

**Anand Workshop 2014**

# **Impact of Genomics on the AI Industry**

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# Size and Scope

9 Joint Ventures  
60+ Countries  
4 mil. Units  
Development



Finance  
Public Relations  
Information Technologies



**AgSource**  
**Cooperative Services**

A Subsidiary of Cooperative Resources International

- ✓ 4,414 Members
- ✓ 694,000 Cows
- ✓ 5.2M Milk Samples
- ✓ 38,800 Feed Samples
- ✓ 774,000 Soil Samples
- ✓ 42,500 Water Tests



**Genex**  
**Cooperative, Inc.**

A Subsidiary of Cooperative Resources International

- ✓ 16,000 Members
- ✓ 60,000 Herds
- ✓ 1.9M Matings
- ✓ 4.5M Units

**Farm Systems**  
\$8.6M Sales

**Central Livestock**  
363,091 Cattle  
178,589 Hogs  
83,227 Sheep  
624,907 Total

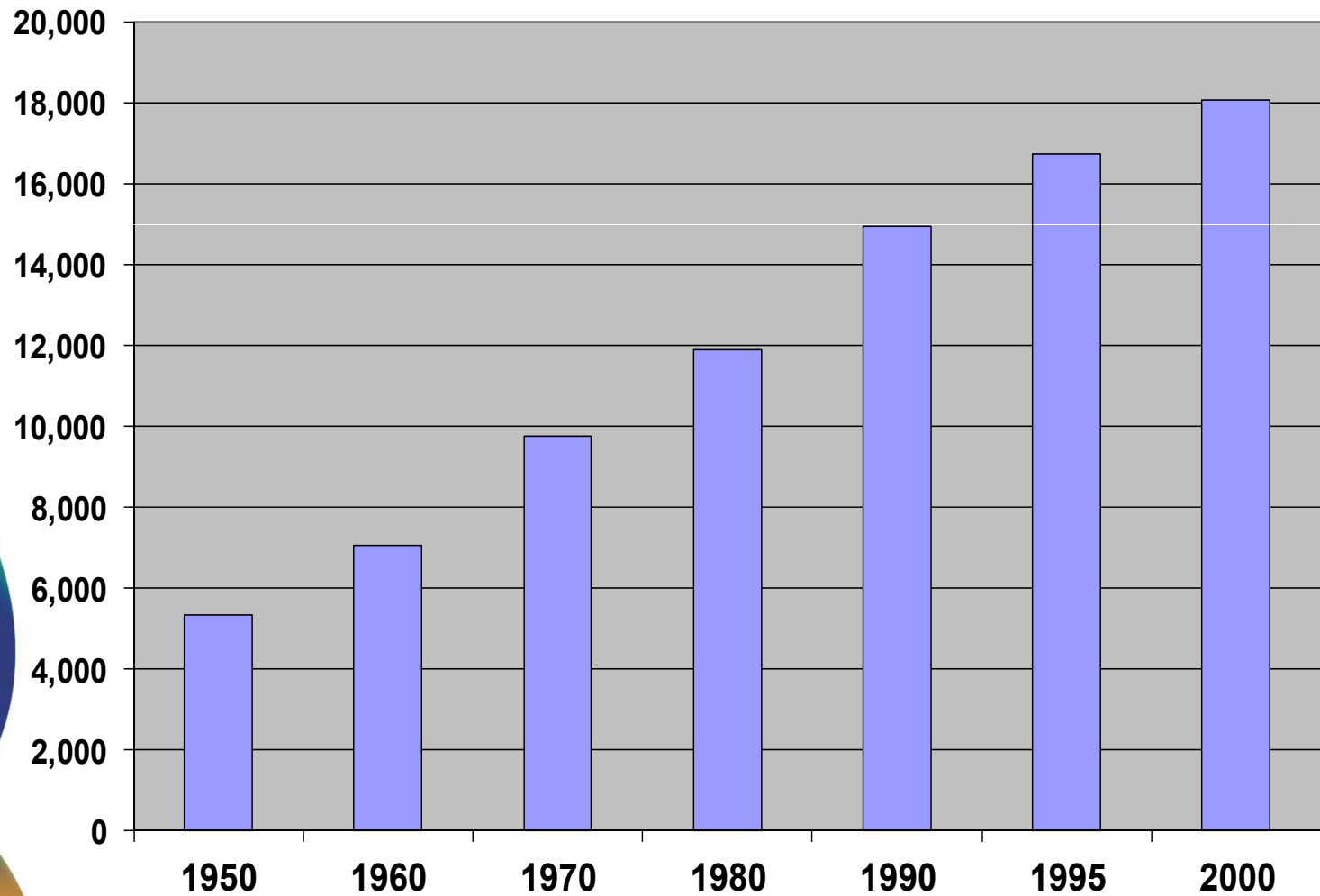




## **1950: About the time of frozen semen introduction**

- **Dairy cows**                      **22 million**
- **Bred AI**                              **2.6 million**
- **Bull studs**                              **97**
- **Milk per cow**                      **5,314 lb**

