IRISH CATTLE BREEDING FEDERATION

The potential application of genomic technology, from farm to fork

Dr. Matthew McClure

National Development Plan
Transforming Ireland

Animal Genomics User Conference. Nov 27, 2014, Swords Ireland

What Can We Do With a Genotype?

Pedigree Verification/Identification

Certificate Issued

Herdbook

Rules Applied

Calf

SNP – Sire Identify

Verified

Failed

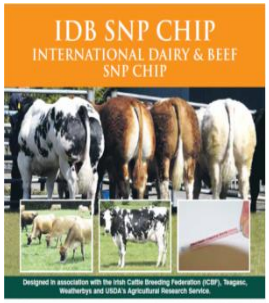
SNP - Sire Check

Verified

Weatherbys

ICBF Database

SNP Genotype



Tissue Sample

ICBF.com

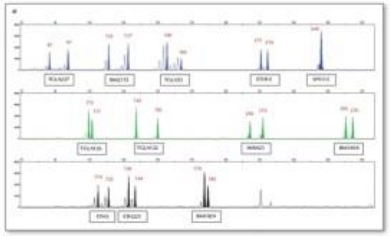
Pedigree Validation: 800 SNP

		Calf		
SNP		An1		Sire1
-PARENT-DQ381153-RS29012842		A_B		A_A
-PARENT-DQ451555-RS29010795		A_B		B_B
-PARENT-DQ404150-RS29012530		A_A		A_B
MARC-PARENT-DQ404149-NO-RS		A_B		B_B
C-PARENT-AY761135-RS29003723		A_B		A_A
C-PARENT-AY943841-RS17871566		A_A		B_B
-PARENT-DQ404151-RS29019282		B_B		A_B
-PARENT-DQ404152-RS29022245		A_A		A_B
MARC-PARENT-AY776154-NO-RS		A_B		B_B
C-PARENT-AY841151-RS29003466		A_B		A_B
-PARENT-DQ422949-RS29011466		A_A		A_A
-PARENT-DQ786757-RS29019900		A_B		A_B
-PARENT-DQ647187-RS29010510		B_B		B_B
C-PARENT-AY842472-RS29001941		A_B		A_B
C-PARENT-AY842473-RS29001956		A_A		A_A
C-PARENT-AY842474-RS29003226		A_A		B_B
-PARENT-DQ435443-RS29010802		A_B		A_A
-PARENT-DQ489377-RS29026932		A_B		A_B
-PARENT-DQ839235-RS29012691		B_B		A_A
-PARENT-DQ647186-RS29014143		A_B		A_B
C-PARENT-AY842475-RS29002127		A_B		A_B
-PARENT-DQ647188-RS29011099		A_B		B_B
MARC-PARENT-DQ470475-NO-RS		A_A		A_B
MARC-PARENT-DQ500958-NO-RS		B_B		A_B
-PARENT-DQ647189-RS29012226		B_B		A_A
C-PARENT-AY844963-RS17871338		A_B		A_B
-PARENT-DQ468384-RS29003967		A_A		A_B
-PARENT-DQ846688-RS29023691		A_A		A_A
-PARENT-DQ647190-RS29013632		A_A		B_B
C-PARENT-AY849381-RS29003287		A_A		B_B
-PARENT-DQ789028-RS29017713		A_A		B_B
-PARENT-DQ888309-RS29013741		A_A		A_A
-PARENT-DQ786758-RS29024430		A_A		A_B

