Pig breeding, selection and hybridisation in Yugoslavia

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Pig production has been a very important branch of agriculture in Yugoslavia. During the last fifteen years, the number of pigs produced has considerably increased and this growth shows a tendency of accelerating. As can be seen in **Table 1**, *the number of pigs was highest in 1984: more than 14 million. However, due to a general crisis in agriculture, as well as poor meat prices, the number of pigs decreased in 1985.*

By means of long-term planning for the period up to the year 2000, pig production is expected to reach 16 million at that time.

Pig production in Yugoslavia occurs in both the private and public sector. Publicly-owned pig farms, especially larger ones, with up-to-date technology, are and will no doubt continue to be a stable part of pig production. This is particularly important when the production of goods and meat is in question. The number of pigs and sows has considerably increased on publicly-owned farms: from 1970 to 1984 it jumped from 1 to 2.2 million animals. The proportion of pigs and sows from the public sector in the total population was 18.5% and 9.4%, respectively, in 1970, and 25.6% and 12.3% in 1985. More than one quarter of the total number of pigs were on publicly-owned farms in 1986.

What is certainly more important is the productivity of sows and meat production in the public sector. Nearly three million pigs for slaughter, with a total live weight of about 270,000 tons, were recently delivered from the public sector. It could therefore be concluded that approximately 10-12% of sows produce about 25-30% of pork production. More precisely, the public sector supplies 50-60% of the market pig surplus which is slaughtered at slaughterhouses.

The total number of pig farms in Yugoslavia, ranging from the smallest and the oldest ones to the largest and most contemporary, is about 200. The capacities of these farms varies widely, ranging from 40 to 6,000 sows, or from 800 to over 100,000 fattened pigs annually.

There are extremely good possibilities for pig selection in Yugoslavia offered by publicly-owned farms possessing large breeding herds, with the most important breeds, testing stations and professional personnel.

I - Organisation of pig breeding

Commercial pig breeding can only be done in those organisations which meet the requirements and criteria set up and defined by the Yugoslav Programme. Only organised production controlled by an appropriate service has been included in the production and turnover, and therefore, it is financed according to the procedure anticipated by the Programme.

Organisations involved in the production of breeding stock must satisfy the following conditions:

1. To meet all the requirements set up by national laws concerning animal breeding,

2. To possess available breeding herds of high quality which are above the contemporary average for the national pig population, based on the results obtained by testing production capability,

3. To be provided with a testing station where production capability can be tested, and to carry out investigations according to uniform methodology,

4. To possess a sufficient number of animals enabling undisturbed realization of the breeding and selection programme,

5. To dispose of healthy breeding stock and to satisfy the essential requirements for health care in the production of breeding and fattening material,

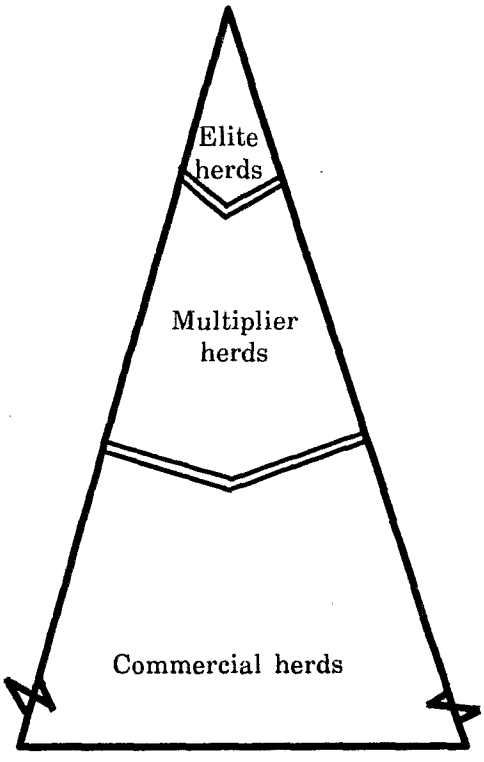
6. To have professional personnel that can perform set up tasks of breeding and selection work in the production of breeding pigs.

Criteria for the choice of breeding stock cannot be permanent. They depend on existing production levels at the beginning of Programme realization, and on improvements achieved while the Programme is being applied. For these reasons, changing of criteria is done by the Committee for Pig Breeding and Production.

Breeding and selection programmes for the production of breeding animals are based on production specialisation. On the basis of the results obtained, the best farms were chosen or the best animals within the breeding stock, and the breeding or elite herds for the production of purebreds were formed. For the expansion of achieved genetic progress, **multiplying herds** were then formed, as well as **commercial herds,** the producers of fattening material, as is shown in the following diagram.

Elite herds – Breeding stock of the highest quality, under constant testing for production capability, systematic selection and planned breeding, is removed for elite herds. For a breeding stock, or part of a pig breeding stock, to become an elite herd, it must exceed the contemporary average for the pig population in the Republic by one standard deviation.

Multiplier herds – As elite animals are not able to provide all needs for breeding material, certain herds must be established to multiply the limited



Herd structure

number of genetically superior animals from the elite herds, in order that more females can be produced to supply the commercial producer.

These herds must be superior to the contemporary pig population average by 0.5 standard deviation.

The basic task of multiplier herds is to produce breeding material for commercial, publicly-owned farms and individual producers.

Commercial herds - These herds are utilized for the production of fattening material. There is no selection in these breeding stocks (except when those animals unsuitable for further production are excluded) and no breeding material is produced. Male and female animals must be supplied out of multiplier herds, so that the genetic improvement thus achieved is transmitted to the whole population.

After several years of gaining experience, pig breeding and selection programmes were implemented in Slovenia, Croatia and Serbia. This brought together in one package a series of the most basic items in animal improvement, namely:

1. An effective test procedure - the performance test on boars (with supplementary sib carcass information),

2. An emphasis on traits of economic importance,
3. A selection index to combine the various traits in an optimum manner,
4. A concentration of test facilities on the important elite herds,
5. An intense selection of test results.

