

COMPARISON OF INTERNATIONAL SELECTION INDICES FOR DAIRY CATTLE BREEDING

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INTRODUCTION

The principal goal of dairy cattle breeding is improvement of economic efficiency of production. A great deal of effort and dollars has been and is being expended by many countries developing breeding objectives to achieve the goal of economic efficiency. The economic merit of an individual animal is a function of the traits identified in the breeding objective weighted by their economic value. Selection indices provide an estimate of the individuals economic merit (based on the breeding objective) and simplify selection. Animals are ranked on the basis of the selection index and the best individuals selected. Globalization of breeding programs is reflected by similarity in breeding objectives. The selection index provides a simplified interpretation of where a country is headed in terms of breeding philosophy. Relationship between breeding objectives influences the resemblance of young sire sampling programs and the extent which similar sires and maternal grandsires of sons are selected. The objectives of this study were to compare selection and or production indices currently in use in several countries and to determine the similarity of young sires sampling programs in terms of parentage.

DATA

Table 1 provides a summary of the selection and production indices considered in this study. Of the indices shown, few are published with standardized weights which account for difference in variance of genetic evaluations of traits considered.

RESULTS

1. Comparison of selection and, or, production indices.

Table 2 provides a summary of the relative emphasis on traits after accounting for differences in standard deviations of genetic evaluations. Relative emphasis is given as a percentage. The absolute values of relative emphasis sum to 100%. For example, in the case of the Italian- ILQ : $|-26.7\%| \text{ Milk} + 6.6 \text{ Fat} + 66.7 \text{ Protein} = 100\%$. Relative selection emphasis placed on protein is highest and ranges from 18 % to as high as 70 % in the selection indices considered. The relative emphasis on protein in the production indices ranges from 32 to 100%.

Figure 1 shows the relative emphasis on production traits versus type traits for the selection indices included in the study. Relative emphasis on type traits compared to production ranges from less than 1% to 50%.

Mammary system received the highest relative emphasis of the type traits considered and represented from 37% to 100% of all type traits considered (Figure 2). The relative emphasis given to mammary traits in the selection indices ranged from 11 to 30%.

Five countries have more comprehensive selection indices which considered other non-production traits other than type. The relative emphasis on these traits are presented in Table 2. Other non-production traits considered included mastitis resistance or selection against somatic cell count, milking speed, temperament, aspects of growth of the bulls (prior to being progeny tested) or productive life a composite trait which receives high emphasis in the US - TMI index introduced this year.

Figure 3 shows the correlation between Canadian proven sires ranked on LPI and their ranking with the other selection indices. The group of Canadian proven sires were those with more than 1000 doses of semen sold during 1993. This group totaled 76. Few comparisons were possible because of differences in traits included in selection indices. Correlations were high between ranking on LPI and the US-TPI, UK-PINII, ITY-ILQM, FRA-ISU and the NET-STIERSOM. Correlations were slightly lower with the European selection indices due to the negative emphasis on milk yield.

Figure 4 shows the correlation with sires ranked on the production component of LPI (ie. 75% protein + 25% fat - see Table 2), compared to their ranking with other production indices. Rank correlations were high and ranged from .88 with ranking on UK-PIN to 1.0 with ranking on the production component of the US-TPI. As shown previously, correlations were slightly reduced with the production indices which placed large negative emphasis on milk yield.

The actual relative emphasis on traits may be different based on correlations between traits. For example, although the Canadian LPI does not include milk yield in the selection index, because of the high correlation between milk yield and protein ($r=.84$), in fact positive selection emphasis is being placed on milk yield. Furthermore, final class included in the LPI is a composite trait which places high emphasis on mammary system. Thus, the relative emphasis on mammary system is in fact higher than shown.

The selection indices presented in Table 1, are provided to dairy farmers to assist them in making selection decisions. However, dairy farmers will vary in their selection criteria. As such, dairy farmers are the primary determinators of breeding objectives by the traits they consider when selecting AI sires.

Selection indices are dynamic and will change as economic conditions change, and as improved parameter estimates become available. Future modifications may also combine quantitative traits with marker gene information.

For countries interested in exporting germ plasm, it is important to have accurate genetic information expressed in terms useful for customers to make wise selection decisions. This further highlights the importance of thorough understanding of selection indices used around the world. If there are sufficient opportunities for export in the short or longer term, this may warrant collecting information on additional traits, and providing genetic evaluations on traits not currently evaluated in the home country.

2. Comparison of pedigrees of young sires sampled in 1993.

Pedigree information on Holstein sires and maternal grandsires of sons progeny tested in 1993 was collected from several countries.

