



IRISH CATTLE BREEDING FEDERATION

Application of a custom SNP chip: Microsatellite imputation, parentage SNP imputation, genomic evaluations, and across-breed nation-wide genetic disease prevalence with the International Beef and Dairy SNP chip



Matthew McClure



IDBv1 SNP chip (International Beef and Dairy)



17K chip, LD base

Diseases

Parentage Validation

Imputation for Parentage

2013: 27,600 Irish cattle

IDB SNP CHIP
INTERNATIONAL DAIRY & BEEF
SNP CHIP

Designed in association with the Irish Cattle Breeding Federation (ICBF), Teagasc, Weatherbys and USDA's Agricultural Research Service.

This custom chip is the very latest design catering for both Beef and Dairy. The chip consists of the illumina LD (7K) base content plus a further 10,000 (10K) SNPs carefully selected to ensure very high imputation accuracy to HD & to convert to Microsatellite data for parentage verification. This extra panel of SNPs provides the very latest dual product for both Beef & Dairy breeds.

Both the core and additional ISAG recommended SNP parentage panels are present on the chip.

The IDB also contains a comprehensive selection of genetic markers to screen for genetic disorders & major genes.

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WEATHERBYS Ireland

CHIP CONTENTS FOR DISEASES & TRAITS

Lethal recessives

- 1 CVM* Complex Vertebral malformation
- 2 DUMPS
- 3 Brachyspina*
- 4 BLAD

Congenital disorders

- 1 Arthrogyposis (Curly Call)*
- 2 Fawn Call Syndrome or Contractural Arachnoidactyly*
- 3 Hypotichosis: PMa17
- 4 Hypotichosis in Belted Galloway, HEPH11 SNP
- 5 Hypotichosis: KRT71*
- 6 Spiderleg: MCCC1 gene- Simmental
- 7 Spiderleg: SGLK gene- Brown Swiss
- 8 Polledness
- 9 Mule Foot
- 10 Tibial Hemimelia (TH)*
- 11 Black/Red Coat Color/Floxed Factor
- 12 Red Recessive coat colour (Different to red factor)
- 13 Silver Color Dilutor
- 14 Dun Color
- 15 RNF11 (affects growth and stature)
- 16 Osteopetrosis (Marble Bone Disease)
- 17 Pink Eye (Infectious Bovine Keratoconjunctivitis)
- 18 Protoporphyria Ferochelatase Gene (Photosensitization)
- 19 SMA- Spinal muscular atrophy
- 20 Beta Lactoglobulin
- 21 Beta Mannosidosis
- 22 Alpha Mannosidosis
- 23 Ceroidemia
- 24 CMDI: Congenital muscular dystonia I
- 25 CMDII: Congenital muscular dystonia II
- 26 Crooked Tail Syndrome*
- 27 Factor XI
- 28 Heterochromia Irides (White Eye)
- 29 SDM- Spinal dysmyelination-SPAST Gene
- 30 Idiopathic Epilepsy*
- 31 Pulmonary Hypoplasia*
- 32 Weaver
- 33 Neuroopathic hydrocephalus* (water head syndrome)

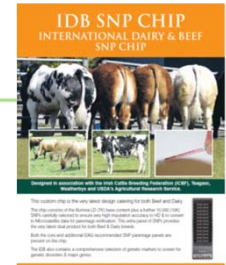
Major genes

- 1 DGAT1
- 2 MSTN (GDF-8) Double Muscling*
- 3 A1/A2 beta casein + *
- 4 Fertility Haplotypes (H-H1, H-H2, H-H3, JH1)
- 5 Kappa Casein I
- 6 Kappa Casein II
- 7 ABCG2
- 8 GH2141 and GH2291 (Marbling, growth rate)*
- 9 IGF1-A/G17143
- 10 STAT1*
- 11 STAT3*
- 12 STAT5*
- 13 Calpain (tenderness) loci

* Royalty fees may apply



IDBv2—18K chip



17K chip, LD base

March, 2014

Diseases-increased

Parentage Validation

Imputation-improved

Diseases

BLAD_Bovine_Leukocyte_Adhesion_Deficiency	Dun_Dexter
BY_Brachyspina	Mulefoot-Syndactyly
Citrullinaemia	NH_Neuropathic_hydrocephalus
CMD1_Congenital_muscular_dystonia_1__	Osteopetrosis
CMD2/Startle_Disease	PHA1_Pulmonary_hypoplasia_with_anasarca
Crooket_tail_syndrome	PHA2_Pulmonary_hypoplasia_with_anasarca
CVM_Complex_Vertebral_Malformation	Protoporphyrin
Dilutor_3bp	Tibial_Hemimelia-TH_Improver

Major Genes

A1/A2_beta-casein,"A2_corp"
Myostatin_MSTN1-nt821DEL11
Myostatin_MSTN2-F94L
Myostatin_MSTN4-Q204X
Myostatin_MSTN5-E226X
Myostatin_MSTN6-C313Y
Myostatin_MSTN7-S105C

IDBv2 Needs Validation

Diseases

Agouti_colour	Dwarfism_BD2_Dexter	Multiple_ocular_defects_2
Alpha_Mannosidosis_662_Galloway	Dwarfism_growth_hormone_deficiency_Brahman	Myasthenic_syndrome_congenital
Alpha_Mannosidosis_961_Angus	Epidermolysis_bullosa	Myoclonus
Anhidrotic_ectodermal_dysplasia	Epidermolysis_bullosa_dystrophic	Neuronal_ceroid_lipofuscinosis
Arachnomelia_Syndrome-SAA_Serum_Amyloid-A-MOCS1_gene	Factor_XI	Perinatal_weak_calf_syndrome
Arachnomelia_Syndrome-SUOX_gene	Forelimb_girdle_muscular_anomaly	PinkEye
Axonopathy	Goitre_familial	PMT_pseudomyotonia_con_chianina
Beta_Mannosidosis	Haemophilia_A	PMT_pseudomyotonia_con_romagnola_1
Brachyspina1	Heterochromia_Irides	PMT_pseudomyotonia_con_romagnola_2
Brachyspina2	HH1_decreased_reproductive_efficiency	Polled_Celtic
Cardiomyopathy_and_woolly_haircoat_syndrome	HH3_decreased_reproductive_efficiency	Polled_Holstein
Cardiomyopathy_dilated	HH4_decreased_reproductive_efficiency	RNF11_growth_retardation_
Chediak_Higashi_syndrome	Hypotrichosis1	Scurs_type2
Chondrodysplasia_1	Hypotrichosis2	Scurs-TWIST1
Chondrodysplasia_2	Ichthyosis_congenita	SDM_Spinal_dysmyelination
Coat_colour_albinism	IE_Idiopathic_Epilepsy	Silver_Char_Dilutor
Coat_colour_Black	JH1_decreased_reproductive_efficiency	SilverColorDilutor1
Coat_colour_dilution	Congenital Paunch Calf Syndrome	SilverColorDilutor2
Coat_colour_dilution-PMel17	Maple_Syrup_Hereford	SMA_spinal_muscular_atrophy
Coat_colour_Red_factor	Marfan_syndrome	Spherocytosis
Colour_Dilutor_SNP	MH1_abortion	Thrombopathia
Dominant_white_with_bilateral_deafness	MH2_abortion	Trimethylaminuria_fishy_flavor
DUMPS_deficiency_uridine_monophosphate_synthase	Mucopolysaccharidosis_IIIB	Weaver_Syndrome
Dwarfism_Angus	Mulefoot	Xanthinuria_type_II
Dwarfism_BD1_Dexter	Multiple_ocular_defects_1	Yellow_fat

