



IRISH CATTLE BREEDING FEDERATION

Developments in GENE IRELAND Dairy Breeding Program.

8th December 2010



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Agenda

- 11.15 Current status.
- 11.30 Genomic Programs for Dairy Cattle in Ireland – **Noirin McHugh.**
- 12.00 Cost Benefit Analysis & Implications – **Andrew Cromie.**
- 12.30 Discussion.
- 1.30 Light Lunch.
- 2.00 Further Discussion and plans for moving forward.
- 3.00 Close of meeting.



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GENE IRELAND Current Status.

8th December 2010



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Dairy Breeding Programs – The challenges.

- EBI is delivering at farm level.
- Genomics can double rates of EBI gain (e.g., Meuwissen. HcHugh...)
- But need to; (i) ensure high levels of accuracy with genomics, (ii) manage; animal health & disease, (iii) maintain genetic diversity.



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Revised GENE IRELAND Program – Spring 2010

- Program 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).
- Opportunity for comments & feedback.

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



i. Genotypes, bulls, cows – project.

- Scientific basis work undertaken by Noirin McHugh, Theo Meuwissen & Anna Sonnesson.
- Simulation based on data structure from Ireland.
 - Varied level of genotyping, age at 1st AI, level of progeny testing & cows available for the breeding program.
- Papers submitted to Journal Dairy Science.
- Results presented and discussed today.

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ii. Cost:benefits

- Work being undertaken by Peter Amer.
- Trade off between cost & benefit.
- Cost elements – genotypes (males & females), progeny testing, data recording, cost of disease etc.
- Benefits – long-term genetic gain (EBI, inbreeding level & reliability).
- Results presented and discussed today.

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iii. Inbreeding & genetic gain - Project.

- Sub-group established – ICBF, Teagasc bull breeders & AI companies.
- High EBI & diverse cows identified (2,200).
- Panel of high EBI & diverse sires of sons identified (~50 bulls).
- Matings allocated and communicated with farmers (Teagasc research).
- 80-100 high EBI young bulls will be born next Spring. Valuable resource for industry.

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iv. R&D data for genomics.

- Working with Teagasc to establish a “next generation” herd at Moorepark.
- Objective: Continually test the EBI.
- 200 cow herd, 40 replacements per year, generating surplus males & females.
- High EBI & diverse heifer calves purchased from commercial herds (e.g., output from breeding programs research).
- Opportunity to link with AI companies in the provision of breeding bulls.
- Work ongoing with Teagasc.

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IRISH CATTLE BREEDING FEDERATION

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

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

8th December 2010



Objectives of Work.

- To develop the business case for industry investment in a new state of the art approach to genetic improvement.
 - Predict increases in profitability for different breeding strategies.
 - Take account of all relevant costs.

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Cost & Benefits Exercise.

- Appropriate model developed.
 - Takes account of different timing of benefits, e.g., short versus long-term.
 - More appropriate for cost-benefit exercises. For example, two programs, with same long-term genetic gain, but different Net Present Values. Also different timing of costs (e.g., short-term benefits from genomics).

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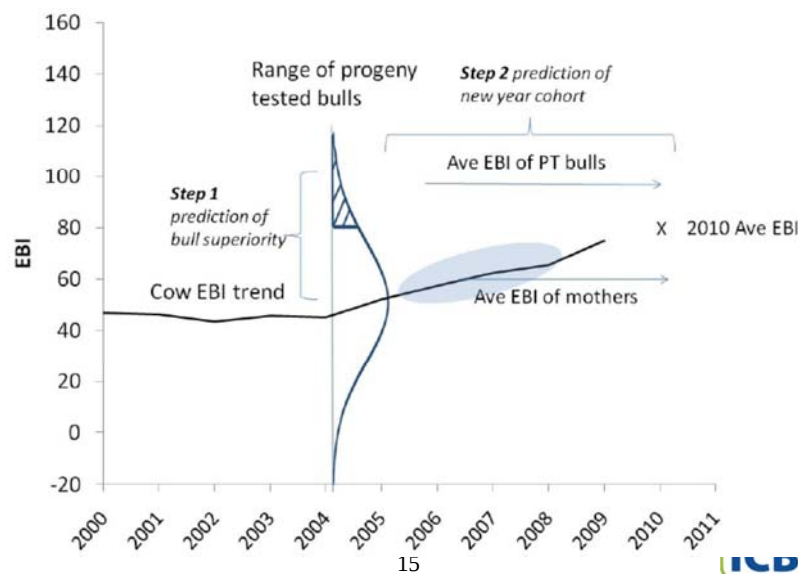
1. Predicting Increases in Profitability.