Pedigree Identification: 800 SNP

	Calf	Potential Sires														
SNP	An1	Sire1	Sire2	Sire3	Sire4	Sire5	Sire6	Sire7	Sire8	Sire9	Sire10	Sire11	Sire12	Sire13	Sire14	Sire15
-PARENT-DQ381153-RS29012842	A_B	A_A	B_B	A_B	B_B	A_B	A_B	A_B	B_B	A_B	A_B	B_B	A_B	A_A	A_A	B_B
-PARENT-DQ451555-RS29010795	A_B	B_B	B_B	A_A	B_B	A_B	B_B	A_B	B_B	A_B	A_B	A_B	A_B	A_B	B_B	A_A
-PARENT-DQ404150-RS29012530	A_A	A_B	B_B	A_B	A_A	A_B	B_B	A_B	B_B	A_A	B_B	B_B	A_A	B_B	A_B	A_B
MARC-PARENT-DQ404149-NO-RS	A_B	B_B	A_A	B_B	A_B	A_B	B_B	A_A	A_B	B_B	B_B	A_B	B_B	B_B	B_B	A_B
C-PARENT-AY761135-RS29003723	A_B	A_A	A_B	A_A	A_B	A_B	A_B	A_A	A_B	A_B	A_B	A_B	A_A	A_B	A_A	A_B
C-PARENT-AY943841-RS17871566	A_A	B_B	A_B	A_B	A_B	A_B	A_B	B_B	B_B	A_A	B_B	A_B	A_B	A_B	B_B	A_B
-PARENT-DQ404151-RS29019282	B_B	A_B	A_B	A_A	B_B	B_B	A_A	B_B	A_B	A_B	B_B	A_B	A_B	A_B	B_B	B_B
-PARENT-DQ404152-RS29022245	A_A	A_B	A_A	A_B	A_A	A_B	A_A	A_B	A_B	A_A	A_B	A_B	A_A	A_B	A_A	A_A
MARC-PARENT-AY776154-NO-RS	A_B	B_B	B_B	A_A	A_B	A_B	A_A	B_B	A_B	B_B	A_B	B_B	B_B	B_B	B_B	B_B
C-PARENT-AY841151-RS29003466	A_B	A_B	A_A	A_B	A_B	A_B	B_B	A_B	B_B	A_A	B_B	A_B	A_B	A_A	A_A	A_A
-PARENT-DQ422949-RS29011466	A_A	A_A	B_B	A_A	A_B	B_B	B_B	A_B	B_B	A_A	A_B	A_B	A_B	A_A	A_B	B_B
-PARENT-DQ786757-RS29019900	A_B	A_B	A_B	A_B	B_B	A_A	A_B	A_B	A_A	A_A	A_B	A_B	A_B	A_B	A_B	A_A
-PARENT-DQ647187-RS29010510	B_B	B_B	B_B	A_B	A_B	B_B	A_B	A_B	B_B	B_B	A_A	A_B	B_B	B_B	A_B	B_B
C-PARENT-AY842472-RS29001941	A_B	A_B	A_B	A_B	A_B	A_B	B_B	A_B	B_B	A_B	B_B	B_B	B_B	B_B	A_A	B_B
C-PARENT-AY842473-RS29001956	A_A	A_A	A_A	B_B	A_A	A_B	A_B	A_B	A_B	A_B	A_B	A_A	B_B	A_B	A_A	A_B
C-PARENT-AY842474-RS29003226	A_A	B_B	A_A	A_B	A_A	A_B	A_B	A_B	A_B	B_B	A_B	A_B	B_B	B_B	B_B	A_B
-PARENT-DQ435443-RS29010802	A_B	A_A	A_A	A_A	A_B	A_A	A_A	A_B	A_A	A_A	A_A	A_A	A_B	A_A	A_A	A_A
-PARENT-DQ489377-RS29026932	A_B	A_B	A_A	A_B	A_B	B_B	A_B	A_A	B_B	A_A	A_A	A_B	A_B	A_B	A_B	B_B
-PARENT-DQ839235-RS29012691	B_B	A_A	A_A	A_A	A_B	B_B	A_A	A_B	A_A	B_B	A_B	A_B	A_B	A_B	A_B	B_B
-PARENT-DQ647186-RS29014143	A_B	A_B	A_B	B_B	A_A	A_B	B_B	A_B	A_B	B_B	B_B	A_B	A_B	A_B	A_A	A_A
C-PARENT-AY842475-RS29002127	A_B	A_B	A_B	A_B	A_B	A_B	A_A	B_B	A_A	A_B	A_A	A_B	B_B	A_B	A_B	B_B
-PARENT-DQ647188-RS29011099	A_B	B_B	B_B	A_A	A_A	A_A	B_B	A_B	A_B	A_A	A_B	B_B	A_B	A_B	A_B	A_B
MARC-PARENT-DQ470475-NO-RS	A_A	A_B	A_B	A_A	A_A	A_B	B_B	A_B	A_B	A_B	A_B	B_B	A_B	A_B	B_B	B_B
MARC-PARENT-DQ500958-NO-RS	B_B	A_B	A_A	A_B	A_B	A_A	A_A	A_A	A_B	B_B	A_B	A_B	A_B	A_B	A_B	B_B
-PARENT-DQ647189-RS29012226	B_B	A_A	B_B	A_B	A_B	A_A	A_B	B_B	B_B	A_B	A_A	A_A	B_B	A_B	B_B	B_B
C-PARENT-AY844963-RS17871338	A_B	A_B	B_B	A_A	B_B	B_B	A_A	A_B	A_B	A_B	A_B	B_B	B_B	A_B	A_A	A_B
-PARENT-DQ468384-RS29003967	A_A	A_B	B_B	A_B	A_B	A_B	B_B	B_B	B_B	A_B	A_A	B_B	B_B	B_B	B_B	A_B
-PARENT-DQ846688-RS29023691	A_A	A_A	A_B	A_A	A_B	A_B	A_A	A_B	A_B	A_A	B_B	A_A	A_B	B_B	A_B	A_A
-PARENT-DQ647190-RS29013632	A_A	B_B	B_B	B_B	A_A	B_B	A_B	A_B	A_B	A_B	B_B	A_B	A_B	A_B	A_A	A_B
C-PARENT-AY849381-RS29003287	A_A	B_B	B_B	B_B	A_B	A_B	A_A	A_A	A_B	A_B	B_B	A_B	A_B	B_B	B_B	A_A
-PARENT-DQ789028-RS29017713	A_A	B_B	A_A	B_B	A_A	A_B	A_A	A_A	A_A	A_A	B_B	A_A	B_B	B_B	A_B	A_A
-PARENT-DQ888309-RS29013741	A_A	A_A	A_B	B_B	A_A	A_B	B_B	A_A	A_B	A_B	B_B	B_B	A_A	A_B	A_A	A_A
-PARENT-DQ786758-RS29024430	A_A	A_B	A_A	A_B	A_B	B_B	A_B	A_B	B_B	B_B	A_B	B_B	A_B	B_B	B_B	B_B

