

# Genotype x Environment Interactions in Dual Purpose Cattle in Harsh Environments

Beat Bapst  
Qualitas AG, Switzerland

30-08-2016  
EAAP 2016, Belfast



# Background

Dairy cattle is kept in various environments worldwide:

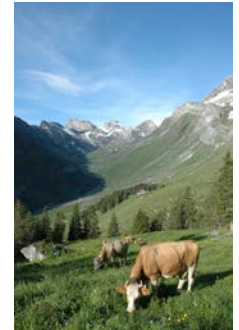
- **Geographic/topographic/climate**
  - Lowlands
  - Alpine regions with alpine summer pasture
  - Tropical/Subtropical/Temperate climate
  - ...
- **Production systems**
  - TMR feeding systems
  - Pasture based feeding systems
  - Organic/conventional systems
  - ...

# Background

Different cows:



Different environments:

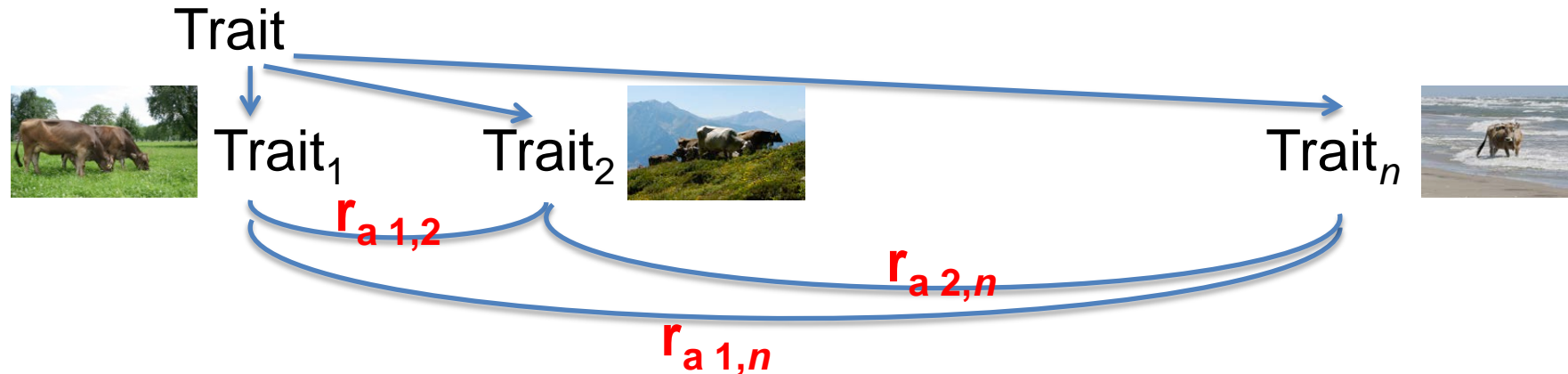


**Interactions between specific environment and genotype (GxE Interactions)?**

# Concept

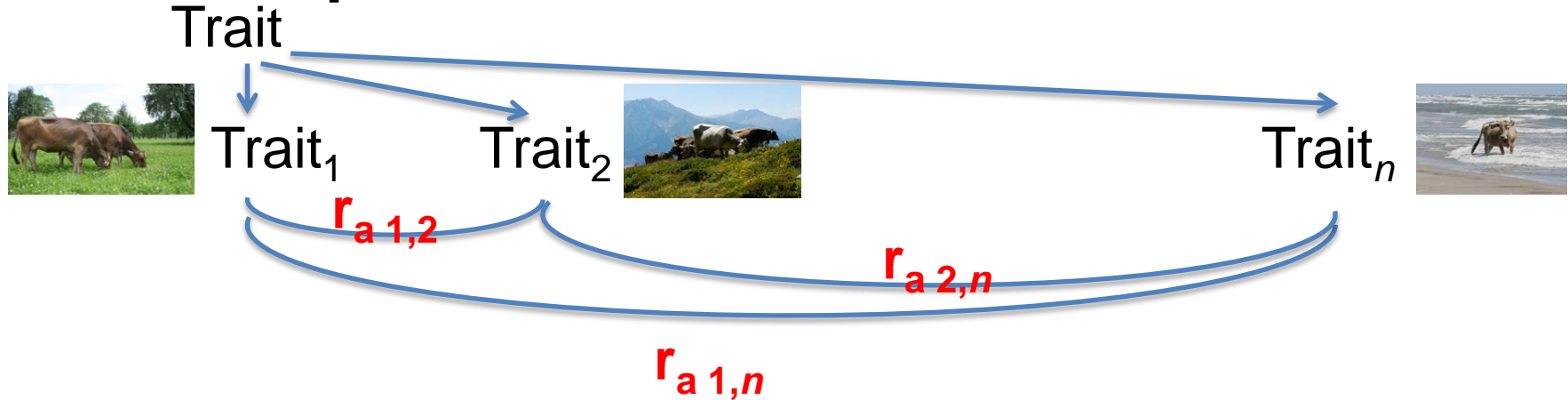
## Multiple trait models

- Split a trait in  $n$  different other traits according to  $n$  defined environments
- Estimate the genetic correlations ( $r_a$ ) between the traits



# Concept

## Multiple trait models



- $r_a = 1$  → No GxE interactions
- $1 > r_a > 0.8$  → Weak GxE interactions
- $r_a < 0.8$  → Strong GxE interactions

# Model

- Multiple trait animal model with repeated measurements
- REMLF90
- Traits: Milk kg, fat kg and protein kg
- Stepwise model development

