THE PRODUCTION OF MEAT AND TRENDS IN THE DEVELOPMENT OF MEAT LIVESTOCK BREEDING.

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FOREWORD

This paper is one of a series reviewing various forms of traditional agricultural production and related aspects. Preliminary work on this review was carried out within the scope of activities of the Food and Agriculture Program's Task 2 ("Technological Transformations in Agriculture: Resource Limitations and Environmental Consequences"). One of the goals of this task's activities is the review of various alternative technologies available in the world for the production of major crops and animal products. This paper can be seen as a first step towards this final objective providing information backed by concrete data.

Research work on the topics presented has been carried out partly at IIASA and partly at the All-Union Research Institute of Information and Technical-Economic Research in Agriculture.

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WORLD MEAT PRODUCTION

One of the important problems faced today is the supply of food products containing adequate amounts of valuable protein for the population. In this connection animal protein consumption is considered an important index of human nutrition. In the developed countries animal protein consumption amounts to between 60 and 70% of the total protein diet. In the developing countries the level of animal protein consumption is 4 to 5 times lower than that of the developed countries (meat consumption is 5 times less, milk consumption 4 times less, and egg consumption 6 to 7 times less than that in the developed countries). Promising new sources of valuable food protein have been discovered recently; these are: corn with high content of protein, lysin and tryptophan, microbial protein (yeast) which is equivalent to animal protein, synthetic amino acids resulting from microbial synthesis to be used as vegetable food additives, analogues of meat, meat products, and various food additives produced on the basis of soybean protein with biological value being equivalent to that of fish and meat. The above sources are likely to make a considerable contribution to the improvement of human nutrition in the future.

At present, however, the only practical source of food protein is livestock breeding which determinates the qualitative structure of the protein diet of humans.

It should be pointed out that, in spite of the fact that there are some general trends which are common for a number of economically developed countries, the structure of meat production in these countries is still highly diversified. It depends to a great extent on the production and consumption rate of meat per capita, the nature of feedstuff resources, national features characterizing meat consumption in a given country, and other related factors.

When considering alterations in the nature of meat consumption, a considerable increase in poultry meat consumption, especially broilers, should be mentioned first. Such factors, as the industrialization of broiler production, a sharp decrease in feedstuff costs, the increase of feeding efficiency, along with the increase of poultry meat production costs, especially broiler production costs should be taken into account. Poultry has come to be the cheapest kind of meat. This gave way to the expansion of poultry meat consumption, involving low paid groups of the population, the expansion covered public nutrition establishments as well. The trend first took shape in the United States where a specialized broiler production industry had been developed; at a later stage a similar process took place in Western Europe. In Eastern European countries this trend was most prominent in Hungary.

The second trend consists of development in the beef cattle breeding industry. While broilers are the cheapest kind of meat, beef, or to be more precise, the best parts of a beef carcass resulting from the intensive beef cattle raising system, is the most expensive kind of meat. It stands to reason that in a

specialized beef cattle breeding industry where the "cow calf" raising system, is used, the feedstuffs consumed by a cow are directly utilized by the calf. In the intensive feeding system, grain rations are widely practiced; the food conversion ratio in cattle is lower than that in pigs, and still lower than that in poultry.

In the extensive raising system which is widely practiced in the United States, Argentina, Australia and other countries, pasture fodder (often of inferior quality) can be used. This enables the breeders to somewhat decrease feedstuff costs. But beef still remains the most expensive kind of meat. It should be mentioned, however, that in cutting the beef carcass, two grades of meat are obtained: fillet, which is sold at a very high price and the inferior grade, usually processed to force meat and meat products which are then sold at lower prices. Force meat has become the basis for relatively cheap meals in chain restaurants and especially in canteens in the United States. Big companies, such as "Macdonald's" specialize in selling such cheap meals. The processed inferior grades of beef carcass along with broilers have become the main sorts of meat being consumed by the low paid income groups in the United States.

But fillets being sold at high prices are still responsible for the greatest share of the profit. The status of the beef cattle breeding industry depends first of all on the fillet market. The existence of certain groups of the population with high income enables this branch of agriculture to function normally. That is why it is no coincidence, that the intensive beef cattle breeding industry with grain feeding system sprung up in the United States. In Western Europe, excluding Great Britain, it was only developed in the latter decades with a market orientation towards expensive beef; in Japan this kind of meat is a luxury being sold at more than 30 dollars per kg. The production of such expensive, marbled, delicate meat is possible only with an intensive feeding system.

Other beef grades obtained from stock herd cows, or from adult animals being fattened, as is still practiced in Latin America, are greatly inferior to the beef grades obtained from fattened young animals: these grades are sold at lower prices and used for the production of sausages and other meat products. But with vast ranges available, an extensive beef cattle breeding industry can provide a considerable production of beef at low costs; this is the case in Latin America, Australia and New Zealand where a considerable share in the world meat production is enjoyed.

The production of beef obtained from fattened young animals first of all depends on the availability of corresponding groups of population with high incomes; further increases in the production of high beef grades depends on the corresponding customers' demands. In the United States more than 80% of the total beef supply comes form the beef cattle breeding industry; this is not the case in Western Europe where the main share of beef supply is covered by dairy cattle breeding industry despite the fact that in Great Britain and in France beef cattle constitutes almost one third of the total cattle population; in West Germany and Italy beef cattle population is considerably smaller as a the result of limited pasture areas.

But the structure of the meat production industry in any particular country depends on local conditions with the above mentioned general trends being taken into consideration. The experience gained in countries with a high meat consumption rate shows that after the level of 70-80 kg per capita is surpassed, the consumption of beef and poultry goes faster than that of other kinds of meat. The market share of pork in the total assortment of meats being consumed decreases with changing demand, i.e., switching over to lean meat - beef and poultry.

In 1979 world meat consumption (beef, veal, pork, mutton, goat's meat, poultry) made up 136.8 million tons, or 1.7% higher than in the previous year, and 28.3% higher than the average level for the period 1969-71. The increase of livestock production as well as livestock productivity accounted for this increase in world meat production.

The regional meat production structure has changed as compared to the period 1969-71; the share of Asia in the total world meat production increased by 2.3%, the figures for Europe and Oceania being correspondingly 1.2% and 0.1%; the share of North and Central America and Africa decreased by 2.6% and 0.3% respectively. As a result the contribution of Africa to total meat production in 1979 accounted for 4.5%, the figures for South America, North and Central America, Asia, Europe (USSR not included) and Oceania were 7.7%, 22.5%, 23.6%, 27.4% and 3% correspondingly.

Among meat producing countries the United States ranks first (18.8%), China ranks second (15.4%), the USSR third (11.3%). In 1979 they produced 45.5% of the total world meat supply. The share of the COMECON countries (including USSR) constituted 18.6%, that of the EEC, 15.3% (see Table 1).

Table 1. World meat production, million tons

Country	1969-71 average	1977	1978	1979*
World, total	106.6	130.4	134.5	136.8
COMECON**	...	24.7	26.0	25.5
EEC	...	21.1	21.7	20.9
China	14.9	20.0	20.6	21.1
Japan	1.6	2.4	2.6	2.8
Canada	2.0	2.3	2.3	2.3
USA	22.8	25.6	25.5	26.7
Argentina	3.2	3.6	3.9	3.7
Brazil	3.0	4.1	3.9	3.8
Australia	2.1	2.9	3.1	3.0

* Estimated data

** Vietnam not included

The average annual increase of world meat production during the period 1971-1979 compared to the average level for 1969-1971, made up 3.2%, with the average increase in beef and veal production being 1.8%, pork, 3.8%, mutton and goat's meat, 0.1% and poultry, 6.4% (see Table 2).

Table 2. World meat production rate, 1979, as compared to the average level for 1969-71 in percent

Country	Total meat production	Beef and veal	Pork	Mutton, lamb and goat's meat	Poultry
World, total	3.2	1.8	3.8	0.1	6.4
Europe	3.8	1.8	4.3	1.3	7.0
Western Europe	3.3	1.5	3.8	1.4	6.0
Great Brit.	1.1	0.9	0.01	-0.05	3.5
Italy	3.8	0.02	6.8	-0.4	7.3
France	3.2	1.4	3.9	4.3	7.3
W. Germany	2.5	1.7	2.6	15.2	5.3
Asia	4.7	2.5	5.6	2.3	6.1
China	4.7	2.1	5.6	2.1	3.8
Japan	8.1	6.2	10.4	--	10.5
Africa	2.2	2.1	3.0	1.0	7.0
N. & Central America	1.7	-0.04	1.8	-4.1	4.8
Canada	1.5	0.7	2.2	-4.2	2.3
Mexico	5.4	3.3	8.8	1.4	8.7
USA	1.4	-0.4	1.4	-5.1	4.7
S. America	2.5	1.9	2.1	-2.5	10.3
Argentina	1.8	2.2	1.0	-8.1	4.9
Brazil	2.8	1.7	1.3	-1.1	12.5
Australia	4.9	11.4	1.6	-3.9	10.8
New Zealand	1.1	3.4	-0.8	-0.7	6.9

The increase of production of poultry meat and pork occurred at a higher rate than that of beef and especially of mutton and goat's meat. The production of poultry meat increased in almost all livestock breeding countries, especially in Brazil (12.5%), Australia (10.8%), Japan (10.5%) and Mexico (8.7%). In pork production Asian countries rank first (5.6% of the total world pork supply), Japan, 10.4%, China, 5.6%; of European countries Italy ranks first (6.8%), France second (3.9%), West Germany third (2.6%).

In beef production the greatest average annual increment was observed in Australia, New Zealand, Japan, Mexico. The increase in the production of mutton and goat's meat during the last nine years has been quite insignificant. In many countries, the chief producers of mutton and goat's meat, the production of this kind of meat decreased.

In the world meat production structure pork comes first, followed by beef, veal, poultry meat, mutton and goat's meat (see Table 3). The greatest share in the production of beef and veal belongs to Argentina (80.1%), Australia (68.0%), Brazil (55.1%), New Zealand (46.3%), Canada (39.6%), USA (37.9%). Pork production prevails in European countries and in a number of Asian countries. The share of poultry meat is gradually increasing, this especially being the case in USA, Canada, Italy, France, Brazil, etc.

CONDITIONS AND TRENDS OF WORLD MEAT LIVESTOCK BREEDING

1. Beef Cattle Breeding

The development of world beef cattle breeding is characterized by a continuous process of industrialization and intensification of production processes. The rates of beef production growth are considerably higher than those of the increase of livestock population. According to FAO data, world increase of livestock population during the period 1950-79 constituted 51.6% (from 797.4 to 1209.2 million heads), with the corresponding increase in beef production being 124.2% (from 20.7 to 46.4 million tons).

The percentage of slaughtered animals also testifies to the intensification and progress in the development of beef livestock breeding (see Table 4).

In Western Europe the decrease of the number of animals to be slaughtered which has been observed recently, results from the decrease in calf population raised for slaughter and fattening of livestock to heavier live weights. In Asia the most intensive beef livestock breeding is observed in Japan where the population of livestock raised for slaughter lately constitutes 1.2 to 1.3 million heads. The population of livestock raised for slaughter was increased in North and South America. In the USA and Canada, countries characterized by an intensive system of livestock breeding, a decrease in animal population raised for slaughter was observed, compared to the previous year. In Argentina and Mexico the number of slaughtered animals also increased in the seventies. Australia enjoyed a considerable increase in the number of animals to be slaughtered (by 115.2%) which was the result of a highly efficient specialised beef livestock breeding and a stable market.

In some countries the intensification of beef and veal production is effected by means of the genetic improvement of pedigree and farm animals, as well as the improvement of the existing new production technologies and those still being developed.

Table 3. World meat production structure in 1979 as expressed in percent

Country	Beef and veal	Pork	Mutton and goat's meat	Poultry	Other kinds of meat
World total	33.9	37.9	5.4	20.5	2.3
Europe (USSR excluded)	27.4	48.6	3.0	13.2	2.8
Italy	32.1	28.8	1.5	31.0	6.6
France	33.7	35.8	3.2	19.9	7.4
W. Germany	31.9	58.5	0.6	7.9	1.1
Asia	15.6	55.0	8.2	19.7	1.5
China	10.9	68.6	3.1	16.5	0.6
Japan	14.8	49.5	--	33.9	1.8
Africa	47.6	5.6	19.0	15.5	12.3
N. & Central America	38.6	27.3	0.6	32.2	1.3
Canada	39.6	31.4	0.2	28.1	0.7
USA	37.9	27.2	0.5	38.2	1.2
S. America	64.5	14.9	3.2	15.3	2.1
Argentina	80.1	6.4	3.7	7.0	2.8
Brazil	55.1	22.3	1.4	20.1	1.1
Australia	68.0	6.7	16.4	8.5	0.4
New Zealand	46.8	3.6	47.1	2.4	0.6

Table 4. World cattle population and amount of animals slaughtered.