Pedigree Verification/Identification



Herdbook

Certificate Issued

Rules Applied

Failed

Calf

SNP – Sire Identify

Verified

Failed

SNP - Sire Check

Verified

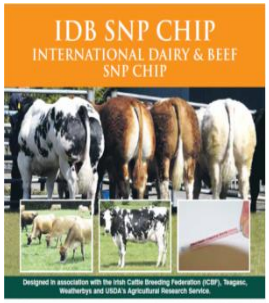
MS - Sire Check

Weatherbys

ICBF Database

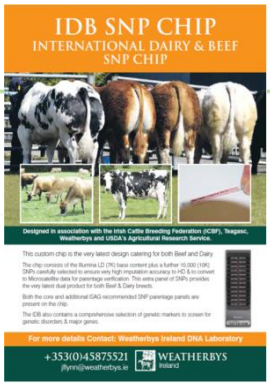
SNP Genotype

Tissue Sample



ICBF.com

Microsatellite Imputation



frontiers in GENETICS
ORIGINAL RESEARCH ARTICLE
published: 18 September 2013
doi: 10.3389/fgene.2013.00176

Imputation of microsatellite alleles from dense SNP genotypes for parentage verification across multiple *Bos taurus* and *Bos indicus* breeds

BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	Bovin
B	A	B	B	A	B	B	A	A	A	B	B	A	B	A	A	
B	A	B	B	B	B	B	A	A	B	B	B	A	B	B	B	

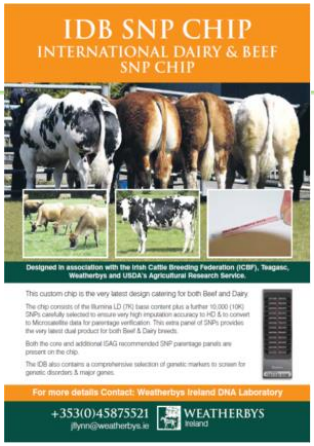
Haplotype	.	Angus	Ayshire	BelgianBlue	Charolais	Guernsey	Hereford	Holstein	Jersey	Limousin	RedAngus	Shorthorn	Simmental	Overall
AAABABBAABBAABABBBBBAABBAAABBAAA/	.		266	266	266		266			266	266	266	266	266
BBBBBAAAABBAABABBBBAABAABAABAAA/	.													262
AABBBABBAAABBABAAABAABAABAABAAA/	.							270						270
BBBBBAAAABBAABABBBBAABAABAABAAA/	.								262					262
AABBABAAABBAABABBBBBAABBAABABBA/	.					280					280			280
AABBBABBABABBABAAABBAAABAAABBAAA/	.													286
AABBBABBABABBABAAABBAAABAAABBAAA/	.												268	268
AABBABBAABBAABABBBBBAABBAABABBA/	.						262							262
AABBABBAABBAABABBBBBAABBAABBAABA/	.													268
BBBBBAAAABBAABABBBBAABBAABBBAABA/	.				272				272					272
AABBABBAABBAABABBBBBAABBAABBAABA/	.		260											260
AABBBABBABABBABAAABBAABAABABBAAA/	.											260		260
AAABABBAABBAABABBBBBAABBAABBAAA/	.				268					268			268	268
AAABBABBABABBABAAAAAABBAABABABBA/	.	262										262	262	262
AABBABBAABBAABABBBBBAABBAABBAAA/	.	258	258		258							258		258
AAABABAAABBAABABBBBBAABBAABBAAA/	.	266		266			266	266						266
AAABABBAABBAABABBBBBAABBAABBAAA/	.				268					268			268	268
AAABABBAABBAABABBBABABABABABBA/	.							262						262
AABBBABBAAABBABAAABBABABBAABBA/	.				266					266			266	266
AABBBABBABABBABAAAABAABBAABABAB/	.						266						266	266

BM1818
262/258

Microsatellites Imputed on >15,000 Irish animals = €300,000 saving

ICBF.com

Sex Determination



Male? Or Female?

