Interreg North-West Europe
HappyMoo
European Regional Development Fund

EUROPEAN UNION

Calculation of dry matter intake and energy balance based on MIR spectral data at European level

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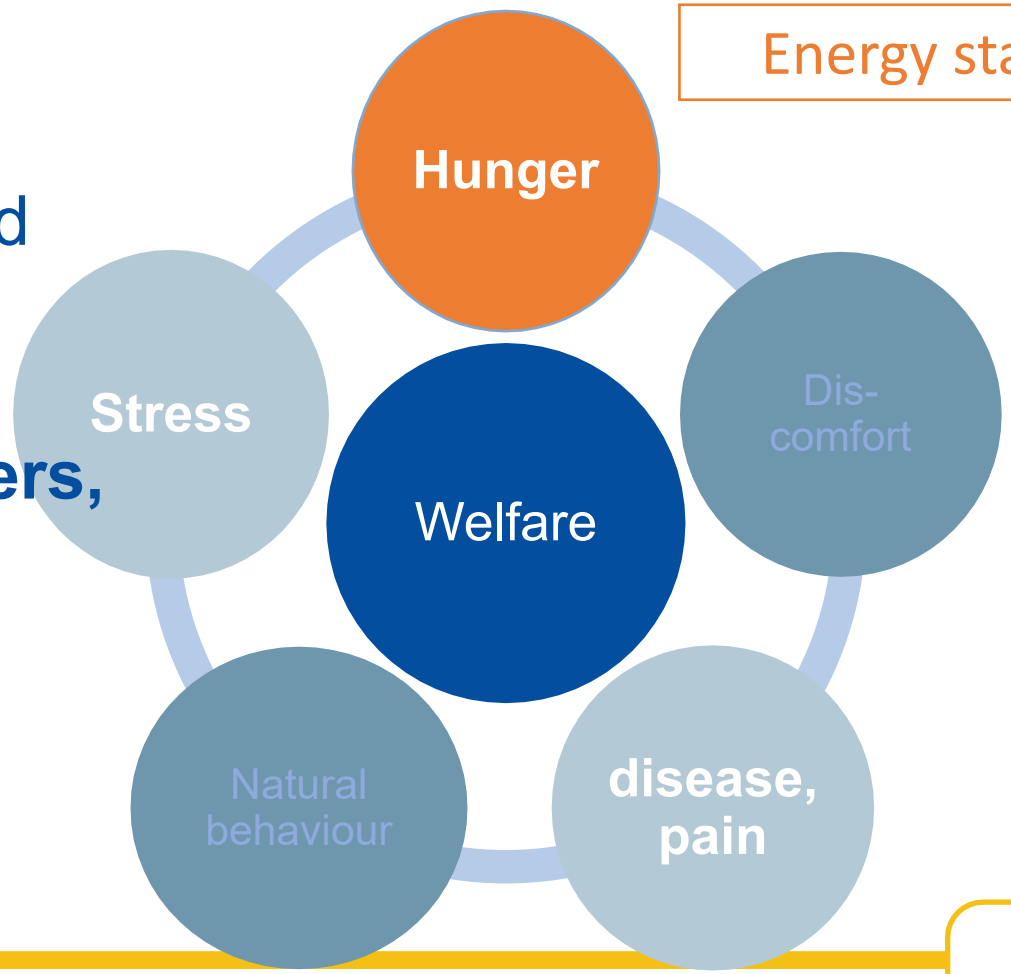
HappyMoo – objective

Use milk mid-infrared spectral analysis to **predict** welfare-related traits (molecules, phenotypes)

→ Monitoring tools for the farmers, vets and extension workers

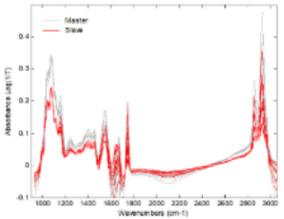


Impact of Negative Energy Balance

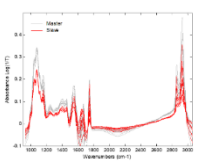
- Failure to cover energy needs can lead to **metabolic disorders**, **stress of the immune system**, **breeding problems** and **reduced milk production**

