Applications of Genomic Technology to Cattle Breeding and Management
The Role of DNA

CSI (cattle science investigations)
Introducing Scidera, Inc.
Recognized Leader in Livestock Genomics

On March 18, 2011, all assets and IP of the former companies MetaMorphix, Inc. and MMI Genomics, Inc. were purchased by a group of investors to form Scidera, Inc. Aquired all

- Genomics discovery assets
- Whole genome sequences (livestock)
- High-throughput genotyping platforms
- Powerful bioInformatics & data systems

Same staff and facilities

- Based in Davis, CA
- 30 employees
- Strong customer base
- Industry alliances

Same DNA-based testing services

- Industry pioneer (over 20 years)
- 30 employees
- Over 3,000,000 samples tested
- > 99% on-time delivery
- Reputation for high accuracy

First Lab to Offer DNA Genotyping for Cattle
Major Uses for Genetic Markers

- Trait Testing
- Identification
- Parentage Testing: Who’s your Daddy?
- Breed Determination: CSI - Are they guilty?
- Disease Testing: What’s going to do me in?
- Trait Testing: What are your talents?
DNA and Cattle Associations

1. Why DNA is Important
2. What are Scidera’s Cattle ID & Parentage Products?
3. What are Scidera’s BREED-TRU™ Products?
4. Where We Are
   Future Value Propositions as We Roll Out
   New Trait Tests Breed by Breed
Why DNA is Important

Cattle Associations use Scidera’s DNA Services to

1. Certify Studbook Records
   Protect Value of the Breed
   ID Individual Animals and Certify their Offspring
2. Protect Breed Integrity and Inherent Traits
3. Create Value,
   Growth and
   Opportunity for
   their Membership
DNA ID & Parentage Products
TRU-Parentage™

- Highest Standard of Record Keeping
- Unique, Permanent DNA ID - Tracability
- DNA Certified Pedigrees (Purebred & Crossbred)
  - Breed Association Requirements
  - Genetic Guarantee of Traits
- Quality Control for AI, ET & Multiple-Sire Calves
- Forensic and Legal Cases – 100% Successful Track Record
- Population and Family Studies
- Standardized Database Allows Comparisons Without Retesting
- Sample Archived for Future Testing
Breed Associations

- Fulfill requirements for registration
  - Fullblood
  - Purebred
  - Percentage AI sires
  - ET donor Dams
  - All live cattle genetics sold at Association sanctioned production sales

Services
- Database creation (reference only)
- Verification of parents: sire, dam, both
- Sample archive

Multi-sire Breeding
- Intentional: multi-sire breeding program
- Unintentional
  - Fence jumping
  - Calves between AI dates
  - ID to sire without dam
Customers of Current Products

Canine
Breed Registries & Parent Breed Clubs
  AKC
  United Kennel Club
  Professional Kennel Club
Breeders and Pet Owners

Cattle
Breed Registries and Ranches
  International Brangus Breeders Association
  Beefmaster Breeders United
  North American Limousin Foundation
  Red Angus Association of America
  American Bucking Bull, Inc.
  American Saler Association
  American Senepol Association
  American Wagyu Association
  Braunvieh Association of America
  North American Piedmontese Association
DNA Sampling: Scidera MicroCards

Benefits of MicroCards
- Convenient: only requires a single drop of blood or nasal swab transferred to MicroCard
- Stable: room temperature storage and shipping
- Reliable: few failures

DNA Sample Collection Kit Components
- Sample Order Form
- Scidera MicroCard
- 18-Gauge Hypodermic Needle or Nasal Swab

Acceptable Sample Formats
- Scidera MicroCards (preferred)
- Additional charge for
  - Semen (ship thawed)
  - Hair
DNA Sampling: Collecting a Good Sample is Key
Two Panels of Microsatellite DNA Markers make up the historic DNA database

- **ISAG Panel: StockMarks 2**
  - Scidera’s primary panel for parentage determination
  - Meets ISAG standards
  - Data interchangeable with other labs and associations
  - Data is accepted throughout the world

