DOI 10.32900/2312-8402-2024-131-40-56
UDC 636.1.082

FACTORS INFLUENCING THE SPEED OF TROTTING HORSES

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The article represents the study of influencing factors on the main breeding characteristic of trotting horses, namely, speed during trialing on racetracks. Differences in the processes of selecting different trotting horse breeds are considered. The development of prize-winning equestrian sports and racetrack business is highlighted. Quantitative characteristics of trotting horses in Ukraine were established, absolute records of speed of trotting horses of domestic selection, fluctuations of the speed index of horses bred and prepared in different technological and climatic conditions were determined.

It was outlined that the speed of trotting horses differs in stud farms due to technological and climatic differences. It was also established that equal horses by breed, age and gender differ in speed when trialed at different racetracks in Ukraine. Thus, horses trialed at the Kyiv Hippodrome with a high probability ($p>0.95$-0.99) prevailed in terms of speed of peers trialed at the Odesa Hippodrome, both by record speed and by speed revealed in all age periods. Differences between peer groups of different gender have also been established. Thus, stallions of all age groups prevailed in terms of speed of mares at both racetracks.

The correlational relationship between record speed and the main body diameters of mares of the newly created Ukrainian trotting breed group was established, and it was found out that the livelier mares are also the largest according to the determined body diameters.

The influence of breeders of different origins on the speed of the progeny of the newly formed Ukrainian trotting breed group was determined. It was established that in all studied age groups the progeny of stallions of the French trotting breed prevailed over purebred peers of both trotting breeds in terms of speed at 1,600 m. It was proved that the use of the gene pool of the French trotting breed for crossbreeding makes it possible to improve the selection characteristics of horses of the newly created Ukrainian trotting breed group, to enrich its gene pool and reduce inbreeding depression in working conditions with a limited gene pool of the breed.

Key words: *horses, trotting breeds, speed, technological factors, climatic factors, genetic factors*

ФАКТОРИ ВПЛИВУ НА ЖВАВІСТЬ РИСИСТИХ КОНЕЙ

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Стаття присвячена вивченню факторів впливу на основну селекційну характеристику коней рисистих порід – жвавість при випробуванню на іподромах. Розглянуто відмінності у процесах формування різних рисистих порід коне. Висвітлено розвиток призового кінного спорту і іподромного бізнесу. Встановлено кількісні характеристики коней рисистих порід в Україні, визначено абсолютні рекорди жвавості коней рисистих порід вітчизняної селекції, коливання показника жвавості коней, вирощених і підготовлених у різних технологічних і кліматичних умовах.

Встановлено, що жвавість коней рисистих порід відрізняється у кінних заводах через технологічні і кліматичні відмінності. Також встановлено, що коні-аналоги за породою, віком і статтю різняться за жвавістю при випробуванні на різних іподромах України. Так, коні, випробувані на Київському іподромі з високою вірогідністю (p>0,95-0,99) переважали за жвавістю ровесників, випробуваних на Одеському іподромі, як за рекордною жвавістю, так і за жвавістю, виявленою в усі вікові періоди. Також встановлені відмінності між групами ровесників різної статі. Так, жеребці усіх вікових груп переважали за жвавістю кобил на обох іподромах.

Встановлено кореляційний взаємозв'язок між рекордною жвавістю і основними промірами тулуба у кобил новостворюваної української рисистої породної групи, виявлено, що більш жваві кобили також і найбільш крупні за визначеними промірами тулуба.

Визначено вплив плідників різного походження на жвавість потомства новостворюваної української рисистої породної групи. Встановлено, що в усіх досліджених вікових групах потомство жеребців французької рисистої породи переважало чистопородних ровесників обох рисистих порід за жвавістю на 1600 м. Доведено, що використання генофонду французької рисистої породи для схрещування дає можливість поліпшити селекційні ознаки коней новостворюваної української рисистої породної групи, збагатити її генофонд і зменшити інбредну депресію в умовах роботи з обмеженим генофондом породи.

Ключові слова: *коні, рисисті породи, жвавість, технологічні фактори, кліматичні фактори, генетичні фактори*

The important element of breeding programs for the improvement of domestic animals is the assessment and further forecasting of breeding value. This involves determining the target characteristics and analyzing the main breeding indicators. In the selection of horses of trotting breeds, the definition of efficiency indicators and factors influencing selection indicators are used. Thus, in Finland, the goals of trotting horse selection are clearly stated in the Rules of entry in the Stud Book (hippos.fi): high indicators of speed, absence of defects of limbs and hooves, correct gaits and energetic non-aggressive temperament, the main selection indicator is record speed and total winning in the race (Kvist , 2021).

The world's first official trials of trotters were held in 1827 in Lebedian, Tambov region. In Europe, 1836 is traditionally considered the beginning of trotting races, when the first trotting competitions between military horses were organized on the banks of Cherbourg in France. These horses, which became the genetic basis of the French trotter, were descendants of thoroughbred stallions from the county of Norfolk and Norman mares (Gorniak, 2020). Further, harness racing gained considerable popularity in France, more than horse racing, especially with the construction of the Vincennes racecourse. Since 1905, French trotters have been trialed all year round, and since 1952 even in the evening. The level of popularity of prize sports in France is confirmed by the number of annual competitions. Thus, only in 2000, 10,000 trotting trials were organized. Currently, the population of French trotting horses numbers more than 80,000, including about 17,000 thoroughbred mares. In 2019, the world record for the French trotting breed was 1:46 min. per mile (1609.344 m).

