vit IT Solutions for Animal Production

Genomic herd management and a new total merit index RZ€ for German Holstein cattle
利用基因组技术加强群体管理 推出德国荷斯坦牛新版总价值指数RZ€

Dr. Zengting Liu, Dr. Dierck Segelke and Dr. Stefan Rensing
IT Solutions for Animal Production (**vit**),Germany

Genomic selection and evaluation in German Holsteins
德国荷斯坦牛的基因组选择与基因组预测

- Genomic evaluation for German Holsteins started in 2009 as a joint project between vit and all German Holstein herdbook + AI organisations **德国荷斯坦牛基因组预测始于2009年，是德国评估组织vit与德国各荷斯坦牛登记簿、人工授精组织共同努力的成果**
- Only the German Genomic Consortium members can nominate genotyping candidates in vit's genomic evaluation and database system **只有德国基因组合作联盟成员可以在vit基因组预测和数据库系统中提名基因组测定候选个体**
- SNP genotyping in two German contract labs **在德国有两个合作的基因组分型实验室**
- German genomic reference population includes bulls and cows and is the largest worldwide **德国参考群包括公牛和母牛，世界最大**
- Semen usage of young genomic AI bulls exceeds 80% on the national level **全国选用青年基因组验证公牛精液比例超过80%**
- Number of Holstein AI bulls with daughters decreased from 1000 to 250 per year **荷斯坦牛人工授精公牛中有女儿后裔的个体从1000头/年降低到250头/年**
- Yearly genetic progress in Holstein cow population more than doubled due to genomic selection **荷斯坦母牛群体的年进展率是基因组选择之前进展的2倍还多**

Genomics 2.0: Large-scale herd genotyping of female animals (KuhVision)
基因组选择2.0：大规模群母牛基因组分型计划（KuhVision）

- German Holstein organisations started a routine, commercial whole-herd genotyping in 2016 **自2016年德国荷斯坦牛育种组织开始了常规、商业化整群母牛基因组测定计划**
- Current status of routine herd genotyping in Germany, as of 11 Sept. 2020 **当前德国测定规模**
  - 1,810 Holstein herds, adding c.a. 20 herds per month **1810个群体，每月增加20群**
  - 714 herds recording health traits **714个群体有健康性状记录**
  - 17.1% all herdbook cows **为登记牛群的17.1%**
  - 552,000 female animals genotyped **共测定55.2万头母牛**
  - > 185,000 cows already calved with early phenotype data **18.5万头牛已分娩并记录了早期表型**
- A mixed genomic reference population **混合型参考群**

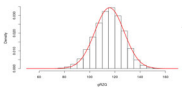
KUHVISION

August 2020	AI bulls 公牛	Cows/females 母牛	Total 总计
Milk production traits 泌乳性状	42,383	204,527	246,910
Conformation 体型性状	40,497	175,208	215,705
Calving traits 产犊性状	35,088	229,769	264,857
Health (Mastitis) 健康（乳房炎）	5,695*	156,164	161,859
Young stock survival 青年牛生活力	11,271*	474,169	485,440

*) A.I. bulls with daughters in DEU, because no IB conversion i.e. no EG bull reference population

Genomics 2.0: Routine genotyping project KuhVision
基因组2.0：常规基因组测定项目KuhVision

- KuhVision herds in Germany, Austria and Luxembourg **该计划覆盖德国、奥地利和卢森堡**
- The system is open for other countries, too **该系统也对其他国家开放**
  - 5 international partner organisations use the German eartag logistic and genomic evaluation **5个国际合作组织用德国耳标采样系统和基因组预测体系**
- Adding all female animals / cows from non-selective herds **将之前未参加系统选育的母牛群都加入项目中**

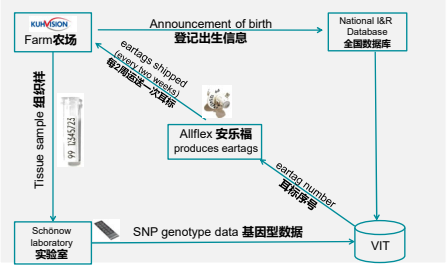


Distribution total merit index gRZG HOL females from herd genotyping ***德国荷斯坦牛选择指数RZG的分布***
尺度: (scale: av. 100, s=12)

