

Experience and perspectives of cross-breeding in milk cattle husbandry

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The purpose. On the basis of world experience to show the role of cross-breeding for justification of mercantilely attractive alternatives of crossing in programs of selection of domestic dairy breeds of cattle. **Methods.** Historical method, use of analytically compared empirical data gained by experimenters worldwide concerning effect of crossing dairy breeds. **Results.** Recommendations are given for further improvement by selection method owing to use of crosses of domestic breeds (Ukrainian red-motley and Ukrainian blackmotley milk). **Conclusions.** Rigid market conditions demand quick search and justification of more efficient programs of selection in cattle husbandry. The availability of crossing genetic differences at dairy breeds, their mating allows to gain genetic improvement of economically important selection tags, development of economically important productive tags of animals of Golshtin breed using method of mating with “contrasting” breeds. The main effect at mating Golshtin breed with series of European breeds is observed to tags of reconstituting and survival rate of calves. One of directions of such development of domestic dairy breeds is searching optimum alternatives of their mating with the following breeds: Monbelyard, Red Swedish, Red Scandinavian, Shvits, and Jersei.

Key words: *cross-breeding, dairy breeds of cattle, selection, mating, reconstituting, productive longevity.*

Methods of pure breeding or crossing are constantly used at the programs of improving of cattle dairy breeds of different countries (S.Yu. Ruban, 1985; M.V. Zubets, Yu.M. Karasyk, V.P. Burkat et al., 1990; Yu.F. Melnyck, V.P. Burkat, M.I. Bashchenko et al., 2003; V.P. Burkat, M.Ya. Yefimenko, 2003, P.M. VanRaden, A.H. Sanders, 2003; B. Cassel, Y. Allister, 2009; B. Heins, L. Hansen, F. Seykora, 2007.).

Considering breed as open and dynamic system, one can quote citation, made by outstanding Ukrainian scientists at the end of 90-ies of last century and which is actual: «It is unacceptable to ignore the experience of specialists of Great Britain, Netherlands, Germany, **Switzerland**, which threw away patriarchal ambitions and in the most wide way use the best gene pool of dairy breeds from the North America» (M.V. Zubets, V.P. Burkat, 1997). Time is fast flowing and already practical breeders of the North America countries use material of such European countries as Germany, Austria, Swiss, Finland and so on.

Evaluating peculiarities of scientific and industrial cooperation structure at post-soviet space and abroad (Azbel M., 1991) one can conclude, that mobility, and the speed of response to severe market society challenges – the main condition of scientific survival.

Ukrainian Red-and-White Dairy breed – the first breed, which became a result of continued creative scientific and practical work of animal-breeding branch specialists (Yu.F. Melnik, V.P. Burkat, M.I. Bashchenko et al., 2003).

The breed was tested and officially approved as the first native specialized dairy with the Scientific-technical council of the Ministry of Agriculture and Food of Ukraine in 1992. The breed is created, using the method of reproductive crossing of Simmental breed (maternal base) with Red Holstein (USA, Canada), and (south-eastern innerbreed type) as paternal breeds were used sires of Montbeliard (France) and Ayrshire (Finland) breeds.

Grounding the schemes of improving of double directed Simmental breed as improving were chosen Montbeliard, Ayrshire, Red Holsten (M.V. Zubets, Yu.M. Karasyk, V.P. Burkat et al., 1990). Ukrainian Black-and White Dairy breed was recognized as selection achievement in 1995 and approved with the order of the Minister of Agriculture and Food of Ukraine on April, 26 of 1996 under № 127. The total number of this breed cows was 1,7mln, and a share over all farms – 35 %. Only in base (breeding) farms productivity of 6176 heifers was 5558 kg of milk with fat content 3,86 % (V.P. Burkat, M.Ya. Yefimenko, 2003).

Maternal base of breed became Simmental and Holland breeds, and preferably pure Holstein sires. Genotype of these animals contained 62,5-75 % and more heredity of improving Holstein breed. For the last years in Ukraine there is tendency to cows number increasing in controlled (breeding) part, which accounts for the last years within 129 th. of cows, where Holsteins – 13 % of total number (Table 1). Sharp increasing of Swiss breed number is caused by strong dairy complex «Yekaterinoslavskiy» creation in Dnipropetrovsk region, where near 800 heifers were imported from abroad.