In the USA, the first racetrack for harness racing (Goshen Historic Track, New York) was opened in 1838, although competitions for trotting horses in harness were held as early as the second half of the eighteenth century (Kallerud, 2021).

Since 1810 in Germany, horse racing has been the main event at Oktoberfest (a traditional beer festival in Munich), and anyone with a horse could take part in it. Since 1847, races of trotting horses of all breeds of German breeding, and later imported Orlov and American horses, have been held at Oktoberfest (Eymold, 2016).

In Ukraine, prize sports in the form of amateur races at large fairs existed already in the early 20s of the 19th century. The first official trials of trotters on the territory of Ukraine took place on February 4, 1848 in Kharkiv on the Horse Square, together with the signing of the Charter of the "Kharkiv Association of Trotting Adherents", which included the most famous horse breeders of the province. Then, for the first time, the rules for conducting races were drawn up, the length and width of the racetrack were established, the number of winter and summer prizes and the value of the prizes were determined. In the same year, the first hippodrome in Ukraine was built in Kharkiv (Tkachova et al., 2015).

The most famous and widespread trotting horse breeds in the world are: American Standardbred, French trotter, Orlov trotter, Russian trotter, as well as Swedish, North Swedish, Finnish trotter, Icelandic Toelter, Gudbrandsdal, or – Dole horse (united by the term Scandinavian Coldblood). Since the 1990s, work has been ongoing to create a Ukrainian trotting breed group of horses.

The Scandinavian Coldblood combines varieties of trotting horses of the Scandinavian countries (Marionneau & Nikkinen, 2023). In these northern countries, local draft horses ("coldblood" in German terminology) have been used in forestry and agriculture for a long time. With the reduction of the need for mass transport in the 19th century, during the period of mass European fascination with trotting races, these breeds began to be used in prize sports. Crossing them with other "warmblood" breeds is prohibited, and they began to be crossed with each other quite recently, e.g., the Swedish branch of breeding stallions is used in Finland, the Norwegian branch – in Sweden. Systematized trials of Scandinavian trotters have been conducted since the 1950s. The Finnish breed was bred by crossing local working horses with Swedish, Gudbransland and Norfolk trotters. In 1907, the Stud book of the Finnish trotter was started. The selection of the breed is carried out with the aim of obtaining horses of universal performance – for riding, harness racing and weight-carrying. That is why today there are four sections in the Stud book of the Finnish trotter: trotting, working, riding and pony class.

The main criterion for evaluating Finnish trotters is the speed found in trials (Kvist, 2021). In order to record a stallion in the trotting section of the stud book, it

must show speed for 1,600 m no less than 1 minute. 35 seconds in terms of 1,000 m, mares must show at least 1 minute 56 seconds. The degree of heredity of the Finnish trotter's speed is quite high – about 40%. However, Finnish breeders carefully work at improving speed, taking into account that other valuable qualities of the horse may deteriorate: exterior, length of productive life, high fertility, etc. Therefore, most Finnish trotters are trialed in closed prizes. The Finnish trotters' speed record is 2 min 07.4 s in terms of 1,600 m.

The Swedish trotting breed is a lighter version of the North Swedish draft horse breed. The North Swedish breed is descended from the oldest Scandinavian breed and is related to the Norwegian breed (Koivuranta, 2021). Swedish horses are used both for trotting races and in agriculture and forestry. They are characterized by a strong constitution, unpretentiousness, immunity to common horse diseases. The Norwegian (Gudbransdal) breed was bred in Norway and got its name from its place of origin – the Gudbransdal Valley, which connects the Oslo region with the North Sea coast. It is assumed that Friesian and Delian horses were used during its creation and formation. There are two types of the Gudbransdal breed – heavy-hauling and light-hauling trotting. In recent years, the crossing of these two types has become more and more common in order to obtain a universal draft horse and the difference between them is becoming less noticeable (Olsen, 2020). Norwegian horses are characterized by an elongated massive body, a long neck, a small head, medium-length limbs with developed brushes. The height at the withers is 145-160 cm, the hearth girth is 190-200 cm, the horses are mostly bay, brown, raven. The approximate number of thoroughbred mares of the Norwegian breed is 1.6 thousand heads (Olsen, 2020).

The largest number of racetracks, race days and prize horses, including trotters and pacers, are located in the United States and Canada. In Europe, France is the leader of trotting sports in terms of the number of racetracks, race days, horses on trials and, most importantly, the totalizer turnover and the profitability of the racetrack industry. In terms of the profitability of prize sports in the world, the main competitors are France, the USA and Australia (Ohorodnichuk, 2022; Cochran, 2023; Marionneau & Nikkinen, 2023). About 35,000 trotters are registered in Germany, of which more than half are of local origin (their own breed group), about 40% are American Standardbred, 5% are French trotters, there is a small population of Orlov trotters, which are used both in prize sports and in driving. In Germany, there are 13 large trotting racetracks and about 40 of local importance. The main prize is the Derby at the Mariendorf Racecourse in Berlin.