Major Genes

ABCG2	Growth_Hormone_GH2291	Myostatin_MSTN-nt374-50
Calpain1_CAPN1_530	Growth_Hormone_GH-F279	Myostatin_MSTN-nt374-51
Calpastain_CAST_2959	LALBA_Lactose_synthase_B	Myostatin_MSTN-nt387
Calpastain_CAST-2870	LGB_beta-lactoglobulin_pre	Myostatin_MSTN-nt414
CSN2_beta_casein	Myostatin_MSTN3a-nt419	Myostatin_MSTN-nt747+7
CSN2_kappa_casein_2	Myostatin_MSTN8-D182N	Myostatin_MSTN-nt748-78
CSN3_kappa_casein	Myostatin_MSTN9-E291X	STAT1
Ferrochelataase	Myostatin_MSTN-nt267	STAT3
Growth_Hormone_GH_2141	Myostatin_MSTN-nt324	STAT5
Growth_Hormone_GH_2291	Myostatin_MSTN-nt374-16	TG5_Thyroglobulin

National Genetic Disease Overview

Citrullinaemia <1%

DUMPs 0%

CVM-4%

Branchspina-2%

Curly Calf 0%

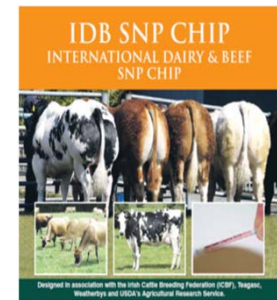
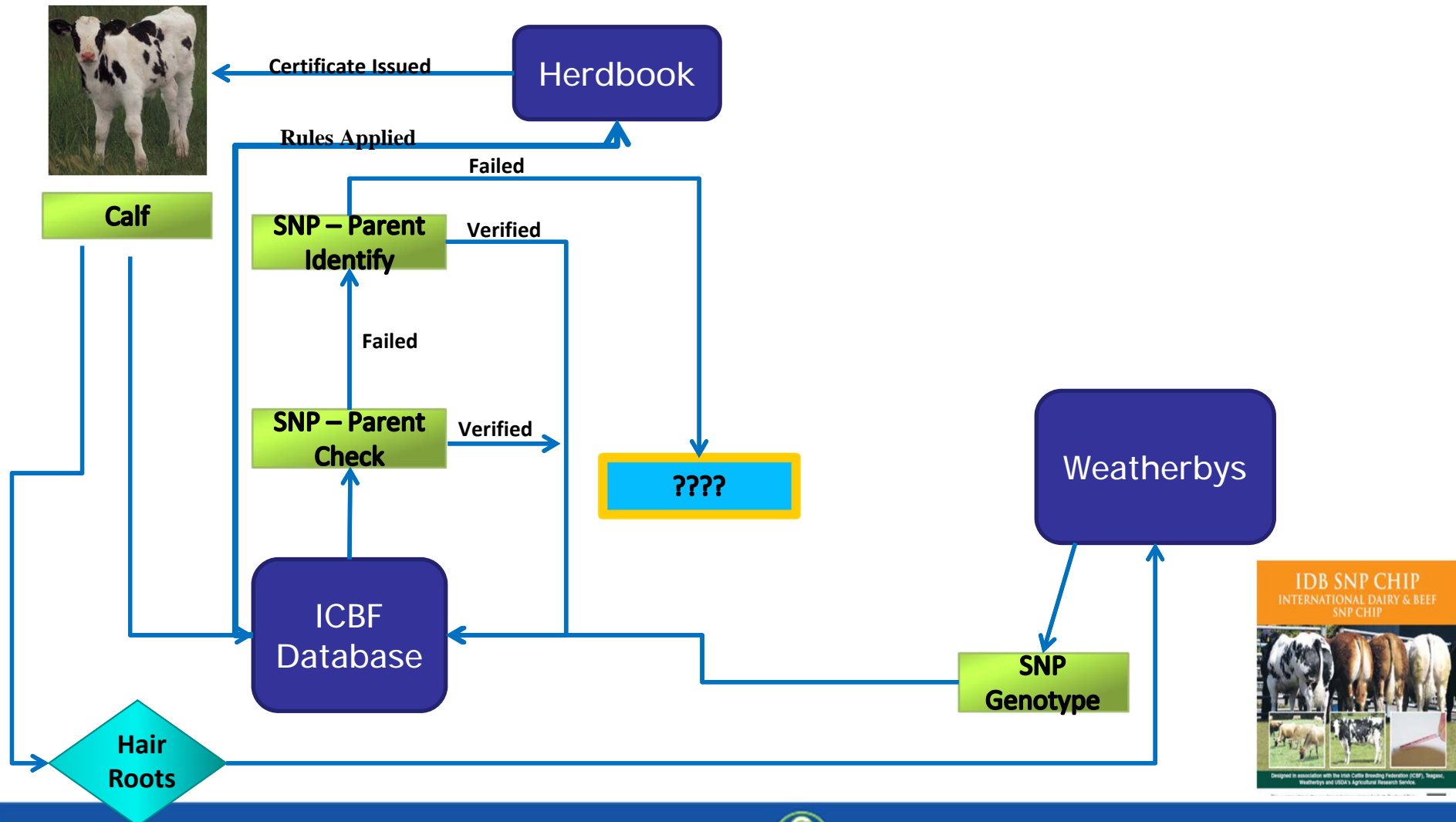
Mulefoot <1%