Testing and selection of breeding animals

In concordance with generally accepted breeding trends, the following evaluations are considered to be the basis for selection:

– fertility and mothering ability of dams;
– testing of breeding animals.

Fertility and mothering ability of dams

Fertility has a strong influence on the economics of pig production, and it is therefore important to improve it. However, according to scientific knowledge and theoretical considerations, the genetic response which may be achieved by a sow selection programme is very low.

Based on current organisational systems the evaluation involves purebred sows already registered or potential breeding animals for Herd Books. The evaluation is carried out in detail and includes:

– number of pigs per litter;
– number of pigs born alive;
– number of pigs at three or four weeks;
– number of pigs weaned;
– weight of litter at one day of age;
– weight of litter at 21 or 28 days of age;
– average weight of piglet at one day, 21 or 28 days of age.

During the last several years, a certain tendency towards simplification of the evaluation of the fertility and mothering ability of dams has been observed. It has been confined to two traits only, i.e., the number of piglets born alive and the number at 21 days, or the number of piglets and the weight of litter at 21 days of age. The results of this evaluation, as well as the origin and body conformation, are the basis for registration and selection of sows as the dams of the next generation. The fertility and mothering ability results are compared with a standard value. The standards differ among the breeds and regions. In Serbia and Slovenia, for example, breeds used as maternal parent lines for breeding herds are chosen from the litter with at least nine live born piglets in the first litter, that is, ten piglets in the second and other litters. When the sire line is in question, they are chosen from the litter with at least eight piglets in the first, namely, nine piglets in the second and other litters.

II - Testing of breeding animals

The pig improvement scheme in Yugoslavia is based on three methods of testing:

1. Performance testing;
2. Sib testing, and
3. Progeny testing.

In the scheme, these three methods are now being combined. A group for testing consists of two young boars which will be performance tested, and a castrate and a gilt which will be tested and slaughtered, all from the same litter. Four litter groups - a total of eight boars, four gilts and four castrate - all by the same sire, will constitute a progeny test on that sire. But the progeny test is no more than a by-product of performance and sib testing, and the emphasis will be on performance testing the maximum number of young boars and gilts.

The male piglets chosen for quality from each selected litter are delivered to the station before any of them have achieved a live weight of 25 kg. The performance testing begins at 30 kg of live weight.

The piglets are penned and fed individually *ad libitum* or twice a day according to appetite. For feeding of pigs we used two mixtures; only in the Slovenia is one mixture used. Mixture I is used from arrival at the station until 60 kg live weight; from 60-100 kg live weight, Mixture II is used. We have about 17.5% crude protein in Mixture I and 15% in Mixture II.

The boars are tested from 30-100 kg live weight for average daily gain and feed conversion, and at approximately 100 kg the backfat thickness, sidefat and eye muscle area are measured ultrasonically.

Besides the performance testing of boars, there is also performance testing of gilts on the farm. On farm testing was started in 1973 in Serbia. Gilts

reared on the farms are penned and fed *ad libitum* in groups.

Performance testing generally includes daily weight gain, ultrasonic measurements of backfat and sidefat thickness. On the farm it is easy to record daily liveweight gain or age at the end of test weight, but individual penning and recording the amount of food fed is more difficult, and it costs a great deal.

All castrates and females after the fattening period are slaughtered and then evaluated. Slaughter and evaluation are performed in slaughterhouses and laboratories. Only the right side of the carcass is partially dissected, as a rule.

The main traits which should be measured are as follows:

- age of progeny at slaughter;
- average daily weight gain during the testing period;
- feed efficiency;
- length of carcass (atlas-os pubis and 1st rib-os pubis);
- backfat thickness as the average of three measurements (on the shoulder, midback, and loin);
- eye muscle area measured by means of planimeter on the cross section between 13th and 14th rib;
- yield of lean meat in primal cuts or weight of meat and bones in ham;
- yield of lean meat in carcass;
- meat quality evaluation is based on pH, waterholding capacity and colour measurements.

Estimation of breeding value in pigs

In order to estimate the breeding value of a boar, in Serbia the absolute values of traits are expressed in points and the sum of points determines the value of a boar. In Vojvodina, Croatia and Slovania, however, selection indices are used.

Taking into consideration relative efficiency of computed indices, a selection index which includes daily gain (DG), food conversion (FC) and ultrasonic backfat thickness (BF) is used for estimation of breeding values of performance tested boars in Vojvodina, as it has a satisfactary correlation between index and aggregate genotype (RIS = 0.50).

$$I = 12.61\ X_{DG} - 1.65\ X_{FC} - 0.22\ X_{BF}$$

Daily gain, food conversion and backfat were adjusted to a constant weight (100 kg).

Environmental differences make it difficult to compare pigs tested at different stations, at different times, and under different forms of management. However, the use of a selection index based on contemporary group comparisons removes the influence of some of these environmental factors and permits more valid comparisons. The variate is defined as a deviation from a moving average of animals tested at the same time, of the same breed and sex (30-50 animals).

Taking into consideration that obtained index values can vary considerably, and that there can even be negative ones, standardization has been performed and thus average value amounts to 100.

Standardized indices were computed for each animal using the following formula:

$$I_s = \frac{I - i}{SD_I} \times SD_S + iS$$

where I_s = standardized index value, I = calculated index value, i = average index for the contemporary group, SD_I = standard deviation of the calculated index, SDs = standard deviation of the standardized index, and i_S = a general mean of the index (100).