Country	1969 - 1971			1977			1978			Slaughtered		Annual variation 1979 level, as compared to 1969-71 average percent
	cattle population million heads	slaughtered		cattle population million heads	slaughtered		cattle population million heads	slaughtered		1978, as referred to ... percentage		
		mill. heads	percentage		mill. heads	percentage		mill. heads	percentage	1969-71	1977	
World total	1095.6	210.8	19.2	1209.9	238.8	19.7	1210.3	239.2	19.8	113.5	100.2	1.7
W. Europe	94.6	36.0	38.0	100.6	36.0	35.8	100.7	35.7	35.5	99.2	99.2	-0.1
Belgium & Luxemburg	2.9	1.1	37.9	3.0	1.0	38.1	3.0	1.1	36.4	100.0	110.0	0.0
Gr. Britain	12.6	3.9	31.0	13.9	4.1	29.6	13.6	4.0	29.4	102.6	97.6	0.6
Denmark	2.9	1.1	37.9	3.1	1.1	35.5	3.1	1.1	35.7	100.0	100.0	0.0
Spain	4.2	1.6	38.1	4.5	1.9	42.2	4.7	1.8	38.2	112.5	94.7	1.6
Italy	9.4	5.1	54.3	8.7	4.8	54.0	8.5	4.7	55.4	92.2	97.9	-1.0
Netherlands	4.3	1.9	44.4	4.9	2.0	41.0	5.0	2.0	40.1	105.3	100.0	0.7
W. Germany	14.1	5.6	39.7	14.5	5.2	35.9	14.8	5.4	36.6	96.4	103.8	-0.4
France	21.7	6.0	36.9	23.9	7.6	31.8	23.8	7.6	32.0	95.0	100.0	-0.6
Asia	346.4	23.1	6.7	357.9	25.9	7.2	360.7	26.6	7.4	105.2	102.7	1.9
Japan	3.6	1.2	33.5	3.9	1.2	31.0	4.0	1.3	32.4	108.8	108.3	1.0
N. & Central America	167.1	49.9	29.9	185.9	60.6	32.6	180.1	56.3	31.3	112.8	92.9	1.6
Canada	11.7	4.1	35.1	13.7	5.3	38.6	13.7	4.9	35.7	119.5	92.4	2.4
Mexico	24.7	2.7	10.9	28.9	3.5	12.1	29.8	3.6	12.3	133.3	102.9	4.2
USA	112.3	40.0	35.6	122.3	48.0	39.1	116.4	44.8	38.1	110.8	92.3	1.3
S. America	178.1	29.5	16.6	216.1	35.6	16.5	216.5	36.6	16.9	124.1	102.8	3.0
Argentina	48.8	12.1	24.8	61.1	14.7	24.1	61.8	16.5	26.7	136.4	112.2	4.5
Brazil	75.7	3.4	12.4	91.0	12.3	13.5	89.0	11.5	12.9	122.3	93.5	2.8
Oceania	31.6	8.9	28.2	41.6	15.6	37.5	39.0	16.2	41.5	182.0	103.8	10.2
Australia	22.4	5.8	25.9	31.5	12.0	38.1	29.4	12.6	43.0	217.2	105.0	14.7
New Zealand	8.7	3.0	34.3	9.5	3.6	38.0	9.1	3.6	39.4	120.0	100.0	2.5

During the last 20 to 30 years, radical changes in the distribution and specialization of livestock has taken place. The increasing demand for beef and the establishment of new markets facilitated the increased development of beef livestock breeding in countries with vast available rangelands. In countries with a relatively low percentage of arable lands (5 to 25%), such as Argentina, Brazil, Uruguay, Columbia, Mexico, Australia, etc., an extensive beef cattle breeding system prevails with the use of natural ranges for the fattening of animals. The availability of free lands at low prices is an economic basis for the development of this branch of agriculture.

Intensive forms of beef livestock breeding with the fattening of young animals to the live-weight 450 to 500 kg at 14 to 16 months of age, are practiced in Great Britain, Italy, France, Canada, USA, and some other countries. An intensive beef livestock breeding is now developing successfully in Bulgaria, Hungary, East Germany, Yugoslavia, as well as in some market economy countries, such as West Germany. In Africa, South America and Oceania along with the traditional fattening methods, an intensive feeding system is used. Fattened young animals are slaughtered at the age of 18 months, with the live-weight being 400 to 450 kg. Rational combinations of grazing with intensive additional feeding with concentrates and indoor fattening with maximum use of cheap traditional feedstuffs are being developed.

1.1. Selection and Breeding in Beef Livestock Production

In the countries with the developed beef livestock industry, selection and breeding depends to a considerable extent on the volume and nature of the beef market. Until the sixties the beef cattle has been selected for such characters as compactness, fast maturation, the ability to accumulate sufficient amount of fat by the slaughter age and to produce meat of high caloricity, according to the customer's demand. By the seventies the market demands have switched over to lean meat, this being the result of gradual decrease of the caloricity demand in human nutrition. The chief British beef breeds ceased to completely satisfy the market demands. Fat produced in abundance by Shorthorns, Aberdeen-Anguses, Herefords, despite all their qualities, has become the main limiting factor in their use as pure breeds for beef production. In beef cattle breeding a very curious phenomenon occurred: during the latest two decades the selection and breeding programs developed before and right after the Second World War have been at variance with the beef market demands. Thus, a gap was formed between selection and breeding and real demands. Therefore, in countries with an intensive beef cattle production, such as USA, Canada, Great Britain, at the end of the sixties and the beginning of the seventies, the selection of Aberdeen-Anguses, Herefords and Shorthorns was revised; the greatest attention was paid to such characteristics as the increase of live-weight, late maturation, and the decrease of fat content at the slaughter age.

The development of modern methods of industrial fattening resulted in the alteration of the very type of beef cattle. The new type that has recently been developed is characterized by an abundant development of muscle tissues at the early age with fat tissues being accumulated at the later age.

The feeding rations have also recently changed. In the rations the percentage of the roughages increased with the decrease of the share of concentrates.

All the above mentioned gave an impulse for the development of the beef livestock breeding industry which would meet the demands laid down by both industrial technology and the modern market.

Specialists of Ohio University forecasted the development of livestock breeding in the USA until 2000. According to the forecast the average live

weight of cattle will increase to 230-270 kg against 180-205 kg in 1975. Average daily weight increment will constitute 1500 g against 1200 g in 1973. Feedstuff consumption rates will decrease from 8-9 metric centners per 1 centner of weight increment in 1973 to 6 m.c. in 2000. Fat percentage in a carcass should not exceed 10%.

According to the calculations of British cattle breeders, in 10 years beef cattle will reach the slaughter weight of about 675 kg with average daily weight increments of 1814 g when fed on rations containing 50% of roughage. But the first objective is the live-weight of 450 to 580 kg at the age of 12-14 months with the average daily weight increment being 1000 to 1400 g.

The pedigree index is one of the most important factors affecting the efficiency of beef cattle breeding industry.

That is why one of the objectives being pursued by foreign scientists are breeds with well developed muscles and inferior ability to accumulate fat tissues. This accounts for large- scale researches being carried out in the field of livestock breeding lately. The research work is conducted with the use of world resources of beef cattle breeding. Extensive investigations into the productivity of various breeds of cattle have shown that heavy European, French, and Italian breeds to a certain extent meet the demands laid down by modern selection and breeding programs. The French breed Charolais deserves special attention. Thus, in France indoor maintenance of animals being fed on roughage from the age of 9 to 13 months resulted in rather poor average daily weight increment of 300 to 400 grams, but this is made up for during the grazing period when the increment can reach 1200 g (without additional feeding).

Recently the Charolais breed, as well as deep-frozen sperm of the pedigree bulls, was imported to the USA, Canada, Australia, New Zealand and other countries. Infusion of Charolais blood facilitated breeding of bigger animals, desirable for the production of meat of the necessary quality. But along with high beef productivity the Charolais has certain drawbacks, namely, high percentage of complicated parturitions and comparatively low milk productivity.

In Australia the artificial insemination of cows of Angus and Hereford breeds with Charolais bulls' sperm is practiced with the purpose of obtaining pure Australian Charolais breed. At present there are 1200 farms in Australia where officially registered Charolais breed is raised. On spring pastures the animals can give the daily weight increment up to 2 kg. The meat produced is lean and in great demand with the customers.

In beef cattle breeding countries Simmentals have become popular. At present the Simmental population in the USA is more than 50 million heads. The breed is valued for good fattening properties with a high percentage of lean meat and high milk yield. They are used for the improvement of the productiveness and pedigree qualities of the existing breeds.

Bulls of various breeds, as well as their sperm, are imported to European countries with the purpose of the improvement and establishment of beef cattle stock reserves in Europe. All European countries, including centrally planned countries, practice the import of thoroughbred cattle; they believe it to be a considerable saving of time in selection and breeding work and the establishment of the pedigree stock.

In the system of measures aimed at the increase of the thoroughbred beef cattle population, the use of industrial crossings between beef breeds is of great importance. In the USA and other countries crossing of beef breeds with dairy breeds for the purpose of obtaining lean carcasses, has become popular. Besides this US scientists are pursuing the objective of breeding animals

capable of being covered by the age of 6 months with parturition at the age of 15 months. If this goal were to be achieved, the periods required for the production of beef would be shortened; the competitiveness of the beef would be higher at the expense of both increased quality and lower production costs.

At present research institutions of many countries carry out large scale investigations into the compatibility of various breeds and crossing efficiency. In the USA careful selection work is carried out resulting in a high pedigree index and productivity of herds. Finally, this resulted in the distribution of cattle breeds according to the local climatic conditions with the development of detailed zootechnical and economic evaluation methods. Careful and purposeful selection and breeding plays a decisive role in the increase of beef cattle productivity.

Under conditions of well developed large-scale fattening of cattle industrial crossing has become a standard practice. As a rule, two-and three-way crossings are practiced with selection being carried out for the offspring with manifested heterosis. Crossings with Aberdeen-Angus bulls are widely practiced to make the parturition easier, since the calves resulting from the above crossings have smaller head size.

Great attention is paid to the possibilities of raising animals with double muscle tissue development and their use for crossings with normally developed cows, the final objective being increased herd productivity.

The crossings of beef and dairy cattle has become more spontaneous recently. In this connection Texas University has developed a recommendation to the effect that greatest emphasis should be laid on the improvement of herd characteristics and not on the development of individual animals. Optimum age and live-weight of hybrid bulls to be slaughtered should be determined.

For instance, an optimum slaughter weight of bulls at the age of 10 months should be 330 kg, as estimated based on a daily average weight increment of 950 g; the slaughter weight of bulls as calculated based on the increment of 2.3 kg - 1.4 kg would be 470 kg. The calculations are based on the bull prices being 10 times the feedstuff costs.

A new system of the evaluation of young animals on specialized farms has been developed at Missouri University; the systems consider such factors as productivity, growth rates after weaning, fecundity of heifers, food conversion ratio, slaughter weight and qualities of the carcass.

In big herds these functions are undertaken by a special service. In small herds the weight of calves is calculated as follows, with weaning done in 205 days:

$$\frac{\text{Weight at weaning, kg} - \text{Weight at birth, kg}^{+)}}{\text{Weaning age, days}} \times 205 + \text{Weight at birth kg}$$

In Oklahoma, USA, the possibilities of the evaluation of productivity of cows based on the manifestation of cow type characteristics have been studied. 220 thoroughbred Angus cows and 990 calves served as test animals. The statistical analysis has shown that manifestation of the type as expressed in points is not very helpful in the forecasting of the productivity of cows. The weight of the first calf at weaning is much more reliable.

Export and import of bulls' sperm is a new form of the organization of the breeding work in the beef-cattle industry. The application of the artificial

+ In case the weight of a new-born calf was not determined, the figure is obtained by subtracting 16 kg from the weaning weight

insemination method with the use of the deep-frozen sperm, its improvement and large-scale introduction created possibilities for fast improvement of cattle population. Bulls' sperm of beef and complex breeds, such as Charolais, Limousin, Kjan, Simmental, etc., is in great demand. The above method is used with the purpose of obtaining animals with lean meat and high dressing percentage, high growth energy and food conversion ratio. Starting from 1968, the USA started importing the sperm of Simmental and Men-Anzhu bulls. In Australia the beef-cattle breeding industry is being developed and improved. Australia purchases the sperm of beef bulls among which Charolais and Simmental prevail.

An increasing use of Simmental bulls' sperm in many countries should be specially mentioned. The artificial insemination with the use of Simmental bulls' sperm is widely performed in the USA, Canada, Great Britain, New Zealand, South America, and Africa.

Animals selected for such characters as precociousness, productivity, durability, high milking capacity, high offspring qualities.

Several programs of beef-cattle breeding have been elaborated recently; each program is based on revealing bulls with high genetic potential, increasing rates of improvement of beef cattle through the intensive use of best bulls and their sons. The pedigree value of an animal is determined based on its individual productivity, as well as productivity of the father, mother, all the half-brothers and half-sisters and their offspring with hereditability of characters and relations being taken into consideration, weights at birth, at weaning at the age of 12, 15 and 18 months, as well as the weight of the cow at each calving. All the indices are compared with the average values for the herd. But according to the information supplied by the American "Feedstuffs" Journal, world beef-cattle breeding genetically is 25 years behind the dairy-cattle breeding.

Investigations are being carried out into the possibilities of the establishment of inbred lines in the beef-cattle industry, despite the fact that they are considered less promising than those in poultry and pig breeding.

Since the 1950's, control stocks of beef-cattle have been used in the USA to serve as reference stocks for the evaluation of genetic improvement of the herds in question. Before that time the idea of establishing such stocks was not very popular, which today is considered a mistake.

Starting from 1 March, 1978, a new rule of the determination of the origin of Aberdeen-Angus animals by blood groups was put into practice in the USA.

The above regulation includes the list of blood phenotypes; the animals having these phenotypes cannot be considered thoroughbreds. The regulation has been derived based on long-term trials having been conducted at the Blood Typification Laboratory, Ohio University, Columbia.

At present, blood analysis is required only for bulls designed for artificial insemination, for animals awarded medals at exhibitions, as well as for animals with unknown parents. Besides that, random examination of one calf out of 15 thousand young animals registered in the pedigree book is carried out. A newborn calf will be registered in the pedigree book only after the blood analysis of the bull, his father, is presented to the Association. The regulation is valid only for calves born after March 1, 1970.

The evaluation of cattle productivity based on the level of thyroid gland secretion activity is becoming a matter of great importance. A combined evaluation of cattle on both genetic and hormonal levels is likely to find a wide application in practical evaluation of cattle productivity. At present, attempts are made in the USA to extend the research work on cytogenetics of cattle.

The program of genetic improvement of cattle has been developed in France (for the South-Western part of the country). Herds in this region are made up of Friesians (50.3%), Schwyz (11%), and Aquitan (3.5%). Charolais and Aquitan breeds are used as male parents in crossing; thoroughbreds are used only as improvers.

The genetic evaluation of bulls is most important and very complicated. In the industrial crossing, high-quality bulls are required, possessing high hereditary characteristics. But morphological and productivity characters have been shown to be inadequate for a comprehensive evaluation of bulls. Moreover, evaluation of bulls at an early age is very desirable.

