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Changes and Breakthroughs in the Making

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Portfolio of promises: Designing and testing a new tool to stimulate transition towards sustainable agriculture

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Abstract

To stimulate innovation towards sustainability, the Multi-Level Perspective and the governance strategies based on it (like Strategic Niche Management and Transition Management), provide a number of useful tools. For the agricultural sectors, however, with its multi-variety of relevant sustainability aspects and its wide range of 'bottom-up' innovation initiatives by entrepreneurial farmers, these approaches have serious shortcomings. To address this, we have developed a 'Learning and Experimentation Strategy' (LES) in which a novelty is indicated with the term 'promise'. The term expresses that a novelty has attractive features from a certain sustainability perspective, but it has also problematic or unknown sides. Importantly, LES not only looks at individual promises but at a whole range of them, called the 'portfolio of promises'. Several of these may be connected as 'smart combinations' to address a variety of sustainability aspects. The PoP as a tool is basically a database that contains information on a number of aspects for each promise that we have applied in the animal production and glasshouse horticulture sectors. Hence, the tool can be applied in different sectors but it appears that a 'tailoring' towards the specifics of a sector is needed to increase its usefulness in practice. This chapter describes four tests that we have carried out with this tool in the animal production sector. This has led us to refine the strategies for using the LES approach, as well as change the architecture of the PoP to tune it to various specific applications in animal production. Although this is still work in progress, the tests indicate that the PoP can be used successfully as a tool in stimulating innovation towards sustainability.

Keywords: Niche, promise, portfolio of promises, combining novelties, animal production

1 Introduction

Building on the multi-level perspective, innovation scholars have proposed various approaches to stimulate innovation towards sustainability. Some well-known approaches include Strategic Niche Management (SNM; Hoogma et al., 2002; Schot and Geels, 2008) and Transition Management (Rotmans, 2003; Loorbach, 2007). We have sought to apply these approaches in the agro-food regime, specifically in the livestock sector.

Applying them, however, posed some serious challenges. Firstly, SNM and TM focus on alternatives with a specific 'technical nucleus', e.g. solar cells or electric cars. Livestock production, however, deals with complex bio-systems, with a wide range of functions that can be and are innovated upon, like feeding, housing, manure processing, tillage, etc. These are tackled by different and often distinct disciplinary groups of researchers and practitioners who hardly interact. Furthermore, SNM and TM focus on 'organized' learning and experimentation (top-down) with little attention for initiatives by practitioners (bottom-up). The great variety of practice initiatives by farmers in animal production would risk to be unrecognized in a top down approach.

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To address these problems, we have developed a "Learning and Experimen¬tation Strategy" (LES; Elzen and Spoelstra 2012) that is inspired by SNM and TM and combines the top-down and bottom-up routes towards change. The central concept in LES is 'promise', a novelty with certain attractive sustainability qualities, but also with problematic or unknown qualities. A range of such promises (called the 'portfolio of promises') is relevant when tackling the sustainability problems of the domain under study. Next to learning on individual promises, a major aim of LES is to combine learning from various promises in the portfolio so that they may add-up to lead towards more 'integrally sustainable' systems.

The portfolio of promises (PoP) is basically a database that contains initiatives with significant potential on one or more aspects of sustainability. The portfolio includes research projects, typically led by scientists, practice oriented projects carried out by networks of farmers, as well as individual farmer initiatives. On each initiative, the PoP contains practical information (description of the innovation, involved stakeholders) as well as an assessment of its 'sustainability potential' and opportunities and barriers in realizing this potential in practice. The concept of sustainability, of course, is far from straightforward and different actors will have different views on what it entails. Further below we describe how we have operationalized it in our case by taking into account the views of a variety of different types of actors, which led us to distinguish 15 different sustainability aspects in the PoP.

The development of the PoP will take place in a number of steps:

1. Development of a prototype tool;
2. Testing the tool with selected audiences;
3. Redesign of the tool;
4. Testing the tool with envisaged end-users;
5. Final design and actual use in practice.

The project is planned to take several years. In an earlier paper we described the general LES approach (Elzen and Spoelstra 2012) and in this chapter we focus on the PoP. We will describe the prototype and our findings on testing and redesigning it in the 2nd and 3rd step. At the time of writing (mid 2015) we were working on the 4th step.

2 The PoP Prototype

2.1 Multi-level Perspective

The portfolio of promises builds on the multi-level perspective (MLP) on transitions (Rip and Kemp, 1998; Geels, 2002). The core of the MLP is that system innovations are shaped by interaction between three levels: the socio-technical landscape, the socio-technical regime and technological niches (figure 1).

Socio-technical systems are located at the meso-level of *socio-technical* regimes. These regimes indicate a set of shared rules that guide and constrain the actors within a production and consumption system in how they try to tackle various challenges they encounter. This typically leads to evolutionary patterns of innovation. The *socio technical landscape* is an exogenous environment of factors with a broader societal relevance like the need to reduce CO_2 emissions. *Technological niches* are the breeding ground for radical innovations that initially poorly fit the regime.

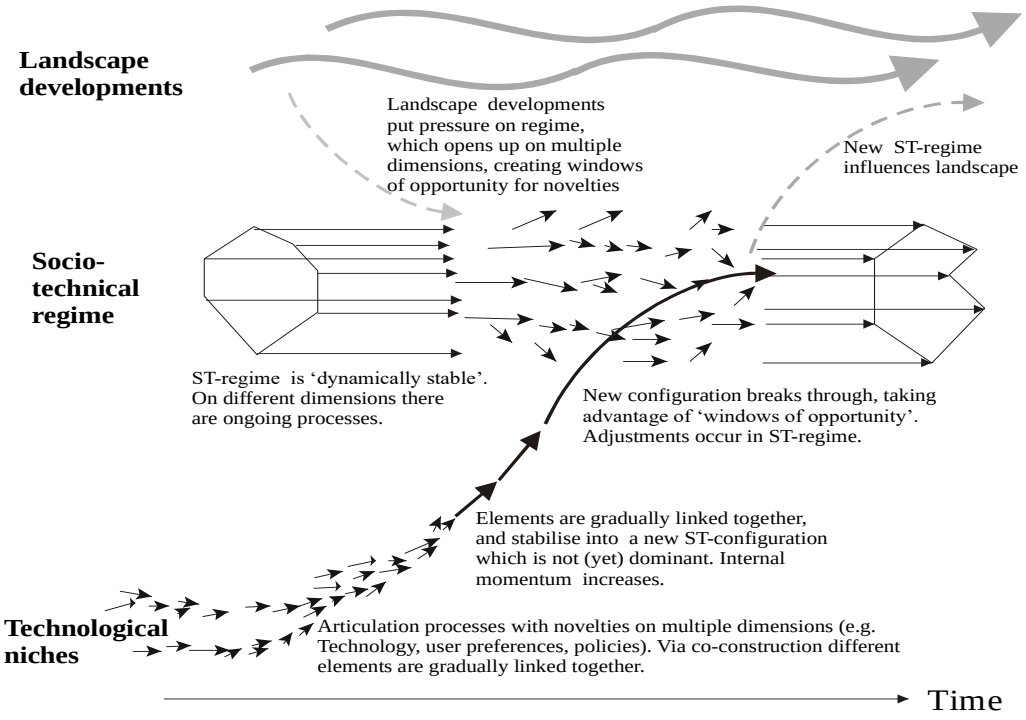

Figure 1: A dynamic multi-level perspective on system innovation (Geels, 2005).

