



IRISH CATTLE BREEDING FEDERATION

Developments in GENE IRELAND Dairy Breeding Program.

10th December 2010



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Background.

- Genomics can double rates of EBI gain.
- But need to; (i) ensure high levels of accuracy with genomics, (ii) manage animal health & disease, (iii) maintain genetic diversity.
- Revised GENE IRELAND objectives.
 - Maximise long-term genetic gain (€).
 - Provide an ongoing resource for R&D into genomic evaluations.
 - To minimise risk for the breeding program.
- Consultation process with industry stakeholders (May/June).



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Key Elements of Future Dairy & Beef Programs.

<u>Time-lines</u>		<u>Key numbers</u>
-12 months	ICBF Cattle Breeding Database	1 million cows
	↓	
-12 months	Identification. Elite females identified based on genomic index & diversity. Mating advice provided.	3k females
	↓	
1 month	Selection. Calves born and selected based on genomic index & diversity.	1000 males
	↓	
1-12 months	Rearing. Calves reared in "High Health" units.	300 males
	↓	
12 months	Lease/ownership. Elite AI bulls identified. Lease/ ownership arrangements established. Surplus bulls sold.	125 males
	↓	
12-24 months	Collection. Elite AI bulls moved to collection centres.	125 males
	↓	
12-24 months	Processing. Semen processed by AI centres.	100 males
	↓	
12-24 months	Distribution. Semen distributed by AI Service Providers	100 males
	↓	
12-24 months	Breeding Replacements. Semen used to breed National Herd	30 males

Revised GENE IRELAND.

- Based on ongoing work and consultation, four work areas identified:
 - Breeding programs to exploit genomics in Ireland.
 - Cost & benefit analysis of the program options.
 - Directed advice for Bull Breeders.
 - Research & development dairy herds (working with Teagasc).
- Meetings this week were focused on areas 1 & 2.



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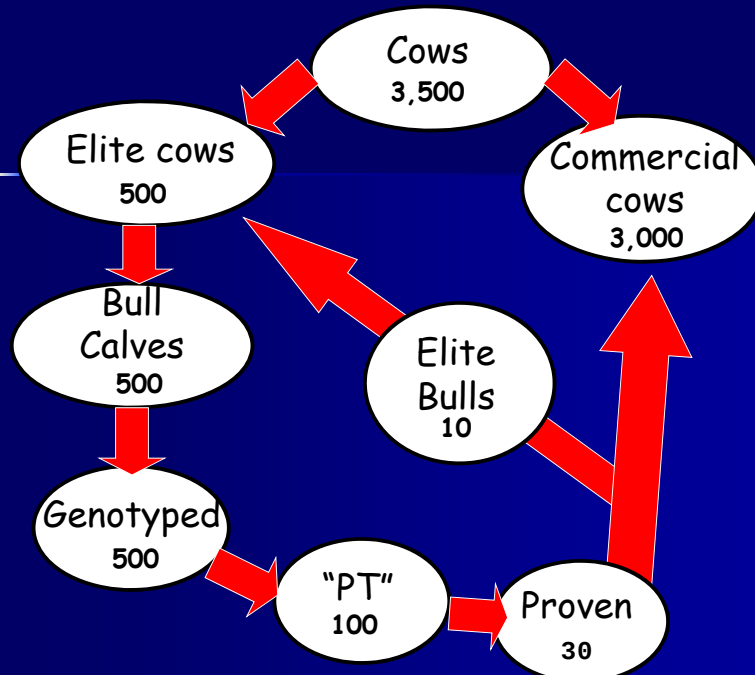
Breeding Programs to exploit Genomic Selection in Ireland

N. McHugh, T.H.E. Meuwissen, D.P. Berry, A.R. Cromie and A.K. Sonesson

Moorepark Dairy Production Centre
Irish Cattle Breeding Federation
University of Life Sciences, Ås, Norway
Nofima Marine, Ås, Norway