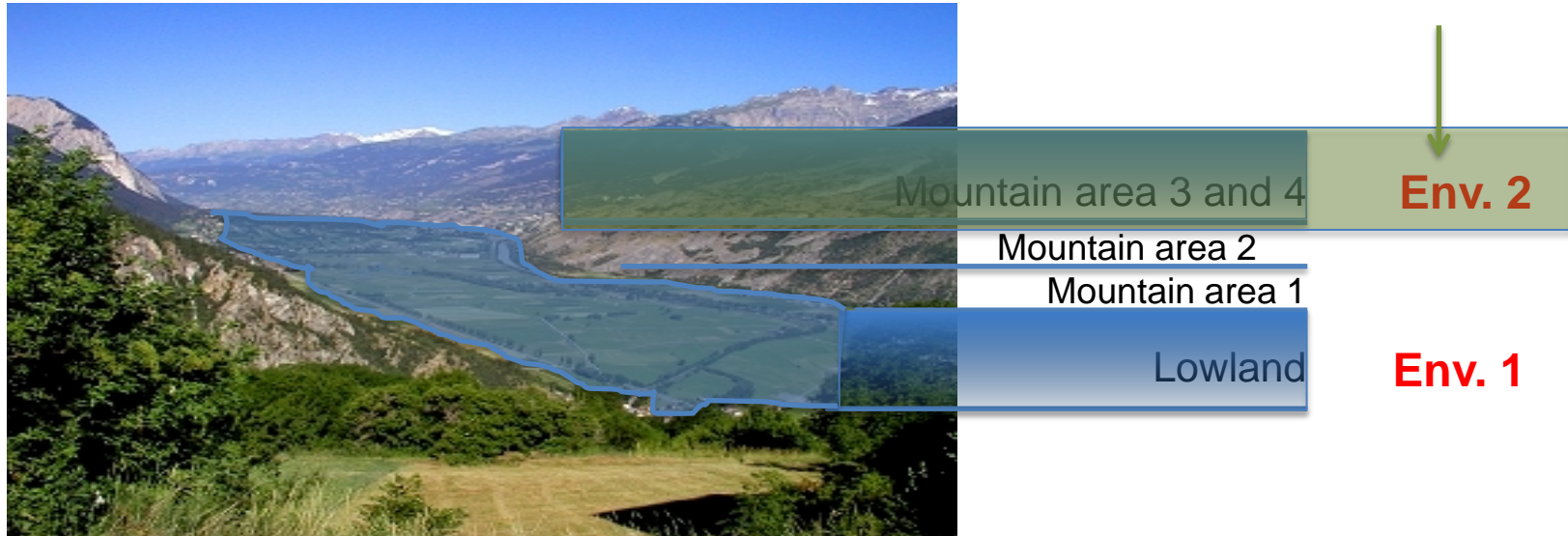
# Model

Effect	Type	Trait	
		Environment 1	Environment 2
<i>Herd * Year</i>	random	Mkg, Fat, Prot.	Mkg, Fat, Prot.
<i>Calving Year * Season</i>	fixed	Mkg, Fat, Prot.	Mkg, Fat, Prot.
<i>Lactation</i>	fixed	Mkg, Fat, Prot.	Mkg, Fat, Prot.
<i>additiv genet. effect of animal</i>	random	Mkg, Fat, Prot.	Mkg, Fat, Prot.