Female

0-1 ChrY SNP

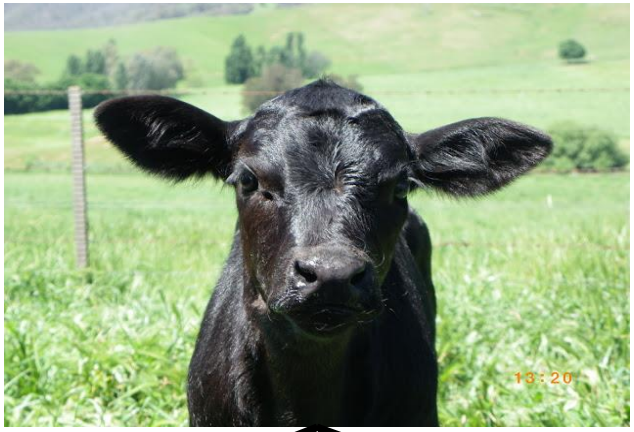
Count 7 ChrY SNP Genotypes

Male

5-7 ChrY SNP

ICBF.com

Breed Composition



?

Angus

Limousin

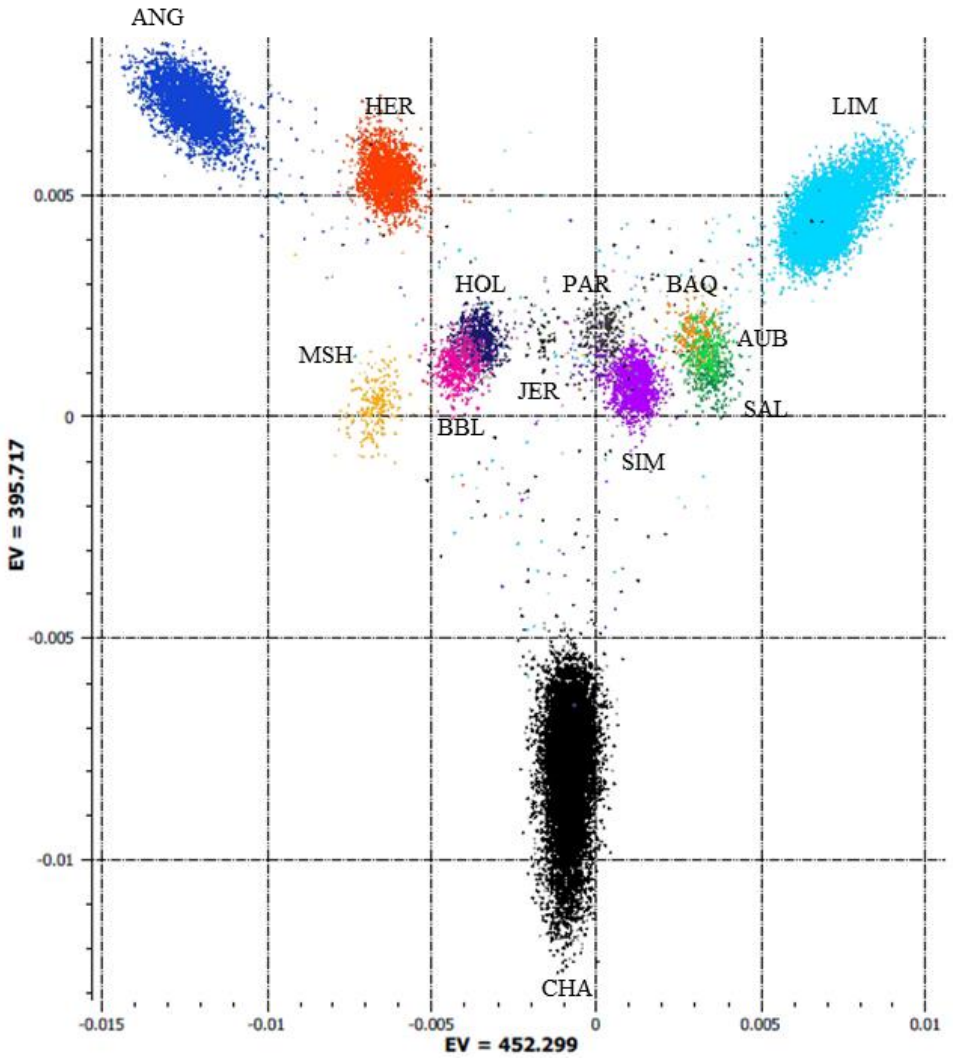
Dexter

Saler

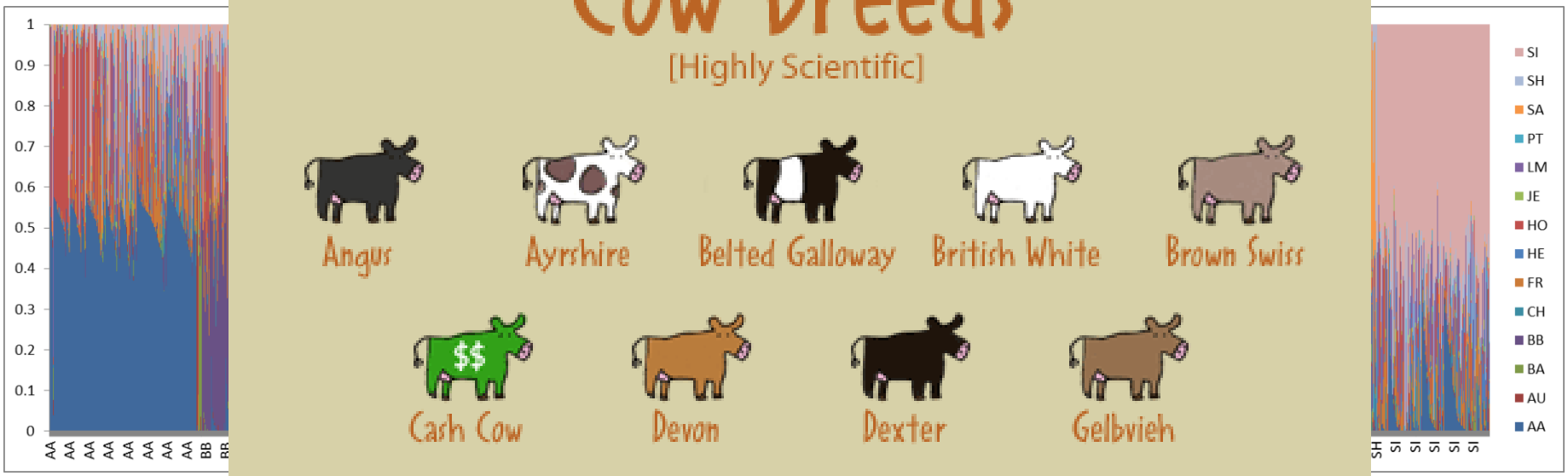
ICBF.com

Breed PCA: 13 Purebreds

AA: 3073
AU: 234
BA: 237
BB: 447
CH: 9395
HE: 1856
HO: 727
JE: 42
LM: 8486
PT: 210
SA: 296
SH: 233
SI: 1362



Predicting Breed Composition



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Genomicly Predicted: Pedigree, Sex, Breed

Create Animal Registration

HERD KEEPER
Name:
Business ID:

Address: CARLOW D.V.O. , DEPT OF AGRICULTURE
CO CARLOW

VIEW HERD OWNER/DEA

Step 1 of 2

Required information:

Tag Number: IE1111999 40016 Date of Birth: 06/07/10

Sex: MALE Stillborn:

Dam Number: IE201044770993

Sire Breed: FR ? AI Code:

CMMS Compliance Certificate Required:

Genetic Dam Indicator:

Additional ICBF:

Sire Number: Retain: Pedigree name of calf:

Dead Calf: Calving Survey:

Traceability

Criminal gangs are raking in €4million a year in the cattle rustling business.

An estimated 3,000 head of cattle are stolen to order every year, mainly in the border counties of Tyrone, Armagh, Cavan and Monaghan. The vast majority are sold on the black market, but some are butchered and sold – on both sides of the border – to butchers and food outlets keen to buy meat on the cheap.

Home News Press Releases ICSA calls for extra Garda resources to counter illegal butchering activity and cattle theft

ICSA CALLS FOR EXTRA GARDA RESOURCES TO COUNTER ILLEGAL BUTCHERING ACTIVITY AND CATTLE THEFT

12th November, 2013

Chief Agent Jerry Flowers' says good guys "wear white hats."

