

## The results of fattening hybrid pigs of Danish selection

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### Abstract

The results of a study of the breed combinations that influence pigs of Danish selection on fattening, meat, and economic indicators are presented. The experimental animals were divided into two groups according to their genotype. The method of groups-analogs was applied. The pigs were similar in terms of conditional heredity, sex, age, and body weight within each group. Five animals from each group were slaughtered at the meat processing plant to study the meat qualities. These studies arose due to the constant search for the most successful and cost-effective options for breed combinations that guarantee the effect of heterosis in hybrid offspring, which determined the scientific novelty and relevance. The dependence on breed combinations of fattening and meat qualities of young pigs obtained by simple two-breed and complex three-breed industrial crossbreeding of breeds of Danish selection has been established. At the final stage of fattening, a significant intergroup difference was established in terms of the average daily increase in body weight in favor of pigs of the breed combination F2 ¼Y ¼L ½D at 5.4% at P > 0.999 compared with analogs of the breed combination F1 ½Y ½L. Crossbreeds of the F2 generation turned out to be more early maturing and reached a body weight of 100 kg in 168.1 days, compared to 173.2 days in crossbreeds of the F1 generation with a difference of 5.1 days (P > 0.95) and a slaughter weight of 110 kg with a difference of 5.5 days (P > 0.95). They also spent less feed by 0.18 feed units per 1 kg of body weight gain, but the intergroup difference was insignificant. At slaughter, the weight of the steamed carcass in the crossbreeds of generation F2 ¼Y ¼L ½D was higher by 6.7 kg (P < 0.95), and the slaughter yield was higher by 5.9 % (P > 0.999). It is concluded that the combination of Yorkshire breeds with Landraces and Durocs achieves a high economic effect on pork production since the level of profitability of pork production in three-breed hybrids is higher by 6.6%, respectively than in two-breed ones.

**Keywords:** DanBred Hybrid young pigs, crossbreeding, DanBred Yorkshire, DanBred Landrace, DanBred Duroc, meat productivity, economic efficiency.

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### 1. Introduction

According to the State Statistics Service of Ukraine (<http://www.ukrstat.gov.ua>), in 2021, as of January 1, 225 thousand industrial sows were raised, which is 6.5 % more than last year. In the live weight of pork, 491 thousand tons were received for the period January-October 2021, which is 8.9 % more than in the same period last year. 471.4 thousand tons, or 4.3 million heads, of pigs, were sold for slaughter during ten months of 2021, which is 12 % more than last year.

However, domestic pig breeding in recent years is characterized by an insufficient level of material base. Therefore, the pace of breeding work to improve breeds is still slow today. For these reasons, animals are not characterized by a high level of productivity, and most industrial enterprises in Ukraine prefer breeding pigs for foreign genetic companies (Ibatullin, 2016).

According to a survey of 87 companies with a population of approximately 200 thousand pigs, it was found that at the beginning of 2020, about 40 % were animals of Danish selection, mainly DanBred Landrace and DanBred Yorkshire, and 21.2 % of English selection (mainly PIC company). The exact number of pigs of French origin in total within companies ChoiceGenetics and Axiom (Likhach et al., 2021).

Due to the genetic heterogeneity of pigs, DanBred Landrace and DanBred Yorkshire companies achieved 22 % genetic differences between pigs in 2019, which is very important for obtaining the effect of heterosis in interbreeding hybrids (<https://danbred.com/ru>).

These companies have paid great attention to the assessment of pigs on the exterior, having achieved in selecting the obtaining of breeding boars, which stably pass on to their descendants a strong body structure. Breeders attach particular importance to selecting pigs with strong fore and

hind limbs and back (Chang et al., 2017; Silva et al., 2019). They use genomic selection, i.e., testing of pigs for a significant number of gene markers, using matrices with 50–60 thousand SNPs that mark the main genes of quantitative traits to identify single nucleotide polymorphisms along the genome and identify desirable genotypes in terms of productive qualities when assessing the breeding value of animals (Zhang et al., 2016; Klein et al., 2018; Tinh et al., 2021).