Certain effect of crossing with Holstein by yield during native dairy breeds creation and dumping at the market of sperm production deliveries resulted in absorbing crossing and along with it display of certain problems of new-created native breeds, which were linked with lowering of reproductive ability, productive longevity, product quality. This problem can be illustrated as well by change of selection evaluative strategies of Holstein breed first-hand in USA.

1. Cows number of different dairy breeds in dairy cattle breeding of Ukraine for the number of years.

Breed	Number of cows, ones	
	2013	2014
Ukrainian Black-and-White Dairy	62690	69328
Ukrainian Red-and-White Dairy	26395	27672
Holstein	11928	16286
Ukrainian Red Dairy	6665	6334
Simmental	2230	3623
Red Polish	506	294
Red Steppe	3244	2291
Ayrshire	539	513
Angler	39	248
Lebedyn	947	713
Swiss	100	1085
Ukrainian Brown Dairy	350	350
Whiteheaded Ukrainian	300	300
Total	115933	129037

So, analysis of priorities evolution concerning selection directions of USA Holstein cattle during 1971-2014 demonstrates, that there is happened not only number of sire selection traits in-

creasing, but as well economically significant matching priorities changing (Table 2). For example, in 1971 evaluation index consisted of 52 % yield value and 48 % milk fat, and now economic value on yield is negative. At the same time significantly increased economic weight of such fitness traits as productive longevity, somatic cell score, type, reproductive traits (Table 2).

2. Change of relative economic weight (%) of selection traits in Holstein cattle breeding value evaluation indices (P.M. VanRaden, J. B. Cole, 2014)

Traits	Index and year of its introduction						
	PD\$ (1971)	NM\$ (1994)	NM\$ (2000)	NM\$ (2003)	NM\$ (2006)	NM\$ (2010)	NM\$ (2014)
Yield	52	6	5	0	0	0	-1
Milk fat	48	25	21	22	23	19	22
Milk protein		43	36	33	23	16	20
Productive longevity		20	14	11	17	22	19
Somatic cell score		-6	-9	-9	-9	-10	-7
Summarized udder score			7	7	6	7	8
Summarized limbs score			4	4	3	4	3
Summarized score on body size			-4	-3	-4	-6	-5
Daughters' level of fertility				7	9	11	7
Cows' level of fertility							2
Heifers' fertility level							1
Calving ability					6	5	5

Notes: PD\$ - predicted difference, dollars

NM\$ - net merit, dollars

However, existing certain differences in breeding value evaluation systems of different countries couldn't but make genetic difference between breeds.

Analysis of production traits of major commercial dairy breeds in data of International Committee on Animal Records (ICAR) allow to find ones, which differs significantly on the level of development of main traits from popular in the world Holstein breed (Table 3).

3. Production of cows of main breeds at certain countries on data of breeding records in 2013 (www.icar.org/wp-content/uploads/2015/08/cow_survey_Publication_2012-2013.)

№ /n	Country	Breed	Number of lactations	Milk production for 305 days	Percent, %		Calving interval
					fat	protein	
1	USA	Holstein	3709885	10967	3,70	3,08	-
		Jersey	252822	7941	4,82	3,65	-
		Swiss	11249	8590	4,19	3,42	-
		Ayrshire	4250	6877	3,92	3,17	-
2	Canada	Ayrshire	8499	7659	4,05	3,36	-
		Swiss	1877	8254	4,13	3,51	-
		Holstein	288717	9979	3,8	3,19	-
		Jersey	10726	6607	4,91	3,79	-
3	Austria	Holstein	36934	8483	4,09	3,27	-
		Simmental	249030	7103	4,15	3,41	-
		Swiss	42647	7111	4,16	3,45	-

