

NSR Muscle Quality EPD Program: Current Structure

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Introduction

The National Swine Registry (NSR) has offered STAGES™ as a selection tool for independent seedstock producers for nearly 20 years. This program uses traditional BLUP methodology to calculate Expected Progeny Deviations (EPDs) for economically important traits, which are then included in separate maternal and terminal bio-economic indexes (Mabry, 1998). Not only is this genetic information available to members, but these values and corresponding trends are also available to any commercial producer or genetic advisor. The genetic selection tools provided by the NSR have facilitated operation-specific selection schemes and resulted in substantial genetic improvement for numerous economically relevant traits within the Duroc, Hampshire, Landrace, and Yorkshire breeds (Chen et al., 2002). Specific goals of breeding programs are subject to change due to alterations in economic values associated with different production parameters. This notion has been vastly characterized in recent years within the swine industry where the general focus of genetic improvement has shifted from a primary emphasis on efficient production of lean product (i.e. lean growth) toward that of a dual focus on carcass leanness coupled with product quality and consistency (Lonergan et al., 2001; Murray et al., 2004). In light of such industry changes, multiple pork chains are forming to meet distinct specifications desired by subsets of consumers. To continue to meet the demand of specific market structures, differentiated genetic lines are necessary to provide products that match their specifications. For this reason, the Genetic Advisory Committee of the NSR has worked with NSR personnel to develop the data collection protocols and statistical analysis tools to enable participating members to incorporate EPDs for select muscle quality traits into their respective genetic improvement programs.

Data Collection Protocols

The National Swine Registry has developed on-going agreements with several pork processors in the Midwest that work with registry personnel on the collection of meat quality data. Pigs from member's herds are evaluated for several meat quality traits. This data is then combined with pedigree data for the calculation of EPDs.

Members who wish to participate in this program can do so in one of two ways. Members can deliver pigs to a pork processor that works with NSR for the collection of meat quality data. This is the method most used by NSR members. Interested NSR members must contact NSR to determine what processors are participating and determine pig delivery dates. For those members who have their own meat quality evaluation program, the data from their program can be submitted for estimation of meat quality EPDs as long as NSR guidelines for data collection and submission are followed. Members must notify NSR about their intent to collect their own meat quality data before

pigs are harvested and data is submitted. The NSR will work with these members to make sure that the appropriate data will be collected and data submitted will be in the appropriate format.

Persons who choose to work with pork packers collaborating with NSR must contact NSR for tattoo numbers and to determine location and date of delivery. The following off the farm data must be matched with the tattoo identification provided by NSR: breed, ear notch, tattoo number, sex, date of birth, live weight prior to harvest, and the date corresponding to the weight measure. These data are matched with pedigree data already in place at the NSR. Animals that do not have the previously mentioned data in place will not have their records included in the analysis. Summary information pertaining to the number of carcasses evaluated per breed and the current member participation is presented in Tables 1 and 2, respectively.

Slaughter Groups

Slaughter group formation for the collection of meat quality data and the subsequent calculation of EPDs requires a similar structure to that of postweaning performance contemporary groups. To effectively estimate EPDs of sires represented among the pigs within the group, a minimum of two sires per breed should be represented among the pigs slaughtered. However, the EPD estimates improve when three or more sires per breed are represented in a slaughter group, assuming adequate numbers of progeny per sire are represented. If possible, pigs from both sexes (barrows and gilts) should be within each slaughter group within breed, to effectively account for sex differences in meat quality traits. Harvest group reports (Figure 1) are returned to the NSR member after the data is processed from each group of pigs harvested. At the end of each harvest summary are EPD estimates for all of the sires that have progeny represented in the harvest group (Figure 2). Much like the performance report illustrated in Figure 1, this summary will be an updated across herd EPD report for these boars. However, the overall average phenotypic information will not be reported. For example, the four boars listed in Figure 2 have had progeny harvested and meat quality data gathered within this harvest group.

