Chapter 5

Engaging with future technologies: how potential future users frame ecogenomics developments
Engaging with future technologies: how potential future users frame ecogenomics developments

Involving relevant publics in an early phase of science and technology development is challenging as concrete applications are absent and societal attention is rather weak. In this chapter we reflect on the third phase of the CTA process, in which groups of potential future users were facilitated to reflect on developments in the emerging scientific field of ecogenomics. We explicate how we defined relevant publics, recruited participants, and facilitated them to reflect on not yet existing technologies. The results show different ways of framing developments in ecogenomics, and provide crucial contextualization for involving a broader range of publics and organizing a frame-reflective dialogue as a next step.

5.1 Introduction

Many scholars have argued that decision-making processes on science and technology should be more participatory and include end users and the public at large (Chilvers 2008; Hagendijk and Irwin 2006; Jasanoff 2003a; Nowotny, et al. 2001; Feenberg 1999; Rip, et al. 1995). Participatory approaches to science and technology development are however inherently complicated due to e.g. uncertainties regarding science and technology developments, and framing differences and power relations between participants (Stirling 2008; Irwin 2006). Within recent literature on participation there is a plea for empirical case studies that take into account the tension between processes of ‘opening up’ and ‘closing down’ (Stirling 2008), and have truly ‘empowering and transformative potential’ (Chilvers 2009 p. 413). Critical reflection on these issues is crucial to the development of theoretical understanding and sound methodologies for opening
up science and technology development processes (Stirling 2008; Hackett, et al. 2007). We aim to make a contribution to these ongoing debates by reflecting on an empirical case study in which a broad range of potential future users was involved in discussing desirable futures for ecogenomics in homogeneous focus groups.

In chapter 4 we presented the first (exploration) and second phase (visions of ecogenomics researchers) of the CTA process on ecogenomics. In designing the third phase of the process, we encountered some specific challenges, which are central to approaches for early integration of science and society. To start, deciding on which publics should be involved has been an important issue in a recent debate in science and technology studies (STS). This debate centres around the tension between either maximizing democratic participation in discussions of new science and technology developments, or defining the limits of public engagement by the level of ‘contributory expertise’ of participants that can complement scientific expertise (Jasanoff 2003a; Rip 2003; Wynne 2003; Collins and Evans 2002). In addition, in the case of emerging technologies, the absence of concrete examples of applications makes unclear to what extent, and in which phase, groups of actor or the public can substantially contribute to the science and technology development process. In this chapter we reflect on specific questions relating to these issues:

- How to define relevant publics?
- How to recruit participants to engage in the process while they are not acquainted with the technology and, thus, not (yet) show a specific interest?
- How to facilitate these actors to reflect on not yet existing technologies?

Below these questions are addressed. In the next section we firstly reflect on how we defined relevant publics in the case of ecogenomics, and how we recruited participants. We subsequently present the methodology we developed to facilitate participants to reflect on ecogenomics and reflect on the focus group discussions. In the final sections we critically discuss our approach and results in light of recent debates in literature on participatory approaches in science and technology developments.
5.2 Involving users

Defining what type of societal groups should be involved in a participatory process, and how they can be identified and recruited is not a straightforward task. In our case we chose to involve groups of potential future users of ecogenomics applications. Here we reflect on the rationales behind this choice, and on challenges we faced in defining who potential future users of ecogenomics are, and in recruiting participants for the focus groups.

Defining relevant publics

In defining upstream engagement, Rogers-Hayden and Pidgeon (2007) talk of ‘publics’ as affected parties. In case of emerging technologies, affected parties can range from the general public to professional stakeholders, consumers and users. Nanotechnology served as the primary test-case for experimenting with upstream engagement (see for example Joly and Kauffman 2008; Rogers-Hayden and Pidgeon 2007). In drawing parallels between nanotechnology and recent controversial technological innovations such as biotechnology, public involvement is considered crucial to adequately address questions of benefits, risks and control (Macnaghten, et al. 2005). Clearly, a certain unease is surrounding nanotechnology developments within society. With ecogenomics, this is not (yet) the case. At the moment there are no indications that ecogenomics tools will be considered highly controversial. Nevertheless, it is not completely clear if and how the public might be affected by ecogenomics. Therefore we decided to first contextualize these developments further by involving potential future users (phase 3 of the CTA process). As a next step, broader reflection upon aspects like acceptability, risks and control becomes possible.

