Questions and Answers About Swine EBVs

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Question Page

Swine Production
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1. What is an EBV?

An EBV (Estimated Breeding Value) is an estimation of the genetic value of an animal. It indicates its value as a parent. EBVs are effective selection tools. Individuals with the best EBVs for a given trait have the highest probability of producing superior progeny for that trait. Since only half of an animal's genes are passed on to progeny, the expected contribution from a parent to its progeny is on average one half of its EBV. The actual contribution to an individual progeny can vary substantially, depending on whether it received a sample, which is better or poorer than the average of its parents' genes. For this reason, the EBVs between siblings within a litter can sometimes vary widely. The key point is that the average genetic value of a large number of progeny will be equal to the average EBV of their parents.

2. How are EBVs computed in the Canadian Swine Improvement Program?

Each of the EBVs are obtained by comparing the performance of each boar or sow and its relatives, to those of other boars and sows in the same management groups. The procedure is called Henderson's Method or Best Linear Unbiased Prediction (BLUP) and takes into account the heritability of the trait, the amount of information available for each boar or sow, the genetic level of the herd, genetic trend, and non-genetic factors such as management groups. The EBVs are based not only on the performance of the boar or sow itself, but also on the performance of all related animals, including ancestors, siblings, and progeny.

3. How are EBVs expressed?

EBVs are expressed in the same units that the trait is measured in. For example, the backfat EBVis expressed in millimeters, EBVs related to age are expressed in days and EBVs related to prolificacy are expressed in number of piglets born.

Type of EBV	Units
Fat EBV	Millimeter (mm)
Age EBV	Day
Lean EBV	Millimeter (mm)
Loin eye area EBV	Centimeter squared (cm^2)
Lean yield EBV	% of yield
Feed conversion EBV	kg feed/kg of gain
Total born EBV	Piglets per litter
Piglet perinatal survivability EBV	%
Litter weaning weight EBV	Kilogram

EBV for farrowing interval	Day
EBV for number of piglets weaned	Piglets per litter
EBV for number of functional teats	Number of teats

It is important to note that EBVs are expressed in relative terms (i.e. to allow the comparison of animals within a group) and are not absolute. EBVs indicate how much better (or worse) the progeny of one animal are expected to be compared to progeny of another animal when raised under the same conditions. For example, Boar A has an EBV of -10 days and Boar B has an EBV of -6 days. Boar A is therefore 4 days better than Boar B. His progeny would reach market weight (100 kg) on average 2 days (half of the difference between their EBVs) earlier than Boar B's progeny. You can see that this doesn't tell you how many days it will take to reach market weight, just that progeny of Boar A will get there faster if raised under identical conditions.

EBVs are adjusted to a base, which reflects the current population for each breed. The current base includes all pigs born and probed in the last three years. EBVs for all animals are expressed against this base group. For example, a Duroc boar with EBVs of -1.0 mm and -6.0 days is estimated to be genetically 1 mm leaner and 6 days faster growing than the average probed Duroc population born in the last three years.

4. What is the difference between national EBVs, on-farm EBVs and parent average EBVs?

In addition to national EBVs, CCSI provides instant on-farm EBVs which are computed using the latest national EBVs of the pig's sire and dam, combined with the most recently collected weight and scan data. On-farm EBVs are computed using the same methodology (BLUP) as national EBVs, and are provided as interim EBVs. They are very good predictors of the next national EBVs, provided they are based on the most recent parental national EBVs. For animals without national EBVs and performances records, parent average EBVs will be computed

5. <u>How is the sire line index of an animal computed from its EBVs for age and fat?</u>

The sire line index (SLI) was designed to maximize economic returns to farmers who are selecting for leaner, faster growing pigs. It is based on several EBVs for sire line traits, such as growth, feed efficiency and carcass composition. The dam line index (DLI) allows for the selection of sow productivity traits while continuing the improvement on growth and carcass traits. The formulae for SLI and DLI are based on the economic value for each of the economically important traits and they are updated regularly according to the industry's economic situation. The current formulae are presented in Tables 1 and 2.