- **Urbana Panel:**
  - Scidera’s secondary panel
    - Used for difficult multi-sire situations
    - Problem resolution
  - Ten marker panel

- Single Nucleotide Polymorphism (SNP) Marker Panels
  - Scidera has thousands available
  - Advantages
  - Disadvantages
### Power of DNA ID & Parentage Markers
**ISAG 11 Marker Panel**

<table>
<thead>
<tr>
<th>Breed</th>
<th>MPR</th>
<th>MPFS</th>
<th>EPR</th>
<th>EPFS</th>
<th>EP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holstein</td>
<td>8.49E-12</td>
<td>7.43E-05</td>
<td>0.9998</td>
<td>0.9613</td>
<td>0.9930</td>
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<tr>
<td>Jersey</td>
<td>6.02E-10</td>
<td>1.77E-04</td>
<td>0.9985</td>
<td>0.9320</td>
<td>0.9723</td>
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<tr>
<td>Braunvieh</td>
<td>1.61E-09</td>
<td>2.74E-04</td>
<td>0.9981</td>
<td>0.9229</td>
<td>0.9688</td>
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<tr>
<td>Red Angus</td>
<td>3.74E-10</td>
<td>1.64E-04</td>
<td>0.9989</td>
<td>0.9375</td>
<td>0.9759</td>
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<tr>
<td>Beefmaster</td>
<td>2.18E-11</td>
<td>7.07E-05</td>
<td>0.9997</td>
<td>0.9592</td>
<td>0.9905</td>
</tr>
<tr>
<td>Wagyu</td>
<td>1.25E-10</td>
<td>1.10E-04</td>
<td>0.9994</td>
<td>0.9476</td>
<td>0.9834</td>
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<tr>
<td>Angus</td>
<td>1.02E-09</td>
<td>2.05E-04</td>
<td>0.9982</td>
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<td>0.9677</td>
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<td>Hereford</td>
<td>1.85E-08</td>
<td>5.33E-04</td>
<td>0.9948</td>
<td>0.8929</td>
<td>0.9350</td>
</tr>
<tr>
<td>Rodeo Stock</td>
<td>2.99E-13</td>
<td>2.96E-05</td>
<td>0.99997</td>
<td>0.9800</td>
<td>0.9981</td>
</tr>
</tbody>
</table>

MPR = Matching Probability of two unrelated individuals  
MPFS = Matching Probability for Full Siblings  
EPR = Exclusion Power when putative and real parent are unrelated and assuming the other parent is known  
EPFS = Exclusion Power when putative and real parent are full siblings and assuming the other parent is known  
EP1 = Exclusion Power when offspring is confronted with only one putative parent, the other parent not being available or not known
Scidera Pedigree Validation is Essential for Research and Genetic Improvement

- Progeny test daughter analysis
  - New Zealand Project (60,000 Dairy Cattle)
    - DNA sire verified all progeny test daughters
    - Determined 14% error rate in recorded pedigrees
    - Outcome – Improved accuracies of genetic evaluations
Parentage is Determined by Exclusion and Inclusion

<table>
<thead>
<tr>
<th></th>
<th>Calf</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
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<tr>
<td>Marker 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marker 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marker 3</td>
<td></td>
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</table>

