

Learning from drivers and conflicts around bedded pack barns

Galama P.J.¹, Dooren van H.J.C.¹, Eilers C.H.A.M.²

¹ Wageningen UR Livestock Research, P.O. Box 65, NL-8200 AB Lelystad, the Netherlands, paul.galama@wur.nl, ²Animal Production Systems Group, Department of Animal Sciences, Wageningen University.

Key-words: alternative housing dairy, sustainable, animal welfare, environment, innovation process

Abstract

Due to problems with the freestall a network of dairy farmers in the Netherlands started looking for alternative housing systems for dairy cattle. Therefore researchers and dairy farmers shared ideas and looked abroad in America and Israel for housing systems without cubicles. This gave inspiration for deep bedded pack systems like in these countries. The drivers (motivations) for these housing systems were animal welfare and manure quality. However, they had to be made suitable for the Dutch climate. Therefore calculations and experiments were done on experimental and commercial farms to keep the bedding dry and see if these drivers create conflicts. During these experiments and discussions with experts conflicts appeared like 1) more space per cow versus more ammonia emission and risk of nitrous oxide emission and 2) using waste materials as bedding versus increased food safety risks and 3) larger buildings versus landscape quality. From international contacts, experiences and experiments on experimental and commercial farms and discussions with suppliers of dairy housing, building aesthetics committees, architects, composting experts and policymakers we learned and get ideas about better management of the bedding and farm designs. However, we are only at the start of the development and implementation of bedded pack barns. Our experiences bring answers but at the same time raise new questions, especially about emissions. This is an ongoing learning cycle, which is described by the DEED model. DEED stands for 4 learning phases; 'Describe', 'Explain', 'Explore' and 'Design' and describes the learning cycle, the factors involved and the negotiation that is part of all phases. The network of dairy farmers involved in the learning cycle is very dynamic, about 100 farmers have participated in discussions. A small group of three farms is monitored and evaluated on sustainability aspects. Those farmers, researchers and experts are involved in workshops and expert meetings to discuss the drivers and conflicts and to find solutions. This learning process results in adapted management of the bedding and new designs. For a good learning process and a major impact it is important to have the right mixture of experiences on commercial and experimental farms together with lab experiments and studies. And it is also important to discuss the conflicts together with experts in an open innovation process.

Introduction

Free stall barns for dairy cattle have been widely used for more than 40 years, and is still the most commonly used housing system in the Netherlands. This system was developed in the 1960s, mainly to improve labour efficiency. Today the emphasis has shifted towards animal welfare. Main animal welfare and health problems relate to the need for more space per cow and softer walking surfaces (less concrete) and less steelwork in the barns (Somers et al., 2003; Haskell et al., 2006; Burow et al., 2011). The demands of the cow, the farmer, the environment and consumers have become more important. If we translate these demands into the current free stall barn system, the costs of these systems might increase. Question is, whether it is possible to develop a different housing system that meets especially the new demands of animal welfare, emissions in stable and manure application and risks of contaminants.

Since 2007, a network of dairy farmers started searching for alternatives to the free stall barn that can strongly improve animal welfare, reduce environmental impact, increase manure quality and be cost-effective. This search for alternatives was necessary for several reasons. First, the free stall does not meet present and future demands on animal welfare (Bos et al., 2009). Second, more dairy cattle are kept in a zero-grazing system (CBS, 2010), therefore the welfare of animals kept indoor year round is becoming more and more important. Third, more dairy farmers do not own enough land to apply their cattle manure on their own land, thus the manure has to be exported from their farm. Dairy slurry of free stalls contains a lot of water and farmers have to pay a lot to export their manure. For this export reason and to increase the soil fertility on dairy and arable farms the farmers of the network like manure with more organic matter, such as compost .

This search for other housing systems and other type of manure was supported by the Ministry of Economic Affairs, Agriculture and Innovation with subsidies for the farmers network, in which farmers look for new options in cooperation with scientists and experts (composting experts, architects, barn suppliers) to develop their farm sustainably (Wielinga et al., 2008 and 2010). Researchers were facilitating the process within this farmers network.