The index, based on daily gain (DG), backfat (BF) and side fat (SF) is used for selection of gilts tested on the farm.

$$I = 0.405\ X_{DG} - 4{,}316\ X_{BF} - 3{,}584\ X_{SF}$$

In order to estimate the breeding value of a boar in Croatia, three selection indices are used:

$$I_{AB} = X_{DG} - 154\ X_{FU} - 24\ X_{BF} + 36\ X_{CS}$$

$$IC = 0.9\ X_{DG} - 172\ X_{FU} - 25\ X_{BF}$$

$$ID = 12\ X_{DG} - 12\ X_{FU} - 18\ X_{BF}$$

where DG = daily gain, FU = feed units per kg gain, BF = ultrasonic backfat, CS = conformation score.

The choice of boars used in the reproduction of purebreds is done on the basis of index value.

For the Swedish Landrace and Large White breeds, boars must be one standard deviation higher than the contemporary average.

For meat breeds, boars must have 1.5 standard deviations higher than the average.

Three indices for selecting boars in Slovenia were developed. The index for performance tested boars is:

$$I_1 = 462 + 0.45\,X_{DT} - 1.74\,X_{FT} - 2.04\,X_{BF}$$

where X_{DT} = days on test, X_{FT} = feed on test and X_{BF} = ultrasonic backfat.

By calculating the index (I_2) of certain animals, all current information is included in the calculation, i.e. boar's own performance, full-sib and half-sib information. Possible results of his offspring can also be included in the index (I_3).

Testing Results

Performance testing of boars, besides being performed at the station of Agricultural Combine "Beograd", is also done on ten other farms in Serbia. Testing is controlled by the Institute for Applied Science in Agriculture.

Average values of all tested pigs per years, as well as tested characteristics, are shown in **Table 2** where a tendency of increase in certain characteristic average values can be observed. However, very little improvement has been achieved over the last several years.

Tables 3, 4 and **5** show testing results of boars for the most important characteristics (daily gain, food conversion ratio and fat thickness) for breeds in Vojvodina for the last six years.

The number of boars tested was the highest in 1985 (2,360 animals), while about 7,500 gilts are tested approximately per year.

Testing results vary considerably from year to year, and from breed to breed. Duroc boars showed the highest daily gain (976 gr) and the best food conversion ratio (2.53 kg) over the last few years. Backfat thickness as measured by ultrasonics had insignificant differences and it was the lowest with Belgium Landrace and Yugoslav Meat Breed.

The production characteristics of boars have now been tested at seven testing stations in Croatia with a capacity of 466 individual pens. Results obtained for the last four years are shown in **Table 6**.

These results point to great differences among and within the breeds and the need to find out and utilize the best breeding boars. This could considerably contribute to pig production improvement in respect to quality and production economics.

Performance tests results in Slovenia are shown in **Table 7**.

It is clear from the table that all tested breeds showed good progress in age at the end of test, daily gain and food conversion ratio, while backfat thickness measured by ultrasonics decreased very slightly.

Selection Intensity

Primary selection of breeding animals is usually performed when animals have already finished the performance test. In Slovenia, however, the first selection is performed when pigs reach a weight of 56-65 kg. All the pigs which showed low gain and higher food conversion scores, especially with regard to their legs, are excluded from further testing. Thus 39-52% of the boars have been excluded in this selection for the last six years (**Table 8**).

A second selection is performed when pigs have completed this test, on the basis of results obtained and index value, as well as conformation score and leg firmness. Some recent results have shown that about 8% of boars are used for AI, 10% for elite herds, and about 26% for commercial herds.

The third selection is performed on farms, where boars are selected according to their behaviour at mating and their semen quality.

III - Hybridisation of pigs

The word "hybridisation" is now often used to cover planned crossing between breeds or specific lines, the main advantages of which are in litter performance. Hybridisation is an essential method

of improvement of traits which are of low heritability. A considerable number of experiments and analyses of records suggest the following principal benefits from cross-breeding.

	Heritability estimates %	Heterosis increase %
Reproductive traits	10	20
Fattening traits	30	5
Carcass traits	50	0

1. Choice of Breeds and Crossing System

In order to maximize benefits from heterosis, it is necessary to arrange crossing in such a way as to benefit both from additive and non-additive effects of an individual and its mother. As additive effects predominate for many characteristics of economic importance, it is necessary to restrict the choice to breeds which are highly competitive with respect to these characteristics. Therefore, breeds characterized by meatiness, intensive gain and high food conversion ratio, should be used. These three criteria exclude large numbers of breeds from the crossing programme.

When non-additive influences are taken into consideration, there is good reason to expect that breeds of various origin will show a higher degree of heterosis. If heterosis can be attributed either to dominace or over-dominance, then the degree of heterosis will depend on gene frequency difference between certain breeds. If observed breeds have a common origin in the not too distant past, then there are no prospects that they will show a high degree of heterosis.

According to hybridisation programmes the following breeds were used in investigations: Large White (L), Swedish Landrace (S), Yugoslav Meat Breed (Y), Dutch Landrace (N), German Landrace (G), Belgium Landrace (B), Piétrain (P), Hampshire (H) and Duroc (D). Each of these breeds possesses different characteristics and by applying appropriate crossbreeding methods one tends to benefit positive characteristics of certain breeds.

By applying single crosses only a part of heterosis is achieved, that which is evident in piglet vitality, surviving and growth rates. By double crossing, maternal heterosis is added, that is, heterosis of those characteristics under the influence of maternal effects. As heterosis was decreased when backcrossing was applied, it has been recommended in Yugoslavia to use a three breed crossing system in order to avoid this. Each of these breeds or lines should possess in its genetic foundation certain characteristics which are synthesized and transmitted to final products or hybrids.

2. Hybridisation Results

Crossbreeding has become the basic method for improving pig production and modern pig production cannot be planned without it.

In Serbia, in fact, at 20 publicly-owned farms with more than 19,500 controlled sows, nearly 45% are crosses.

For the production of F_1 females, Swedish Landrace and Large White were used. They were bred on the farms and systematically tested for a longer period of years.