The important role of users in shaping technologies has received much attention in recent years (see for example Rohracher 2005; Oudshoorn and Pinch 2003). In addition to providing context, reflections of potential future users are directly relevant for the technology development process as they are able to connect their practical needs and experiences to the emerging technology. But who are those potential future users in the case of ecogenomics? In the second phase of the CTA process on ecogenomics, researchers articulated their ideas about the future of ecogenomics. In interviews and focus groups, we specifically challenged them to express not only technical aspects, but also contextual elements of the future of ecogenomics. They identified societal groups in the areas of agriculture, soil pollution and nature conservation that they expected to either gain or lose
something as a result of ecogenomics developments (Roelofsen, et al. 2008). These groups ranged from farmers to bioremediation companies, and were taken as a starting point for identifying groups of participants for our focus groups. In some cases, the societal groups mentioned by the ecogenomics researchers needed further specification. For example, they stressed the importance of including policy makers. For the focus groups we chose to include civil servants from local government. Local government is often ‘problem owner’ in the case of polluted soils, and deals directly with the tools used for (biological) remediation (either as an assigning body or as a controlling institution).19

The visions of the ecogenomics researchers can, however, be limited in perspective on which actors should be considered as potential future users. Therefore we also identified other relevant, but less evident, groups that might have an interest in ecogenomics developments. We identified hobbyist gardeners as expert citizens with regard to soil use. They were included as an additional group of potential future users. In contrast to the other groups of future users, their interest in soil use is not stemming from a professional perspective, but rather from a personal interest. Their knowledge can also be considered ‘contributory expertise’ (Collins and Evans 2002) from which they can provide alternative views on ecogenomics developments.

**Recruiting participants**

Almost all future users invited for the focus groups had never heard of ecogenomics before. In contacting them we had to explain ecogenomics in a relatively simple way as a new scientific field in which insight is gained in the soil ecosystem. To emphasize the practical implications it could have for their practice, we mentioned the soil life-support functions ecogenomics tries to unravel: disease-suppressiveness, bioremediation-capacity and biodiversity. We invited the participants to discuss these developments with us, and in particular to share their knowledge of, and ideas about, current practices and problems with soil use, and their needs for the future. We also stressed the early phase ecogenomics is currently in. They were invited at a point that applications did not yet exist, but with room to adjust the developments to the practice of soil use. For some participants this was a reason not to attend the focus group, since they felt it was not relevant for them on a short term. At the same time, the early phase of the developments was an important reason for others to participate. They were

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19 Although not in the focus groups, national government as a central player in the field is involved in the process throughout the different phases (e.g. through regular informal meetings, interviews and participation in the fourth phase of the CTA process). The same holds for other relevant actors like intermediary organizations and NGOs.
Enthusiastic about contributing to the development of new technologies in this way.

Most participants were invited on the basis of their specific experience as an individual, or the specific experience of their company or institution. The farmers were however recruited in a different way. After contacting some farmers about our project, they appeared to be difficult to recruit. They often were not particularly interested in soil life and did not feel a need to discuss new technological developments in that field. It became clear that we needed to invite farmers with an interest in sustainable use of soils. Organic farmers as a group evidently meet this requirement. However, when it comes to more sustainable use of soils in agriculture, the ecogenomics researchers expected that conventional agriculture would probably benefit most from ecogenomics developments. We thus intended to involve both organic and conventional farmers. We identified one organization of organic farmers with a specific interest in soil life and one organization of conventional farmers aiming for sustainable agriculture. At annual meetings of both organizations we presented our research project and invited members of the organizations to participate. In the focus group, a balanced mix of farmers from both organizations participated. The hobbyist gardeners were also not individually recruited. We approached the chairmen of two garden parks and together with them invited hobbyist gardeners to participate in our focus group.