<i>Permanent environment</i>	random	Mkg, Fat, Prot.	Mkg, Fat, Prot.
<i>Residual</i>	random	Mkg, Fat, Prot.	Mkg, Fat, Prot.

# Concept

2 Opposed environments/farms:

Scenario FA: **Farm altitude**






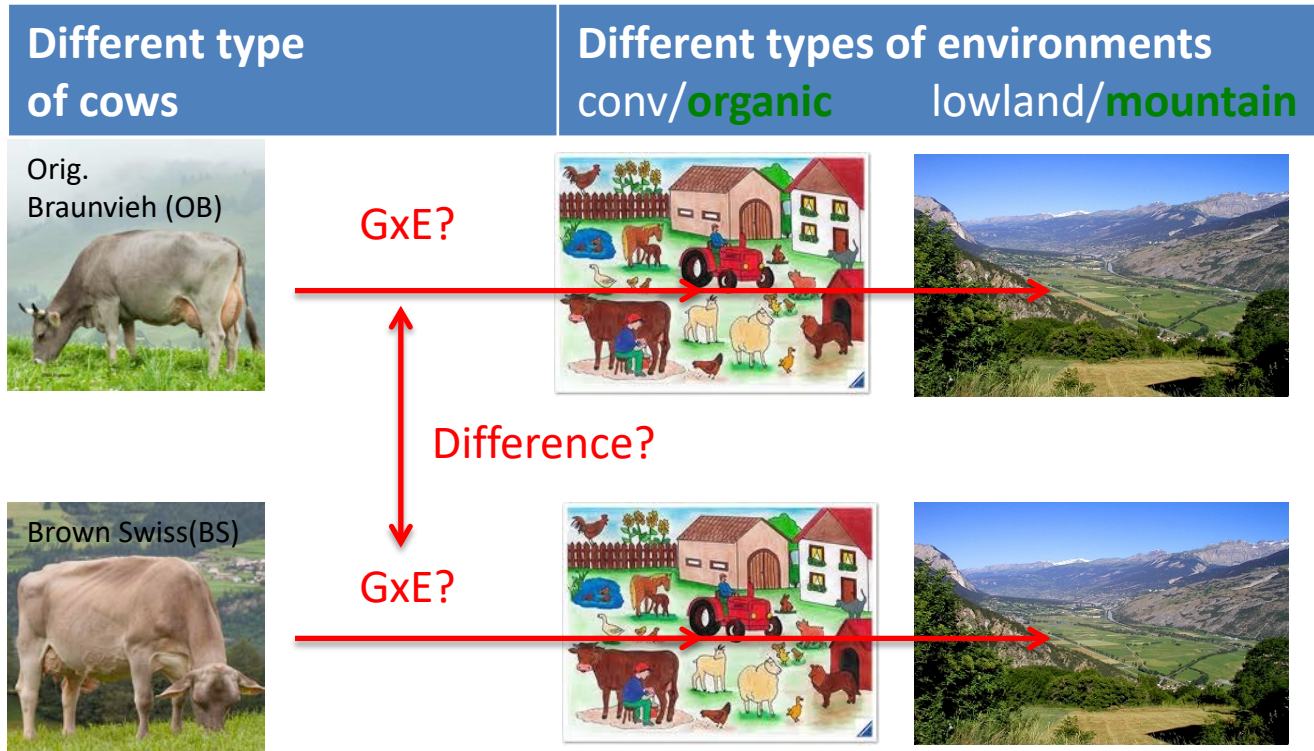
# Concept

## 2 Opposed environments/farms: Scenario FS: **Farming system**

Harsh env.