A smart logistic and information system
一个智能化的采样、运输和信息系统

- An integrated sample logistic for maximum comfort with minimum trouble **整合的采样计划确保采样过程中母牛福利、人员便利**

KuhVision: Smart logistic system for the farmer is the key
为农户提供智能的采样运输系统是成功的关键

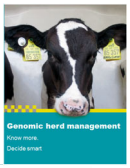


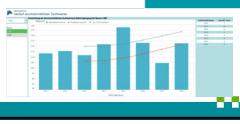
KuhVision: Third eartag for collecting tissue sample 用于采样的第三个耳标

- Use of individualised eartags for tissue samples 个性化的耳标用于采集耳组织样品
  - Preprinted with animal registration numbers 已经预先打印了个体登记号

A smart logistic and information system 智能采集运输系统及信息体系

- **NETRINDgenom** is a personalised online information system for genomic evaluation results 个性化在线系统展示基因组预测结果
- Weekly genomic evaluation provides evaluation results for newly genotyped animals 每周为新近测定基因型的个体提供基因组预测结果
- Numerous statistics on evaluation results available for 众多基因组预测结果
  - Groups of genotyped animals 一组基因型测定个体的预测结果统计
  - Comparison of animals in own herd over time 同群个体间的预测结果比较
  - Comparison to the population averages and top quarter, … 本群均值与排名前25%个体的比较





Evaluation of genetic traits or defects 质量性状或遗传缺陷判型

- **Negative genetic traits 不利质量遗传性状**
- Holstein haplotypes fertility: HH1, HH2, HH3, HH4, HH5, HH6 荷斯坦牛繁殖单倍型
  - Fertility haplotypes causing embryonic death 造成胚胎死亡的繁殖单倍型
  - Carrier frequency between 1 and 4% 携带者比例1-4%
  - Economic loss between 70 und 100€ for each homozygous embryo 每个纯合单倍型造成经济损失70-100欧元
- Brachyspina 短脊椎症
  - Genetic defect causing embryonic death 遗传缺陷造成胚胎死亡
  - Carrier frequency < 2% 携带者频率低于2%
- Cholesterol deficiency Holstein (CDH) 荷斯坦牛胆固醇缺乏症
  - Disorder causing death of young calves 造成幼龄犊牛机能紊乱
  - Carrier frequency 6 bis 7% 携带者频率 6-7%

Economic loss 400€ each homozygous calf 纯合犊牛经济损失400欧元

- **Positive genetic traits 有利质量遗传性状**
- Horn status 角形性状
  - Distinction between horned animals, heterozygous and homozygous animals 区分纯合有角、杂合及纯合无角
  - Carrier frequency: 8% 携带者频率8%
- Kappa casein κ酪蛋白
  - Increase of cheese yield 提高奶酪产率
- Beta casein β酪蛋白
- Variant Red factor VRC 红毛色突变
  - Dominant red colour 显性红毛色基因

Parentage verification and discovery 亲子关系验证与发现

- vit is among the first certified DNA data interpretation centres by ICAR / Interbull since 2019 2019年vit经ICAR / Interbull 认证，成为第一批经认证的DNA数据解读中心
- A set of 200 SNP markers are used for the parentage verification or test 共200个SNP用于亲子关系的验证或检测
- Parentage test is conducted routinely when genotypes of an animal enter the genomic system 一旦个体基因组信息进入基因组预测体系，自动进行亲子关系验证
- If the reported sire is not verified, correct sire will be searched using c.a. 50,000 Holstein AI bulls 如果报送的父本信息验证失败，将从约5万头荷斯坦公牛的数据库中搜寻正确的父本
  - In case of wrong dam, genotypes of all female animals are used for finding correct dam 如果母本信息验证错误，所有母牛基因型用于搜寻正确的母本
  - A set of c.a. 540 SNP markers are used according to ICAR rule 搜寻亲本按照ICAR规则用约540个SNP
- Possible sources of mismatch in genotypes 基因型错误的可能原因
  - Eartag tissue samples switched, calves ID switched, interchanged semen at insemination 耳标组织样调换、犊牛号调换、输精时冻精调换