5.3 Methodology: focus groups

With the third phase of the CTA process we had two main purposes: (1) to gain insight in current soil practices and desires for the future, and (2) to facilitate in-depth reflection on ecogenomics developments.

1. Gain insight in current soil practices and desires for the future

The Ecogenomics Consortium aims to develop soil assessment tools that can be used in different practices like agriculture, nature conservation, and soil pollution. Within these practices, there are established ways of working, policies are in place and (inter)organizational structures have developed over time. Eventually, ecogenomics tools have to find their ways into these practices. Understanding the context is thus crucial for successful development and implementation of ecogenomics tools. For a large part, ecogenomics researchers are unfamiliar with these practices.
Nevertheless they ‘inscribe’ their assumptions about intended use into the technology and, by doing so, create a script of expected user behaviour that is materialized in the product (Akrich 1992). Chilvers (2008) emphasizes that early engagement of stakeholders in science and technology development should contribute to adequate framing of problems, alternative courses of action, and acceptability criteria.

2. Facilitate in-depth reflection on ecogenomics

Science and technology developments in ecogenomics are still in an early phase and practical applications do not yet exist. In the exploration phase of our process it became clear that societal actors were barely aware of ecogenomics developments. Interviewees specifically expressed the need for more concrete and understandable visions of the technology, in order to be able to reflect upon ecogenomics in depth. To guarantee access to information and expertise has been recognized as a core aspect of (early) public/stakeholder involvement (Chilvers 2008). In addition, we aimed to facilitate potential future users to reflect on ecogenomics from their own perspective. This gives insights in their ideas on how ecogenomics may address their needs, and the extent to which ecogenomics fits into current practices. Furthermore, multi-actor dialogues often suffer from hierarchical power relations among the actors (Lengwiler 2008). We assume that by reflecting on ecogenomics and developing their ideas about it, they are better equipped to enter the dialogue phase of the CTA process and discuss desirable futures for ecogenomics together with researchers and other relevant actors.

The focus group methodology has become widely used in academic social research, e.g. to involve the public in science and technology issues (Kupper, et al. 2007; Rowe and Frewer 2000; Dürrenberger, et al. 1999). Focus groups can be characterized as a form of group interview in which the emphasis is on the production of data and insights through a group interaction rather than on a group interview with question – response format (Barbour and Kitzinger 1999; Morgan 1997). The interactive character of focus groups stimulates the co-construction of meaning and understanding (Madriz 2000). It is specifically this element of group interaction that offers opportunities for reflecting on each other’s ideas, needs, interests, and values in the case of emerging technologies. The analysis of ideas about emerging technologies in focus groups gains legitimacy, since the analysis is made by the potential future users themselves.
Meeting the abovementioned purposes requires specific translation into a tailor-made focus group design. Interestingly, in literature only very few scholars pay explicit attention to the actual design and implementation of deliberative tools like focus groups (see for example Kupper, et al. 2007; Macnaghten, et al. 2005; Ryfe 2005; Dürenberger, et al. 1999). Here we present the focus group design we developed for the third phase of the CTA process on ecogenomics.

The focus group design
In the period of May 2006 – April 2007, nine focus groups with homogeneous groups of potential future users were organized (69 participants in total). These groups comprised farmers, people from agricultural laboratories, people from large and small soil companies, people from environmental laboratories, civil servants, nature conservators and hobbyist gardeners. Table 5.1 shows the groups and number of potential future users that were involved in the focus groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of participants</th>
<th>Number of focus groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Agricultural laboratories</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Large bioremediation companies</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Small bioremediation companies</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Environmental laboratories</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Civil servants</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Nature conservators</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Hobbyist gardeners</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>69</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

The focus group design was standardized for all groups and was semi-structured. The duration of the group discussions was two and a half hours. Each group was led by an experienced facilitator who guided the discussion, and notes were recorded by an assistant. The facilitators had substantive knowledge about ecogenomics and the practices of the participants, but were independent and impartial to the outcomes of the process. The discussions were audio taped and transcribed for further analysis. The participants consented to these recordings on conditions of anonymity and restricted use for the purpose of this study. Participants were actively involved through short individual and collective assignments while post-its and rounds were used to make sure that the ideas of
all participants were incorporated. The facilitator visualized the outcomes of the discussions on large schemes on the wall.