Since the time of the first racetracks and prize sports, horse breeders have been trying to increase the speed of trotting horses. Hippologists also work in this direction, trying to establish factors that can influence the increase in speed. Speed is the main characteristic of fast gait horses, which include trotting breeds, this feature determines the competitiveness of breeds and currently remains relevant. Therefore, the aim of the study was to establish the factors affecting the prize-winning performance of trotting horses of domestic breeding.

Materials and methods. The material for the research was a database formed from the materials of the breeding records of trotting horses in the breeding center of the Institute of Livestock Breeding of the NAAS and the State Enterprise "Agency for Identification and Registration of Animals", as well as data from expedition surveys of stud farms and breeders of Ukraine. Indicators of prize-winning performance (speed at a distance of 1,600 m) were studied based on the annual reports of racetrack trials of trotting horse breeds of domestic selection. The horses were divided according to the tender sign by the age of 2, 3, 4 ,and older. Scientific and methodical approaches were based

on the zootechnical and genealogical array of trotting horses. Calculations were made in the Microsoft Excel.

Research results. In order to understand the difference between the indicators of speed and the exterior of horses of different trotting breeds, which determine their technological characteristics, an analysis of their creation methods, selection approaches and trial systems was carried out.

The Orlov trotting breed (known since 1776) was created thanks to the successful crossing of the best horse breeds of that time (Arabian, Danish, Dutch, thoroughbred riding, Mecklenburg, Norfolk, etc.), rational choice and selection, as well as systematic training and trotting trials. Until the end of the 19th century, it was the liveliest of the trotters, but later gave way to the American trotter, consolidated for maximum speed over short distances. The system of trials of Orlov trotters was based on the developing distance trotting and included long-distance trials, as well as races in heavy crews (Ohorodnichuk, 2022). The modern domestic population of Orlov trotting horses under the influence of the selection process has acquired special features, which gives it uniqueness and the possibility of further breeding in the conditions of a limited gene pool. Horses are trialed in general and closed prizes at distances of 1,600, 2,400, 3,200 and 4,800 m.

In 2023, the absolute records of speed of horses of the Orlov trotting breed of Ukrainian selection are: for a distance of 1,600 m – at the age of 2 – 2.08.8 minutes, at the age of 3 – 2.03.5 minutes, at the age of 4 – 2.02, 8 min., older age – 2.01.2 min.; for a distance of 2,400 m: at the age of 3 – 3.15.2 minutes, at the age of 4 – 3.09.2 minutes, at an older age - 3.09.2 minutes. with; for a distance of 3,200 m: at the age of 4 - 4.25.7 min., older age – 4.16.7 min.; for a distance of 4,800 m: at the age of 4 – 6.59.8 min., older age – 6.42.3 min. Speed record for 6,400 m horses at the age of 4 – 10.15.7 min. (the record was set by the stallion Reaktiv in 1954), older age – 9.35.7 minutes (the record was set by the mare Kapitansha in 1940).

The speed records of horses for the years 2010-2023 by gender and age groups are shown in Table 1.

Table 1

Speed records of horses of the Orlov trotting breed of different gender/age groups

Year	Gender/age groups						
	2 years old		3 years old		4 years old		Older age (stallions)
	colts	fillies	colts	fillies	stallions	mares	
2010	2.15.6	2.11.2	2.11.6	2.10.6	2.06.7	2.09.0	2.02.5
2011	2.13.0	2.14.2	2.09.9	2.08.7	2.06.6	2.10.3	2.01.2
2012	2.14.2	2.13.4	2.03.5	2.11.2	2.07.3	2.07.9	2.03.9
2013	2.18.5	2.15.1	2.10.0	2.10.8	2.08.1	2.05.3	2.07.3
2014	2.15.5	2.16.0	2.09.5	2.11.5	2.08.0	2.08.6	2.04.9
2015	2.18.7	2.19.5	2.10.0	2.12.2	2.07.1	2.14.9	2.05.9
2016	2.18.4	2.16.9	2.07.8	2.11.7	2.06.1	2.11.7	2.06.2
2017	2.16.6	2.17.2	2.07.1	2.09.4	2.07.2	2.14.6	2.05.1
2018	2.18.4	2.18.3	2.07.0	2.08.9	2.06.1	2.05.7	2.07.0
2019	2.17.2	2.20.8	2.08.7	2.09.7	2.06.3	2.06.1	2.04.6
2020	2.24.6	2.21.6	2.13.1	2.12.6	2.08.2	-	2.04.4
2021	2.18.2	2.19.3	2.09.5	2.08.4	2.06.7	2.07.5	2.03.0
2022	2.20.5	2.14.0	2.09.2	2.11.0	2.08.0	2.07.3	2.04.1
2023	2.14.0	2.13.2	2.09.9	2.11.8	2.06.4	2.08.8	2.04.1

The American Standardbred breed is descended from a thoroughbred horse that began to be trialed in racing competitions in the Northern states since 1778 (Kallerud, 2020). The first official racing trials in America took place at the Long Island racetrack (New York) in 1806 with a record faster than 3 minutes (set by a colt of unknown origin Yankee 2.59.0 min.). The next breeding milestone was crossed in 1845 at the New Jersey racetrack, where the gray mare Lady Suffolk covered 1,609 m (1 mile) in 2.29¼ min.. The American trotting breed, as such, did not yet exist in those days, horses of any origin were used in the races, which were distinguished by a brisk trot. Racetrack lines began to emerge when the mare Lady Suffolk ran a mile in 2 minutes 30 seconds in 1854. and racing sports gained enormous popularity. Since 1879, on the initiative and program of Wallace, in the stud books of breeds (Wallace's Lear book trotters), only racing horses with the definition "Trotting Register" have been registered following the standard of speed: a trotter must run a mile (1,609 m) no less than in 2 minutes 30 seconds, and a pacer – in 2 minutes 25 seconds. Since 1931, the main requirement has been the origin of horses from parents registered in the stud book (Sole, 2020; Marionneau, 2023).

