Investment	Conventional	Organic
Buildings	**10 196 798**	**16 386 670**
Breeding sows	2 932 600	5 571 940
Gilts (120-150 kg)	184 754	351 032
Weaners	1 562 262	2 257 534
Gilts (30-120 kg)	157 831	259 388
Fattening pigs	5 359 351	7 946 775
Machinery and equipment	**2 497 596**	**2 194 150**
Breeding sows	1 102 000	1 102 000
Gilts (120-150 kg)	39 690	39 690
Weaners	385 336	292 334
Gilts (30-120 kg)	25 276	21 868
Fattening pigs	945 294	738 258
Total investment	**12 694 394**	**18 580 820**

Source: the authors' evaluation, based on experts' interviews

The depreciation of investment is calculated by cautiously assuming that the useful life of buildings is 25 years, machinery and equipment – 5 years.

Results and discussion

Market potential of Latvian organic pork

During the last decade, the market value of organic food has more than doubled in the EU. In 2019, the annual growth rate of 8.0% was recorded for the EU organic market, while in France it reached even 13.4%, making it the fastest growing EU organic market. Furthermore, 2020 was a very special year in terms of growth as under Covid-19 circumstances increasingly more customers paid attention to healthy products [10]. Available data on 2020 for Germany, the EU's largest market for organic food, reveal that Covid-19 and the resulting inhouse consumption pushed organic market tremendously – it grew by 22.3% (9.7% in 2019) and that is twice as fast as the general food market [11].

The EU customers spend on average 84 EUR on organic food per person annually (2019 data), while Danish spendings total 344 EUR, and in Germany it is 144 EUR. In Latvia, the organic market value is not so large yet – it is estimated that consumers in Latvia spend on average 6 EUR per capita annually, in Lithuania – 18 EUR, but in Estonia – 47 EUR [10].

Although, pork and meat in general are not among the most popular organic food products chosen by the EU customers. In Denmark, the most developed organic market in the world (with 12.1% of the organic share in total food market) [10], meat and meat products accounted for about 8% of the total turnover of organic food in retail stores in 2020 (fruits and vegetables – for more than $^1/_3$) [12]. Among selected products in Denmark's supermarkets, the market share of pork is 4.6%, compared to 9.4% for beef, 34.3% for milk and 47.6% for carrots [13]. In Germany, organic meat (excluding meat products and poultry) accounted for 3.6% of total household meat purchases (one of the lowest shares among the main products) in 2020. Also, information on France shows that meat accounts for 10% of the total market for organic products, as well as in Italy organic meat is not among the top 10 products [14; 15]. At the same time, poultry and red meat had the largest sales growth in household purchases among the main organic products in Germany in 2020 versus 2019 (+55% for red meat) [11].

According to the Latvian consumer survey carried within the study in 2020, about 30% of households have bought fresh pork at least once, and another 26% would like to buy it in the future (n=815, respondents who consume pork). In general, when choosing pork for household consumption the most important factor is the price and country of origin, though more than half of the respondents indicated that the strategy chosen for pork production – organic farming system or antibiotic-free farming system – is also important.

To increase the market potential of organic pork in Latvia, it is necessary to improve the availability of organic pork at places convenient to buyers, as 83% of respondents who consume pork indicated that

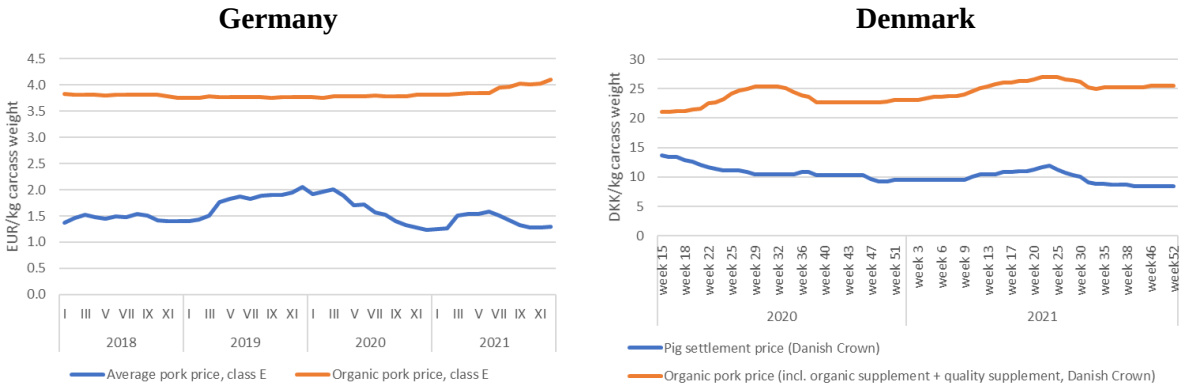
improving the availability of organic pork could greatly or rather greatly encourage these households to change their preferences in favour for organic pork. The local origin is also an important motivating factor for 80% of respondents who consume pork, and that serves well local producers. Also, as organic pork is more expensive than pork produced on conventional farms, production cost reduction and increased supply-chain efficiency resulting in lower prices would have a positive impact on the demand – almost 76% of respondents who consume pork consider the price an important incentive. Another important direction to stimulate the demand for organic pork is raising awareness of the benefits of organic pork.

