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- Presentation Joop Lensink, Dean of Education ISA (School of Agriculture and Bio-engineering) Lille in cooperation with Elfriede Ofner-Schröck - HBLFA Raumberg-Gumpenstein - Austria
Foreword

EuroDairy is an international network to support a sustainable future for European dairy farmers. It will ‘unlock’ knowledge to increase the uptake of innovation and best practice. One of the (sub-) themes within EuroDairy is alternative housing systems. An alternative could be bedded pack and compost barns.

To exchange knowledge (and collect knowledge gaps) the Project Work Package Animal Care organized a cross border workshop about bedded pack and compost barns for dairy cattle at 23 February 2017 in Lille (France).

For practical and strategical reasons this half-day workshop was organized during the European Forum Livestock housing: ‘Let’s build the future’ from 22- 24 February 2017 of the French Mixed Technology Network (RMT) livestock housing for the future. This forum is visited by the same target group as wanted by EuroDairy, namely stakeholders, like researchers, advisors, education and farmers from different countries. In addition EuroDairy partners were facilitated to invite farmers from their countries. The workshop was visited by about 100 people. Though the number of farmers was relatively low, the farmers who attended were very active in the discussion.

This report contains the presentations of the experts, the questions and answers and the results of the round table discussion. As the report is available at the EuroDairy website it is useful for further dissemination of knowledge and will be also input for other EuroDairy deliverables.

I would like to thank the RMT for this possibility and the good cooperation, Joop Lensink and students of the Institute Supérieure d’Agriculture (ISA) de Lille for their contribution to this workshop and this report and last but not least Jean-Luc Menard for his assistance in organizing this workshop.

Willem Koops

Project leader EuroDairy WP 5 Animal Care

June 2017
Program workshop

EuroDairy workshop at February 23rd 14.00 h -18.00 in Lille France

Bedded pack and compost barns for dairy cattle
Moderator: Willem Koops – ZuivelNL – Netherlands

14.00 Introduction: EuroDairy and Alternative housing for dairy cows
Willem Koops - ZuivelNL - the Netherlands

Development and sustainability of Free walk housing in the Netherlands
Paul Galama - Wageningen Livestock Research - the Netherlands

First experience in France and some transcriptions of recommendations on traditional straw yards
Jean-Luc Ménard - Institut de l’Élevage – France

15.45- 16.15 Break

Farmer’s Experience with a bedded pack barn
Marc Havermans – dairy farmer- the Netherlands

Compost barns for dairy cows - studies on animal welfare and recommendations in Austria
(Elfriede Ofner-Schröck – HBLFA Raumburg-Gumpenstein)
Joop Lensink - ISA Lille – France

Round table discussion with speakers

The workshop is organized during the European Forum Livestock housing: ‘Let’s build the future’ form 22- 24 February 2017 at Lille France.
Questions and answers

Questions – Answers after Presentation by Paul Galama, Wageningen Livestock Research (Netherlands)

Question 1: “Is there a difference in use of Nitrogen for slurry or composted wood chips?”
Answer 1: “If we have slurry from the cubicles stables, we calculate about 50% is coming in use the first year and if you have composted wood chips it’s like compost, it’s about 30% in the first year. Composted wood chips is more a soil improver than a N-fertilizer.”

Question 2 (Nadège Edward, INRA): “Did you see any differences in terms of ammonia emissions, in terms of aeration if you using sucking or blowing air?”
Answer 2: “The important thing is that you have a good composting process, that say between 40 and 50 °C, to get less ammonia emission. A good compost in process means that you have to mix it every day. But it’s not only the aeration system. You need to use the right fresh wood chips, fresh and start in November, it’s also good to have some leaves in it. But personally, I think a blowing system seems easier to manage than the sucking system. You have to circulate much more air that with a blowing air system, but it’s not only the air system. The type of wood chips is important, the way of cultivating and extra ventilation. You have to manage it very well. There is a lot of differences between farmers how do it very well and farmers who don’t. Another important thing is the depth of the bedding, it has to be (the litter) about 50 cm. If you have 20 or 30 cm the litter can cool down, you need some buffer to keep it warm.

Question 3: “How much air we need for one m²?”
Answer 3: “I don’t know how much air it is exactly. You have small holes at the beginning of the pipe and big holes at the end of the pipe. The pipes are about from two meters to each other, or less. It blows every 2 hours about 10 min and when it is cold don’t blow too much.”

Question 4: “If the temperature of compost is over 72°C during the compost process and that created resistance of bacteria, how do we manage that?”
Answer 4: “If you manage it well, it doesn’t get that hot.”

Question 5: “Are you emptying and completely replenishing the litter after a while and how often, on average?
You were talking about surface by cows, is that only for the sleeping area or also the exercise area?
Are there some systems with phase separation of slurry and reuse of the solid fraction?”
Answer 5: “Most of the farmers clean it once a year but there are many differences. Most of them start in November and if you have a good composting process, after 10-11 months the compost in process is finished, then they start again. Some farmers let it stay about 2 years in the stable. So, there is a lot of differences.
The 15 m²/cow is only for the laying area.
When it was started in 2007 in the USA with the use of sawdust as bedding material the Dutch farmers said it was too expensive. I said well, who wants to go with me to a cheaper system in Israel? Because there you have only cows in free housing system and they use dried manure. So I
went to Israel and they use about 20 m²/cow in a better climate. I have compared the climate in the USA with strong winters and the climate in Israel with twice as much sunshine as in the Netherlands. To keep the bedding dry in a wet climate in Western Europe we came up with wood chips and aeration system. But we should also look at some alternatives. So, I hope that at the end of the afternoon, we get some other alternatives. But dry manure in Israel, it opened my eyes. We have to do it different.”

Question 6: “Do you have any data on the impact on lameness or welfare indicator or laying time?”

Answer 6: “Yes, we have information about laying time. It’s about the same but the time to stand up and to lay down is about twice as less as in the cubicles. But the lying times is not so much different. Also, we see much less legs problems.”

Questions – Answers after Presentation by Jean-Luc Ménard – Institut de l’élevage – France

Question 1: “From a traditional system (on straw yards) to new methods, could we not in France use the system of composted bedding like in the Netherlands? What is your opinion about that?”