Excluded
DAD
Excluded
DNA Multi-Sire Analysis

<table>
<thead>
<tr>
<th>Tested Animal</th>
<th>BM1824</th>
<th>BM2113</th>
<th>ETH10</th>
<th>ETH225</th>
<th>ETH3</th>
<th>INRA23</th>
<th>SPS115</th>
<th>TGLA122</th>
<th>TGLA126</th>
<th>TGLA227</th>
<th>TGLA53</th>
<th>Parentage</th>
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</thead>
<tbody>
<tr>
<td>Bull 1</td>
<td>125/181</td>
<td>125/139</td>
<td>217/217</td>
<td>140/142</td>
<td>119/125</td>
<td>214/216</td>
<td>252/256</td>
<td>137/141</td>
<td>119/121</td>
<td>77/81</td>
<td>160/186</td>
<td>paternity excluded</td>
</tr>
<tr>
<td>Bull 2</td>
<td>140/142</td>
<td>139/141</td>
<td>219/219</td>
<td>140/144</td>
<td>101/123</td>
<td>216/218</td>
<td>250/254</td>
<td>137/145</td>
<td>121/127</td>
<td>77/93</td>
<td>160/184</td>
<td>paternity excluded</td>
</tr>
<tr>
<td>Bull 3</td>
<td>146038A</td>
<td>125/133</td>
<td>217/219</td>
<td>140/142</td>
<td>101/113</td>
<td>214/218</td>
<td>248/256</td>
<td>141/141</td>
<td>121/125</td>
<td>83/93</td>
<td>160/160</td>
<td>paternally included</td>
</tr>
<tr>
<td>Calf</td>
<td>202144A</td>
<td>133/137</td>
<td>217/218</td>
<td>140/142</td>
<td>101/129</td>
<td>214/214</td>
<td>248/260</td>
<td>141/143</td>
<td>121/121</td>
<td>83/93</td>
<td>160/164</td>
<td>paternally included</td>
</tr>
</tbody>
</table>

exclusion

Data shown using ISAG standardized allele nomenclature
Application to Integrated Production Systems

Create a Link Between Genetics and Profits
DNA-based Sire Verification

Carcasses
- The Good (Prime)
- The Bad (Select)
- The Ugly (Out Cattle)

Sire Identification through DNA testing

Bulls
- Keep
- Cull
- Replacement

- Using parent verification to increase profitability
  - ID bulls not producing calves
  - Genetic Improvement Programs
Bull Fertility - Percentage of Calves Sired

Each bull in a multiple sire breeding pasture does not sire an equal number of calves

- differences in genetic potential of calves
- feeding bulls that are not contributing to the next generations
50% of the bulls sire 80% of the calves
DNA Certified Beef Program

- Production
- Harvest
- Retail
- Consumption

DNA-based System Audits
DNA-based Problem Resolution
The Role of DNA

Advances in Genetic Trait Testing
Animal Genomes

Using its **Genius - Whole Genome System™**, Scidera scientists developed sets of DNA markers for association studies.

- 786,000 Proprietary Bovine SNPs identified (August, 2001)
- 115,000 SNPs identified in public projects (March, 2006)

- Public Canine Sequence
  - 650,000 Putative SNP Markers
- Cattle Sequence
  - 786,777 Putative SNP Markers
- Swine Sequence
  - 631,000 Putative SNP Markers
- Chicken Sequence
  - 96,000 Putative SNP Markers
SNPs (Single Nucleotide Polymorphisms)

Angus
Wagyu

Differences in DNA Lead to Differences in Cattle
Genetic Management

Genetics + Management = Phenotype

How much value can genetics create?

Products must have DNA markers tightly associated with genes.
Cargill – Scidera
Whole Genome Discovery Strategy

800,000 Putative Mapped SNPs  6,000 Validated SNPs  Associated Diagnostic SNPs

Marbling  Tenderness  Yield Grade  ADG
Outcomes

- Identified 100’s of regions across the genome that influence production, carcass and consumer traits

- Products account for a significant amount of the genetic differences among animals for these traits

  Tru-Parentage™
  Tru-Marbling™
  Tru-Polled™
  Tru-Tenderness™
  Tru-CoatColor™
  Tru-Finish™
Diagnostic SNPs on a Chip

- Breeding
- Management & Selection

- Branding
  Breed Identity

- Source Verification
  Traceability

Carcass Traits
Production Traits
Tenderness
Feedlot Management
Technology Application

and Value Creation
Using Genetic Markers to Improve Breeds

Average Daily Gain

3.0 lbs/day

Mean

Using MAS, you can achieve rapid improvement in a particular trait by selecting the top individuals and using them to create a new breed or line.
Using Genetic Markers to Improve Breeds

Average Daily Gain

3.0 lbs/day

Cull

Mean

MAS can also be used to achieve steady progress with a particular trait by culling the bottom group in your breeding population.
Using Genetic Markers to Improve Breeds

- Either strategy allows for dramatic improvement in traits over a very short period of time.