Key Questions for Ireland

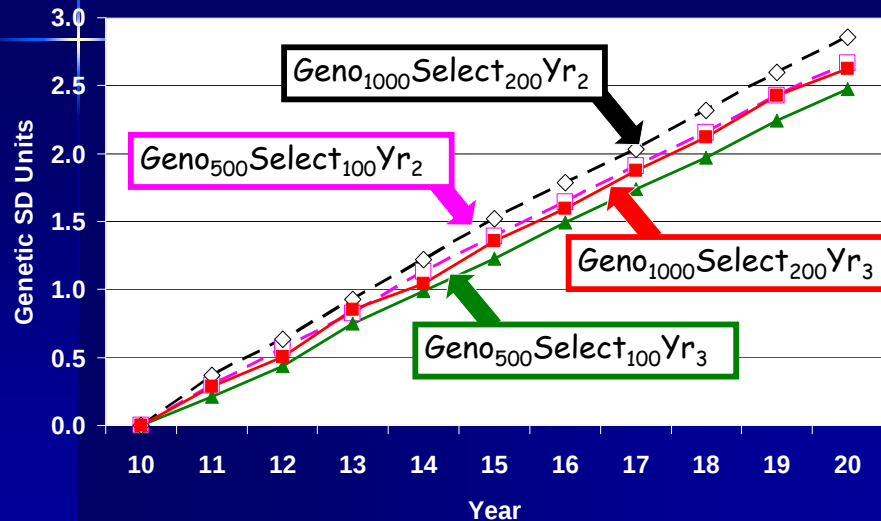
- Aim to design a optimal breeding program for Ireland, taking into account costs and benefits and the management of inbreeding
 - What age should genotyped bull calves be released for AI
 - How many bull calves should be genotyped per year
 - How many bull calves should be progeny tested
 - Possible role of females within the breeding program



Age of Bulls entering AI

2 versus 3 years of age

Genetic gain

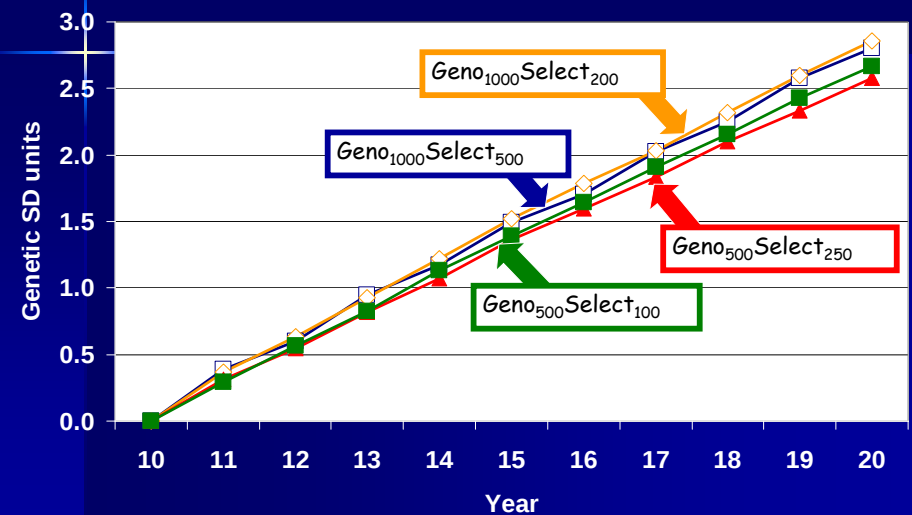


Summary

- **Genetic Gain**
 - Greater gain when selecting animals for AI at younger age
- **Inbreeding**
 - Higher inbreeding levels associated with animals selected at a younger age
- **Reliability**
 - Greater reliabilities for larger numbers entering "PT"
- **Generation Interval**
 - Lower generation intervals for animals selected at a younger age