Answer 1: “In the composted beddings, the temperature can increase, and there is more humidity. Yet, ventilation in the buildings is already a big issue, especially with the cattle bigger and bigger. So, it should be adapted, which is a huge constraint.

In the other countries, 10-15m²/cow is given for lying space, which is an important area. The composition of the ground is also different: blowing pipes and canalizations should be installed. Several French breeders have been abroad to visit some farms with composted beddings. They are interested by the idea, but are afraid of the costs of such investments. To convince them, capitalizing the foreign experiences should be done, in order to know the prices of the installations. Feedback of the French breeder: Idea of combination with a methanizer (project with Paul Galama) to bring warm air, and keep the temperature low.”

Question 2: “What is the optimum temperature of the bedding? In Netherlands, for the composted beddings what is said is that a temperature around 40-50°C is good for composting, but perhaps is also favoring the bacteria, and so mastitis.”

Answer 2: “The ideal temperature at the surface is below 25°C, which corresponds to below 36°C at 10 cm of depth. In free area, temperature is increasing in surface.

It is important not to mix too deep the beddings, to avoid contamination of surface (with anaerobia bacteria) and therefore of cow’s teats.”

In the Netherlands usually the bedding is around 40-50 cm deep. If we add a layer of 20-30cm of wood chips, the ventilation is better. There is a difference of conception between optimum temperature for composting (for composted beddings), and optimum temperature to avoid the emergence of bacteria.

“It is a difference in the composted bedding (like in the Netherlands), and the mixed bedding. In France, the idea of a courage every 2 or 3 months is possible, because there is no entire composting, and areas are smaller (8-9 m²/cow).
Nowadays, a renewing of bedding is usually done every 15 days. To add a new layer of bedding’s material healthy, clean, and dry (in a logic of accumulation). This method is used to handle the bacteria (staphylococcus, Escherichia coli), and to obtain a clean surface."

**Question 4:** “For the animal, the free area system is probably better instead of the cubicles. However, in a country like France, with a lot of sanitary rules (especially for a country producing cheese with raw milk), is it cautious to already try this system, with few or without information? Should we already start the experiences?”

**Answer 4:** “The mixed bedding is a good system, and an alternative to straw yards. Benefit of already having the experience of other countries. France: country with a high diversity of systems (cheese with raw milk is not produced in every region). Project are already beginning in the whole country, and some in region with a high production of cheese. Concerning the composted bedding like in the United States or in the Netherlands, if enough breeder show interest for this system, the manager of the milk sector in France would agree for launching experiences on the topic. Since several years, J.L. Ménard has already been suggesting to look what is going on mixed beddings. Future study possible, maybe in the following of the EuroDairy program. Already European projects about straw yards existing: so, topics of study to dig.”

**Questions – Answers Presentation Mark Havermans, dairy farmer with loose housing system, Netherlands**

The presentation of Mark Havermans, started with a movie and a Prezi presentation of his farm.

**Question 1:** “Do you have dust problem in the barn when you carrying straw?”

**Answer 1:** “When adding the straw, it can be quite dusty but because we have this construction, normally the windows are open and that only for 5 minutes (when we add straw). But the barn is getting dirty. Look at this picture you can see those windows, there are all dirty now. There is dust but it really depends on the straw we get. The cows don’t have trouble. The compost is worse than straw (for the dust) because the dust come from compost is more aggressive than the dust from straw. When we are putting straws with wind, the dust is just here during 1 or 2 minutes and then dust is gone. I would like not to have dust but I don’t have the choice.”
Question 1: “The use of saw dust or of wood chips is more frequent. Do you know if studies have been made to know the releasing of nitrogen of this kind of compost in the soil? Is there any difference with the compost made with straw?”
Answer 1: “In the context of these works, studies have been made on this topic. From an agronomic point of view, the compost made with these kinds of material seems to bring a similar quantity of nitrogen, compared to the compost with straw.”

Question 2: “What temperature is needed to install the bedding?”
Answer 2: “It was advised in Austria to not start in the middle of winter. Below 0-5°C, the temperature is too low, which slows the composting process, the bedding is soon wet and dirty. The optimum temperature is around 15°C.”

Question 3: “There are several results of temperature at different depth: 10 cm, 20 cm, and 30 cm. Are these results averages? Is there an evolution before and after mixing?”
Answer 3: “The results are indeed averages. Not the data concerning the comparison before and after mixing. There is an evolution, but very few variations comparing others schemes (especially a case with a bedding mixed twice a day, and a frequent blowing).”

Question 4: “With mixed beddings, do we know if cows get older?”
Answer 4: “Study on small herds, and a little production (4000-7000 of milk produced). So no effects with the housing on the longevity.”

Question 5: “Beddings changed twice a year, but is the process of composting finished?”
Answer 5: “Cannot really say. With some materials like saw dust, the composting process is much faster.”
Round table discussion with speakers

Why not using lab studies on the composting process? Could we use some sensors, some models for the bedding management?
(P. Galama) Studies and models have been made (one of his colleagues did the model, based on composting process). But it is not easy to compare with the real conditions.
(M. Havermans) Every barn is different, every day is different (with very hot and very low temperatures), so it is really hard to find the best model.
For measuring the temperature, for 7 years he has been walking in his barn and measuring the temperature in different points.
In Sweden breeders are using peat and are happy of it, because it lowers the pH.
(P. Galama) He agrees, because in the Netherlands one experience has been made with peat. And indeed, the pH is lower with the peat.
The peat came from Estonia. It was dry for the dairy cows, very dry for the calves, and not cheap.
Another idea was to take the peat they use in horticulture. After growing plants on it, they could recycle the peat by giving it to the dairy cow. That would have been a cheaper solution, but he is afraid of the chemicals they use in horticulture. These chemicals could be found in the peat, and harm the dairy cows.

Does the feeding have an influence on the quality of compost?
(M. Havermans) In a system where the cows are fed with grass, the compost is not as thick as the one in as system where the cows are fed with concentrates.
With dry manure, it is easier to conduct the composting process. And it is easier with dry cows and young stock too.
But the goal of the barn is not composting, it is to keep the cows dry and clean. Then, if it makes compost, this is a second point.
(P. Galama) In Israel, there is a high temperature in compost. So farmers in this case have to be careful about the feeding of their cows (because it changes a lot the composition of the bedding).