Osteopetrosis <1%

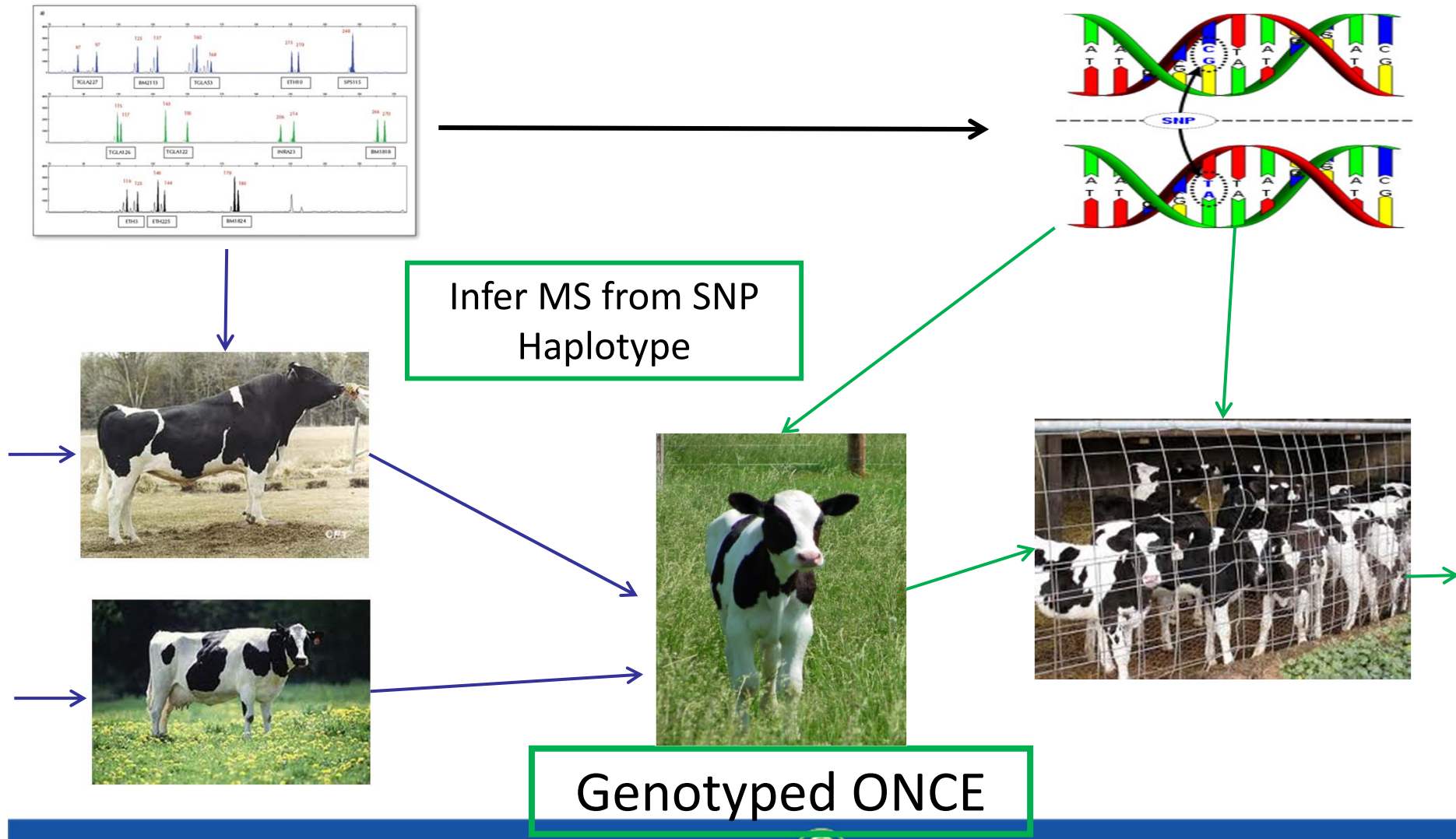
50 km



Irish Parent Verification Process



Microsatellite Imputation



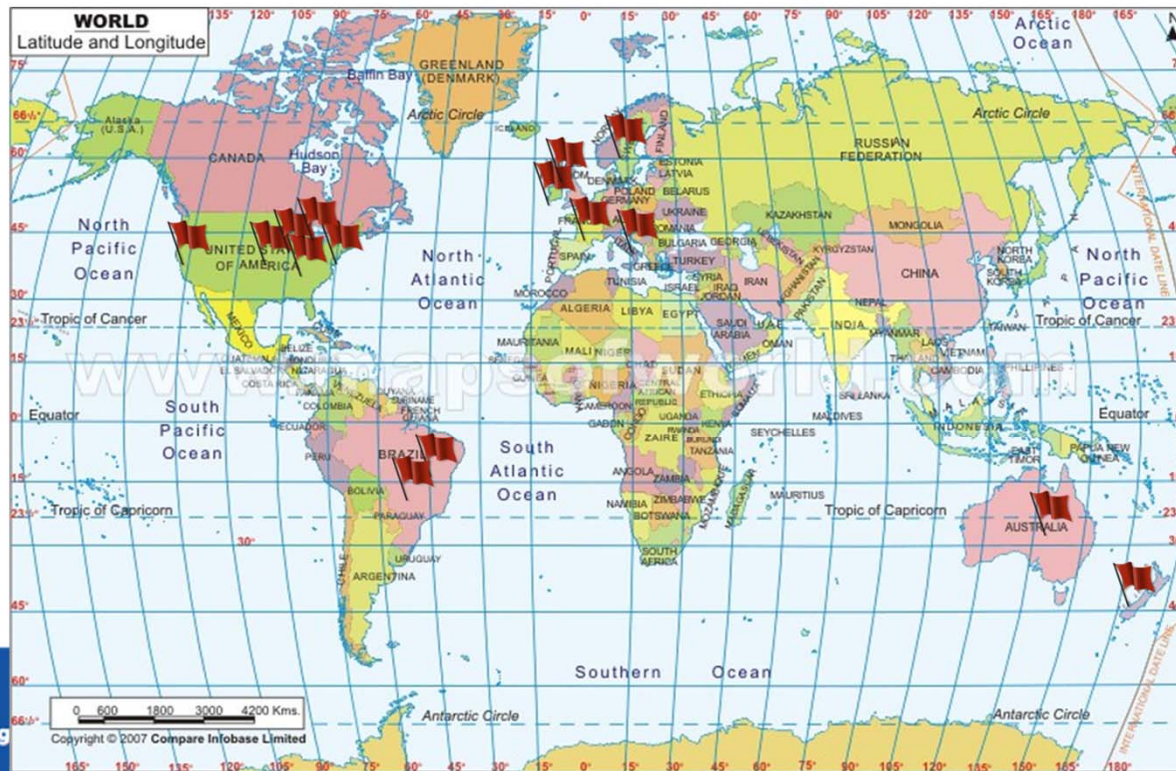
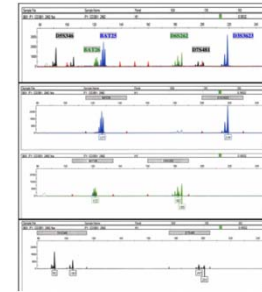
Microsatellite Imputation

Initial reference population: SNP + ISAG MS genotypes

7,076 *Bos taurus*

1,008 *B. indicus*

39 pure breeds



Breed	SNP	SNP+MS
Abundance	172	165
Angus	623	235
Aubrac	239	234
Ayshire	523	86
Bazadaise	80	53
Beefmaster	36	36
Belmont Red	40	
Belgian Blue	210	12
Blonde D'Aquitain	225	201
Brahman	410	364
Brangus	13	13
Braunvieh	17	17
Bretonne Pie Noire	27	16
Brown Swiss	91	64
Brune Des Alpes	109	109
Charolais	1449	1109
Chiangus	19	0
Crossbred	506	3
Devon	16	16
Dexter	15	15
Friesian	163	35
Gasconne	142	142
Gelbvieh	44	0
Gir	209	101
Guernsey	110	18
Hereford	853	243
Holstein	2596	678
Jersey	87	131
Kerry	1	0
Limousin	2171	1572
Longhorn	13	13
Maine Anjou	38	16
Montbeliard	257	251
Murray Grey	22	
N'Dama	24	0
Nelore	2659	135
Normande	256	242
Parthenaise	291	218
Pie Rouge Des Plaines	160	116
Piedmontese	24	17
Red Angus	61	47
Red Pie (italian)	2	0
Romagnola	23	23
Rouge Flamande	41	41
Salers	258	234
Santa Gertrudis	99	0
Sheko	18	0
Shorthorn	188	0
Simmental	907	324
Swedish Red	12	9
Tarentaise	167	155
Tropical Composite		336
Vosgienne	53	49
Watusi	15	15
TOTAL	17138	8259