- 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.



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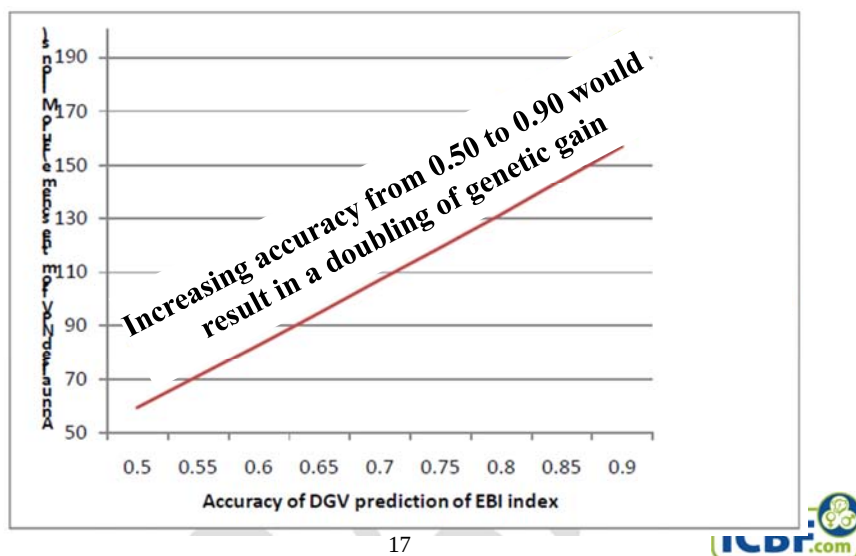
Step 1. Prediction of Superiority.

- Function of;
 - Accuracy of selection (or increase in reliability - width of normal distribution).
 - Parent average = 30% reliability
 - Genomics = 40%, 50%, 60%, 70%.....?
 - Depends on traits, level of genotyping, role of females...
 - Progeny test = 80% reliability.
 - Number of animals tested.
 - More animals = greater selection intensity.
 - Potential role of females.
 - Selection differential.
 - Elite & nucleus herds.

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Example: The Benefits of accuracy of selection.



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Example: The Benefits of Females.

Situation	Low h^2 ($=.03$)				r_{GS}
	N_{Bulls}	$h^2_{effective,Bulls}$	N_{Cows}	$h^2_{effective,Cows}$	
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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Example: 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	3.28	3.42 (Scheme 9)
5000	0	3.26 (Scheme 8)	-	-
2000	0	3.15	-	-
1000	0	3.01 (Scheme 7)	-	-

ICBF.com

Step 2. Genetic Trends

- Each calf crop has merit ½ way between merit of cows & selected bulls.
- Baseline of no genetic gain for next 20 years (EBI of sires = €136).

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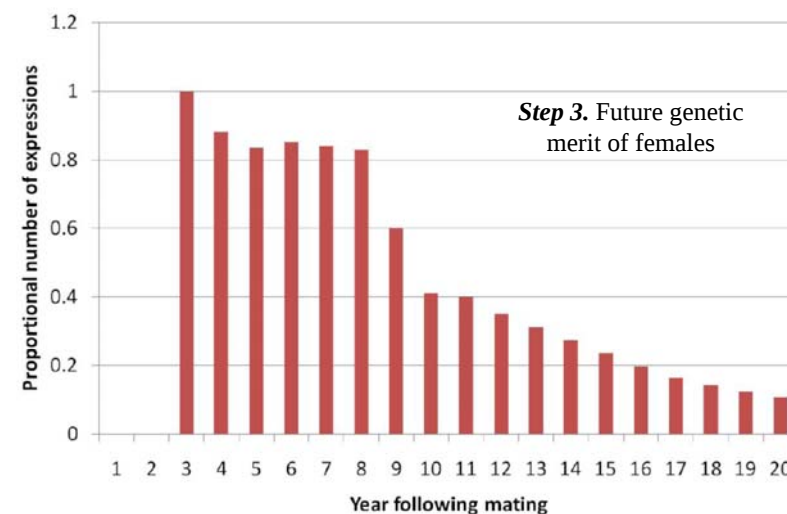
Step 3. Annualised Benefits.