Based on the survey results, the potential market for organic pork in Latvia has been assessed at 0.67 thousand tonnes annually in the medium term, which is about 1% of the total domestic consumption of pork and its products (in meat equivalent). The estimated consumption volume is more than ten times the current pork production level in Latvia. With the increase in the income levels and considering the consumption trends in the Scandinavian countries, the annual demand for organic pork in Latvia could reach 5.1 thousand tonnes that would account for about 7% of the current consumption of pork and its products (in meat equivalent).

Modelled performance of pig production in Latvia

The producer price level of organic pork is an important input to the modelling of economic viability of organic pig production in Latvia.

Available price monitoring data show that in Denmark (exports about 70% of its organic pork production [16]) the producer price of organic pork was on average about 2.4 times the price level of conventional pork (ranging from 1.53 to 3.04) – totalling 3.26 EUR per kg of carcass weight in 2020-2021 (see Figure 1). In Germany (has considerable imports of organic pork – about 30% of domestic consumption [17]), the average price received by organic producers in 2020-2021 was 3.86 EUR that is about 2.5 times the standard pork price (ranging from1.88 to 3.17).



Source: compilation by the authors, based on [18; 19; 20]

Fig. 1. **Organic and conventional pork prices in Denmark and Germany**

Organic pork price time series in Denmark, but especially in Germany, indicate that the producer prices of organically produced pork tend to be more stable and resilient to market fluctuations. Thus, at the time of declining pig prices, the difference between organic and conventional pork prices has the tendency to increase.

Based on the methodology, the data and the assumptions described above, revenue and costs have been estimated for both conventional and organic pig farming. The modelling results are presented in Table 7.

According to the theoretical simulation of the performance of organic pig farming done by the authors, economically viable organic pig production is feasible in Latvia. The results of the modelling indicate that organic pig production reaches break-even. Though, this result can be achieved upon the condition that the market situation is favourable to attain break-even in conventional pig farming. Also, it is crucial that the assumptions about the ratio of organic pig price to conventional pig price (2.4) and the ratio of organic feed price to conventional feed price (2.6) hold. Thus, the economic viability of organic pig production is dependent upon these two ratios. Organic pig farms that produce own feed are

in a more advantageous position regarding market risks as compared to farms relying on purchased inputs.

Table 7

Modelling results for conventional and organic pig production

Indicators	Conventional		Organic	
	EUR	Share in revenue	EUR	Share in revenue
Revenue	**4 570 595**	**100.0 %**	**9 144 789**	**100.0 %**
Selling of fattening pigs	4 509 805	98.7 %	9 001 046	98.4 %
Quantity, kg live weight	2 778 236	-	2 307 960	-
Other revenue (selling of culled pigs)	60 790	1.3 %	143 743	1.6 %
Quantity, kg live weight	94 881	-	91 937	-
Feeding costs	**2 833 847**	**62.0 %**	**6 897 312**	**75.4 %**
Gross production margin	**1 736 748**	**38.0 %**	**2 247 477**	**24.6 %**
Other costs	**829 357**	**18.1 %**	**1 111 091**	**12.1 %**
Veterinary	67 612	1.5 %	40 941	0.4 %
Labour	483 840	10.6 %	725 760	7.9 %
Biomaterials (insemination)	34 500	0.8 %	34 200	0.4 %
Electricity	144 000	3.2 %	144 000	1.6 %
Other:	99 405	2.2 %	166 190	1.8 %
Fuel (heat)	56 291	1.2 %	89 590	1.0 %
Water	13 834	0.3 %	16 600	0.2 %
Maintenance	19 200	0.4 %	19 200	0.2 %
Repairs	9 600	0.2 %	9 600	0.1 %
Animal bedding (straw)	480	0.0 %	31 200	0.3 %
EBITDA*	**907 391**	**19.9 %**	**1 136 386**	**12.4 %**
Depreciation of investment	907 391	19.9 %	1 094 297	12.0 %
EBIT	**0**	**0.0 %**	**42 089**	**0.5 %**

* earnings before interest, taxes, depreciation, and amortisation

Source: the authors' calculations

In general, organic pig production as well as conventional pig farming depend on the ratio of revenue to feed costs (or the share of feed costs in revenue). The increase in feed prices without an adequate increase in pig prices or vice versa will impair the economic viability of both pig production systems.

Conclusions

1. The organic market value continues to exhibit a grow trend in the EU countries that presents a potential for Latvian pork sector to meet the existing and potential demand of local consumers, including in terms of sustainable food and environmentally friendly farming practices.
2. Demand for organic pork exists in Latvia and can be further increased by improving the availability of organic pork at convenient locations, highlighting its local origin, and raising awareness of its benefits. The demand for organic pork in Latvia is largely influenced by the price.
3. In the medium term, the potential market for organic pork in Latvia has been assessed at 0.67 thousand tonnes annually.
4. Experience from Denmark and Germany shows that producer prices of organic pork tend to be more stable than conventional pork prices and on average 2.4 times the conventional price level.
5. The modelling results show that economically viable organic pig farming is feasible in Latvia, and, similarly as in conventional farming, economic viability of organic pig production depends on the ratio of market revenue to feeding-related costs.
6. To promote the development of organic pig farming in Latvia, particular efforts should be dedicated both to encouraging the demand for organic pork and reducing purchased input reliance.

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Author contributions

Conceptualization and methodology, A.A., I.L. and A.K.; validation, A.K.; investigation, A.A., I.L. and A.K.; data curation, A.A.; writing – original draft preparation, A.K. and A.A.; writing – review and editing, A.A., A.K. and I.L.; visualization, A.K. and A.A. All authors have read and agreed to the published version of the manuscript.

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