Traits Evaluated

At the plant, pigs are slaughtered and carcasses are chilled for approximately 24 hours. After chilling, the following information is collected on the face of the loin muscle at approximately the 10th rib:

1. CIE L*, a*, b*
2. pH
3. Marbling Score (1-10).
4. Firmness Score (1-3).
5. Color Score (1-6).

Current breed means for each of the above traits evaluated within the Pork Quality Alliance Program are presented in Table 3.

The CIE L*, a* and b* measurements must be collected with a portable colorimeter or spectrophotometer. Instruments produced by the Minolta Company are used to collect objective loin color measures. The L* measurement is an assessment of light reflectance, and has a typical range of 36% to 66%. Lower values indicate darker meat and higher values indicate lighter colored or paler meat. The a* value is a measure of the spectrum difference between red to green while b* is a measure of the spectrum difference between blue to yellow.

Measurements of pH of the loin muscle is collected at the 10th rib 24 hours after harvest. This measure represents differences in product acidity and is a transformed value of the hydrogen ion concentration. Depending on muscle type, most pork will have pH values between 5.6 and 5.9. Extremely light, low quality pork will have lower pH values of approximately 5.3. A small percentage of pork in the normal population will have pH values greater than 6.0. The pH meters must be calibrated before each use using standard pH solutions.

Marbling score is a visual evaluation of intramuscular fat with a range of 1-10 taken on the cut surface of the loin muscle at the 10th rib. The scale used is that recommended by the National Pork Board, Des Moines, IA. The National Pork Board has developed standards that can be used to assist in assessing these marbling, firmness, and color scores. This scoring system for marbling was developed so that each score represents an approximation of percent intramuscular fat. For example, a marbling score of 3 should correspond to a loin chop with approximately 3% intramuscular fat. Loin firmness is evaluated subjectively where a score of 1 corresponds to soft texture and a score of 3 represents very firm pork texture. Subjective color scores are evaluated on a 6 point scale where scores correspond to Minolta L* values. For example, a color score of 1 is designed to represent a Minolta reflectance of 61% while a color score of 6 corresponds to approximately 31% reflectance. Personnel who determine subjective scores should have the National Pork Board standards in hand for standardization purposes.

NSR members collecting their own meat quality data must provide all the required information necessary for this program as listed above. In addition, assurances must be made regarding the training and skill of persons collecting meat quality data. Furthermore, the equipment used for collecting CIE L*, a*, b* and pH must be agreed upon by the NSR Advisory Committees overseeing this program.

Genetic Analysis

The PEST software is used for the genetic evaluation module for the multivariate analysis of pH, marbling score, and Minolta reflectance. The animal model utilized for estimation of genetic merit includes fixed effects of harvest contemporary group and sex. Random effects include an animal genetic effect and residual. Contemporary group is defined as harvest date nested within herd and breed. For analysis, pH is transformed to hydrogen ion concentration (H⁺). The relationship matrix among all animals within a breed is included in the analysis to better account for the genetic relationships that existed among

animals with common ancestors. Genetic parameters for meat quality traits included in the analysis are presented in Table 4 (See et al., 2005).

It is important to remember that the data from animals harvested will be used to estimate their own EPDs and the EPDs of their relatives. However, the EPDs of interest will be those estimated on the parents and the littermates that were retained for replacements within the herd. The EPDs for parents and littermates are based only on relative information. It becomes critical that the animals slaughtered represent the families that exist within the herd including the retained littermates. The optimum strategy for estimation of meat quality EPDs would be to slaughter a minimum of a barrow and gilt per litter. Since these EPDs are calculated using a BLUP Animal Model, each record is used in the EPD calculation of the individual and all family members. For example, the record collected for each pig slaughtered is used to calculate a minimum of seven EPDs. These seven animals represent the animal harvested, the sire and dam, and the four grandparents. If the sire and dam have any half or full sibs retained in the herd, the number of EPDs in which a meat quality record is used expands by the number of family members. To estimate EPDs effectively, every family within a herd and within the breed should be adequately represented within the meat quality database to achieve accurate meat quality EPD estimates.