- Superiority is translated into projections of genetic merit and then aggregated to give overall benefits.
 - Long term benefits.
 - Permanent & cumulative
 - Appropriate discounting
 - Net present values compared to baseline figures.
 - Annualised over the period of genetic gain (10 years).

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Step 3. Long-term benefits.

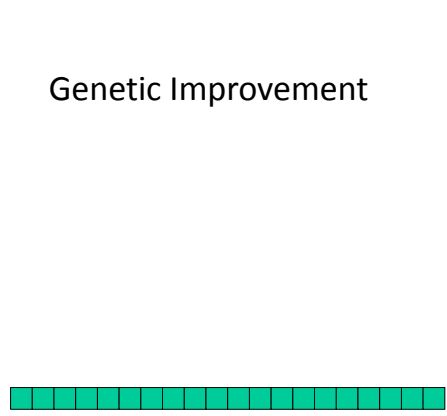


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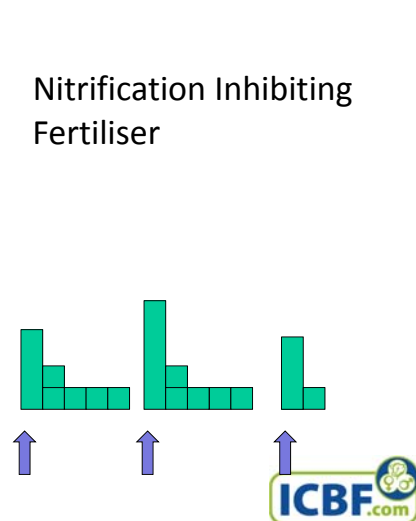
Permanent

Genetic Improvement



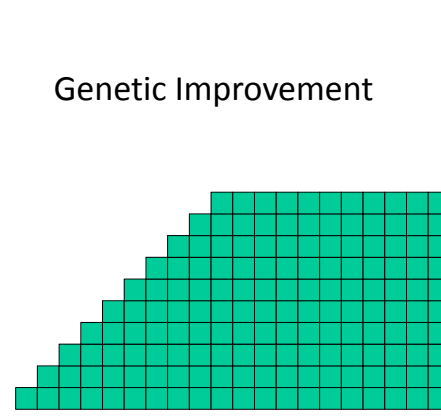
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Nitrification Inhibiting Fertiliser



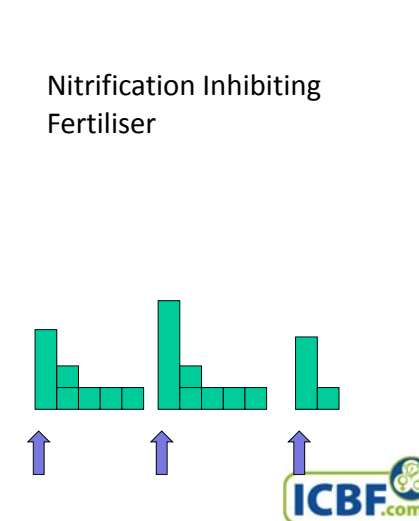
Permanent and Cumulative

Genetic Improvement

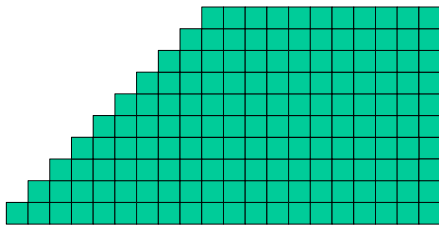


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Nitrification Inhibiting Fertiliser