Table 3 and 4 summarizes the number of young sires sampled from to the top 10 most popular sires and maternal grand sires of sons for 1993. The top 10 most popular sires of sons represented 62% of the 4172 sons represented in the study. The top 10 most popular maternal grandsires represented 63% of sons sampled. Although countries have equal opportunity of selecting from the global Holstein gene pool, not exactly the same sires are selected - even for countries with a high correlation between selection criteria. Within each of the countries considered in this study, the number of sires selected was higher than recommended for maximum genetic response (Goddard 1992; Goddard and Smith, 1990; Koopman et al., 1992).

SUMMARY

Failure to account for differences in standard deviations of genetic evaluations will lead to misleading interpretation of indices.

Protein generally receives the highest relative selection emphasis in all indices considered.

Largest differences between indices were observed for relative emphasis on milk yield (positive or negative selection emphasis) and relative emphasis on production versus type traits. Although, there are apparent difference in selection criteria, the rank correlations of sires with different indices was high ($r > .88$).

Although, there are sons sampled in many countries with near identical pedigrees, there is substantial variation in the sires and maternal grandsires of sons progeny tested in 1993.

REFERENCES

- Goddard, M.E. 1992. J. Dairy Sci. 75:2902.
Goddard, M.E., and C. Smith. 1990. J. Dairy Sci. 73:1113.
Koopman, J.N.M., C. Smith and J.C.M. Dekkers. 1992. Livest. Prod. Sci. 32:295.

Table 1. Production and selection indices used in several countries. Genetic evaluations for milk, fat and protein abbreviated as M, F and P respectively. Indices for which relative weights are standardized are denoted by *.

Canada	LPI	6(3 F + 8 P) + 4(3 final class + 4 mammary + 2 feet&legs + capacity)
US	MFP\$ TPI * TMI	.04756 M + .68 F + 1.52 P [3(P/19) + (F/22.5) + (type/7) + (udder composite/.8)]50 + 234 .7 MFP\$ + 11.028 productive life - 27.528 (somatic cell score - breed mean somatic cell)
Italy	ILQ UCI ILOM	4.5(-.173 M + F + 11.3 P) .18 fore udder + .16 rear udder height + .05 rear udder width + .2 central ligament + .25 udder depth + .16 teat placement .9 ILQ + 180 UCI
Netherlands	INET STIERSOM *	-.15 M + 2 F + 12 P 63INET + 20.4 mammary system + 8.5 feet&legs + 3.4 rump angle/width + 1.7 capacity + stature + 2 milking speed
UK	PIN PINIP	-.039 M + .94 F + 2.75 P -.015 M + .6 F + 3.84 P + 3.9 angularity + 1.8 foot angle + 4.8 udder + -4.1 teat length
France	INEL * ISU *	1.15 (P + 3 P%) .7 INEL + .25(.6 udder + .3 capacity + .1 legs) + .05 milking speed
Germany	RZM *	92 + .15 F + .6 P
Denmark	Y-INDEX I-INDEX S-INDEX	-.004 M + .28 F + .724 P daily gain + muscle area + feed intake + 100 .5 Y-index + .31 I-index + .23 daus. fertility + .13 calving index + .18 mastitis resist. + .19 body + .34 feet&legs + .51 mammary + .15 milking speed + .03 temperament
Israel	PD91 *	-.274 M + 6.41 F + 34.85 P
New Zealand	PBI LI PI TBI	-.2771 M + .2521 F + 1.0251 P -.2767 M + .4226 F + .8541 P -.2768 M + .3755 F + .9014 P PBI + Management Index + Efficiency Index + Conformation Index

¹ To be introduced January 1995.

² Expressed as deviations from mean of bulls at test station. Adjusted for environmental factors.

Table 2. Relative emphasts on traits adjusted for differences in standard deviations of traits. Absolute values of percentages sum to 100.

Country	Index	milk	fat	protein	protein %	final class	stature	angularity	capacity	feet & legs	foot angle	rump width	mammary system	mastitis resistance /SCS	milking speed	daus. fertility	calving ease	temperament	growth traits	productive life
Canada	LPI		18	53		8.7			2.9	5.8			11.6							
US	MFP\$	42	26	32									16.7							
	TPI		16.7	50		16.7								6.7						26.6
	TMI	28	17.3	21.3																
Italy	ILQ ¹	-26.7	6.6	66.7									20							
	ILQM	-21.4	5.3	53.4																
Netherlands	INET	-27.8	13.4	58.7											2					
	STIERSON	-17.5	8.4	37			1		1.7	8.5		3.4	20.4							
UK	PIN	-26.4	23.6	50.6							6.2		30.3							
	PINII	-5.3	7.6	37.6				13.3												
France	INEL			76.9	23.1								15		5					
	ISU			53.9	16				7.5	2.5										
Germany	RZM		20	80																
Denmark	Y-Index	-10	30	60					7	12			11	10	4	10	4	1	11	
	S-INDEX	-3	9	18																
Israel	PD91	-18	13	69																
NZ ¹	PBI	-7	15.7	83.5																
	LI ³	-8	27.3	71.9																
	PI ²	-8	24.1	75.2																