How many compost do you take of your barn?
(M. Havermans) It is a difficult question. Some manure is lost because when the cows go in the feeding or drinking places, they are shitting/peeing on the concrete floor, and dejections are not mixed with the straw.
It depends: some years he can take of his barn 2000 t of manure, but wet. And some other years he can take of his barn 500 t of manure, but dry.
(J. L. Ménard) 2 breeders whom he work with are using pushing barriers to lead the cows to the scraped areas. So it reduces the quantity of dung and urine, and makes the place less dirty.
But those are systems compatible with small areas (8-10m²/cow), and a tiny depth of free area.
In the too big areas, the cows’ repartition is not really homogeneous, and the dejections’ repartition is not so homogeneous as well.
(M. Havermans) The feeding place is on one side of the barn, and the drinking places are on the opposite side of the barn. So the cows are spread out in the barn. And the milking robot can also be at another side.
(J. L. Ménard) In the free areas, the feeding and drinking places are usually the dirtiest.
(M. Havermans) He does not do anything else, no particular cleaning, but he installed 15 drinking places, spread out in the barn. A lot of drinking places, and everywhere, is the key of a clean barn.
People are putting drinkers high, to avoid them to be filthy. But he puts them low, because the cows naturally will not make it dirty.
(J. L. Ménard) He agrees in this case: with a big area, the solution is probably to spread out the drinking and the feeding places.
We should find an alternative to the cubicles and concrete floor, what do you think about this?
(J. Lensink) We should not generalize over countries. For example in the Netherlands, first it was the cubicles, then the slatted floors, then the free walks. In France it was from the straw yards to the cubicles.
But perhaps people have been too far, and should slow down in the new experiences.
(M. Havermans) Farmers are a bit afraid of the no-cubicles system, because they have the feeling they are losing control on their cattle. Milking robots, a big barn, free walks: that makes a lot of cows in freedom (for instance to catch a cow). He has 5 milking robots, and no gates. But he learned to manage with this system, and now can handle 300 cows.
(P. Galama) Biggest change in mind to come, but there are a lot of advantages like better manure, and better welfare for the cows.
In the Netherlands, there are from 60 to 80 compost barns now, but it could increase faster.
But we could think to a system mixing cubicles and free walks in the same barn.

Round up
(Willem Koops) it was an interesting workshop with good questions and discussion. It was good to meet each other and exchange the ideas (the objective is not to convince). The aim is to improve the housing of the dairy cows.
Development and sustainability of Free Walk housing in the Netherlands

February 23 2017, Lille France
WUR: Paul Galama, H.J. van Dooren, W. Ouweltjes, H. de Boer
NIZO: Frank Driehuis
Why Free Walk (Bedded Pack Barns)?

- Labour efficiency
- Animal welfare and manure quality
Why Bedded Pack Barns?

Lying area is also manure storage
Environment

Manure quality

Input NPC

export NPC

Compost and Wooden chips

Emission of NPC

N2
N2O
NH3
CH4
Experiments on 3 regional farms

Composting: wooden chips and sawdust

Drainage with sand

Absorbing with peat ground and reed

Cows in Greenhouse with folie
Monitoring 10 commercial farms; 5 are composting wood chips

1. Blowing air
2. Blowing air
3. Suckling air
4. Suckling air
5. No aerating
four using green waste compost
one cultivates straw

Farms 6 to 9
use compost

10 Straw
Composting...

once a day mill the bedding

12 – 15 m² per cow
Aerating system,
Blowing air
Aerating system, Suckling air
Bedding material used on grassland and arable land
Roof from horticulture
## Farm characteristics

<table>
<thead>
<tr>
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<th>1</th>
<th>2</th>
<th>3</th>
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<th>8</th>
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<th>10</th>
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<tbody>
<tr>
<td><strong>Number of cows</strong></td>
<td>60</td>
<td>130</td>
<td>50</td>
<td>105</td>
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<td>55</td>
<td>185</td>
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<tr>
<td><strong>M2 per cow</strong></td>
<td>16</td>
<td>15</td>
<td>13</td>
<td>14</td>
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<td>22</td>
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<td><strong>Bedding material</strong></td>
<td>W</td>
<td>W</td>
<td>W</td>
<td>W</td>
<td>W</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
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<td><strong>Grazing</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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</tbody>
</table>

- Bedding material:
  - W = wood chips
  - C = Compost
  - S = Straw

- Aeration system:
  - B = blowing air
  - S = sucking air
  - N = no aeration
Animal health (Mastitis), SCC (*1000 cells/ml)
Longevity

![Bar chart showing culling and replacement rates across different farms. The chart includes data for individual farms as well as the average for bedded pack and national average.](chart.png)
### Animal welfare and health

<table>
<thead>
<tr>
<th>Welfare</th>
<th>Bedded pack vs freestall</th>
</tr>
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<tbody>
<tr>
<td>Time required to lie</td>
<td>+</td>
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<tr>
<td>Hygiene</td>
<td>0/+</td>
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<tr>
<td>Skin injuries</td>
<td>++</td>
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<tr>
<td>Legs and claws</td>
<td>+</td>
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<tr>
<td>Natural behaviour</td>
<td>+</td>
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### Health

<table>
<thead>
<tr>
<th></th>
<th>Bedded pack vs freestall</th>
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<tbody>
<tr>
<td>Udder health</td>
<td>0</td>
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<tr>
<td>Antibiotics usage</td>
<td>0</td>
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<tr>
<td>Longevity</td>
<td>+?</td>
</tr>
</tbody>
</table>