Important to have **fast**, **recurrent** and **cheap detection** of negative energy balance

Use milk mid-infrared spectral analysis to **predict** negative energy balance traits



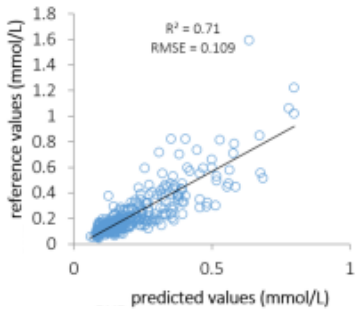
HappyMoo Energy balance models – how?



Reference values

Standardised spectra

Models



Prediction of:
Energy Balance (EB_NEL)
Dry Matter Intake (DMI)
Feed Efficiency (FE_ECM)

Reference values to calculate Energy Balance status

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Data collected in experimental farms in France (Trinottières) and Germany

Energy intake

Individual Dry matter intake × Energy provided by the feed

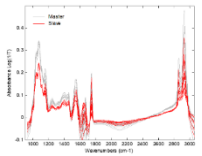
GfE (2001)

Energy requirements

- For Maintenance *(0.293*(BodyWeight^0.75)*
- For lactation *(0.38* Fat + 0.21 * Protein+ 0.95 + (0.1))* MilkYield*
- For Pregnancy *(0.044*exp(0.0162*GestationStage))/0.29)*

HappyMoo Energy balance models – how?

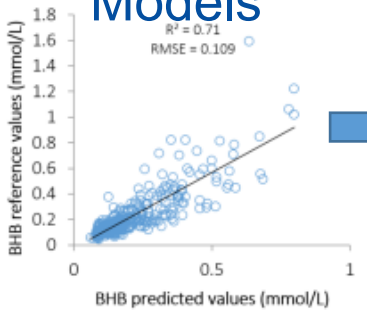
Energy Balance (EB - NEL)
Dry Matter Intake (DMI)
Feed Efficiency (FE_ECM)
(as a function of milk yield corrected with fat, and protein content and the DMI)



Reference values

Standardised spectra

Models



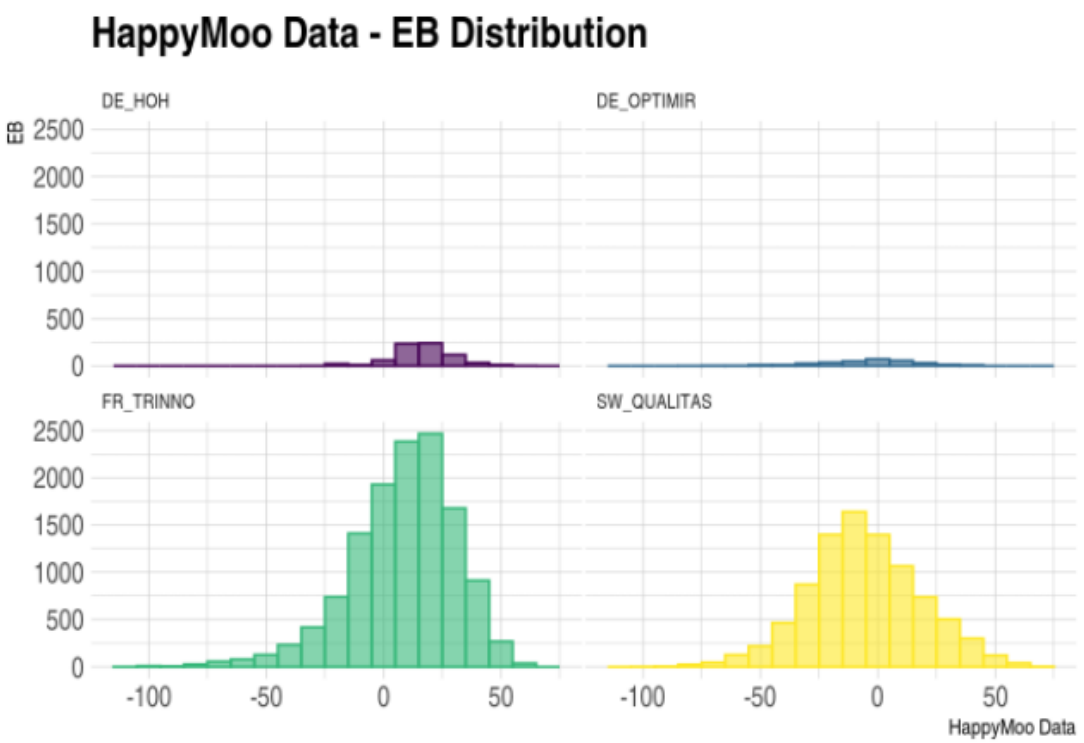
Prediction of:
Energy Balance (EB_NEL)
Dry Matter Intake (DMI)
Feed Efficiency (FE_ECM)