The collective activity in the focus groups was structured as a step-by-step process and started with more general discussions on current practices and needs for the future.

**Step 1: the current situation**
The aim of this step was to gain insight in the current practices regarding soil use, the informational elements that are currently considered relevant in work or everyday life, how this information is obtained and for what purposes. Furthermore, it aimed to clarify the relation of information about soil to other types of information used by the participants.

**Step 2: ideal situation**
In the second step, participants were asked to mention types of soil information they need or would like to use in their work or everyday life, but is not available at the moment (due to e.g. lacking knowledge and methods).

**Step 3: introducing ecogenomics**
After discussing the current situation and the needs for the future, ecogenomics was introduced to the participants. The information provided to the participants

<table>
<thead>
<tr>
<th>Application 1: Plague organisms</th>
<th>Measure the presence and activity of plague organisms in the soil.</th>
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<tbody>
<tr>
<td>Application 2: Contaminants</td>
<td>Measure the reaction of organisms in the soil to contaminants to determine the presence and bio-availability.</td>
</tr>
<tr>
<td>Application 3: Disease suppressiveness</td>
<td>Measure the presence and activity of multiple organisms with disease-suppressive capacity (e.g. antibiotic production), to gain information on the disease suppressiveness of the soil and on how to stimulate it.</td>
</tr>
<tr>
<td>Application 4: self-purifying capacity</td>
<td>Measure the presence and activity of multiple organisms with the capacity to break down contaminants, to gain information on the self-purifying capacity of the soil the speed of the break down process.</td>
</tr>
<tr>
<td>Application 5: Bioremediation</td>
<td>Discovering new organisms with the capacity to break down contaminants, and develop ways to stimulate organisms with this function.</td>
</tr>
<tr>
<td>Application 6: Soil Health</td>
<td>Measure the presence and interplay between biotic and a-biotic soil elements to say something about the health of soils.</td>
</tr>
</tbody>
</table>
Engaging with future technologies: how potential future users frame ecogenomics developments

was based on the visions of the ecogenomics researchers that were articulated in the second phase of our CTA process. We only presented limited information about the future applications, in order to let the participants articulate their own views on relevant contextual aspects. Table 5.2 shows the applications and their descriptions used for the focus groups.

Step 4: reflecting on ecogenomics
Participants were asked to reflect on the presented applications from their own perspectives. To this aim a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis was performed in which the participants jointly and constructively discussed the different ecogenomics applications. In the focus groups with hobbyist gardeners, a different approach was used in this step. Since these participants were unfamiliar with soil functions like disease-suppressiveness and bioremediation capacity, we asked them to discuss these functions first (what images or associations come up in their minds?). Then we asked them to think of advantages and disadvantages of the tools.

Step 5: evaluation
As a last step the participants were asked to reflect on the quality and usefulness of the focus group. Two weeks after the focus group, participants received a detailed report and an evaluation form. They were asked about their experiences with the focus group, if they felt they had been able to give a constructive contribution, if they had any suggestions for improvement and how they felt about future participation. 34 of 69 evaluation forms were filled in and returned (49%).

Step 6: data analysis
The focus groups resulted in extensive descriptions of current soil use, desires for the future and reflections on ecogenomics. Based on the descriptions of the participants, we constructed stories for agriculture, soil pollution, nature conservation/development and hobbyist gardening. In these stories we identified different perspectives on soil use, current trends in policy, interactions between different actors and gaps between current situations and needs for the future. Subsequently we analysed the different frames of meaning from which actors make sense of ecogenomics developments.
5.4 Reflecting on the focus group discussions

Based on the results, we first reflect on the two purposes we had with the focus groups: (1) gain insight in current soil practices and needs for the future, and (2) facilitating in-depth reflection on ecogenomics. Subsequently, we present the participants experiences and reflections regarding early involvement and learning that resulted from the focus group interactions (based on the evaluations and direct observation).