Total benefits



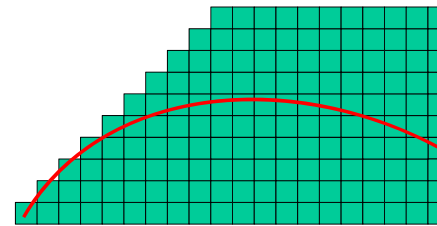
10 years genetic improvement
over 20 years

Multiplier = 155

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Total benefits + discount



10 years genetic
improvement
over 20 years

Multiplier = 155

Discount at 7% then
Multiplier = 75

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What is an EBI Gain of €10 worth to the industry (i)?

- How many times are the genes expressed?
 - 4 lactations, 2 grand-daughter lactations, 1 great grand daughter.....(~8 in total)
 - Discount penalty of 7% due to future expressions.
 - ***One cow = 5 lactation expressions.***

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What is an EBI Gain of €10 worth to the industry (ii)?

- What is the value per cow & per year?
 - 5 lactation expressions = €50 per heifer (in EBI terms).
 - Multiply by 2 (profit per cow) = €100
 - ***210k replacement heifers per year = €21 million per annum.***

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What is an EBI Gain of €10 worth to the industry (iii)?

- What is the value over 10 years?
 - Discount penalty of 7% (NPV terms).
 - Year 1 = €21m
 - Year 2 = €21m * 2 * 0.93) = €39m
 - Year 3 = €21m * 3 * 0.86) = €55m
 - Year 10 = €781 million.
 - **Annualised return of €78 million.**
 - **Permanent, cumulative & cost effective.**

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2. Taking Account of Costs.

- 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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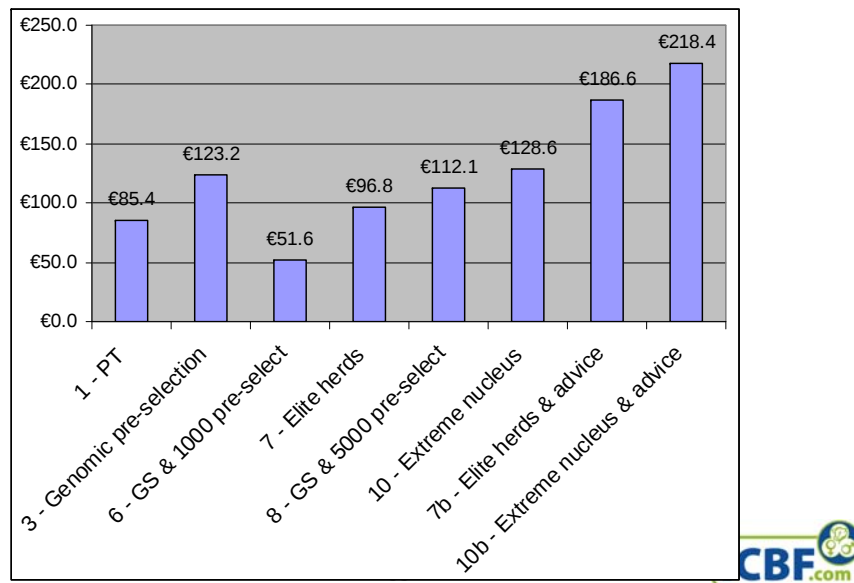
Benefits from different schemes.

Opt	Description	Annual NPV (€mill)
1	30 bulls selected from 100 progeny tested	€85.4
3	30 bulls selected from 100 progeny tested with genomic pre-selection .	€123.2
6	30 bulls selected from 1000 genomic tested	€51.6
7	30 bulls selected from 1000 genomic tested from elite herds .	€96.8
8	30 bulls selected from 5000 genomic tested from elite herds	€112.1
10	30 bulls selected from 5000 tested in elite herds and 200 tested in extreme nucleus herds	€128.6
7b	30 bulls selected from 1000 genomic tested from elite herds with directed breeding advice	€186.6
10b	30 bulls selected from 5000 tested in elite herds and 200 tested in extreme nucleus herds with directed breeding advice	€218.4

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Benefits from different schemes.