The network started with the idea of developing a bedded pack barn, which has no cubicles and the resting and exercise areas are combined. This area is also manure storage together with the bedding material. This combined resting and exercise area is spacious and provides a soft, permeable and/or moisture-absorbing bedded pack (Galama et al, 2008 and 2011). Following the ideas of the farmers network in 2007 and 2008 an innovative process with experiments and studies around bedded pack barns started and is still going on. The participative innovative process with researchers and farmers started at the end of 2008 following the DEED method.

Objective

This paper presents the motivation (drivers) and conflicts that arise during the participative innovative process around bedded pack barns.

Research questions were:

What did we learn from this participative innovative process around bedded pack barns?

- What drivers (motivations) were found?
- What conflicts arose?
- Did the DEED method (Giller et al., 2008) and the network approach help to solve conflicts?

Reflection on participative innovative process

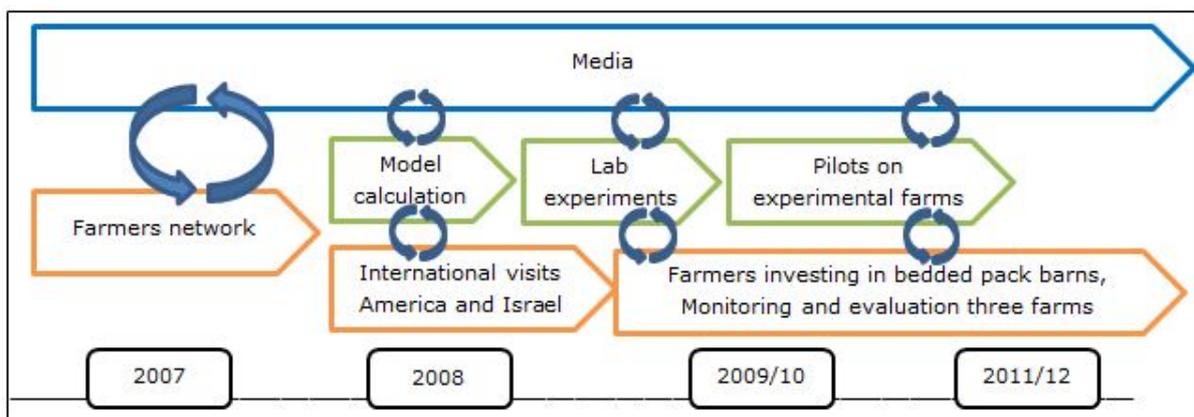


Figure 1. Participative innovative process around the bedded pack barns from 2007 till now. The arrows represent the open communication among interested farmers, stakeholders and scientists that are represented in the network and the media.

The innovative process started in 2007 with a farmers network (Figure 1) who got inspired by international visits to the US (Proceedings, congress June 2007, Minnesota) and Israel. In 2008, the network of farmers put bedded pack barns on the research agenda of the Dutch Dairy Board and the Ministry of Economic Affairs, Agriculture and Innovation. As a result, several studies and experiments related to the new housing system were started. The learning process with farmers, stakeholders and scientists (DEED) about the bedded pack barns started and is still continuing. In this paragraph the network approach and two rounds of the learning process DEED around bedded pack barns are described.

From network approach towards innovation process

The farmers network created new ideas for alternative dairy housing systems and did put the bedded pack barns on the research agenda. The promising bedded pack barns inspired a large group of farmers to think and discuss the pros and cons of the new barn and to implement it. At this moment (2012) about 15 farms have built a bedded pack barn and hundreds in the Netherlands and other countries are interested. This despite the fact that not all problems are solved yet, especially problems related to emissions of ammonia and greenhouse gasses in the new barn and food security.