- No heat stress from heat production bedding

- Temperature sensor
Economic effect of lower culling rate

**Difference in net income**

- **green line**: without manure export
- **blue line**: with manure export

**X-axis**: Difference in culling rate

**Y-axis**: Net income per cow (in euros)

- 0, 50, 100, 150, 200, 250, 300, 350 euros

LIVESTOCK RESEARCH
WAGENINGEN UR
# Economics bedded pack barns

<table>
<thead>
<tr>
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<th>Bedded pack barn vs freestall</th>
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<tbody>
<tr>
<td>Investment manure storage</td>
<td>-</td>
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<tr>
<td>Investment roof</td>
<td>++</td>
</tr>
<tr>
<td>Total investment</td>
<td>+</td>
</tr>
<tr>
<td>Yearly costs stable and bedding</td>
<td>+</td>
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<tr>
<td>Higher production per cow</td>
<td>+</td>
</tr>
<tr>
<td>Lower replacement</td>
<td>--</td>
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<tr>
<td>Total yearly cost</td>
<td>-</td>
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</table>
Contribution of bedding material to net N input on the barn floor

WC = wood chips, GWC = Green Waste Compost
Range in N loss (% of total N-input)

Gaseous N loss (% of N excreted on the barn floor)

WC = wood chips
GWC = green waste compost
Low N loss with active composting

<table>
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<th>Date</th>
<th>Active composting</th>
<th>Passive composting</th>
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<td>28-10-14</td>
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N loss (% of N excreted on the barn floor)

Date

LIVESTOCK RESEARCH
WAGENINGEN UR
Intensive composting: strong relationship between development of N loss and C/N ratio (1)
## Overall sustainability

<table>
<thead>
<tr>
<th>Sustainability aspect</th>
<th>Criteria</th>
<th>Wood chips 5 farms</th>
<th>Compost 4 farms</th>
<th>Straw 1 farm</th>
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<tbody>
<tr>
<td>Economics</td>
<td>investment</td>
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<td>Yearly costs</td>
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<td>longevity</td>
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<td>Cow</td>
<td>Production, health</td>
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<td></td>
<td>Welfare</td>
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<td>Milk quality</td>
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<td>Environment</td>
<td>N losses stable</td>
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<td>N losses land</td>
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<td>Ammonia emission stable</td>
<td>2 farms and Dairy Campus</td>
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<td>Nitrous oxide emission</td>
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<td>Manure Quality</td>
<td>Soil Improver</td>
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<td>N mineralisation</td>
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- **Better**: Green
- **Attention needed**: Yellow
- **Worse**: Red

*Livestock Research Wageningen*
Change of bedding
Use of compost is prohibited, now straw
Conclusions

- Free Walk housing can be profitable if bedding material is not too expensive and cow replacement will be reduced.

- “Intensive” composting can reduce the N-loss of the bedding by incorporation of excreted N in bacterial biomass.

- Ammonia emission in stable uncertain until end of 2017, but emission in the field is lower.

- “Composted wood chips / manure” is a good soil improver, but N will release slowly.

- (X)TAS bacteria is a point of attention.
Points to continue

- Bedding material and management
  - Alternative for Green Waste Compost
  - Control composting process of wood chips
  - Emission factor (kg NH3/cow/year)

- Synthetic floors
  - Hygiëne floor / cow and milk quality
  - Emission factor (kg NH3/cow/year)

- Sustainability of whole farming system

- Multiple use of building
Draining artificial floor

Feces

Urine
Separating feces and urine on rubber floor

Feces

Urine
“Cowgarden” and floor cleaning robot

Floor from ID Agro (Netherlands)

Robot from Betebe (Germany)
Dairy Campus facilities in Leeuwarden

**Emission measuring unit**
for case control research
6 units of 15 cows:
- 4 Cubicles
- 2 Free Walk
Meadow floor

...to reduce ammonia emission while improving cow mobility..
aerating

...to mix slurry and reduce ammonia emission...
Free Walk Holistic View

ERANET-Susan project with 8 countries (2017-2020)

Economics
Animal welfare
Environment
Quality
Society

Cow
Manure ‘Compost’
Crop
Soil
NPC balance
Farm

Soil fertility
Multiple use of building
Bio-diversity
Thank you

Paul.galama@wur.nl

More information: www.vrijloopstallen.nl
Composted bedding for dairy cows: 1st experiences in France and proposed recommendations

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Workshop EuroDairy 23/02/2017
Contents

1. Evolution of buildings in France and first inventory of composted resting areas
2. Description of 4 farms equipped with composted bedding
3. Proposed recommendations and management of composted bedding areas in relation to the experience of traditional straw yards
4. Conclusion
Evolution of the type of housing of dairy cows

- 2001 and 2008: Surveys Ministère de l’agriculture – Agrieste
- 2016: Survey Ministère de l’agriculture, results not available, hypothesis Institut de l’élevage

<table>
<thead>
<tr>
<th>Type of building</th>
<th>2001</th>
<th>2008</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tied stalls</td>
<td>23 %</td>
<td>11,0 %</td>
<td>≈ 5 % ?</td>
</tr>
<tr>
<td>Straw yards</td>
<td>54 %</td>
<td>55,4 %</td>
<td>≈ 40 % ?</td>
</tr>
<tr>
<td>Cubicle barns</td>
<td>23 %</td>
<td>33,6 %</td>
<td>≈ 55 % ?</td>
</tr>
</tbody>
</table>

- Regular decline of tied barns (maintenance in mountain areas)
- Recent decline of straw yards (maintenance in "small" herds)
- Very steady increase of cubicles barns
Some explanations for the decrease of the straw yards and the development of cubicles barns

**Structural developments:**
- Bigger herds + more time spent in the building + working time and labor conditions:
  - Straw yards → cubicles with solid manure → cubicles with slurry
- Availability and costs of straw

**Milk quality and mastitis**
- Microbiological quality of milk, including butyric spores (*clostridium tyrobutyricum*): target < 1 000 spores/litre of milk
  - = chain requirements: contamination of manure, *animal cleanliness* and milking hygiene
- Risks of mastitis with straw areas poorly controlled (environmental conditions, animal density, maintenance, cleaning…)

---

Lille - 22 au 24 février 2017
Bâtiments d’Elevage de demain : construire l’avenir
Important challenge: rehabilitating free bedding areas in big herds (1)

• Raising awareness among advisors and farmers about:
  – Advantages of free bedding areas: comfort, evolutionary building, cleaner feet, less lameness, agronomic interests of manure ...
  – But requirements on animal density, design (basement, optimized ventilation during winter/summer periods, positioning of drinking troughs ...), quality of litter materials, maintenance ...