In the MLP dynamic, system innovations develop as follows. A novelty emerges in a local practice and becomes part of a niche when a network of actors is formed that share certain expectations about the future success of the novelty, and who are willing to fund and work on further development. Niches may emerge and develop partly in response to pressure and serious problems in an existing regime which can be either internal to the regime itself (such as animal welfare in industrial animal production) or come from the socio-technical landscape (e.g. the pressure to curb CO_2 emissions which affects more than just the animal production sector). The further success of niche formation is on the one hand linked to processes within the niche (micro-level), and on the other hand to developments at the level of the existing regime (meso-level) and the socio-technical landscape (macro-level). Supported by actors willing to invest in the new concept (industries, R&D organisations, government) and initially protected from competition at the market place (e.g. through subsidies), the technology is improved within the niche, broader networks are formed around it, and more is learned about directions for improvement and functions it may fulfil.

Following a certain degree of improvement of the technology, and after learning more about its use in practice, it may find its way in specific market applications, often typical segments that exploit new functional characteristics of the technology and focus less on cost structures (e.g. organic food). Through further improvement, increasing reliability, and cumulated experiences and learning about functionalities and potential applications, the technology can spread to other market niches and/or trigger an expansion of market niches. Processes of rule formation also play an important role, such as the development of standards and regulations for the technology, and processes to reduce the mismatch of the emerging technology with the rules of the dominant regime. As it starts to compete on or with main markets, the novelty may transform or substitute the existing regime and thus trigger a system innovation process.

This perspective allows for a very dynamic view on innovation processes as its application to a variety of historical cases has shown. These studies, however, tend to focus on the vicissitudes of a specific alternative technology to an existing system (e.g. sailing ships replacing steamships; Geels, 2002) although the new technology does not simply diffuse but changes in the process. This works fine for retrospective studies but it is problematic to use as a heuristic in a 'learning and experimentation strategy' seeking to contribute to system innovation. We do not know which alternative development will play a key role in the

development towards a sustainable livestock sector. We need to acknowledge that 'innovation in action' is much messier than retrospective historical studies portray it (e.g. Elzen et al., 2012).

2.2 Portfolio of promises

In the MLP, niches are the locus to learn about and to further develop novelties. A niche consists of a variety of projects that share a technical nucleus, e.g. electric propulsion for cars (Hoogma et al., 2002). Using the niche concept in a sector like animal production, however, is problematic because innovative projects and practice initiatives are very diverse. For instance, they may relate to new types of animal feed, new manure collection technologies, new husbandry concepts, etc. Learning between these initiatives is often minimal and, therefore, they do not fit the definition of a niche in MLP.

To address such innovations we will use the term 'promise'. The term promise expresses that each of these novelties has attractive features from a certain sustainability perspective (e.g. lower CO_2 emissions, or better animal welfare) but it has also problematic (e.g. more expensive) or unknown sides. Initially, a promise may just be an idea or a concept, explored in a single project or farmer's initiative. After a certain period of time more projects may be started in connection with the promise. When these projects start exchanging information and lessons learned, the promise may thus develop into a niche.

Historical cases (*e.g.* Geels 2005) show that system innovations are not the result of the 'massive diffusion' of a new technology but a lengthy process of combining and re-combining 'partial innovations'. This implies that, to induce or stimulate system innovations, attention should not go to a single novelty (or promise) but to range of novelties that we call the 'portfolio of promises'.

For each of these promises, a process of learning and experimentation is needed to find out in practice how the problematic sides may be solved and to explore whether it raises new problems. For an individual promise, even if it does not (yet) constitute a niche, the approach of Strategic Niche Management (SNM) provides valuable suggestions on how to do this (Hoogma et al., 2002; Schot and Geels, 2008). But SNM looks at the level of a single novelty and not at the portfolio level, i.e. across a variety of niches in MLP terms. To make a more encompassing contribution to system innovation, we need to addresses two levels, i.e. the level of individual promises and the level of the portfolio of promises.

- The **individual promise level**: because we are not only looking at technical innovations but also at new practices, new meanings, etc.; it is important to make various stakeholders, to whom the novelty may be relevant, part of the network exploring it and developing it further.
- The **portfolio level**: because a system innovation will result from a process of combining and recombining partial innovations it is important to analyse how various promises might be combined to create a full system that is more sustainable than the existing one. Such an analysis at the portfolio level (the 'portfolio integration') may result in starting new experiments with combined promises (thus creating a new, more encompassing promise) or in giving feedback to ongoing experiments to include certain aspects based on the portfolio integration. Because a variety of promise networks need to be running for a longer period, this portfolio integration should be a more or less continuous activity.

This combination of learning and experimentation at two levels we call the "Learning and Experimentation Strategy" (LES). It can be seen as an extension of SNM in two directions: (1) it addresses promises before they constitute a niche and (2) it looks across a range of promises (or multiple niches, in SNM terms).

2.3 MLP revisited

Promises may result from research projects ('top down'), as well as from practice initiatives by farmers ('bottom up'). This is captured in Figure 2 below, which gives a representation of the multi-level dynamic, focusing on the relationships between projects, practice initiatives, promises and the regime.