Number of Potential Candidates

Genetic Gain

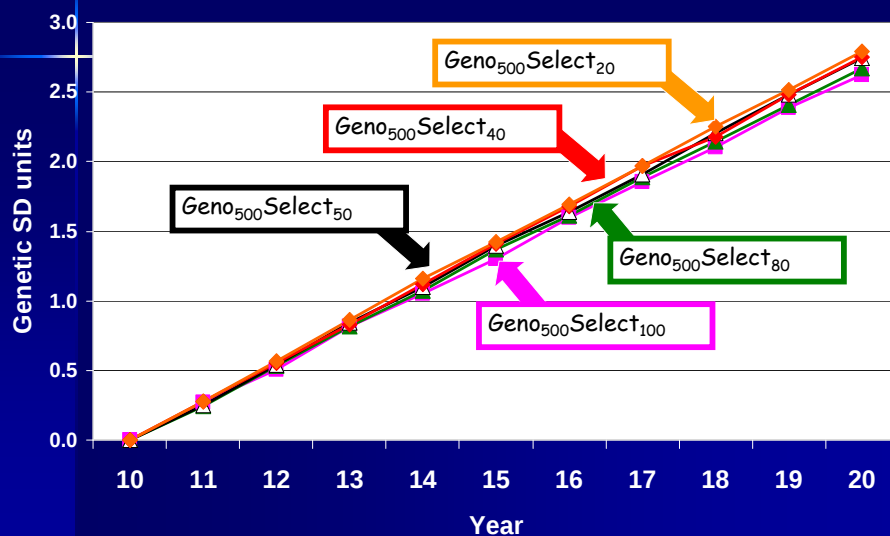


Summary

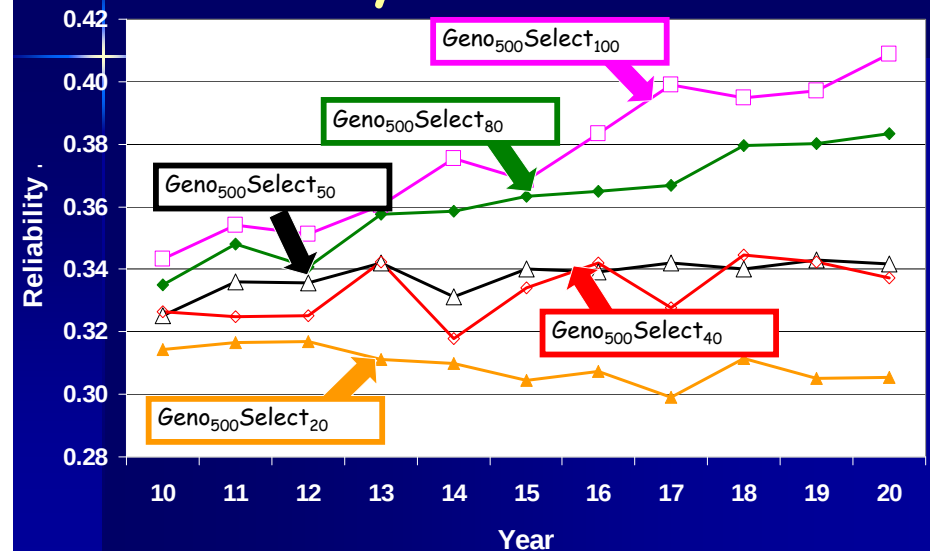
- Genetic gain
 - High selection intensity the greater gain
- Inbreeding
 - Lower numbers selected leads higher inbreeding
- Reliability
 - Greater numbers selected = greater reliabilities
- Generation Interval