• Barns with straw at reasonable cost:
  – new buildings with straw yards in farms of more than 100 cows,
  – including with AMS and little grazing,
  – with very frequent cleaning to better control the hygiene ...

(Photo : L. Dubreuil, GDS61)
The problem: rehabilitating free resting areas in big herds (2)

- If no straw available: experience with sawdust
  - Initial filter bedding and adding sawdust twice a week (3 à 5 kg/cow/day),
  - Manual maintenance (no mechanical mixing), once or twice a day

**Under floor filter**
- Wood shredded 3/5 cm
- chips 0,5 à 1,5 cm
- « chopped »

**+ Sawdust**
(Stored under shelter)

- Why not composted bedding areas? Some 1st experiences but no studies in France …

Lille - 22 au 24 février 2017
Bâtiments d’Elevage de demain : construire l’avenir
Location of some composted bedding areas for dairy cows (including projects)

5 regions involved in EuroDairy

- Development of compost beddings
  - 6 in practice
  - 9 projects (some farmers visited the Netherlands)

Location of some composted bedding areas for dairy cows (including projects): Lille - 22 au 24 février 2017

Bâtiments d'Elevage de demain : construire l'avenir
## Presentation of 4 farms with stirred compost beddings areas in France

<table>
<thead>
<tr>
<th></th>
<th>Farm 1</th>
<th>Farm 2</th>
<th>Farm 3</th>
<th>Farm 4</th>
</tr>
</thead>
<tbody>
<tr>
<td># of dairy cows/breed</td>
<td>200 P’Holst</td>
<td>140 P’Holst</td>
<td>130 Norm</td>
<td>200 P’Holst</td>
</tr>
<tr>
<td>Grazing</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Start</td>
<td>2014</td>
<td>2013</td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>Type of building</td>
<td>new</td>
<td>new</td>
<td>new</td>
<td>existing</td>
</tr>
<tr>
<td>Previous building</td>
<td>? (Merger of 2 herds)</td>
<td>Cubicles slurry</td>
<td>Straw yard</td>
<td>Straw yard</td>
</tr>
<tr>
<td>Feeding area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Floor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• width</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• maintenance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Slatted floor</td>
<td>Concrete groove</td>
<td>Concrete groove</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4,5 m</td>
<td>4,5 m</td>
<td>6,5 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>flushing</td>
<td>flushing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Farm 1</td>
<td>Farm 2</td>
<td>Farm 3</td>
<td>Farm 4</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>Surface per cow</strong></td>
<td>25 sqm</td>
<td>8.5 sqm</td>
<td>7 sqm</td>
<td></td>
</tr>
<tr>
<td><strong>Floor under bedding</strong></td>
<td>clay</td>
<td>sand</td>
<td>clay</td>
<td></td>
</tr>
<tr>
<td><strong>Used materials</strong></td>
<td>Vegetable compost</td>
<td>Sawdust</td>
<td>Miscanthus</td>
<td></td>
</tr>
<tr>
<td><strong>Material depth at start-up</strong></td>
<td>5 cm</td>
<td>10 cm</td>
<td>7 cm</td>
<td></td>
</tr>
<tr>
<td><strong>Bedding renewing</strong></td>
<td>NO</td>
<td>Dolomite (1x/yr)</td>
<td>1 x/wk.</td>
<td>NO</td>
</tr>
<tr>
<td><strong>Mixing frequency</strong></td>
<td>1 x/wk harrow</td>
<td>1 x/day harrow</td>
<td>2 x/yr (winter) cultivator</td>
<td>1 x/day harrow</td>
</tr>
<tr>
<td><strong>Stirring equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Compost clean out</strong></td>
<td>Once a year</td>
<td></td>
<td>3 monthly</td>
<td>3 monthly</td>
</tr>
<tr>
<td><strong>Particularities</strong></td>
<td>Horizontal ventilation, Solar panels roof</td>
<td>Straw if sawdust not available</td>
<td>Barriers, exercise area without roof</td>
<td></td>
</tr>
</tbody>
</table>
Farm 1 : 25 sqm/cow and vegetable compost

- Roof with one slope oriented south (solar panels) and shed to the north

- Composted area ventilated with removable wind break and fans

- Feeding area with water troughs and access to milking robots
First impressions farms 1 and 2

- Same concept inspired by Israel experiences,
- In summary: A large area (25 sqm per cow) with litter made from vegetable compost in very small quantities and a maintenance (mixing) as limited as possible, long accumulation, with horizontal ventilation...
- But difficulties in hygiene management and cleanliness of animals may appear during the winter and humid periods
- Necessary to optimize these conditions:
  - On the nature, quantity and mode of maintenance of these bedding areas
  - With these adaptations, interest to have such an important surface?
Farm 3 : 8,5 sqm / cow with sawdust
(pictures A. BRUEL, CA72)

- Roof with two slopes, open side south/east.
- Area composted (width 11 m) with sawdust but problems with availability and costs: currently traditional straw yard
- Feed area with grooved concrete and flushing 2 x/day
First impressions farm 3

- Same design as building with traditional straw yard
- Earlier experience with straw yard
- Use of sawdust with daily mixing during 2 years:
  - Very positive appreciated by farmers compared to straw yards
  - Good health and milk quality results
  - Less daily work and less frequently cleaning (3 months) = storage in the field (authorization if more than 2 months under the animals)
  - Simplified management during summer: less sawdust, mixing 1 x/day
- Change of bedding materials depending on availability and costs: currently sawdust too expensive… so return to straw yard.
Farm 4: 7 sqm/cow with crushed miscanthus

*pictures G. CAILLER, CA44*

- Composted area (width 10 m), single sided east oriented + uncovered feeding area with flushing + covered feed through
- Push-on barrier to direct cows from bedding area to feeding area
- Daily maintenance with rotary harrow (10 min/day)
First impressions farm 4

• Identical design to a building with traditional straw yard
• Previous experiences of farms with a straw yard
• Choice of litter material after several trials
  – Straw: 8 kg/cow/day with external purchase (high cost), variable quality, working time 1 h/day, expensive monthly cleaning out (and disturbing for animals)
  – Dusty woodchips: large volume, high cost 120 € / tonne
  – Fine sawdust: muddy bedding, large volumes to be stored
  – Buy chopped straw of Miscanthus (http://www.novabiom.com/en/) to 90 €/tonne, an initial intake, regular quality, 10 minutes of maintenance per day, clean-out 3 times a year (3 months in winter). Appreciated by farmers.
• To optimize? Bedding renewing in order to maintain the good cleanliness before clean-out..
Some possible recommendations for future projects?