Insight in current soil practices and needs for the future

The first two steps in the focus groups resulted in many reflections on the current situation and needs for the future in the different practices. Ecogenomics focuses on the assessment of the living soil. Interestingly, it became clear that living elements in the soil currently receive little attention in all practices discussed. Particularly in fields with high governmental regulation, like within the field of soil pollution, biological parameters and biological techniques to clean up contaminated sites play a minor role. In discussing desirable futures for their practice, insight in soil life was often mentioned by the participants as an important element for different reasons. Many participants pointed out the current lack of knowledge about soil life as an argument for future attention. They also stressed that the established (and often chemically based) approaches to assessing soils and the regulations that are currently in place reduce the role soil life can play at the moment. Participants from the field of soil pollution stressed that they feel there is little room for innovative approaches to assess soils, particularly in the case of assessing soil life. Participants from soil companies indicated that current rules and regulations are rigid and that there is no room for innovative approaches. If innovative approaches are used, it is time consuming to comply with the rules, and assigning bodies often do not want to waste more time than absolutely necessary. As a results, approaches like biological remediation currently comprise a small part of remediation in practice. All participants in the field of soil pollution indicated that there is currently little insight in the bioavailability of contaminants, and therefore in the actual human health risks of pollutions. Current rules and regulations are based on worst-case scenarios, and according to the participants too strict. More insight in these risks is considered desirable, and expected to lead to the development of rules and regulations which allow for a more flexible assessment in specific situations.

Also within the field of agriculture, soil life receives little attention. First of all, there
is a clear distinction between organic and conventional farming. In conventional farming the focus is on the analysis of chemical and physical soil characteristics. Furthermore, there are established tools for chemical and physical analysis, while tools to investigate soil life remain rather basic. Participants from the agricultural laboratories emphasized that the focus within conventional farming is on pathogen organisms. Within organic farming, soil life plays an important role and there is a broader perspective on what is considered relevant information about soil life. Positive indicators within the soil, like the presence of worms, are highly valued as well. Both conventional and organic farmers stressed that information about soil life is important in their daily practice. Information about soil life is informative for the amount of fertilizers needed and how to manage the soil optimally. The information is obtained both by laboratory analysis and by looking at the soil. They mentioned however, that looking at soil life using your hands and eyes is not a wide spread approach within conventional agriculture. Both farmers and participants from agricultural laboratories mentioned a current lack of knowledge about soil organisms and the meaning of their presence. More insight is expected to be valuable in predicting the chances for success for crop growth. Furthermore, a lot of pathogens in the soil are dynamic: they only strike and are present in large numbers when a crop is growing. Therefore they stressed that other parameters are needed for determining the risks for certain pathogens.

Within the field of nature conservation/development, soil life currently plays a minor role, simply because knowledge about the relation between soil life and nature conservation/development is lacking. In the Netherlands, soil plays an important role in the (re) arrangement of nature areas. It is considered more important in the development of nature than in nature conservation. Within nature conservation, the focus is more on vegetation. Information about soil life is currently not obtained and used. However, participants expressed an interest in how soil quality characterizes the type of nature, as this would be informative for determining whether the development of a certain type of nature on a specific location is realistic, and how this process should be managed. In addition they stressed a need for less expensive methods, as there is little budget within the field of nature conservation/development for additional soil measurements.

Where most groups of participants use soil analysis as an integrated element in their daily work, hobbyist gardeners work in an experimental way with the soil in their garden, without the use of laboratory analysis. Soils play an important role in their daily practice. They look at the soil and the vegetation, and feel the
structure. The presence of soil life is used by some participants as an indicator for the ‘richness’ of soils. Some enjoy experimenting with these types of observations, and use it in arranging their garden, while others are not particularly interested in information about soils and are happy with whatever grows in their garden. In discussing needs for the future concerning the use of soils, they expressed an interest in demonstrating the effectiveness of the way they handle their soils. They also showed an interest in more information about several soil elements, like soil life, effects of insecticides or how compost develops. However, this interest seems to stem from general curiosity more than from their daily use of soils, as most participants do not consider this information to be directly relevant for themselves.