Mean

3.0 lbs/day
Either strategy allows for dramatic improvement in traits over a very short period of time.
Either strategy allows for dramatic improvement in traits over a very short period of time.
Opportunity for Value Creation

Supply

Demand

Standard
Select
Choice
Prime

Quality Grade
Value Creation Opportunities in Beef

- Breeders & Producers: Breeding Tools
  - Increase accuracy of selection
  - Target traits difficult to measure with traditional selection
- Producers & Feeders: Animal Management Tools
  - Sort and manage animals based on genetic potential
  - Optimized marketing
- Packers/Processors: Branded Beef Products
  - Create range of branded products with guaranteed palatability attributes
  - Forward marketing/sales of beef products based on predictable supply

All Segments: Parent Verification & Identity Products
Cargill – Scidera Project Outcome
Breeding & Management Products

Diagnostic Assays Enable

– Advanced Breeding Tools
  • Focus on traits that create value
  • Increase speed & accuracy of selection
  • Marker information will be incorporated into existing genetic evaluations
  • Products will account for the majority of genetic variation

– Animal Management Tools
  • Sorting based on genetic potential
  • Feed cost savings
  • Optimized marketing
  • Branded Meat Products
Seedstock Products

Animal Breeding and Selection Tools
TRU-Polled™ Trait Test

Use Markers as signposts to predict underlying effects
  – Horned vs Polled – Polled is dominant to horns
  – Scidera developed a SNP-based test determines if an animal is homozygous for polled or heterozygous
Scidera’s DNA Testing Pays

**DNA TRU-Polled™ Testing Makes 12 to 1 Return on Investment**

NALF-sponsored research at Colorado State University using 2005-2006 sale-price data from more than 2,500 Limousin bulls.
Joint Research Collaboration with Cargill

- Use commercial population for research and validation
- Requires thousands of animals - 4000 feedlot steers
- Requires thousands of markers

Over 20 million genotypes generated
Complex Trait Diagnostics

Traditional discovery approaches pick up very few genes that contribute to complex metabolic traits and fail to pick up the many genes that do.

*TRU-Marbling™* – 128 Proprietary SNP Markers  
*TRU-Tenderness™* – 11 Proprietary SNP Markers  
*TRU-Gain™* – 92 Proprietary SNP Markers

“Deliver a high quality, tender product to the consumer time after time”
Molecular Genetic Value (MGV)

**Molecular Genetic Value** is an estimate of the genetic potential of an individual animal. It is the sum of all genetic effects at specific genome locations including additive and non-additive effects. (Tech. Bull. B0702.01)
# MOLECULAR GENETIC VALUE (MGV) REPORT

**NAME**
Legends of the West - Angus Farm

**ADDRESS**
13457 Trujillo Creek Road
Aguilar, CO 81020

**CONTACT**
Wes Johnson, Foreman

**REPORT DATE** 08/23/2006

**ORIGINAL REPORT** 08/23/2006

**CASE ID** MT-0059302S

**CUSTOMER** LWAF - Legends of the West Angus Farm

---

# TRU-MARBLING and TRU-TENDERNESS REPORT

<table>
<thead>
<tr>
<th>BREED</th>
<th>NAME</th>
<th>REG #</th>
<th>TAG/ TATTOO</th>
<th>SEX</th>
<th>BORN</th>
<th>SAMPLE ID</th>
<th>MARBLING MGV</th>
<th>TENDERNESS MGV</th>
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</thead>
<tbody>
<tr>
<td>Angus</td>
<td>AF Paul Bunyan</td>
<td>19352178</td>
<td>AZ-105</td>
<td>M</td>
<td>06/14/2004</td>
<td>0539812G</td>
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<td>0.92</td>
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<td>Angus</td>
<td>AF Casey Jones</td>
<td>19352211</td>
<td>AZ-112</td>
<td>M</td>
<td>05/29/2004</td>
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<td>AZ-146</td>
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<td>AZ-175</td>
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<td>12/20/2004</td>
<td>0539815G</td>
<td>70.15</td>
<td>-4.40</td>
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# Results in Commercial Feedlot Cattle Quality Grade