Table 1 . Calculation of Sire Line Index in points

Sire Line Index** =

100 + 25/SD* x [2.55 xLoin Eye Area EBV – 1.10 x Age EBV - 87.90 xFeed Conversion EBV + 0.65 x Lean Depth EBV]

Breed	**SD***
Yorkshire	11.2

Landrace	10.6
Duroc	13.1

The dam line index (DLI) takes into account the sire line traits and the EBV for total piglets born. More than 50% of the dam line index is made up of the total number born EBV because an increase in the number of piglets has an important impact on the economic value. The weights on sire line traits are reduced but still exist.

Table 2. Calculation of Dam Line Index in points

Dam Line Index** = 100 + 25/SD* x [11.49 x Total Born EBV + 1.70 xPiglet Survival EBV + 8.0x Functional Teats EBV – 0.375 x Farrowing Interval EBV + 1.275 x Loin Eye Area EBV– 0.55 x Age EBV – 43.95 x Feed Conversion EBV+ 0.325 x Lean Depth EBV]

Breed	**SD***
Yorkshire	17.2
Landrace	11.8
Duroc	9.6

* SD represents the specific standard deviation for each breed, and are updated once a year

** A note on SLI and DLI formulae: The EBV for LEA (loin eye area), feed conversion, LEAN (lean muscle depth) and total number born are the animal's own EBVs. For each breed, the average sire line index of all pigs probed in the previous three years will be 100. The standard deviations of both the indicesare set to 25. This means that about 2 out of 3 animals will have an index between 75 and 125 while about 19 out of 20 animals will have an index between 50 and 150. Only the top 2.5% of pigs will have an index above 150.

6. What is the repeatability of an EBV?

The repeatability is an indication of the reliability of an EBV (i.e. the likelihood that the EBV will not vary too widely from one evaluation to the next). Repeatabilities can range from 0% to 99%. The more information that is included, the higher the repeatability and the more stable the EBV will be. An EBV with a repeatability of 90%, for example, is not expected to change much even if new information becomes available (such as new progeny records). An EBV with a repeatability of less than 50% can change substantially. The repeatabilityis also higher for traits that are more heritable. For example, repeatability for backfat thickness (heritability = 52%) is generally higher than the repeatability for age (heritability = 30%).

Table 3 shows how the repeatability of traits can vary according to the number of progeny. It also indicates the range within which 90% of the EBVs are expected to remain in future evaluations (i.e. as new progeny records are added). In each example, it is assumed that the animal and both its parents have their own record.

Table 3. Repeatability and number of progeny

Nb of progeny	Age to 100 kg (d)		Backfat thickness at 100 kg (mm)		Sire Line Index	
	Rep	Int	Rep	Int	Rep	Int
0	38	± 8.8	59	± 1.6	48	± 41
5	45	± 8.3	68	± 1.4	57	± 38
10	51	±7.8	74	± 1.3	63	± 35
20	60	± 7.1	81	± 1.1	70	± 32
50	73	± 5.7	90	± 0.8	82	± 25

Consider a young boar with no progeny and an EBV of -10 days and an older boar with the same EBV (-10 days) but with 50 progeny. Using the table above, the range for age with 0 progeny is 8.8 days. With 50 progeny the range is only 5.7 days. As a result, there is a 90% chance that the true breeding value for the young boar is between -1.2 and -18.8 days. For the older boar, the range is much narrower (between -4.3 and -15.7 days).

7. What is the purpose of the management group (contemporary group)?

A management group is a group of pigs of the same breed and sex that are raised under identical rearing conditions and that are evaluated during the same time period. The management group is a reference group to compare the performances of animals to those of pigs raised in identical conditions. In the Canadian Swine Improvement Program, some guidelines have been developed regarding proper management groups, which should be composed of a minimum of 10 pigs of the same breed and sex, born from at least three different sires.

8. What are the relative contributions to an EBV from an animal's performance, from its parents' performance and from its progeny's performance?