**In-depth reflection on ecogenomics: different frames of meaning**

Frames have been defined by Schön and Rein (1994) as structures of belief, perception and appreciation which underlie policy positions. Intractable policy controversies arise there were contending parties hold conflicting frames. Grin and Van de Graaf (1996b) emphasized the role of interactive forms of technology assessment in; first, understanding the differences in frames of meaning of actor groups, and, second, use this understanding to optimize the debate among actors groups. Within vision assessment, this is referred to as uncovering the assumptions underlying ones own and others’ visions (Grin and Grunwald 2000). In designing and implementing interactive approaches for emerging technologies, the challenge is to stimulate actors to recognize their own and others’ perspectives on the science and technology developments (Schot 2001). Exposing and discussing different ways of framing in an early phase offers opportunities for avoiding (policy) frame conflicts further downstream the technology development process. In this section we first present the different ways of framing ecogenomics developments that we identified. Subsequently we characterize the frames of meaning according to first-order elements (practice definitions and proposed actions) and second-order elements (underlying values) (Grin and van de Graaf 1996b; Grin and van de Graaf 1996a).

**Different ways of framing ecogenomics developments**

In their guiding visions, the ecogenomics researchers emphasize the importance of natural soil functions, such as disease suppressiveness and self-purifying capacity. They often frame soil use and soil biology in disease and health terms (Roelofsen, Kloet, et al. 2010). The reflections on current soil use and ecogenomics of participants from the field of soil pollution show that this way of framing closely
connects with the needs experienced in this field. They were very interested in these new developments, and stressed that it addresses a broad experienced need in the field for more emphasis on bioavailability and the actual health risks of pollution. As a result, the discussions did not focus on the potential positive and negative aspects of ecogenomics developments, but directly focused on obstacles in rules and regulations, and the need for a new regulatory framework in order to optimally make use of ecogenomics developments. In these discussions it became clear that at policy level there are two conflicting frames in place, the biological versus the chemical frame. Successful implementation of ecogenomics tools in the field of soil pollution largely depends on the extent to which this frame conflict is successfully addressed.

Participants from the field of agriculture saw a clear connection between ecogenomics and their field. They did however stress that within agriculture there is not a wide experienced need for more attention to soil life. Currently, negative indicators (like the presence of pathogens) are considered to be important, and issues like disease suppressiveness and soil health do not receive much attention yet. Furthermore, the farmers that participated questioned whether ecogenomics tools would have only positive effects on the use of chemicals. More knowledge about pathogens might also lead to an increased use of chemicals. They emphasized the importance of understanding the interplay of a pathogen with its environment, and avoid a narrow focus on elimination of the pathogen. At the moment there seems to be only a small niche in this field that is interested in ecogenomics developments.

The focus group with nature conservators showed that the framing of ecogenomics is not in line with the way they approach soils in their daily work. They currently do not look at soils in terms of disease or health, and also did not see a direct relevance to do so. Nevertheless they tried to make connections between ecogenomics and their own perspective, and came up with other ways of framing that could be relevant for nature development and conservation. Participants indicated that they rather talk about soils in terms of resilience against e.g. natural disasters and the potential to recover from that. In thinking about how ecogenomics could be useful for them, they stressed the importance of developing a shared language.

The hobbyist gardeners, although very curious and interested in ecogenomics, did not feel a need to use ecogenomics in practice. The focus group results show
how they make sense of ecogenomics by formulating questions out of curiosity. Several participants stressed the importance of common sense and valuing your own ‘science’. They did not connect ecogenomics with actual practical needs they have, and also did not express a need to do so. In addition, they also questioned whether these tools would be simple and cheap enough to use in a garden.

**Characterizing the different frames of meaning**

In table 5.3 we characterize the frames of meaning we identified for the different practices, based on the results presented above. First order elements are referred to with practice definitions and proposed actions. Second order elements are referred to with underlying values.

