CLIMATE AND BEDDING IN DIFFERENT BARN SYSTEMS

ABSTRACT # 29959

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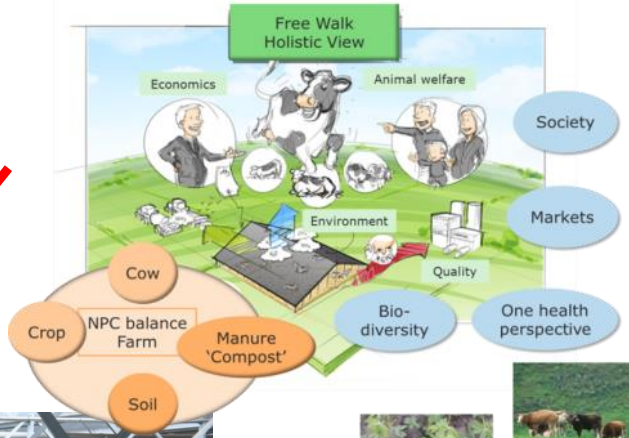
ERANET SUSAN Project: FREEWALK

The term "**freewalk housing**" has been used to describe **housing systems that provide animals the opportunity to walk more freely within the barn**, often in combination with grazing access (Bewley et al., 2017).

Compost-bedded pack barns (CBP)

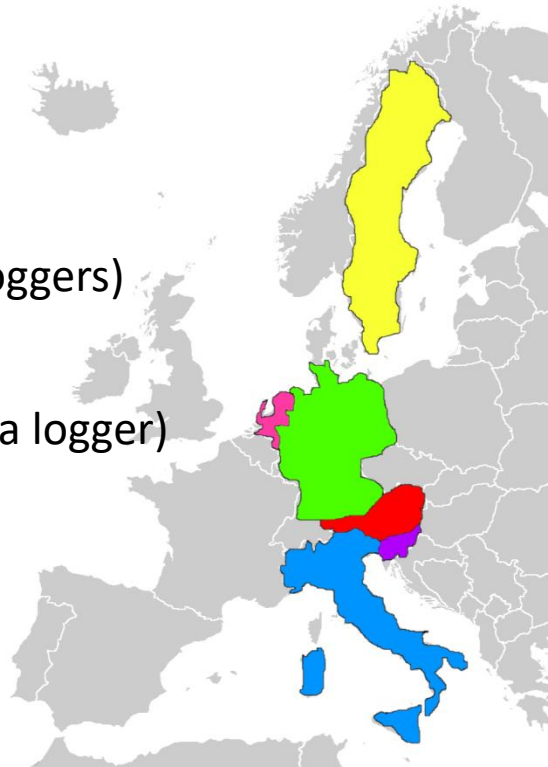


Cow garden with artificial floor

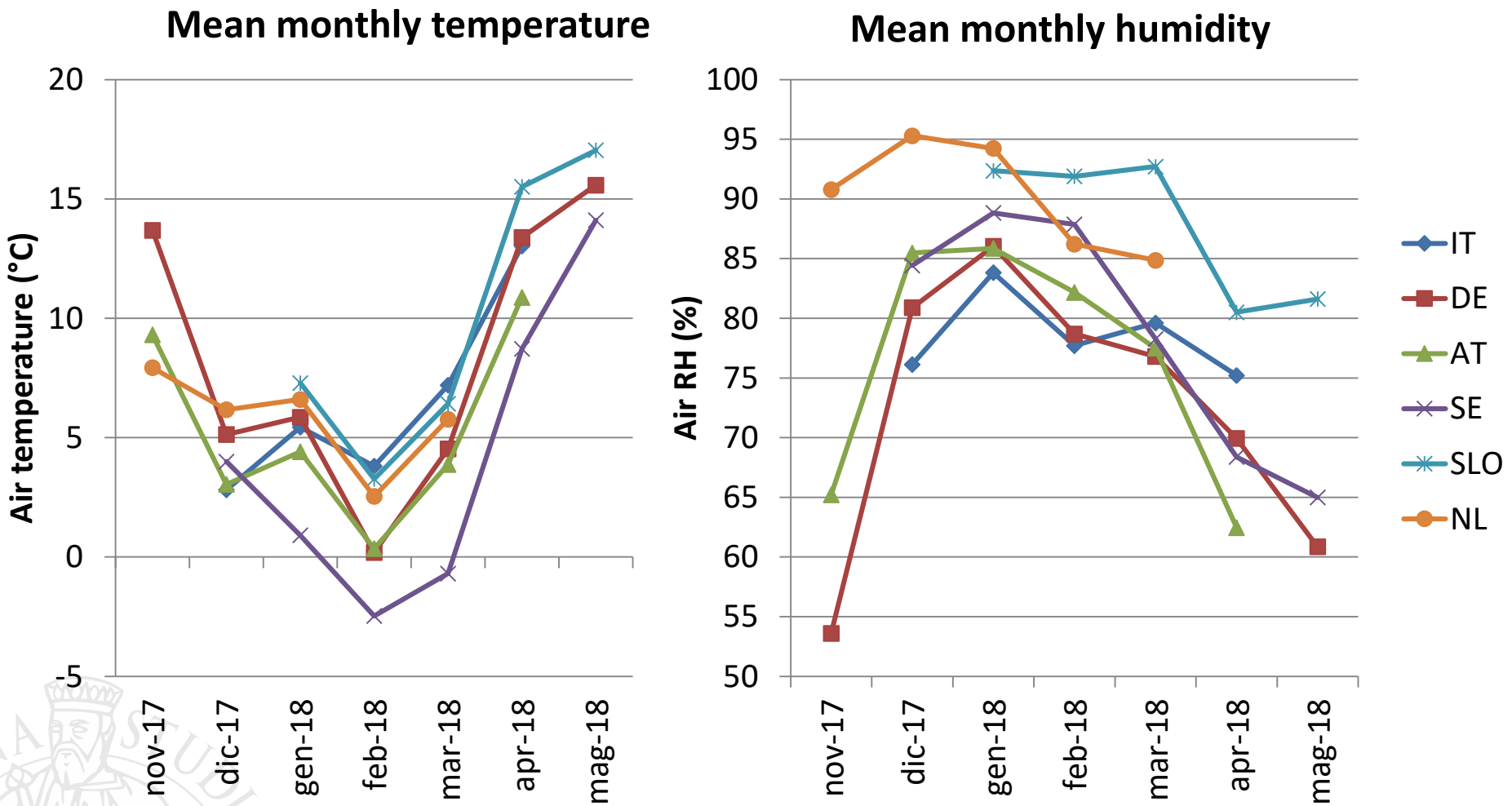
A CBP consists of a large, open resting area, usually bedded with sawdust or dry, fine wood shavings. Bedding material is composted in place, along with manure, when mechanically stirred on a regular basis (Bewley et al., 2017).