1. Control of microbiological contamination of litter surface: litter temperature measurement as an indicator?

2. With standard surface bedding areas (farms 3 and 4): which material to choose?

3. Which management to propose in this situation?
Control of microbiological contamination of litter surface: a major challenge

• Work on the maintenance and management of the temperature of the straw yards (Ménard et al., 2002) and their contamination (Ménard et al., 2004)

• Objectives:
  – to appreciate one of the factors of controllable bacterial development
    • To avoid mesophilic bacteria (streptococci, E. coli):
      Optimum temperature = 37 to 40 °C
    • To promote microbial competition with psychrophilic bacteria (optimum = 10 to 25 °C, max= 30 °C)
  – Optimize litter maintenance,
  – Propose rules of interpretation of the temperature to objectify the quality of bedding and a date to clean-out
Why litter temperature measurement at 10 cm depth? (Ménard et al., 2002)

- Compared to litter surface: less correlated to outside temperature = possible measurements at any time of the day

<table>
<thead>
<tr>
<th>Depth of measurement (n=612)</th>
<th>Surface</th>
<th>Some cm</th>
<th>10 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation with outside temperature</td>
<td>$R^2 = 0.38$</td>
<td>$R^2 = 0.30$</td>
<td>$R^2 = 0.21$</td>
</tr>
</tbody>
</table>

- More repeatable and reproducible with a probe of 10 cm implanted vertically in litter
- Less influenced by the time of litter maintenance or cow sleeping
- Strong correlation between temperatures in the 1$^{st}$ cm and at 10 cm depth ($R^2 = 0.91$)
Protocol to measure litter temperature and interpretation (Ménard et al., 2002)

- **Location of measurements:**
  - Every 5 to 10 m, 3 measurements (edge, middle, bottom of the resting area), at least 4 sets per resting area

- **Interpretation of mean results for straw areas**
  - **Objective:** <25 °C in surface area equivalent to <36 °C at 10 cm depth
    - Beyond: vigilance, adaptation of maintenance practices ... before clean-out
  - **Maximum:** <30 °C in surface area equivalent to <40 °C at 10 cm depth
    - Beyond: clean-out to be carried out as quickly as possible

- **Interpretation of temperature differences between zones:**
  - Factors involved: distribution of animals, homogeneity of straw...

- **Use of this indicator for composted areas?**
Definition of a "good" litter material for mixed and composted areas

• With bedding areas of common design and size and where the objective is to replace the straw (farms 3 and 4)
• Important criteria:
  – Health: uncontaminated, not moldy ...
  – Of vegetable origin (limitation of sanitary risks)
  – Dry and absorbent ...
  – Few or not fermentable to avoid excess temperature
  – Not aggressive for animals and especially the udder (teats)
  – Ensuring good lift of the animals during accumulation
  – Easy to apply (initial supply and additions) and to be resumed during the clean-out
  – And ... can be mixed easily with a simple material
Absorbing capacity* litter materials
(Arvalis – Institut du végétal, 2012)

* Litre / kg material

Litter vegetable can be mixed

Reference straw bedding

<table>
<thead>
<tr>
<th>Material</th>
<th>Litre/kg material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ouate de Cellulose</td>
<td>9.00</td>
</tr>
<tr>
<td>Paille de triticale (Chênevotte)</td>
<td>7.50</td>
</tr>
<tr>
<td>Chênevotte</td>
<td>7.50</td>
</tr>
<tr>
<td>Fraction solide du Lisier</td>
<td>7.50</td>
</tr>
<tr>
<td>Feuille mortes (séchées)</td>
<td>7.00</td>
</tr>
<tr>
<td>Paille de Pois</td>
<td>7.00</td>
</tr>
<tr>
<td>Paille d’Orge</td>
<td>7.00</td>
</tr>
<tr>
<td>Paille de Colza</td>
<td>7.00</td>
</tr>
<tr>
<td>Anas de Lin</td>
<td>7.00</td>
</tr>
<tr>
<td>Sciere de bois (scierie)</td>
<td>7.00</td>
</tr>
<tr>
<td>Miscanthus ensilé (3cm)</td>
<td>6.50</td>
</tr>
<tr>
<td>Plaquettes de Peuplier</td>
<td>6.50</td>
</tr>
<tr>
<td>Plaquettes de Sapin</td>
<td>6.50</td>
</tr>
<tr>
<td>Paille de Blé Broyée (15 mm)</td>
<td>6.00</td>
</tr>
<tr>
<td>Poudre de Chanvre</td>
<td>6.00</td>
</tr>
<tr>
<td>Bouchon de Paille de Blé</td>
<td>6.00</td>
</tr>
<tr>
<td>Pellets de Miscanthus</td>
<td>5.50</td>
</tr>
<tr>
<td>Paille de Blé Défibrée</td>
<td>5.50</td>
</tr>
<tr>
<td>Pellets de Switchgrass</td>
<td>5.50</td>
</tr>
<tr>
<td>Paille de Blé Non Défibrée</td>
<td>5.50</td>
</tr>
<tr>
<td>Menue-Paille de Blé</td>
<td>5.00</td>
</tr>
<tr>
<td>Cannes de Maïs</td>
<td>5.00</td>
</tr>
<tr>
<td>Menue-Paille de Colza</td>
<td>5.00</td>
</tr>
<tr>
<td>Paille de Chanvre</td>
<td>5.00</td>
</tr>
<tr>
<td>Papier Déchiqueté</td>
<td>5.00</td>
</tr>
<tr>
<td>Menue-Paille d’Orge</td>
<td>5.00</td>
</tr>
<tr>
<td>Plaquettes de Cyprès</td>
<td>4.50</td>
</tr>
<tr>
<td>Plaquettes de Bouleau</td>
<td>4.50</td>
</tr>
<tr>
<td>Plaquettes d’Aulne</td>
<td>4.50</td>
</tr>
<tr>
<td>Plaquettes de Bois (scierie)</td>
<td>4.50</td>
</tr>
</tbody>
</table>