4	Denmark	Holstein	363282	9661	4,09	3,38	-
		Red Danish	34697	8820	4,30	3,51	-
5	France	Montbeliard	421130	7023	3,86	3,41	399
		Norman	225713	6524	4,19	3,58	404
		Prime Holstein	1681336	8995	3,87	3,28	430
6	Finland	Ayrshire	135381	8731	4,27	3,41	418
		Holstein	80231	9574	3,96	3,29	418
		Jersey	237	7522	4,74	3,58	406
7	Norway	Norwegian Red (NRF)	138715	7074	4,20	3,38	380
		Holstein	1227	8775	4,08	3,32	395
8	Sweden	Swedish Red*	116573	8753-	4,36	3,56	398
		Holstein	147924	9764	4,10	3,38	413
9	Germany	Swiss	167609	6998	4,24	3,58	415
		Simmental	890211	7069	4,16	3,50	393
		Holstein Black-and-White	2123027	8791	4,07	3,37	415
		Holstein Red-and-White	241082	7859	4,23	3,40	411

* - 2012 years' data.

In our opinion, such breeds are the groups of «local» breeds of such countries as Sweden, Norway, Finland, France, Austria, Germany. It's the innerbreed genetic differences, that made breeders to improve economically important productive traits of Holstein breed by crossing it with «contrast» breeds.

So, in the early 2000-s specialists of Animal Improvement Program Laboratory, strategic developments of which are funded by Ministry of Agriculture of USA, a work on different breed combinations evaluation amongst dairy breeds of USA was done (Table 4).

4. Average value of different indices of evaluation of crosses of first generation (F₁) compared to pure bred Holsteins (P.M. Van Raden, A.H. Sanders, 2003)

Combination of parental breeds	Total value (\$)*	Value for processing of milk into cheese (\$)*	Milk value
Ayrshire	-58	-27	-201
Swiss	18	79	-241
Guernsey	-184	-138	-395
Jersey	44	113	-269
Dairy Shorthorn	-249	-223	-373

* - ratio in dollar equivalent

Analysis involved 41131 crossbred and 726344 purebred Holstein cows, which lactated from 1960 till 1991. According to P.M. Van Raden, A.H. Sanders (2003) total effect of heterosis when crossing of Holstein cows with bulls of Ayrshire, Swiss, Jersey, Guernsey and Dairy Shorthorn breed was in yield 3,4 %, fat content – 4,4 %, protein content – 4,1 %, at the same time gene recombination effect (creation of new detached DNA areas in genome after crossing) fluctuated on mentioned productive traits from 2,2 till 1,9 %. Summing up such crossing in general, genetic effect was estimated in dollar equivalent (Table 4). On traits of absolute dairy production Holsteins

were the first (all crosses yielded to this breed), but on traits, connected with milk quality or total value (Net merit) crosses with Swiss and Jersey breeds were leading (Table 4).

To a certain extent it stimulated the development as Swiss and Jersey breeds in USA, so the popularity of their crossing with Holstein cows. These trends were widely picked up by the service of scientific developments implementations (Extension) into practice in USA.

According to B.Cassel, J.Allister (2009), large part of such work was done by cooperatives on implementations of Virginia state.

Farmers significantly noted certain effect on the results of crossing on such traits as milk quality and reproduction level (Table 5).

5. Results of crossing of Holsteins and European improving breeds

Traits	Holsteins	Crossing combinations		
		Holsteins Normans	Holsteins x Montbeliards	Holstein x Scan- dinavian Red
Number of animals	380	245	494	327
Yield, kg	9766	8537	9169	9289
Fat content, %	3,55	3,76	3,65	3,66
Protein content, %	3,13	3,25	3,20	3,20
Distocia, %	17,70	11,60	7,20	3,70
Stillbirth, %	14,00	9,90	6,20	5,10

Great experience in American Holstein breed crossing with sires of such European breeds as Montbeliard (France), Scansinavian Red (Sweden), Norman (France), Swiss (Austria, Germany) is cumulated in Virginia state. In Table 6 there are given the results of 2- and 3-breed crossing combinations (B. Heins, L. Hansen, F. Seykora, 2007), which were hold at some farms of USA.