Summary

Independent seedstock breeders within the Duroc, Hampshire, Landrace, and Yorkshire breeds have been successful in improving the genetic merit of their herds for postweaning performance and carcass composition. The addition of the Pork Quality Alliance Program within the current STAGES genetic evaluation system of NSR will allow producers to better direct genetic change within their herds to fit specific market structures that emphasize components of meat quality. The addition of meat quality traits to the current genetic evaluation system will enhance the flexibility and available information for the design of breeding programs by independent seedstock producers.

References

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Table 1. Number of carcasses evaluated by breed and year.

| Year | Breed | | | |
|--------------|--------------|------------------|-----------------|------------------|
| | Duroc | Hampshire | Landrace | Yorkshire |
| 1998 | 28 | 5 | 16 | 15 |
| 1999 | 192 | 18 | 45 | 103 |
| 2000 | 252 | 15 | 30 | 113 |
| 2001 | 154 | 0 | 18 | 38 |
| 2002 | 183 | 0 | 85 | 68 |
| 2003 | 206 | 65 | 293 | 270 |
| 2004 | 350 | 4 | 635 | 272 |
| 2005 | 326 | 7 | 374 | 141 |
| 2006 | 271 | 16 | 273 | 162 |
| 2007 | 215 | 0 | 39 | 50 |
| Total | 2177 | 130 | 1808 | 1232 |

Table 2. Number of carcasses evaluated by herdmark.

| HERD | No. of Pigs Evaluated |
|-------------|------------------------------|
| IREW | 41 |
| BCF | 256 |
| CBS | 38 |
| CBSW | 172 |
| CC | 855 |
| CR | 32 |
| DMP | 13 |
| DPF | 8 |
| DZS | 28 |
| GFWF | 6 |
| HAM | 118 |
| HP | 32 |
| ID | 11 |
| ISGE | 24 |
| ORU | 23 |
| RGFD | 16 |
| RWG | 25 |
| SDF | 14 |
| SDH | 36 |
| SRS | 5 |
| STN | 30 |
| TOSU | 839 |
| WFD | 849 |
| WHI | 66 |
| WHIH | 55 |
| WWU | 196 |
| ZMACC | 1190 |

Table 3. Current least squares means for carcass traits evaluated in the Pork Quality Alliance Program.

| Trait | Breed | | | |
|-----------------------------------|--------------|--------------|--------------|--------------|
| | Duroc | Hampshire | Landrace | Yorkshire |
| Backfat, in | 0.91 ± 0.03 | 1.00 ± 0.04 | 0.93 ± 0.04 | 0.81 ± 0.03 |
| Loin Muscle Area, in ² | 6.28 ± 0.38 | 7.40 ± 0.30 | 5.96 ± 0.34 | 6.59 ± 0.53 |
| Subjective Color | 3.16 ± 0.09 | 3.25 ± 0.19 | 2.21 ± 0.09 | 2.51 ± 0.09 |
| Subjective Firmness | 2.51 ± 0.16 | 2.15 ± 0.18 | 1.56 ± 0.28 | 2.21 ± 0.16 |
| Subjective Marbling | 2.83 ± 0.09 | 2.03 ± 0.19 | 1.75 ± 0.08 | 1.74 ± 0.08 |
| pH | 5.77 ± 0.02 | 5.57 ± 0.05 | 5.60 ± 0.02 | 5.60 ± 0.02 |
| Minolta L* | 48.03 ± 0.36 | 50.00 ± 0.74 | 52.39 ± 0.33 | 52.13 ± 0.35 |
| Minolta a* | 17.69 ± 0.39 | -- | 16.40 ± 0.37 | 17.12 ± 0.26 |
| Minolta b* | 5.63 ± 0.18 | -- | 6.22 ± 0.28 | 6.52 ± 0.21 |

Table 4. Heritability estimates (diagonal), genetic correlations (above diagonal), and phenotypic correlations (below diagonal) for meat quality traits.

| | Minolta L* | Hydrogen ion conc. | Marbling score |
|--------------------|------------|--------------------|----------------|
| Minolta L* | 0.16 | 0.05 | -0.19 |
| Hydrogen ion conc. | 0.18 | 0.21 | -0.39 |
| Marbling score | -0.07 | 0.17 | 0.34 |

Figure 1.