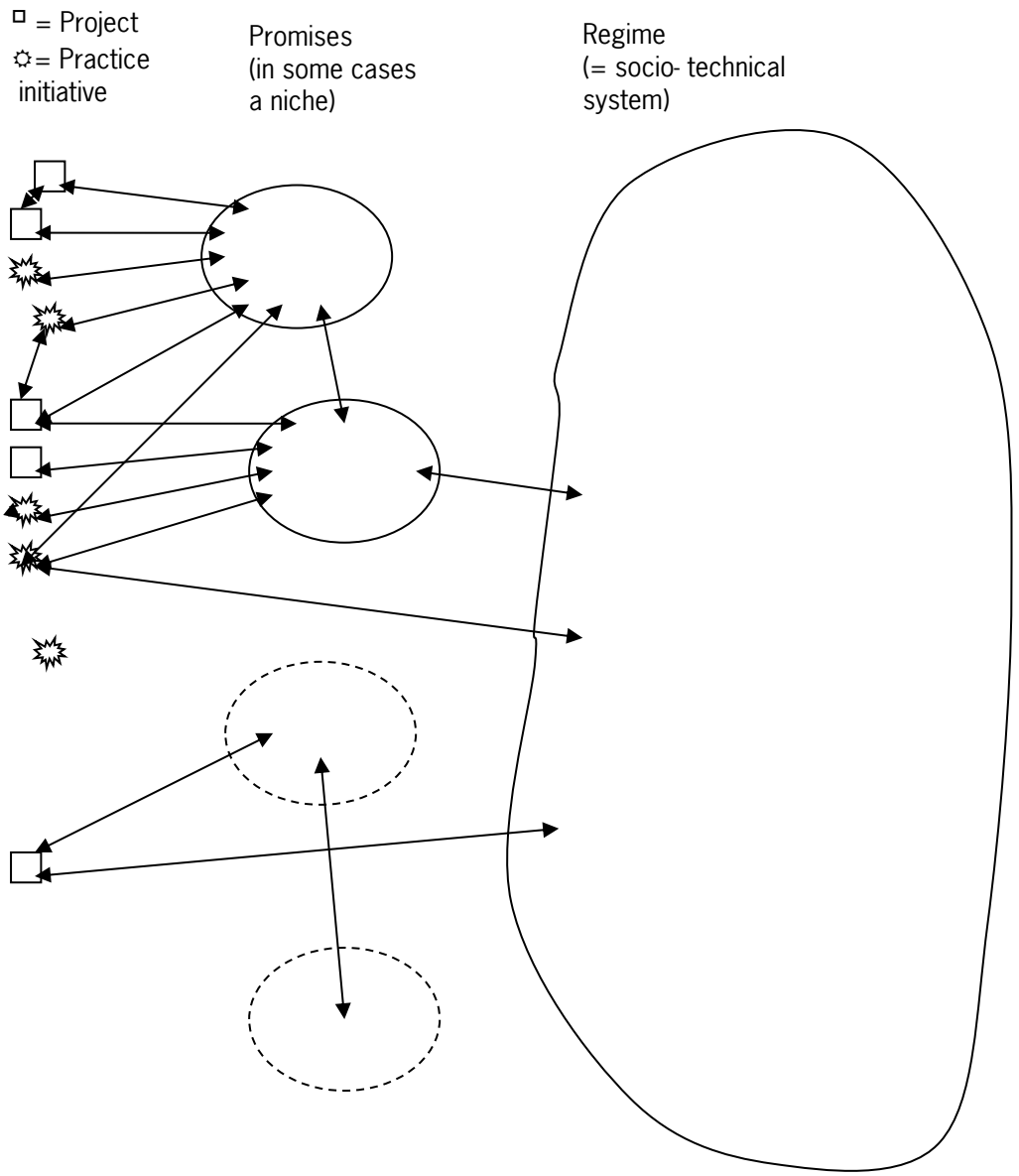

Figure 2: LES concepts in the multi-level dynamic (Elzen and Spoelstra, 2012).

Some explanatory remarks concerning the figure:

- Two-way arrows are used to indicate that influences may go both ways.
- Projects and initiatives may contribute to more than one promise.
- Some of the promises have been dashed, indicating they are (still) conceptual ideas that are not or hardly supported by a network. One of these is not supported by any project or initiative, indicating it is still just a conceptual idea.
- Projects and practice initiatives may influence each other directly.
- Projects and practice initiatives may also have an influence on the regime directly.
- Promises may also influence the regime.
- Promises may influence one another.
- One isolated initiative is not connected to any promise as an example of many such initiatives that do not fit the portfolio of promises.

2.4 Identifying and assessing Promises

Farmers introduce novelties for a variety of reasons. There may be thousands of such initiatives, some of which may be inspired for sustainability reasons (e.g. because of societal pressure) while many others are motivated otherwise (e.g. for economic reasons). This begs the question how to assess which initiatives, and especially their constituent promises, might make a contribution to sustainable development.

We can approach this issue in various ways. Firstly, we might simply try to assess the actual 'sustainability' of the initiative as such, using a set of predetermined indicators. Although there is a range of systems in the Netherlands that try to do this (for farms or for the sector at large) in one way or the other, for instance in quality assurance schemes (cf. www.smk.nl), this assessment is cumbersome, laden with interpretation and almost impossible to do for initiatives, isolated from their context.

The second approach in assessing bottom up initiatives is to see them as part of an ongoing process. The question then becomes: "Which initiatives have a potential to contribute to sustainable animal production?" This requires a more thorough understanding of what makes the initiative special. In the PoP, we do this by identifying one or more novelties in the initiative, and qualitatively assess their respective potential contribution to 15 aspects of sustainability.

As a third approach, the question may be reversed. "How can we use these initiatives to learn about possibilities for sustainable animal production?" The initiatives are then seen as learning experiments to render knowledge on barriers and incentives for sustainable development. Thus, they can be made part of the 'portfolio of promises' within LES. This requires a process of continuous monitoring of which innovations are explored in the animal production practice and assess the relevance of the locally learned lessons within the broader portfolio.

In LES, the second and third approach are combined. This requires a tool to assess the various promises on their potential contribution to sustainable animal production.

2.5 PoP Prototype

As a tool, the portfolio of promises has the form of a database that contains an overview of initiatives that might make a sector more sustainable. This includes research projects, typically led by scientists, practice oriented projects including networks of farmers, as well as individual initiatives from farmers. On each initiative, the PoP contains practical information (description of the innovation, involved stakeholders) as well as an assessment of its 'sustainability potential'.

Different actors will have different views on what would be needed to make the sector more sustainable. In the Netherlands, these diverging views were discussed within a platform called the the 'Uitvoeringsagenda Duurzame Veehouderij' (UDV; "Action Plan for Sustainable Animal Production"; cf. section 3.5 below). UDV is a governance network with a broad range of stakeholders in and around the Dutch livestock production sector, ranging from NGOs to farmer representatives. UDV collectively agreed upon an agenda of 15 sustainability aspects that would have to be improved (Koole, 2013) and these were taken as an operationalization of the sustainability criteria for the PoP.

Table 1 below gives a selection of the main categories that are filled in for each initiative, together with a brief description of each category and guidance for filling in the PoP. The table only lists those categories that we focused on in the tests described below. Important other categories, that we will explore in depth in further work, are the barriers and incentives for developing a promise further, and the network of actors engaged in its development.