A considerable contribution to the efficiency of breeding in foreign countries is made by stations performing the evaluation of bulls by the offspring quality. For evaluation purposes a group of cows are sired by young bulls; the offspring raised, fattened, and then evaluated by a complex of characters. For example, in France the Charolais breeding centre purchases 50 pedigree bulls annually from various artificial insemination farms aged 7 to 8 months. In the course of the year 10 to 12 bulls are tested (in future not less than 15 bulls are supposed to be tested). Each test bull is able to inseminate 250 cows. The percentage of complicated parturitions, malformations, and stillbirths is considered.

Bulls are evaluated by the exterior, growth energy and development of the offspring during the first 5 months after birth. Based on this evaluation 10-12 bulls are left for further testing. For their evaluation the Station purchases 20 daughters of each bull in the zone of Charolais cattle breeding. At the age of 15 months the heifers are inseminated to get offspring at the age of 2 years; at the age of 30 months, after weaning, the cows together with their offspring, are either slaughtered (the worst animals) or used for further reproduction. By the end of the test period 3 or 4 bulls remain; they are given over to the artificial insemination station for the accumulation of semen and for use in mating.

In Soualet a beef bull testing station has been established. There are more than 400 bulls at the age of 3 months to 8 years at the station. After final testing only 5 to 13% of those initially chosen are used. There are reserves of deep-frozen semen (9 million dosages) obtained from high-quality bulls. The semen is used for the production of new generations of bulls. Their productivity and origin is controlled by laboratories existing in each department. The information is supplied to the National Cattle Breeding Institute, and then to the Computer Centre processing more than 20 million pedigree cards annually. The results come back to the Institute and then to the farms.

The pedigree work with beef-cattle in foreign countries is based on the activity of pedigree cattle societies and artificial insemination organizations. In the USA the pedigree work is dealt with also by big farms and fattening enterprises.

In France the pedigree work is dealt with by cooperatives for selection and artificial insemination as well as by associations for beef-cattle breeding.

In West Germany the improvement of pedigree qualities of cattle is performed by the Simmental Cattle Breeding Society; Simmental is actually a beef and dairy breed.

1.2. Raising and fattening technology

1.2.1. Fattening technology in the countries with developed beef-cattle breeding

In the countries with developed beef-cattle breeding, such as the USA and Canada, 60 to 80% of the beef produced accounts for the specialized cattle fattening system.

The changes that have taken place during the last 20 to 30 years in the USA in the population of beef-and dairy-cattle are given in Table 5.

Table 5. Population of beef and dairy cattle, beginning of the year, million heads

Groups of cattle	1969	1975	1979	1979 in percent to 1969
Total cattle population	110.0	131.8	110.9	100.8
incl. cows:				
dairy	12.5	11.2	10.8	86.4
beef	35.5	45.5	37.0	104.2
being fattened	49.6	59.2	51.2	103.2

The share of beef-cattle, including animals being fattened, increased from 77.4% in 1969 to 79.5% in 1979; the share of dairy cows decreased correspondingly from 11.4% to 9.7%. Starting from the middle of the 1970's the population of both beef-and dairy-cattle decreased. The slaughter weight increased from 250 to 256 kg. Consumption of beef increased as well. While the consumption rate in 1967-69 was 50.3 kg per capita, in 1977-79 it constituted 56 kg. According to the forecasts of Arizona specialists, consumption of beef and veal will increase by 33% by 1985. Up to 70% of beef-cattle will be raised using the outdoor/box maintenance system.

Average daily weight increments are forecast to reach 1500 g in the year 2000 against 1200 g in 1973. Food conversion ratio will decrease from 8-9 centners in 1973 to 6 centners in 2000, and the average weaning weight will become 230-270 kg against 180-205 kg in 1975. Consequently, the decrease of the production costs will be basic to further growth of beef production under conditions of saturated market and competition. Beef production takes place on large industrial sites accounting for 75% fattened animals. But from the middle of the 1970's a trend has been observed towards the decrease of the number of animals delivered for slaughter from the industrial fattening sites. The number of the sites decreased from 168.8 thousand in 1976 to 131.9 thousand in 1977, or by 12.8%, with the amount of cattle decreased from 46.8 to 45.4 million head. According to the American specialists, sites with a capacity of 4 to 16

thousand head are considered most efficient.

The decisive factor providing for the success of beef-cattle breeding the USA are feedstuff reserves. For the production of 11.5 million tons of beef in 1975-76, 284 million tons of feedstuffs were required, including 188 million tons of pasture grasses, 56 million tons of silage and hay and some 40 million tons of grain, or 26% of the total amount of fodder grain and grain wastes consumed in the country. The increase of prices for grain resulted in the use of feedstuffs with high roughage content. It has been shown that the increase of roughage content in the ratio from 12 to 33 and up to 38% at 11.5% protein results in the increase of the dressing percentage by 5% with 4% decrease of feedstuff requirements. But in connection with the increase of labor costs the total production costs become 5-7% higher.

In Canada as compared to the USA, the population of beef-cattle constantly increased (Table 6).

Table 6. Population of dairy and beef cows in Canada, million heads.

Groups of cattle	1965	1970	1978	1979
Total cattle population	13.26	13.06	13.71	13.76
including:				
dairy cows	2.80	2.55	1.9	1.07
beef cows	3.04	3.08	3.88	3.70

In Canada 2.6 to 2.7 million adult animals and 670 to 760 thousand calves are slaughtered annually. The average weight of a fresh carcass varies from 240 to 250 kg, the weight of a calf carcass being 45 to 58 kg. Industrial fattening sites are also used in Canada. The construction of sufficiently large fattening enterprises with a capacity of up to 50 thousand head takes place. But industrial sites with a capacity of 200 to 300 head are most common.

Good feedstuff reserves are also basic to the successful development of livestock breeding in Canada where pastures are the main source of fodder. The annual production of fodder protein in Canada constitutes 6 million tons, with some 4 million tons in pasture grasses and hay, 1.6 million tons coming from the milling and brewing industry, and 280 million tons in mill cake with small amounts of animal protein (136 thousand tons). Practically all mill cake protein is fed to cattle in concentrates. The production of high-energy feedstuffs exceeds the requirements of livestock breeding.

Grazing is the chief method of beef-cattle maintenance. An average size of a herd is about 300 head. A characteristic feature of Canadian beef livestock breeding is all-year-round grazing and keeping cattle on open sites (this refers to both reproductive and fattening cattle). Paddocks are surrounded by special fences to have animals protected from prevailing winds. Special researches on the beef-cattle organism as affected by severe climatic conditions are being conducted at Alberta University. Hereford and Aberdeen-Angus have been shown to

be most resistant to unfavorable conditions. Sometimes in winter animals are additionally fed with grain, hay or straw in various amounts depending on local conditions. On an average, Canadian farmers need about 90 kg of alfalfa hay to be used in a 6-month period.

In Australia, Argentina, Brazil, and Mexico a considerable share of beef comes from specialized beef-cattle being raised with the use of an extensive system of maintenance.

In Australia beef-cattle breeding is the most stable and fast developing branch of livestock breeding. According to the information available as of March 31, 1979, the cattle population numbered 26.8 million head, including 23.9 million head, or 89.2%, of beef-cattle. Even in the 1970's which were characterized by a general decrease of agricultural production, including many branches of livestock breeding, not only did beef-cattle breeding not decline, but progressed considerably. The number of beef cows and heifers doubled and amounts now to 13 million head.

Steady rates of the development of beef-cattle breeding are forecast at least for the 15-20 years to come. Low labor consuming and capital investments account for the fast and steady development of this branch. The increase of beef production requires an insignificant increase in capital investments.

According to calculations made by the Australian economists the last doubling of beef-cattle population took place after an 8-10% decrease in employment occurred. Capital was invested only in the construction of fences and water drinking places. Current operating expenses include only those for the repair of fences. According to the production technology and specialization beef cattle breeding farms fall under one of the four types of enterprises (see Table 7) The technology of beef-cattle breeding in Australia includes all-year-round grazing in the areas surrounded with barbed wire. This makes the hiring of herdsmen unnecessary. Mating as a rule is voluntary. On pedigree farms group mating is employed (35 to 40 cows are kept with one bull on a separate pasture). The animals are fattened either on natural or sown pastures. Only about 2% of very fat beef (with 30% fat in a carcass) are obtained from 2 to 3 year-old animals, mainly heifers, fattened at special sites. This kind of beef is exported to Japan to be used for the national dish "cabi-beef".

Brazil ranks first among South-American countries as far as cattle population is concerned. One of the characteristic features of Brazilian cattle breeding is the low productivity and low marketability of the branch. In 1978 only 12.9% of the total population of cattle was slaughtered, while in the USA and in Argentina the figures are 38.1% and 26.8% correspondingly. Brazil has no fattening sites for mass meat production. Fattening in enclosures is practiced to a very limited extent. Due to favorable climatic conditions, cattle are grazed on pastures all year round. Cattle breeding is most developed in the Rio Grande do Sol state in South Brazil. More than 50% of the country's cattle are concentrated in this region where intensive breeding of mainly European breeds, such as Hereford, Aberdeen-Angus and Charolais. Two types of pastures are used - natural and sown; the latter are established on the lands having been under rice for one year. These lands are used as pastures for 3 to 4 years and then planted with rice again. In central regions, especially in Sao Paulo, a distant pasture grazing system is used in connection with the burning of pastures in summer and the rising necessity to move to marshy lands. In this region Zebu type cattle and its hybrids with European breeds are most common. The Santa-Gertruda breed enjoys the most extensive distribution. Cattle are fattened for 2 to 4 years and longer. Rapid growth of the cattle population has become possible due to the establishment of pastures in remote regions and burning out of forests.

Additional sowing of grasses and legumes in such territories is becoming more common.

Table 7. Most common types of farms in Australia

Farm Specialization	Production Characteristics	Slaughtering age, month months	Average weight, kg		Average size of the herd, heads
			live weight	carcasses	
Veal production	Complete cycle from production to sale	6-12	170-340	90-180	118
Young beef production	same	12-16	300-400	220-300	365
Fattening of the purchased calves	Fattening of calves purchased from the 1st & 2nd types	24-36	400-540	220-300	542
Mixed production	Fattening of calves obtained from own and purchased cows	16-36	400-450	220-300	147

In Argentina an extensive system of beef-cattle breeding is also employed. This part of the work ranks second as far as cattle population is concerned. The main part of cattle population is concentrated in the La Pampa region. Very big farms exist there with pasture areas occupying several thousand hectares. The E. Dojao farm, located 300 kilometers from Buenos Aires has 8625 hectares of land with 4200 Hereford cows. Natural pastures occupy 46% of the territory, and 50% of the total 30 million hectares of arable lands are occupied by sown pastures. The main cattle breeding regions are located in the steppe zone. Lately a trend has been observed towards a rational use of vast ranges under an extensive system of cattle breeding.

The whole cycle of beef production - mating, calving, raising, fattening - take place in the pastures. Additional feeding with concentrates is not used. The cattle is kept outdoors all year round, but in well equipped enclosures, mainly in sown pastures. The sizes of pasture plots vary from 30 to 300 hectares. In the locations with no available natural water sources, artificial water reservoirs are constructed with the use of groundwater; automatic group water drinking bowls are also installed. Such a system of cattle maintenance reduces labor consumption to the minimum, since all the processes come to the surveys of the enclosures, carrying out of veterinary measures and separation of animals in case of necessity.

Fattening animals are kept separately from reproductive herds. Fattening of castrated animals is stopped at the age of 20 to 30 months. In reproductive herds, cows are covered in a short period of time to have all the calving cases more or less simultaneously. Parturitions take place right in the pasture without man's interference, unless necessary. Weaning is done at the age of 6 to 8 months. In winter, additional feeding is used - hay in bales or rye, wheat or oat straw at a rate of 1 kg per head. The Argentinian farmers believe a uniform and continuous feeding system to be efficient in obtaining carcasses with lean meat. In the northern regions of the country a remote pasture grazing system is used, where the slaughter weight is gained only by the age of 5 to 6 years.

1.2.2. Fattening technology in countries with prevailing dairy-cattle breeding.

In Great Britain, Italy, and France where both dairy and beef cattle breeding are developed, most beef is obtained from the replacement animals and culled cows.

In Great Britain beef cattle breeding is one of the leading branches of livestock breeding. The population of beef cattle amounts to 1.76 million head, or 34.9% of the total population. This branch of livestock breeding is well developed in all zones of the country, but it is especially true for Scotland which has considerable areas under natural meadows and pastures. The sizes of fattening farms are not big. The average farm cattle population increased from 12% in 1969 to 18% in 1974. Farms dealing with raising and fattening of young animals have a maximum capacity of 500 to 1000 head. The most specialized farms practice separate raising of dairy calves. The average daily weight increment is 800 g to 1000 g. Animals are slaughtered at the age of 18 months, their weight being 450 - 500 kg.

Pasture grasses are the main fodder for cattle in Great Britain. 62% of agricultural lands are occupied by haylands and pastures, including 26.2% under sown pastures. Sown grasses occupy 31.7% of the arable land; 85% of feedstuff requirements are covered by natural and artificial pastures; this share in beef livestock breeding is considerably higher. In connection with a sharp increase in grain prices the share of concentrates in the rations decreased considerably. All the pastures are fenced. In summer which lasts 7 to 8 months, and often

longer, beef cattle are kept outdoors during the whole period. Additional feeding with concentrates is supplied only to bulls and to young animals at the final stages of fattening. In winter beef cattle are kept in stalls. Animals are fed mainly on silage or hay produced as a rule from grass. Thus, the technology of beef-cattle breeding and beef production is adapted to maximum use of pastures.