United Duroc Swine Registry

STAGES Pig Meat Quality CG Report

Herdmark: QPB
Quality Pork Breeders
67 County Ln.
Anytown, IN 55555

| Contemporary Group Summary For Group 17 - Slaughter Date 04/15/04 | | | | | | | | | | |
|---|-------|-------|---------------|-----|---------------|-------|---------------|-------|---------|-------|
| Number in Group | | | Avg Slaughter | | Avg. Color L* | | Avg. Marbling | | Avg. pH | |
| Total | Gilts | Barr. | Wt. | Age | Gilts | Barr. | Gilts | Barr. | Gilts | Barr. |
| 18 | 18 | 0 | 248 | 171 | 50.2 | | 2.17 | | 5.69 | |

Report Date: 4/16/2004

| Ear Notch | Sex | Birth Date | Dam Avg NBA | Pig NBA EPD | Dam Avg LWT | Pig LWT EPD | Loin pH | | Color L* | | Marbling Score | | Indexes | | | Sire Name & Ear Notch | Dam Ear Notch | Reg. # |
|-----------|-----|------------|-------------|-------------|-------------|-------------|---------|-------|----------|-------|----------------|-------|---------|---------|-------|-----------------------|---------------|------------|
| | | | NBA | EPD | LWT | EPD | ACT | EPD | ACT | EPD | ACT | EPD | SPI | Matern. | Term. | | | |
| 89-6 | F | 10/24/2003 | 9.1 | -0.3 | 94 | 1.8 | 5.66 | -0.01 | 50.9 | -0.25 | 2 | -0.50 | 96.4 | 107.2 | 131.4 | JOHN 66-1 | 98-4 | XXXXXXXXXX |
| 97-7 | F | 10/31/2003 | 8.4 | -0.1 | 121 | -0.3 | 5.67 | -0.01 | 52.0 | 0.06 | 2 | 0.03 | 99.0 | 109.5 | 130.6 | BILL 10-8 | 129-9 | XXXXXXXXXX |
| 102-6 | F | 11/7/2003 | 9.0 | 0.2 | 123 | -0.9 | 5.63 | -0.03 | 50.0 | -0.26 | 2 | 0.06 | 101.7 | 111.9 | 129.8 | BILL 10-8 | 113-6 | XXXXXXXXXX |
| 85-3 | F | 10/23/2003 | 4.0 | -0.1 | | 1.5 | 5.72 | 0.02 | 48.7 | -0.46 | 2 | -0.40 | 99.5 | 109.3 | 129.0 | JOHN 43-2 | 123-5 | XXXXXXXXXX |
| 99-9 | F | 11/5/2003 | 10.2 | 0.0 | 116 | 1.9 | 5.61 | -0.04 | 53.4 | 0.17 | 2 | -0.70 | 100.9 | 110.0 | 127.3 | JOHN 66-1 | 3-9 | XXXXXXXXXX |
| 86-4 | F | 10/23/2003 | 8.2 | -0.1 | 96 | -0.3 | 5.71 | 0.01 | 48.7 | -0.54 | 2 | 0.02 | 98.5 | 107.5 | 127.2 | JOHN 66-1 | 116-9 | XXXXXXXXXX |