One of the listed categories in the PoP concerns the 'sustainability effects' which distinguishes 15 different aspects that are presented in Box 1 below the table.

Category	Description	Specification	Test questions
Functional core	The essence of what is done differently from conventional production methods, which results in a substantial sustainability improvement of the system on one or more aspects.	A farm can combine several system innovative cores What is done, not how it's done specifically Is concrete enough to be combined with other functions in the farming system Is open enough to imagine several possible solutions	
Specific solution	How the system innovative core is being realized in the system		How is the system innovative core being realized at the farm?
Other solutions	Other ways of realizing the system innovative core		How could you also realize the system innovative core?
Ambition	The driving reason to rearrange part of the production system differently. Drivers can be Internal (personal motivation External (e.g. changing legislation)		What drives the starter of the initiative? What is the dream? Which kind of 'energy' fuelled the start of the initiative?
System element	Part of the production system that is changed	Choose from: • Soil • Crop • Feed/water • Manure • Nutrients • Cow (/Animal) • Housing • Milking system • Energy infrastructure • Labour • Product & market • Citizen • Capital • Rules and regulations Several options may apply	
Sustainability effects	Projected effect on sustainability performance of the specific solution for the system innovative core. See table 1 for sustainability aspects taken into account.	Only indicate when >20% better/worse than conventional Elaborate why performance change is expected.	-1 = gets worse 1 = gets better ϟ = uncertain if positive or negative Why do you expect the system innovative core to have a substantial effect on sustainability performance?

Table 1: PoP main categories addressed in the tests and guidance for filling in the database.

The possible contribution of a promise to sustainable animal production is assessed on the following aspects:

1. Fossil fuel: Dutch livestock production at farm and chain level, will not use energy from non-renewable fossil fuels.
2. Climate: Dutch livestock production contributes proportionally to limiting the rise in global temperature to 2°C maximum.
3. Global biodiversity: Dutch livestock production contributes to conservation of species and restoration of global biodiversity
4. Local biodiversity: Local biodiversity is not being limited, but restored by Dutch livestock production.
5. Phosphate: Dutch livestock production at farm and chain level only uses phosphate from renewable, non-mined sources.
6. Soil quality: soil used for/by Dutch livestock production remains suitable for agriculture or other purposes.
7. Water reserves: Dutch livestock production does not deplete strategic water reserves.

8. Water quality: Dutch livestock production keeps ground and surface water around the farm clean, so it can be used as a source for drinking water and aquatic ecosystems can thrive.
9. Animal welfare: animals in Dutch livestock production are able to meet all needs in their behavioural repertoire without pain or limitations. Interventions that violate the integrity of the animal are no longer executed structurally.
10. Animal health: Animals in Dutch livestock production remain healthy without structural medication.
11. Public health: Dutch livestock production and its products are safe for human health.
12. Relations with the local community: Dutch livestock farms are an accepted part of the community and do not cause local nuisance.
13. Profitability: Dutch livestock production is profitable.
14. Labour: Labour in Dutch livestock production is attractive, physically tolerable up to pensionable age and rewarding.
15. Knowledge, innovation and adaptability: Dutch livestock production is able to adapt continuously to changing conditions through a broad knowledge base and innovation.

Box 1: PoP sustainability aspects for animal production. These were agreed upon by the UDV platform, a governance network with a broad range of stakeholders in and around the Dutch livestock production sector (Koole, 2013; translation by the authors).

3 Testing the PoP

3.1 Introduction

In its general form, the PoP tool can be used in different agricultural subsectors and, together with colleagues from Wageningen UR, we have applied it in the greenhouse horticulture and dairy cow subsectors. In this chapter, we focus on the latter work.

In the 2nd step of our long-term approach (cf. general Introduction) we discussed and tested the prototype with different types of actors. The overall objective of these tests and discussions was to gather feedback on the usefulness of the approach in various practical situations and use that as an input for redesign. These tests were carried out with the following actors:

- Various stakeholders in the province of Limburg engaged in a provincial sustainability initiative;
- Researchers engaged in various applied projects, working with stakeholders from the sector;
- Students at CAH Vilentum University of Applied Sciences who are the 'farmers of the future';
- The UDV platform, a governance network to stimulate transition to sustainable livestock production in the Netherlands.

The results of these tests are described below.

3.2 Testing 1: Province of Limburg Innovation Agenda

3.2.1 Approach

In 2010, the government of the Dutch province of Limburg and the LLTB (the provincial farmers representative organization) made an innovation agenda for sustainable animal production. They assigned us to use the PoP approach to assist them in their activities.

Our approach consisted of the following steps:

- Use the PoP to create an overview of provincial farmers initiatives to make animal production more sustainable in three main sub-sectors, i.e. pig fattening, dairy cattle, and poultry;
- Conduct a critical assessment of this portfolio to identify strengths and weaknesses;
- Identify possibilities for smart combinations;
- Discuss the results with stakeholders from the province, including farmers;
- Develop recommendations for our clients to realize the objectives of the provincial innovation agenda.

3.2.2 Results and consequences for PoP design

The initial PoP design was comprehensive, and contained a lot of information on each initiative. As a result, the prototype was complicated with a variety of categories and sub-categories. The province, however, only had a limited budget and urged for a much simpler version that would be more easy to fill in. Therefore, a 'stripped' version of the format was developed.

Furthermore, because of time constraints, only a 'quick scan' could be conducted to identify farmers sustainability initiatives in the province and there was limited time to actually fill in the PoP. As a result, about a dozen initiatives from each of the three animal production sectors was included which was very limited. This was called an 'indicative' portfolio to stress its limited ambition.

Even with this stripped version, it appeared that filling in and scoring various initiatives was far from straightforward. There were numerous discussions on how to characterize a specific novelty, how to 'score' various sustainability criteria and how to identify possible barriers and incentives for its use. In a process of 'learning by doing', more specific criteria for filling in the various initiatives were developed.

The details from the critical assessment will not be discussed here, as the focus in this chapter is on aspects that affected the design of the PoP. Suffice to say, that various 'gaps' in the sustainability initiatives were identified and that the networks involved in these initiatives lacked specific stakeholders to facilitate orientation towards societal objectives. The provincial clients found these conclusions helpful in developing their further strategy for the innovation agenda.

The province was very interested in the idea of 'smart combinations'. On the basis of an analysis of the PoP, the project team would suggest a number of such smart combinations, which would subsequently be discussed in a workshop with provincial stakeholders.