Number of Bulls Progeny Tested

Genetic gain



Reliability

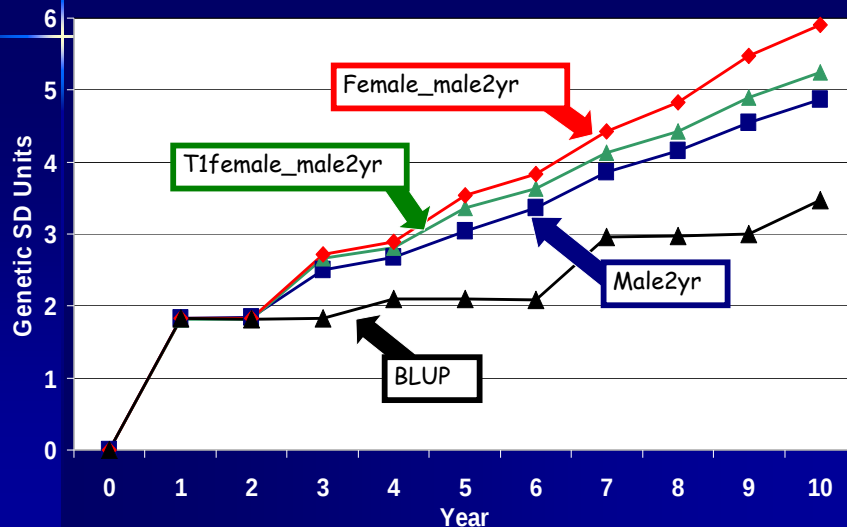


Summary

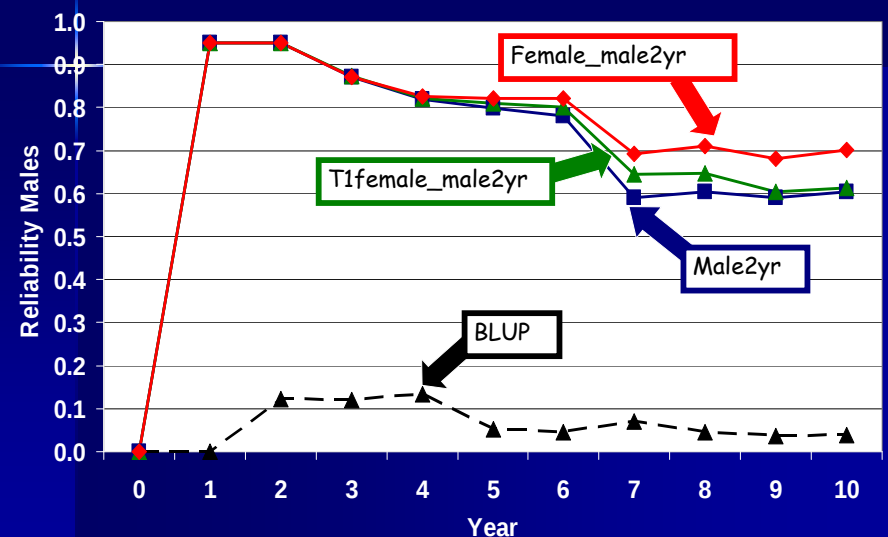
- Genetic gain
 - Little difference between schemes
- Inbreeding
 - Lower the number of animals selected
→ greater inbreeding
- Reliability
 - Higher numbers selected → higher reliability

Potential roles of females

Genetic gain



Reliability



Summary

- **Genetic gain**
 - Genotyping females increases genetic gain (doubles compared to BLUP).
- **Inbreeding**
 - Lower Levels associated with BLUP scheme
- **Reliability**
 - Higher numbers of males and females selected → higher reliability

Overall Summary

- To increase genetic gain genotyped females, select animals at a younger age, use high selection intensities
- The greater the number of animals selected the lower the inbreeding
- Higher levels associated with younger animals
- Reliability is a function of the number of animals selected.
- Reliability increases greatly if females genotyped

Recommendations

- Use genotyping as a pre-selection for potential AI sires
- Bulls that are selected to enter the progeny test should ideally become selection candidates at two
- The number of animals selected to enter the progeny test has little effect on overall genetic level
- There is major potential in the genotyping of females
- It is advisable to maintain some form of progeny test



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Implications of Alternative Breeding Program Structures for Dairy Cattle in Ireland.

Peter Amer (Abacus Bio) &
Andrew Cromie (ICBF).

8th December 2010



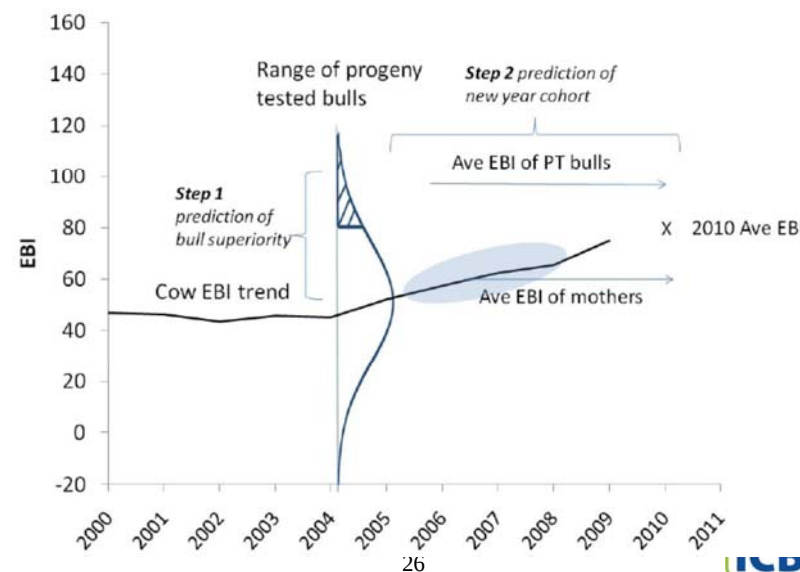
Predicting Increases in Profitability from different schemes.