In France the total population of cattle is 23.5 million head with 10.2 million cows. 75% of the cows are used for milk production, and 25% for raising suckling calves. The production of veal is from 3 month old calves with a live-weight of 150 - 200 kg. Veal consumption is 7 to 8 kg per capita annually (in West Germany the annual consumption rate is 2 kg). Another feature characterizing beef production in France is the slaughter of bulls at 2-3 years of age, which have been fattened over several grazing seasons. This sort of beef is supplied to the home market; carcasses of animals slaughtered at the age of 15 - 20 months are exported. 35 - 38% of cattle slaughtered annually accounts for culled dairy cows. This results in the general decrease of the population of cows in the country which which in turn results in a decrease in the number of calves. There are no big specialized fattening enterprises in France. Maximum size of fattening herds on farms is 200 to 250 head. Small farms with a cattle population of 10 to 20 heads are more common. Large enterprises with the capacity up to 10 thousand head of cattle were established only a few years ago. Perennial pastures accounting for about 50% of agricultural lands are widely used in France. Average grass yield for hay is 45 centners. Some 1 million hectares, or 6% of arable land is planted with corn grown for silage, fodder beet and cabbage. The cattle are kept outdoors with minimum use of concentrates (for sucklings). The leading regions of beef production are Limousin, Auvergne, Lower Normandy, Brittany and the Loire which produce about 30% of the total amount of beef in the country.

In West Germany the average size of fattening farms is 100 to 150 head, the maximum capacity being 4000 head of cattle (but the latter are not numerous). Beef-cattle are kept indoors for most of the year, in summer grazing in pastures and paddocks is practiced. The main fattening fodder is silage and concentrates. Young animals of Simmental breed are imported to be fattened at the specialized sites; the starting weight is 300 kg. Of the total amount of cattle slaughtered 49% accounts for bulls, 30% for culled cows, 14% for heifers, 5% for calves of the current year and 2% for castrates.

In West Germany much attention is paid to the increase of the carcass weight through the use of heavy beef breeds and the increase of fattening time. During the 1970's they managed to increase the carcass weight by 13-14%. This resulted in a considerable additional supply of beef with the decrease of its import. Besides the traditional regions of beef production - West Schleswig-Holstein, Wildeshausen, Braunschweig, Münster, Nordenham, Niederbauer, new regions have sprung up - East Schleswig-Holstein, Lünenburg, Osnabrück, Aurich, Düsseldorf. The largest highly mechanized fattening farms are located in Lower Saxony. Young animals to be fattened are often imported in similar way to the USA.

1.2.3. Main Methods of intensification of fattening in the COMECON countries

In 1960-78 in the COMECON countries an increase of beef production took place. It was especially noticeable in Bulgaria (3.2 times), Poland (2.1 times), East Germany (by 94%) and Czechoslovakia (by 75%).

In Bulgaria the intensification of cattle fattening is provided for by the construction of specialized enterprises with the simultaneous raising and fattening

of 3 to 20 thousand young animals, as well as the reconstruction, expansion and modernization of existing farms with the increase of their capacity up to 500 to 2000 head. Significant changes took place in organization and production technology. Stall and loose housing systems of cattle maintenance were substituted for the grazing system. At most specialized enterprises the starting age is 4 to 6 months. At some enterprises a complete cycle has been introduced, starting from the raising of 10 to 20 day-old calves and ending with their fattening. The highest concentration has been achieved in the Tolbukhin district where 77% of fattened young animals are kept at the interfarm enterprise. More animals undergo fattening. 79% of young animals to be slaughtered will be fattened. Cattle of main breeds have proved to have a high beef productivity and a good food conversion ratio (Table 8).

Table 8. Bulgaria: Live weight of bulls of various breeds raised with the intensive feeding system

Breeds	At the age of 14 months		At the age of 15.5 months	
	Liveweight, kg	Food conversion ratio	Liveweight, kg	Food conversion ratio
Bulgarian brown	461	5.6	515	6.8
Bulgarian Simmental	468	5.5	533	6.0
Bulgarian red	430	6.4	495	6.7
Black & White	443	6.1	480	6.9

An extensive program of the improvement of feedstuffs reserves has been developed. By 1980 the share of corn in the food rations will increase up to 71%; the production of legumes, mainly soyabean, will increase 7 to 8 times. Great attention is paid to the development of beef-cattle breeding. By 1980 the population of beef cows will reach 200 thousand head.

In Hungary 2 types of fattening are practiced - the traditional and at specialized enterprises. Bulls being fattened are not castrated. The traditional method of fattening consists of grain feeding ad lib. This method provides for an average daily weight increment of 1200 to 1400 g, with a liveweight of 550 - 600 kg at the age of 14 - 16 months. More recently a modernized traditional method using lower consumption of concentrates and a higher percentage of silage in the ration has been employed.

Specialization and concentration of beef production develops mainly on the basis of intrafarm cooperation, construction of new production units and moderization of existing premises. First production complexes with the capacity 1000 heads were constructed according to "Agroterv" Institute design. At such production units the starting weight of bulls to be fattened is 120 to 130 kg which is

increased up to 550 - 600 kg. The planned daily weight increment should be 1320 g. Concentrates are mainly used, but bulky feedstuffs can be used as well. The production units are designed to have semi-open premises of light-duty type, loose housing with no litter on slit floor, or with deep litter in places where animals are supposed to lie down. In the industrial production all-year- round feeding of animals on mono-rations is employed; these rations have proved to be economically efficient. Great attention is paid to the improvement of feedstuff reserves. Grain production, especially corn production, is increased, the areas under sown pastures are expanded, concentrated production industry is being developed.

Hungary is the biggest meat-producer in the world and a permanent meat exporter. Meat production per capita constitutes 140 kg, with 70 kg being consumed by the home market. Beef- cattle breeding is being constantly developed. By the end of the 1970's the beef cow population numbered 70 thousand head; by 1985 it should have increased to 380 thousand head. Beef production will be based on the use of replacement young animals, culled adults (dairy-cattle), as well as on the development of specialized beef-cattle breeding.

In East Germany considerable experience has been gained under conditions of operating big industrial units. Industrial units with a capacity of 18 and 36 thousand head are most common. Along with the construction of new big industrial units, reconstruction of existing premises is made. In industrial feeding the following types of fattening are employed: feeding with dry fodder with the use of complete feedstuff mixtures; concentrates with silage as the main feedstuff mixture ingredient; feedstuffs based on concentrates and sugar beet processing products. Young animals are fattened up to the age of 15 months to reach the slaughter weight of 424 to 427 kg at an average daily weight increment of 822 g to 964 g. Beef production amounts to more than 400 thousand tons. In the future the following measures are planned: organization of the fattening of replacement animals, increase of the daily weight increment as well as the slaughter weight of animals, increase of cattle productivity based on industrial crossing using Simmentals and heavy European beef breeds, such as Charolais, Kian, Piedmont, Rhomaniole. As an additional source of young animals as well as one of the ways of increasing the slaughter weight of heifers, the method of single use of replacement heifers is being introduced.

In Romania an extensive program of livestock intensification is being put into practice. Recently, 29 big industrial units and farms for the raising and fattening of cattle were established.

The five-year plan includes the further development of intensive livestock breeding, extensive measures regarding the improvement of feedstuff reserves, construction of premises, concentration and specialization of production processes, and the introduction of new industrial technology.

In Czechoslovakia concentration and specialization of production processes are considered to be the basis for further development of beef-cattle breeding. The specialization is effected through cooperation and the establishment of big farms for the raising and fattening of cattle. At present the cooperation network includes 10 specialized production units for raising and fattening various age groups of cattle. Bulls at the age of 6-8 months are transferred to fattening farms where their weight is increased to 450-550 kg. Due to this specialization, beef production increased by 64.7% with an increase of cattle population of 15.3%. Beef-cattle are raised in 2 ways: by single industrial crossing of culled dairy cows with beef bulls; the progeny is fattened together with the cow; and by the breeding of Hereford hornless cattle imported in 1975. Extensive work is being done for the improvement of feedstuff reserves - increasing of grain crop

and fodder crop yields, and improving methods of supply and processing of fodder. The production of dry mass of fodder crops will make up 2 million tons in 1985, as compared to 559 thousand in 1974.

To provide for the further development of beef production the following is planned: increase the replacement heifer population - 32 to 33 heifers per 100 cows; increase in the number of calves born - from 101 to 108 per 100 cows; decrease of the age of the replacement heifers; to fatten bulls (the hybrids between Czechian and Slovakian black-and-white cattle with 25-37% blood infusion from Ayrshire cattle) to the slaughter weight of 470-500 kg; to feed the hybrids between black-and-white cattle with Red Golshtines to a slaughter weight of 530 kg; to fatten bulls, the hybrids between Czechian and Slovakian black-and-white cattle, to a slaughter weight of 550 to 580 kg.

2. Swine Industry

In 1979 the world pig population reached 761.1 million, or exceeded the average pig population in 1969-71 by 21.8%. Pork production increased by 34.0% and reached 51.8 million tons. Rates of growth for pigs during the 1960's and 1970's were approximately the same whereas production of pork in the 1970's grew faster which indicates a higher level of intensification.

Table 9 presents data on pig populations in different developed countries in different years.

Table 9. World pig population, thousand animals

Country	1969-71	1978	1979	% in 1979 compared to		Year to year % variation
				1969-71	1978	
World total	624.9	736.8	761.1	121.8	108.3	2.4
Bulgaria	2.4*	3.8	—	159.2**	—	7.4
Hungary	7.3*	8.0	—	109.6**	—	1.2
East Germany	9.7*	11.7	—	121.2**	—	2.6
Poland	13.9*	21.1	—	152.3**	—	6.5
Romania	6.4*	10.3	—	162.6**	—	7.8
Czechoslovakia	6.5*	7.6	—	137.5**	—	4.7
Yugoslavia	5.7	8.4	7.7	135.1	91.7	3.9
Chinese People's Republic	246.3	295.5	305.2	123.9	103.3	2.6
Great Britain	8.2	7.7	7.9	96.0	102.1	-0.4
Denmark	8.3	8.7	9.4	112.3	106.9	1.4
Italy	8.5	9.4	9.8	115.2	103.9	1.7
The Netherlands	5.5	9.2	9.7	176.1	106.0	8.4
France	10.5	11.6	11.7	111.3	101.4	1.3
West Germany	19.7	21.4	22.7	115.2	106.0	1.7
Sweden	2.2	2.7	2.7	125.5	100.7	2.8
Canada	6.6	6.7	6.8	103.0	101.6	0.3
The USA	61.7	56.5	59.9	97.0	105.9	-0.3

* 1970

** 1978 as % of 1970

In the majority of pork producing countries growth in pork production outstripped growth in pig numbers. In West Germany the pig population increased by 15.2% while pork production increased by 23.7%. In France, the increase in pig numbers and pork production amounted to 11.3% and 34.5%, in Denmark 12.3% and 24.6%, in Italy 15.2% and 61% respectively. In the USA the pig population decreased by 3% while pork production increased by 12.3%. In Great Britain the pig population decreased by 4% while the level of pork output remained constant. The average pig population for 1970-1978 in Hungary increased by 9.6% and pork production increased by 62.2%, in Romania by 62.6% and 80% respectively.

2.1. Stock Breeding

Many years of stock breeding aimed at improved performance and better fitness for commercial production led to a reduction in the number of breeds used in the swine industry. At present, the range of breeds used in the world pig industry is mainly limited to some 10 breeds of meat and bacon type.

In the USA swine of three main breeds (Duroc, Hampshire and Yorkshire) represent 73% of all pig population (pedigree). In West Germany pigs of the German Landrace breed account for some 90% of all breeding pigs. In France some 63% of all breeding pigs belong to the Large White breed and over 14% to the Landrace Breed. In Denmark Danish Landrace is the only officially registered breed, in Sweden two breeds are registered in stud books. In Finland pigs of the Finnish Landrace breed account for 37% of the breeding population and pigs of the Finnish Yorkshire breed account for 63%. Belgian Landrace pigs represent 85.1% of the breeding population in Belgium, and Dutch Landrace pigs represent over 80% of breeding swine in the Netherlands. In Poland 60% of breeders belong to the Polish Large White breed and 37% to the Polish White Drooping Ear breed.

In the USA 8 main breeds make up the pig population in the following percentages - Duroc 30%, Hampshire 25.3%, Yorkshire 18%, White Chester 9.2%, Spot breed 6.7%, Polish-Chinese 4.1%, Landrace 2.9% and Berkshire 2.5%. Duroc pigs are characterized by fast growth and the highest average daily gain during growing and fattening (950 g. and more). Yorkshire pigs are the second highest gainers (923-932 g), leaving Hampshires slightly behind (891-900 g).

As for meat-to-fat ratio, Hampshire pigs are far superior to pigs of all other breeds. Live animals have back fat of 2-2.3 cm, carcass back fat is 2.9 cm, "eye" area is 37-38 square cm Duroc hogs are characterized by higher relative fat content in carcass - live animals back fat is 2.3-2.5 cm, carcass back fat is 3.3 cm, "eye" area is 33-35 square cm. Yorkshire carcass conformation approaches that of the Duroc breed. These three breeds differ considerably in rates of growth and meat-to-fat ratio, however, they are characterized by virtually the same feed-conversion efficiency - 2.58, 2.59 and 2.58 kg of air-dried feed per 1 kg of liveweight gain respectively. Special consideration is presently given to the Hampshire breed. In the USA in recent years this breed became the second largest in pig population and the best breed so far as conformation of the carcass is concerned. As for breeding performance, the basic breeds in the USA are distributed in the following way - the average number of live Duroc piglets at birth is 9.7, Hampshire 8.8 and Yorkshire 11.1.

During the 1960's - 1970's intensive breeding for better meat-to-fat ratio and carcass conformation was under way in developed countries due to lower production costs of lean pork and a decline in demand for animal fat. Meat-type hogs require more protein feed. However, good fecundity, early maturity and high dressing percentage make feeding such hogs more economical compared to feeding animals of lard-type breeds. In the USA, Great Britain and West

Germany relative numbers of meat-type hogs account for 85-95% of the total population. During the 1960's and 1970's in the USA the weight of hogs at slaughter remained practically the same (about 110 kg) while the amount of fat per 100 kg of carcass weight declined from 29 kg in 1960 to 15 kg in 1974. Lower fatness makes for better feed justification by weight gain since fat contains about 90% of dry matter compared to meat dry matter content of 30%. Even in Hungary, where traditionally lard breeds were popular, meat-type hogs constitute 85% of the pig population. It was found that animals with 3.3 cm back fat and less require less feed per 1 kg of weight gain than swine with thicker back fat.