The organization of rearing and training is of great importance in the formation of high speed of Standardbred trotters. Stud farms grow young animals up to 1.5 years old, then they are sold at auctions and then undergo training in specialized farms. Only young animals with speed no less than 2 minutes 15s per mile are sent to racetracks. The breed is the most precocious, i.e. absolute records were set at the age of 3-4, but due to selection only for speed, American trotters do not have a clearly expressed harness type, a correct trotting gait, there is a wide variability in their caliber and exterior (Speed, 2020). The modern system of trotter trials in the USA and Canada involves a mile (1,609 m) competition, usually in one hit, with an auto start, on leveled tracks with a high-quality surface (Samsonstuen, 2020).

Today, all world records for 1 mile are held by American Standardbred trotters. The liveliest trotters in the world are bred in the USA, Canada, France, Italy, and Sweden, their speed reached the 2-minute mark a long time ago (Trotting races, 2023). However, it should be taken into account that the progeny of breeding stallions of American Standardbred stallions' number several hundred, therefore, the intensive selection is supposed to take place. The main incentive for breeding horses of this breed is the considerable popularity of trotting trials on racetracks and the high value of international prizes.

The French trotting breed was originally created as a breed of combined use, both in harness and under saddle in the 19th and 20th centuries in the province of Normandy by crossing local coarse massive horses with Arabian, and later with thoroughbred riding and Norfolk breeds. Later, Orlov and American trotters were also used in breeding work. The selection and training of horses provided for the development along with speed and endurance, because the distance set was 4-6 km (Jez, 2015). The combination of these qualities was fixed in the descendants. Horses of the French trotting breed are distinguished by their stalling abilities and are world record holders for long distances. Horses of this breed are widely distributed, the French population of the breed includes 650 breeding stallions and 17 thousand thoroughbred mares. Every year, 14,000 French trotters are trialed on racetracks, and bring significant income to their owners (Cochran, 2023).

The origin of French trotters has a lot in common with the methods of selection of Orlov trotters: the accumulation of outstanding representatives in the distant ranks of ancestors, moderate inbreeding on the best representatives made it possible to obtain a lively and consolidated trotter.

The system of trialing the French trotter has its own differences: the prizes are played mainly for medium and long distances, and a quarter of them are for trot races under the saddle, with a rider weighing 60-85 kg, so French trotters are distinguished not by sprinting, but by stalling abilities and set world records for long distances (Thiruvenkadan, 2009).

High speed for stable distances in combination with an expressive harness type, large caliber, correct exterior are those qualities that trotting horse breeding requires. Thus, in the trotting horse breeding of Sweden and Italy, the practice of infusing the blood of the French trotting breed at the level of 1/4-1/8 (horses of outstanding speed Varenne, Copiad, Ina Scot, Mr Lavec) is used (49).

Horses of trotting breeds have been bred in Ukraine since the beginning of the 20s of the 19th century along with the popularization of prize-winning equestrian sports. The first recognized breeder of trotting horses in Ukraine was the representative of the royal family and the head of the imperial stud farm, Grand Duke Dmytro Romanov, who founded the Dibriv stud farm in Poltava province in 1888. Since then and until now, the Dibriv stud farm has maintained a leading position in the selection of Orlov trotting horses and the new Ukrainian trotting breed group (Strijak T.A., 2014). Already at the beginning of the last century, trotting horses underwent significant population changes, in particular, a part of horses that, in order to increase speed, were crossed with the precocious and lively American Standardbred trotter. Crossing of prize trotters with the French trotter breed began in Ukraine in 1965 and increased in volume since 2002. Taking into account the separation of trotting horse selection directions, the stud farms of Ukraine – Dibriv, Lozova, Zaporizhzhya and Lymariv, along with the preservation of the population of the original Orlov trotter, through long-term selection for speed, prize precociousness, endurance, distance, created their own type of trotting horse, and in 2016, the first stage of approbation of the newly created Ukrainian trotting breed group of horses was carried out (Tkachenko O.O., 2016).

Thus, all known trotting horse breeds differ among themselves in methods of creation, productivity (Table 2), exterior characteristics.

Table 2

Basic technical characteristics of trotting horse breeds

Breed	Record speed at 1,600 m at the age of 2, min.s	Absolute record for the distance of 1,600 m, min.s	The age of the "Derby" draw, (distance, m)
Orlov trotter	2.11.3	1.57.2	4 (1600 m)
Russian trotter	2.10.2	1.56.9	4 (1600 m)
French trotter	1.16.3 (2.02.1)*	1.10.8 (1.53.3)*	4 (2875 m)
American Stand-ardbred	1.53.2	1.51.0 (1.46.2**)	3 (1609 m)
Scandinavian Coldblood	Trials since the age of 3	1.18.9 (2.06.2)	4 (2600 m)

*Note. * - in terms of 1600 m; **- trial by other means (alure)*

Indicators of selection of trotting horse breeds differ according to the traditional systems of their trials.