WP 2: Materials and techniques for bedding management

- **Monitoring 22 case farms with FW/CBP throughout Europe**
  - 6 dairy + 1 beef in Germany
  - 5 dairy in The Netherlands
  - 4 dairy in Italy
  - 3 dairy in Austria
  - 1 dairy + 1 beef in Slovenia
  - 1 dairy in Sweden
- **Other 22 farms with free stalls are included as reference**
- **Monitoring period will last 18 month, during which:**
  - **Continuous monitoring** of air temperature + RH (fixed data loggers)
  - Planned **6 visits** in each farm (1 every 3 months) to measure:
    - Climate inside and outside the barn (with hand-held data logger)
    - Bedding temperature (with hand-held data logger)
    - Bedding moisture (samples to the lab)
    - Bedding consumption/management monitored
- **Housing facilities surveyed (main dimensions/ventilation)**



Climate in different countries: temperature/RH

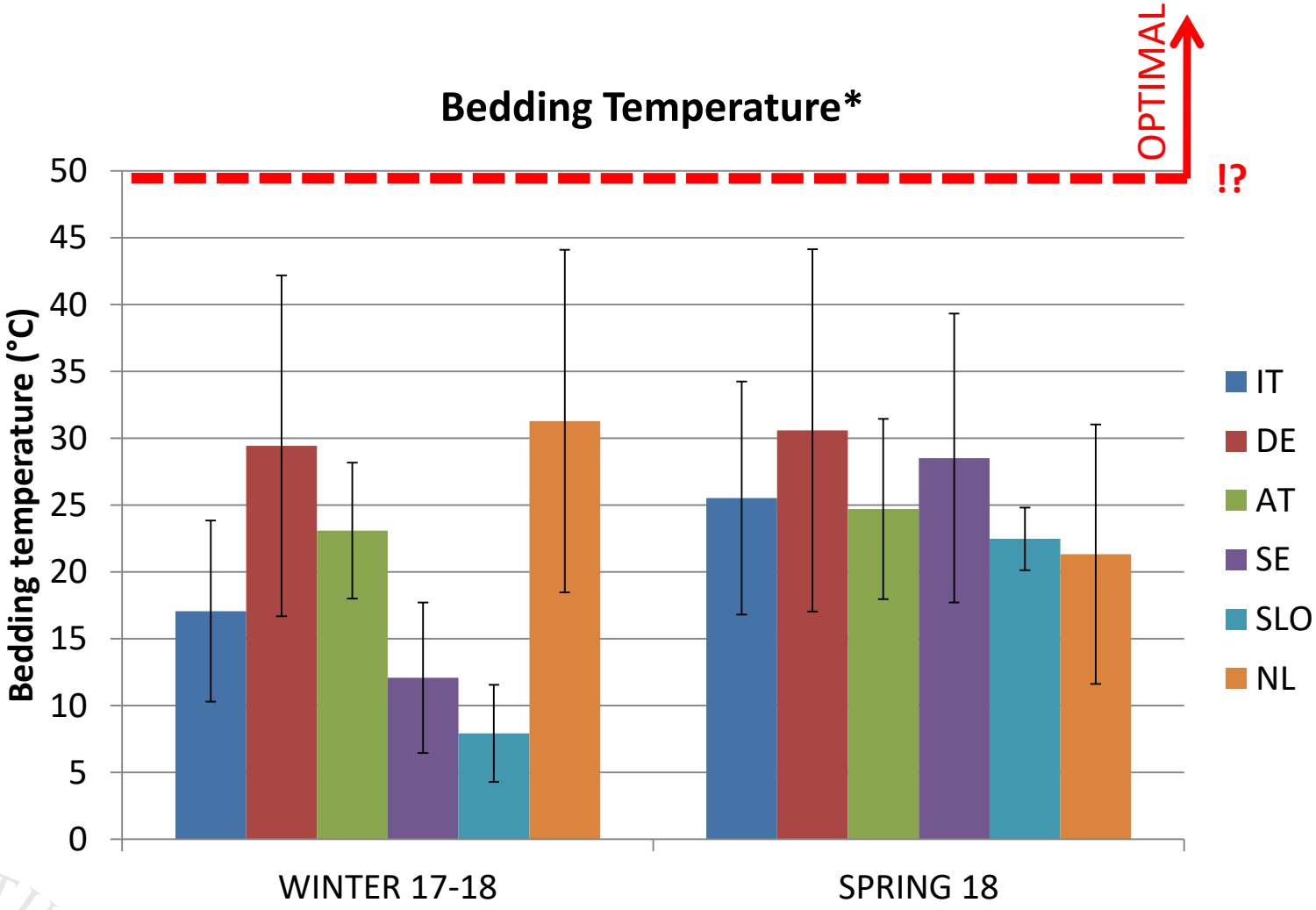


Bedding conditions in different countries: moisture

	Bedded space per cow* (m^2/cow)			Depth of bedded area* (cm)		
	MIN	MEAN	MAX	MIN	MEAN	MAX
IT	9.45	**14.52**	23.25	10	**31**	60
DE	9.80	**14.26**	23.80	20	**53**	80
AT	4.96	**10.35**	16.24	60	**70**	80
SE	11.41	**11.68**	11.94	100	**100**	100
SLO**	12	**12.25**	12.5	-	-	-
NL**	11	**13.5**	15	-	**~80**	-

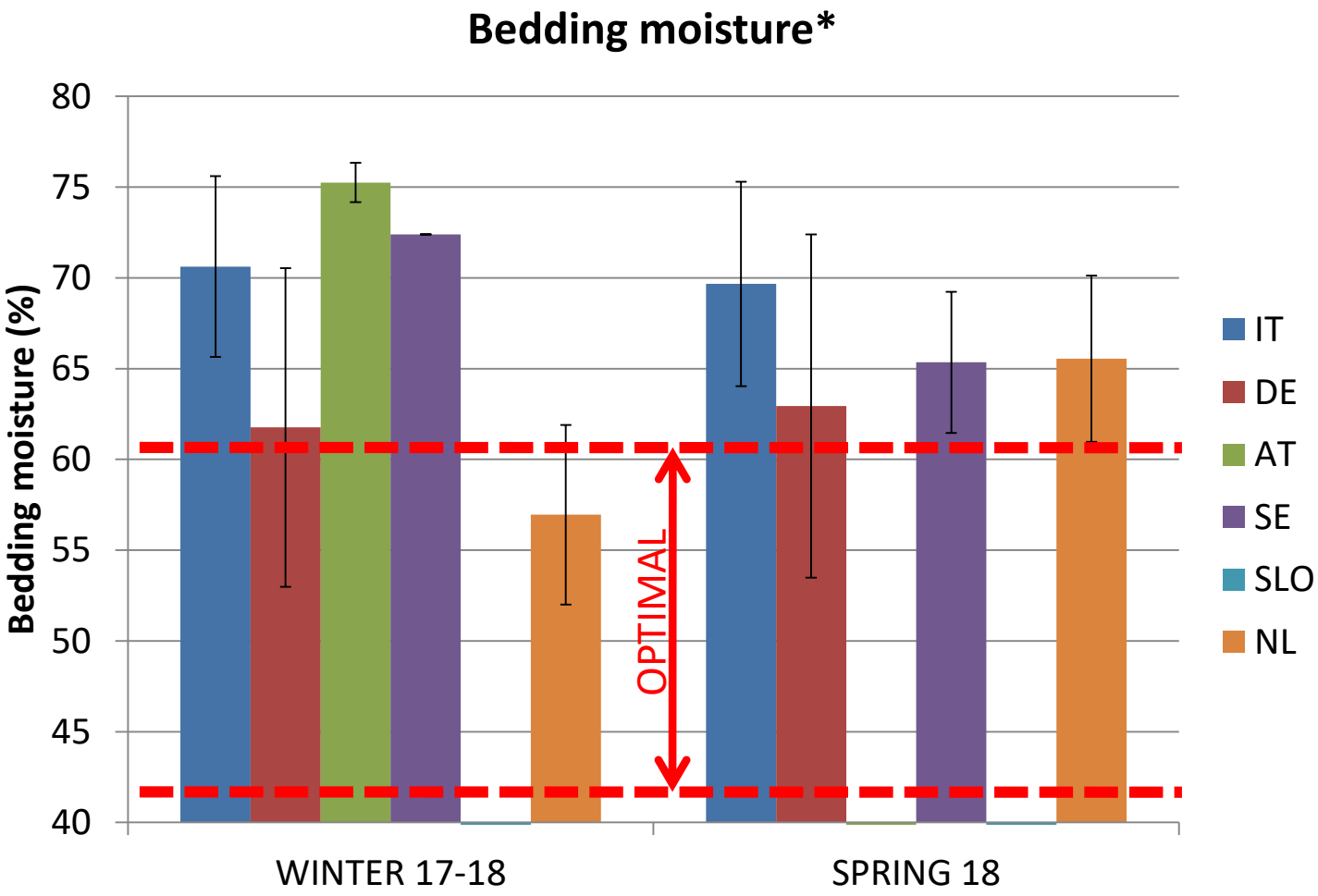
*include both lactating and dry cows pens
**based on declarations from farmers (actual measures still not available)