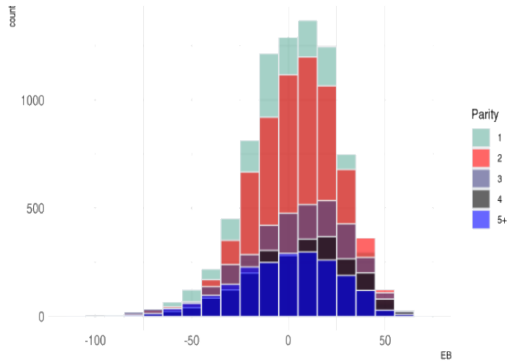
Descriptive statistics – Energy balance, Dry matter intake, Feed efficiency

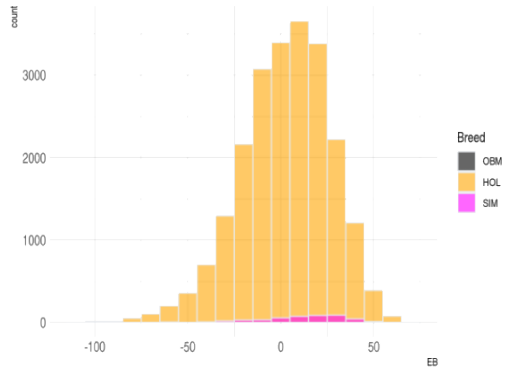
Parameters	French	Swiss	German – OptiMIR	German – LKVBW	HappyMoo
Number of rows	**15579**	**10917**	**708**	**2093**	**22813**
Mean EB	7.20	-6.87	-4.68	18.32	2.88
SD EB	27.51	29.22	25.05	14.50	23.96
Mean DMI	22.35	21.18	21.98	----	22.11
SD DMI	3.86	3.98	3.65	----	3.85
Mean FE	1.50	1.49	1.68	----	1.51
SD FE	0.37	0.43	0.35	----	0.37

Outliers	
Fat Diff – 0.5 g/dl	2911
GH > 8	787
DIM ≥ 5	127

Descriptive statistics – EB parameter







Energy balance modelling

	Calibration			Validation		
Daten	N	Mean	SD	N	Mean	SD
EB	15971	2.96	23.96	6842	2.68	23.94

Material

Animal Related Data:

Parity: 1-5, >5=5
Breed: OBM, OBD, OBF
Milking Moment: AM/PM, AM, PM
Milk Yield Classes:
<25, 25-30, 30-35, 35-40, >40
Days in Milking (DIM)

Milk Related Data:

MIR-Spectral Data

MIR-Spectral Data:

Spectra + DIM Polynomial correction

Method

PLS - Partial least square regression: OSCORES, SIM

PCR – Principal component regression

CPPLS - canonical correlation analysis

GLMNET Regression

1st Validation - Spectra Selection

- 70% calibration model
- 30% validation model

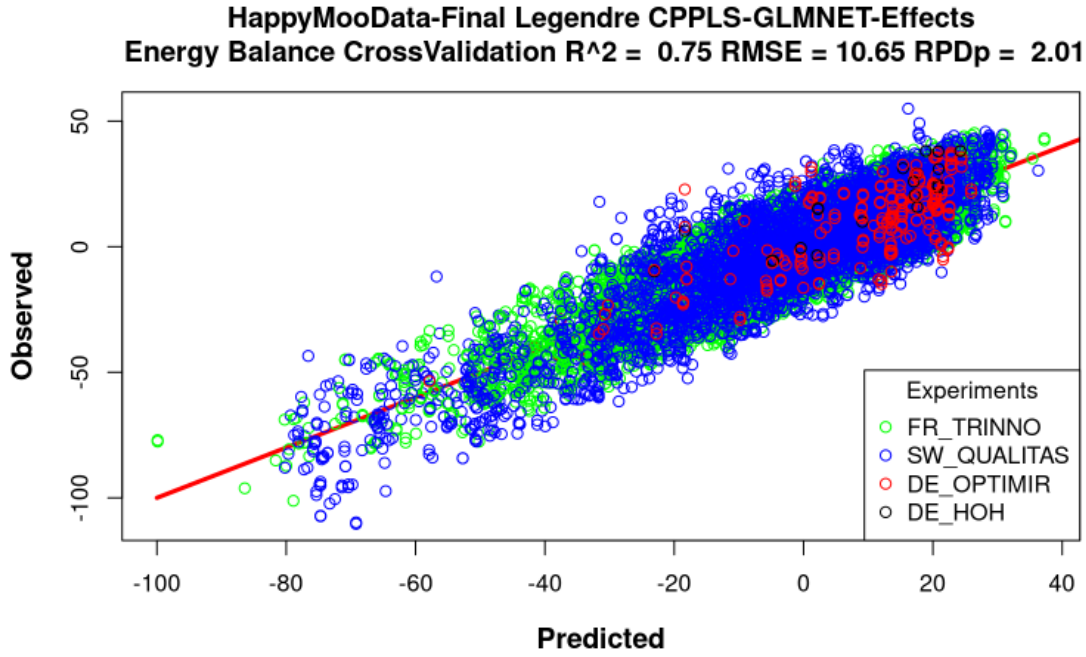
2nd Validation - Animal Selection

- 70% calibration model
- 30% validation model

Prediction of Energy balance EB_NEL

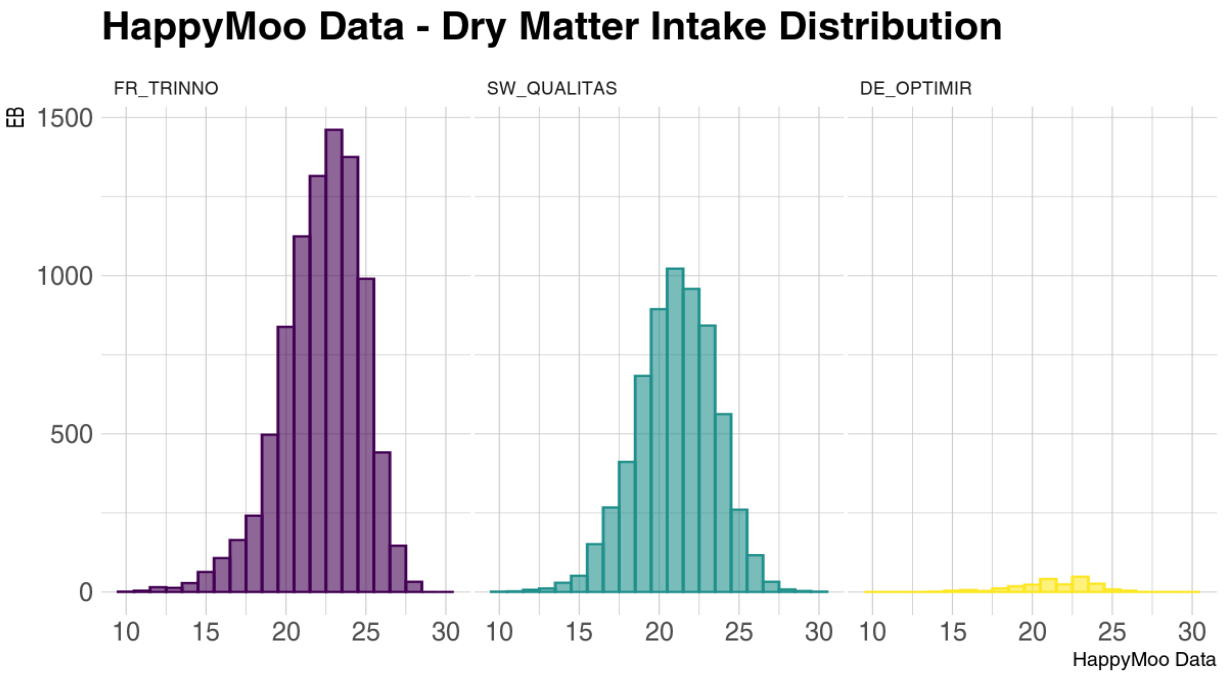
HappyMooData - Statistical Parameters Energy Balance equations calibration and validation