In order to produce three-breed F_1 crosses, females were mated with boars of terminal breeds of Belgium, German Landrace, Hampshire or Duroc breeds. Reproductive characteristics of some cross combinations are given in **Table 9**.

Due to maternal heterosis effects of some crosses, high fertility has been realized with all cross combinations. The number of piglets per litter at 21 days was also high, ranging from 9-10 piglets, and mortality was very low with all cross combinations, which is obviously the result of higher piglet vitality with three-breed crosses.

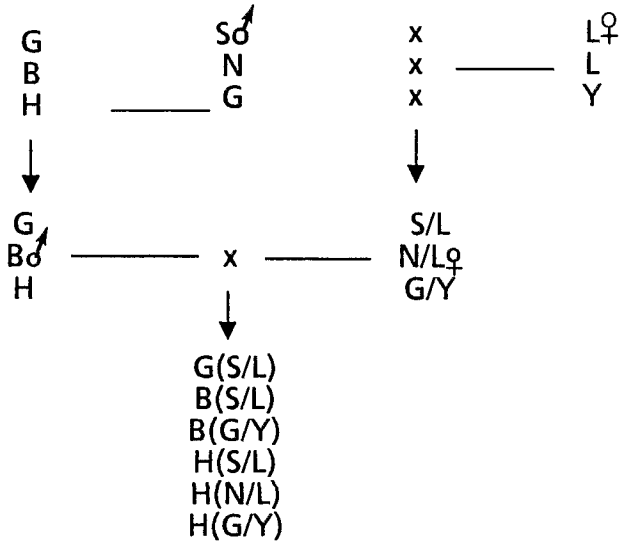
Results obtained for fattening and slaughtering characteristics are shown in **Table 10**.

The highest daily gain was found with H(S/L) and G(S/I) combinations. Food conversion ratios show a similar tendency. The highest meatiness was achieved with H(S/L) cross combination.

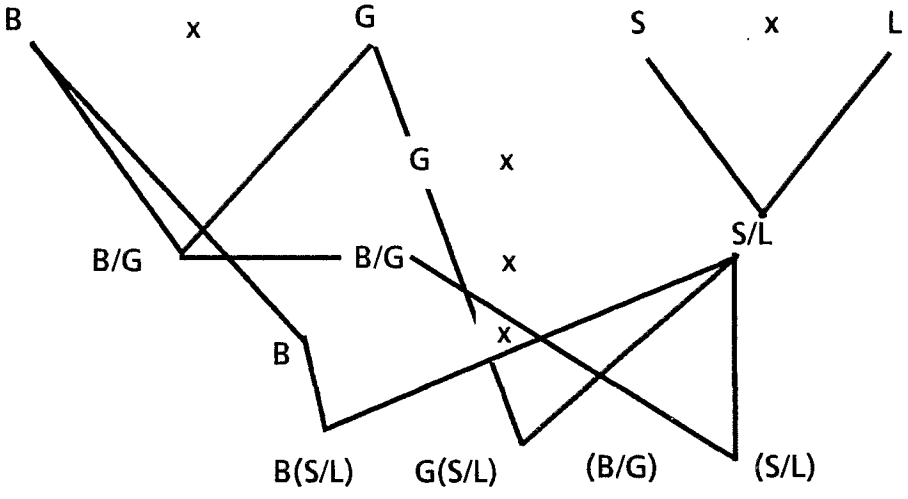
Considered as a whole, all results presented demonstrate that crossbreeding of early-maturing breeds reflects favourably on reproductive, fattening and slaughter characteristics, and that total productive value was the highest with H(S/L) crosses. This cross combination, therefore, has been most frequently recommended in production.

Crossbreeding programmes

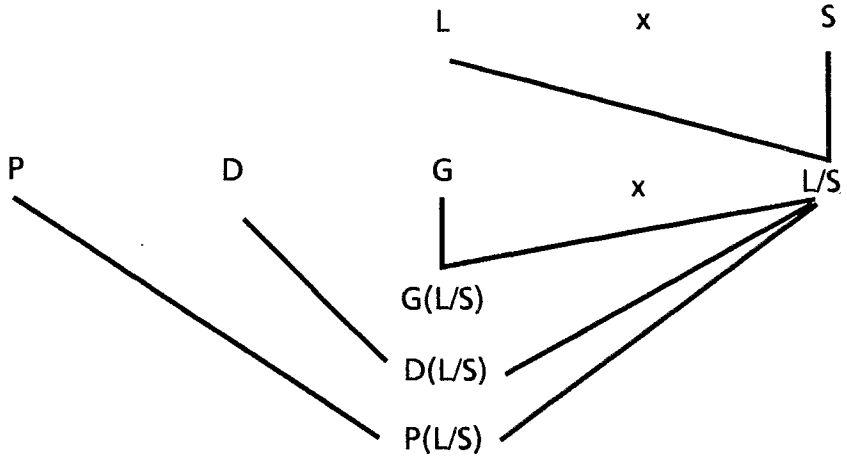
In Serbia



In Croatia



In Slovenia



The most intensive pig production is in Vojvodina, where there are now about 45% of crossbred sows (**Table 11**).

Swedish Landrace, Large White, Yugoslav Meat Breed and Dutch Landrace are used on the female side for crossbreeding. For the production of three-breed crosses as terminal breed (male parent) German Landrace, Belgium Landrace, Hampshire and Duroc are used.

The results obtained in the most extensive crossbreeding field trials are shown in **Table 12**. Crossbred sows proved to have better fertility and higher litter size at birth and four weeks than purebred females.

Fattening characteristics have not been significantly increased, while the heterosis effect on slaughter characteristics has not been expressed and crossbreds tend towards parental average.

It can be noted from **Table 13** that 25% of sows on publicly-owned farms in Croatia are purebred, and 75% crossbred sows. The number of Swedish and German Landrace sows has recently increased, while Large White numbers considerably decreased.