# Milk Production per Cow





# DNA Businesses

- **Genomics & cloning businesses**
  - 1989 GenMark → Infigen
  - Mid 90s ABS → 1998 Infigen; MAS 1996-2003
  - 1998 Genetic Solutions → Pfizer
  - 2000 GenomicFX → folded
  - 2002 ViaGen + ProLinia → TransOva
  - 2003 IGENITY → Neogen/GeneSeek
  - 2003 Bovigen → Pfizer → Zoetis
- **Genotyping laboratories**
  - GeneSeek → Neogen
  - Genaissance
  - Sequenom
  - Expression Analysis
  - Several in other countries

# Bovine Genome Sequencing Project

➤ **\$53 million project with funding from:**

- NIH
- State of Texas
- USDA
- Other USA sources
- Genome Canada
- CSIRO, Australia
- Ag Research, New Zealand

➤ **Started December 2003**

➤ **18 months to finish**

➤ **Total cost > \$75 million**

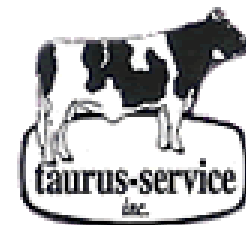


**L1 Dominette 01449**



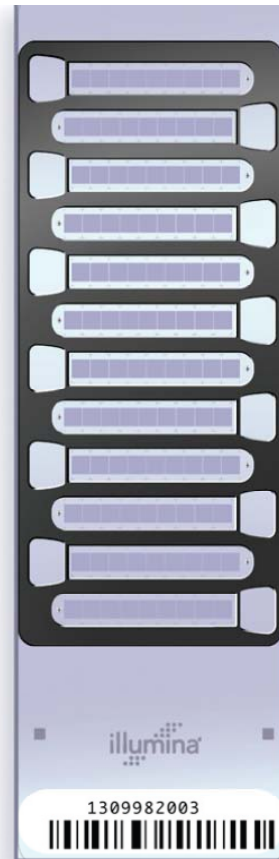
# CDDR Contributors

(Cooperative Dairy DNA Repository)



10 straws/bull

# Illumina BovineSNP50 Genotyping BeadChip



**\$250 per animal initially;  
< \$85 now**

TABLE 3: BOVINESNP50 BEADCHIP CONTENT VALIDATION

BREED	SAMPLES	POLYMORPHIC LOCI*	MEAN MAF <sup>†</sup>	MEDIAN MAF <sup>†</sup>
Angus	60	41,491	0.21	0.21
Beefmaster	24	42,925	0.22	0.21
Bos indicus Gir	24	23,971	0.11	0.02
Bos indicus Nelore	21	25,814	0.11	0.02
Brahman	25	30,284	0.13	0.08
Brown Swiss	24	36,347	0.19	0.17
Charolais	26	42,589	0.22	0.21
Guernsey	21	38,632	0.19	0.17
Hereford	32	42,992	0.20	0.23
Holstein	64	42,730	0.22	0.22
Jersey	28	35,976	0.18	0.14
Limousin	45	42,821	0.22	0.22
N'Dama	25	29,049	0.14	0.08
Norwegian Red	21	42,782	0.22	0.21
Piedmontese	24	42,185	0.22	0.21
Red Angus	15	40,188	0.21	0.20
Romagnola	24	38,830	0.20	0.19
Santa Gertrudis	24	42,064	0.22	0.21
Sheko	20	35,726	0.17	0.12
Outgroup <sup>‡</sup>	18	11,206	0.05	0.00
<b>Overall</b>	<b>565</b>	<b>47,545</b>	<b>0.25</b>	<b>0.24</b>