Bedding conditions in different countries: temperature



*include both lactating and dry cows pens

Bedding conditions in different countries: moisture



*include both lactating and dry cows pens

So how can we control (reduce) pack moisture in FW systems?

Increasing absorption →

Increasing evaporation →

Increasing space per cow

Increasing drying rate

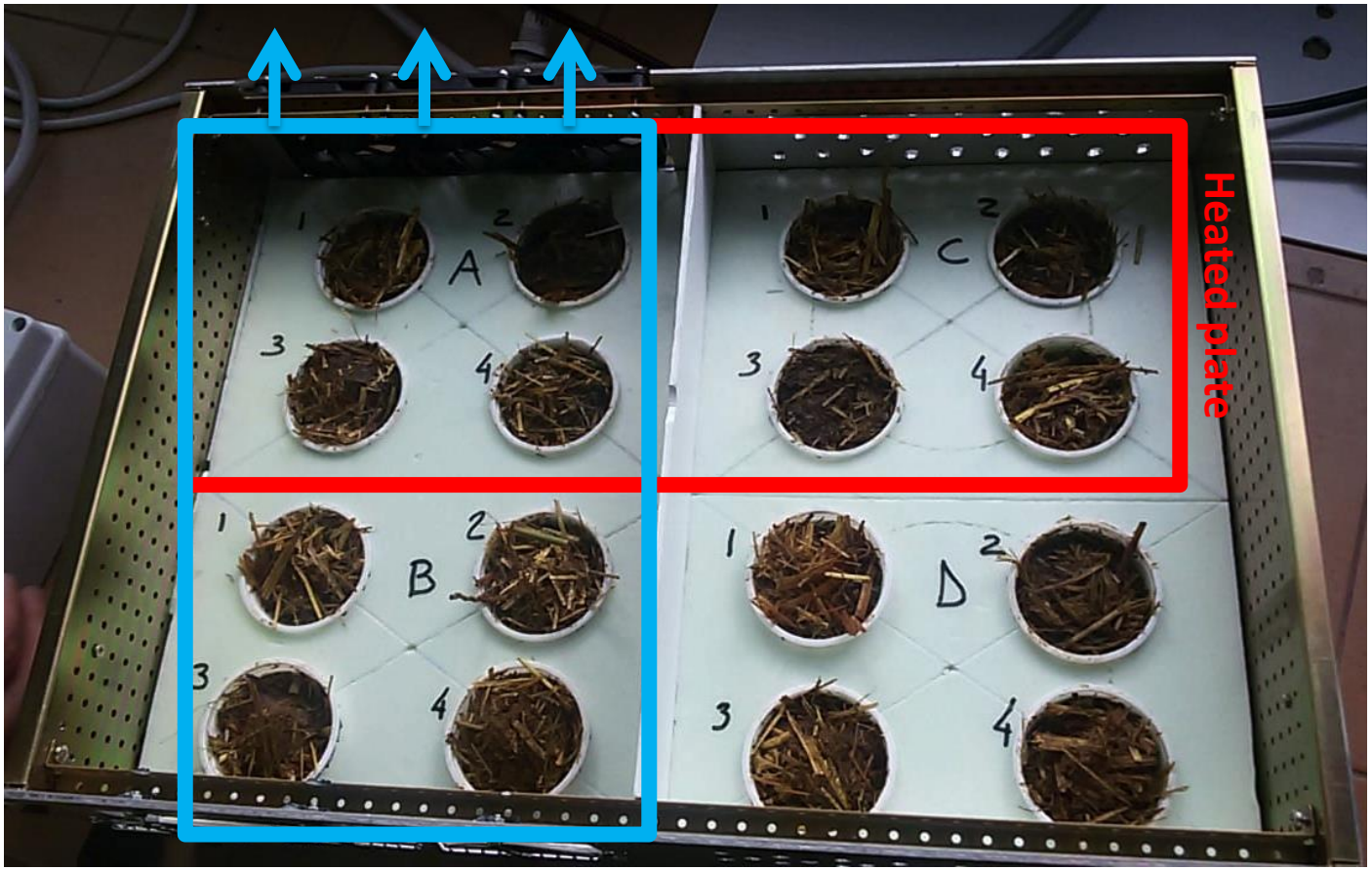
Evaporation experiment in a climate chamber: aims