*(l/kg de matériau)
Proposals for recommendations: design and management of composted areas

- A conventional sizing (7 to 8 sqm / cow with large sizes) with natural ventilation is possible (as in farm 3) if:
  - Adequate litter intake and regular additions (2 to 4 weeks depending on the season)
  - Daily mixing (1 to 2 times per day over critical periods) at shallow depth (limitation of temperature increases)
  - A clean-out programmed according to the temperature evolution of litter (objective 3 months in winter due to the experience of farmers)

- In large herds
  - Batch management with differentiated housing modes and at least one lot with composted free area (most sensitive animals ...?)
  - Installation of removable barriers for a more efficient grouping of animals towards the feeding area (farm 4) for milking or other ...
The adaptation of conventional free areas by replacing the straw with materials that can be mixed is possible, simple and at "reasonable" costs.

The experience of large bedding areas and with little litter material with annual clean-out should be optimized.

The objective of proposing composted areas with accumulation over a year requires more complex adaptations as proposed in some countries: some French farmers think about it ... but at what costs?

Important work remains to be done to study these compost mixed areas in a transversal way and to develop them in an optimized way with the farmers.
References

Presentation Marc Havermans

The transcription of the prezzi presentation:

Loose housing 2010 – 2017

Our dairy “Klaverhof”
- 285 cows
- 175 young stock
- 185 hectare land (all grass)
- Milk production 2016
  - 8,500 kg milk
  - 4.44% fat
  - 3.57% protein

Green house construction
- Low cost
- Flexible building style
- Short building time
- Plastic floor
- 20 cm sand
- 5-75 cm compost
- 600 m2 with ventilation
- Wood chips
- 2 year experience
- Blowing or sucking air?
- Our conclusion

Feed systems
- Feed alley (concrete floor)
  15 m2/cow lying area
- Feed wagon
  30 m2/cow total compost

Current situation with straw
- Temperature 25-35 degrees
- 30-35% dry matter
- Cultivate every day
- New straw every day in wintertime
- Clean out once in August (50% dm)

Questions?
Compost barns for dairy cows: Austrian case studies and research

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Situation in Austria

Approximately 12-15 farms, first farm in 2009

- Study performed by Raumberg-Gumpenstein in 2011-2013
- 7 compost barns with detailed analysis on management practices, animal behaviour and welfare (Ofner-Schröck et al, 2015)
- Small sized farms: 15 to 62 cows (Fleckvieh breed)
- Comparison on certain aspects with other housing systems (free stall – cubicles) – data originating from other Austrian studies
Austrian building examples 1
Austrian building examples 1

- Outdoor exit
- Feed alley
- Feed alley - cows
- Compost bedding
- Outdoor exit
Austrian building examples 1
Austrian building examples 2

Feed alley

Feed alley - cows

Compost bedding

Compost bedding – dry cows / pregnant heifers
Specific building design
Concrete flooring with air flow underneath
- Dryer bedding specific in (more) humid climate areas
Litter – bedding applied
High availability of forest industry material
◆ Detailed data on 5 of the 7 farms studied

<table>
<thead>
<tr>
<th></th>
<th>Farm 1</th>
<th>Farm 2</th>
<th>Farm 3</th>
<th>Farm 4</th>
<th>Farm 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>New</td>
<td>Renovation</td>
<td>Renovation</td>
<td>New</td>
<td>New</td>
</tr>
<tr>
<td>Previous</td>
<td>Straw yard</td>
<td>Tie stall</td>
<td>Tie stall</td>
<td>Tie stall</td>
<td>Cubicles</td>
</tr>
<tr>
<td>Bedding material</td>
<td>Sawdust, diff. Rest material wood industry</td>
<td>Sawdust</td>
<td>Sawdust</td>
<td>Sawdust / wood chips</td>
<td>Wood chips</td>
</tr>
<tr>
<td>Wood type</td>
<td>Various</td>
<td>Various</td>
<td>Spruce (epicea), poplar (peuplier)</td>
<td>Spruce, various</td>
<td>Spruce</td>
</tr>
</tbody>
</table>
Litter – bedding applied

Quantities applied and interval between applications

- Depending on size of the farms
- Different practices

<table>
<thead>
<tr>
<th>Farm</th>
<th>Farm size (cows)</th>
<th>m2 / cow</th>
<th>Interval (days)</th>
<th>Quantity (m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm 1</td>
<td>30</td>
<td>6</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>Farm 2</td>
<td>24</td>
<td>6,3</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Farm 3</td>
<td>35</td>
<td>9,1</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Farm 4</td>
<td>15</td>
<td>16,2</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Farm 5</td>
<td>62</td>
<td>8</td>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>Farm 6</td>
<td>27</td>
<td>16,1</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Farm 7</td>
<td>20</td>
<td>7</td>
<td>14</td>
<td>20</td>
</tr>
</tbody>
</table>
Management of the bedding

Different tools used for shredding / mixing

6 farms

1 farm

Shredding / mixing ➔ twice per day – 10 to 15 minutes (Austrian survey)
Litter – bedding applied

Bedding practices for the 7 farms – bleu = start level; red = end level (when mocking out)

Mocking out: most of the time twice per year ➔ 6-8h each time with 2-3 persons
# Litter – bedding applied

Cost price for 7 farms (data from 2013)