\*MAF > 0.05

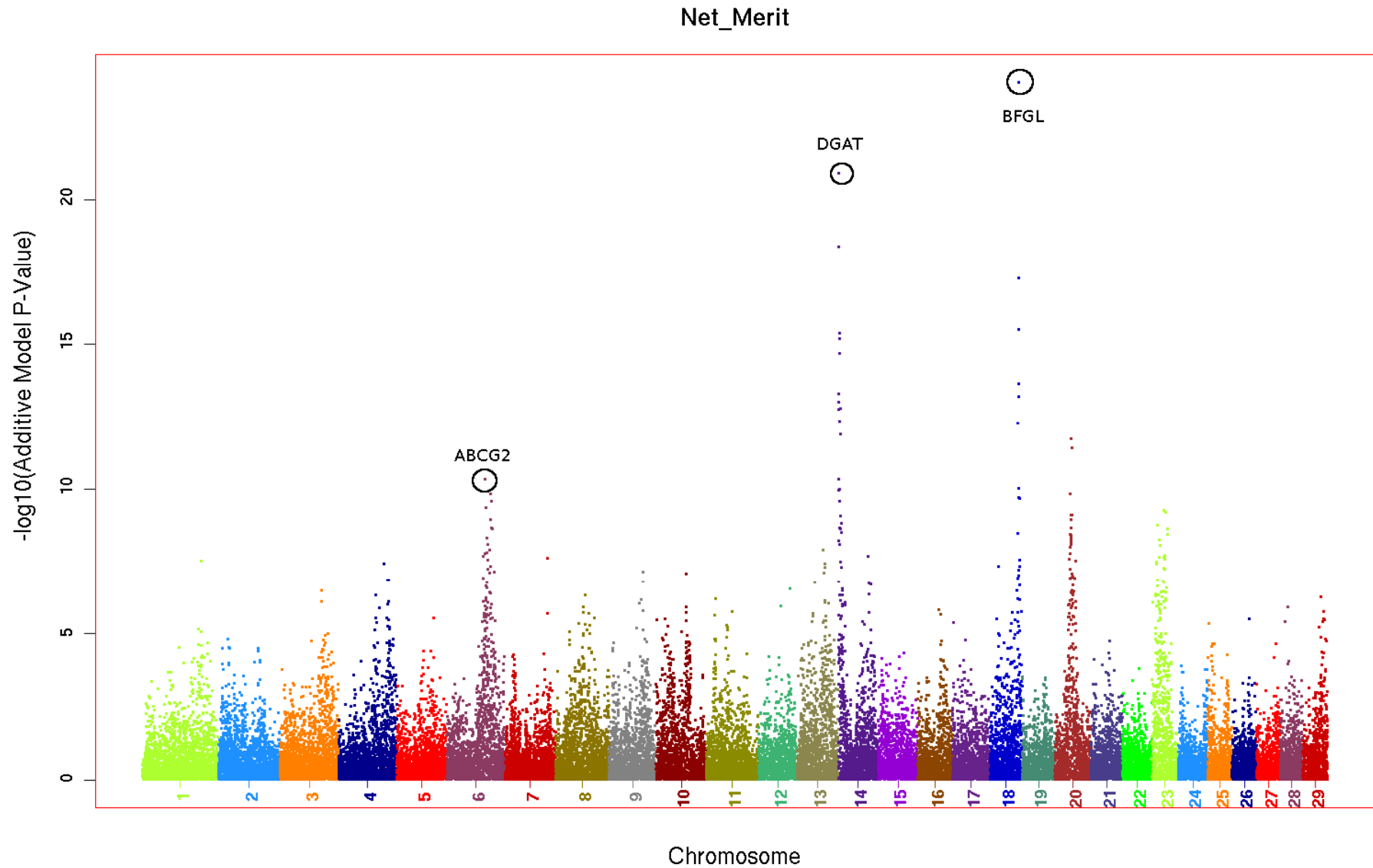
<sup>†</sup>Across all 54,001 loci

<sup>‡</sup>*Bos bison*, *Bos gaurus*, *Bos grunniens*, *Bos javanicus*, *Bubalus depressicornis*, and *Syncerus caffer*.