Microsatellite Imputation -Beagle used



PHASE



BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI	BovineHI
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
AAABBBAAABBAABBBBBAABBAABBA/		266	266	266		266			266	266	266	266	266
BBBBBAAAABBAABBBBBAABBAABBA/													262
AABBBABBAABBAABBAABBAABBAAB/							270						270
BBBBBAAAABBAABBBBBAABBAABBA/								262					262
AABBABAABBAABBBBBAABBAABBA/					280					280			280
AABBBABBAABBAABBAABBAABBAAB/													286
AAABBBABBAABBAABBAABBAABBA/												268	268
AAABBBAAABBAABBBBBAABBAABBA/						262							262
AABBBAAABBAABBBBBAABBAABBA/													268
BBBBBAAAABBAABBBBBAABBAABBA/							272		272				272
AABBABAABBAABBBBBAABBAABBA/		260											260
AABBBABBAABBAABBAABBAABBAAB/										260			260
AAABBBAAABBAABBBBBAABBAABBA/							268		268			268	268
AAABBBABBAABBAABBAABBAABBA/	262									262	262		262
AAABBBAAABBAABBBBBAABBAABBA/	258	258			258					258			258
AAABBAABBAABBBBBAABBAABBAAB/	266		266			266	266						266
AAABBAABBAABBBBBAABBAABBAAB/												262	
AAABBAABBAABBBBBAABBAABBAAB/													262
AABBBABBAABBAABBAABBAABBAAB/							266						
AABBBABBAABBAABBAABBAABBAAB/								266					

BM1818
262/258

980 SNP
8,483 Reference Pop

frontiers in
GENETICS

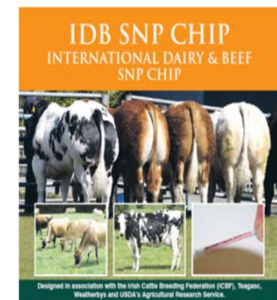
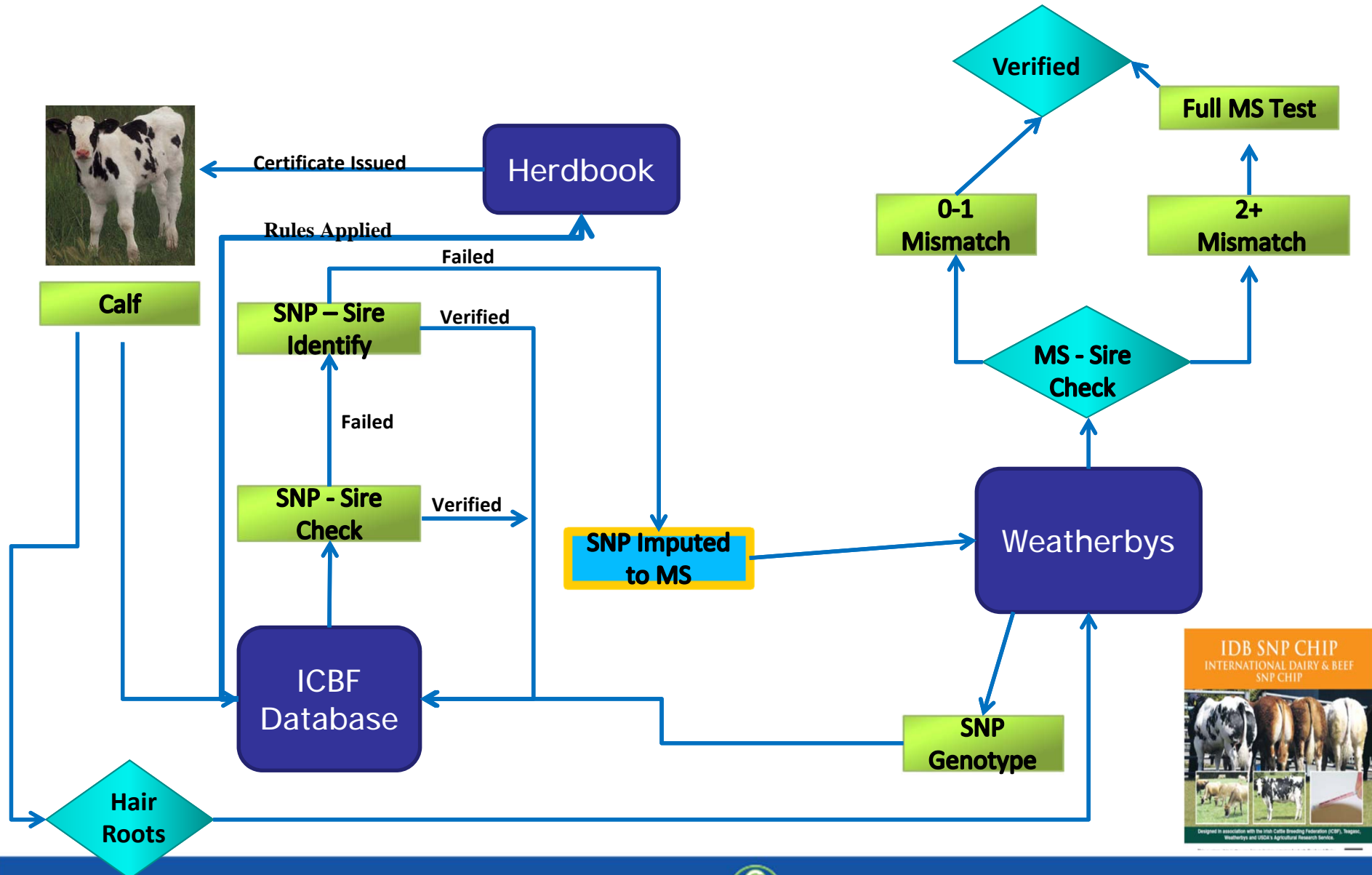
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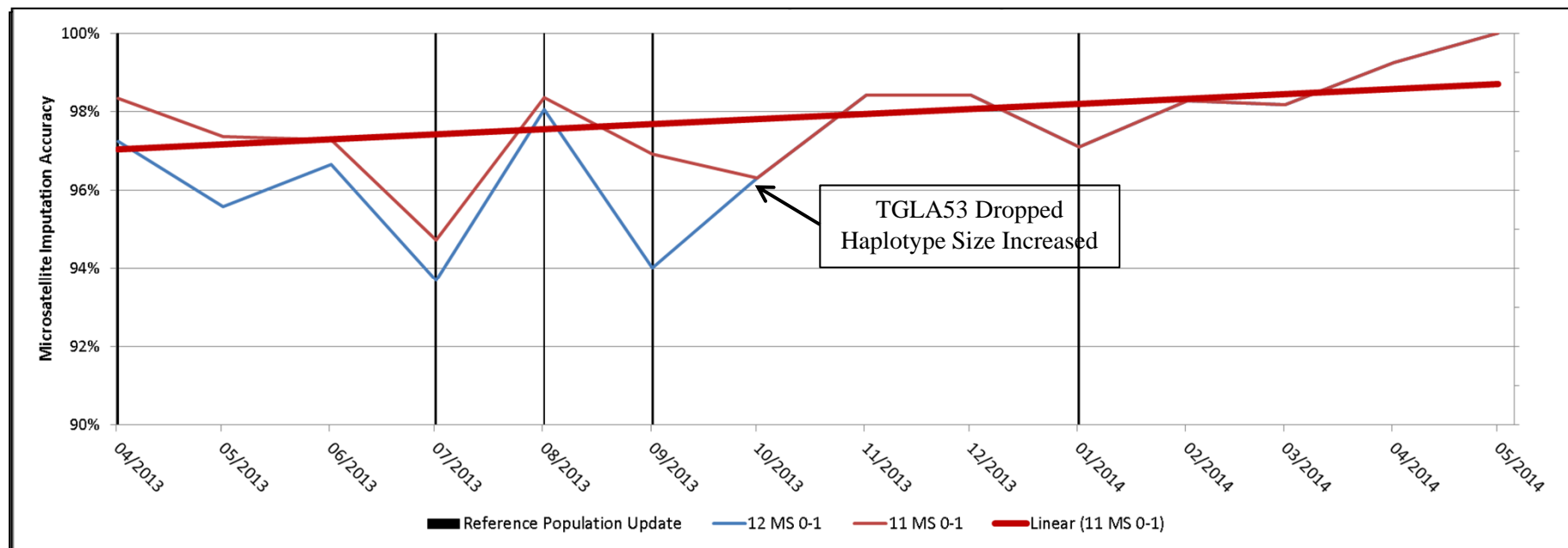
Imputation of microsatellite alleles from dense SNP genotypes for parentage verification across multiple *Bos taurus* and *Bos indicus* breeds