It has been established that the systems of trialing trotting horses in countries with developed horse breeding differ significantly. The analysis of the ratio of trotters of different age groups on the racetracks of France, the USA, and Finland gives an idea of some regularities in the development of racing sports. So, in the USA, the precocious and very lively trotter is popular in short distances, and the main prizes are won on horses of 2-3 years old. In France, the main prizes are played for horses older than 4 years old at long distances (2,000-4,000 m), therefore, the trotter is more distant and late maturing. In Finland, both directions are practiced – the prize precocious race and the distance race on local coldblood trotters, and both systems work equally successfully. In Ukraine, the newly formed Ukrainian trotting breed group is distinguished, which is more precocious and lively for short distances, as well as the Orlov trotting breed which is late maturing and more distant. The main prizes for Orlov trotters in accordance with the "Rules of Trials" are drawn separately.

Moreover, the main group of horses on racetracks in the USA and Europe (about 53%) are four-year-old and older trotters. This is necessary for the normal functioning of the system of trotting trials and the profitable totalizer, because two-year-old horses begin to be trialed in May, no more often than once every 7 days and only in their age group, and horses of the Scandinavian breed are not trialed at all at the age of two, which contributes to their better development. Therefore, in order to maintain the attractiveness of competitions, which guarantees high reliability of the totalizer and the profitability of equestrian sports, it is necessary to have a significant number of older horses on the racecourse. Along with this, the great competition of young horses on the racetrack leads to a constant increase in the requirements for their prize performance, which contributes to the selection process.

Thus, it was established that in the countries with developed horse breeding, the breed composition of horses, different trial systems, traditions and principles of racing competition organization are very different, but they have one thing in common – a profitable totalizer, high prize amounts, state support for the selection process, which ultimately stimulates the development of prize horse breeding and guarantees its high profitability.

The analysis of the current breeding (accounted) stock of horses of domestic breeding showed (Table 3) that all of them are in the status of "in a state of danger" (from 100 to 1000 capable of reproduction females) according to the FAO classification. In particular, trotting breeds in Ukraine are represented by two populations that have long been the subject of selection by domestic studs, namely, Orlov trotting (194 mares) and the newly created Ukrainian trotting breed group (182 thoroughbred mares). 90 horses of the French trotting breed (including 15 thoroughbred mares) are bred in two stud breeders.

Table 3

The number of breeding horses of trotting breeds in stud farms of Ukraine

Breed	2023			
	in total		including	
	number	%	stallions	mares
Orlov trotter	465	*55,1*	30	194
Newly created Ukrainian trotting breed group	301	*35,7*	15	182
French trotter	78	*9,2*	6	30

By geographical feature, trotting horse breeds are traditionally distributed in the eastern regions of Ukraine (Fig. 1), which may be related to their adaptive features in these climatic conditions. The first stud farms of Ukraine were founded on the fertile lands, where trotter horses are currently bred: Luhansk (Lymariv stud farm, 1818), Poltava (Dibriv stud farm, 1888), Kharkiv (Lozovf stud farm, 1936), Zaporizhzhya (Zaporizhahya stud farm, 1945). In the area of activity of these stud farms, trotter horses are most often distributed among the population, and stud farms are formed.

Figure 1. **Geographical concentration of trotting horses in Ukraine**

In addition, trotting horses are bred in breeders of the Sumy, Kyiv, Zhytomyr, and Rivne oblasts, and they are also popular among horse owners in all regions of Ukraine.

Trotting horse breeding enterprises are located in the climatic zones of Ukraine, which differ quite a lot in terms of indicators (Table 4). So, if the Dibriv, Lozova and Lymariv stud farms are located in adjacent regions on almost the same geographical latitude, Zaporizhzhya is much further south.

The Lymariv stud farm is located in the north-eastern part of the Luhansk oblast on the banks of the Derkul River, in a temperate-continental climate zone with pronounced drought, hot dry summers and frosty winters with little snow and thaws. The subsoil, and accordingly the underground water, is rich in chalk, which has a positive effect on the strength of the bones of horses, and there are also sources of mineral water. The region belongs to the zone of risky agriculture, because atmospheric precipitation is uneven. A special feature of the stud farm, in particular the training racetrack, is its location within a forest area of about 150 hectares, which provides protection from winds and drafts, and radially from the racetrack of the stud farm, channels have been dug to drain meltwater into the river. These technical means ensure high-quality training of horses, and also mitigate temperature changes. The training track is built by filling up

the soil, which allows horses to be trained in early spring and during the season of heavy rains.