ICBF.com

Traceability

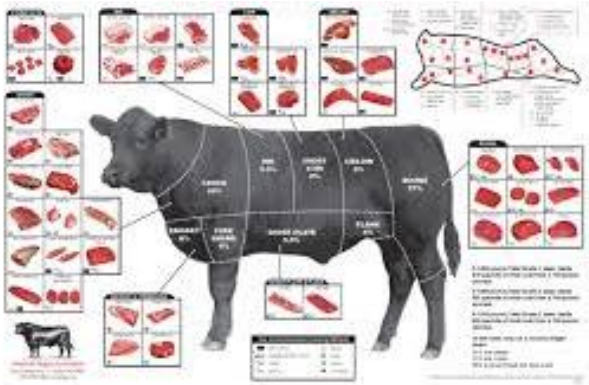
1.5 Billion Cattle world wide (*Stastica, 2014*)

35 “Perfect” SNP = 3.4 Billion (10^10) unique combinations

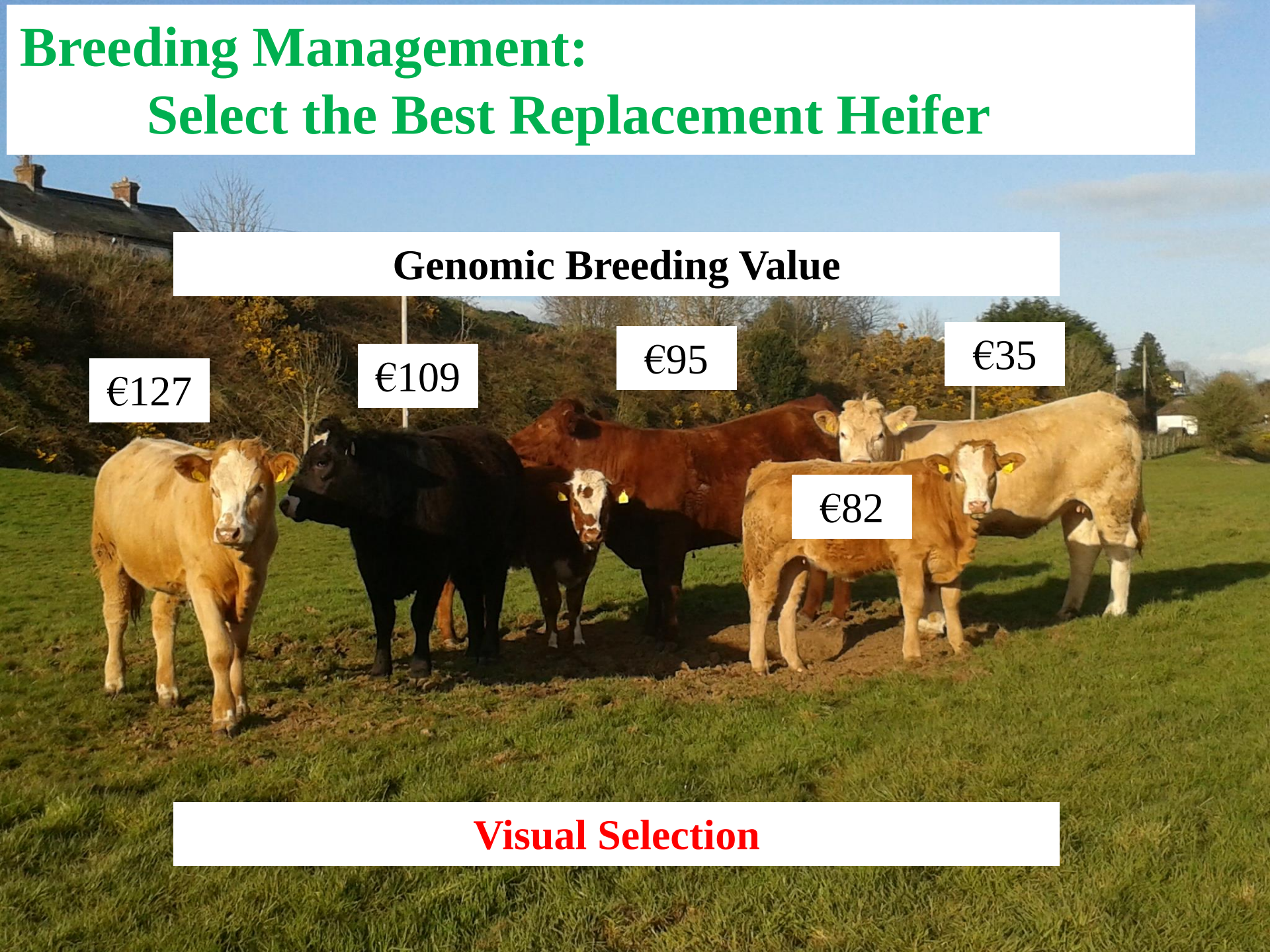
100 SNP = Nonillion (10^30) unique combinations