Methods which intensify the breeding process have gained wide recognition. First and foremost these are practiced in the USA, Great Britain, France, West Germany. Methods of testing used in other countries for swine evaluation include progency performance evaluation, a considerable reduction in intervals between generations, the large-scale breeding of traits with high hereditability, and the wide use of artificial insemination.

These methods employed, for instance, in MLC breeding programs during 12 years allowed for the reduction of feed requirements per 1 kg of weight gain from 3.3 kg to 2.7 kg and raised the "eye" area from 26.7 to 31.7 square cm. The cost of arrangements aimed at improvement of the pig population stipulated by the MLC program accounts for about 200 thousand pounds sterling while the minimum estimation of benefits from the improvement of national stock resulting from the MLC program approaches 3 million pounds sterling.

Organization of breeding in many foreign countries is, as a rule, carried out within the framework of a single body (association, society or commission) financed by member farms. Such an organization has its own budget, employs specialists in animal breeding, works out programs for breeding, supervises implementation of these programs on the member farms and continuously improves breeding program.

Interest has considerably increased in cross breeding and hybridization allowing the traits of several breeds to be combined. It has been scientifically proved that cross-breeding improves animal performance by 8-10%. In Great Britain hybrid youngsters make up 90-100% of commercial feeder hogs, in Hungary 80%, in France and West Germany 10%, in the USA 85%. Improvement of user crossing method resulted in the implementation of hybridization programs in such countries as Great Britain, the USA and other countries in the late 1950's, and in Hungary, France, West Germany and other countries in the early 1970's.

In Great Britain 8 our of over 50 commercial firms supply about 33% of hybrid gilts and 12-15% of all breeding boars sold. Hybrid hogs account for 20-30% of all hogs for slaughter; this percentage is forecast to reach 75% by the mid-1980's.

In 1976 in the breeding association "Kahib" (Hungary) hybrid pigs for slaughter numbered 1 million animals or 20% of total number of pigs for slaughter. Production of hybrids in the country started in 1962 on the basis of the Magaly breed, Yorkshire, Cornwall, Middle White and other breeds. Hypor and Sykes hybrid swine (imported in 1968) were used in the program to develop Hungarian Kahib hybrids which were then registered by State Commission in 1972. Evaluation of the performance of Kahib hybrids in 1972-1973 showed that 1012 weaners were weaned from 100 postpartum sows, average daily gain was 694 g (weaners fed to 105 kg), feed consumption per 1 kg of weight gain was 2.8 kg. Kahib hybrids are superior to true-bred hogs and crosses in the most important traits.

In 1969 West Germany imported animals of 11 West-European and North-American breeds and placed them in 20 experimental farms. From this initial material 27 combinations were developed consisting of 7 maternal lines and 8 paternal lines. The best combinations are selected by vitue of an economic index which takes into account the number of piglets raised per sow, liveweight gain, carcass length, fat-to-meat ratio, and the results of evaluation of gammon and colour of the meat.

In the USA pig hybridization is carried out by private companies and firms. The "Farmer's Hybrid" company has two experimental farms with a stock of 12 boars and 90 sows. The company has contractual relations with 110 reproduction farms (with a pig population of 700 boars and 6000 sows) and nearly 15 thousand commercial cash farms (with a pig population of 17 thousand boars and 245 thousand sows). The main advantages of hybrids are the greater numbers of piglets born and weaned, better carcass quality and uniformity of animals which allows for standardization of feeding and management techniques and better fitness for commercial-scale production.

In recent years in Great Britain, West Germany, the USA and other countries, those animals which are free from pathogenic microflora (SPF) - agents of enzootic pneumonia, infectious atrophic rhinitis, dysentery and other diseases which cause considerable decline in production, are used for hybridization. Such animals are characterized by longer life-expectancy, they grow faster and utilize feed more efficiently. According to data from American sources disease-free swine may have a daily weight gain 20% higher and require 9.5% less feed compared to common animals.

Success of hybridization is directly dependant on the level of the breeds involved. That is why the majority of hybridization programs are based on the best world breeds such as Large White, Swedish, Danish and Belgian Landrace, Hampshire and some other breeds. The following breeds were used to develop "Cotswald" hybrid (Great Britain), Large White (fast growth and feed conversion efficiency), English Landrace (carcass length and quality, Wessex-Saddleback (good milking performance and maternal qualities) and Welsh (high meat producing capacity, sound constitution and good maternal performance).

Creation of hybrid pigs was necessitated by demands of modern technology which requires strong and stress-resistant swines of the meat type characterized by faster maturing and better carcass quality.

2.2. Raising and feeding technology

Over the last 50 years in the countries with developing swine industries average daily gain increased by more than 450 g, feed requirements per 1 kg of weight gain reduced by 3 kg, average back fat reduced by nearly 3.0 cm "eye" area increased by 12 square cm, number of piglets weaned per litter increased by 2.5. Average age of slaughter hogs is presently 5 months younger than 50 years ago.

On the basis of historic data on the progress in the pig industry in developed countries for the period 1922-1972 a well known American scientist, T. Coona, forecasts the following developments (Table 10):

Table 10. Progress in science and technology of the pig industry

Item	1922	1972	2022
Number of weaners per 1 litter	5.12	7.4	12.0
Average age of weaners (weeks)	10.0	6.0	2.0
Average daily weight gain from birth to slaughter (g)	317.5	544.3	816.5
Feed required for 1 kg of weight gain (kg)	6.5	3.5	2.5
Average age of slaughter hogs (months)	11.0	6.0	4.5
% of hogs fed in hogcotes	very low	4.0	90.0
% of sows housed in hogcotes	none	4.0	75.0
Average back fat (cm)	6.2	4.0	3.0
% of gammon and sirloin	32.0	39.0	45.0
"eye" area (cm^2)	18.8	25.6	34.4

Improved performance makes for greater pork output per animal. At present the average world pork production per animal amounts to 53 kg a year. Annual pork production per animal in Czechoslovakia is 102.8 kg, in the USA 101 kg, in East Germany 87.8 kg, in Poland 79.7 kg, Romania 71.6 kg, Bulgaria 62.4 kg, and in Yugoslavia 61.9 kg. In Great Britain the average number of slaughter hogs raised per 1 sow is 14.5 a year, in West Germany 13.6, in France 11.1, in Denmark 10.1, in Italy 8.6 and in the USA 9.4.

From 1930-1950 the growth and intensification of pork production was mainly realized through improvement of management and feeding, increase in swine population and solving of veterinary and sanitary problems. From the beginning of the 1960's the role of concentrated production, improved breeding and feeding has become increasingly important. Modern diets balanced in nutrients allows an average daily increase of more than double that of rations fed in the 1940's. According to the Ministry of Agriculture in the Netherlands, the following alterations in pig diets occurred between 1973-78, percentage of grain and soybean meal in the rations was reduced from 38% to 14% and from 14% to 12.5% (44% crude protein) respectively; the content of cassava, high-gluten corn feed, and wheat processing by-products and wastes, increased from 12% to 34%, from 3% to 8% and from 10% to 13% respectively. 20 years ago the amount of grain imported from the USA (mostly corn) in swine diets exceeded 60%. Breeding, cross breeding and hybridization, aimed at cheaper meat-type hogs, is receiving more and more attention.

In the future a further reduction in the amounts of feed required per unit of weight gain is envisaged, which will be achieved through better feeding (by 46%),

developments in breeding (by 36%) and improved management (by 18%).

In market-economy countries, where the small-farm system is common, the most popular methods to increase productivity in the swine industry is the use of genetic resources and improvement of feeding and management. In the planned economy countries, for instance, Hungary, in addition to the above mentioned factors, use is made of the large scale production, mechanization and automation of technological practices, scientific organizations of production, labor and management.

In Hungary 23% of maternal stock supplying 30.9% of all feeders are placed in industrial-type farms. Pig raising enterprises (such an enterprise is named "complex") are divided into 4 groups according to size of operation - less than 300 sows - 62 complexes (22%), 300-600 sows - 146 (52%), 600-1000 sows - 51 (18%), more than 1000 sows - 21 (8%). 20% of procured pork comes from industrialized farms with a stock of over 750 sows (about 15 thousand feeder hogs a year).

In East Germany industrialized farms in 1977 supplied 30% of procured pork. This percentage is planned to reach 50-55% by 1990.

In Bulgaria industrialized farms produce 27% of pork. By 1980 the pig population in the complexes is supposed to account for 40% of the total pig population. New complexes are intended for the annual fattening of 30-36 thousand pigs each.

In Yugoslavia about 15% of pork comes from large industrialized full-cycle complexes. The capacity of each complex is 10-80 thousand pigs a year. These complexes include their own abbatoirs and mixed feed plants.

Since swine in the USA are raised and fattened almost entirely with concentrates and transportation of animals and meat is less expensive than transportation of feedstuffs, an overwhelming majority of the pig population is concentrated in the corn belt, corn and soyabeans are grown intensively. Five states in this region, Iowa, Illinois, Indiana, Minnesota and Missouri produce 57% of commodity hogs fattened in the country. Regional concentration of pig industry runs parallel with the concentration of the pig population in a limited number of farms. During the 1970's the number of hog farms was reduced by half - from 1.5 million to 750 thousand. The average size of the swine herd in a farm increased from 69.8 pigs in 1964 to 116 pigs in 1974 (by 66%). The average size of the swine herd in 5 leading pork producing states increased to 160 animals (in Iowa - 197, in Illinois - 178, in Indiana - 153). 85% of the farms in these states have herds of 100 animals and more. Three-quarters of the farms in the USA with a pig population exceeding 1.0 thousand animals are situated in these 5 states. However, farms with an annual volume of sales of 200-500 animals play the leading role in the region and nationwide.

In the USA the same farms perform both pig rearing and fattening. Some division of labor is also observed. Part of yelts are reared in Wisconsin, Missouri, Kentucky, and Tennessee and fattened to saleable conditions in Iowa, Indiana, and Illinois. It is expected that by 1985 large animal-specialty farms will become the main type of hog farms (70-75% of the pig population will be housed in buildings) situated on a comparatively limited land area which is, however, sufficient to utilize manure as fertilizer.

In West Germany there are two zones of intensive pork production north-western and southern. Rearing and feeding the greater part of pigs is concentrated in the north-western region of the country due to comparatively low prices for feed grain, formula feed, protein and mineral additives (nearly all the enterprises of mixed feed industry are located in the sea-ports along the north

coast). Hogs are fed mostly feed grain (imported or locally grown) with commercial protein and mineral additives. In the southern region hogs are fed potatoes.

Analysis of economic conditions for pork production in West Germany reveals that at 8% of hog feeding operations daily weight gain amounts to 567 g, at 6% of hog farms to 639 g, and at 86% of farms to 580-629 g. Average daily gain of hogs fed at 55% of hog feeding operations exceed 600 g. It has been found that if a building accommodates more than 200 hogs, average daily gain is lower and mortality rate is higher than in small stalls. However productivity in smaller stalls is also lower.

In Great Britain there was a 50% reduction in the number of hog farms which presently amounts to 30 thousand farms. However, 4000 large hog operations (13% of all hog farms) produced 75% of total volume of commodity product. Farms with over 50 sows, feed over 50% of the total pig population. Average number of feeder hogs per farm increased from 57 to 145. 22% of hogs for slaughter come from operations feeding over 1000 animals a year. Hog farms are mostly located in areas of intensive grain production. It is forecast that by the early 1980's, 75% of the swine industry products will come from 3000 reproduction farms with an average of 200 sows, and from 4000 feeding operations with 1000 feeder hogs per year capacity.

In France, as reported by the Central questionnaire research statistical service of the Ministry of Agriculture in 1977, 70% of swines are kept on farms each having 100 swines or more. 8.4% of pig stock are kept on larger farms each having 1000 animals or more. 38.3% of total number of reproduction farms have up to 20 sows, 52% of the farms have between 20 and 100 sows, and 0.3% of the farms have over 1000 sows. In the early 1970's, the pattern of zonal distribution of pork production changed - volume of pork production in Britanny and Middle Pyrenees considerably increased. In 1978, 39.2% of the total pig population and 41.4% of all sows were in Britanny. Many farms in Britanny have more than 50 sows (11.5%), and 44.6% of all sows are kept on these farms. 75% of all swines in Britanny are kept on farms owning more than 200 animals.

A trend of rapid increase in total number of swines and a reduction in number of hog farms was observed in the Netherlands during the 1960's and 1970's. During 1960-1978 the number of swines increased from 2955 thousand to 9122 thousand animals or, calculated per farm, from 20 to 180 animals. The number of farms declined from 146 thousand to 50.4 thousand. In 1978 there were 1139.2 thousand sows and gilts weighing more than 50 kg. 2.5% of all farms had 40 sows. Of a total of 30229 swine farms, 51% had less than 20 sows per farm, 28% had between 20 and 50 sows, 15% had between 50-100 sows, 5% had between 100-200 sows, and 1% had over 200 sows. At the same time a trend towards specialization and amalgamation of hog farms with abbatoirs and feed industry enterprises was observed. In 1977 in the province of Helderland (accounting for over 25% of country's pig population) there were 15281 hog farms. There was an average of 144 hogs per farm. 400 farms kept sows, averaging 68.4 each.

In Austria and Sweden farms specializing in hog breeding produced 2-5% of the total pork output, in Norway such farms supply 15.7% of the piglets and 37.2% of the matured hogs, in Finland these figures are 25% and 35% respectively. Farms in Sweden, Finland and Norway specializing in hog breeding maintain a stock of between 500-630 swine. In Belgium, some larger herds are kept, accounting for 300 sows and 4000 feeder hogs.