- Aim of the experiment was to evaluate **effects of different parameters (environment + bedding) on the evaporation** of water from a bedded pack
- Based on **direct measurements (exp. evidence)** rather than matemathical modelling

Evaporation experiment in a climate chamber: Mat & Met

- Experiment was carried out in a **climatic chamber** which allowed controlling **Air temp and RH**
- **Air velocity and sample temperature** (composting) were created by means of a **custom cabinet** (Dunlop et al., 2015)
- **Divergent initial moisture contents** were tested (reconstituted in lab)
- **Different materials** were tested (collected from real barns)
- (2AirT*2RH*2AirVel*2SamT*2SamMoist*4mat)*2reps=**256 samples**

Custom cabinet (placed in the climate chamber)

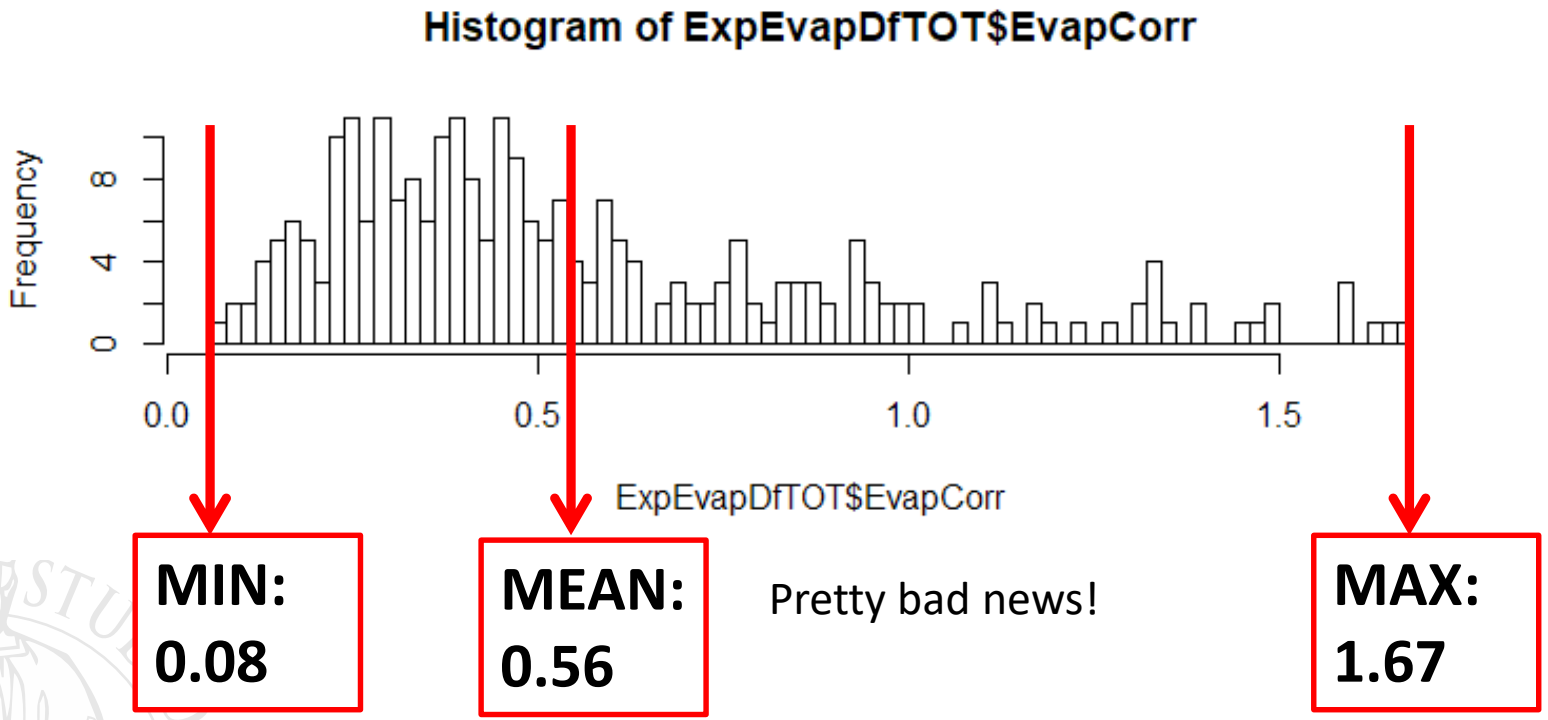


- A=Samp heating + Forced vent.
- B= Forced ventilation
- C=Sample heating
- D= none