1,000 SNP = Centillion (10^303) unique combinations

Traceability



Breeding Management:
Select the Best Replacement Heifer



Breeding Management:
Sire Selection

€127

Bull	Name	HO %	Sire	EBI	EBI rel	Proof Source	Milk	Fert	Calv	Beef	Maint	Mmgt	Health	Milk	Fat %	Fat kg	Prot %	Prot kg	Calv Int	Surv	Calv Diff / Progeny
WLY	IMLEACH LUCKY WHISTLER	63	MWH	327	54	GS	85	184	44	-16	19	7	4	96	0.25	16.9	0.16	11.4	-9.3	5.7	2.0 / 393
RBH	(IG) SRUTHAN ROBERTO	63	HYZ	309	53	GS	77	200	36	-15	14	2	-7	106	0.22	15.8	0.14	10.6	-10.9	5.4	3.3 / 81
DBW	DOONMANAGH DSU BOWSER	75	DSU	307	51	GS	85	175	33	-10	20	1	2	-134	0.48	19.6	0.25	7.9	-10.5	3.7	4.1 / 257
KZY	COOKSTOWN BUDDY	59	HFT	303	56	GS	60	201	42	-18	23	-3	-2	-101	0.31	12.4	0.18	5.7	-12.7	3.6	1.8 / 89
PKX	PARKDUV MAGNET	81	SOK	302	60	GS	104	149	46	3	-10	10	-1	248	0.19	19.9	0.15	15.9	-7.4	4.8	1.9 / 549
PRW	BALLYBRIDE PRINCE	72	IRP	295	59	GS	82	177	40	-22	13	2	4	38	0.24	14.1	0.18	10.7	-9.5	4.9	3.1 / 128
CFF	(IG) CREFOGUE DONCASTER	78	MDW	292	52	GS	83	165	39	-5	4	4	3	95	0.23	16.2	0.16	11.2	-9.8	3.5	1.4 / 243
YGM	GARRYMARTIN CRONIC	75	WDS	290	52	GS	101	149	34	-17	14	7	2	417	0.00	16.0	0.09	18.4	-7.1	5.1	2.2 / 108
WTC	CLOUNTIES WINTER	56	GVV	290	53	GS	58	206	28	-12	10	2	-2	-103	0.29	11.2	0.18	5.6	-11.7	5.0	2.7 / 177

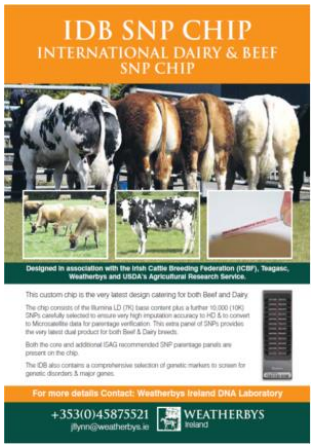
Breeding Management:

Genetic Disease and Major Genes

Validated		
BLAD	DUN	NH
ABCG2	EBD	OS
AM_662	GH_2141	PCS
BC_A1A2	GH_2291	PHA1
BC_A3	GHR_F279Y	PHA2
Black_E	HH1	PMT_491
BM	HH3	PMT_632
BY	HH4	PMT_857
CAPN1_316	HY_KRT71	POLL_C
CAPN1_4751	JH1	POLL_H
CAPN1_530	KC	PROTO
CAST_282	LGB	RED_e
CAST_2870	MC	RNF11
CAST_2959	MF	SD1
CMD1	MH2	SMA
CMD2	MSU_SH	STAT1
CSN2_A3	MYO_C313Y	STAT3_19069
CT	MYO_E226X	STAT3_25402
CTS	MYO_E291X	STAT5_13244
CVM	MYO_F94L	STAT5_13319
DGAT1	MYO_nt821	STAT5_13516
DLT3	MYO_Q204X	TH-Improver
DUMPS	MYO_S105C	

In Progress		
AED	HA	MYO_nt748-78
AH1	HH2	PWCS
AM_961	HH5	SAA_MOCS1
BD1	HI	SAA_SUOX
BD2	HY_HEPHL1	SCD1
BH1	IBK	SCD2
BH2	IE	Scurs_2
BSD	LAA	SD2
CD2	MOD	STAT5_12195
ChrY_Fem	MPS_IIB	STAT5_3117
CHS	MSU_HE	TG5_257
CMS	MYO_D182N	TG5_335
CWH	MYO_nt267	TM
Dilution	MYO_nt324	Weaver
Dilutor	MYO_nt374	Xan_II
Dwarf_PRKG2	MYO_nt414	YMF
Factor_XI	MYO_nt419	

Needed	
Agouti	MYO_nt387
Albino_TYR	MYO_-nt747+11
AX	MYO_nt747+7
CD	NCL
CD1	PMEL17_A612E
Dward_GH1	PMEL17_del
DWBD	RVC
FGMA	SP
Goitre	TG5_422
IC	THR
Marfan	