Conventional	Organic
	<p><b>Restrictions:</b></p> <ul style="list-style-type: none"><li>• Amount of concentrates</li><li>• Health management</li><li>• Application of breeding technologies</li><li>• ...</li></ul>

# Concept of the current analysis



# Data

**OB:** 104,984 standard lactations (35,614 cows)

**BS:** 2,113,959 standard lactations (753,667 cows)

- 2000 – 2015
- Traits: Milk kg, fat kg and protein kg
- Restrictions: Test days only on the same farm during lactation, cows from lowland with summer alpine pasture were excluded
- Phenotypic key figures:

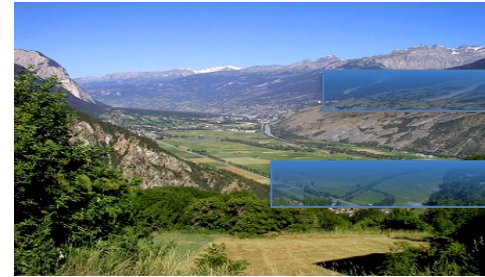
Year	OB			BS		
	Milk kg	Fat kg	Prot. kg	Milk kg	Fat kg	Prot. kg
2000	5677	213	184	6342	251	210
2015	6066	238	201	7197	290	244

```

992384922 CH120000286063 331100 1 20100703 20150510 3 1 18331 444 391 385 585
992354684 CH120000285987 331100 1 20100427 20150521 3 1 8161 326 285 385 585
990558062 CH120005356454 331100 1 20110919 20150522 2 1 9805 368 331 385 585
991595779 CH120053707469 331100 1 20070122 20150524 6 1 8249 338 388 385 585
991780894 CH1200053740053 331100 1 20071125 20150527 5 1 8161 382 326 385 585
990380276 CH120000285502 331100 1 20090027 20150613 3 1 8880 463 523 385 585
990514271 CH120005356311 331100 1 20110819 20150616 2 1 6896 381 241 385 585
990378051 CH120000285523 331100 1 20080016 20150606 4 1 7481 319 277 385 585
990514263 CH120005356324 331100 1 20110811 20150608 2 1 6775 283 258 385 585
992087726 CH120075639263 331100 1 20090331 20150609 5 1 7570 329 277 385 585
990507820 CH120005356652 331100 1 20111123 20150610 2 1 5834 223 228 385 585
991545146 CH120053707292 331100 1 20061114 20150615 7 1 7568 332 298 385 585
990861070 CH120005356067 331100 1 20120613 20150616 2 1 5344 280 284 385 585
992515816 CH120000286629 331100 1 20101215 20150616 3 1 7778 273 288 385 585
997228740 CH1201033718016 331100 1 20120313 20150620 1 1 6376 264 252 385 585
997043037 CH1201033718519 331100 1 20120918 20151002 1 1 6045 298 273 385 585
990447543 CH120005356884 331100 1 20111110 20151003 2 1 6823 251 207 385 585
997043031 CH1201033718548 331100 1 20120926 20151005 1 1 5888 265 189 385 585
992042233 CH120075639096 331100 1 20090306 20151006 5 1 8845 323 312 385 585
990817028 CH120082000916 331100 1 20030317 20151009 10 1 9227 418 334 385 585
990718022 CH120005356662 331100 1 20111207 20151017 2 1 6395 242 229 385 585
997043020 CH1201033718564 331100 1 20120927 20151019 1 1 6768 273 265 385 585
997043035 CH1201033718526 331100 1 20120923 20151029 1 1 5980 229 218 385 585
997043033 CH1201033718513 331100 1 20120925 20151103 1 1 5867 248 219 385 585
990490350 CH120000285295 331100 1 20090419 20151103 5 1 8646 335 384 385 585
997018008 CH1201033718472 331100 1 20120029 20151108 2 1 6223 270 230 385 585
997490280 CH120000286449 331100 1 20101129 20151108 3 1 7920 371 384 385 585
991746250 CH1200537400022 331100 1 20071114 20151115 6 1 7138 284 273 385 585
992080696 CH120075639164 331100 1 20090317 20151123 5 1 8340 412 382 385 585
990777398 CH120005356812 331100 1 20120214 20151126 2 1 7012 288 278 385 585