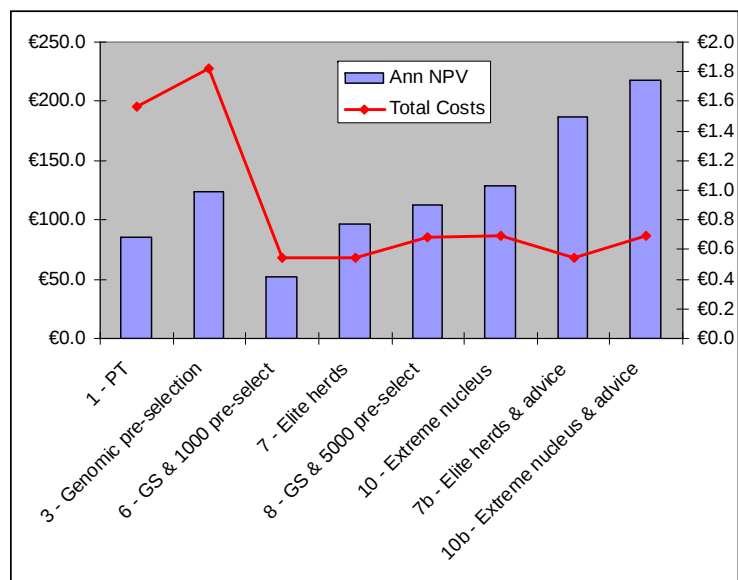


Cost & benefit from different schemes

Opt	Description	Annual NPV (€mill)	Total Costs (€mill)
1	30 bulls selected from 100 progeny tested	€85.4	€1.560
3	30 bulls selected from 100 progeny tested with genomic pre-selection .	€123.2	€1.818
6	30 bulls selected from 1000 genomic tested	€51.6	€0.541
7	30 bulls selected from 1000 genomic tested from elite herds .	€96.8	€0.541
8	30 bulls selected from 5000 genomic tested from elite herds	€112.1	€0.681
10	30 bulls selected from 5000 tested in elite herds and 200 tested in extreme nucleus herds	€128.6	€0.691
7b	30 bulls selected from 1000 genomic tested from elite herds with directed breeding advice	€186.6	€0.541
10b	30 bulls selected from 5000 tested in elite herds and 200 tested in extreme nucleus herds with directed breeding advice	€218.4	€0.691

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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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Executive Summary.

- Bio-security.
 - Lay off GS bulls for potential return to AI. More cost effective than increasing PT.
- Inbreeding.
 - Manage through targeted advice & Active Bull List. More cost effective than increasing PT.

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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	Identification. Elite females identified based on index & diversity. Mating advice provided	3k females	100k females
1 month	Selection. Calves born and selected based on genomic diversity.	1000 males	5000 males
1-12 months	Rearing. Calves reared in “High Health” units	300 males	50 males
12 months	Lease/ownership . Elite AI bulls identified. Lease/arrangements established. Surplus bulls sold	125 males	50 males
12-24 months	Collection. Elite AI bulls moved to collection centres	125 males	50 males
12-24 months	Processing. Semen processed by AI centre	100 males	30 males
12-24 months	Distribution. Semen distributed by AI Service Providers	100 males	30 males
12-24 months	Breeding Replacements. Semen used to breed National	30 males	30 males

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Key Elements & Costs - DRAFT

	Elite	Next Generation	Cost
Number Herds	1,000	5	€500,000
Number Cows	100,000	1,000	€0
Genotype females	30,000	500	€1,525,000
Genotype males	5,000	500	€275,000
Commercial AI Bulls	15	15	€300,000
Additional AI bulls	10	10	€100,000

- Program costing €3million has potential to generate €200 million.
- Many elements are already in place.

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What next?

- Comments & feedback.
- Webinar – this Friday.
- Develop up industry proposition.
- Establish suitable funding model.
- Get started!

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