Table 4

Climatic indicators of horse breeding areas

Indicators	Stud farm			
	Dibriv	**Zaporizhzhya**	**Lozova**	**Lymariv**
Altitude	146	101	138	69
Geographic coordinates: north latitude east longitude	 50º02′18″ 33º31′05″	 47º57′27″ 36º00′54″	 49º00′51″ 36º33′10″	 49º16′36″ 39º35′58″
Average annual temperature, ºC: in summer in winter	 +21.4 -3.7	 +22.8 -4.9	 +20.8 -5.2	 +14.9 -3.0
Average air temperature, °C: the warmest month the coldest month	 (July) +18.5 (January) -4.7	 (July) +23.4 (January) -2.4	 (August) +20.8 (February) -6.5	 (July) +22.0 (January) -9.0
Average annual precipitation, mm	480-580	504-572	575	459-505
Average annual relative humidity, %	67-84	72-76	66-85	70-75
Average annual wind speed, m/s	2.3	2.6	5.5	2.5-3.0

The Dibriv stud farm is located in the center of the Poltava Oblast, 12 km from Myrhorod in the forest-steppe zone with a moderate-continental climate with unstable average humidity, hot, sometimes dry summers and cold winters, in a region known for mineral waters and rich pastures. The stud farm is surrounded by fertile lands with reservoirs and dense forest plantations, and has its own artesian well.

The Lozova stud farm is located in the south of the Kharkiv oblast in the Steppe zone with a moderately continental climate with warm, moderately hot, sometimes dry summers and moderately cold, mild winters. The territory is poor in water bodies, in the village where the stud farm is located there is a dry stream. According to the amount of precipitation, the area where the stud farm is located is in the zone with average humidity. North-east and north-west winds prevail.

The Zaporizhzhya stud farm is located in the north of the Zaporizhzhya region in a relative lowland – the Nechaivskaya stream, through which a drying stream with dams flows, in the zone of the steppe Atlantic-continental climate with hot, dry summers and moderately cold winters with little snow and frequent thaws. North and northeast winds prevail.

The technology of housing, feeding and training horses of trotting breeds is traditional for domestic stud farms, however, each stud farm has its own peculiarities in the building of stables and day pens, microclimate indicators, feed rations (chemical

composition of local fodder crops), water quality and watering system, duration of grazing period, grazing technology and pasture quality, etc. All these factors, under the conditions of a high breeding level in all stud farms, affect speed, as evidenced by the results of the analysis of the record speed of thoroughbred mares, which are the basis of the formation of the reproductive composition (Table 5).

Table 5

Indicators of speed for a distance of 1,600 m of thoroughbred mares of trotting breeds in stud farms

Breeder	n	Speed in trial for a distance of 1,600m (min., s)			
		average record speed	2 years old	3 years old	4 years old
Orlov trotting breed					
Dibriv stud farm	29	2.14.3±1.22	2.27.7±1.33	2.14.1±0.90	2.11.6±0.90
Zaporizhzhya stud farm	61	2.17.0±1.03	2.27.4±1.08	2.16.7±0.62	2.15.8±1.26
Lymariv stud farm	19	2.27.1±2.94	2.35.8±3.13	2.23.6±2.17	2.17.3±2.04
Lozova stud farm	12	2.22.9±3.19	2.28.6±2.22	2.18.5±2.09	2.13.3±2.30
PAE Komyshanske	14	2.16.2±2.01	2.22.6±1.59	2.14.3±2.73	2.13.0±0.95
Individuals	11	2.21.9±3.32	2.24.5±3.33	2.21.6±5.08	-
On average:	145	2.18.5±0.81	2.28.1±0.79	2.17.2±0.59	2.14.6±0.84
Ukrainian trotting breed group					
Dibriv stud farm	29	2.08.1±0.88	2.26.5±1.75	2.11.3±0.73	2.05.4±0.64
Zaporizhzhya stud farm	43	2.11.3±0.99	2.24.9±1.47	2.11.7±0.77	2.10.0±0.74
Lymariv stud farm	37	2.18.6±2.07	2.28.1±1.49	2.17.2±1.77	2.10.9±1.24
On average:	109	2.12.9±0.93	2.26.4±0.90	2.13.3±0.72	2.08.9±0.59

75.1% (145 mares) of all thoroughbred mares of the Orlov trotting breed were trialed on racetracks. Almost a quarter of thoroughbred mares (24.9%) are untrialed, which negatively affects the selection process. Mares are trialed for speed at the classic distance of 1600 m. This indicator was chosen because trotting horse breeds are trialed mainly at this distance, at longer distances (2,400 m, 3,200 m) much smaller number of horses are trialed – 11.3% of stallions and 3.2 % of mares.

Mares of the Ukrainian trotting breed group were trialed on racetracks more – 91.6% with an average speed of 2.12.9 min. All mares (100%) were trialed at the Zaporizhzhya Stud Farm No. 86. The fewest number of mares trialed was at Lymariv stud farm No. 61 (82.2%). The liveliest mares were selected for breeding stock of the Dibriv stud farm No. 62 (average speed 2.08.2±0.86 min.). In prize-winning precocity, mares of Zaporizhzhya stud farm No. 86 with a high probability ($p<0.01$) prevail over mares of other stud farms (average sprightliness at 2 years of age – 2.24.9±1.47 min.). Naturally, the best (lifetime record) speed of mares is shown at an older age, it was the highest in mares of Dibriv stud farm No. 62 (2.05.4±0.64 min.). However, some mares show record speed at the age of 3 years, sometimes - a high level of speed is manifested at the age of 2 years and the mare's trials are completed in order to return her to the stud farm as soon as possible for further lively offspring.

On average, mares of the newly created Ukrainian trotting breed group probably outperform their peers of the Orlov trotting breed both in terms of average record speed and speed in all age groups.

Horse trials at the state level are carried out at the Kyiv and Odesa Hippodromes, and at the local level there are regional and stud farm racetracks.