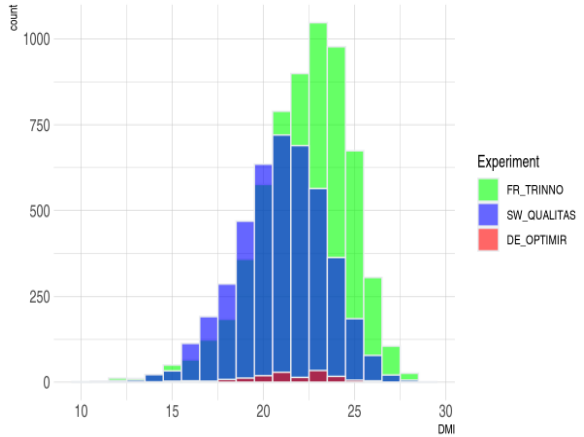
	R^2c	RMSEC	R^2p	RMSEP	RPDp
PLS_SpectraSelection	0.68	12.02	0.62	13.86	1.62
PLS_AnimalSelection	0.69	11.5	0.64	14.17	1.67
CPPLS_SpectraSelection	0.68	12.02	0.62	13.86	1.62
CPPLS_AnimalSelection	0.69	11.5	0.64	14.17	1.67
GLMNET_SpectraSelection	0.69	11.84	0.63	13.59	1.65
GLMNET_AnimalSelection	0.69	11.34	0.66	13.9	1.7
EB_GLMNET_Spectra_P_M_B	0.7	11.73	0.66	13.13	1.71
EB_GLMNET_Animal_P_M_B	0.7	11.25	0.69	13.33	1.77
LegGLMNET_SpectraSelection	0.7	11.62	0.66	13.12	1.71
LegGLMNET_AnimalSelection	0.7	11.17	0.67	13.63	1.73
Leg_CPPLS_GLMNET_Spectra	0.76	10.56	0.7	12.41	1.81
Leg_CPPLS_GLMNET_AnimalSelection	0.76	10.06	0.68	13.27	1.78

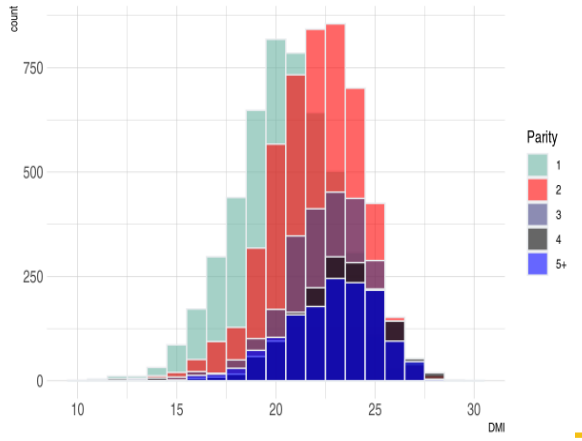


	n	Mean	SD	SEC	R2	SECV	R2cv	RPDcv	Use
EB NEL [MJ /d]	16993	0.32	21.41	10.6	0.75	10.65	0.75	2.01	0