Matthew C. McClure^{1*}, Tad S. Sonstegard¹, George R. Wiggans², Alison L. Van Eenennaam³, Kristina L. Weber³, Cecilia T. Penedo⁴, Donagh P. Berry⁵, John Flynn⁶, Jose F. Garcia⁷, Adriana S. Carmo⁸, Luciana C. A. Regitano⁹, Milla Albuquerque¹⁰, Marcos V. G. B. Silva¹¹, Marco A. Machado¹¹, Mike Coffey¹², Kirsty Moore¹², Marie-Yvonne Boscher¹³, Lucie Genestout¹³, Raffaele Mazza¹⁴, Jeremy F. Taylor¹⁵, Robert D. Schnabel¹⁵, Barry Simpson¹⁶, Elisa Marques¹⁶, John C. McEwan¹⁷, Andrew Cromie¹⁸, Luiz L. Coutinho¹⁹, Larry A. Kuehn²⁰, John W. Keele²⁰, Emily K. Piper²¹, Jim Cook²², Robert Williams²³, Bovine HapMap Consortium and Curtis P. Van Tassell¹

Irish Parent Verification Process



Microsatellite Imputation Accuracy



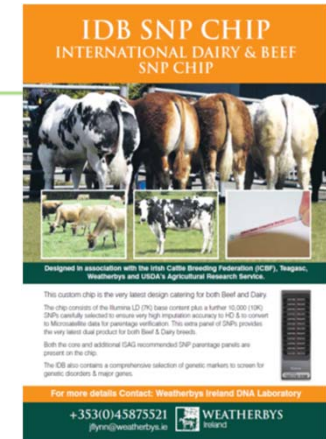
Addition use for Microsatellite Imputation

Correcting Human Error

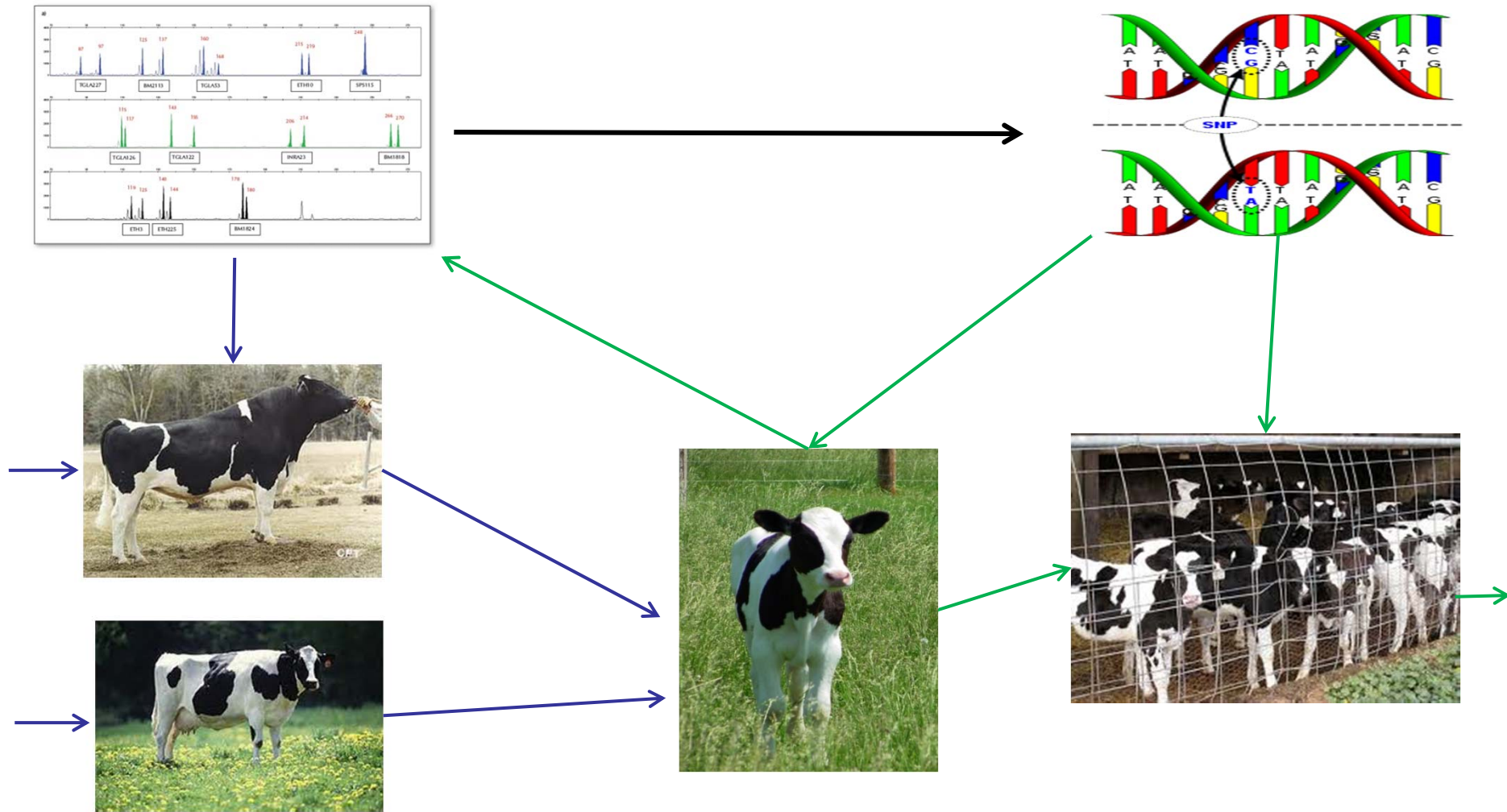
Bull DNA sent for HD	MS matches to
Hillcrest Jerome	Hillcrest Jerome
Lorabar Mighty Prince	Thrunton Unstoppable
Thrunton Unstoppable	Maine Dragon (FT)
Hillcrest Champion	Lorabar Mighty Prince D113 (FT)
Curaheen Tyson	Hillcrest Champion
Woodhall Dynamite	Curaheen Tyson
Sacombe Wishful Thinking	Woodhall Dynamite
Jupiter (JPR)	Jupiter (CH)
Blakestown Artiste (BZT)	Blakestown Artiste
Hurtig Fleckvigh	Hurtig
Dovea Napoleon (NAP)	Dovea Napoleon
Paulern Ulysses	Dovea Napoleon
Maine Dragon	Paulern Ulysses
Fieldson Alfy	Fieldson Alfy
Friarstown Edition	Friarstown Edition G028
Freetown Regent	Friarstown Edition G028
Exodus	No match found
Rainbow Hills Independence 46X	No match found
BUT	No match found
Bellman Of Knockadrinan	No match found