- A three stage approach.
 1. Predict genetic merit of future bull teams.
 2. Model genetic trends in calves (and cows), compared to baseline.
 3. Express future genetic merit of these females in profit terms (NPV).

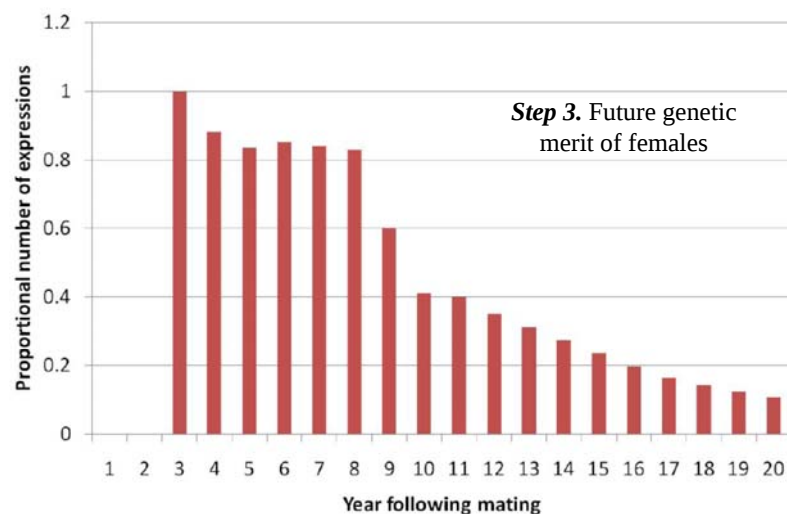
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Deterministic Model - Steps 1 & 2.



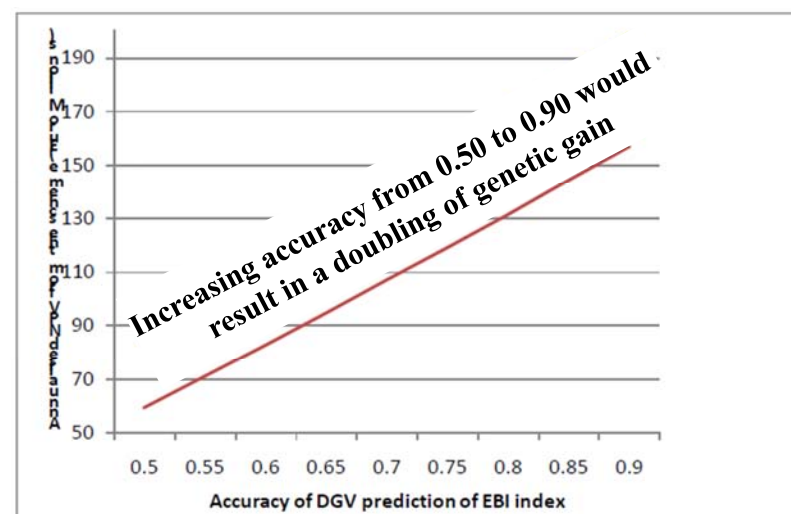
Step 3. Long-term benefits.



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The Benefits of accuracy of selection.



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The Benefits of Females.

Situation	Low h^2 ($=.03$)				
	N_{Bulls}	$h^2_{effective,Bulls}$	N_{Cows}	$h^2_{effective,Cows}$	r_{GS}
Base	1100	.50	0	0	.58
2000 cows genotyped	1100	.50	2000	.06	.62
5000 cows genotyped	1100	.50	5000	.06	.65
20000 cows genotyped	1100	.50	20000	.06	.75

- Females have potential to increase accuracy by ~30%

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The Benefits of Nucleus Herds.

- Nucleus herds have potential to increase selection intensity by 14%
- At what cost?