DEED

To describe this learning process we used the DEED model. DEED stands for 'describe', 'explain', 'explore' and 'design' and describes the learning cycle and the factors involved (Giller et al., 2008) (Figure 2)

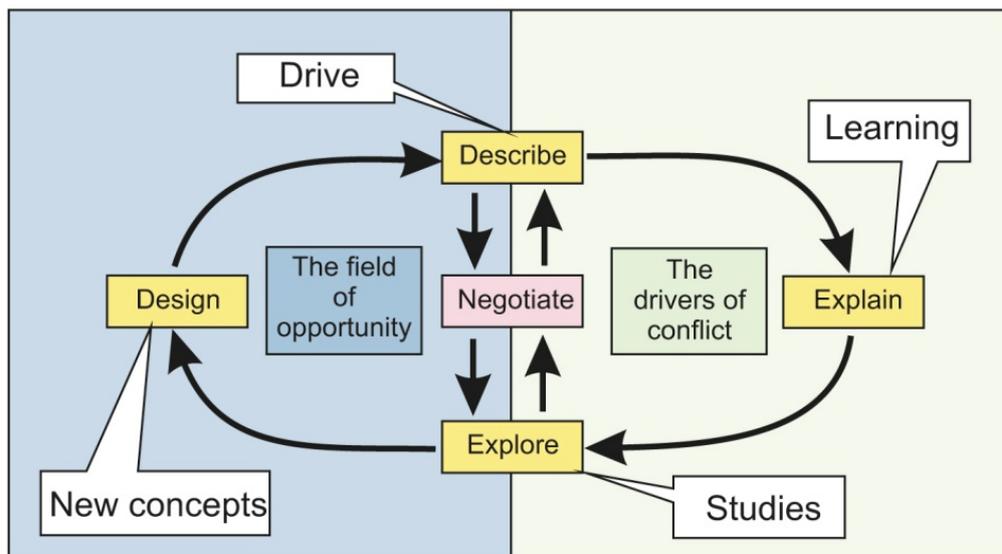


Figure 2. Iterative cycle of learning process with farming participants (DEED method, applied by Giller et al., 2008)

First round of learning process

Drive (motivation)

DEED starts with a description of the motivations (drivers) of farmers. At meetings with dairy farmers who consider acquiring a bedded pack barn, their main motives for alternative dairy cattle housing include:

- Better animal welfare
- Healthier cattle with a longer life expectancy
- Better manure with little odour emission and better soil fertility

- Smaller manure volume

Bedded pack barns could form an opportunity to improve many issues in dairy farming. The challenge is to combine more space for the animals with lower emissions and at the same time a reduced cost price (or at least a stabilised cost price). More space on a softer bedded pack can result in less claw problems and a more natural behaviour. We may think of various types of bedding material, such as sand, compost, wood chips, sawdust, dry manure or soil (clay or peat). The bedding material, when soiled with faeces from the cows, produces a fertiliser with a high organic matter to improve soil fertility. Other countries have gained experiences with various types of organic bedded packs. It remains to be seen what can be achieved under Dutch climatic conditions.

Describe

The Ministry has concerns about emissions of ammonia and greenhouse gasses from bedded pack barns. The Dairy Industry is more concerned about food safety risks (contaminants) and risks for animal diseases, especially when the bedding is not dry and not hygienic. A crucial component of the bedded pack barn, therefore, is the pack material and its management. The principles of the packs are different, all having the objective of keeping the top layer dry and reducing the emission of ammonia (Dooren et al., 2009, 2010 and 2011):

- Sand pack to drain moisture and separate faeces and urine.
- Composting bedded pack to evaporate moisture by heat development in the pack and fixate the nitrogen.
- Compost bedded pack and bedded pack of dried clay or peat with reed to absorb moisture by large amounts of dry material and fixate of nitrogen.