Impact of Microsatellite Imputation

- >11,000 MS imputed Irish animals (May, 2014)
 - SNP parentage failed (small #)
 - Embryo transfer animal
 - No SNP genotype on sire (most of them)
- Saved Irish cattle farmers **>€220,000**
 - MS genotyping ~€20/animal
- >98% accuracy
 - 2+ misconcordances = MS genotyped

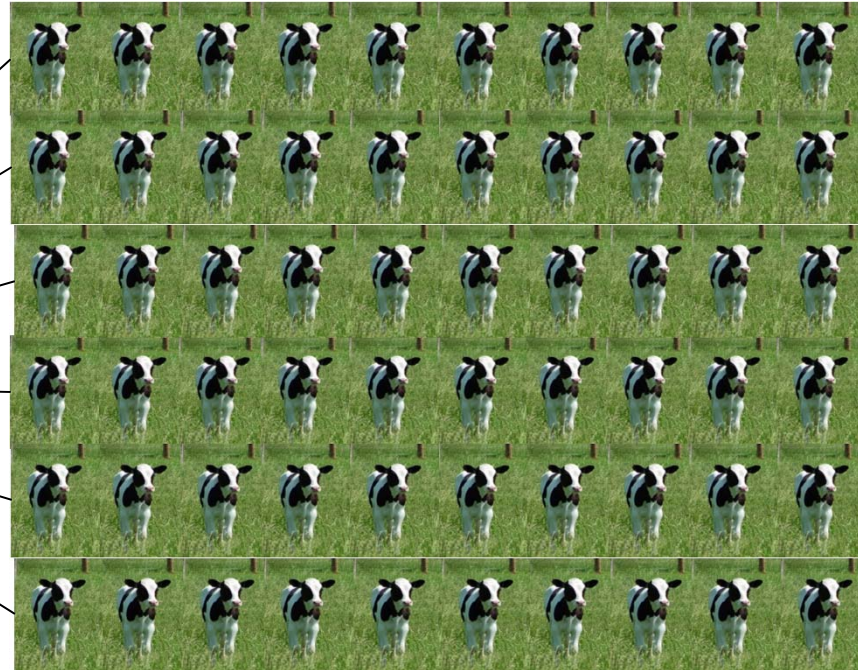
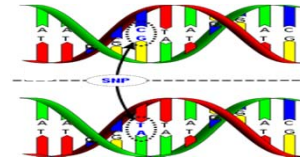
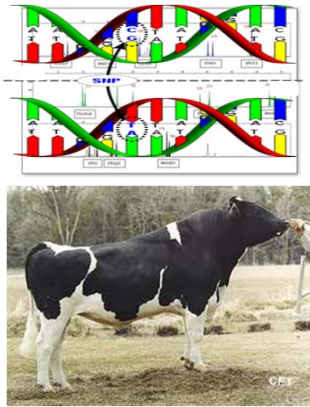


Parentage SNP Imputation?



Parentage SNP Imputation

>99% accuracy?

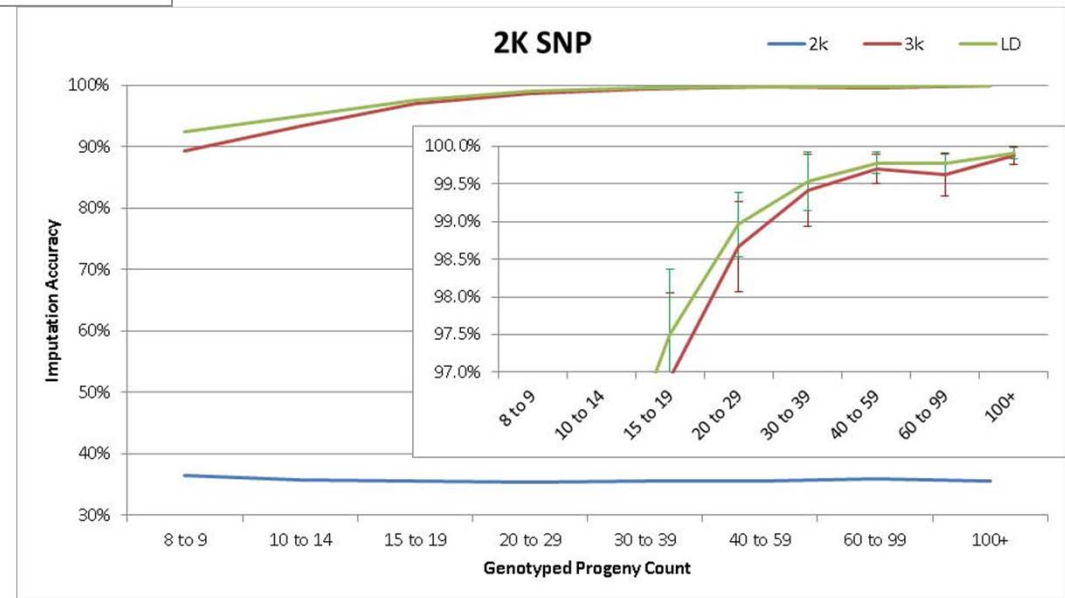
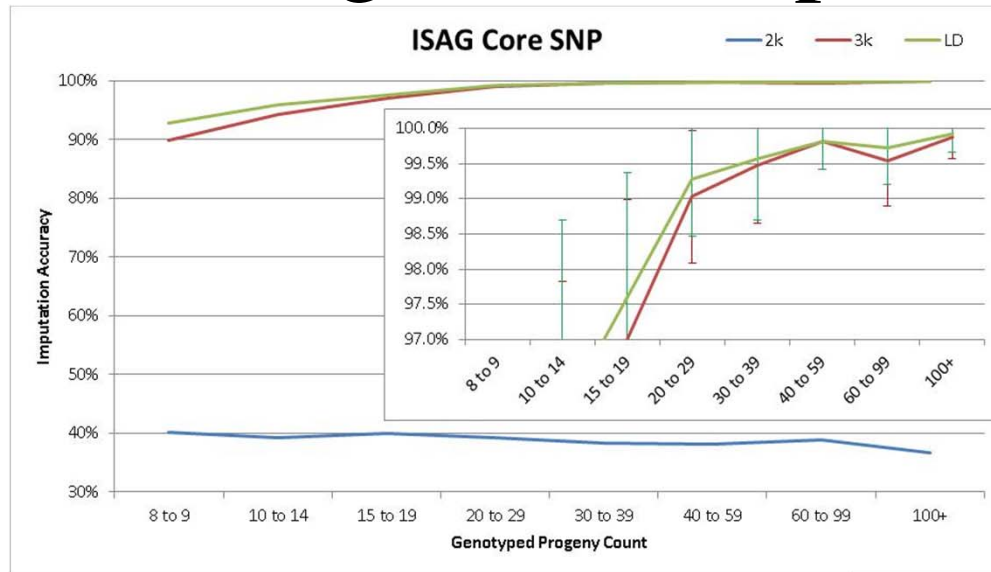