As can be seen, crossbred sows make up the largest number on publicly-owned farms. They are the product of crossbreeding mostly between Swedish and German Landrace and Large White or *vice versa*, as well as backcrosses with one of these breeds. Dutch, German and Belgium Landrace, and recently Hampshire, are used as third, final breeds in a crossbreeding system.

It was found out, by comparative investigations, that the results were considerably better for the number of liveborn and weaned piglets and average litter weight (7.01%, 8.60% and 9.03%) with three-breed crossing in relation to purebreds.

Systematic crossbreeding investigations in pig production were started in Slovenia in 1964. Swedish Landrace, Belgium Landrace and Piétrain were used in investigations to find out the best crossbred combinations.

Out of 16 different tested combinations, the best results were achieved by three-breed crossing of Swedish Landrace, Large White and German Landrace, which have been extensively used in production since 1973. Improvements with three-breed crossing G(L/S), when compared to foundation breeds, amounts to 2.70% for age at 100 kg up to 9.12% for the number of liveborn piglets, and food consumption ratio per 1 kg of gain from 30 kg up to 100 kg decreased by 4.5%.

During 1982 new pig breeds (Duroc and Piétrain) were provided and crossbreeding was started. Reproductive, fattening and slaughtering characteristics are shown in **Table 14**.

When fertility was considered, there were no significant differences among tested cross combinations. Piglet losses were somewhat lower with P(L/S) combinations.

Crosses with Piétrain have lower daily gain, and food conversion ratio from 30 kg up to 100 kg was lower for 0.21 kg or 6% than with German Landrace crosses. As far as slaughtering characteristics are concerned, all other characteristics are significantly better with Piétrain crosses except carcass length.

Meatiness results according to Yugoslav standards show that meat content in relation to live weight was 33.7% for Piétrain crosses and 32.8% for German Landrace crosses. This means 1,065 more dinars were realized per fattened pig with Piétrain crosses.

As far as crossbreeding with Duroc is concerned, results are shown in **Table 15**.

It can also be summed up here that, among tested cross combinations, there were no differences in reproductive characteristics. Three-breed crosses with Duroc showed higher intensity in growth rate, and also better food conversion ratios (6.48%) than crosses with German Landrace. Meat content percentage in relation to live weight was 34.8% for crosses with Duroc and 33.8% with German Landrace. Thus 1,350 more dinars can be obtained per fattened cross with Duroc.

On the basis of data processing, it was concluded that 60.5% of total litter production on publicly-owned farms in Slovenia was produced by crossbreeding.

The hybrid boar now has little influence on Yugoslav pig production but some experimental work has been done. At present, a certain number of hybrid boars are produced by programmes which provide the improved hybrid gilt. It is too

early to say what influence hybrid boars may have on Yugoslav pig production.

IV - Conclusion: the influence of testing and selection on commercial pigs

It is difficult to determine the influence of testing and selection on the population of commercial pigs in the country. One of the most reliable sources for evaluating progress from a testing scheme would be a comparison with control herds. But there are no control herds in Yugoslavia. However, according to the testing results obtained during the last several years, certain progress can be observed in the improvement of the pig population in Yugoslavia. The data presented in **Table 2** indicate that in Serbia there was progress in daily gain and food conversion and decrease of backfat thickness and increase of eye muscle area. There was also an improvemant of these traits in the population of fattening pigs delivered during the same period to the factories by commercial producers (**Table 16**). The results presented indicate that there was certain progress in the leanness (estimated lean content in carcass according to Yougoslav standards).

Similar tendencies and results were obtained in Croatia (**Table 17**) for lean meat percentage of live weight and lean meat in carcass.

The greatest progress has been recorded in Slovenia where the testing programme was tied to a pig population structure embodying specified breeding centres or elite herds.

It is clear from the testing results that marked improvement was made in daily gain and food conversion, but very little improvement was made in ultrasonic backfat thickness.

Similar improvements have occurred (**Table 18**) in commercial herds in food conversion of all categories (piglets, fattening pigs, gilts, sows and boars) and meat content with simultaneous decrease of backfat thickness (**Table 19**). Both the breeding herds and the commercial producers were proceeding in the same direction, with the breeding stock having a marked lead. This cannot be put forward as an estimate of genetic improvement as managerial and other factors influence the results to a considerable degree.

In commercial production, the crossing between breeds has been applied in all regions but, to date, no evaluation of this sector has been made.

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Table 1: Pig population
(in thousands)

	Year				
	1970	1975	1980	1984	1985
Total number of pigs	5 544	7 683	7 502	9 337	8 673
Sows and gilts for breeding	958	1 375	1 238	1 523	1 350
Boars for breeding	46	57	47	54	46
Pigs slaughtered annually	8 786	12 518	13 090	14 418	--

Source: Yugoslav statistical yearbook 1970-85

Table 2: Some results of performance tested boars in Serbia

	Year					
	1974	1981	1982	1983	1984	1985
No. of boars tested	223	714	826	940	1 134	1 012
Age at the end of test (days)	176.00	170.40	168.60	167.00	168.20	165.00
Daily gain (g)	836	863	869	878	865	877
Food conversion (kg)	3.12	2.92	2.87	2.86	2.92	2.83
Average backfat (mm)	2.84	2.21	2.17	2.15	2.08	2.04
Eye muscle area (cm 2)	3.31	3.48	3.47	3.56	3.75	3.81

Source: Annual reports 1984 and 1985

Table 3: Performance test results in Vojvodina
Daily gain from 30 to 100 kg live weight (g)