Genomics 2.0: Genomic herd management tool 基因组技术辅助牛群管理

- Benefits of herd management using genomic information 基因组信息有助于提升牛群管理

1) Effective selection based on GEBV of calf even for late-measured trait longevity 基于基因组育种值可有效选择和淘汰后备母牛，甚至表现较晚的性状如长寿性
   - Selection of dams for the next generation animals based on GEBV 基于GEBV选择下一代的母本
     - Inferior cows to be inseminated with semen of beef bulls 遗传水平差的个体使用肉牛冻精配种
     - Superior cows to be inseminated with sexed semen for higher selection intensity 遗传水平高的个体使用性控冻精从而提高选择强度
   - Selection of young animals / heifers based on GEBV 基于GEBV选择幼龄个体/青年母牛
     - Use mainly pure-bred insemination 主要使用纯种选配
     - Surplus, genomic inferior heifers for sale 出售多余的和/或基因组预测水平差的个体
     - Differences in GEBV of full-sisters can be used for selection decision 全同胞姐妹可使用GEBV区分其遗传水平，从而做出明智的选淘决定

Genomics 2.0: Genomic herd management tool 基因组技术辅助牛群管理

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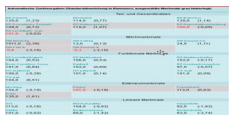
2) Targeted mating using GEBV of all traits: early or late measured traits 利用各性状的GEBV估计值进行目标选配：兼顾早期或后期表达的性状
   - Also applicable to heifers before first calving 在母牛首次产犊前即可实施
   - Web-based mating software: **BAP** (**B**ull **A**dvice **P**rogramme) 使用网络版选配软件：BAP（公牛推介）
   - BAP is fully integrated in vit Holstein information system with instant access to all available data BAP整合vit荷斯坦牛信息系统，随时利用所有最新数据进行公牛推介

BAP – a web based mating programme 基于互联网的选配软件

选配
match

- According to individual herd breeding goal by the farmer 基于定制的群体选育目标
- Satisfy special needs or requirements for each individual cow 顾及每头母牛的特殊需求或要求
- Optimal control of inbreeding and genetic defects 优化控制近交及遗传缺陷



Two options of international use of RZG for herd management
其他国家奶农应用RZG进行牛群管理的两个选项

- **Option A**: Genotyping in Germany (if it is allowed to send tissue samples to Germany) 选项A：在德国进行基因型分析（允许将样品寄往德国的情况下）
  - Foreign partner submits herd phenotype and pedigree data to **vit** (in Interbull 200 or csv format) 国际用户向vit提交群体表型和系谱（依Interbull 200 或许csv文本格式）
  - **vit** submits animal ID data to Allflex for eartags that are then sent to foreign partner vit将个体ID号提交给安乐福获得专用耳标递送至国际用户
  - Foreign farmer collects tissue sample using the special eartages and send to German laboratory 国际用户使用特制耳标采集组织样并寄送至德国实验室
  - **vit** conducts genomic evaluation every week. The foreign farm obtains access to its data in NETRINDgenom vit每周运行一次基因组预测。国际用户通过NETRINDgenom获得其群体的基因组预测结果
  - Mating using BAP (not Glo-BAP) 利用BAP软件进行选配（不是Glo-BAP）
  - Currently unavailable for China, because of import and export restrictions 限于进口和出口原因，目前这一服务尚未对中国用户开放