On the basis of the content of the PoP, however, it appeared to be very difficult to actually identify smart combinations in a systemic way. In interaction with the province, three types of smart combinations were distinguished, i.e.:

- No obvious large barriers to realization; the combination might be realised immediately or in the short term.
- Serves a significant external (societal/political) or internal (in relation to husbandry) need but faces substantial barriers to realization; might be realised in the medium term.
- Large barriers to realization but offers interesting options to build upon further in the longer term.

For each of these types, 5-10 combinations were identified rather intuitively which were presented in a workshop with stakeholders, including farmers, LLTB-staff, representatives from the province, environmental NGO and others. Although the suggestions were a bit haphazard, the participants were enthusiastic about quite a number of them. Moreover, in breakout sessions they came up with a number of further smart combinations that some of them intended to explore further. The provincial clients were very happy with this result.

Although the research team was sceptical about the usefulness of a stripped version of the PoP, it appeared to be an effective tool to make recommendations for the provincial authorities and to stimulate creative thinking among provincial stakeholders. This led to the conclusion that the detailed design of the PoP would have to depend upon the specific objectives in using it. If it is used basically as a communicative tool, a rather simple version of the database[1] and an intuitive identification of smart combinations will suffice.

[1] Actually, a little further down the project the province wanted us to make a 'quick and dirty' overview of sustainable animal production initiatives in the rest of the Netherlands. For this, we stripped the PoP even further, to its bare bones. Yet, this sufficed to present our client with an overview of what was happing elsewhere as input for determining their own strategy.

If the objective is more scientific, however, a more systematic approach is needed. This especially manifested itself in the identification of smart combinations. It appeared that, in many cases, initiatives were not combined as a whole, but only certain elements of it. This led to a need, not to take an initiative at 'face value' but to break it down to its 'core' (or cores, if there are more). To allow making various combinations, it appeared to be easier if we did not see this core as a new solution, but as a new 'function' which was called the "functional core". For instance, emissions of ammonia can be significantly reduced by collecting urine and manure separately at the source. This 'early separation' we call the *functional core* which can be realized by various technical means. At face value, these technical means jump to the eye but for the PoP, an abstraction is made to identify this function, i.e. "separation of manure and urine at the source". This is entered as a 'promise' into the portfolio.

3.3 Testing 2: Agriculture researchers

3.3.1 Approach

The project team filled in the PoP with various novelties known to us that were developed by individual dairy farmers (which we call 'farmers initiatives'). These were discussed with six researchers from Wageningen UR Livestock Research, studying various aspects of dairy production (feed, housing, manure treatment, etc.), who were asked to complement the preliminary PoP with missing (details about these) initiatives. The goal was to develop an overview that would be representative for *all types of novelties* that are developed in Dutch dairy farming. With each expert, a meeting was held to discuss additions and how to analyze these for use in the PoP. Also, the application of the tool in research, farming practice and policy was discussed. The assessment of the sustainability performance of the novelties was not addressed in this test.

3.3.2 Results & consequences for PoP design

The test resulted in several additions to the PoP: (reformulation of) promises, specific solutions for functional cores and listing of entrepreneurs that are experimenting with promises. The structure of the PoP was also slightly altered on the basis of the test.

One main issue, raised by dairy researchers, was to determine whether a promise is innovative enough to add to the portfolio. A selection from a huge range of promises needs to be made to keep the PoP manageable. Basically, every dairy farm is unique, consisting of a specific set of combinations of more or less common practices and solutions. How to determine, then, that a promise is sufficiently innovative to be included in the PoP? The answer to that question appeared to be largely subjective and the researchers disagreed on several occasions.

Seeking to develop criteria for this, the project team defined promises in the PoP as a new technology, new way of working, or new chain relations, that improves the performance of the farm on one or more of the sustainability aspects (cf. Box 1), by 20% or more. This definition, however, proved difficult to apply. For instance, the installation of PV-cells on the roof of the farm can significantly reduce on-farm fossil fuel use. This technology has been proven extensively already. Thus, the novelty does not fit the first part of the definition, but it does fit the second part. Furthermore, it opens up new possibilities on the farm when combined with small electromotor driven appliances, like manure robots. Therefore, this promise was included in the PoP and led to the conclusion that the definition should also include 'new combinations' of existing technologies, systems, relations, etc. Actually, this stresses the importance of 'smart combinations'.

Another complicating factor was that promises are embedded in a production system and their functioning can only be understood in this context. However, the 'whole production system' is not a useful unit of analysis to combine with other promises. It is difficult to isolate one specific promise from the system, since an innovative farmer usually changes several things at the same time and all these elements work interdependently. For instance, a farmer may combine a loose housing compost bedded pack barn with more space per cow than conventional, a mobile feeding system and a greenhouse foil roof. A specific part of this, e.g. a greenhouse roof construction, can be applied in any type of housing system, mainly to reduce

costs. However, it is especially interesting to do so combined with a compost bedded pack, since the radiation from the sun and ventilation openings help evaporate the moisture (urine) that is absorbed in the packed bed. Thus, both promises together have a synergistic effect, but applying them separately can also be interesting for farmers.

There were 32 novelties in the initial PoP database that were extracted from 14 innovative farms. The dairy experts added names of entrepreneurs working on similar promises, which led to adding a column in the PoP to indicate that more farmers were working on the novelty. After the expert consultation, the PoP contained 52 novelties that 275 entrepreneurial farmers were experimenting with.

The experts found it important to also indicate what landscape and regime changes drive the development of novelties (e.g. increasingly strict environmental legislation), since it is a motivating factor for other farmers to change farm management. This was included in the PoP database under the title 'ambition'.

The experts consulted saw farmers as the main user group for the PoP. The experts work in applied research, aiming to develop knowledge that can be applied in farm practice. All agreed that the PoP has added value for their own work, because it provides a broad overview of novelties, also from outside their own area of expertise, which they are not usually exposed to. Going over the PoP periodically, would be a good way to evaluate current promises that researchers are working on, identify possible problems these promises might encounter, and develop a research agenda based on these problems.

Tables 2a and 2b (cf. separate pages, after references) provide a sample of 8 promises as they are entered into the PoP to illustrate what it looks like.