¹ Example $-26.6 + 6.6 + 66.7 = 100\%$

² TBI places 96% emphasis on PBI and 1.2 % on Management, Efficiency and Conformation

³ Indexes used for selection of cows only. LI = lactation index showing potential performance of a cow for the current lactation relative to animals within a particular herd. PI = potential productive ability of a cow relative to all other animals within a particular herd, based on past and current performance.

Leitch, H.W. 1994. Comparison of international selection indices for dairy cattle breeding. Interbull Annual Meeting, Ottawa, Canada.

Figure 1. Relative weighting production and type traits.

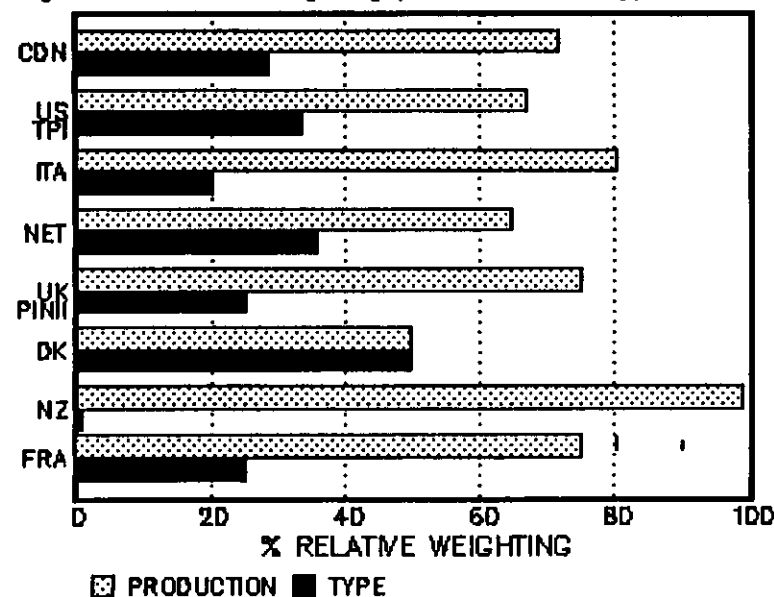


Figure 3. Correlation of active Canadian AI sires ranked on LPI with ranking using other selection indices.

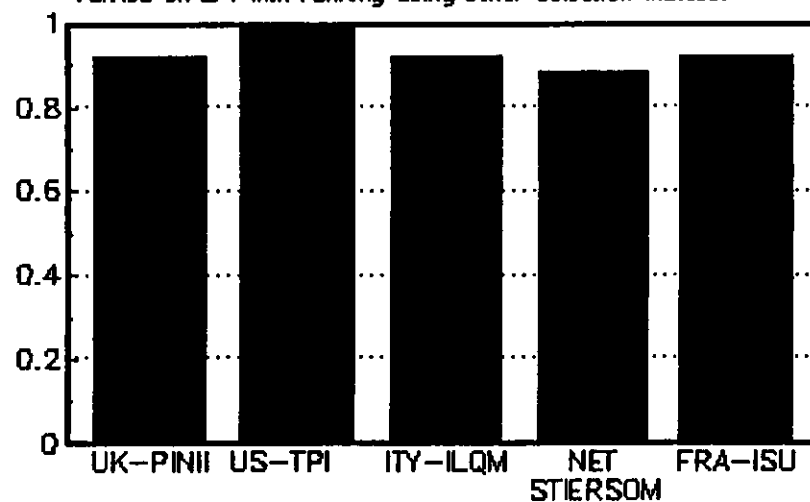


Figure 2. Comparison of relative emphases on type traits.