Two options of international use of RZG for herd management
国际上应用RZG进行牛群管理的两个选项

- **Option A**: Genotyping in Germany (if it is allowed to send tissue samples to Germany) 选项A：在德国进行基因型分析（允许将样品寄往德国的情况下）
- **Option B**: Genotyping outside Germany with genotype import to vit system 选项B：在德国以外的试验室进行基因型分析之后将基因型数据输入至vit系统
  - Foreign partner submits herd phenotype and pedigree data to **vit** (in Interbull 200 or csv format)国际用户向vit提交群体表型和系谱（依Interbull 200 或许csv文本格式）
  - Laboratory or evaluation centre in the foreign country sends SNP genotype to **vit** 境外基因型测定实验室或遗传评估中心将SNP基因型信息发送到vit
  - **vit** conducts genomic evaluation every week. The foreign farm obtains access to its data in NETRINDgenom vit每周运行一次基因组预测。国际用户通过NETRINDgenom获得其群体的基因组预测结果
  - Mating using BAP (not Glo-BAP) 利用BAP软件进行选配（不是Glo-BAP）

Flexible SNP genotype exchange for herd management from Germany
德国灵活的SNP基因型信息交换计划提升牛群管理服务水平

- The German Holstein genomic system allows SNP genotype exchanges with any country 德国荷斯坦牛基因组信息系统允许将SNP基因型与任何国家进行交流
  - Import SNP genotypes of all available SNP chips from almost all laboratories 从几乎所有实验室输入任何版本芯片的SNP基因型信息
  - Export on demand SNP genotypes and pedigree data for all partners in requested formats 可以按照合作伙伴要求的格式输出需求的SNP基因型和系谱数据
- Routine genotype exchanges for young AI bulls with EuroGenomics and North American Consortium 与欧洲基因组计划及北美基因组选择合作组织定期进行青年人工授精公牛基因型信息交换

Flexible SNP genotype exchange for herd management from Germany
德国灵活的SNP基因型信息交换计划服务牛群管理

- Enhance efficiency of your farm based on your own breeding goal 基于牛群个性化育种目标帮助提高管理效率
  - Minimise rearing costs of your farm and consider genetic defects / traits in selection 最大限度降低牛群的饲喂成本并有效管理遗传缺陷和本群重点选育性状
- Optimised genomic mating for higher genetic progress with genomic evaluation of a high reliability 优化基因组选配策略，以更高的估计可靠性帮助牛群取得更快遗传进展
- Improve health of your animals in your herd based on genomic evaluations of all the new health traits 利用所有新推出的健康性状基因组遗传评估结果改进牛群健康状况

The all-round service package for the whole herd from Germany
为德国牛场提供全方位服务

- Optimal use of your own herd and pedigree data 牛群本场的数据和系谱信息得到最大程度的应用
- The fastest and easiest logistics can also avoid animal identification confusion through ear tagging 通过打耳标的最快捷和便利采样运输方式避免个体标识错误发生
- Parentage verification and discovery automatically detects all possible errors 系谱验证和寻找父母并自动监测所有可能的错误信息
- Genetic traits or defects are evaluated automatically 质量遗传性状的基因型自动评估
- Genomic evaluation on a weekly basis 每周进行一次基因组评估
- Daily updated genomic breeding values in NETRINDgenom 在NETRINDgenom系统中每日更新基因组育种值
  - Representative benchmark statistics for Holstein farms 为荷斯坦牛群提供代表性的基准点统计量
- High correlation between early genomic breeding values and later own phenotypic performance 早期基因组预测值与后期自身表型呈系相关高
- Genomic evaluation for the novel health traits available 新推出健康相关性状的基因组预测结果
- Individual mating using BAP for cows or heifers 利用BAP为成母牛和青年牛制定个性化选配计划
- No hidden costs like for beta casein 如酪蛋白基因的基因组测定等无隐性成本

A new total merit index: RZ€

- Economy of breeding in focus

聚焦育种经济学的新版总经济指数： RZ€

RZ€ as a new total merit index for maximising herd profit
新版总价值指数RZ€ -目的在于促进群体利润最大化