Learn and explain

In 2008, the Dutch Dairy Board financed a pilot study on the prospects of bedded pack barns in the Netherlands. There were many questions from the farming practice whether the bedded pack barn, as developed in America (Minnesota) and Israel, is feasible under Dutch conditions, as moisture evaporation is crucial. Every day a dairy cow produces around 65 liter of moisture in her urine and faeces. How much of this will evaporate in the Dutch climate? To find an answer to this question a moisture balance was calculated for the climate in these three countries. In addition, the bedding materials used in these three countries are quite different. These differences in material also has consequences for the environmental impact of these packs. In Israel and America the environmental impact has remained underexposed so far. For that reason, laboratory experiments were done to make a tentative estimate (Smits et al, 2009). The evaporation study (Smits et al., 2009) has demonstrated that the moist Dutch climate requires additional measures to keep the top layer of organic bedded packs dry.

Explore and make new design

Inspired by experiences in the US about additional measures to keep the top layer dry the idea was explored on the Wiersma farm to use a pack material that is cheaper than sawdust combined with an aeration system to stimulate the composting process (blowing air through pipes under the pack). Experts have been called in to design a good aeration system. The experiences since December 2009 are such that aeration for one hour per day has a favourable effect on the composting process. Over the time, however, the bedded pack of coarse wood chips will change into a fine material with a smaller volume that is becoming more and more difficult to aerate and consequently to keep dry. The effects of the aerated composting process on the ammonia emission, the temperature in the pack and the manure composition are measured and evaluated (*explain*). Based on experiences gained with aeration, space per cow and changes in the bedding material over time, the system will be altered (*explore*).

Second round of learning process

Describe: Composting bedded packs

From 2010 until 2012 more farmers became interested in composting and compost bedded pack barns, however, the decrease of ammonia emission remained a concern (Dooren et al., 2011). The Waiboerhoeve experimental farm has been composting wood chips and sawdust without aeration. The same bedding was used on Compost Dairy Barns in the US (Minnesota). One of the Dutch farms, the Wiersma farm, has changed the American system by composting wood chips with an aeration system (pipes that blow air). On these and other farms we try to grasp the composting process (Figure 3).

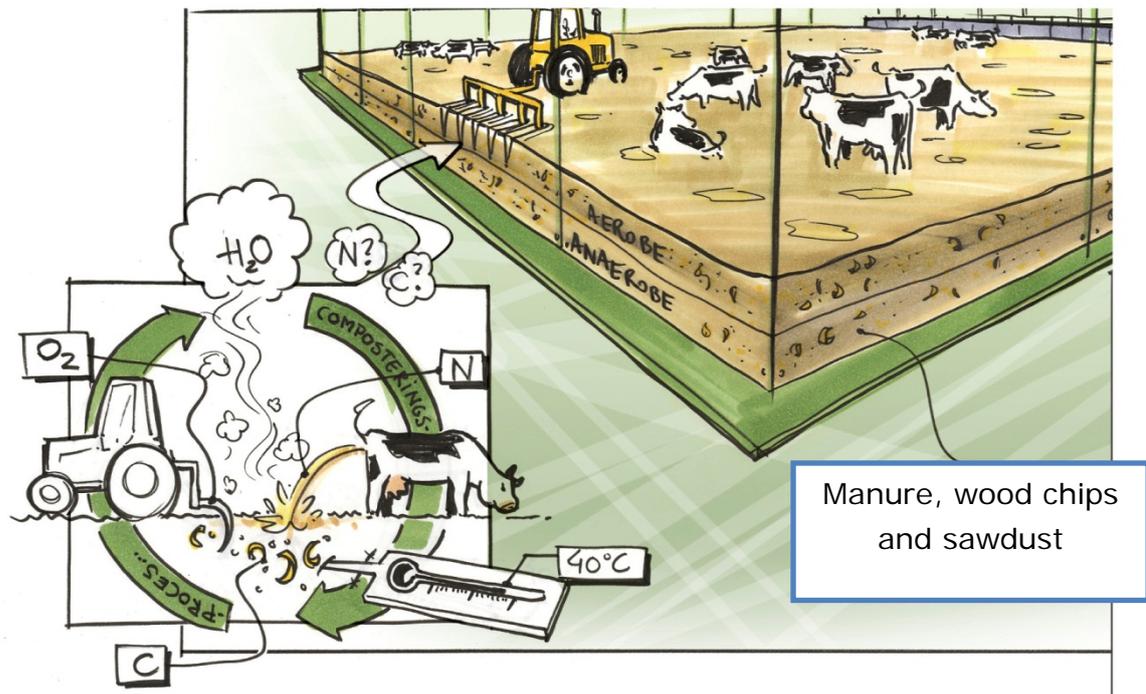


Figure 3. Composting process on a bedded pack barn in which the C/N proportion (bedding material (C) and cows per m² (N)) and the composting process is controlled by cultivation (O₂).