Elite calves genotyped	Nucleus calves genotyped	Intensity A ¹	Intensity B ²	Intensity C ³
5000	200	3.31	3.42	3.53 (Scheme 10)
2000	200	3.22	3.36	3.48
1000	200	3.11 (Scheme 9)	3.28	3.42
5000	0	3.26 (Scheme 8)	-	-
2000	0	3.15	-	-
1000	0	3.01 (Scheme 7)	-	-



Taking account of costs from different schemes.

- Two main costs associated with breeding program:
 - Cost of genotyping (inc sample)
 - 3k = €50, 50k=€110.
 - Cost of AI bulls.
 - Progeny test=€15k, genomic=€10k
- Additional considerations, e.g., bio-security.
 - Additional bulls & lay-off facilities.

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Scenarios to Compare.

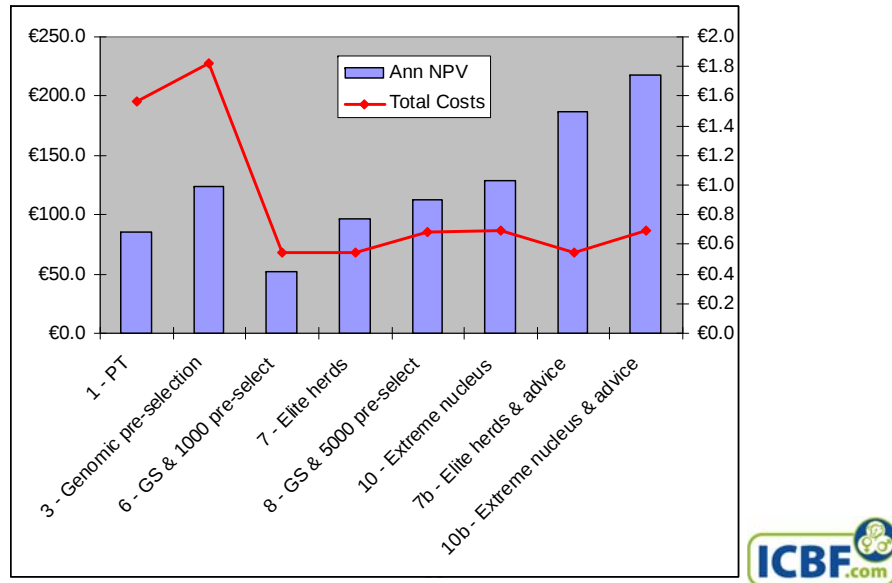
- 14 different schemes examined.
 - Progeny test & genomic.
 - Pre-selection.
 - Level of genotyping.
 - Elite herds
 - Nucleus herds.
 - Directed advice.
- 8 selected for discussion

Opt	Description
1	30 bulls selected from 100 progeny tested
3	30 bulls selected from 100 progeny tested with genomic pre-selection .
6	30 bulls selected from 1000 genomic tested
7	30 bulls selected from 1000 genomic tested from elite herds .
8	30 bulls selected from 5000 genomic tested from elite herds
10	30 bulls selected from 5000 tested in elite herds and 200 tested in extreme nucleus herds
7b	30 bulls selected from 1000 genomic tested from elite herds with directed breeding advice
10b	30 bulls selected from 5000 tested in elite herds and 200 tested in extreme nucleus herds with directed breeding advice

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Cost & benefit from different schemes



Executive Summary.

- Very high rates of return.
 - €1 = €50-€100, depending on uptake.
- Genomic schemes are more cost-effective than progeny test schemes.
- Increasing accuracy of GS prediction can double rates of genetic gain.

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Executive Summary.

- Invest in genotyping females.
 - €250k in females = €20m per annum.
- Targeting of high merit herds with breeding advice.
 - Elite calves & accuracy.
- Important role for “Next generation” herds in future.
 - Elite calves, accuracy, R&D & focus.

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Implications.

- Increased role for females.
 - Training & directed advice.
 - Moving away from 100 bulls & 100 dtrs.
- Working with elite herds.
 - Genotypes & phenotypes.
- Establishment of Next generation herds.
 - In conjunction with industry stakeholders.
- Inbreeding through breeding advice.

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Key Elements of Future Dairy & Beef Programs.