Parentage SNP Imputation

- >35,600 animals
- FImpute2 used
- # Offspring
 - 8 balanced groups
 - 501 Sires
- SNP density
 - 3 levels
- SNP imputed
 - ISAG core
 - 1980 Common SNP

Breed	All Animals					Imputed Sires
	LD	IDB	50K	HD	Total	
AAN	79	1,365	.	521	1,965	24
AUB	1	1	.	.	2	.
AYS	.	.	.	2	2	.
BAQ	5	8	.	3	16	.
BBL	7	184	.	331	522	7
BRF	.	.	80	89	169	23
CHA	10	3,790	.	1,016	4,817	62
DNR	.	.	.	1	1	.
HER	1	1,314	.	343	1,658	24
HOL	2,745	12,721	3,852	436	19,754	264
IRM	.	93	.	.	93	.
JER	3	.	4	81	88	1
KER	.	.	.	1	1	.
LIM	119	3,983	.	1,030	5,132	68
MON	.	.	1	33	34	.
MRY	.	.	4	11	15	.
MSH	.	31	.	3	34	.
NWR	2	.	1	18	21	.
PAR	.	77	.	1	78	.
PIE	.	2	.	.	2	.
RBT	.	.	.	1	1	.
SAL	2	12	.	2	16	1
SIM	10	784	.	400	1,194	24
SWR	.	.	.	1	1	.

Parentage SNP Imputation Results

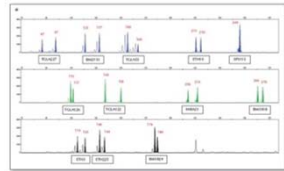
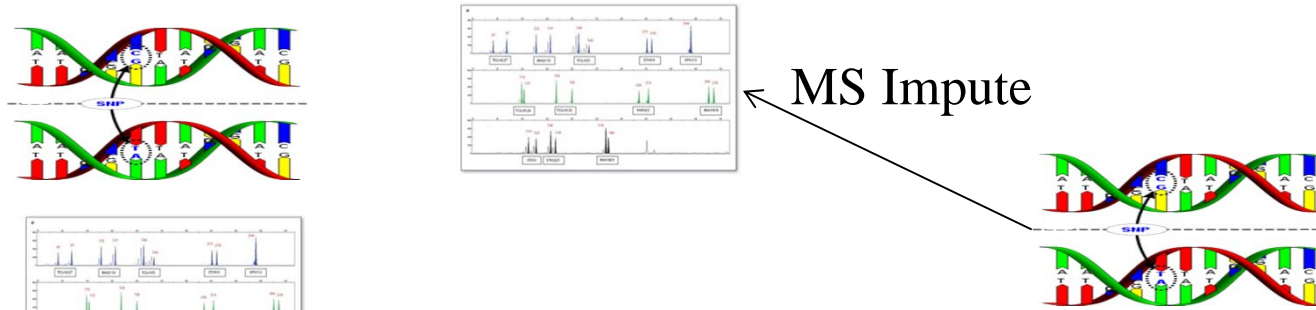


Most imputation errors are BB/AA where the sire is A/B

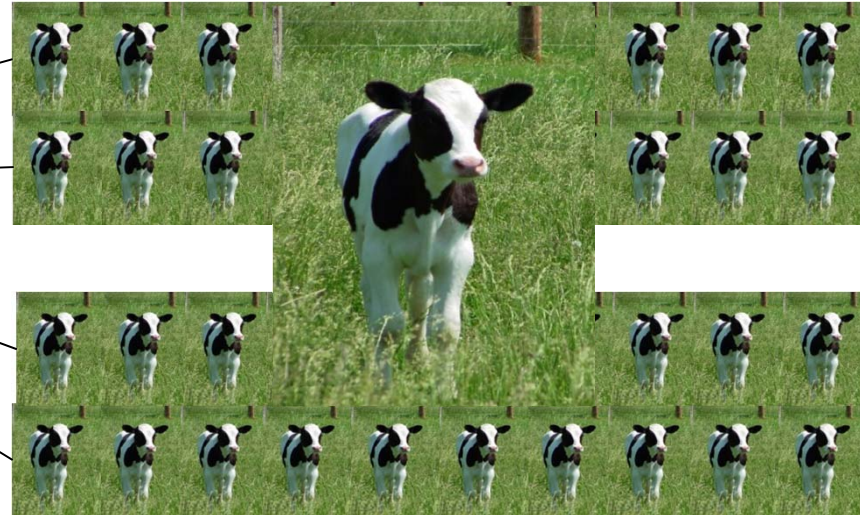
Marker			BTB-01969338
Call Rate			0.996
Minor Allele			A
Major Allele			B
Minor Allele Frequency			0.0288
Major Allele Frequency			0.9712
AANGBRM00000ELFP126	AANGBRM00000ELFP126	1.original	A_B
AANGBRM00000ELFP126	AANGBRM00000ELFP126	2k	A_A
AANGBRM00000ELFP126	AANGBRM00000ELFP126	3k	B_B
AANGBRM00000ELFP126	AANGBRM00000ELFP126	4.LD	B_B
AANIRLF151224610987	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF151224680993	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF151224690961	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF151597710663	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF151597720648	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF151597770652	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF151597780653	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF151597790654	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF151653460944	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF151653460977	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF161552870266	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF181816670453	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF181816680446	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF182321420277	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF221375810313	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF251078150284	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF272006710256	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF272127880272	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF272138050167	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF272192660333	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF272422890153	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF291285280255	AANGBRM00000ELFP126	6.offspring	B_B
AANIRLF301069740649	AANGBRM00000ELFP126	6.offspring	A_B
AANIRLF311125940183	AANGBRM00000ELFP126	6.offspring	B_B