The DanBred crossbreeding program is divided into two phases. First, DanBred Yorkshire sows are crossed with DanBred Landrace boars with high combinational qualities, and DanBred Hybrid half-blooded sows are obtained. In the second stage, their sows, more pronounced reproductive qualities, are crossed with DanBred Duroc boars. The result is a world-famous hybrid with high vigor, high feed conversion, a good percentage of meat, and desirable meat quality (Noppiboo et al., 2016; Lopez et al., 2018; 2019).

Therefore, under the same economic conditions of breeding, individual breeds of pigs and their hybrids realize their genetic potential of productivity in different ways and pay for feed with production (Krupa & Wolf, 2013; Paura, 2014; Lopez & Seo, 2019). Therefore, it is relevant to substantiate the most successful variants of breed combinations during the foreign introduction (Chen et al., 2003; Chansomboon et al., 2010; Abell et al., 2012).

## 2. Materials and methods

Studies of the fattening qualities of hybrid young animals were carried out at AGROIND LLC, Dneprovskiy district, Dnepropetrovsk region. To assess the meat quality, five animals from two groups were slaughtered at the meat processing plant partner of the Rentwell LLC farm in Kamenskoye. The purpose of the research was to determine how the fattening and meat qualities of young pigs obtained by simple two-breed and complex three-breed industrial crossing of Danish breeds depend on breed combinations.

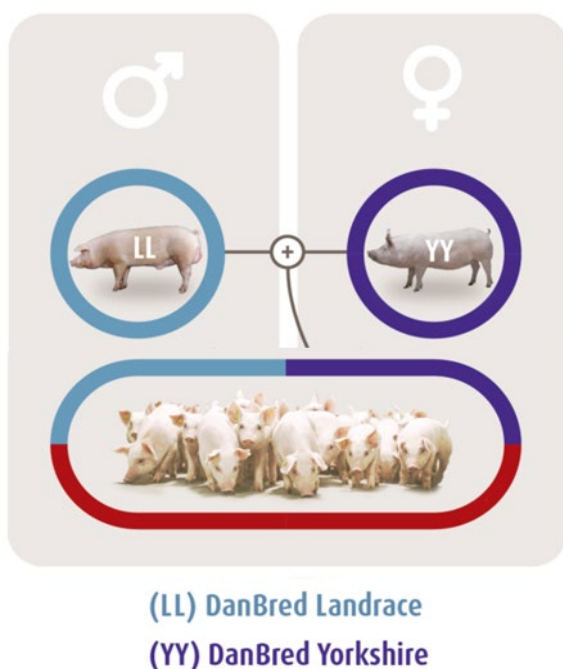


Fig. 1. Scheme of the two-breed crossing of Yorkshire sows with Landrace boars.

According to the scheme (Fig. 1), crossbred boars  $\frac{1}{2}Y \frac{1}{2}L$  are sent for fattening for meat, and crossbred young sows  $\frac{1}{2}Y \frac{1}{2}L$  are used in the subsequent three-breed crossing.

The scheme of a complex three-breed industrial crossing is shown in Figure 2. According to this scheme, thanks to a complex industrial three-breed crossing, the final hybrid piglets for fattening meat are obtained:  $\frac{1}{4}Y \frac{1}{4}L \frac{1}{2}D$ .