Results: DRYING RATE (descriptive stats)

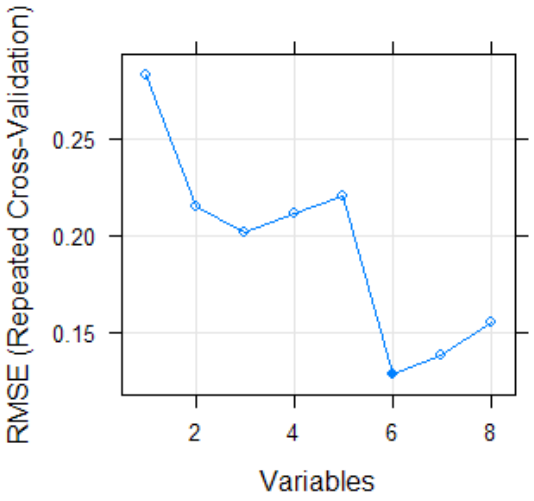
- Response was DRYING RATE (**kgH_2O/m^2*day**) which was calculated as:

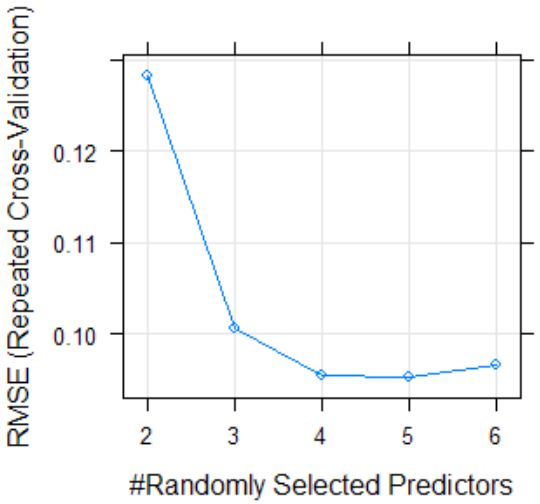
$$DR = \frac{(\text{Weight}_{\text{Initial}} - \text{Weight}_{\text{Final}})}{\text{Sample area}} * \frac{1}{\text{Time}_{\text{exp}}}$$



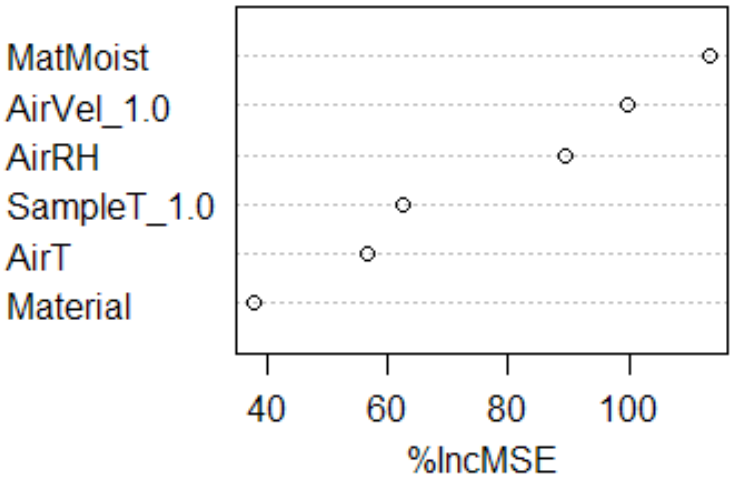
Pretty bad news!

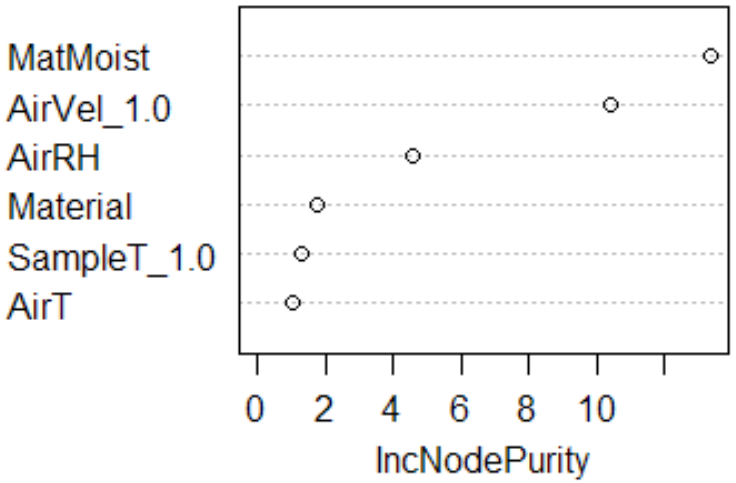
Results: rand. forest: RFE + model training (caret) + var impo