3.4 Testing 3: Agriculture students

3.4.1 Approach

About 25 third-year students from CAH Vilentum University of Applied Sciences, doing the animal production/agricultural entrepreneurship educational program, were taken through a course consisting of four interactive lectures and a student assignment. In the first lecture, students were introduced to the PoP in the context of sustainability and transition management. Also, the student assignment was introduced: students (in groups of 2) had to choose a novelty from the database, find a farmer experimenting with it through their own network and find out from the innovative farmer a) how exactly the promise is put into practice on the farm, b) what motivates the entrepreneur to work on the novelty, c) what hurdles/incentives the entrepreneur encountered, d) what network he used to develop the novelty, and e) what the novelty yielded in terms of improved sustainability performance, as specified by the indicators in the PoP. The second lecture concerned an elaboration on the concept of sustainability, using the goals defined by the UDV platform (cf. section 3.5 below) to make the abstract concept of sustainability more concrete at farm level. In the third lecture, the findings of the students were presented, shared and discussed, providing the students with a broader overview of the innovation arena in dairy production and a deeper understanding of the relation between (aspects of) the farming system and its sustainability performance. In the fourth lecture, students were challenged to come up with an improved dairy production system, based on the weaknesses of the promise they had studied and inspiration from other promises. The ideas were pitched, the presentation was supported by a poster. Afterwards, the lectures and assignment were evaluated with the students via e-mail.

3.4.2 Results and consequences for PoP design

Some groups selected the promise to be studied based on their own unacquaintedness with the farming practice, i.e. as a learning opportunity, while others' choices were based on easy access to the entrepreneur through their network, i.e. on least amount of work. As in the test with agricultural researchers ('Testing 2'), a discussion point was how 'innovative' the promises in the PoP really are. Sometimes, uncertainty was due to how the novelty was formulated in the PoP. For instance, one of the novelties listed was to seed grass in an existing pasture, as opposed to tilling and newly planting the pasture. In the initial

design of the PoP, novelties were formulated 'positively' (i.e. what is done, rather than what is *not* done). In the pasture case, many farmers improve its quality by seeding in the existing pasture if possible, since this induces lower cost than complete pasture renovation. Some innovative farmers, however, do *not* apply tilling at all anymore, which is the true promise. Novelties can therefore also be (most tersely) described as an *abandoned practice* from the existing regime.

The student assignment yielded additional entrepreneurs, working on novelties in the PoP database. The main result, however, was the learning effect for the students themselves. Most students grew up on a dairy farm, where farm management is executed according to tradition. Through this assignment, they were exposed to a wide range of innovative farming practices. The fact that a farmer, rather than a researcher, is motivated to apply a novelty and accept the risks associated, makes the students take the initiative more seriously.

The students made combinations between novelties, to improve a negative side effect of a new farming practice. The combinations did not always improve integrated sustainability performance however. One example of a combination made was to feed the packed bedding material from a loose housing system into a manure digester for energy production. The organic material in the bedding (straw) would increase the energy yield from the digester, making other co-products redundant. The original idea of farmers using organic bedding material, however, is to bind minerals from urine and manure to organic matter, creating a product that can be applied to improve soil quality. When digested, this effect cannot be sorted. Another example of a combination made was to guide visitors virtually through the farm instead of personally, to reduce the risk of zoonosis.

From the evaluation it can be concluded that students appreciated the overview of novelties and think that such an overview can be instrumental in exploring options for a farms development strategy.

3.5 Testing 4: National UDV platform

3.5.1 Approach

In the Netherlands, a formalized governance network (or transition arena) strives to stimulate sustainable development of livestock production. It is called the 'Uitvoeringsagenda Duurzame Veehouderij' (UDV; the name meaning "Action Plan for Sustainable Animal Production") and it consists of the national government, primary sector partners, chain partners, knowledge institutes and two NGOs (on animal protection and environmental issues). In 2009, the partners concluded a covenant for collaboration to make the sector fully sustainable by 2023 (Koole, 2013).

The project team had an open discussion with two representatives from the UDV platform to explore the potential of applying the PoP in the transition arena that they were setting up. Both representatives, one working for the Dutch Federation of Agriculture and Horticulture (a farmers' interest group), and the other working for "Stichting Natuur & Milieu" (an environmental NGO), had recent experience with projects with a similar aim, yet different approach, named "Innovation in practice" and "Ranking the stars". Before the meeting, information about the status of each other's projects was exchanged to compare methods, results and hurdles encountered in the projects.

3.5.2 Results and consequences for PoP design

In both UDV projects, that worked complementary, pig farming, rather than dairy farming was the focus domain. Frontrunners in the pig sector were selected with a group of sector experts from the UDV platform. "Ranking the stars" analyzed four different strategies carried out by farmers to innovate and their characteristics (added value for innovation of the sector as a whole, challenges, entrepreneurs' attributes and partners involved). These frontrunner farms' performance was analyzed for a set of eight sustainability goals, based on expert opinion. The projects' results have been translated into a brochure for use by farmers and in education.

"Innovation in practice" aims to stimulate entrepreneurs to develop certain aspects of farming practice by showcasing forerunners in the sector at farmers meetings. Such meetings were organized by sustainability theme (e.g. health) or innovative farm (full farm concept). The project's current main challenge is to position the forerunners' meetings in the communication towards farmers in such a way, that the meetings will attract enough attendants. There is much competition from study groups, workshops and seminars offered for free by commercial advisors (e.g. vets, feed companies). Communication is a sensitive matter, since the farmers' organization represents a wide range of farmers, some of whom might be offended when alternative farming practices are presented as being 'innovative' and 'sustainable', which implicitly disqualifies practices from other farmers as less sustainable, which might leave them feeling not supported.

The UDV representatives thought the PoP approach would have added value for the aforementioned two projects in several ways. For one, the functional analysis of novelties in the PoP allows for a more specific search for possible solutions, compared to the whole farm being taken as the unit of analysis. This added value was considered specifically interesting for advisors in the livestock sector, who encounter a wide range of entrepreneurs with strategic choices every day, whereas individual farmers only make these choices when making major investments, i.e. once every 5-10 years. The PoP is instrumental in providing an overview of possible solutions and their sustainability effect. Another added value mentioned is the in-depth evaluation of sustainability performance of initiatives. It was suggested to have this evaluation executed by university students as a standard assignment in their curriculum, as it would fit the learning objectives (Bloom *et.al.*, 1956), would prepare students for future sustainability challenges and at the same time would guarantee sufficient quality of the analysis through supervision by university staff. Lastly, great potential was seen in comparing promises experimented with in different livestock sub-sectors. A quick scan shows that some aspects, like soil quality, are addressed in dairy production whilst not in pig production. This observation could urge the pig sector to explore strategies to improve on this hitherto unaddressed aspect as well.

As a consequence of the projected added value, the representatives thought the emphasis in the re-design of PoP should be on its use as a "morphological (i.e. function) chart". It would enable acquiring information concerning the solutions in the chart, like a description of inspirational initiatives from practice (including network, incentives, hurdles, etc.), where the novelty is applied, or sustainability performance of the novelty. An open access web-based relational database would allow the required functionality to be linked to information on each solution and make it available to a wide public. To keep maintenance cost of the PoP low, information/descriptions from other projects should be used as much as possible. The ambition of completeness was not considered realistic, nor necessary for inspiring advisors & entrepreneurs to start experimenting with promises. Communication was seen as much more important, and an attractive and clear design of the user interface is therefore crucial.