The relative contribution from a record to an animal's EBV depends on the relationship of the animal making the record to the animal being evaluated. The most important record is the animal's own performance. Individual parents and progeny have half their genes in common with the animal. Therefore, the contribution of each record from an individual parent or progeny to that of the animals own EBVs is also very important. The records of other relatives such as grand-sires, grand-dams and siblings are also included in the EBV calculation. The further away the relative is in the pedigree from the animal, the less contribution it makes to the animal's EBV.When the number of progeny records is high, however, the records of the offspring can have a greater impact on the EBV than the animal's own record.

Table 4 gives examples of the relative contribution of parent and progeny records versus the animal's own record.

Table 4.Relative Contribution of an animal's sire, dam, individual and progenyrecordsaccording to the number of progeny tested *

	Relative Contribution to the EBV

Nb of progeny	Sire's record	Dam's record	Animal's record	Progeny records
0	25 %	25 %	50 %	0 %
1	20 %	20 %	40 %	20 %
5	11 %	11 %	22 %	56 %
10	7 %	7 %	14 %	71 %
20	4 %	4 %	8 %	83 %
50	2 %	2 %	4 %	92 %

* In the case where sire, dam and animal each have their own record.

What impact do brothers and sisters, aunts and uncles, etc. have on an animal's EBV? These relatives influence the animal's EBV indirectly through the parents. These relatives increase the accuracy (repeatability) of the parents' EBVs and their EBVs are reflected in the animal's EBVs through the parents. The relative contribution depends also on the heritability of a given trait. The more a trait is heritable, the more the animal's own record will bea better indication of its genetic value for that trait. Thus, more weight is put on the animal's own performance if the heritability of a trait is higher.

In the case of backfat thickness (heritability = 52%), the maximum contribution from each parent would be 32.5%. The minimum contribution from the animal's own record is therefore 35%. For age to 100kg (heritability = 30%), the maximum contribution from each parent would be 41%, leaving a minimum contribution of 18% from the animal's own record. Note that these are maximum parental contributions and require in theory 100% repeatability for both the sire and the dam. If parent EBVs have lower repeatabilities, the contribution will be lower. Practically, the EBV repeatabilities of parents are lower and their contributions are lower. If an animal has its own progeny, the parents' contribution to the animal's record will be even lower.

9. Why are most of the pigs in my herd getting indexes for sire and dam lines above 100?

This indicates that you have a good selection program and as a result your genetic level is above the national breed average. This is due to the fact that, on average, relatives of your pigs are performing above average in other herds. These relatives could include A.I. boars, animals you have sold, parents of animals you have bought, etc.

10. What is the purpose of the HAM report?

The Herd Activity Monitor (HAM) Report is provided to individual breeders to show recent genetic and management trends in the herd. It also indicates where the breeder's herd ranks both for genetics and management compared to other herds for the same breed. The report covers the most recent two and a half years and shows for each six-month period, the number of pigs born, average EBV, and average management level. Note that there is a base adjustment, which changes the genetic averages slightly every month. This adjustment keeps the average EBV of the current population close to zero (see Question 2).

11. Why do the EBVs of some animals keep changing over time?

The genetic evaluation of pigs in Canada is based on the evaluation of progeny. To reflect the new information available, CCSI recalculates the EBVs of all active animals on a bi-weekly basis. Thus, each time new data are available, they may have an effect on the calculation of related animals.
In addition, new animals are constantly added to theCCSI database. These animals are on average better than animals removed from the reference populationbecause they were born more than three years ago.When animals age, their genetic value decreases because they are being compared to a base groupthat has a higher genetic value.
In order to track past evaluation results, CCSI stores all EBVs computed since 2002 for every animal in the database. This allows searching the EBV history for a particular animal, and is also very useful for research, especially in genomics. It is important to remember that the most recent EBV is always the most accurate one, since it was computed on all information available.

12. How is the management level of my herd computed?

The management level of a herd is the difference between the herd average and its genetic level. It is adjusted to a 100 kg female equivalent. The genetic level of your herd can be estimated as long as there are animals in other herds, which are related to animals in your own herd. For example, if you use a popular AI boar and its progeny perform much better in your herd than in other herds, this indicates that you have superior management. The management level would be the difference between the performance of the boar's progeny in your herd and the performance of its progeny in other herds. In practice, of course, the genetic evaluation does not solely rely on the joint use of A.I. boars to determine genetic and management differences from one herd to another. It relies instead on all of the genetic relationships between herds, including those resulting from the purchase and sale of genetics and breeding stock.