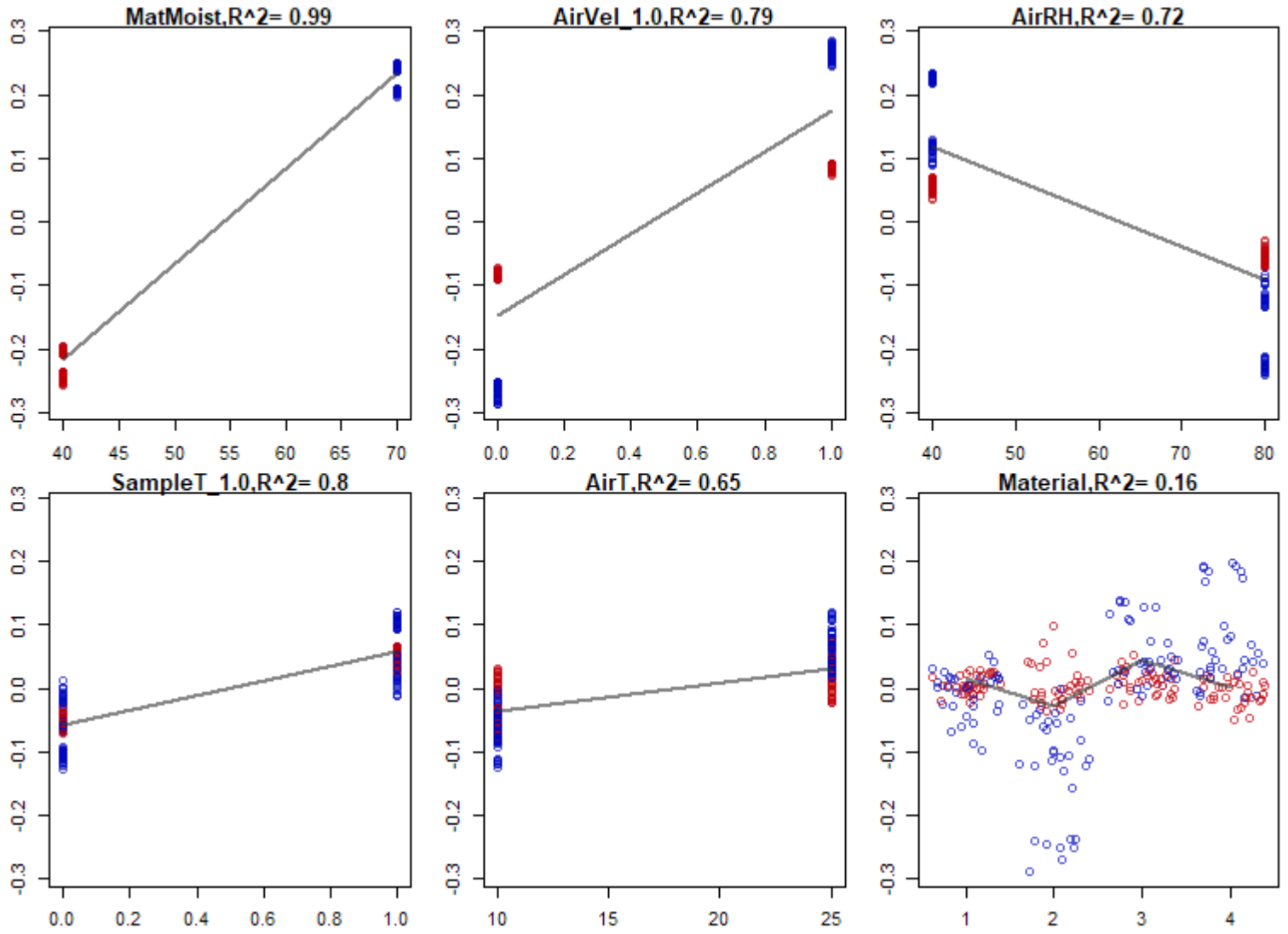


Var. importance



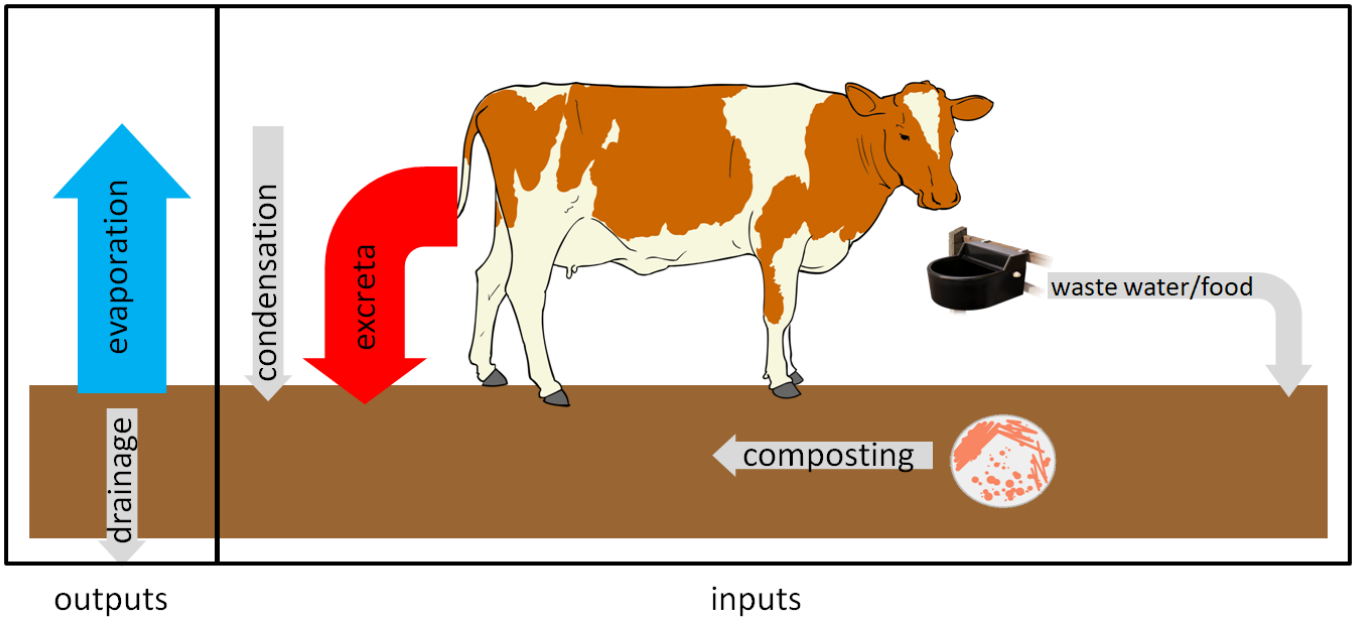


Results: random forest: forestFloor (partial dep. Plot)



CONCLUSIONS

- Drying rates measured in this experiment are **lower than results reported** in previous studies based on modelling (0.25-3.6 kg/m^2*day; Smits & Aarnink, 2009)
- **Low var. importance detected for pack temperature** (composting) is in contrast with conventional reccomendations for CBP mangement (Bewley et al., 2017)
- **Preliminary results** which will need to be further validated (also in real farms)
- Results about drying rate will allow modelling a **water balance** for the bedded pack in CBP/FW, in which evaporation represents the main output



THANKS, QUESTIONS?

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FREEWALK

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BEDDING MATERIALS

- **Varoius (organic) bedding materials are used in FreeWalk systems around Europe**
  - Most common are wood-based (sawdust, wood chips, wood shavings)
  - Straw is becoming increasingly popular
  - Less common are: cereal husks, Miscanthus, compost*



HBLFA Raumberg-Gumpenstein 2016/2017

- **The high volumes of bedding needed (high cost) and limited availability are the most important issues in FreeWalk systems**

- **One of the main objectives of the project (WP 2.1) is to identify alternative beddings which should be:**
  - Waste/byproduct source
  - Cheap
  - Largely and readily available (depending on the region)
  - Suitable characteristics for CBP/FW systems