<table>
<thead>
<tr>
<th>Farm</th>
<th>Litter</th>
<th>Wood type</th>
<th>Costs</th>
<th>Distance to wood mill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm 1</td>
<td>Sawdust, diff. rest material wood industry</td>
<td>Various</td>
<td>5 to 13€/m³</td>
<td>3 to 12 km</td>
</tr>
<tr>
<td>Farm 2</td>
<td>Sawdust</td>
<td>Various</td>
<td>10€/m³</td>
<td>10 km</td>
</tr>
<tr>
<td>Farm 3</td>
<td>Sawdust</td>
<td>Spruce (epicea), poplar (peuplier)</td>
<td>9€/m³</td>
<td>5 to 20 km</td>
</tr>
<tr>
<td>Farm 4</td>
<td>Sawdust / wood chips</td>
<td>Spruce, various</td>
<td>10 to 12€/m³</td>
<td>10 to 15 km</td>
</tr>
<tr>
<td>Farm 5</td>
<td>Wood chips</td>
<td>Spruce</td>
<td>14.5€/m³</td>
<td>12 km</td>
</tr>
<tr>
<td>Farm 6</td>
<td>Wood chips + Miscanthus</td>
<td>Spruce, Miscanthus</td>
<td>7€/m³</td>
<td>2 km</td>
</tr>
<tr>
<td>Farm 7</td>
<td>Wood chips + Miscanthus</td>
<td>Spruce, Miscanthus</td>
<td>7 to 8€/m³</td>
<td>4 km</td>
</tr>
</tbody>
</table>
Litter – bedding applied
Temperature of bedding at 10, 20, 30 cm at the 5 farms
### Characteristics of different substrates

Analyses based on different Austrian results

<table>
<thead>
<tr>
<th>Wirtschaftsdüngerform</th>
<th>TM</th>
<th>Nges.</th>
<th>Ca</th>
<th>K</th>
<th>Ca:K</th>
<th>pH-Wert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gülle (unverdünnt berechnet)</td>
<td>100</td>
<td>4,5</td>
<td>2,1</td>
<td>5,4</td>
<td>2,6</td>
<td>7,4</td>
</tr>
<tr>
<td>Stallmist</td>
<td>191</td>
<td>5,4</td>
<td>3,2</td>
<td>4,8</td>
<td>1,5</td>
<td>7,9</td>
</tr>
<tr>
<td>Rottemist</td>
<td>199</td>
<td>5,7</td>
<td>4,9</td>
<td>5,7</td>
<td>1,2</td>
<td>8,1</td>
</tr>
<tr>
<td>Stallmistkompost (Dreiecksamte)</td>
<td>324</td>
<td>7,8</td>
<td>8,0</td>
<td>9,3</td>
<td>1,2</td>
<td>8,1</td>
</tr>
<tr>
<td>Kompoststall-Substrat (6 Monate und älter)</td>
<td>367</td>
<td>5,4</td>
<td>8,4</td>
<td>7,8</td>
<td>0,9</td>
<td>8,1</td>
</tr>
<tr>
<td>Kompoststall-Substrat (0-4 Monate im Stall)</td>
<td>314</td>
<td>3,6</td>
<td>2,8</td>
<td>5,9</td>
<td>2,1</td>
<td>7,7</td>
</tr>
</tbody>
</table>

*Quellen: Schachtner et al. (1991), Pollinger et al. (2003), eigene Analysen (2012)*
Animal behaviour & welfare
Cleanliness

Cleanliness – dirtiness of different body parts (score 0 – 2)
**Cleanliness**

Observations in 5 Austrian farms – different body areas (Ofner-Schröck et al., 2015) – 135 cows

<table>
<thead>
<tr>
<th>Farm</th>
<th>Number of animals</th>
<th>Base of tail</th>
<th>Rear of udder</th>
<th>Lower leg</th>
<th>Side of udder</th>
<th>Upper leg</th>
<th>Mean value for all zones</th>
<th>Total for zones (index)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27</td>
<td>0.70</td>
<td>0.26</td>
<td>1.26</td>
<td>0.26</td>
<td>0.81</td>
<td>0.66</td>
<td>3.29</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>0.72</td>
<td>0.41</td>
<td>1.04</td>
<td>0.30</td>
<td>0.37</td>
<td>0.57</td>
<td>2.84</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
<td>0.50</td>
<td>0.25</td>
<td>0.56</td>
<td>0.14</td>
<td>0.14</td>
<td>0.32</td>
<td>1.59</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>0.21</td>
<td>0.16</td>
<td>0.26</td>
<td>0.08</td>
<td>0.21</td>
<td>0.18</td>
<td>0.92</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>0.51</td>
<td>0.29</td>
<td>0.79</td>
<td>0.19</td>
<td>0.41</td>
<td>0.44</td>
<td>2.19</td>
</tr>
<tr>
<td>Mean value for all cows</td>
<td>n = 135</td>
<td>0.54</td>
<td>0.28</td>
<td>0.80</td>
<td>0.19</td>
<td>0.39</td>
<td>0.44</td>
<td>2.17</td>
</tr>
</tbody>
</table>
Cleanliness
Comparaisons between farm systems (Ofner-Schröck et al., 2015)
Lying – resting behaviour
Observations in 5 Austrian farms – morning – afternoon (Ofner-Schröck et al., 2015)

Figure 1. Proportion of cows lying in different areas of the lying area—edge, centre, and others.
Hock – integument lesions
Hair loss and injuries found on carpal and hock joints
Hock – integument lesions

Hair loss and injuries found on carpal and hock joints
Hock – integument lesions

Hair loss and injuries found on carpal and hock joints
Hock – integument lesions

Comparaisons between farm systems (Ofner-Schröck et al., 2015)

Figure 3. Animals with alterations to the joints in different housing systems (comparative values on compost barn from [15] [18] [19]).
Lameness
Overall rating generally on a scale from 1 to 5 (Sprecher et al., 1998)
Lameness
Comparaisons between compost barns and cubicle housing (Ofner-Schröck et al., 2015)

Figure 4. Degree of lameness in all of the cows (n = 138) on the farms with compost barns investigated compared to the degree of lameness in all of the cows (n = 175) in the farms with cubicle housing systems investigated according to Ofner-Schröck et al. [20].
Conclusions
Overall conclusions

Farm situation in Austria (studies 2011-2013)
- Relatively small herds
- Proximity of forest and wood industry is important
- Differences in management practices
- Overall farmers’ satisfaction

Behaviour and welfare studies
- Positive impact on joint lesions, lameness
- No clear negative impact on cleanliness