- RZ€ expresses profit deviations, expressed in monetary unit (€), from population average **RZ€ 指数表示为某个体与群体平均的利润差，以欧元为单位，**
  - Determined by genetic differences **由遗传差异造成**
  - Genetic differences between two animals expressed in € per lifetime (c.a. 3 years/lactations) **两个个体之间的RZ€ 指数差异表示为终生效益差值（约为3年/胎次）**
- Derivation of RZ€ requires following parameters **获得RZ€ 需要提供以下参数**

I) How much phenotypic units correspond to one unit of (relative) breeding value? **表型单位与相对育种值单位间的转换关系**

- 1 genetic standard deviation = 12 points in relative breeding value (RBV) **遗传标准差=12 （相对育种值，RBV)**

II) Margin (profit) of one additional phenotypic unit (e.g. +1 kg protein) **表型增加一个单位的边际效益（例如+1kg乳蛋白）**

- Marginal income – marginal costs **边际收入-边际成本**

EBV differences in bulls versus phenotypic differences in daughter groups
公牛EBV差异与女儿组表型差异

公牛育种值	女儿表型性状	女儿表型值 所有胎次	标准差
Relative EBV	daughter trait	daughter phenotype (Ø all lact.)	12 points EBV = +/-
RZS	cell count (tsd/ml)	218*	83*
RZN	longevity (days)	1115	259
RKFit	survival rate (%) until 35 mo.	93.0*	4.4*
1st-to-last heifer	1st-to-last heifer (days)	31.3	6.2
NR heifer	NR heifer (%)	72.0	5.0
calv.-1st	calv.-1st (days)	84.2	9.0
1st-to-last cows	1st-to-last cows (days)	51.5	10.1
NR cows	NR cows (%)	55.7	6.3
CE direct	difficult calvings (%)	3,5*	2.0*
SB direct	still born calves (%)	5.8*	2.4*
CE daughter	difficult calvings (%)	3.2*	1.7*
SB daughter	still born calves (%)	5.8*	3.1*
dairy type	dairy type (scores)	81.9	0.9
body	body (scores)	82.1	1.1
feet & legs	feet & legs (scores)	80.6	1.0
udder	udder (scores)	81.2	1.0
stature	stature (cm)	148.4	2.1
RZO	milking speed (kg/min.)	2.42	0.40

Novel health traits **新推出健康性状**

Relative EBV	daughter trait	daughter phenotype (Ø all lect.)	12 points EBV = +/-	
RZudderfit	mastitis % 乳房炎	25.6*	12.0*	
RZhoof 蹄部健康	mortellaro %	24.1*	12.0*	Simultaneous change in all underlaying traits
	sole ulcer %	15.1*	13.2*	th index Rzhoof
	digital phlegmon %	8.4*	10.8*	合成为蹄部指数，同时改进各性状
	white line defect %	7.6*	6.4*	
	laminitis %	6.8*	3.5*	
	tylom %	5.1*	4.4*	
RZrepro 繁殖健康	ovarian cycle disorders %	19.7*	11.5*	RZrepro Simultaneous change 繁殖指数
	metritis %	13.1*	7.4*	
	retained placenta %	7.5*	4.9*	
RZmetabol 代谢健康	displaced abomasum %	1.4*	3.1*	RZmetabol Simultaneous change 代谢指数
	milk fever %	1.9*	1.7*	
	ketosis %	3.1*	2.4*	

Summary of marginal profits for all traits 所有性状的边际效益汇总

Lifetime profit per EBV unit was derived from marginal profit for one phenotypic unit and std dev
由表型变化一个单位的边际效益及性状遗传标准差可获得育种值每变化一个单位的终生效益