# Marker Effects for LNM\$





**Impact of Genomics on**

# **SOURCING GENETICS**

# Sourcing Genetics at Genex before Genomics

- **US Cow Population (75%)**
  - top 0.5% Net Merit
  - 240 bulls
- **MOET population (25%)**
  - 80 bulls



# Genesis MOET Program

- **1989 Started pilot program**
- **Contract 100 bull mothers**
- **4 embryos from each implanted into recipients**
- **Produce 1 bull & 1 heifer**
- **Top 80 bulls sampled**
- **Top 40 heifers – MOET**





# Genesis

the future of your herd and ours


Post-G

- > 45,000 cows and breeding-age heifers
- 17 production sites and nucleus herds
- ~300 Donor females selected for ET/IVF
  - > 80 maternal families represented

Expect to produce 3,500 embryos

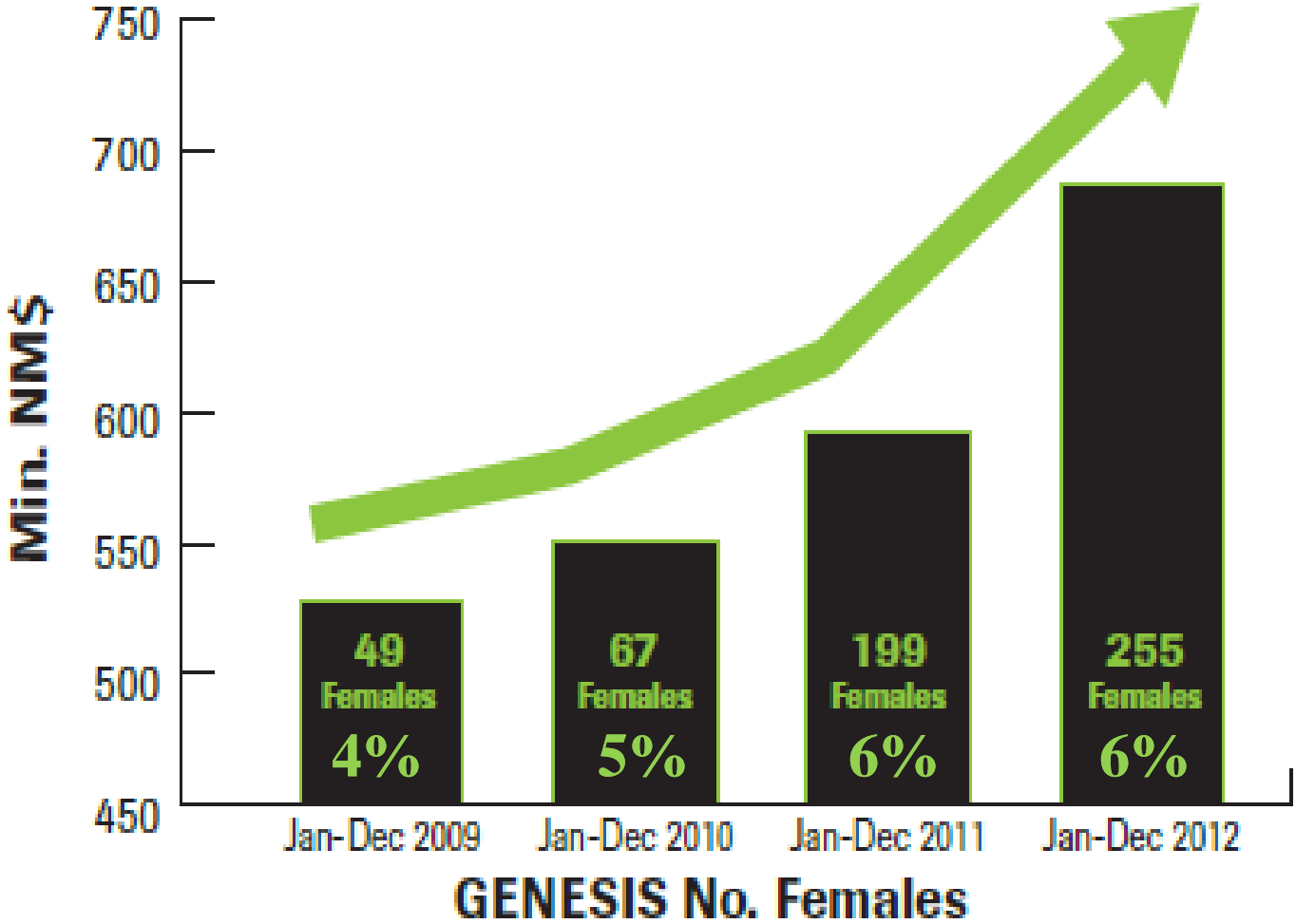
85 to 100 ET bulls selected, & natural calves