Explain

We have learned so far that a pack thickness of at least 50 cm is required otherwise heat will disappear from the pack. The adequate C:N ratio has to be >30:1; which can be achieved by adding feed rests. Aeration to add sufficient oxygen to stimulate the composting process can be achieved by cultivation and pushing air through pipes under the bedding. If you ventilate too much the pack will cool down and the composting process will slow down. Pushing too much air through the pack may also increase ammonia emission. The aspects to negotiate between in a composting bedding is that a soft airy bedded pack ensures proper absorption of urine, thereby reducing the chance of ammonia emission, however the soft bedding makes it more difficult for the cow to walk on the bedded pack.

Explore

The bedded pack barn aims at improving the sustainability with regard to various aspects. There is a chance that trade-offs occur among sustainability aspects. The most prominent characteristic of the bedded pack barn is that it offers more space to the animals that means more m² per cow. In combination with up scaling (i.e. more cows per farm), the barns will become much larger, which has a large effect on animal welfare, landscape quality, economics and environment. More space is good for animal welfare, but will result in a larger soiled area and consequently a larger risk of increased

ammonia emissions. The farmers are interested in improved animal welfare and economics. The Ministry, however, is more concerned about emissions from the barn. Building committees are interested in landscape quality. Barns become wider and ridge height reduction requires a different farm design; functionally and aesthetically. Therefore there will be a negotiation between more space per cow for a better animal welfare and the aspects of landscape, environment and economics. The challenge consists of making such a design and management of the bedding that the bedded pack barn will be sustainable with regard to all aspects of dairy farming.

New concepts, design

Smart designs and management of bedded pack barns are called for to prevent trade-offs among sustainability aspects. Aspects to be considered are inexpensive bedding material combined with e.g. organic household wastes or dredged mud from ditches. Several regulators had to be created to manage bedding material quality and solve emission problems; such as m² per cow, type of bedding material, bedding management methods (cultivation, aerating) etc. These new concepts can result in new or adapted designs of the bedded pack barn and next learning cycles can be started.

Discussion

The DEED approach is mainly used in complex processes with many stakeholders. In this case it is used to describe an innovation process with dairy farmers and experts to learn from the studies and experiments and to make new dairy housing designs. The different phases are followed and negotiation is part of each phase. It is an iterative cycle and Figure 1 can be passed again and again. The farmers network have strong drivers to start the innovation process and the learning cycle. Ministry and sector are concerned and raise conflicting issues such as food safety and emissions. Conflicting interests force the network to improve and come with new and innovative ideas to solve the problems at hand. In other words, the DEED approach can be used very well within innovative processes.

The network approach helped a lot to inspire a group of farmers to search for alternative housing systems. The discussions in the farmers network about problems with the current free stalls and ideas, especially from US and Israel, occurred in an open innovation process. Inspiration from abroad was widely disseminated through the press. This inspired also other farmers. Some of them started to experiment on their farm and many of them visited seminars. In these seminars results of on-farm experiments and work on experimental farms were shown. This very open innovation process had a major impact on farmers who thought about new housing systems. The interaction with these farmers and experts accelerated the innovation process and enlarged the impact. For example, farmers are experimenting with different type of bedding material, active aerating systems and cultivating systems of the bedding. Different expertise is required to discover the best practice. Knowledge about composting process in relation to emissions of ammonia and green house gasses, knowledge about contaminants of different material and practical knowledge about how to keep the cows clean are necessary. Also knowledge of architects is important to incorporate the needs of more space per cow, more ventilation and a cheap roof in a new farm design that fits into the landscape. In the second round of the learning process we learned that aerating the bedding helps a lot to manage the composting process and keep the cows clean with less space per cow, but too much aerating increases the risks of emission of ammonia. An architect made a new roof design to fit the building better in the landscape.

