Breeding Program for USA Swine Genetics

Dr. John Mabry
Iowa Pork Industry Center
Iowa State University
Ames, Iowa, USA

Swine Production Goals
- Primary goal = Maximize Profit
- Start with the best genetic merit GGP animals
- Improve the merit of the GGP animals
- Use the most efficient Genetic System
- Provide an adequate environment for the animals to express their genetic merit

USA Purebred Genetic System

USA Purebred Genetic System
- National Selection for Genetically Superior Animals
- GGP P

Best Genetic Merit Population
- Large number of purebred GGP animals
- Can identify where the genetically superior animals are within the population
- Demonstrated genetic improvement in the economically important traits

National Program to Identify the Genetically Superior Animals
- One example is STAGES = Swine Testing and Genetic Evaluation System
- Program of “across-herd” genetic evaluation
- Largest, most accurate national genetic evaluation program in the world

Duroc - Top Sires for TSI
Ranked on Terminal Index (TSI) July 2004

<table>
<thead>
<tr>
<th>Sire Name</th>
<th>Pig No</th>
<th>Dam</th>
<th>Reg. No.</th>
<th>Pig</th>
<th>BF</th>
<th>Days</th>
<th>Lbs.</th>
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<tr>
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Iowa Pork Industry Center
Maternal Line Index

Terminal Sire Index

Steps For a Successful Importation
- Tour selected purebred swine farms in USA
- Select purebred Yorkshire, Landrace and Duroc animals for purchase
- Extensive health testing of pigs
- Delivery of pigs
- Now, what do you do with them?

General Breeding Plan Strategy
- Produce Duroc, Landrace and Yorkshire animals for GGP farm
- Possibly produce GGP and GP purebred animals to sell
- Produce F1 (parent stock) females
- Produce terminal boars (AI stud)

Breeding Program Goals
- Want to make genetic improvement in the pigs you purchased
- Want to minimize inbreeding
- Value of these products is the genetic merit of the animals
  - Expressed as Breeding Value or BV

Genetic Improvement Program
- Selection (Which animals to purchase)
  - Which breed, which animals in the breed, use BV's
- Mating System (How to mate them)
  - Decide on number of desired purebred animals
  - Set up a mating plan
Genetic Improvement Program

- Utilize traditional technology
  - Heterosis
- Utilize new genetic technologies
  - Computerized data management system
  - Real-time ultrasound technology
  - BLUP based selection technology

Terminal Cross - F1 Female

- Grandparent Female Cross Y x L
- Parent Cross Duroc x F1 Y/L
- Market Hogs

Heterosis

- Litters/sow/year = +18%
- Litter size = +8%
- Preweaning mortality = -5%
- Growth rate = +5%
- Pounds product/sow/year = +40%

Heterosis Levels of Traits

Genetic System Structure

- GGP: York sows x York boars ⇒ Yorks
- GP: York sows x Land boars ⇒ F1 parents
- Parent: F1 sows x Duroc boars ⇒ market hogs

Genetic System Heterosis

<table>
<thead>
<tr>
<th>System Level</th>
<th>Maternal</th>
<th>Offspring</th>
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</thead>
<tbody>
<tr>
<td>3% GGP(York x York, Land x Land)</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>12% GP (York x Land)</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>85% PS (Duroc x F1)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Entire Genetic System</td>
<td>85%</td>
<td>97%</td>
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</table>
General Mating Plan

- **GGP = 3%** (York and Landrace sows)
  - Best Y or L sows x Y or L boars => York or Landrace GGP gilt
  - Other Y or L sows x Y or L boars => York or Landrace GP gilts
- **GP = 12%** (Yorkshire and Landrace sows)
  - Y sows x Landrace boars => LY parent gilts
  - L sows x Yorkshire boars => LY parent gilts
- **Parent = 85% F1 sows**
  - F1 sows x Duroc boars => market hogs

Starting Your GGP Herd

- Which breeds to use?
- How many of each breed?
- How many lines within each breed?
- How to mate the GGP to avoid inbreeding?

How Many of Each Breed?

- **GGP herd size = minimum 50 sows per breed**
  - The larger the GGP the greater the potential for genetic progress
- Need both maternal and terminal breeds
- Terminal Durocs
- Maternal Breeds
  - *Yorkshire and Landrace sows*

Number of Lines

- Within each breed, get animals from 3-4 unrelated lines
- Make matings of unrelated lines to produce replacement GGP and GP animals
- Must separate the Duroc, Landrace and Yorkshires into GGP lines

GGP Unrelated Matings

- Line A sow x Line B boar
- Line C sow x Line A boar
- Line B sow x Line C boar

General Purebred Mating Plan

- Divide the purchased purebreds into four separate lines (A, B, C, D)
- For the purebred matings:

<table>
<thead>
<tr>
<th>Females From Line</th>
<th>Mated To Sires From Line</th>
<th>Offspring Given Line ID</th>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>Females B, Males A</td>
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<tr>
<td>B</td>
<td>C</td>
<td>Females C, Males B</td>
</tr>
<tr>
<td>C</td>
<td>D</td>
<td>Females D, Males C</td>
</tr>
<tr>
<td>D</td>
<td>A</td>
<td>Females A, Males D</td>
</tr>
</tbody>
</table>
Enter Animals Into Inventory in Computer Program