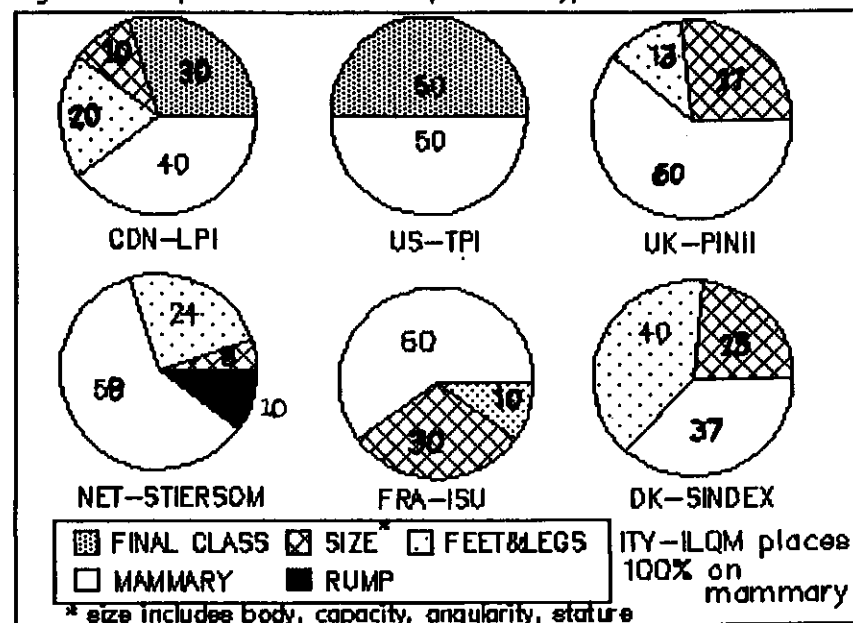


Figure 4. Correlation of active Canadian AI sires ranked on production component of LPI with ranking using other production indices.

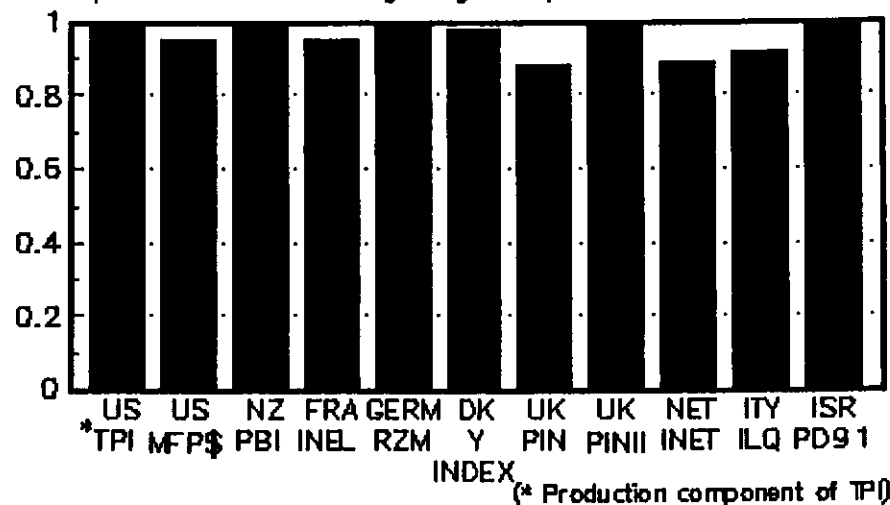


Table 3: List of 10 Most Popular Holstein Sires of Sons entering AI sampling programs in 1993.

Name	Can	US	UK*	France	Neth	Germany*	Italy	Den	Aust.	Total
Total Number sons sampled	408	1226	112	922	359	324	277	319	225	4172
Leadman	62	164	17	173	52	54	52	52	55	681
Blackstar	35	48	10	134	6	54	15	93	1	396
Aerostar	72	79	14	45	23	38	40	64	11	386
Mascot	10	135	8	31	22	1	41	0	29	277
Tesk	20	147	8	36	28	0	14	0	2	255
Thor	22	99	1	7	0	0	25	0	1	155
Southwind	7	11	3	56	6	11	3	40	1	138
Cubby	0	67	0	4	29	1	0	0	19	120
Holiday	0	37	0	1	16	0	17	0	30	101
Wister	9	68	0	4	2	1	9	0	4	97
% of sons sampled	58%	70%	55%	53%	51%	49%	78%	78%	70%	62%

Table 4: List of 10 Most Popular Holstein Maternal Grand Sires of Sons entering AI sampling programs in 1993.

Name	Can	US	UK*	France	Neth	Germany*	Italy	Den	Aust.	Total
Chief Mark	80	209	10	121	10	8	22	12	10	482
Ned Boy	6	139	20	143	57	21	45	0	20	451
Blackstar	16	169	2	37	57	0	32	0	46	359
Cleitus	15	154	3	55	38	7	44	20	7	343
Valiant	50	20	7	140	0	0	0	46	1	264
Rotate	11	101	9	95	21	2	4	0	15	258
Secret	0	53	2	56	31	0	21	0	16	179
Starbuck	63	7	7	25	0	25	4	27	3	161
Ivanhoe Bell	3	31	8	61	0	17	0	35	2	157
Enhancer	31	62	1	17	4	2	0	0	2	119
% of sons sampled	67%	77%	62%	81%	61%	25%	62%	44%	54%	63%

* INCOMPLETE - not all organizations sampling young sires included.