There is a gradual tendency towards larger farms specializing in hog breeding in market-economy countries. As reported by Agricultural Department of

FAO, EEC the following sizes are considered to be optimum for reproduction farms - in Belgium, Denmark and Canada - 100 sows with piglets before weaning, in Italy (preliminary estimate) - 300-360, in Norway, France, West Germany, Sweden and the USA - 30-60 sows. Feeder farms in the Netherlands, Norway, and France are intended for 100-700 feeder hogs a year, in West Germany - 1000 hogs, in Belgium, Great Britain and Denmark - 1000-3000 feeder hogs. Construction of large farms in some market economy countries during the early 1960 has not really developed. While the creation of large farms is still being attempted, due to several reasons (unstable market situation, heavy capital investments, problems of veterinary character) farm capacity does not exceed 15-20 thousand hogs a year.

In the USA specialists from the Agricultural Development Center in Iowa State University studied the efficiency of pork production as dependent on farm size under different systems of management - grazing, semi-open type pig housing and allthe-year-round housing. Efficiency level was determined in terms of pork prime cost (in prices effective in 1970). Research data suggest that hog farms with a capacity of 3500 slaughter-hogs a year are optimum if the grazing system of management is employed and 9000 hogs a year farms are optimum for two other systems of management. A further increase in the scale of production does not reduce cost price of produce. The enlargement of farm size to 750-1000 sows (approximately 13.5 - 18 thousand slaughter-hogs a year) at all-the-year-round housing results in higher costs of manure removal and odor control.

In evaluating the economic efficiency of large hog farms (annual volume of production from 5 thousand hogs to 15 thousand hogs) American farmers mention the following advantages of large-scale production: concentrated supply and marketing, specialization requirements in skilled labor, the necessity of heavy capital investments, a high volume of by-products and wastes and the problem of utilization of those by-products, problems of swine health and reproduction.

In Hungary, according to data from Centre of State Farms, hog farms with a sow population of less than 250 sows are unprofitable and farms with a population of 250-400 sows are characterized by a very moderate level of profitability.

Hungarian specialists are of the opinion that it is not necessary to build farms larger than farms intended for 2-3 thousand sows, due to the difficulties in observing the necessary veterinary and sanitary measures. Another reason is that the time required for construction is too long (over a year).

In a number of countries specialists are prone to consider a sow population of 700-1500 animals (that means 15-30 thousand feeder hogs a year) to be optimum for a hog farm. In market economy countries, for instance in Italy, West Germany, Sweden and the USA, the largest hog enterprises are mostly intended for feeding 10-15-30 thousand hogs a year.

In a number of plan economy countries the establishment of even larger hog farms is considered possible. In Romania there are feeding enterprises intended for nearly 100 thousand hogs a year, in Czechoslovakia for 30-60 thousand hogs and in Yugoslavia for 10-15-30-100 thousand hogs a year.

Enterprises with a complete production cycle are gaining in importance though they are still not so numerous as highly specialized farms. The desire to have their own maternal stock is explained by the benefits this may have - rythmical supply of weaners, lower costs of weaners, piglets better adapted to local conditions, and veterinary reasons.

Modern technology of feeding and management is differentiated by swine sex and age groups. Barren sows are kept in groups on slatted floor without

bedding or in tie-stalls with smooth floors. Barren sows are fed individual concentrated diets twice a day. Milking sows are kept tethered or in stalls with bedding for the piglets. In-pig sows are mostly fed limited rations during the period of pregnancy. Sows during the lactation period receive abundant diets balanced in all nutrients. The practice of feeding dry full-ration mixes or granulated formula feed with top-quality grass or hay meal and protein and mineral-vitamin additives to concentrates is gaining recognition. Four-week old piglets are kept without bedding in controlled microclimate conditions (it is foreseen that piglets will be kept in cages). They are fed ad libitum balanced rations with high nutrient content. Feeder gilts are kept grouped (15-20 animals) in slated floor stalls, and are fed full ration mixes.

During the 1970's, more intensive use of maternal stock was observed. Sow performance depends on fecundity (number of piglets born in a litter), number of litters per year and piglet survival rate. During the 1960's - 1970's sow fecundity virtually did not show any increase. Present mortality rate before weaning exceeds 20%, this high mortality level being very detrimental to the swine industry. In Great Britain losses caused by mortality are estimated at 40 million pounds (current exchange value). However, countries with a developed swine industry achieved an increase in the number of litters per sow per year through shortening of the suckling period. A shortened lactation period (26-28 days) favors a greater pig crop per sow per year (by 40-60%), better utilization of feed in general (by 20-30%) and capital savings through reduction in the housing area required for milking sows (by 12-16%).

In the USA about 60% of pig farms wean piglets at 3-5 weeks of age, in Great Britain and West Germany early weaning is also becoming a widely practiced technique. In Great Britain the sow lactation period is forecast to last only 1-2 days at 3 litters per year by 2000. The introduction of early weaning is especially effective with the simultaneous use of hormonal stimulants for the sow reproductive system. Various methods for estrus and farrowing stimulation and synchronization were elaborated and tested.

3. Sheep Farming

No dramatic changes in world sheep farming were observed during 1969/71 - 1979. According to FAO data, the world sheep population was 1.09 billion, an increase of 1.0% compared to the average in 1969-71. The world production of mutton and goat meat amounted to 7356 thousand tons (0.9% increment). During this period the population of goats increased by 38 million animals (9.4% increment).

In Europe, Asia and Africa the sheep population increased by 4.3%, 16.7% and 6.1% respectively. In North and South America and Oceania the sheep population considerably decreased - by 29.7%, 6.9% and 16.2% respectively (Table 11).

Table 11. World sheep population (million sheep)

Region/Country	1969-71	1973	1979	1979 as % compared to: 1969-71	1979 as % compared to: 1968	Year to year variation %	% of world population 1969-71	% of world population 1979
World total	1075.5	1062.2	1086.6	101.0	102.3	0.10	100.0	100.0
Europe	127.2	130.7	132.7	104.3	101.5	0.47	11.8	12.0
West Europe	93.5	95.2	95.9	102.5	100.7	0.27	8.7	8.7
Great Britain	26.3	29.7	30.0	113.8	100.9	1.53	2.4	2.7
Spain	18.7	15.4	15.5	82.8	100.6	-1.91	1.7	1.4
Italy	8.1	8.7	8.7	107.8	100.4	0.86	0.74	0.8
France	10.0	11.5	11.6	116.4	101.1	1.62	0.9	1.0
West Germany	0.8	1.1	1.1	135.5	100.0	3.094	0.07	0.09
Asia	267.2	301.7	312.2	116.7	103.4	1.85	24.8	28.7
CPR	78.0	90.4	95.4	122.3	105.6	2.47	7.2	8.8
India	40.7	40.7	41.0	100.8	100.7	0.08	3.7	3.8
Iran	32.0	33.6	33.7	105.3	100.2	0.53	2.9	3.0
Turkey	36.4	42.7	43.9	120.4	102.3	2.26	3.4	4.0
Africa	161.4	169.2	171.4	106.1	101.3	0.67	14.9	15.7
Rep. of South Africa	35.5	31.4	31.5	88.5	100.3	-1.27	3.3	2.8
North America	31.0	22.0	21.3	70.3	99.1	-3.00	2.8	1.9
USA	20.5	12.3	12.2	59.6	98.6	-4.48	1.9	1.1
South America	115.2	108.0	103.8	93.1	108.8	-0.76	10.7	10.0
Argentina	42.7	35.5	35.4	82.7	99.7	-1.92	3.9	3.2
Oceania	236.9	193.7	198.6	-83.8	102.5	-1.80	22.6	18.8
Australia	177.5	181.5	135.1	-76.1	102.7	-2.65	16.5	12.4
New Zealand	59.5	62.2	63.5	106.7	102.0	0.74	5.5	5.8

The increase in the sheep population in Europe, Asia and Africa was accompanied by an even greater increase in the output of sheep farming products. The growth in production of mutton and goat meat in Europe, Asia and Africa amounted to 11.3%, 21.1% and 9.0% respectively. New Zealand is the largest producer of lamb among market-economy countries - in 1979 this amounted to 506 thousand tons. The semi-fine-wool/mutton- wool type of sheep represents 98% of the sheep population in the country. Mutton-wool type sheep grazing on rich pastures show very good performance.

In the majority of European countries and in some countries in Asia sheep farming is intended for mutton production. Considerable growth in demand for mutton, especially for young lamb, gave rise to an increase in the population of sheep of the early-maturing meat-wool breeds, characterized by high qality mutton. During recent years the following countries became the largest mutton producers: New Zealand, the People's Republic of China, Australia, India, Turkey, Iran, Great Britain and France. The greatest increase in mutton production from 1969-71 to 1979 was observed in Asian countries (by 8.7-18.8%) and in France (by 39%).

In Europe large mutton producers are Great Britain and France. In Great Britain, despite 13.8% increase in the number of sheep, during the 1970's mutton production did not increase - amounting in 1979 to 220 thousand tons. In France annual rates of mutton production growth (4.3%) outstripped rates of increase in sheep population (1.8%).

In general sheep farming in market-economy and developing countries during the 1970's was characterized by uneven development both in different years and in different countries and continents. Uneven development results from direct dependence of the sheep industry on the market situation and current weather and feed conditions.

3.1. Stock Breeding

In the majority of countries stock breeding is carried out by associations on separate breeds. These associations set standards and requirements the animals of the given breed are to meet, direct and supervise use and testing of tupping rams on performance and progeny, evaluate performance of material stock and determine how to use it. Sheep farming in such countries as Great Britain, France, Australia, New Zealand and some other countries is characterized by the high level of stock breeding in separate breeds and in the sheep industry as a whole. These countries have herds of established structure - parental, breeding and commercial - with different methods and levels of breeding. Use of high-performance breeding stock in commercial sheep farms contributes favorably to the improvement of breeds.

In planned economy countries, stock breeding is carried out on specialized farms under the supervision of research institutes and experimental stations. High levels of stock breeding occur in Bulgaria, East Germany, Romania and other countries.

In countries where sheep farming is wool oriented, stock breeding is aimed at improving traits such as wool clip, yield and fineness. Since wool clip is determined by a number of traits, such criteria as liveweight, conformity, presence of skin folds, etc. are also taken into consideration. In Australia, wool fineness on different parts of the animal and crimp are also taken into consideration, since the degree of crimp has a negative effect on the wool clip.

In mutton-wool type farming, the following traits are considered most important: conformity and general constitution, growth rate and early maturing,

quality and quantity of mutton and wool. In Australia and New Zealand, such traits as wool length, density, fineness and yield are strictly registered and taken into consideration. In East Germany and France, stock breeding farms select and evaluate possibilities for mating animals at 7-10 months of age. Mutton quality is evaluated in terms of dressing percentage and ratio of bone, mutton and fat on a carcass.

Improvement of mutton and wool both in quality and quantity remains the most important problem in sheep farming. In the majority of countries improvements to mutton receives priority since, at present, the main goal of sheep farming to increase the production of mutton, especially young lamb. In this respect, fecundity in most countries is the most important criterion for selection and breeding. New breeds characterized by a greater lamb crop have been developed in Great Britain, the USA and Australia. Use of these breeds for crossing with more common breeds has increased fecundity in sheep farming as a whole. Along with breeding for fecundity, many farms in Hungary, Great Britain, France and the USA employ systems to accelerate lambing to raise the output of lambs. The introduction of regulated lambing has contributed to a more even supply of slaughter animals throughout the year. Estrus synchronization and gonadotropines enable higher fecundity to be achieved, and lots of feeder lambs levelled by age.

3.2. Technology of rearing and feeding sheep

In Australia natural pasture covers a greater part of the agricultural land which is mostly situated in the zone of less than moderate rainfall (375 mm. and less). Since pastures represent the main source of feed a pasture management system has been developed in the country which includes obligatory decision into fenced pasture sections, periodical change of sheep grazing and determination of maximum number of sheep grazed in pastures of different types. Such a pasture management system allows for economy of labor and costs, so long as no herdsmen are needed and sheep are just moved from one section to another. Increased grazing capacity is achieved mainly through exclusion of separate sections from grazing and partially through application of fertilizers, additional sowing and surface improvement. Cultivated pastures situated in zones receiving sufficient rainfall receive a lot of fertilizer, however this area is rather limited. In average years, farmers lay in hay from native haylands, but in years of drought, lack of feed sometimes results in high sheep mortality. In years with more favorable conditions, farmers gradually restore their flocks.

Droughts resulting in considerable declines in the sheep populations occur periodically in Argentina and Uruguay. In the USA during the 1970, the sheep population dropped dramatically, by 8.3 million sheep or 40.4%. The main cause for this decrease was the reduction in areas of pasture land as a result of plowing for growing crops and a drop in pasture land productiveness caused by free (without fencing) and disorderly exploitation. High prices for the use of pastures and great damage due to beasts of prey also contributed to a considerable decline in the sheep population in the western states which are the major areas of grazed sheep farming.

In Asia and Africa an extensive grazing system also prevails. In Asia the growth in the number of sheep is comparatively stable, however, low productiveness of pasture considerably restrains improvement of sheep performance. Generally the grazing system allows the use of vast territories unfit for other farm animals to produce mutton and wool without additional feed costs and with insignificant labor expenditure. However, a high degree of dependence on weather conditions, and uneven conditions of feeding and management do not

guarantee the stable develop- ment of sheep farming.

In the mountainous regions and foothills of Europe (in Great Britain, Italy, France and other countries) sheep receive creep feeding (additional roughage or concentrates) during periods of insufficient amounts of feed at pasture. In other countries (Bulgaria, Romania, Iceland) a combination of grazing and box placement of sheep is common. Sheep graze from spring till fall; in fall and in winter they are placed in boxes and fed full-value diets. In the mountainous regions of Great Britain (Scotland) in recent years farmers started keeping ewes in boxes for 2-2.5 months (the last month of pregnancy and 1.5 months of lactation). This system allows the increase of ewe fecundity and lamb crop, allows 20-27 sheep to graze per hectare of grassland and contributes to greater productivity of pasture.