```

# Farm altitude



Mountain  
area

Lowland

Heritabilities (diagonal elements) and genetic correlations,  $r_a$  for *OB* / *BS*:

	Milk kg 1	Fat kg 1	Prot. kg 1	Milk kg 2	Fat kg 2	Prot. kg 2
Milk kg 1	0.33 / 0.27					
Fat kg 1	0.85 / 0.78	0.23 / 0.20				
Prot. kg 1	0.87 / 0.82	0.86 / 0.83	0.24 / 0.18			
Milk kg 2	<b>0.99 / 0.99</b>	0.85 / 0.78	0.86 / 0.81	0.30 / 0.23		
Fat kg 2	0.83 / 0.74	<b>0.99 / 0.99</b>	0.87 / 0.82	0.83 / 0.74	0.26 / 0.22	
Prot. kg 2	0.89 / 0.82	0.85 / 0.81	<b>0.99 / 0.99</b>	0.88 / 0.83	0.86 / 0.80	0.28 / 0.22

# Farming system



conventional /  
organic

Heritabilities (diagonal elements) and genetic correlations,  $r_a$  for *OB* / *BS*:

	Milk kg 1	Fat kg 1	Prot. kg 1	Milk kg 2	Fat kg 2	Prot. kg 2
Milk kg 1	0.29 / 0.26					
Fat kg 1	0.82 / 0.76	0.24 / 0.20				
Prot. kg 1	0.82 / 0.85	0.85 / 0.83	0.19 / 0.17			
Milk kg 2	<b>0.99 / 0.99</b>	0.82 / 0.76	0.82 / 0.82	0.27 / 0.21		
Fat kg 2	0.78 / 0.71	<b>0.99 / 0.99</b>	0.85 / 0.80	0.78 / 0.71	0.24 / 0.18	
Prot. kg 2	0.85 / 0.85	0.85 / 0.80	<b>0.99 / 0.99</b>	0.85 / 0.84	0.84 / 0.77	0.26 / 0.22

- GxE interactions do not exist for yield traits between common and harsh environments for OB and for BS dairy cattle
- OB and BS do not react differently to harsh environments
- Confirmation of earlier investigations for Swiss populations:  $r_a$  0.96-0.98 for yield traits in conventional and organic environments  
(Bapst et al., 2007 in Simianer, 2007)
- Other investigations show similar results, partly with slightly stronger GxE interactions  
(e.g. Pfeiffer et al., 2016; Cole, 2015; Streit et al., 2012)
- Stronger reactions were found in more contrasting environments: e.g. South Africa (Neser et al., 2014)

→ No need for action for the breeding program and for genetic evaluation

But:

- Establish different environment definitions
- Test other methods/models/breeds (SI versus HO/RH)

# Thanks for your attention



## Acknowledgements:

- The authors acknowledge the financial support for this project provided by transnational funding bodies, being partners of the FP7 ERA-net project, CORE Organic Plus, and the cofund from the European Commission
- We would like to acknowledge Braunvieh Schweiz for the permission to use their data for this study
- Thanks to Bio Suisse and FiBL for providing information regarding organic Swiss farms