<table>
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<tr>
<th>Grade</th>
<th>Number of Observations</th>
<th>Avg. MGV</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime</td>
<td>3</td>
<td>34.53</td>
<td>5.10</td>
</tr>
<tr>
<td>High Choice</td>
<td>62</td>
<td>21.54</td>
<td>2.56</td>
</tr>
<tr>
<td>Medium Choice</td>
<td>785</td>
<td>15.04</td>
<td>0.78</td>
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<tr>
<td>Low Choice</td>
<td>3128</td>
<td>9.49</td>
<td>0.40</td>
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<tr>
<td>Select</td>
<td>10881</td>
<td>-5.03</td>
<td>0.22</td>
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<tr>
<td>No Roll</td>
<td>1477</td>
<td>-18.68</td>
<td>0.52</td>
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</tbody>
</table>
Feedlot *Tru-Marbling™* and *Tru-Gain™*

**Value Proposition**

- **DNA Genotyping:**
  - to determine genetic potential
- **Sort:**
  - into outcome groups based on genetic potential
- **Manage:**
  - to optimize the genetic potential of each group
- **Market:**
  - into grid-based program that provides greatest return
## Feedlot Sorting and Management Opportunities

<table>
<thead>
<tr>
<th>Group</th>
<th>Low Potential</th>
<th>Standard Potential</th>
<th>High Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tru-Gain MGV</td>
<td>0.4</td>
<td>0.491</td>
<td>0.553</td>
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<tr>
<td>Tru-Marbling MGV</td>
<td>-14.581</td>
<td>-2.054</td>
<td>11.559</td>
</tr>
<tr>
<td>Initial Wt</td>
<td>736</td>
<td>726</td>
<td>726</td>
</tr>
<tr>
<td>DOF</td>
<td>169</td>
<td>175</td>
<td>180</td>
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<tr>
<td>Final Wt</td>
<td>1323</td>
<td>1339</td>
<td>1350</td>
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<tr>
<td>ADG</td>
<td>3.516</td>
<td>3.558</td>
<td>3.538</td>
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<tr>
<td>REA</td>
<td>14.82</td>
<td>14</td>
<td>13.26</td>
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<tr>
<td>BF</td>
<td>0.42</td>
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<td>0.63</td>
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<tr>
<td>MS</td>
<td>1.367</td>
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</tr>
<tr>
<td>YG</td>
<td>2.5</td>
<td>3.08</td>
<td>3.58</td>
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<tr>
<td>N</td>
<td>2528</td>
<td>5055</td>
<td>2528</td>
</tr>
</tbody>
</table>

* Data sorted by actual MS (bottom 25%, mid 50%, top 25%)
# Carcass Value Grid Example

<table>
<thead>
<tr>
<th>Quality Grade Adjustment</th>
<th>Yield Grade Adjustment</th>
<th>Carcass Wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime</td>
<td>YG1</td>
<td>&lt;500 lbs ($35.00)</td>
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<tr>
<td>$7.00</td>
<td>$5.00</td>
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</tr>
<tr>
<td>Choice</td>
<td>YG2</td>
<td>500-599 ($10.00)</td>
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<tr>
<td>$2.50</td>
<td>$3.00</td>
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<tr>
<td>Select</td>
<td>YG3</td>
<td>600-950 $0</td>
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<tr>
<td>($10.00)</td>
<td>$0</td>
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<tr>
<td>No Roll</td>
<td>YG4</td>
<td>951-999 ($10.00)</td>
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<tr>
<td>($12.00)</td>
<td>($15.00)</td>
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</tr>
<tr>
<td></td>
<td>YG5</td>
<td>&gt; 999 ($35.00)</td>
</tr>
<tr>
<td></td>
<td>($25.00)</td>
<td></td>
</tr>
</tbody>
</table>