This mix of the network approach and the open innovation process differs from the Reflexive Interactive Design (RIO) approach (Bos et al. 2008, Grootkoerkamp et al, 2008) This is an approach to combine objectives that appear to be conflicting, in a single coherent design. This RIO approach is more focussing on making a totally integrated sustainable design based on requirements of animals,

farmers, environment and consumers. A platform of stakeholders from Ministries, Animal Protection Organisation, Farmers Association and Feed and Health Organisation were involved, This RIO approach was based on four turnarounds in thinking, namely the cow, nutrients cycle, capital and labour and soil. Four different design are made where these themes are combined on a different way. These designs serve as inspiration for different groups. The learning of this approach is about to prevent trade off between sustainable aspects in the design process. On the other hand the DEED approach on bedded pack barns is an open innovation more based on bottom up experiments, based on solutions to solve problems in free stalls and aimed at learning from these experiments. This open learning process results into a variety of designs and management of bedded pack barns and has a major impact among farmers and in society. The experiments had a character of trial and error both on experimental and commercial farms, which stimulated the learning. In this process much has been learned about the trade off aspects between animal welfare, emissions and food safety.

Conclusions

This paper studied the motivation (drivers) and conflicts that arise during the participative innovative process around bedded pack farms. The main drivers for farmers to switch to bedded pack farms and participate in the process were the promised improved animal welfare with healthier cattle and less manure of better quality with little odour emission. The main drivers for the researchers were to design a totally integrated bedded pack barn with proper management of the bedding. The main drivers for government were to reduce the ammonia and greenhouse gas emissions. The Dairy Industry was especially interested in food quality issues and risks for animal diseases.

The main conflicts that arose were: 1) more space per cow versus more ammonia emission and risk of greenhouse gas emissions and 2) using waste materials as bedding versus increased food safety risks and 3) larger buildings versus landscape quality.

The DEED method and network approach had as advantage that farmers were very involved in the innovation process. Experimenting on commercial farms increases the exposure of the innovative farming systems (as can be seen by about 15 farmers have built a bedded pack barn, about 15 farmers are in process of getting permission and hundreds are interested). The result of this process in relation to these three conflicts in 2012 is that not all the problems are solved. The ammonia and greenhouse gas emissions need another learning cycle. Food safety risks seem not to be a problem, however, they still have to be monitored. New designs for the roof are made and still have to be made to solve landscape quality problems.

Recommendations

For a good learning process and a major impact it is important to have the right mixture of experiences on commercial and experimental farms together with lab experiments and studies. At the same time conflicts that arise during the innovative process should be discussed with stakeholders, such as local and national government, Dairy Industry, experts and architects. When more farmers are involved and they experiment in various ways, the innovation process can be accelerated. In addition experiments on experimental farms gives researchers more opportunity to regulate the management of different beddings, which gives more fundamental insight in the effects on sustainable aspects.

References

Bos, A.P., Cornelissen, J.M.R., Groot Koerkamp, P.W.G, & Mittelmeijer.M. (2009). Kracht van koeien: springplank naar een duurzame veehouderij: hoe dierenwelzijn, milieu en economie elkaar kunnen versterken in de melkveehouderij. Wageningen UR Livestock Research, Lelystad. Available at <http://edepot.wur.nl/51159>.