National Genetic Disease and Major Gene Overview: from 100,000 Genotyped Animals

Trait	Carrier Count	National %
ABCG2	583	0.583%
Agouti	0	0.000%
AM_662	1	0.001%
BC_A1A2	44239	44.239%
BC_A3	124	0.124%
BLACK_E	25751	25.751%
BLAD	221	0.221%
BM	17	0.017%
BY	394	0.394%
CAPN1_316	28042	28.042%
CAPN1_4751	43504	43.504%
CAPN1_530	36252	36.252%
CAST_282	42538	42.538%
CAST_2870	45252	45.252%
CAST_2959	30934	30.934%
CMD1	230	0.230%
CMD2	89	0.089%
CSN2_A3	124	0.124%
CT	63	0.063%
CTS	529	0.529%
CVM	727	0.727%
DGAT1	22061	22.061%
DLT3	7017	7.017%
DUMPS	1	0.001%
DUN	13	0.013%
EBD	0	0.000%
HH1	427	0.427%
HH3	768	0.768%
HH4	62	0.062%
HY_KRT71	336	0.336%
JH1	31	0.031%
KC	44768	44.768%
LGB	44202	44.202%

Trait	Carrier Count	National %
MC	0	0.000%
MF	33	0.033%
MH2	41	0.041%
MSU_SH	0	0.000%
MYO_C313Y	248	0.248%
MYO_E226X	54	0.054%
MYO_E291X	3	0.003%
MYO_F94L	23295	23.295%
MYO_nt821	5281	5.281%
MYO_Q204X	54	0.054%
MYO_S105C	4	0.004%
NH	0	0.000%
OS	9	0.009%
PCS	6	0.006%
PHA1	3	0.003%
PHA2	0	0.000%
PMT_491	0	0.000%
PMT_632	6	0.006%
PMT_857	7	0.007%
POLL_C	9536	9.536%
POLL_H	63	0.063%
PROTO	765	0.765%
RED_E	24979	24.979%
RNF11	277	0.277%
SD1	13475	13.475%
SMA	7	0.007%
STAT1	26176	26.176%
STAT3_19069	40188	40.188%
STAT3_25402	43496	43.496%
STAT5_13244	44630	44.630%
STAT5_13319	12206	12.206%
STAT5_13516	44725	44.725%
TH_IMPROVER	195	0.195%

Breeding Management:
Avoid Carrier X Carrier Mating

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PCS

Bull	Name	HO %	Sire	EBI	EBI rel	Proof Source	Milk	Fert	Calv	Beef	Maint	Mmgt	Health	Milk	Fat %	Fat kg	Prot %	Prot kg	Calv Int	Surv	Calv Diff / Progeny
WLY	IMLEACH LUCKY WHISTLER	63	MWH	327	54	GS	85	184	44	-16	19	7	4	96	0.25	16.9	0.16	11.4	-9.3	5.7	2.0 / 393
RBH	(IG) SRUTHAN ROBERTO	63	HYZ	309	53	GS	77	200	36	-15	14	2	-7	106	0.22	15.8	0.14	10.6	-10.9	5.4	3.3 / 81
DBW	DOONMANAGH DSU BOWSER	75	DSU	307	51	GS	85	175	33	-10	20	1	2	-134	0.48	19.6	0.25	7.9	-10.5	3.7	4.1 / 257
KZY	COOKSTOWN BUDDY	59	HFT	303	56	GS	60	201	42	-18	23	-3	-2	-101	0.31	12.4	0.18	5.7	-12.7	3.6	1.8 / 89
PKX	PARKDUV MAGNET	81	SOK	302	60	GS	104	149	46	3	-10	10	-1	248	0.19	19.9	0.15	15.9	-7.4	4.8	1.9 / 549
PRW	BALLYBRIDE PRINCE	72	IRP	295	59	GS	82	177	40	-22	13	2	4	38	0.24	14.1	0.18	10.7	-9.5	4.9	3.1 / 128
CFF	(IG) CREFOGUE DONCASTER	78	MDW	292	52	GS	83	165	39	-5	4	4	3	95	0.23	16.2	0.16	11.2	-9.8	3.5	1.4 / 243
YGM	GARRYMARTIN CRONIC	75	WDS	290	52	GS	101	149	34	-17	14	7	2	417	0.00	16.0	0.09	18.4	-7.1	5.1	2.2 / 108
WTC	CLOUNTIES WINTER	56	GVV	290	53	GS	58	206	28	-12	10	2	-2	-103	0.29	11.2	0.18	5.6	-11.7	5.0	2.7 / 177

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