Breed	Year											
	1980		1981		1982		1983		1984		1985	
	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
Large White	396	872	378	852	279	861	195	868	431	894	474	894
Dutch Landrace	277	799	237	814	194	765	167	696	178	787	254	828
Swedish Landrace	974	844	946	845	743	858	481	868	582	890	770	832
Yugoslav Meat Breed	119	801	128	798	123	748	118	793	122	819	170	834
German Landrace	197	874	294	847	228	838	155	822	229	855	201	876
Spotted Meat Line	26	821	22	783	16	717	8	833	13	810	29	852
Piétrain	--	--	--	--	--	--	--	--	33	727	39	737
Belgium Landrace	70	885	104	868	98	852	86	817	80	849	124	856
Duroc	129	802	76	790	46	848	14	852	26	976	21	943
Hampshire	33	835	55	813	48	796	36	774	85	842	120	833
Crossbreeds	2	824	1	1100	43	922	63	945	183	839	158	847
AVERAGE	2 223	842	2 238	838	1 816	836	1 323	832	1 962	864	2 360	850

Source: Livestock Research Institute, Novi Sad, 1985

Table 4: Performance test results in Vojvodina
Food conversion from 30 to 100 kg live weight (kg)

Breed	Year					
	1980	1981	1982	1983	1984	1985
	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
Large White	2.83	2.81	2.76	2.70	2.64	2.66
Dutch Landrace	3.09	2.93	3.13	3.30	2.89	3.09
Swedish Landrace	2.86	2.82	2.85	2.66	2.65	2.68
Yugoslav Meat Breed	2.91	2.88	2.93	2.95	3.03	3.03
German Landrace	2.79	2.82	2.87	2.88	2.71	2.70
Spotted Meat Line	2.83	2.98	2.96	2.92	3.02	3.12
Piétrain	--	--	--	--	2.87	2.74
Belgium Landrace	2.74	2.80	2.80	2.81	2.77	2.69
Duroc	2.84	2.97	2.76	2.62	2.88	2.53
Hampshire	2.93	2.90	2.92	2.89	2.78	2.75
Crossbreeds	3.23	2.92	2.80	2.66	2.89	2.88
AVERAGE	2.88	2.84	2.83	2.82	2.74	2.79

Source: Livestock Research Institute, Novi Sad, 1985

Table 5: Performance test results in Vojvodina
Ultrasonic backfat thickness (mm)

Breed	Year					
	1980	1981	1982	1983	1984	1985
	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
Large White	2.43	2.49	2.47	2.49	2.53	2.46
Dutch Landrace	24.90	25.20	25.40	25.50	26.10	25.00
Swedish Landrace	23.80	24.10	24.20	24.30	24.40	23.80
Yugoslav Meat Breed	22.50	22.00	22.30	23.10	23.20	23.60
German Landrace	23.80	24.60	24.20	24.90	25.10	24.30
Spotted Meat Line	22.40	22.40	22.60	22.90	22.70	23.20
Piétrain	--	--	--	--	23.20	22.60
Belgium Landrace	21.20	22.90	22.00	23.60	23.80	23.30
Duroc	22.10	24.70	22.40	24.00	24.50	24.70
Hampshire	23.90	23.30	23.60	23.80	24.20	24.10
Crossbreeds	25.50	24.00	24.80	25.10	24.80	24.00
AVERAGE	23.80	24.20	24.10	24.50	24.70	24.10

Source: Livestock Research Institute, Novi Sad, 1985

Table 6: Performance test results in Croatia

Breed	Year							
	1981		1982		1983		1984	
	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
	Daily gain (g)							
Large White	154	899	228	905	272	865	195	865
Swedish Landrace	114	860	100	814	182	865	160	826
German Landrace	33	829	19	892	71	836	50	872
Dutch Landrace	33	849	36	864	43	815	47	852
Belgium Landrace	30	836	72	826	90	96	41	896
Crossbreeds	29	893	57	827	54	95	11	850
	Food conversion (kg)							
Large White	154	2.80	228	2.81	272	2.89	195	2.80
Swedish Landrace	114	2.93	100	3.02	182	2.93	160	2.99
German Landrace	33	2.94	19	2.81	71	2.98	50	2.78
Dutch Landrace	33	2.86	36	2.80	43	2.96	47	2.92
Belgium Landrace	30	2.85	72	2.79	90	2.70	41	2.42
Crossbreeds	29	2.74	57	2.93	54	2.81	11	2.57
	Ultrasonic backfat thickness (mm)							
Large White	154	20.90	228	20.50	272	20.80	195	25.20
Swedish Landrace	114	22.30	100	23.40	182	22.90	160	23.30
German Landrace	33	19.10	19	20.60	71	19.90	50	21.10
Dutch Landrace	33	21.40	36	19.00	43	18.10	47	22.50
Belgium Landrace	30	24.00	72	24.00	90	23.00	41	18.70
Crossbreeds	29	24.00	57	25.00	54	26.00	11	17.30

Source: Annual reports 1981 -1984

Table 7: Performance test results in Slovenia (Ian)

Year	Swedish Landrace		Large White		German Landrace		Crossbreeds	
	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
				Age at the end of test weight (days)				
1980	356	168.00	71	171.50	181	162.30	--	--
1981	238	162.00	94	169.40	238	160.00	--	--
1982	281	163.90	114	170.00	266	159.40	--	--
1983	221	155.20	87	158.50	239	155.00	59	152.50
1984	144	156.90	79	158.20	240	152.60	70	150.70
1985	298	162.20	96	164.10	245	159.30	96	152.30
				Daily gain from 30 to 100 kg live weight (g)				
1980	356	852	71	865	181	955	--	--
1981	238	859	94	883	238	937	--	--
1982	281	847	114	893	266	976	--	--
1983	221	910	87	969	239	990	59	952
1984	144	918	79	922	240	966	70	979
1985	298	905	96	900	245	933	96	985
				Food conversion per kg gain (kg)				
1980	356	3.13	71	2.99	181	3.00	--	--
1981	238	3.02	94	2.87	238	2.89	--	--
1982	281	2.99	114	2.93	266	2.87	--	--
1983	221	2.82	87	2.76	239	2.77	59	2.64
1984	144	2.87	79	2.80	240	2.78	70	2.67
1985	298	2.87	96	2.85	245	2.78	96	2.73
				Ultrasonic backfat thickness (mm)				
1980	356	22.60	71	20.10	181	22.80	--	--
1981	238	22.10	94	19.30	238	22.00	--	--
1982	281	20.00	114	18.60	266	20.60	--	--
1983	221	21.00	87	19.40	239	20.80	59	20.30
1984	144	20.70	79	20.00	240	20.90	70	19.60
1985	298	20.10	96	18.50	245	19.70	96	19.00