| 102-7 | F | 11/7/2003 | 9.0 | 0.2 | 123 | -0.9 | 5.84 | 0.12 | 49.3 | -0.34 | 3 | 0.14 | 101.7 | 110.6 | 127.1 | BILL 10-8 | 113-6 | XXXXXXXXXX |
| 77-8 | F | 10/15/2003 | 10.6 | 0.0 | 105 | 0.9 | 5.63 | -0.03 | 49.7 | -0.27 | 2 | -0.01 | 100.5 | 109.0 | 126.2 | JOHN 66-1 | 53-9 | XXXXXXXXXX |
| 76-10 | F | 10/15/2003 | 9.8 | -0.1 | 99 | 1.4 | 5.59 | -0.05 | 50.9 | -0.01 | 2 | -0.05 | 100.1 | 107.9 | 124.5 | JOHN 66-1 | 132-3 | XXXXXXXXXX |
| 84-9 | F | 10/22/2003 | 13.0 | 0.2 | 90 | -1.8 | 5.75 | 0.03 | 48.6 | -0.41 | 2 | 0.06 | 100.8 | 108.1 | 123.6 | BILL 10-8 | 124-5 | XXXXXXXXXX |
| 99-5 | F | 11/5/2003 | 10.2 | 0.0 | 116 | 1.9 | 5.69 | 0.00 | 49.1 | -0.23 | 2 | -0.06 | 100.9 | 107.3 | 121.6 | JOHN 66-1 | 3-9 | XXXXXXXXXX |
| 86-1 | F | 10/23/2003 | 8.2 | -0.1 | 96 | -0.3 | 5.61 | -0.01 | 51.5 | -0.31 | 3 | 0.09 | 98.5 | 104.8 | 121.5 | JOHN 66-1 | 116-9 | XXXXXXXXXX |
| 95-6 | F | 10/28/2003 | 8.5 | 0.0 | 114 | -1.1 | 5.61 | -0.02 | 52.2 | 0.14 | 3 | 0.14 | 99.3 | 105.3 | 120.9 | BILL 10-8 | 119-6 | XXXXXXXXXX |
| 101-7 | F | 11/7/2003 | 9.8 | 0.0 | 114 | 2.1 | 5.58 | -0.08 | 51.2 | 0.05 | 1 | -0.07 | 100.3 | 104.3 | 113.8 | JOHN 66-1 | 4-8 | XXXXXXXXXX |
| 96-7 | F | 10/31/2003 | 7.3 | -0.2 | 125 | 3.2 | 5.94 | 0.13 | 46.1 | -0.44 | 2 | -0.01 | 98.7 | 101.2 | 113.0 | JOHN 66-1 | 2-9 | XXXXXXXXXX |
| 96-5 | F | 10/31/2003 | 7.3 | -0.2 | 125 | 3.2 | 5.59 | -0.02 | 52.0 | 0.09 | 3 | 0.07 | 98.7 | 100.9 | 112.5 | JOHN 66-1 | 2-9 | XXXXXXXXXX |
| 64-9 | F | 10/4/2003 | 13.7 | 0.4 | 76 | -2.2 | 5.85 | 0.09 | 50.0 | -0.03 | 2 | -0.01 | 104.7 | 106.0 | 110.5 | JIM 9-4 | 35-4 | XXXXXXXXXX |
| 64-8 | F | 10/4/2003 | 13.7 | 0.4 | 76 | -2.2 | 5.74 | 0.03 | 50.1 | -0.02 | 2 | -0.01 | 104.7 | 104.4 | 107.1 | JIM 9-4 | 35-4 | XXXXXXXXXX |
| 97-3 | LM | 10/31/2003 | 8.4 | -0.1 | 121 | -0.3 | | 0.01 | | -0.10 | | 0.05 | 99.0 | 109.3 | 130.0 | BILL 10-8 | 129-9 | XXXXXXXXXX |