Unsort		C	1	5	3
Map	itt		sire_itt		ARS-USMARC-PARENT-EF093511-RS2901320
1	HERAUSM00000GRKA584			1	B_B
2	HERIRLM141607070601		HERAUSM00000GRKA584		
3	HERIRLM151225330379		HERAUSM00000GRKA584		A_A
4	HERIRLM151225340413		HERAUSM00000GRKA584		A_A
5	HERIRLM151225360423		HERAUSM00000GRKA584		A_A
6	HERIRLM151225370399		HERAUSM00000GRKA584		A_A
7	HERIRLM151225380425		HERAUSM00000GRKA584		A_A
8	HERIRLM151225380441		HERAUSM00000GRKA584		A_A
9	HERIRLM191141760568		HERAUSM00000GRKA584		A_A
10	HERIRLM231305310207		HERAUSM00000GRKA584		A_A
11	HERIRLM241245190385		HERAUSM00000GRKA584		A_A
12	HERIRLM331493150493		HERAUSM00000GRKA584		A_A
13	HERIRLM361055830685		HERAUSM00000GRKA584		A_A
14	HERIRLM361055880665		HERAUSM00000GRKA584		A_A
15	HERIRLM121182590084		HERAUSM00000GRKA584		A_B
16	HERIRLM121201450915		HERAUSM00000GRKA584		A_B
17	HERIRLM121201460899		HERAUSM00000GRKA584		A_B
18	HERIRLM141643520372		HERAUSM00000GRKA584		A_B
19	HERIRLM151225310435		HERAUSM00000GRKA584		A_B
20	HERIRLM151225330412		HERAUSM00000GRKA584		A_B
21	HERIRLM151225390376		HERAUSM00000GRKA584		A_B
22	HERIRLM151313160329		HERAUSM00000GRKA584		A_B
23	HERIRLM151654470902		HERAUSM00000GRKA584		A_B
24	HERIRLM211463520049		HERAUSM00000GRKA584		A_B
25	HERIRLM211463580046		HERAUSM00000GRKA584		A_B
26	HERIRLM231305370204		HERAUSM00000GRKA584		A_B
27	HERIRLM241842660174		HERAUSM00000GRKA584		A_B
28	HERIRLM281110080573		HERAUSM00000GRKA584		A_B
29	HERIRLM291166240641		HERAUSM00000GRKA584		A_B
30	HERIRLM301207290630		HERAUSM00000GRKA584		A_B
31	HERIRLM311122080052		HERAUSM00000GRKA584		A_B
32	HERIRLM311317670240		HERAUSM00000GRKA584		A_B
33	HERIRLM331340371248		HERAUSM00000GRKA584		A_B
34	HERIRLM331358460991		HERAUSM00000GRKA584		A_B
35	HERIRLM121182560081		HERAUSM00000GRKA584		B_B
36	HERIRLM141607090603		HERAUSM00000GRKA584		B_B
37	HERIRLM151225340421		HERAUSM00000GRKA584		B_B
38	HERIRLM151225370424		HERAUSM00000GRKA584		B_B
39	HERIRLM151313130326		HERAUSM00000GRKA584		B_B

MS-SNP Imputation 2-step--Proposal



ISAG Core
SNP Impute



Parentage Prediction
SNP Impute



Thank you

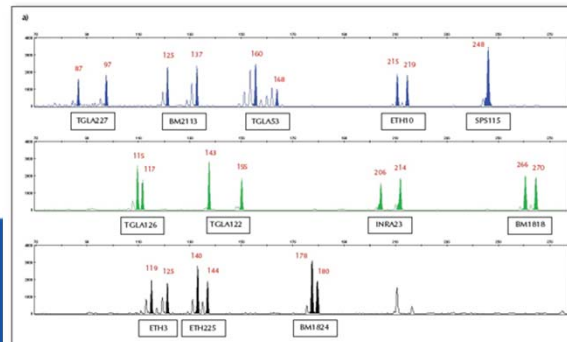


<1990's

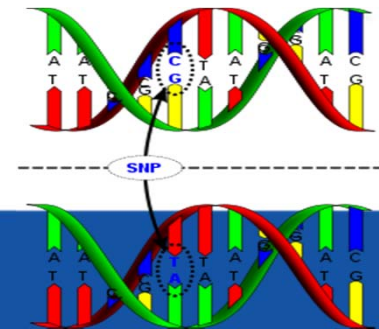
Recipient's blood			Reactions with donor's red blood cells			
ABO antigens	ABO antibodies	ABO blood type	Donor type O cells	Donor type A cells	Donor type B cells	Donor type AB cells
None	Anti-A Anti-B	O				
A	Anti-B	A				
B	Anti-A	B				
A & B	None	AB				

Compatible Not compatible

Present



Future



Parentage SNP ^b	Progeny ^c	2K ^a			3K			LD		
		Ave ^d	STD ^e	Wrong ^f	Ave	STD	Wrong	Ave	STD	Wrong
2K	8 to 9	0.3657	0.0144	1242	0.8932	0.0274	209	0.9250	0.0214	147
	10 to 14	0.3576	0.0159	1258	0.9339	0.0251	129	0.9502	0.0190	97
	15 to 19	0.3551	0.0121	1263	0.9692	0.0113	60	0.9749	0.0088	49
	20 to 29	0.3536	0.0111	1266	0.9866	0.0060	26	0.9896	0.0043	20
	30 to 39	0.3566	0.0195	1260	0.9942	0.0048	11	0.9953	0.0039	9
	40 to 59	0.3565	0.0134	1260	0.9970	0.0020	6	0.9978	0.0014	4
	60 to 99	0.3589	0.0129	1255	0.9962	0.0028	7	0.9977	0.0013	5
	100+	0.3566	0.0107	1260	0.9988	0.0012	2	0.9991	0.0007	2
ISAG core	8 to 9	0.4018	0.0484	60	0.8978	0.0444	10	0.9279	0.0376	7
	10 to 14	0.3924	0.0502	61	0.9431	0.0352	6	0.9594	0.0276	4
	15 to 19	0.3991	0.0549	60	0.9700	0.0199	3	0.9760	0.0176	2
	20 to 29	0.3920	0.0570	61	0.9903	0.0094	1	0.9929	0.0081	1
	30 to 39	0.3838	0.0584	62	0.9948	0.0082	1	0.9957	0.0088	0
	40 to 59	0.3811	0.0431	62	0.9981	0.0039	0	0.9981	0.0039	0
	60 to 99	0.3888	0.0590	61	0.9954	0.0063	0	0.9973	0.0052	0
	100+	0.3665	0.0567	63	0.9988	0.0032	0	0.9992	0.0027	0