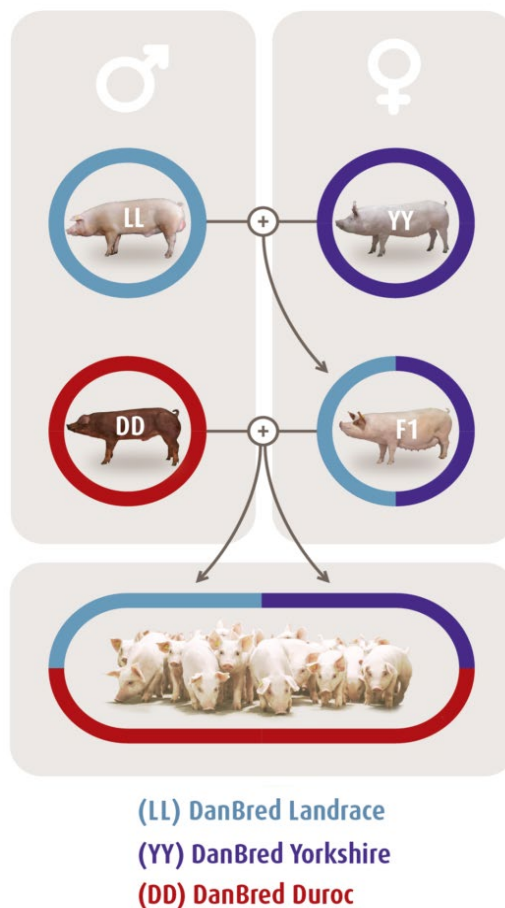


Fig. 2. Scheme of a complex three-breed industrial crossing (<https://danbred.com/ru>)

The conditions for keeping sows and suckling piglets were provided with equipment, farrowing pens, a ventilation system, feed transportation, and feeding manure removal in building No. 3 – the French manufacturer I-TEK (Fig. 3).



Fig. 3. Pen for farrowing sows and keeping suckling pigs with additional feeding in the feeder (I-TEK company)

### 3. Results and discussion

#### 3.1. Results

The indicators of reproductive ability characterize the genetic peculiarities of sows and the quality of their preparation for farrowing (table 1).

Since the sows were kept under the same technological conditions and the feeding rations do not differ, this eliminates the influence of conditions on the results of comparisons.

Therefore, from the data in Table 1, it can be seen that crossbred sows of breed combinations  $\frac{1}{2}$  Y  $\frac{1}{2}$  L. However, they show a slightly lower prolificacy than purebred York-

shire analogs; during the lactation period before weaning from the mother (28 days), their piglets have slightly higher growth energy. This is manifested in the greater mass of the litter during weaning. In addition, they are characterized by higher viability since the offspring's safety during weaning is also higher. This indicates the feasibility of two-breed crossing to improve the reproductive qualities of two-breed sows, further used in the three-breed crossing scheme. Two-breed castrated young boars ( $\frac{1}{2}$ Y  $\frac{1}{2}$ L) are no longer used but are sent for fattening.

The study results of the fattening qualities of crossbred boars are shown in table 2.

**Table 1**

Reproductive qualities of purebred and crossbred sows of the second farrowing

Indicator	Animal groups depending on breed combinations				± to control
	Yorkshire breed (control group)		breed combination $\frac{1}{2}$ Y $\frac{1}{2}$ L		
	M ± m	Cv%	M ± m	Cv%	
Number, heads	26	-	26	-	-
Litter size, pigs	11.5 ± 0.40	22.3	11.3 ± 0.43	21.9	-0.2
Litter weight at birth, kg	16.1 ± 0.44	25.1	16.9 ± 0.47	26.3	+0.8
Birth weight of a piglet, kg	1.4 ± 0.02	19.7	1.5 ± 0.01	21.1	+0.1
Piglets at weaning in 28 days, heads	11.1 ± 0.39	24.4	11.2 ± 0.50	27.1	+0.1
Litter weight in 28 days, kg	93.2 ± 1.22	25.4	95.2 ± 1.65	27.1	+2.0
Average live weight in 28 days, kg	8.4 ± 0.10	20.3	8.5 ± 0.08	19.2	+0.1
Survival ability of piglets, %	96.5	-	99.1	-	+2.6

**Table 2**

Results of fattening of crossbred boars

Indicator	Generations and breed combinations of experimental fattening boars		
	F1 $\frac{1}{2}$ Y $\frac{1}{2}$ L	F2 $\frac{1}{4}$ Y $\frac{1}{4}$ L $\frac{1}{2}$ D	
Supplied for fattening animals, heads	25	25	
Age at supplying for fattening days	90.6 ± 2.12	90.2 ± 2.02	
Live weight at supplying for fattening kg	30.8 ± 1.55	30.2 ± 1.74	
Removed from fattening heads	25	25	
Live weight at the end of fattening, kg	100.6 ± 3.39	100.8 ± 3.17	
Average daily gain (for 3–7 months), g	852.5 ± 8.51	898.2 ± 9.2***	
Age of reach of live weight of 100 kg, days	173.2 ± 1.99	168.1 ± 1.87*	
Feed costs per 1 kg of gain, FU	3.45 ± 0.097	3.27 ± 0.101	