Source: Annual reports 1980 - 1985

Table 8: Selection intensity

	1980	1981	1982	1983	1984	1985	$\bar{x}$
Selection at 60 kg:							
No. of pigs tested	1 089	1 018	1 170	1 277	1 350	2 349	
Selected (%)	60.90	58.70	59.30	53.40	51.80	47.90	55.40
Culled (%)	39.10	41.30	40.70	46.60	48.20	52.10	44.60
Selection at 100 kg:							
No. of pigs tested	637	570	664	641	593	917	
Selected (%)	34.60	42.10	43.20	44.60	47.40	51.30	43.90
Elite herds (%)	9.30	9.80	8.30	12.30	12.10	11.20	10.50
A. I. (%)	3.60	4.60	8.40	6.40	13.70	9.20	7.60
Commercial herds (%)	21.70	27.70	26.50	25.90	21.40	31.40	25.80
Culled (%)	65.20	57.90	56.70	55.40	52.60	47.70	55.90

Source: Annual reports 1980 - 1985

Table 9: Reproductive characteristics of some combinations of crosses (Serbia)

Characteristics	Combinations			
	B (S/L)	G (S/L)	H (S/L)	D (S/L)
Number of litters	126	122	125	120
Number of pigs per litter	10.97	10.49	9.75	11.23
Number of pigs born alive	10.76	10.33	9.63	11.06
Number of still born pigs	.21	.16	.12	.17
Number of pigs at 21 days	9.85	9.53	8.98	10.23
Number of pigs lost 0-21 days	.91	.80	.66	.83
Percentage loss 0-21 days (%)	8.46	7.74	6.85	7.50
Weight per litter at birth (kg)	14.77	14.65	13.78	15.31
Weight per pig at birth (kg)	1.37	1.42	1.43	1.38
Weight per litter at 21 days (kg)	46.89	47.48	44.96	49.50
Weight per pig at 21 days (kg)	4.76	4.98	5.01	4.84

Source: Gajic et al., 1986

Table 10: Fattening and carcass characteristics of some combinations of crosses (Serbia)

Characteristics	Combinations			
	B (S/L)	G (S/L)	H (S/L)	D (S/L)
Number of pigs	113	86	121	121
Initial body weight (kg)	29.84	29.91	30.04	29.72
Final body weight (kg)	99.93	99.93	100.33	99.89
Length of fattening (days)	94.87	88.13	88.32	89.76
Age at slaughter (days)	177.84	170.72	170.17	169.10
Daily gain (g)	739	795	796	782
Food conversion (kg)	3.31	3.23	3.16	3.19
Daily feed intake (kg)	2.44	2.56	2.52	2.49
No. of pigs slaughtered	113	83	120	120
Weight of chilled carcass (kg)	78.35	78.19	78.75	78.60
Carcass length (cm)	79.92	81.58	80.39	79.67
Backfat thickness (mm)	32.15	31.32	30.94	34.10
Eye muscle area (cm2)	25.08	33.70	35.01	31.82
Meat of ham (kg)	13.72	13.28	13.74	12.78
Meat of EMA (kg)	3.58	3.48	3.50	3.34
Meat of shoulder (kg)	8.16	8.00	8.36	7.92
Meat in carcass (kg)	41.14	40.38	42.39	39.71
Fatty tissue (kg)	25.13	25.66	24.10	26.38
Bones (kg)	5.85	6.04	6.12	5.99
Percent meat in carcass (%)	52.51	51.64	53.82	50.68

Source: Gajić et al., 1986

Table 11: Number and percentage of registered sows in Vojvodina

Breed	Year											
	1980		1981		1982		1983		1984		1985	
	n	%	n	%	n	%	n	%	n	%	n	%
Large White	1 278	6.80	1 382	6.60	1 169	5.50	1 339	5.90	1 364	5.70	1 723	7.20
Dutch Landrace	2 868	16.34	2 851	13.70	2 467	11.60	2 711	11.80	2 575	10.80	2 575	10.80
Swedish Landrace	7 113	40.60	8 408	40.40	7 924	37.40	8 392	36.70	8 175	34.30	7 287	30.50
Yugoslav Meat Breed	287	1.60	440	2.10	474	2.20	492	2.10	717	3.00	629	2.60
German Landrace	335	1.90	376	1.80	499	2.40	397	1.70	478	2.00	620	2.60
Belgium Landrace	31	.20	36	.20	43	.20	42	.20	59	.30	191	.80
Duroc	230	1.30	206	1.00	106	.50	156	.70	95	.40	94	.40
Hampshire	25	.10	70	.30	84	.40	32	.10	79	.30	79	.30
Crossbreeds	5 350	30.60	7 026	33.79	8 422	39.80	9 278	40.50	10 278	43.20	10 689	44.80
TOTAL	17 517	100	20 798	100	21 188	100	22 886	100	23 820	100	23 887	100

Source: Livestock Research Institute, Novi Sad, 1985

Table 12: Difference in mean performance
(Crossbreeds - Pure breeds)