4 Redesign

The results from the testing stage led us to redefine our objectives in using the PoP and make them more specific. As a result, three different types of main objectives were defined, notably:

a) to directly inspire stakeholders with novel farm practices;
b) to identify smart combinations, that potentially have synergistic effects;
c) to identify 'blank spots' in innovation programs and activities.

Each of these specific objectives sets its own requirements for the architecture of the portfolio. The requirements challenged us to partially redesign the PoP to address the more specific objectives. Below we discuss the three main objectives in using the tool, the requirements these have for the PoP, and the structural changes made in the PoP design.

4.1 Objective 1: Direct Inspiration

The ultimate objective in using the PoP is to inspire farmers and other stakeholders to incorporate sustainable practices at farm and chain level to induce a transition towards sustainable agriculture (or animal production, in our specific case). The main purpose of the PoP is to provide interested stakeholders with inspiration and information on opportunities that are available, and to teach them about solutions & initiatives that they might be interested in. The main users of the tool for this objective are advisors and innovative farmers.

This objective sets the following requirements for the tool:

- The tool needs to be freely accessible for all stakeholders in the sector, so that various target groups have open access to the information it contains.
- To keep the overview up-to-date, it should be easy to add information to the PoP. However, this should be done efficiently, re-using information generated within other projects when available. A thorough functional analysis of all novelties is too time consuming to perform and should therefore not be aimed for. Additions to the PoP should be made by an independent expert to ensure coherence of its contents.
- In communication about novelties in public, it needs to be clear who supports a certain novel practice that is showcased via the PoP.
- The information from the PoP needs to be presented in an attractive and clear way for the specified target group, using appropriate wording and indicating key information for the target group (e.g. expected investment costs).

4.2 Objective 2: Identify smart combinations

These are combinations of initiatives that are separate whilst, in combination, they could lead to synergistic effects. To meaningfully, systematically and traceably recombine novelties, it is essential to analyse initiatives on what is functionally done differently from common practice. This is problematic, since it requires an extensive knowledge of the system, is very time-consuming and thus costly for a practice tool. Alternatively, smart combinations can be identified more intuitively by farming system experts, and then discussed with advisors, innovative farmers and other stakeholders to explore their potential in practice. The main users of the tool in this case are researchers and advisors.

This type of application sets the following requirements for the design and use of the tool:

- Farming system knowledge (e.g. resource flows) to intuitively assess the potential of combining novelties within or between sectors.
- Frequent interaction with stakeholders (researchers/advisors/entrepreneurs) to test the viability of smart combinations. A large network in the sector is a precondition to be able to apply the tool in this way.

4.3 Objective 3: Identify blank spots

'Blank spots' are sustainability challenges that are addressed insufficiently. These can be used as input for innovation strategy and policy in the sector, to stimulate action to address these blank spots. Main users of the tool are researchers who use it to advice policy makers and strategic actors in the sector, i.e. actors who are responsible to carry out an innovation agenda or strategy.

The requirements associated with this objective are:

- The novelties in the PoP should be somewhat representative for the range of innovative activities in the sector, although completeness can never be obtained.
- Requires an assessment of the impact of novelties on various sustainability dimensions. The assessment needs to be of sufficient quality, e.g. by involving experts on the different aspects of sustainability.

4.4 Changes to PoP

Based on these specific objectives and requirements, the PoP was critically evaluated. This led to small changes in the structure of the database and to more radical changes in the use of the tool.

Changes in the structure of the database were a description of a promise's functional core, listing of various entrepreneurs working on a promise (rather than just the one listed initially), and the option to identify several novelties per initiative when relevant.

Changes in the use of the tool were more substantial. Since a database as such does not provide a user-friendly overview for various user groups, researcher-processed content from the PoP is used in communication with relevant stakeholders. For instance, the information can be processed for interactive sessions with stakeholders, including farmers. It can be processed to make a morphological chart or spider web graph of sustainability performance, which can fuel a discussion on various options to realize certain functionalities. When the PoP is applied more as a communicative tool, ownership of the content of the PoP should get more attention, e.g. via the UDV platform.

5 Discussion and conclusions

The examples above clearly indicate that sustainable innovation in animal production is and needs to be multi-facetted. A range of novelties is needed and needs to be combined to achieve sustainability on a variety of dimensions, including animal welfare, emissions, profitability, etc. Many of such novelties are already being developed by a broad range of farmers who focus on application on their own farm rather than seeking to contribute to a broader transformation. A strategy to develop a more sustainable animal production should make use of this innovative power.

Although SNM provides a useful starting point for developing such strategies, the characteristics of the animal production regime imply that the approach needs to be transformed and extended. We have sought to realize this by developing, what we have called, the Learning and Experimentation Strategy – LES. Within LES, we use the term 'promise' to indicate a novelty, rather than 'niche' as in SNM, since many of these promises are in a stage of development and embedded in a network that do not (yet) satisfy the definition of a niche. A broad variety of these promises is currently being worked on, which we call the 'portfolio of promises' (PoP).

Crucial in LES, in contrast to SNM, is that it emphasises the importance of combinations of such promises (the 'smart combinations') to acknowledge the multi-variety of the ongoing innovation process and to be able to address a variety of sustainability dimensions within the same strategy.

In testing the prototype, it appeared that using the term promise provides a useful concept to create an overview of ongoing initiatives at the farm-level, but that it is too crude to develop suggestions for 'smart combinations'. It appeared that many initiatives by farmers consist of a combination of novelties addressing different aspects. Therefore, we chose to distinguish promises from (farmer's) initiatives. Furthermore, it appeared that there were various promises that were technically different but that served the same function (e.g. separating manure and urine at the source). It appeared that combining such functions provided a better stepping stone to stimulate innovation than combining solutions. The reason is that a combination of functions creates room for variety in solutions and, therefore, for a farmer to bring in personal preferences.

This led to the conclusion that we should *not* consider each farmer's initiative as a promise, but to take two analytical steps first, notably:

1. To assess whether an initiative constitutes a singular promise or a combination of several of them;
2. To break down each promise to its 'functional core'.

It appeared, that these two steps are far from straightforward and led to various discussions on how to actually do this. By doing this in a wide range of situations in the future we will attempt to develop some guidelines for this.