Note: \* P > 0.95; \*\*\*P > 0.999 when compared with F1 crossbred boars

There were no significant differences between the groups of animals in terms of live weight when put on fattening and at the end of the fattening period. The average daily gain in live weight for the fattening period (3–7 months) was the highest in boars of breed combinations  $\frac{1}{4}$ Y  $\frac{1}{4}$ L  $\frac{1}{2}$ D – 898.2 g, which is more by 45.7 g (5.4 %; at P > 0.999), compared with crossbreed generation F1  $\frac{1}{2}$ Y  $\frac{1}{2}$ L. The age of reaching a live weight of 100 kg was the lowest in crossbred boars  $\frac{1}{4}$ Y  $\frac{1}{4}$ L  $\frac{1}{2}$ D – 168.1 days, the longest was in animals  $\frac{1}{2}$ Y  $\frac{1}{2}$ L – 173.2 days, the intergroup

difference is significant and amounts to 5.1 days (2.9 %, with P > 0.95). The lowest feed costs per 1 kg of live weight gain were in the group of crossbreeds  $\frac{1}{4}$ Y  $\frac{1}{4}$ L  $\frac{1}{2}$ D – 3.27 FU, which is 0.18 FU (5.2 %) at P < 0.95.

The meat qualities of pigs were studied at the meat processing enterprise Rentvel LLC, a partner company of AGROIND LLC. The features characterizing the post-slaughter qualities of pigs are essential in terms of meat productivity when selling products and result from the efficiency of fattening (table 3).

**Table 3**

Results of the slaughter of crossbred boars

Indicator	Generations and breed combinations of experimental boars	
	F1 $\frac{1}{2}$ Y $\frac{1}{2}$ L	F2 $\frac{1}{4}$ Y $\frac{1}{4}$ L $\frac{1}{2}$ D
Animals slaughtered, heads	5	5
Age at slaughter, days	190.3 ± 1.85	184.8 ± 1.74*
Pre-slaughter live weight of boars, kg	104.5 ± 3.64	105.2 ± 3.52
Slaughter weight (steamed carcass), kg	70.2 ± 1.85	76.9 ± 1.74*
Slaughter yield, %	67.2 ± 0.87	73.1 ± 0.95***

Note: \* P > 0.95; \*\*\*P > 0.999 when compared with F1 crossbred boars

Analysis of individual post-slaughter signs revealed that the indicators of slaughtered boars of the breed combination F2  $\frac{1}{4}$ Y  $\frac{1}{4}$ L  $\frac{1}{2}$ D turned out to be the best. Compared to analogs of the F1  $\frac{1}{2}$ Y  $\frac{1}{2}$ L breed combination, they quickly reached a slaughter weight of 110 kg by 5.5 days (2.9 %

( $P > 0.95$ ), with a higher slaughter weight of 6.7 kg (9.5 % ( $P < 0.95$ ) and the highest slaughter yield – by 5.9 % ( $P > 0.999$ ).

The economic efficiency of pork production is presented in table 4.

**Table 4**  
Economic efficiency of pork production in LLC “AGROIND” (2021 prices)

Indicator	Generations and breed combinations of experimental boars	
	F1 $\frac{1}{2}$ Y $\frac{1}{2}$ L	F2 $\frac{1}{4}$ Y $\frac{1}{4}$ L $\frac{1}{2}$ D
Number of animals	25	25
Average daily gain, g	852.5	898.2
Duration of fattening to live weight 110 kg, days	190.3	184.8
Total weight gain, kg	4055.76	4149.68
Cost of 1 kg of live weight gain, UAH	37.2	35.3
The market price of 1 kg of live pork meat, UAH	46.0	46.0
Cost of total live weight gain, UAH	3771856.8	3662092.6
The market price of total gain of live weight of pork, UAH	4664124.0	4772132.0
Profit from sales of products, UAH	892267.2	1110039.4
Profit per 1 head, UAH	35690.6	44401.5
The level of profitability, %	23.7	30.3

The calculations were carried out on experimental animals, taking into account their distribution into the appropriate groups depending on the breed combinations. The average selling price of 1 kg of live weight gain in pigs for 2021 at AGROIND LLC was 46.00 UAH.