Descriptive statistics – DMI parameter



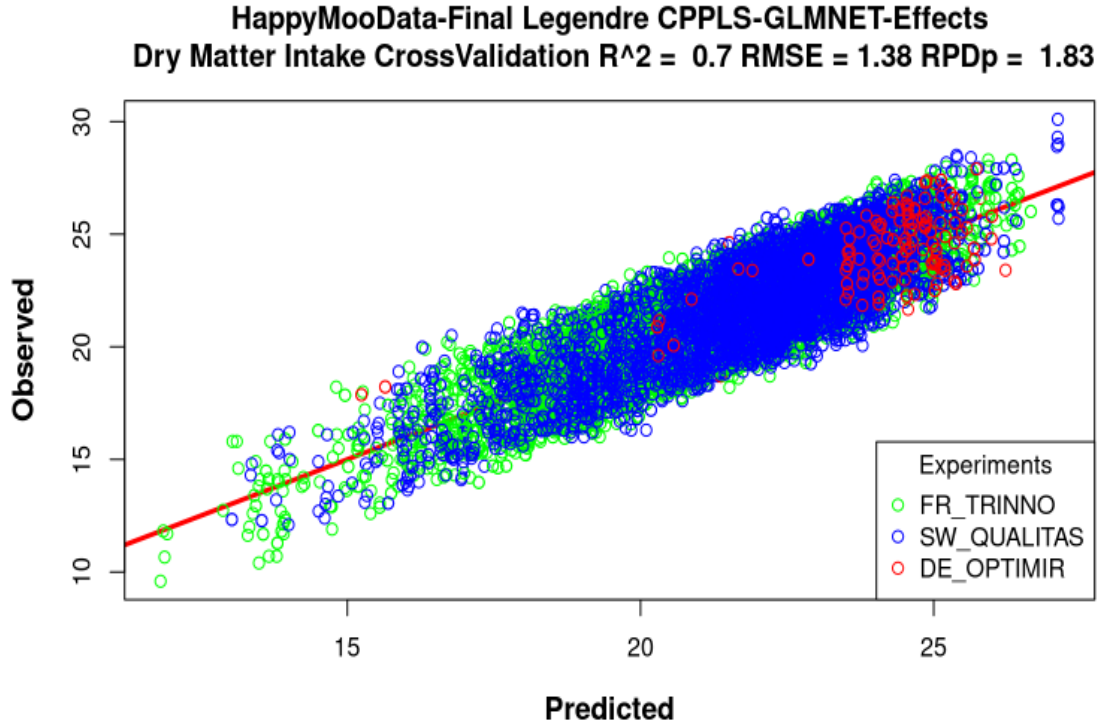




Prediction of dry matter intake (DMI)

HappyMooData - Statistical Parameters Dry Matter Intake equations calibration and validation

	R^2c	RMSEC	R^2p	RMSEP	RPDp
PLS_SpectraSelection	0.66	1.46	0.62	1.56	1.61
PLS_AnimalSelection	0.66	1.45	0.62	1.6	1.62
CPPLS_SpectraSelection	0.66	1.46	0.62	1.56	1.61
CPPLS_AnimalSelection	0.66	1.45	0.62	1.6	1.62
GLMNET_SpectraSelection	0.67	1.45	0.62	1.56	1.62
GLMNET_AnimalSelection	0.66	1.44	0.62	1.6	1.63
EB_GLMNET_Spectra_P_M_B	0.69	1.41	0.65	1.5	1.69
EB_GLMNET_Animal_P_M_B	0.68	1.41	0.66	1.51	1.72
LegGLMNET_SpectraSelection	0.67	1.45	0.62	1.55	1.63
LegGLMNET_AnimalSelection	0.67	1.43	0.63	1.59	1.64
Leg_CPPLS_GLMNET_Spectra	0.75	1.23	0.62	1.54	1.63
Leg_CPPLS_GLMNET_AnimalSelection	0.7	1.36	0.62	1.6	1.62