# Genex Genomic Males BYR 2012

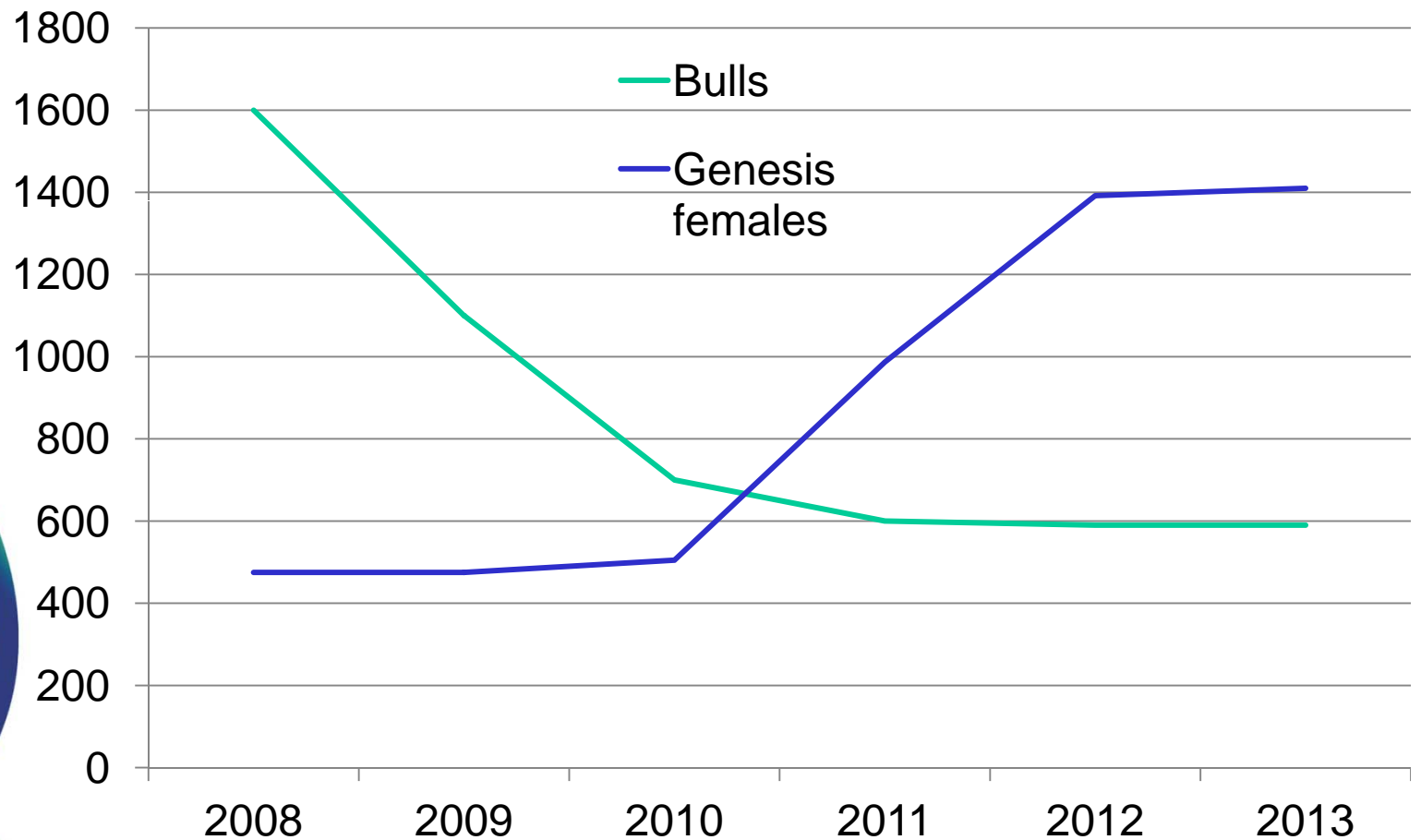


<u>Genetic level</u>	<u>GENESIS</u>	<u>Outside sources</u>
<b>&gt;=900 NM</b>	<b>2</b>	<b>2</b>
<b>850-899 NM</b>	<b>5</b>	<b>2</b>
<b>800-849 NM</b>	<b>14</b>	<b>13</b>
<b>750-799 NM</b>	<b>41</b>	<b>25</b>
<b>700-749 NM</b>	<b>64</b>	<b>64</b>
<b>650-699 NM</b>	<b>110</b>	<b>108</b>
<b>600-649 NM</b>	<b>128</b>	<b>126</b>