Calculating the cost of 1 kg of pork gain on this farm, we proceeded from the actual data, namely the cost of compound feed for fattening pigs, which is 9.5 UAH per 1 kg, and the feed consumption per 1 kg of live weight gain, which differs for different breed combinations. It was taken into account that feeds in the total cost of pork on this farm is 73%. Based on these data, we carried out the corresponding calculations. We found that the cost of pork obtained from two-breed crossbred young animals for fattening F1 is 37.2 UAH (2.87 kg of compound feed x 9.5 UAH = 27.2 UAH, which is 73%; and the total cost (100 %), respectively, is 37.2 UAH). From three-breed crossbreeds, the F2 generation is 35.3 UAH (2.72 kg of compound feed x 9.5 UAH = 25.8 UAH, which gives 73 %, and the total cost (100 %), respectively, 35.3 UAH).

Based on the calculations of the economic efficiency of pork production at AGROIND LLC, we concluded that it is more efficient to breed, grow and fatten three-breed crossbred pigs of the combination  $\frac{1}{4}$ Y  $\frac{1}{4}$ L  $\frac{1}{2}$ D on the farm since they received more profit per head – 44401 UAH. This is for 8710.9 UAH. (24.4 %) exceeds the profit received from two-breed hybrids of the  $\frac{1}{2}$ Y  $\frac{1}{2}$ L combination. Moreover, pork production's profitability level in three-breed hybrids is higher by 6.6 %, respectively.

### 3.2. Discussion

The highest fattening and meat qualities of young hybrid pigs obtained from crossing Yorkshire, Landrace, and Duroc breeds were obtained due to the effect of heterosis (Alam et al., 2021). It was found that this is the result of the genetic heterogeneity of the original breeds (Likhach et al., 2021). Just genomic selection and the use of selection for the strength of the body structure, which has been carried out in recent years by the Danish companies DanBred Landrace and DanBred Yorkshire, have provided the result obtained (Klein et al., 2018). Indeed, for the manifestation of the effect of heterosis,

it is not so much phenotypic as genetic differences in interbreeding that are important (Lopez et al., 2019).

It was also determined that the fattening of three-breed hybrids (Y x L x D) is more effective than two-breed ones (Y x L). This is probably due to the genetic characteristics of the Durocs. DanBred Duroc boars are characterized by high fecundity, high offspring viability, high feed conversion, low slaughter losses, and a high percentage of meat per carcass (Chang et al., 2017, Lopez & Seo, 2019). Thus, it can be argued that the effectiveness of interbreeding of Yorkshires, Landraces, and Durocs is achieved by their high combinative ability, which as a result, stimulates the manifestation of the effect of heterosis in hybrid offspring.

### 4. Conclusions

Under appropriate conditions of feeding and keeping, young pigs obtained from three-breed industrial crossing, namely: crossbred boars of the F2  $\frac{1}{4}$ Y  $\frac{1}{4}$ L  $\frac{1}{2}$ D generation, are characterized by the best fattening and meat qualities. Their genetic features are manifested in higher growth energy, lower feed costs per 1 kg of growth, and higher early maturity when a live weight of 100 kg is reached.

It is more cost-effective to breed, grow and fatten three-breed crossbred pigs of the combination  $\frac{1}{4}$ Y  $\frac{1}{4}$ L  $\frac{1}{2}$ D. It is received from them more profit per head – 44,401.5 UAH, which is 8,710.9 UAH (24.4 %) exceeds the profit received from two-breed crossbreeds of the  $\frac{1}{2}$ Y  $\frac{1}{2}$ L combination, and the level of profitability of pork production in three-breed crossbreeds is higher by 6.6 %, respectively.

### Conflict of interest

The authors declare that there is no conflict of interest.

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