Under the soft and humid climatic conditions existing in Denmark, the Netherlands, the plains of Great Britain and New Zealand, sheep farming is based on cultivated perennial pasture with a grazing rate of 17-25 sheep per hectare. Fencing and regular improvement result in good sheep performance and insignificant labor expenditure. In recent years studies have been made in the effectiveness of additional creep feeding under conditions of deficient plant stand in dry summers.

In some states in the USA, and in regions of intensive crop farming in France, all sheep are fully kept in boxes which allows for a considerable increase in sheep population per hectare of land. In summer high-yielding fodder crops are sown (corn, ryegrass, vetch and oat mixes), in winter sheep are fed hay and silage. In the last month of pregnancy and during lactation ewes are fed an additional 0.3-0.5 kg of grain.

Such a system of management necessitates mechanization of feed preparation and distribution. On small farms in market economy countries, which have on average 300-500 ewes, bunker (hopper type) self-feeders (for concentrates) and mobile feed distributors (for roughage and succulants) are used. Chopped roughage is fed to avoid losses. Such intensive sheep management systems allow high lamb crops to be achieved, and accelerated lambing (8 month intervals). As a result lamb crops per 100 ewes accounts for 170-175 lambs. Comparison of the three management systems: combined keeping in boxes and grazing (1 lambing), 3 lambings during 2 years, and keeping in boxes with 3 lambings in 2 years, performed by the French association of sheep breeders reveals that the system of management in boxes and accelerated lambing results in the highest profits - 2403 francs per hectare of feeding area.

Fecund breeds and programs of accelerated lambing are efficient only under conditions of intensive sheep farming and provided maternal stock and replacements receive full-value feeding. Before mating, ewes are moved to better pasture or receive improved diets, during the second half of the gestation period ewes receive additional creep feed. Pregnant ewes are fed hay, dry beet press, silage made of fine-chopped corn, grass hay, meal, and concentrates. Lambs start receiving hay and formula feed creep feed from 2 weeks of age. Lambs are weaned at 60 days, provided they were fed adequate full-value rations. After weaning lambs are fed diets consisting of corn, dried molasses, alfalfa hay, and mineral additives.

Lambs from multiple births are fed artificially. Whole milk replacer in combination with other feedstuffs provides full value feeding. Artificial rearing is widely practiced in nearly all the countries in Europe and in regions of intensive crop farming in the USA.

In the majority of European countries young animals are fed until they are

100-120 days old and have reached a liveweight of 40-45 kg. Balanced rations guarantee approximately 200 g of daily gain. The same feedstuffs are fed - roughage, silage, grain and grain by-products. In areas of intensive crop farming in the USA, lambs are fed to 49-50 kg liveweight, with finisher rations containing 75-85% concentrates. Young feeder stock is purchased in western states and fed in large feedlots (30-40 thousand feeders). Feed preparation and distribution is mechanized.

In the planned economy countries during the 1970's there was a steady growth in sheep farming (Table 12) and an increase in the production of mutton and wool. By early 1979 the total number of sheep in the COMECON countries amounted to 49.2 million, an increase of 11% over 1970. Mutton production increased by 14.1%, and amounted to 362.2 thousand tons in 1978.

The highest rates of growth in sheep farming were in Bulgaria, Mongolia and Romania. In Mongolia, mutton production increased by 3.6%. In Romania, the sheep population increased 12.9%, mutton production 15.4% and wool production 20.8%. In East Germany and Poland the sheep population increased by 22.9% and 39.1%, while wool production increased by 59.4% and 49.4% respectively. In East Germany the increment in mutton production reached 44.9%.

In the mountain regions and highlands of Bulgaria, Hungary and Romania, where vast areas of meadow and range are situated, the pasture-stall system of sheep management is practiced. In summer the sheep are in fenced pastures (without a herdsman) or graze free. All young replacements and young lambs for feeding, graze on pasture. In winter animals are placed in boxes and receive rationed feeding. Mixtures of roughage, succulants and concentrates are widely employed in feeding. Part of the concentrates, as far as possible, is replaced by products of processing fruits, such as grape and sugar beet.

In regions of intensive crop farming in Bulgaria, East Germany, Poland and Romania keeping sheep in stables is combined with grazing in perennial cultivated pastures (sometimes with full absence of natural grassland). Sheep do not graze in fodder crop plantings. Grass or fodder crops are cut and transported to the feeding area. Transportation of grass or fodder crops to the feeding area helps adequate feeding and makes for a higher coefficient of land use. Closed and semi-closed feeding areas with mechanized feed distribution are widely used. In southern Romania the number of sheep per hectare of land goes up to 50-60. In East Germany the practice of grazing on cereal stabble and in vegetable fields after harvesting is widely practiced.

Intensive systems of sheep management widely employ artificial rearing, early weaning and accelerated feeding.

In Bulgaria, Hungary and Romania artificial lamb rearing is combined with milking of ewes. In Romania young animals are artificially raised for slaughter. Lambs are usually weaned 24-48 hours after birth and reared to 40 days of age in specially equipped premises. Full-ration feed mixes are fed in addition to whole milk replacer. Artificial lamb rearing contributes to an increase in the crop of youngsters, in milk yield and allows for early mating in programs of accelerated lambing.

In Bulgaria this method of rearing young animals resulted in an increase in the milk yield of 17 litres per ewe. Bulgarian sheep breeders wean lambs at 20-22 and 30-35 days of age. Young stock is fed full-ration feed mixes containing alfalfa meal, fish meal, concentrates and mineral additives. At 90 days of age an average daily gain of 200-260 g results in average liveweight of 25-30 kg. Both lambs for feeding and lambs intended for further raising are weaned at 30-35 days. In Bulgaria feeding enterprises are intended for 6-10 thousand feeders, in Romania--for 30 thousand feeders or more.

Table 12. COMECON countries: Sheep population by end of year, thousand sheep

Country	Sheep				Goats			
	1970	1977	1978	1978 as % of 1970	1970	1977	1978	1978 as % of 1970
Bulgaria	9678	10144	10105	104.4	335	326	374	11.6
Hungary	2316	2619	2864	123.7	80	11	11.6	14.5
East Germany	1598	1927	1965	123.0	135	34	29	21.5
Mongolia	13312	13430	14153	106.3	4204	4411	4705	111.9
Poland	2661	3593	3704	139.2	127	...	...	...
Romania	13818	14463	15612	113.0	536	404	412	76.9
Czechoslovakia	981	841	865	88.2	285	82.9	71.7	25.2

Feeders are fed feed mixes, usually ad librium. Feed mixes include 45-60% of roughage, silage made of corn with cobs, chopped beets and concentrates. Feeding operation have feed preparing plants where feed is chopped and steam-treated with addition of water solution of molasses or urea. Preparation and distribution of feed mixes are fully mechanized. These techniques result in a high average daily gain and the consumption of 3.5-3.8 feed units per 1 kg of weight gain.

In recent years and currently in planned economy countries in Europe, industrial-type technology of sheep management is being introduced on the basis of concentration and specialization. The technology is based on the establishment of sufficient feed-base and enlarged farms with complex mechanization of basic processes. Such enterprises also use (with regard for natural and climatic conditions) grazing in mountain and highland pasture as a source for providing sheep with the cheapest possible feed. Introduction of new technologies make for better animal performance and higher profitability. In Bulgaria (1975 data) average wool clip per sheep in such complexes (4.52 kg) exceeds average nationwide wool clip by 0.7 kg (or by 18.3%). Mutton production per ewe amounted to 34.6 kg which is 6.7 kg (24%) more than average in the country. In Romania the level of profitability of sheep farming in complexes exceeds average for common-type farms by 7-12%.

4. Poultry Industry

4.1. Stock Breeding

Virtually all broilers and turkeys raised for meat (and to a considerable extent ducks) are hybrids of 2, 3 and 4 lines. This line of stock breeding been taken due to the difficulty of combining such contradicting traits as high rate of growth and high life-expectancy, or heavy bodyweight and high egg producing ability since these traits are negatively correlated. That is why birds characterized by high egg producing ability are used as maternal stock and birds with high rates of growth as paternal stock. Chicks resulting from crossing go for feeding (so called commercial hybrids), for reproduction only parental forms are used.

Crosses used in commercial poultry farming are not breeds but highly specialized groups of meat-type poultry. The number of crosses used in the broiler industry is not great: in chicken farming: 12-15, in duck breeding: 6-8, in turkey breeding: 14-17. In the USA nearly 90% of broilers belong to crosses between Arbor-Acres and Cobb, in Great Britain over 75% of the broiler population belong to crosses between Ross and Marshall. In France, the Grimot firm breeds virtually all perching ducks. Only large firms can afford such a limited number of crosses used and fast introduction of high-performance poultry replacing older less productive crosses.

In early times of broiler industry stock breeding was mostly aimed increasing bodyweight before slaughtering age, more efficient feed conversion and an increased survival rate. Currently the main emphasis is placed on shortening the growing period (without sizable decrease in bodyweight), more efficient feed conversion and improved reproduction of the parental stock. The quality of poultry is gaining importance for two reasons, a glut on the markets of the majority of countries and the levelled out in performance and quality of the best crosses.

4.2. Technology of rearing and feeding

Production of poultry meat during the 1960's and 1970's showed high rates of growth in all countries. World poultry meat output in 1979 amounted to 28 million tons, or exceeded the 1969-71 level by more that 1.5 times. The increase in production resulted from the growth in the number of poultry and improvement in performance. The number of broilers in the USA during the period 1960 to 1978 increased from 1.8 to 3.5 billion; in France from 32 million to 453 million; in Great Britain from 30 million to 391 million; and in West Germany from 15 million to 250 million. In 1960 in developed market economy countries, the average slaughter weight of a broiler was 1.4 kg, the feed period lasted 63-70 days, and feed consumption per kg of weight gained was 3.7 kg. By 1978 these figures changed and were 1.7 kg, 49-56 days and 2.5 kg, respectively.

During the 1960's and 1970's, expenditure for feed per kg of weight gained decreased: for turkey production from 5.6 kg to 3.6 kg; for duck production from 6.0 kg to 4.0 kg; and for goose production from 8.0 kg to 5.0 kg.

The leading world poultry meat producers are the USA, Japan, France, Italy, Brazil, Great Britain, and Spain. Broilers account for 92.5% of all poultry raised in Brazil, 89% in Spain, 78% in the USA, 73.5% in Great Britain and 62.3% in France. Second in importance are turkeys, followed by ducks and geese.

The USA has the most developed broiler industry, producing approximately 25% of the world's broilers. The broiler industry in the USA, Great Britain, West Germany and, to a lesser extent in France, were, at an early stage, soon controlled by large firms specializing mostly in formula feed and food industry. These firms control all the key aspects of the broiler industry, its initial stages, production of formula feed, rearing of breeders, production of hybrid eggs (broiler industry is based on use of hybrid birds) and hatching, as well as the final stages, slaughtering, packing and marketing. Feeding of broilers is only formally under the control of independent farmers, since farmers perform contracted work under the supervision of special services of large farms (in the USA, farmers produce about 80% of broilers, in Great Britain about 60%).

A good example of agro-industrial complexes and modern organizational structure and managerial system is Wilson-Lauren Poultry Company Rederalsburg, Md) The firm produces about 100 million broilers a year. AIC comprises 5 formula feed plants, 5 poultry processing plants, 5 hatcheries and 4 reproduction farms (production of breeder and hybrid stock). The firm has five branches located in Georgia, Arkansas, North Carolina, Delaware and Virginia. Each branch manager controls various departments and their heads, such as purchasing, and production departments, the poultry processing plant, veterinary surgeon, nutritionalist, and the accounts department. Each branch has contracts with approximately 300 farms and organizes the production. It provides the farms with day-old chicks, drugs and formula feed. The farmer must supply the housing, and equipment, etc. As a rule he must raise 4 - 4.5 lots of chickens per year and reach certain productivity indices. In the USA, for instance, this would typically be 49-56 days of feeding to reach 1.5 - 1.8 bodyweight, feed consumption 2-2.2 kg per kg of weight gain and 3-5% mortality rate.

Broiler farms are located not further than 50 km from a processing plant. A processing plant capacity is 500 thousand broilers a week, one-shift work. The loading and transporting of broilers from the farms to the processing plant are scheduled and carried out by company.

A formula feed factory produces mixed feed only for broilers, dry granules made according to four recipes. Annual capacity of the formula feed factory is 100 thousand tons. The company also has an experimental farm for 40 thousand

birds. The farm is designed to study problems of how to increase efficiency of production. The marketing system is mainly based on consumer demands. In the USA the number of firms engaged in the poultry meat industry (broiler industry and turkey production) is declining. During 1972-1977 the number of broiler firms in the USA decreased from 227 to 169. In 1977 the 20 largest firms produced 55% of all broiler production, compared to 43% in 1972. In 1972 there were 80 such enterprises and in 1977, 95. In 1977 the 8 largest firms (56 enterprises) produced 33% of broiler production, 4 firms (26 enterprises) 20% of broiler production. In 1978 60 large companies produced 67.7 million broilers a week, one firm named Gold Keest produced over 5 million, Holy Farms produced 4.7-5.2 million, Tyson Foods produced over 4 million, while 8 other firms produced over 2 million broilers a week.

During 1972-1977 the number of turkey-specialty firms declined from 163 to 113. The share of 20 leading firms in supplies of turkey meat increased from 72% to 86%.

The usual capacity of a broiler farm in the USA is 100-300 thousand broilers a year. The limiting factor is the labor consuming character of broiler production. A farmer can handle not more than 300 thousand broilers a year while hired labor is virtually not used.