- **Plausible alternatives (selected among many) include:**
  - manure solids, Miscanthus/reed, cereal husks

Implications of measured DRYING RATE on water balance

- A "typical" lactating Holstein dairy cow (LW=625 kg, MY=30 kg/day) produces **~62 kg of manure per day at 87% moisture** (ASABE STANDARDS, 2010)
- Considering just 60% of the manure (**37.2 Kg/cow*day**) is dropped on the bedded pack area (remaining 40% in feeding alley)
- We have **32.4 kg H_2O** that are added to the pack every day by each cow
- So to keep the pack constantly at 60% moisture (without using any bedding) we would need to evaporate **26.6 kg H_2O/cow*day** from the bedded pack
- To achieve an evaporation of **26.6 kg H_2O/cow*day** at **DR=0.56 H_2O/m^2*day** we would need **47.5 m^2/cow** (to avoid using bedding)
- At **DR=0.56 H_2O/m^2*day** , in a "normal" FW barn with **15 m^2/cow** we would have an excess of water equal to **18.2 kg H_2O/cow*day** which would need to be absorbed by adding dry bedding

Evaporation experiment in a climate chamber

- **Response was Drying Rate in kgH2O/m2*day (corrected for 24h)**
- **Explanatory variables**
  - Air temp -> 2 Levels (10, 25 °C)
  - RH-> 2 Levels (40, 80 %)
  - Air velocity -> 3 Levels (~0, 1 m/s)
  - Sample temperature (at 5 cm depth) -> 2 levels (ambient, 35°C)
  - Initial sample moisture content -> 2 levels (40, 70%)
  - Sample material -> 4 levels (cow straw, cow sawdust, horse pellet straw, horse pellet sawdust)
  - All tests were repeated twice -> (2 reps)

- (2AirT*2RH*2AirVel*2SamT*2SamMoist*4mat)*2reps=**256 samples**