Genetic Improvement Options for Swine

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Goal of Selection

- Identify the animals with the best genetic merit
  - Focus on economically important traits
- Allow them to reproduce
- Cull the other animals with lower genetic merit

- ***Result = Permanent improvement in performance due to better genetics***

Economically Important Traits

- Reproduction
  - Semen quality, farrowing rate, litter size, non-productive sow days, longevity
- Growth
  - Days to market, feed conversion, mortality
- Carcass/Meat
  - Percent lean, eating quality (marbling, color, pH)

Starting Point

- *Phenotype = Genetic merit + Environment*

- Phenotype is what we see or measure
- Genetic merit is animals gene content
- Environment is the sum of the non-genetic factors that influence the expression of a trait
  - Weather, nutrition, disease, management, housing

Procedures to ID Genetically Superior Animals

- 1. Phenotypic evaluation
  - Visual assessment
- 2. Phenotypic evaluation
  - Measure trait performance
- 3. BLUP genetic evaluation
  - Using trait measurements
- 4. Molecular genetic evaluation
  - ID individual gene content

Phenotypic Evaluation (Visual Appraisal)

- *Look at the phenotype to estimate the genotype*

- Structural Soundness
  - Influences longevity
- Reproductive Soundness
  - Influences semen traits, farrowing rate
- Frame size
  - Larger frame = larger mature size, later growth

Phenotypic Evaluation (Measure Traits)

- *Objectively measure the phenotype to estimate the genotype*
- Litter size, semen quality = slight improvement
- Days to market = moderate improvement
- Percent lean = excellent improvement
- Eating quality = modest improvement

BLUP Genetic Evaluation (Using Measured Performance)

- Reduce environmental effects not related to genetics using computer based technology
  - Use of Contemporary group deviation
  - Account for other fixed effects in computerized data analysis
- Include performance information of animals that are relatives to better estimate the genetic merit of each animal
- ***Result = great increase in accuracy of selection***

Molecular Genetic Evaluation

- *Identify individual gene effects on animal performance*
- Very difficult and costly and inconsistent
- Successful in
  - Halothane gene selection
  - Rn (Napole) gene selection
- Inconsistent results in litter size, meat quality
  - Genes have different results in different populations therefore inconsistent

Steps in BLUP Genetic Evaluation: Litter Size

- 1. Define contemporary group as all sows bred and gestated during a set time frame at one farm and include in genetic analysis
  - This removes the environmental effects due to season and farm on litter size
- 2. Include breed of sow as a fixed effect in the analysis model since some breeds have greater litter size than others
  - Landrace compared to Duroc
  - F1 sows compared to purebred sows

Steps in BLUP Genetic Evaluation: Litter Size

- 3. Include parity as a fixed effect in the analysis model since parity 0 females and very old sows have less litter size than optimal parity sows
- 4. Include service sire in the analysis model since semen quality of mate can influence the litter size the sow produces
- 5. Include permanent environmental effects in the analysis model to account for effects on repeated records (ie: abnormal uterus)

Steps in BLUP Genetic Evaluation: Litter Size

- 6. Include the performance of all relatives of the sow in the genetic analysis
  - Mother's records, sister's records, cousin's records, progeny records
- These procedures have been examined and approved by the National Swine Improvement Federation and the Genetic Advisory Committee of the National Swine Registry

BLUP Example: LS

- Sow dBCXE3217
  - FT herd, CG=200207ft, LW, Parity 1, LS = 13
- Step 1: CG deviation
  - 200207ft avg LS = 11.0302 (fixed effect solution)
  - CG dev = 13 – 11.0302 = +1.9698
- Step 2: Breed of sow adjustment
  - LW fixed effect = -.5309
- Step 3: Parity of sow adjustment
  - P1 fixed effect = -.8027

BLUP Example: LS

- CG deviation adjusted for fixed effects
  - 13-(11.0302)-(-.5309)-(-.8027) = 3.3034
- BV estimated only from one individual record
  - BV = heritability X CG deviation
    - Accuracy of 3217 = .504, thus effective h^2 of .254
  - BV = 0.254 * 3.3034 = 0.84
- Now, use other relative information to estimate BV more accurately
  - Sire 1313B had 7 progeny records
  - Dam 1833 had 2 individual records