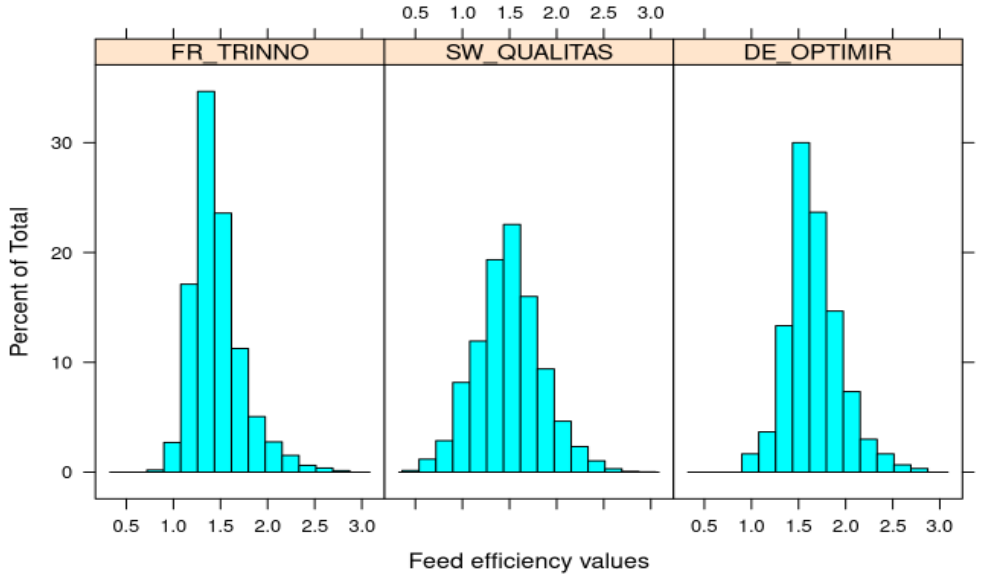
	n	Mean	SD	SEC	R2	SECV	R2cv	RPDcv	Use
DMI [kg]	14804	21.77	2.52	1.36	0.71	1.38	0.7	1.83	0

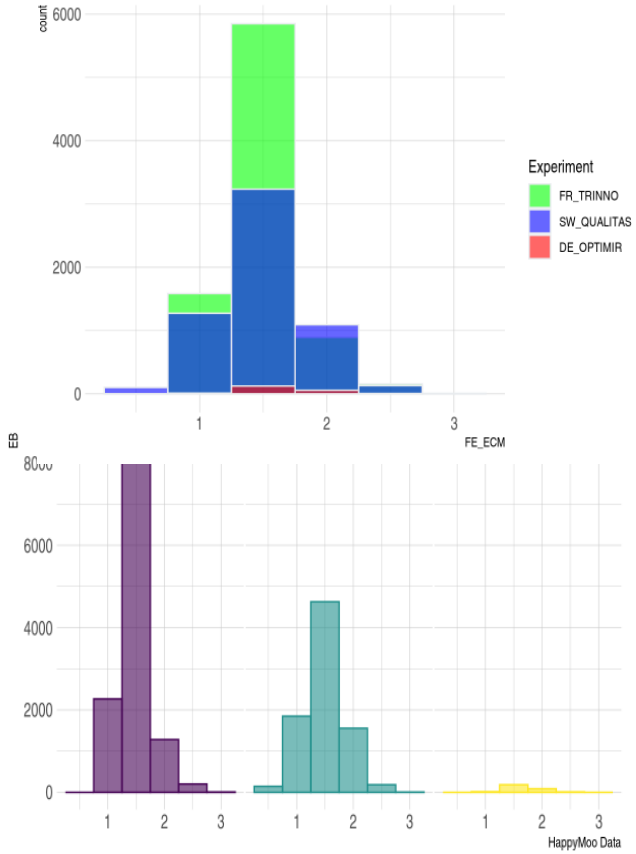
Descriptive statistics – FE parameter

Definition of Feed Efficiency

FE = ECM /DMI

ECM = MY24H*((1.05+0.38*FC+0.21*PC24H)/3.28)