### Top 5% of Genomic Tested Females by Birthdate



# Change in Animal Population at Genex





# Female Nucleus Programs

AI companies are transitioning from managing only bulls to also managing elite females







**Impact of Genomics on**

# **PROGENY VS. GENOMIC TESTING**

# AI Center Population before Genomics

- 
- **75 bulls routinely collected**
    - 35 Progeny-test bulls
    - 40 “Proven” mature bulls
      - 4 – new “Proven” bulls from SS
      - 36 – “Proven” bulls (3 yr life span)
  - **350 – bulls ‘in-waiting’ population**
  - **35 – Quarantine**
- 
- **460 head – Total bull population**

# AI Center Population

- 
- **40 – bulls in Quarantine**
  - **235 bulls in Collection Barn**
    - 110 – bulls in collection – yr 1
    - 75 – bulls in collection – yr 2
    - 50 – bulls in collection – yr 3
    - Average age 21 mo
- 
- **275 hd – Total bull population**



# Progeny Test vs. Genomic

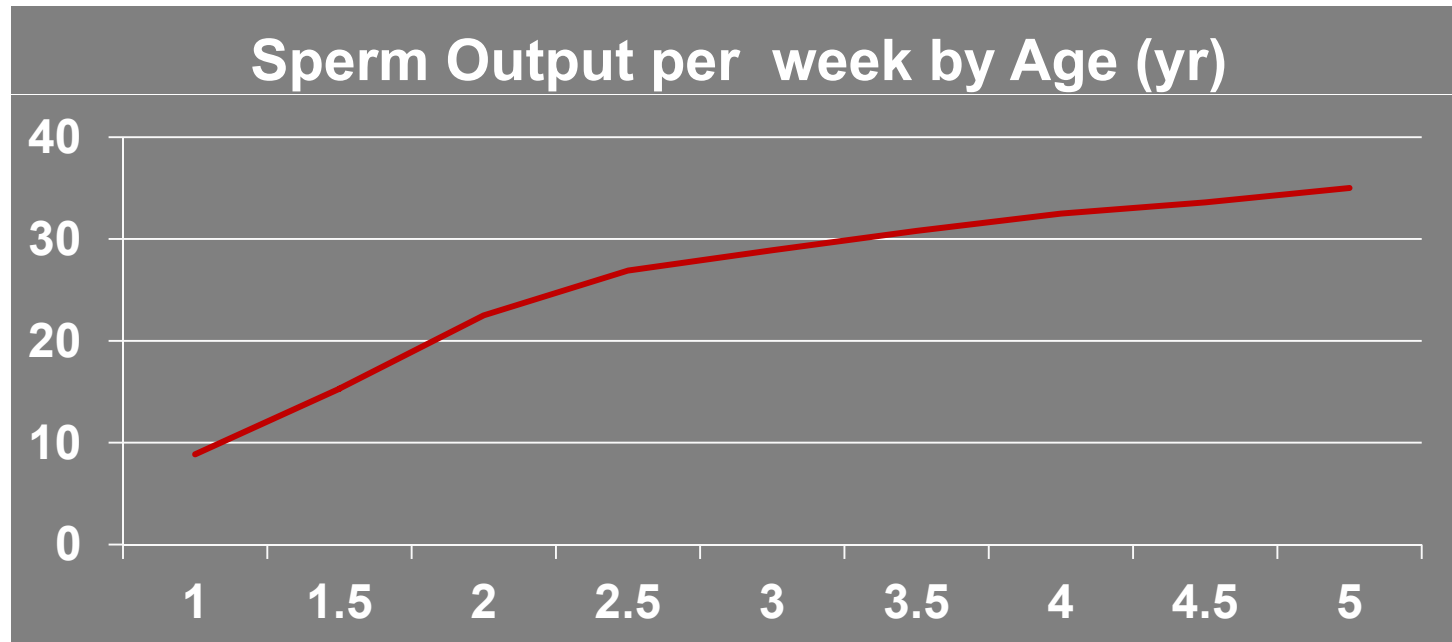
## Traditional Program

- 160 On-farm sel
- 75 Collection
- 350 “in-waiting”
- 460 Total bulls
- 6 yr Ave age
- 1 Prod. capacity

## Genomic Program

- 1000 On-farm testing
- 235 Collection
- 0 “in-waiting”
- 275 Total bulls
- 1.75 Ave age
- 0.57 Prod. capacity