Still, this provided a fruitful strategy to identify a number of smart combinations. This can be done rather intuitively, which proved to provide useful inputs for workshops with farmers and inspired them to explore whether they could actually realize them in their own practice. This also proved to be a good teaching tool, as the testing with students illustrates.

For strategic purposes, e.g. to identify 'blank spots', we think that we need a more systematic approach to identify smart combinations, e.g. to ensure that the full range of sustainability aspects distinguished in the portfolio is addressed appropriately. Our attempts in doing so, which are still ongoing, indicate that this is a labour intensive process. This may well be a serious handicap as we seek to use this tool in a practical situation where the budgets available for this type of work are limited.

Summarizing, our tests indicate that the simple version of the tool and the intuitive identification of smart combinations can already provide useful input for stimulating innovation towards sustainability. In the next phase we will develop this further in practical situations with stakeholders in the animal production sector and we encourage others to do this in other sectors as well.

Furthermore, we also seek to further develop a more advanced version of the tool for strategic purposes. It will be a challenge to do that in a cost effective way to increase the usefulness of the Portfolio of Promises in practical situations.

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References

Bloom, B.S. (Ed.), Engelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain*. New York: David McKay.

Bos, Bram (2009). "Concepts and objects as boundary objects for sustainable animal husbandry: Anticipating regime transformations by design." Paper for 1st European Conference on Sustainability Transitions, Amsterdam, 4-6 June 2009

Elzen, Boelie, and Sierk F. Spoelstra. 2012. "Developing Sustainable Livestock Production Systems: Outline of a Learning and Experimentation Strategy (LES)". In Marc Barbier and Boelie Elzen (Eds.). *Proceedings of the first international workshop on System Innovations, Knowledge Regimes, and Design Practices towards Sustainable Agriculture*. Paris: INRA, pp.208-225. Downloadable from:

Elzen, Boelie, Cees Leeuwis and Barbara van Mierlo, 2012. "Anchoring of Innovations: Assessing Dutch efforts to harvest energy from glasshouses". *Environmental Innovation and Societal Transitions*, 5, pp.1-18.

Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy* 31 (8/9): 1257–1274.

Geels, F.W. (2005). *Technological Transitions and System Innovations: A co-evolutionary and socio-technical analysis.* Edward Elgar Publishing Ltd., Cheltenham.

Hoogma, R., R. Kemp, J. Schot and B. Truffer (2002). *Experimenting with Sustainable Transport: the approach of Strategic Niche Management.* London: Spon Press.

Koole, J. 2013. *4e Voortgangsrapportage Uitvoeringsagenda Duurzame Veehouderij*. (Fourth Progress report UDV). The Hague: Uitvoeringsagenda Duurzame Veehouderij.

Loorbach, D. (2007). *Transition Management: new mode of governance for sustainable development*. PhD-dissertation. Rotterdam:Erasmus University.

Rip, A., and R. Kemp (1998). Technological Change. In S. Rayner and E.L. Malone(eds). *Human Choice and Climate Change.* Columbus, Ohio: Battelle Press. Volume 2: 327-399.

Rotmans, J. (2003). *Transitiemanagement, sleutel voor een duurzame samenleving*. Assen: Van Gorcum.

Schot, J., and F.W. Geels (2008). Strategic niche management and sustainable innovation journeys: theory, findings, research agenda and policy. *Technology Analysis & Strategic Management*. 20: 537-554.

Table 2a: Portfolio of Promises: sample of 8 promises for dairy production (for sustainability scores cf. table 2b)

	System innovative core	**Specific solution**	**Other solutions**	**Ambition**	**System element**	**Farmers working on the promise**
1	Provide living space without obstacles and soft bedding	Loose housing system with low cow density and compost bedded pack from wood chips	Straw yard Pasture based system	Improve cow welfare and increase culling age	Housing system	Havermans/Wiersma/Hartman/de Haan/Lubbersen/Groenwegen/Wilms/Veenhouwer/Jensma/De Regte/Hoogland/Bomers/Faes/
2	bind animal manure & urine to organic matter to fertilize crop/grassland	Loose housing system with low cow density and compost bedded pack from wood chips	Loose housing system with compost bedded pack from garden compost, straw, reed, ditch sediment etc (aerobic decomposition) Straw yard (anaerobic decomposition) Pasture based system	Turn manure into a valuable soil improvement product	Housing system Manure	Havermans/Wiersma/Hartman/de Haan/Lubbersen//Groenwegen/Wilms/Veenhouwer/Jensma/De Regte/Hoogland/Bomers/Faes/
3	Separate & collect urine and manure in the barn to fertilize crop/grassland	Concrete flooring system with sloped slots and drainage holes Straw in cubicles & manure robot	Flooring system consisting of a top layer of filtering cloth, middle layer of compressable material and under layer of coarse drainage material Autonomous manure cleaning device(koeientuin)	Turn manure into a valuable soil improvement product	Housing system Manure	Kwatrijn
4	Not dehorn cows	Round house and more space per cow	Tie stall Straw yard with more space per cow Pasture based system	Maintain physical integrity of the cow	Cow Housing system	De Groote Voort
5	Maximize milk from grass	Pasture based system All cows calve in spring	Summerfeeding	Independence from the bank, low variable cost for landwork, vet, feed concentrate and artificial fertilizer.	Crop, Feed, Nutrients	Pure Graze (+/- 40 farms)
6	Producemilk with special properties & processinto specialty product for niche market	Jersey cow, special feed (grass/clover/hay/herbs) Cheese from raw milk with Ghee crust	?	Obtain higher milk price	Crop, Feed, Nutrients Product & Market	De Groote Voort
7	Cows not owned by the farmer	Consumers own cows	Cooperative owns cows Nature conservation organization owns cows	Involve citizens with farm	Capital	Veld en Beek
8	Bring milking parlor to cows	Rapid exit milking parlor on wheels	Mobile milking robot Hand milking	Milk cows in nature reserves	Milking System	Sjaak Sprangers

Table 2b: Portfolio of Promises: sustainability assessment of promises from the sample in table 2a (Aspects taken from Koole, 2013)
(Meaning scores: -1 = gets worse; 1= gets better; ϟ = uncertain (might be either positive or negative)

novelty	Fossil fuel	Climate	Global biodi-versity	Local biodi-versity	Phos-phate	Soil quality	Water reserves	Water quality	Animal welfare	Animal health	Public health	Relations with the local community	Profit-ability	Labour	Knowledge, innovation and adaptability
1		-1		-1					1	ϟ	ϟ	ϟ			
2		1		1		1									
3		1		1	1	1				ϟ			1		
4									1						
5	1		1	1					1	1		1	1		
6													1		
7												1	1		1
8												1			