Zonal concentration: In the majority of countries the poultry meat industry is characterized by territorial (zonal) concentration In the USA over 88% of the broiler population is concentrated in 3 regions - south-east central region, south-west central region and the South-Atlantic states. The broiler population in 9 states (Delaware, Maryland, North Carolina, Texas, Georgia, Alabama, Mississippi, Arkansas and California) accounted for over 80%, while the broiler population in four of these states (Georgia, North Carolina, Alabama and Arkansas) accounted for about 54% of the total broiler population. At the same time, in 20 states, broilers are virtually not raised while the broiler population in 13 other states accounts for only 3.5% of the total broiler population (Table 13).

The distribution of broiler production in the USA is determined by such factors as the warm and mild climate in the south, south-east and south-west regions and by the available cheap labor. Proximity to markets (where many workers move to cities and land prices are high) and proximity to sources of feed in this case are not of great importance.

A warm climate characterized by minimum temperature variations during the day is one of the most important factors favoring development of the poultry industry. Under such conditions farms may use lighter poultry houses, so the consumption of fuel and maintenance feed is reduced. Respiratory diseases are less likely which results in lower mortality during rearing. In addition to that, southern states enjoy resources of cheap labor, especially after the considerable reduction in acreages under cotton. The rapid expansion of the broiler industry into the heart of the southern region, where farm wage rates are lower, is indicative of the importance of wage rates as a factor of broiler production.

In the south-east region broiler production is the least costly. In Iowa broiler cost price is 77% higher and in New York State 81% higher than in south-eastern states. Such a difference, even when supplemented with relatively low procurement prices, makes farms located in suburban areas and areas where concentrated feed is produced unable to sustain competition. The lowest prime cost is observed in regions with a warm climate despite feed being brought from a distance of 1500 km and more, and produce being marketed in places 1000-2000 km away.

Table 14 presents data on economic efficiency of poultry meat production in the USA.

Table 13. The USA: Broiler Population

State	1970		1977		1977 as % of 1970
	million broilers	%	million broilers	%	
Maine	76.1	2.5	86.9	2.5	114.3
Pennsylvania	53.7	1.8	88.1	2.6	164.2
Ohio	9.5	0.3	19.4	0.6	203.2
Indiana	13.7	0.4	13.6	0.4	99.4
Wisconsin	15.0	0.5	10.9	0.3	72.6
Minnesota	10.9	0.4	14.2	0.4	129.6
Delaware	135.6	4.5	156.1	4.6	115.1
Maryland	187.1	6.3	198.5	5.8	106.1
Virginia	69.1	2.3	98.0	2.9	141.9
North Carolina	308.6	10.3	339.3	9.97	109.9
South Carolina	27.7	0.9	34.5	1.0	124.6
Georgia	453.9	15.2	485.9	14.3	107.0
Florida	46.6	1.5	75.7	2.2	162.6
Tennessee	46.2	1.5	48.9	1.4	105.7
Alabama	376.1	12.8	428.1	12.6	113.8
Mississippi	247.8	8.3	255.8	7.5	103.2
Arkansas	450.8	13.1	569.6	16.9	126.3
Oklahoma	20.0	0.7	29.3	0.9	146.5
Texas	185.5	6.2	185.3	5.4	99.9
Washington	21.1	0.7	16.8	0.5	79.8
Oregon	24.8	0.8	15.6	0.4	62.9
California	85.9	2.9	112.5	3.3	130.9
Luisiana	51.1	1.7	63.6	1.9	124.5
TOTAL:	2986.8	100.0	3400.0	100.0	118.8

Table 14. The USA: Some indices of broiler production efficiency

Year	Labour expenditure per 1000 broilers, man hours	Average body weight of slaughter broilers	Meat production per 1 man-hour kg
1940	250	1.309	5.2
1950	100	1.395	14.0
1955	48	1.391	29.0
1960	34	1.518	44.6
1965	26	1.576	60.6
1970	14	1.640	117.1
1975	7	1.703	243.3
1978	5	1.758	351.6

Territorial concentration of poultry meat production is observed in other countries as well (in Great Britain, Italy, France, West Germany, etc.). In West Germany in 1977, the overwhelming majority of broilers were produced in Lower Saxony and Bremen (50.6% of the population), Bavaria (20.2%) and Northern Rhine-Westphalia (12.7%).

The high level of poultry meat production in a number of foreign countries results from a complex solution of the main problems - genetic improvement of poultry stock, improved management systems, the creation of a formula feed industry, common technology of eggs and poultry meat production.

Intensification of poultry meat production pre-supposes the introduction of advanced progressive poultry management systems. Management technology of poultry meat production is developing in two directions - on-floor system of management improvement and the introduction and study of better management of caged poultry.

Caged poultry farming is becoming increasingly popular. It maximizes available space, eliminates the need for bedding and requires less personnel to manage it. Additionally the birds require less feed per kilo body weight gained than on-floor managed poultry. Caged poultry farming also has certain disadvantages, an increased number of broilers with bruised or deformed carcasses, increased body fat, weaker legs and a higher mortality rate.

These disadvantages have in turn encouraged more interest in improving on-floor management systems. One method has been to increase the number of birds per unit area, more space being achieved by introducing wooden perches into the poultry batteries. A research centre in Edinburgh has developed and sells technology for raising on-floor broilers using wooden perches ("O" shaped butt-end). The length of the perches correspond to the length of the battery run. Perches are placed 125 cm apart, 30 cm above the bedding. Use of perches allows for an increased stocking capacity (up to 25 birds per square meter of floor space), and reduced heating costs. Mounting of perches is relatively inexpensive, but it is necessary to have more feed and drinking bowls and ventilation has to be improved.

Over stocking results in reduced bodyweight and only a slight increase in meat production per unit of floor space.

Investigations into the possibilities of re-using bedding material have been started since bedding is both scarce and expensive. Studies carried out by the Veterinary Board of the Veterinary College in Hyderabad (India) suggest that repeated use of bedding does not involve increase in feed costs, higher mortality rate or decreased bodyweight. Bedding used repeatedly is characterized by higher moisture content (by 0.05- 4.05%) and higher acidity (pH 7.3-7.5 compared to 6.2), and is contaminated with aerobic bacteria and fungi. However, sun-drying lowers fungi contamination. Melathion residues have not been isolated from broiler meat.

In Great Britain, Winstone Fields Farm started repeated use of bedding (wood shavings) in 1974. Used bedding is bull-dozered away from the poultry house and collected in the yard in a compost heap. Before accommodating a new lot of chicks two- fifths of the broiler house must be covered with new bedding. Newcomer chicks are placed under the covered section and screened from the rest of the poultry house with plastic sheeting. The other three-fifths of the poultry house area is covered with used bedding kept on compost heap for 10 weeks. 2-4 week-old broilers are placed on re-used bedding. The thickness of the bedding layer is 7.5-10.2 cm. Repeated use of bedding (for 2.5 years) did not result in diseases or lower productivity. Some reduction of E.cali, Cl.welehii

contamination and salmonellae contamination was observed, probably due to exzothernal reactions during composting. In rainy weather the wet layer of stored bedding does not exceed 2.5-10 cm in thickness. This layer is removed before putting bedding into a poultry house. Analysis reveals that repeated use of bedding offers 25-56% economy of bedding material.

An original system of broiler feeding was developed at the college of agriculture in the University of Georgia (USA). The system is based on on-floor management without bedding (on electrically heated plates). This maintains the desired temperature and dries droppings at the same time. Good heat insulation and high heat-holding capacity of plates eliminate a drastic reduction in temperature even after the heating is switched off. Broilers are placed in section 10 x 46 m, 6000 broilers in each section. Birds feel calm and comfortable due to reduced-intensity lighting (white and dark blue light). Ventilation and floor-heating allow the control and adjustment of the humidity and ammonia content in the atmosphere, and, by virtue of this, eliminates the main causes of bruising. Droppings are removed once after feeding is completed. Mini-bulldozers and special conveyers are used to remove droppings. The conveyer, located in the middle of the section is also used for poultry transportation.

Special mobile panels are used to catch broilers. These panels, located along edges of sections, move to meet each other and push broilers to the conveyer. If necessary the panels may be raised above broilers and returned back. Only 5 persons are engaged in the catching compared to 9-12 people involved in catching before this system was introduced. Another advantage is that the number of injured birds is reduced by half. The system of management described above reduces the veterinary interval and gives 6 cycles a year instead of 4.5 cycles, and reduces losses caused by lower grade of carcass, diseases etc. Mechanization and electrification allow for a reduction in manual labor and saves 3 cents per broiler compared to the common-type on-floor management.

Commercial broiler production in the majority of countries is based on broiler growing on deep bedding. However, cage manage- ment of meat-type poultry is not excluded. In 1970 in Belgium 1 million broilers were fed in cages. Feeding broilers in cages showed positive results in the USA, Canada, Great Britain, the Netherlands, Italy, West Germany and other countries. The Avideza Firm (Spain) annually feeds over 12 million broilers in cages. In Japan and Israel about 50% of broilers are fed in cages.

The main disadvantages of growing broilers in cages are the increased number of birds with bruises and more frequent perosis (non-infectious disease characterized by weakened ligaments and tendons of extremities resulting in free displacement of joints). New cages (consisting of containers) designed by the Quality Equipment Firm (Great Britain) reduce disease frequency to the same as that for on-floor management. The size of a cage for 16 broilers is 974 cm x 525 cm x 298 cm which corresponds to a stocking rate of 49 broilers per 1 m2 of floor space in a poultry house. Battery cages are of 4-tier design, equipped with an automatic system for the removal of droppings and removable feed and water cups. The floor is covered with soft plastic. Trials performed by the Lomann firm at one of its farms (about 1 million broilers) show that the frequency of perosis, if broilers are raised in such cages, increases insignificantly (by 2-4%) compared to on-floor management. As for bruising - no significant difference was observed. There were no mathematically significant differences in body- weight at 41, 48, 55, and 62 days of age. Fed consumption per 1 kg of weight gain of broilers in cages grown to 41-48 days of age was lower, by 55-62 days of age the difference in feed expenditure levelled out.

The creation of a formula feed industry, improvement of feed quality and elaboration of balanced rations played a most important role in the intensification of world poultry production.

In Common Market countries in 1978 production of formula feed for poultry amounted to (million tons): 4.4 in France, 3.5 in Italy, 3.4 in Great Britain, 3.2 in West Germany, 2.5 in the Netherlands, 0.5 in Denmark and 0.2 in Ireland. These countries produce 26.5% of all formula feed (18.9 million tons compared to a total of 71.4 million tons).

The use of formula feed along with the use of hybrids resulted in a considerable reduction of amounts of feed consumed for egg production. Feed consumption per 12 eggs in the USA presently amounts to 1.6-1.8 kg compared to 2.7-3.2 kg in the 1950's.

In 1923 in the USA typical figures were: 16 weeks of feeding, 0.997 kg bodyweight of slaughter broilers, 4.7 kg feed consumption per 1 kg of weight gain and 82% survival rate. In 1953 these figures were respectively: 10.5 weeks, 1.450 kg, 3 kg, and 97.3%. Presently, these figures are: 6.5-7 weeks, 1.7-1.8 kg, 1.8-1.9 kg and 98.5%. Poultry performance in Great Britain, Italy, the Netherlands, and France also considerably improved.

The following figures are forecast for 2000: 36-40 days feeding period, 1.6-1.8 kg liveweight of slaughter broilers, 1.6-1.7 kg feed consumption per 1 kg of weight gain and 98% survival rate.

A high degree of specialization and the creation of large complexes demand the use of proper technology. At present, commercial production of poultry meat is based on growing on thick bedding and, partially, in cages (broilers). As for turkey and ducks, semi-intensive systems of management with a limited run (grass or water) are employed.

In the USA about 30 thousand farms specialize in growing broilers. A farm belonging to the Leyton family (150 thousand broilers a year) is typical for the USA. The farm observes standard technology of production. There are two poultry houses, one of them is old, 111m x 12m, its iron roof is mounted on poles at the height of 3.5 m above ground. Plastic screens go along the walls, these screens may be raised or lowered to adjust the air flow. Inside there are 350 metal feed cups filled in the morning and in the evening. There are 60 metal, 2.5 meter drinking troughs. Each trough is filled from a hose connected to it. A special device automatically overlaps hoses when the troughs are full. There are 20 suspended gas brooders arranged along the poultry house. The temperature under the brooder is adjusted by moving it up and down from maximum (lower position) to minimum (upper position).

The second poultry house (new) is 93 m x 15 m. It is located parallel to the old one, 25 meters apart. Feed is automatically transported into 4 feed troughs arranged along the poultry house. When the automatic feed distributor is turned on, computer- formulated feed mix (supplied from an integrator firm) comes in batches into troughs from the feed-receiving bunker situated inside the building. Feeding normally lasts 35-40 minutes.

In each house the Leytons keep 15 thousand chicks, that makes a total of 30 thousand at a time. Chicks are fed from one day to 8 weeks of age, when they reach 1.8 kg bodyweight. The broilers raised belong to the integrator farm, McCartey State Pride Farms, Inc. The firm provides farmers with 1-day old, vaccinated chicks, feed, and a special team of people who perform catching and transportation. In addition to that, a firm representative visits the Leytons 1-2 times a week to advise and direct the work.

The team which performs the catching comes at night (or if called by a farmer). They catch birds in the dark or under a weak red light so as not to disturb the birds which are half- asleep. The broilers are transported in cages in a special truck. The broilers go to the nearest poultry processing enterprise (usually 25-30 km from the farm) and are taken immediately to the slaughter department.

After mechanized (or hand) killing with electrical stunning (or without stunning), broilers are automatically plucked and arrive at a conveyer with heads and feet cut off. Skilled workers quickly dissect the carcasses to be examined by USDA inspectors. All the noticed defective parts are cut off. After dissection of the liver, stomach muscle etc., the next inspector sends the carcass to a refrigerator. The interval between killing and entering the refrigerator lasts only 20 minutes.

After cooling and grading the carcasses are automatically sorted by weight. Then they go for packing as whole carcasses or as parts, or they are processed into sausages, canned food etc. Wastes and by-products to to a special enterprise to be processed into feed - feather or meat and bone meal, canned food for animal or pet food, etc.