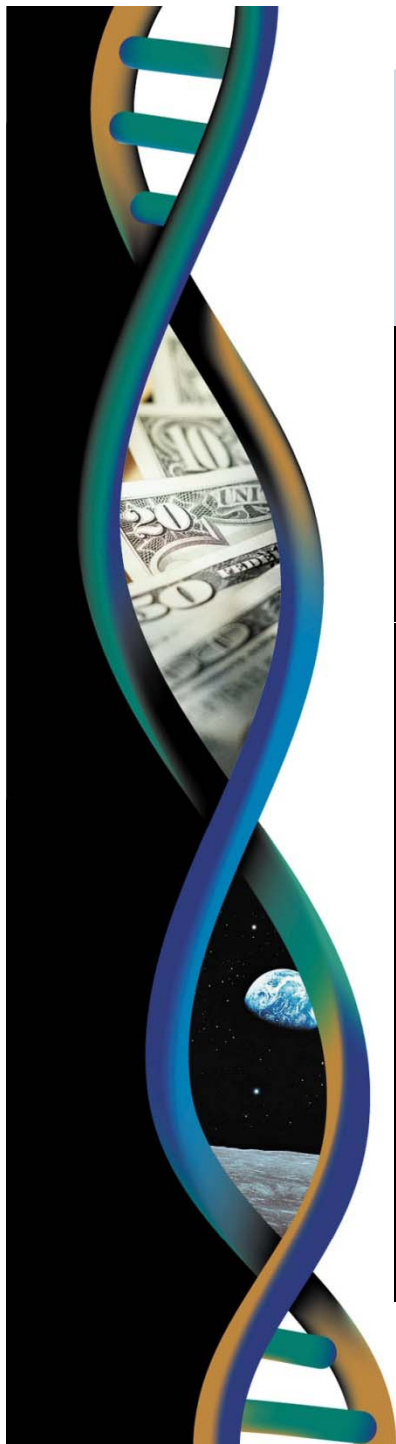
# Progeny Test vs. Genomic



# Straw Production – at one center

	2008	2012 to 2013	Comparison of 2013 to 2008 in Ithaca	
	All Progeny-tested bulls	Genomic bulls + a few Progeny-test bulls		
<b>BU to Inv.</b>	3,569,860	3,972,725	1.11	11% more straws for inventory
<b>Inv. Pot. BUs</b>	3,632,996	4,077,528		
<b>Disc. Pot. BUs</b>	71,391	89,129		
<b>Total Pot. BU</b>	3,704,387	4,166,657		
<b>BU Used</b>	4,228,000	5,145,000		
<b>Overage Total</b>	523,613	978,344		
<b>% Ovg/Total</b>	14.1%	23.5%		
<b>Collections to Inv.</b>	8,091	11,327	1.40	From 40% more collections
<b>Collections to L</b>	86	126		
<b>Collections to X</b>	361	528		
<b>Total collections</b>	8,538	11,981		
<b>Inv Batches</b>	5,154	6,764	1.31	From 31% more batches
<b>Discarded Batches</b>	135	233		
<b>Total Batches</b>	5,289	6,996		
<b>Total Pot. BU / Collections to Inv</b>	458	368	0.80	Straws per collection decreased 20%
<b>Total Pot. BU / Inv Batches</b>	719	616	0.86	Straws per batch decreased 14%
<b>% Discarded Batches</b>	2.6%	3.4%	1.31	Rate of PT discards increased 31%
<b>Proportion of consolidated total</b>	49.1%	43.0%		