13. What should I look for when I select or purchase breeding stock?

The basic principles are:

- Select or purchase animals that have a high (sire line and/or dam line) index;
- To improveyour herd’s genetic level, use animals that have EBVs or higher indexes than the average in your herd;
- Select animals that are in good physical condition and that have acceptable conformation;
- Make sure that herd health measures in your herd are being followed and that all procedures related to biosecurity are being respected;
- Preferentially use animals that come from herds with a connectedness rate of 5% or more with your herd or that have progeny in many herds;
- Select enough animals to reduce inbreeding and genetic estimation risks.

In recent years, the selection of dam lines or the animals destined for the production F1 hybrid females and the selection of sire lines or the animals destined for the production of terminal boars have been differentiated.

Dam line selection

In the past, the selection of different breeds across Canada was carried out according to growth and carcass traits. In order to improve litter size, a new EBV was created: number born EBV. This EBV is the ratio of the number of piglets born per litter and it has been used since the late 1990's in the selection of dam lines like in the Yorkshire and Landrace breeds. Significant genetic improvements have been made on sow prolificacy at birth. More recently, new maternal traits (age at first farrowing, farrowing interval, piglet perinatal survivability, number of piglets weaned, litter weight at weaning) were added to the list of traits evaluated on the Canadian Swine Improvement Program.

Sire line selection

Just like in the past, it is essential to continue selecting sire lines like the Duroc breed for growth and carcass traits. Given that the selection pressures of growth and carcass traits are reduced in the dam line, it is even more important to maintain a strong selective pressure on these traits in the sire line. The sire line index aims to improve growth, feed efficiency and the loin eye area traits. The selection on backfat thickness and lean yield to respond to the market's needs was very efficient in the past, but the direct selection pressure on these traits has been reduced.

14. Can I compare EBVs across breeds? Across herds?Across regions?

EBVs cannot be compared across breeds because each breed is evaluated separately in genetic evaluations. However, across-herd comparisons of EBVs within breed are valid, because the management effect of the herd in which each record has been made has been accounted for.

This is possible because of the genetic links between herds caused mainly by the use of A.I. boars in different herds. In order to help in the comparison of genetic values across herds, the average connectedness rate between herds participating on the Canadian Swine Improvement Program is calculated twice a year. Two connectedness rates are published for each breed: a connectedness rate for fat and age and a second for the evaluation of the number born EBV. The connectedness rate reflects the intensity of genetic links between herds. The higher the connectedness rates between herds, the more accurate the comparison of EBVs between both herds.

15. How do we use the newsow productivity EBVs?

Since 2005, the Canadian Swine Improvement Program calculates new EBVs. The new EBVs are:

- Piglet Perinatal Survival EBV (in %)
- Age at first farrowing EBV (in days)
- Farrowing Interval EBV (in days)
- Litter weight at weaning EBV (in kg)
- Piglets weaned EBV (number of piglets per litter)

- Functional Teats EBV

These new EBVs are provided to breeders who collect the data on farm for these traits. It allows breeders to obtain additional information on the maternal qualities of their animals. These new EBV s need to be used mainly in the selection of dam lines. Some have been includedin 2011 in the national dam line index (piglet survival, functional teats and farrowing interval). The other sow productivity EBVs will be included in the Dam Line Index as soon as they are routinely collected in participating herds on the Canadian Swine Improvement Program.

16. <u>If I have further questions about swine EBVs, whom should I contact?</u>

For any other information regarding EBVs, you may contact the Canadian Centre for Swine Improvement at the following address:

Canadian Centre for Swine Improvement
Central Experimental Farm, Building # 54,
960 Carling Avenue, Ottawa, Ontario,
CANADA K1A 0C6
Telephone: (613) 233-8872 Fax: (613) 233-8903
Email: info@ccsi.ca web site: http://www.ccsi.ca/