- Bos, A.P. (2008). Instrumentalization theory and reflexive design in animal husbandry. *Social Epistemology*. 22(1): 29-50.
- Burow, E., T. Rousing, P.T. Thomson en J.T. Sorensen. (2011). Effect of summer grazing on the probability of hock injuries in intensive dairy cow production systems. p54. In: T. Widowski, P. Lawlis en K. Sheppard (eds.). *Proceedings of the 5th International Conference on the Assessment of Animal Welfare at Farm and Group Level*. Wageningen. Nederland. Wageningen Academic Publishers.
- CBS, (2010). Centraal Bureau voor de Statistiek. *Weidegang 2010 per weidegebied*
- Dooren van, H.J.C., P.J. Galama, M.C.J. Smits, W. Ouweltjes, F. Driehuis (NIZO), S. Bokma. (2011). *Bodems voor vrijloopstallen*. Report 411, Wageningen UR Livestock Research, Lelystad (in preparation)
- Dooren van, H.J.C., P.J. Galama. (2009). Internationale verkenning van ervaringen met vrijloopstallen. Report 244, Wageningen UR Livestock Research. Lelystad, 25 pp.
- Dooren van, H.J.C., G. Biewenga, A.G. Evers, P.J. Galama. (2009). Economische aspecten van de vrijloopstal: kosten and baten in vergelijking met een ligboxenstal, Report 238, Wageningen UR Livestock Research, Lelystad, 21 pp.
- Dooren, H.J.C. van, M.C.J. Smits, A.J.A. Aarnink, P.J. Galama. (2010). Feasibility of different bedding materials in loose housing systems for dairy cows, In proceedings of 14th Ramiran international conference, Lisbon, Portugal 12-15 September 2010 pp.: 66-69
- Galama P.J., C. de Vries, H.J.C. van Dooren. (2009). 'Grensverleggend huisvesten van melkvee' (New horizons for dairy cattle housing), *Cowfortable part 3*. Courage, Zoetermeer, 103 pp.
- Galama P.J., Prospects of bedded pack barns, 2011. Book Wageningen UR Livestock Research.
- Giller, K.E., C. Leeuwis, J.A. Andersson, W. Andriessse, A. Brouwer, P. Frost, P. Hebinck, I. Heitkönig, M.K. van Ittersum, N. Koning, R. Ruben, M. Slingerland, H. Udo, T. Veldkamp, C. van de Vijver, M.T. van Wijk, and P. Windmeijer. (2008). Competing claims on natural resources: what role for science?. *Ecology and Society* 13(2): 34.
- Groot Koerkamp, P.W.G., Bos, A.P., (2008). Designing complex and sustainable agricultural production systems: an integrated and reflexive approach for the case of table egg.
- Haskell, M.J., L.J. Rennie, V.A. Howell, M.J. Bell en A.B. Lawrence. (2006). Housing system, milk production, and zero-grazing effects on lameness and leg injury in dairy cows. *Journal of Dairy Science*. Vol. 89. pp 4259-4266.
- Proceedings of the National Compost Dairy Barn Conference, June 21 & 22, 2007. Burnsville, Minnesota (USA)
- Smits, M.C.J., F. Dousma, G.C.C. Kupers, K. Blanken. (2009) Oriënterend laboratoriumonderzoek naar ammoniakemissie uit bodempakketten voor vrijloopstallen. Report 231, Wageningen UR Livestock Research, Lelystad 18 pp.
- Smits, M.C.J., A.J.A. Aarnink. (2009) Verdamping uit ligbodems van vrijloopstallen; oriënterende modelberekeningen. Report 230, Wageningen UR Livestock Research, Lelystad, 18 pp.
- Somers, J.G.C.J., K. Frankena, E.N. Noordhuizen-Stassen en J.H.M. Metz. 2003. Prevalence of claw disorders in Dutch dairy cows exposed to several floor systems. *Journal of Dairy Science*. Vol. 86. pp 2082-2093
- Wielinga, E., Zaalmink, W., Bergevoet, R., Geerling-Eiff, F. Holster, H. Hoogewerf, L. Vrolijk, M. (2010). Networks with free actors. Encouraging sustainable innovations in animal husbandry by using the FAN approach (Free Actors in Networks). Book, Wageningen UR.
- Wielinga, E., Vrolijk, M. (2009). 'Language and Tools for Networkers', *The Journal of Agricultural Education and Extension*, 15: 2, 205 — 217.