- Data management program(s)
  - Need to monitor reproductive performance
  - Need to be able to manage growth testing
  - Need to estimate breeding value (BV)
  - Need to create indexes of BV's for selection
- Each animal that has been brought to the farm needs to be entered into inventory (sows and boars)

Animal Information into Computer

- Entry date
- ID (sow tag)
- Breed or Genetics
  - Landrace or YL Line
  - Origin
  - Waldo USA
- Pedigree Info
  - Sire and Dam
  - Date of birth
  - Alternate ID
  - Reg. number
  - Tattoo id
  - Ear Notch

Traits to Focus On for Profit

- Reproductive traits
  - Farrowing rate, litter size, preweaning mortality, wean-estrus interval, non-productive sow days
- Growth traits
  - Growth rate (ADG, days to market), feed conversion, mortality rate
- Carcass traits
  - Backfat, loin muscle area, percent lean, marbling, color, pH, water holding capacity

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

Procedures to Identify Genetically Superior Animals

1. Phenotypic evaluation
   - Visual assessment
2. Phenotypic evaluation
   - Measure trait performance
3. BLUP genetic evaluation
   - Using trait measurements

Phenotypic Evaluation (Visual Appraisal)

- Look at the phenotype to estimate the genotype
- Structural Soundness
  - Influences longevity
- Reproductive Soundness
  - Influences semen traits, farrowing rate
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

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

Selection of Boars for AI

- Should have EBV on boars for the economically important traits (top %)
  - growth rate, lean percent, litter size, etc.
- AI boars must be structurally correct

Selection of Replacement Females

- GGP females should be performance tested with EBV’s or EPD’s
- All replacement females should be structurally sound

Selection For Feet and Leg Soundness

- Breeding animals must be structurally correct and mobile to carry out normal functions
- Research suggests that soundness is heritable
- All potential breeding animals should have their structural soundness evaluated and those that are unacceptable should not be selected
### Soundness Scoring

#### Scoring System For Soundness
- Score 1-5 for the front legs and 1-5 for rear legs
- Add to get a total score of 1-10
- Unacceptable = 1-3 points (severe problems that restrict ability to breed)
- Good = 4-7 points (slight structural problems)
- Excellent = 8-10 points

### Improvement of Carcass Quality
- Carcass Quality has two components
  - Composition (percent of lean)
  - Eating quality (marbling, pH, color)
- Need to measure in the live pig if possible
- So the tested animals can be used for breeding

### Meat Quality
- Ultimately, meat quality is defined as a wholesome product that tastes good, has good value and generates repeat sales

### “Quality” Indicators
- Color
- Marbling
- Firmness
- Water holding capacity
- pH
- Tenderness
- Taste

### Color Scores
- 1
- 2
- 3
- 4
- 5
- 6
Improvement of Carcass Quality

- We can measure composition accurately on the live animal, not eating quality
- Improve eating quality by using terminal sire breed known for superior eating quality

Measuring Carcass Composition
Real-time Ultrasound Evaluation

- Breeding animal evaluation and selection
- Eliminates need to slaughter animal
- Monitor lean growth and predict growth curves

Pig Holding Crate

- Pig must be restrained so that they can be measured accurately
- Scales today had too much room for the pig to move around
- Must be easy for the pig to enter and exit

Anatomical Locations on the Pig

- Last Rib
- 10th Rib
- 5th Rib

Ultrasound Technology

- Uses high frequency sound waves to map tissue boundaries
- Sound waves received through quartz crystals
- Sound waves reflected back at different speeds from different tissues
- Central processor collects time and distance information to form ultrasound image
- Reports a measurement or image for the technician
A-mode Ultrasound

- Introduced in 1950's
- Single quartz crystal receives sound waves
- Gives point estimate of characteristics of the tissue of interest
- Digital read-out of depth or graphical representation of sound waves
- Accurate for backfat depth - inconsistent for loin depth
- Cannot measure loin muscle area.

Easy to Use Ultrasound

- Must be easy to use
- Must have probe designed to measure backfat
- Digital readout is easy to read

Renco Lean Meter

B-mode Ultrasound or Real-time

- Multiple quartz crystals
- Aligned in sequence over a linear space (up to 18 cm)
- Creates a linear ultrasonic image displayed on a video monitor
- Real-time -- updated at high rate of speed
- Highly accurate for backfat and loin muscle area

Example Ultrasound Image
On-Farm Evaluation of Backfat

- Measured at 10th rib
- 100 ± 10 kilograms
- Measure 5 cm off midline
- Average both sides for A-mode
- Single measurement for B-mode
- Backfat depth at midpoint of loin - include skin and all fat layers

Summary

- Purchase best animals from best genetic population
- Breeding program should be complete and simple
- Testing program needs correct equipment (holding scale, ultrasound machine)
- Must start computerized data management