BLUP Example: LS

- $P_{3217} \overset{h}{\leftarrow} G_{3217} = ½\ BV_{Sire\ 1313B} + ½\ BV_{Dam\ 1833}$
- Three sources of info to estimate the BV of sow 3217
  - One individual record on 3217 (BV=0.84)
  - 7 progeny records of sire 1313B (BV=.39)
  - 2 litter records on dam 1833 (BV=-.35)
- Must now combine these sources of information about the BV of sow 3217

BLUP Example: LS

- To combine the sources of information to determine the best estimate of the BV of sow 3217 we must use
  - the magnitude of the BV estimate
  - the accuracy of the BV estimate
  - the genetic relationship of the source of information to sow 3217

BLUP Example: LS

Source of Information	BV estimate	BV accuracy	Genetic Relationship
3217 one ind. record	0.84	.400	1.0
1313B 7 progeny	0.39	.6343	0.5
1833 two ind. records	-0.35	.4576	0.5

BLUP Example: LS

- BV_{3217}= (0.84 * 0.40*1.0) + (0.39*0.6343*0.5)+(-0.35*-.4576*0.5)
- BV = 0.38 (based on ind+sire+dam)
- Then adjust for other relative records
  - Littermates, sibs, grandparents, cousins, etc
- BV_{3217} = 0.3966 by BLUP total analysis

Steps in BLUP Genetic Evaluation: Days to 100 Kg

- 1. Define contemporary group as all pigs farrowed and raised during a set time frame at one farm on the same rations
  - This removes these environmental effects due to season, farm and ration on growth
- 2. Include breed of pig as a fixed effect in the analysis model since some breeds have greater growth rate than others
  - Landrace compared to Duroc
  - F1 pigs compared to purebred pigs

Steps in BLUP Genetic Evaluation: Days to 100 Kg

- 3. Include sex of pig as a fixed effect in the analysis model since boars and barrows grow faster than gilts
- 4. Measure weight using electronic scales
  - Reduce measurement error
- 5. Calculate trait to be days to common market weight using formula based on published procedures and approved by National Swine Improvement Federation

Steps in BLUP Genetic Evaluation: Days to 100 Kg

- 6. Include the performance of all relatives of the pig in the genetic analysis
  - Pig's record, parent's records, sib's records, cousin's records, progeny records
- These procedures have been examined and approved by the National Swine Improvement Federation and the Genetic Advisory Committee of the National Swine Registry

Steps in BLUP Genetic Evaluation: Percent Lean

- 1. Define contemporary group as all pigs farrowed and raised during a set time frame at one farm on the same rations
  - This removes these environmental effects due to season, farm and ration on leanness
- 2. Include breed of pig as a fixed effect in the analysis model since some breeds have greater lean content than others
  - Landrace compared to Duroc
  - F1 pigs compared to purebred pigs

Steps in BLUP Genetic Evaluation: Percent Lean

- 3. Include sex of pig as a fixed effect in the analysis model since barrows are fatter than boars or gilts
- 4. Measure backfat depth and loin muscle area using Real Time Ultrasound
  - Reduce measurement error
- 5. Calculate traits to a common market weight using formula based on published procedures and approved by National Swine Improvement Federation

Steps in BLUP Genetic Evaluation: Percent Lean

- 6. Include the performance of all relatives of the pig in the genetic analysis
  - Pig's record, parent's records, sib's records, cousin's records, progeny records
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Relative Accuracy of Selection

Trait Procedure	Litter Size	Growth Rate	Percent Lean
Visual Appraisal	0.05	0.20	0.50
Measured Performance	0.12	0.55	0.70
BLUP Genetic Eval	0.50	0.75	0.85

NSIF Adjusted Backfat

ABF = BF + (desired wt. - actual wt.)*[BF/ (Actual wt - b)]

where:

- **ABF = backfat adjusted to target weight**
- **BF = actual backfat at the 10th rib, mid-loin (unadjusted)**
- **Desired wt. = Desired target weight used for standardization**
- **Actual wt. = Weight on day measured**
- **b = sex specific coefficient for calculation of fat deposition rate**
- **b = -20 for boars; b = +30 for barrows; b = +5 for females**

NSIF Days to Market

Days = Age + (desired wt. - actual wt.) * [(Age - a)/ actual wt.]

where:

- **Age = age in days at off test weight**
- **Desired wt. = Desired target weight used for standardization**
- **Actual wt. = Weight on day measured**
- **a = sex specific coefficent for calculation of growth rate**
- **a = 50 for boars; a = 50 for barrows; a = 40 for females**