The racetracks where trotting horses are trialed also differ in technological equipment and processes, as well as in location in different climatic zones (Table 6).

Table 6

Climatic indicators of racetrack locations

Indicators	Hippodrome	
	Kyiv	Odesa
Altitude	179	48
Geographic coordinates: north latitude east longitude	 50º37′52″ 30º46′48″	 46º26′40″ 30º44′15″
Average air temperature, °C: the warmest month the coldest month	 (July) +20.5 (January) -3.5	 (July) +22.6 (January) -0.5
Average annual precipitation, mm	616.9	453.0
Average annual relative humidity, %	74.0	75.0
Average annual wind speed, m/s	2.5	3.2

The Kyiv Hippodrome is located in the southwestern district of Kyiv in a temperate continental climate zone with mild winters and warm summers, with an average annual temperature of +9◦C. The Odesa Hippodrome is located 500 km to the south on the Black Sea coast, respectively, in the zone of a humid continental, close to subtropical climate, with an average annual temperature of +10.7ºC. Taking into account the infrastructure of the cities within which racetracks are located, it can be assumed that the quality of air, water, and soil can affect the results of horse trials. The length of the racing circle of the prize track of the Kyiv Hippodrome for trialing trotting horses is 1,600 m, the width is 30 m, the track is soil, has calculated bends; the length of the training track is 1,477 m, the width is 20 m, the track has a slag coating up to 18 cm thick. The prize track of the Odesa Hippodrome is also 1,600 m long and has a soil surface, there is also a winter sand track that is suitable for trialing in wet weather, its length 1,476 m. Under such ecological conditions of the location of racetracks and their technological features, there are logical differences in the results of trials of trottered horses.

Speed indicators of young horses of the Orlov trotting breed trialed at various racetracks over the past 5 years were determined (Table 7).

It was established that the horses trialed at the Kyiv Hippodrome with a high probability (P>0.95-0.99) prevailed in terms of speed of peers trialed at the Odesa Hippodrome, both in terms of record speed and speed revealed in all age periods. Differences between peer groups of different genders have also been established. Thus, stallions of all age groups prevailed in terms of speed of mares at both racetracks.

Researchers pay a lot of attention, and it is logical, to the connection of speed of trotting horses with their exterior indicators. It is believed that the height at the withers, the size, the hearth girth and the cannon girth can affect the performance of horses.

Table 7

Speed of young Orlov trotting breed of Ukrainian selection (2017-2021)

Hippodrome	Gender	Speed a distance of 1,600 m (min., s), at the age of					
		n	2 years old	n	3 years old	n	4 years old
CE "Kyiv Hippo-drome"	colts/stallions	88	2.25.9 ±0.778	61	2.13.5 ±0.594	48	2.09.9 ±0.900
"	fillies/mares	64	2.27.6 ±1.139	41	2.13.9 ±0.820	10	2.09.9 ±0.900
Branch "Odesa Hippodrome" SE "Horse Breeding of Ukraine	colts/stallions	53	2.30.5 ±1.395	50	2.16.4 ±0.800	25	2.12.3 ±0.621
	fillies/mares	92	2.32.3 ±1.192	91	2.21.9 ±0.900	50	2.15.4 ±0.760
On average	colts/stallions	141	2.27.6 ±0.735	111	2.14.8 ±0.504	73	2.10.8 ±0.640
	fillies/mares	156	2.30.4 ±0.861	132	2.19.5 ±0.744	60	2.14.5 ±0.700

The correlational relationship was established between record speed and the main body measurements of mares of the newly formed Ukrainian trotting breed group (Table 8), and it was found that the more lively mares are also the largest according to the determined body measurements.

Table 8

Correlations (r) between prize productivity and body measurements of mares of the Ukrainian trotting breed group

Speed indicators	Measurements, cm				
	record speed	height at withers	diagonal length of body	hearth girth	cannon girth
All trialed fillies/mares (n=109)					
Record speed	×	-0.116	-0.076	0.085	-0.013
Speed at the age of					
2 years old	0.311	-0.033	-0.147	-0.141	-0.251
3 years old	0.909	0.074	0.044	0.032	0.084
4 years old	0.940	-0.015	-0.018	0.054	0.270

During the research, when creating the Ukrainian trotting breed group, 16 breeding stallions of the American Standardbred and 12 of the French trotting breed were used in crossing. The efficiency of their use is given in Table 9.

It was established that in all studied age groups, the progeny of stallions of the French trotting breed exceeded purebred peers of both trotting breeds in terms of speed at 1,600 m. Thus, according to the average indicators of speed at the age of two, the crossbred horses prevailed over the purebred ones (Ukrainian trotting breed group) by 7.5 s (P>0.95), three-year-olds – by 4.4 s (P<0.90), four-yea-olds – by 4.7 s (P>0.90). Peers of the French trotting breed prevailed in the corresponding age periods by 1.7 s, 3.6 s and 4.3 s.