<u>Time-lines</u>		<u>Old</u>	<u>New</u>
-12 months	ICBF Cattle Breeding Database	1 mill cows	1 mill cows
-12 months	↓		
-12 months	Identification. Elite females identified based on index & diversity. Mating advice provided	3k females	100k females
-12 months	↓		
1 month	Selection. Calves born and selected based on genomic diversity.	1000 males	5000 males
1-12 months	↓		
1-12 months	Rearing. Calves reared in "High Health" units	300 males	50 males
1-12 months	↓		
12 months	Lease/ownership. Elite AI bulls identified. Lease/arrangements established. Surplus bulls sold	125 males	50 males
12-24 months	↓		
12-24 months	Collection. Elite AI bulls moved to collection centres	125 males	50 males
12-24 months	↓		
12-24 months	Processing. Semen processed by AI centres	100 males	30 males
12-24 months	↓		
12-24 months	Distribution. Semen distributed by AI Service Partners	100 males	30 males
12-24 months	↓		
12-24 months	Breeding Replacements. Semen used to breed National Breeding Stock	30 males	30 males



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Developments in GENE IRELAND Dairy Breeding Program. Key Outcomes

10th December 2010



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Key Outcomes – Cost & Benefits

- Very high rates of return on investment in genetic were identified from the work (€1 invested = €50-€100 returned).
- Genomic schemes have the potential to double rates of genetic gain, and more than halve the cost of our current breeding programs.



Key Outcomes – Females.

- Future genetic gain will be primarily driven through accurate recording of females (i.e., both genotypes and phenotypes).
- This data will be used to; (i) identify the best females for the GENE IRELAND breeding program, and (ii) develop more accurate genomic predictions.
- Priority must be now given to developing a service that facilitates the widespread genotyping of females.



Key Outcomes – Herds (i)

- It is anticipated that future data recording will happen in two types of herds;
 - “Bull Breeder” herds (initially 1,000 herds & 100k cows), where, over time, all females will be genotyped, with accurate recording of relevant on-farm data, and
 - “Next Generation” herds (5 herds & ~1000 cows), where the highest EBI industry females will be recorded for on-farm data and additional traits of research interest, e.g., health traits (including vet treatments) and feed intake/efficiency.

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Key Outcomes – Herds (ii)

- Over time (5-10 years) it is anticipated that all dairy animals will be genotyped on a routine basis by farmers.
- In launching this new program it is important that ICBF demonstrates the benefits of farmers genotyping all females, not just selected high EBI animals.
- With the benefit of genomics, a large component of the additional genetic gain will come from directed breeding advice to farmers. This will also be key in managing inbreeding within the overall program.

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Key Outcomes – AI Bulls

- With the switch towards genotyping females, the need for progeny testing 100 bulls with 100 daughters is now reduced. Instead it is anticipated that some 30 new AI bulls per year will service the bulk of National dairy herd.
- It is recommended that the initial semen from these bulls (some 1000 straws collected at 15 months of age) is distributed to targeted herds (e.g., bull breeder herds), as this will allow early identification of any problems around calving difficulty and/or major genes. The remaining semen on these bulls (~20k doses) would then be distributed the following season when the bulls are 1 year older.

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Key Outcomes – Bio-security.

- In future concerns over bio-security will be managed through a combination of;
 - Smaller groups of bulls in rearing units (now only 30 bulls/year required),
 - Smaller numbers of bulls at AI stations (due to faster turn around of GS bulls) and
 - Retaining previously used GS bulls for an extended period (in isolation), to cover the possibility of disease breakdown in the AI centre.

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Key Outcomes – Inbreeding.

- In future concerns over inbreeding would be managed through a combination of;
 - Directed sire advice for bull breeders.
 - Additional constraints on the ICBF Active Bull List, e.g., limiting the number of sons for any one sire, and
 - Semen limits for bulls that are approved for widespread AI usage.

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What next?

- ICBF to develop up a breeding program proposition that covers each of the following elements;
 - Females.
 - Bull breeder and next generation herds.
 - Breeding bulls, including those for AI.
 - Managing risk including inbreeding and bio-security.
- This proposition should include both a funding model and proposed structure for this new National breeding program.
- This proposition would be available for discussion and feedback with industry in January 2011.

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