Given data witness about some advantages on milk protein and fat yield of 3-breed crosses, compared to 2-breed ones. According to these authors when using 3-breed combination schemes one can see maximum heterosis effect, but after this one should orient the system of sire matching again to the main breed, in this case – Holstein.

6. Production of heifers of different genetic combinations for 305 days of the first lactation

Crosses	Cows, ones	Number of cows' fathers, ones	Yield, kg	Yield of milk	
				fat	protein
2-breed					
Holstein x Norman	37	9	8865	345	288
Holstein x Montbeliard	366	32	9432	351	302
Holstein x Scandinavian Red	162	15	9500	350	305
3-breed					
Holstein x Swiss x Montbeliard	44	8	9297	349	302
Red Holstein x Montbeliard x Scandinavian	43	9	9461	356	308
Holstein x Scandinavian Red x Norman x Montbeliard	86	10	8809	361	320

According to B.Y. Heins., L.B. Hansen., A.Y. Seykora (2006), the main effect when crossing Holstein breed with European breeds is found for reproduction and calves' survival traits (Table 7).

7. Distocia and stillbirth cases of purebred Holsteins and crosses

Breed, crosses	№	Distocia, %	Stillbirth, %
Purebred Holsteins	676	17,7	14,0
Holstein x Normans	262	11,6	9,9
Holstein x Montbeliard	370	7,2	6,2
Holstein x Scandinavian Red	264	3,7	5,1

From economical point of view prevailing of these traits is very important for their more profitable position.

Taking into account native and foreign experience, one can recommend for the improving of Ukrainian Red-and-White and Black-and-White Dairy breeds as improving breeds, which are mentioned in Table 8.

8. Breeds, recommended for the realization of program «Procross» at the cows of native Red-and-White and Black-and-White dairy breeds of Ukraine

Breeds, which should be improved	Improving breeds (country of origin)
Ukrainian Red-and-White dairy	Montbeliard (France) Red Swedish (Sweden) Ayrshire (Finland)
Ukrainian Black-and-White dairy	Red Swedish (Sweden) Swiss (Austria, Germany) Jersey (USA)

Methodology of evaluation as the results of innerbreed crossing, so heterosis effect display was repeatedly highlighted in the works of certain scientists (S.Yu. Ruban, 1999; S.Yu. Ruban, V.A. Dunshyn, 2002; V.A. Danshyn, 2008; G.E. Dickerson, 1973; E.U. Dillard, O. Rodriguez, O.W. Robison, 1980; O.W. Robison, B.T. McDaniel, E.J. Rincon, 1981). Such approaches are widely recognized and often used for the reliable estimation of genetic and non-genetic factors impact.

So, availability of several breeds or crosses in a population of estimated animals gives certain peculiarities into evaluation of breeding value (V.A. Dunshyn, 2008). Such peculiarities are:

1. Necessity of strict breed composition record or formal counting of blood share of different breeds inside crosses' genetic composition, when define genetic groups.
2. Availability of innerallele effects of breed genes interaction (heterosis), when interallele effects are considered by way of including into linear model of effect of different breed effects.

Methodics of evaluation of general genetic value with including of heterosis effect (G_1) looks as follows (V.A. Danshyn, 2008):

$$G_1 = u_i + \sum_i S_i h_i$$

where S_i - predicted part of loci in the genotype of i -th animal, heterosis breeds of the l -st combination; h_l – heterosis effect for the l -st breed combination; u_i – additive genetic (breeding) value of i -th animal.

As addition to this proposal can be treated recommendations on careful analysis of proposed crossing schemes when realizing at the base of breeding, zootechnical, and especially, genetic control in farms of Ukraine.

Conclusions

Availability of innerbreed genetic features on fitness and productive traits between Holstein breed and breeds of European selection allows at their crossing to get genetic improving of economically important selection traits. The main effect in this case is found on reproductive and calves' survival traits. One of the directions of such improving of native dairy breeds is a search of optimum ways of crossing of them with such breeds as Montbeliard, Red Swedish, Red Scandinavian, Swiss and Jersey.

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