Table 9

Comparative analysis of prize performance of horses of different genetic groups at a distance of 1,600 m

Age, year	Genetic group of horses							
	thoroughbred				crossed			
	Ukrainian trotting breed		French trotting breed		progeny of French trotting stallions		progeny of American Standardbred stallions	
	n	speed, min.	n	speed, min.	n	speed, min.	n	speed, min.
2	1195	2.30.8±0.50	43	2.25.0±0.14	37	2.23.3±0.12	68	2.26.0±0.80
3	1085	2.16.3±0.66	47	2.15.2±0.13	37	2.11.9±0.97	68	2.13.4±0.81
4	763	2.10.3±0.27	41	2.09.3±0.10	20	2.05.0±0.71	45	2.08.5±0.62

Horses from stallions of the French trotting breed turned out to be livelier than peers from stallions of the American Standardbred: at the age of two – by 2.7 s, at the age of three – by 1.5 s, at the age of four – by 3.5 s. Moreover, in the progeny of stallions of the American standardbred breed, more horses of speed class 2.10 min. were found and livelier – by 7.2%, speed class 2.05 min. and livelier – by 8.9%. Breeding stallions of the American Standardbred were on average inferior to stallions of French selection in terms of speed at 1,600 m by 2.3 seconds. So, it has been proven that the use of the gene pool of the French trotting breed for crossbreeding makes it possible to improve the selection characteristics of horses of the newly created Ukrainian trotting breed group, enrich its gene pool and reduce inbreeding depression in the conditions of working with a limited gene pool of the breed.

Discussion. Many studies have proven that the breeding characteristics of horses, as in all domestic animals, are influenced by the genotype, the level of feeding, and the conditions of housing. The genetic component of the inheritance of speed in horses of trotting breeds has been little studied. Thiruvenkadan et al (2009) determined the annual genetic progress in the Swedish and Dutch trotting breeds at the level of 5.0% of the standard phenotypic deviation, in the French trotting – 3.6%.

The degree of influence in a rather significant positive degree (r=0.340) of the record speed of mares on the speed indicators of their progeny at the age of four and older was established. The speed of the dam affects the speed of sons only after they reach the age of 5 and older, and the speed of daughters does earlier – at the age of four (Tkachova et al., 2022).

The positive effect of crossing the Russian trotter breed with the French trotter on improving the lively characteristics of horses was experimentally proven (Tkachova et al., 2019). In all the studied gender-age groups, young horses bred by the French trotting breed outperformed purebred peers of both trotting breeds in terms of speed at 1,600 m. Horses from stallions of the French trotting breed were livelier than peers from stallions of the American Standardbred: at the age of two – by 0.5 s, three – by 1.2 s, four – by 1.1 s.

Exterior features are also determined by the genotype and are related to the speed of trotting horses. In this direction, Jansson et al. (2022) worked and established that horses of the Standardbred with the worst speed had pronounced asymmetry of the hind limbs. Therefore, detecting this anomaly at an early stage is important to prevent the development of musculoskeletal disorders in the future (Kallerud, 2020). Egenvall et al. (2022) demonstrated the effects of rein tension, bridle quality, and the rider's ability

to communicate with the horse using the harness on the horse's speed.

Considering horses, paratypical factors are important influencing factors, namely, training and trialing on racetracks, year and month of birth, year and season of trialing, distance, starting method, covering and condition of the racetrack, rider qualification, season of the year and weather conditions, quality of shoeing (Štrbac, 2015; Crevier-Denoix, 2017; Sole, 2020). The researchers propose to include these factors in models for predicting breeding traits of trotting horses.

Verdegaal et al. (2021) prove that the speed and endurance of horses is significantly influenced by the temperature of the surrounding environment. This factor needs to be studied more carefully considering the conditions of Ukraine. We have proven the difference in speed indicators of horses grown and trialed in different climatic zones.

By studying the results of a trial of Standardbred horses, Kallerud et al. (2022) established the influence of the interaction of the forelimbs with the racing track on different areas and the angle of inclination of the surface, which causes asymmetry of the horse's body while running. Interesting data was presented by Hobbs et al. (2016) regarding the possibility of individual horses using dissociation models at moderate speeds, that is, able to maintain gait stability. In addition, experiments on Orlov trotters have proven that the condition of the track surface also affects speed with a force of 23.5% (Gladkikh & Kuznetsova, 2021). Our data confirm the difference in speed indicators of trotting horses trialed on racetracks with different technological equipment. We have also established a positive correlation between record speed and the main body measurements of horses of the newly created Ukrainian trotting breed group. The genetic component in the manifestation of record speed of trotting horses is confirmed by the difference in the indicator and horses of different origins.

As we can see, a significant number of factors affect such a breeding trait as speed of horses, and these factors require a detailed study on horses of domestic breeding in the conditions of racetracks of Ukraine.

Conclusions. The difference in speed indicators of trotting horses under the influence of technological, climatic and genetic factors was established. In particular, differences in speed indicators were found in horses bred in different stud farms and trialed on racetracks, different in location, climatic and technological features. Trotting horse breeds are traditionally bred in stud farms with different technological and climatic characteristics, therefore, these factors can affect speed, which is proven by the analysis of this characteristic by economic entities.

The correlational relationship between record speed and the main body measurements of mares of the newly created Ukrainian trotting breed group was revealed, and it was proved that more lively mares are also the largest according to the determined body measurements.

The influence of the breeding stallion breed on the speed of horses of the newly created Ukrainian trotting breed group was determined, it was proved that the use of the gene pool of the French trotting breed for crossing makes it possible to improve the selection characteristics of horses of the newly created Ukrainian trotting breed group, enrich its gene pool and reduce inbreeding depression in the conditions of working with a limited gene pool species.

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