		Year					
		1980	1981	1982	1983	1984	1985
Number of litters	- Pure breeds	49 352	53 557	52 641	53 863	55 546	52 375
	- Crossbreeds	22 244	28 673	33 267	36 006	38 337	46 176
Number born alive	- Pure breeds	10.05	9.91	9.79	9.54	9.79	9.63
	- Crossbreeds	10.29	10.27	10.38	10.29	10.37	10.01
	Difference	.24	.36	.59	.45	.58	.38
Number at 28 days	- Pure breeds	8.92	8.79	8.63	8.76	8.62	8.51
	- Crossbreeds	9.26	9.13	9.07	9.01	8.92	.87
	Difference	.34	.34	.44	.25	.30	.19
% lost 0-4 weeks	- Pure breeds	11.24	11.30	11.85	10.97	11.95	11.63
	- Crossbreeds	10.00	11.10	10.89	12.43	13.98	13.08

Source: Livestock Research Institute, Novi Sad, 1985

Table 13: Number and percentage of registered sows in Croatia

Breed	Year									
	1980		1981		1982		1983		1984	
	n	%	n	%	n	%	n	%	n	%
Swedish Landrace	1 903	10.15	3 122	14.93	3 578	15.08	3 699	13.28	5 195	14.50
Large White	1 769	9.45	2 044	9.78	2 101	8.85	2 288	8.22	2 446	6.80
German Landrace	116	.62	819	3.92	334	1.41	567	2.04	965	2.70
Dutch Landrace	173	.92	183	.87	201	.85	273	.98	317	.90
Belgium Landrace	26	.14	23	.11	32	.13	41	.15	43	.10
Crossbreeds	14 753	78.72	14 716	70.39	17 487	73.68	20 978	75.33	26 935	75.00
TOTAL	18 740	100	20 907	100	23 733	100	27 846	100	35 901	100

Source: Annual reports 1980-1984

Table 14: Reproductive, fattening and carcass characteristics of some combinations of crosses (Slovenia)

Characteristics	Combinations P (L/S)	G (L/S)
Number of litters	102	188
Number of pigs per litter	10.42	1.04
Number of pigs born alive	9.76	9.95
Number of still born pigs	.66	.45
Number of pigs weaned	8.49	8.39
Percentage loss (%)	13.00	15.70
Weight per pig at weaning (kg)	5.59	5.62
Number of pigs	29	27
Length of fattening (days)	109.86	10.73
Daily gain (g)	637	652
Food conversion (kg)	3.32	3.55
Weight at slaughter	97.4	98.7
Weight of warm carcass (kg)	79.3	78.9
Weight of chilled carcass (kg)	78.3	78.4
Carcass length (cm)	95.4	99.2
Backfat thickness (mm)	27.6	34.3
Eye muscle area (cm2)	41.9	33.5
Meat and bones of ham (kg)	9.1	8.0
Fat tissue of ham (kg)	2.2	2.9
Untrimmed ham (kg)	11.3	10.9
Number of pigs	171	338
Corrected weight of warm carcass (kg)	85.00	85.00
Backfat thickness (mm)		
Loin	23.5	27.9
Midback	25.9	27.6
TOTAL	49.4	55.5
Kg lean in carcass	34.9	34.0
% lean in carcass	41.1	40.0
% lean in live weight	33.6	32.8

Source: Salehar et al., 1984

Table 15: Reproductive, fattening and carcass characteristics of some combinations of crosses (Slovenia)

Characteristics	Combinations D (L/S)	G (L/S)
* First farrowing		
Number of litters	54	109
Number of pigs born alive	9.13	9.13
* Sows		
Number of litters	162	552
Number of pigs born alive	10.48	10.35
* Total		
Number of pigs weaned	8.69	8.39
Percentage loss (%)	14.1	14.4
Number of pigs	35	36
Daily gain from birth to 135 kg (g)	600	590
Food conversion from 50-135 kg (kg)	3.86	4.11
Age at slaughter (days)	222.8	230.7
Weight of warm carcass (kg)	112.0	1086.7
Backfat thickness (mm)		
Loin	29.0	34.6
Midback	26.4	30.4
Meat and bones of ham (kg)	9.9	8.9
Fat tissue of ham (kg)	3.4	3.9
Number of pigs	832	338
Corrected weight of warm carcass (kg)	85.0	85.0
Backfat thickness (mm)		
Loin	20.2	24.2
Midback	20.8	24.5
TOTAL	41.0	48.7
Kg lean in carcass	36.0	35.0
% lean in carcass	42.41	41.24
% lean in live weight	34.78	33.81

Source: Salehar et al., 1984

Table 16: Meat content of fattening pigs produced on farms in Serbia according to YUS

Year	Meat in carcass %
1974	39.7
1981	41.6
1982	41.6
1983	41.9
1984	41.4
1985	41.5

Source: Annual reports 1984 and 1985

Table 17: Meat content of fattening pigs produced on farms in Croatia according to YUS

Year	No. of pigs slaughtered	Weight at slaughter (kg)	Weight of warm carcass (kg)	Meat in carcass (kg)	Meat in carcass %
1980	135 454	96.0	77.7	31.3	40.3
1981	171 109	95.8	75.9	31.0	40.9
1982	154 179	94.9	76.6	31.1	40.6
1983	169 508	95.6	76.6	31.6	41.2
1984	194 979	98.5	79.6	31.7	39.9

Source: Annual reports 1980-1984

Table 18: Food conversion all categories * of pigs produced on the farms in Slovenia

Year	Weight at slaughter (kg)	Food conversion (kg)
1980	96.4	4.04
1981	100.8	4.02
1982	98.7	3.91
1983	99.9	3.94
1984	100.2	3.89

* (Piglets, fattening pigs, gilts, sows and boars)

Source: Salehar, 1985

Table 19: Meat content of fattening pigs produced on farms in Slovenia according to YUS

Year	Fat Thickness midback + loin * (mm)	Meat of live weight %	Meat in carcass %
1980	62	31.29	38.16
1981	61	31.70	38.66
1982	59	31.97	38.99
1983	58	32.24	39.32
1984	56	32.78	39.98

* At 85 kg weight of warm carcass

Source: Salehar, 1985