| 89-4 | LM | 10/24/2003 | 9.1 | -0.3 | 94 | 1.8 | | 0.00 | | -0.36 | | 0.05 | 96.4 | 106.5 | 129.9 | JOHN 66-1 | 98-4 | XXXXXXXXXX |
| 85-2 | LM | 10/23/2003 | 4.0 | -0.1 | | 1.5 | | 0.01 | | -0.36 | | -0.05 | 99.5 | 109.5 | 129.3 | JOHN 43-2 | 123-5 | XXXXXXXXXX |
| 85-1 | LM | 10/23/2003 | 4.0 | -0.1 | | 1.5 | | 0.01 | | -0.36 | | -0.05 | 99.5 | 109.2 | 128.8 | JOHN 43-2 | 123-5 | XXXXXXXXXX |
| 77-6 | LM | 10/15/2003 | 10.6 | 0.0 | 105 | 0.9 | | 0.00 | | -0.20 | | 0.01 | 100.5 | 109.8 | 127.4 | JOHN 66-1 | 53-9 | XXXXXXXXXX |
| 84-5 | LM | 10/22/2003 | 13.0 | 0.2 | 90 | -1.8 | | 0.00 | | -0.30 | | 0.08 | 100.8 | 108.6 | 124.7 | BILL 10-8 | 124-5 | XXXXXXXXXX |
| 64-3 | LM | 10/4/2003 | 13.7 | 0.4 | 76 | -2.2 | | 0.03 | | 0.02 | | 0.00 | 104.7 | 105.0 | 108.5 | JIM 9-4 | 35-4 | XXXXXXXXXX |
| 64-2 | LM | 10/4/2003 | 13.7 | 0.4 | 76 | -2.2 | | 0.03 | | 0.02 | | 0.00 | 104.7 | 103.4 | 105.0 | JIM 9-4 | 35-4 | XXXXXXXXXX |
| 89-5 | LF | 10/24/2003 | 9.1 | -0.3 | 94 | 1.8 | | 0.00 | | -0.36 | | -0.05 | 96.4 | 108.2 | 133.4 | JOHN 66-1 | 98-4 | XXXXXXXXXX |
| 97-6 | LF | 10/31/2003 | 8.4 | -0.1 | 121 | -0.3 | | 0.01 | | -0.10 | | 0.05 | 99.0 | 109.3 | 130.1 | BILL 10-8 | 129-9 | XXXXXXXXXX |
| 84-12 | LF | 10/22/2003 | 13.0 | 0.2 | 90 | -1.8 | | 0.02 | | -0.30 | | 0.08 | 100.8 | 110.2 | 128.0 | BILL 10-8 | 124-5 | XXXXXXXXXX |
| 102-8 | LF | 11/7/2003 | 9.0 | 0.2 | 123 | -0.9 | | 0.02 | | -0.26 | | 0.09 | 101.7 | 110.5 | 126.8 | BILL 10-8 | 113-6 | XXXXXXXXXX |
| 99-11 | LF | 11/5/2003 | 10.2 | 0.0 | 116 | 1.9 | | -0.02 | | -0.12 | | -0.06 | 100.9 | 109.1 | 125.4 | JOHN 66-1 | 3-9 | XXXXXXXXXX |
| 86-3 | LF | 10/23/2003 | 8.2 | -0.1 | 96 | -0.3 | | -0.02 | | -0.47 | | 0.03 | 98.5 | 106.4 | 125.0 | JOHN 66-1 | 116-9 | XXXXXXXXXX |
| 64-11 | LF | 10/4/2003 | 13.7 | 0.4 | 76 | -2.2 | | -0.02 | | -0.12 | | -0.06 | 100.9 | 106.5 | 119.8 | JIM 9-4 | 35-4 | XXXXXXXXXX |
| 64-10 | LF | 10/4/2003 | 13.7 | 0.4 | 76 | -2.2 | | 0.03 | | 0.02 | | 0.00 | 104.7 | 106.1 | 110.9 | JIM 9-4 | 35-4 | XXXXXXXXXX |