**Tru-Marbling MGV<<0**
Hit high end of target weight
Implant aggressively, market as YG1, reduce days on feed

**Tru-Marbling MGV 0-10**
Evaluate choice-select spread
Determine feed cost for increasing number of days on feed

**Tru-Marbling MGV>20**
Target for premium markets
Feedlots – The TRU-Finish™ Opportunity

Pen of Cattle

Determine marbling (DNA) and back fat thickness (ultrasound) data

Sort based on DNA marbling scores

High marbling
No Implant
Sort based on back fat thickness to determine DOF
Short

Low marbling
Implant
Sort based on back fat thickness to determine DOF
Short

Scidera
Feedlots – The Opportunity

Results of Tru-Finish Management System

<table>
<thead>
<tr>
<th></th>
<th>Prime</th>
<th>Choice</th>
<th>Select</th>
<th>No Roll</th>
<th>YG 4/5s</th>
<th>Over/Under</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>&lt;1.0%</td>
<td>20.99%</td>
<td>75.4%</td>
<td>2.59%</td>
<td>19.6%</td>
<td>20.8%</td>
</tr>
</tbody>
</table>
Feedlots – The Opportunity

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<tr>
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<td>2.59%</td>
<td>19.6%</td>
<td>20.8%</td>
</tr>
<tr>
<td>Premium</td>
<td>4.2%</td>
<td>88.57%</td>
<td>6.19%</td>
<td>1.04%</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Feedlots – The Opportunity

Results of Tru-Finish Management System

<table>
<thead>
<tr>
<th></th>
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<td>75.4%</td>
<td>2.59%</td>
<td>19.6%</td>
<td>20.8%</td>
</tr>
<tr>
<td>Premium</td>
<td>4.2%</td>
<td>88.57%</td>
<td>6.19%</td>
<td>1.04%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.96%</td>
<td>&lt;0.5%</td>
</tr>
</tbody>
</table>
TRU-Marbling™ and TRU-Tenderness™

Value Proposition for Seedstock Segment

- MGVs can be used to rank animals genetically
- MGVs can be used to mate specific animals
- MGVs can be estimated at any time in an animal’s life
- MGVs can increase the accuracy of selection and decrease the age at which animals can be selected.
TRU-Marbling™ and TRU-Tenderness™

Value Proposition for Feedlot Segment

- Reduced feed costs by feeding to the optimum end-point/growth curve, not beyond
- Increased carcass value by hitting thresholds for quality,
- Market to the optimum grid or pricing formula based on genetic potential and management scheme
- Improved ability to forecast product mix between choice and select quality grades,
- Enhanced ability to supply product for branded programs

Sample Collected on EID cattle
MGVs or Sort Programs for Tru-Finish Tru-Gain
Forecast on quality grades 60-90 pre-harvest

Supply management for branded programs

Feedlot
Scidera
Processor
TRU-Marbling™ and TRU-Tenderness™

Value Proposition for Cow/Calf Segment

Advantages of Utilizing MGVs

- Select cattle for breeding
  - To accelerate quality improvements
  - To reduce feed costs
  - Herd sire and replacement female selection
  - More accurate estimate of epds from birth
- Evaluation of genetic needs
  - Direct selection pressure to address weaknesses
- Identify sires of calves
  - For sire selection on replacement females
  - For herd sire evaluation report
- Evaluate qualities of cattle at point of sale
  - To retain ownership or not
  - To target correct customers
  - To determine proper pre-sale management practices
- Provide additional value to a feedlot that uses the information for sorting
Summary

• Continue to be the leader in providing DNA testing services to the livestock and companion animal industries:
  • Provide unparalleled levels of customer satisfaction and value
  • Operate with great efficiency
  • Strive to understand our customer’s business so that we can better provide genomic solutions to address their needs and create value
  • Continually evaluate technologies to allow us to more efficiently and economically extract genetic information
Scidera’s BREED-TRU™ Products

- TRU-Parentage
- TRU-Polled™
- TRU-CoatColor™
- TRU-Marbling™
- TRU-Tenderness™
- TRU-Finish™
- TRU-Gain™
- Myostatin
- Dwarfism
- Osteopetrosis
- Alpha-Mannosidosis