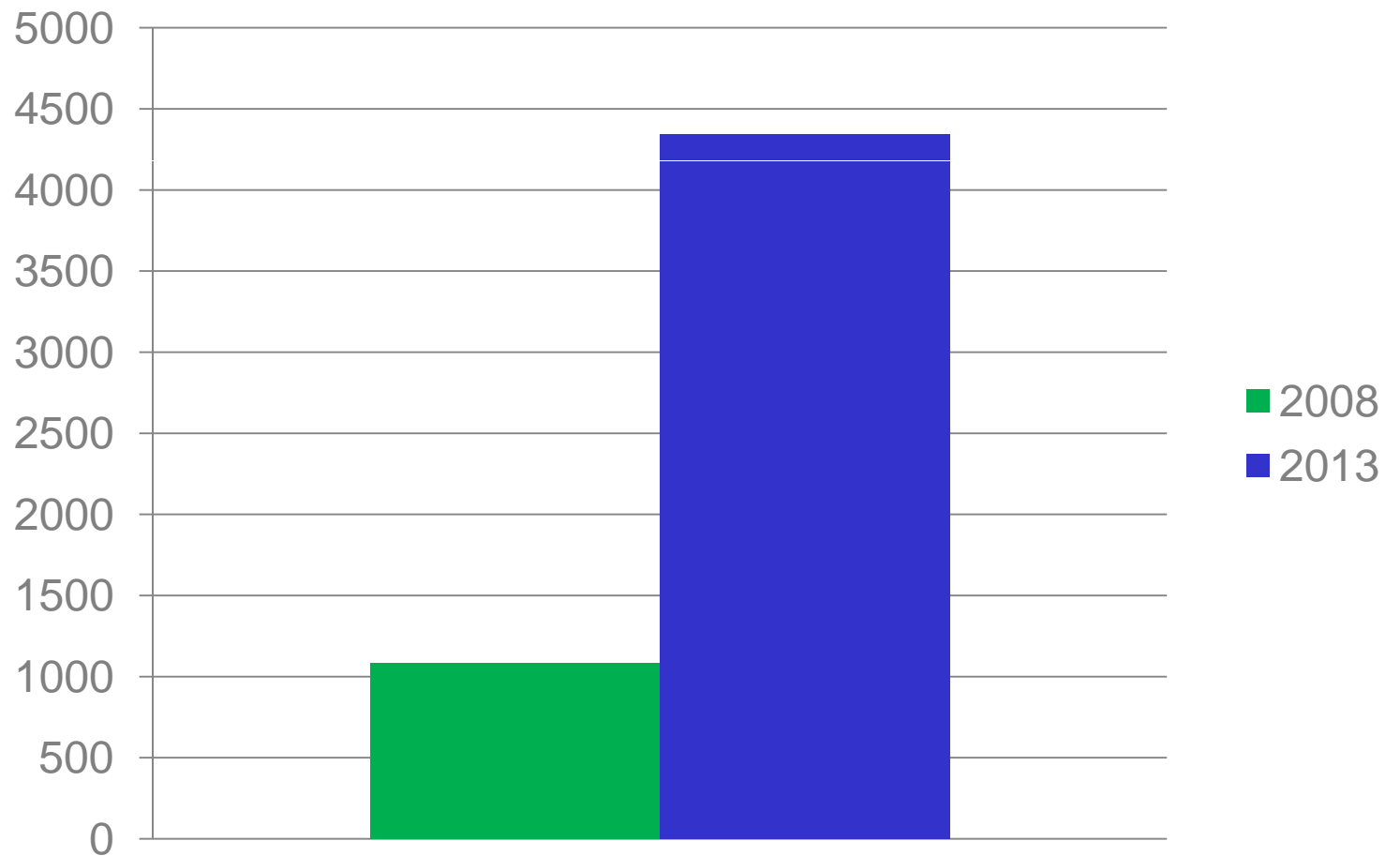




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# Impact of Genomics on GenChoice Collections



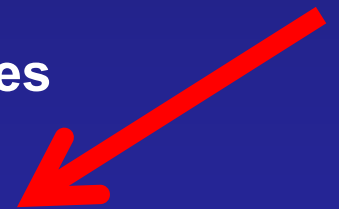
# Discovery of Missing Ancestors

**Ancestor discovered (if genotyped)**


<b>Breed</b>	<b>Sire % Correct*</b>	<b>MGS % Correct</b>	<b>MGGS % Correct</b>
<b>Holstein</b>	<b>100</b>	<b>97</b>	<b>92</b>
<b>Jersey</b>	<b>100</b>	<b>95</b>	<b>95</b>
<b>Brown Swiss</b>	<b>100</b>	<b>97</b>	<b>85</b>

\* % Correct = Top ranked candidate ancestor matches the true ancestor.

**In 2013, >50,000 missing or incorrect sires were discovered and reported to breeders**



# Important Numbers for 2013

- 
- 2,500 bulls genotyped
  - 10,000 females genotyped
  - 45,000 GENESIS females
  - 50% of bulls from GENESIS
  - At least 1 million phenotype records in QUANTUM database
  - Over 85,000 genotypes

# QUANTUM Size & Scope

- 200 herds and 250,000 cows
- 100,000 breeding records each month, over 2 million records in current PregCheck database
- Phenotypic Events Database thru 3/30/13
  - 600,555 cow events
  - 88,828 heifer events
- Expanding to include International data