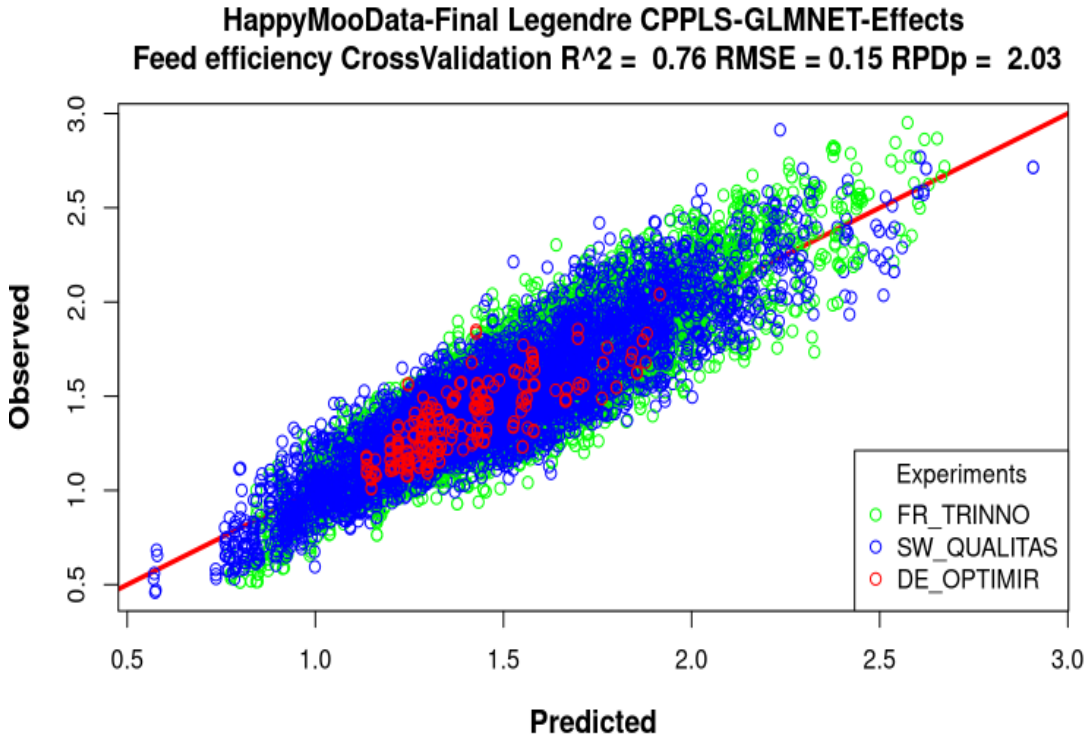




Prediction feed efficiency (FE_ECM)

HappyMooData - Statistical Parameters Feed efficiency equations calibration and validation

	R^2c	RMSEC	R^2p	RMSEP	RPDp
PLS_SpectraSelection	0.66	0.18	0.66	0.18	1.72
PLS_AnimalSelection	0.65	0.18	0.67	0.18	1.74
CPPLS_SpectraSelection	0.66	0.18	0.66	0.18	1.72
CPPLS_AnimalSelection	0.65	0.18	0.67	0.18	1.74
GLMNET_SpectraSelection	0.67	0.18	0.67	0.18	1.74
GLMNET_AnimalSelection	0.66	0.18	0.68	0.18	1.77
EB_GLMNET_Spectra_P_M_B	0.71	0.17	0.7	0.17	1.84
EB_GLMNET_Animal_P_M_B	0.66	0.18	0.68	0.18	1.77
LegGLMNET_SpectraSelection	0.68	0.17	0.67	0.17	1.75
LegGLMNET_AnimalSelection	0.68	0.17	0.67	0.18	1.72
Leg_CPPLS_GLMNET_Spectra	0.72	0.16	0.71	0.16	1.87
Leg_CPPLS_GLMNET_AnimalSelection	0.71	0.16	0.7	0.17	1.79



	n	Mean	SD	SEC	R2	SECV	R2cv	RPDcv	Use
FE [ECM /DM kg]	20747	1.48	0.31	0.15	0.76	0.15	0.76	2.03	0

Conclusion

Energy balance	Best model with CPPLS, GLMNET based on Legendre polynom and fix effects: breed, parity and milk yield classes. RPD of 2 → a good prediction ability
Dry matter intake	DMI is interesting to know if cow has enough to eat. RPD of 1.83 → model need some improvement
Feed efficiency	Feed efficiency is more linked to the performance of the cow to convert feed. RPD of 2 → good prediction ability

Thank you for your attention!