除去乳脂和乳蛋白的牛奶 ⟹

RZ€	margin/unit €	12 points EBV equal	€/Sg+life	€/EBV point+life
Fat *(kg)*	2.56	25.1	197.72	7.88
Protein *(kg)*	4.09	19.8	248.76	12.56
F/P free milk *(kg)*	-0.02	690	-51.13	-0.07
RZN *(replacement, days)*	1099	259	258.69	21.56
FtL heifers *(day)*	1.67	6.2	10.35	0.86
CtF cows (day)	0.33	9.0	6.05	0.50
FtL cows *(day)*	1.99	10.1	52.06	4.34
SB direct	138	2.4	9.87	0.82
SB maternal	138	3.1	12.81	1.07
CE direct *(heavy calv., %)*	49	1.9	5.03	0.42
CE maternal *(heavy calv., %)*	49	1.8	4.03	0.34
RZudderfit *(Mastitis, %)*	186	12	61.39	5.12
Rzhoof *(case, %)*	32-74	4-13	30.13	2.51
RZrepro *(case, %)*	28-100	5-12	17.10	1.43
RZmetabol *(case, %)*	131-289	2-3	39.86	3.32
RZcalffit *(loss, %)*	450	4.4	54.61	4.55

Relative weights on trait groups in RZ€
RZ€ 中各性状组的相对权重

No direct economic weight on somatic cell counts

体细胞数没有直接经济权重

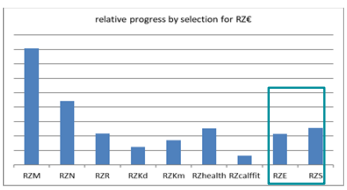
Weight on conformation <1%
Thus not included in RZ€

体型的权重低于1%因此没有加入到RZ€ 中

RZ€	€/Sg+life	Resulting relativ weights (%)			
Fat *(kg)*	197.72	20.7			
Protein *(kg)*	248.76	26,0	41	milk production traits	泌乳性状
F/P free milk *(kg)*	-51.13	-5.3			
RZN *(replacement, days)*	258.69	27.0	27	productive life	生产寿命
FtL heifers *(day)*	10.35	1.1			
CtF cows (day)	6.05	0.6	7	daughter fertility	女儿繁殖力
FtL cows *(day)*	52.06	5.4			
SB direct	9.87	1.0			
SB maternal	12.81	1.3	3	calving traits	产犊性状
CE direct *(heavy calv., %)*	5.03	0.5			
CE maternal *(heavy calv., %)*	4.03	0.4			
RZudderfit *(Mastitis, %)*	61.39	6.4			
Rzhoof *(case, %)*	30.13	3.1	16	health traits	健康性状
RZrepro *(case, %)*	17.10	1.8			
RZmetabol *(case, %)*	39.86	4.2			
RZcalffit *(loss, %)*	54.61	5.7	6	young stock survival	青年牛生活力
Sum		100.0	100		

Selection responses by traits for RZ€ RZ€ 中各性状的选择反应

- Relative genetic progress within trait complexes by selection with RZ€ **使用RZ€ 指数进行选择预计各分指数的相对遗传进展**
- Even without direct weights, significant progress will be achieved in somatic cell counts and conformation **虽然体细胞数和体型性状在RZ€ 指数中没有权重，但仍能取得显著进展**



Summary: the new total merit index RZ€ for profit
小结：助力提高生产效益的新版总价值指数RZ€

- Relative importance of traits, in terms of margin to total margin, has not changed significantly for currently evaluated traits, compared to 2008 **按边际效益看，当前估计的性状的相对重要性,与2008年相比, 没有剧烈的变化**
- New direct health and young stock survival traits have substantial economic values **新推出的健康性状和青年牛生活力性状占有重要的经济权重**
- Selection with RZ€ help dairy farmers achieve maximising profitability **奶农使用RZ€进行牛群选育有助于利润最大化**
  - RZ€, expressed in € as profit deviation to average cow, makes impact of selection alternatives directly visible **RZ€表示为与平均水平个体的利润差，使选择不同个体留种的效果直接可视化**
- The new profit TMI meets the societal expectation according to accepted breeding goals **新指数基于广为接受的育种目标符合行业的期待**
  - Sum of weights on function / heath traits higher than production traits, 59 vs. 41 **功能/健康性状的总权重高于泌乳性状，59对41**
  - Economically optimised instead of maximised milk production **实现经济效益最大化而不是产奶量最大化**
- RZ€ has been well accepted by farmers and breeding organisations **RZ€已为广大奶农和育种组织所接受**

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