Except for hobbyist gardening, all the practices discussed relate to some extent to ecogenomics on the level of second order elements. For the practice of soil pollution, ecogenomics developments address the importance of health effects and offers the opportunity to safely ground the choice for bioremediation with scientific prove and tools. For agriculture, ecogenomics offers opportunities for sustainable use of soils. It is important to realize that both the first and second order elements identified for the field of agriculture are only shared within a small niche, and not representative for the whole agricultural sector. The lack of interest of many farmers to participate indicates that their way of working is not in line with the ideas behind ecogenomics, on both first and second order elements. For nature conservation there seems to be a relation only on the level of second order elements. Nature conservators stressed the importance of natural processes of soils, while at the same time expressing a need for insight in how to intervene in these processes in order to develop a specific, desirable, type of nature. Although the kind of tools the ecogenomics consortium aims to develop at the moment does not seem directly useful for nature conservation, the participants saw additional opportunities for ecogenomics in addressing needs from their practice.

**Participant reflections on early involvement and learning**

In the evaluative rounds and evaluation forms, participants reflected on how they perceived participating in the focus group. Furthermore, direct observation of the focus groups gave information about the interaction between participants and their actual inputs in discussions. Informal dialogues with participants after the focus groups gave additional insight in how they perceived the focus group.

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20 The characteristics of ecogenomics practices are based on the guiding visions of the ecogenomics research that are presented in chapter 4.
Table 5.3 Frames of meaning

<table>
<thead>
<tr>
<th>Underlying values</th>
<th>Practice definitions</th>
<th>Proposed actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ecogenomics</strong></td>
<td>'Define ecosystem health' 'Contribute to sustainable use of soils by understanding natural soil functions like disease-suppressiveness and self-purifying capacity'</td>
<td>Develop tools that can be used to measure and optimally use natural soil functions.</td>
</tr>
<tr>
<td>Sustainability</td>
<td>'Define ecosystem health' 'Contribute to sustainable use of soils by understanding natural soil functions like disease-suppressiveness and self-purifying capacity'</td>
<td>Develop tools that can be used to measure and optimally use natural soil functions.</td>
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<td>Develop tools that can be used to measure and optimally use natural soil functions.</td>
</tr>
<tr>
<td>Human health</td>
<td>'Define ecosystem health' 'Contribute to sustainable use of soils by understanding natural soil functions like disease-suppressiveness and self-purifying capacity'</td>
<td>Develop tools that can be used to measure and optimally use natural soil functions.</td>
</tr>
<tr>
<td>Malleability of nature</td>
<td>'Define ecosystem health' 'Contribute to sustainable use of soils by understanding natural soil functions like disease-suppressiveness and self-purifying capacity'</td>
<td>Develop tools that can be used to measure and optimally use natural soil functions.</td>
</tr>
<tr>
<td><strong>Soil pollution</strong></td>
<td>'Relying on biological assessment too insecure' 'Policy focus on chemicals impedes use of biological tools'</td>
<td>Develop tools to measure bioavailability of pollution. Develop tools to assess options for bioremediation. Change rules and regulations.</td>
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<td>'Strong focus on pathogens within conventional farming' 'Biological soil assessments only used within a small niche'</td>
<td>Develop tools to predict (and improve) crop growth success. Develop tools that indicate how to improve crop growth success. Start in a small niche. Expose sector-wide problems to initiate change.</td>
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<td>Sustainability</td>
<td>'Strong focus on pathogens within conventional farming' 'Biological soil assessments only used within a small niche'</td>
<td>Develop tools to predict (and improve) crop growth success. Develop tools that indicate how to improve crop growth success. Start in a small niche. Expose sector-wide problems to initiate change.</td>
</tr>
<tr>
<td><strong>Nature conservation</strong></td>
<td>'Information about soil life currently not used' 'Interest in resilience and the potential of soils to recover' 'Natural potential versus nature development'</td>
<td>Develop tools to assess how soil characteristics relate to type of nature. Develop tools to assess options for intervening. Develop a shared language.</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>'Information about soil life currently not used' 'Interest in resilience and the potential of soils to recover' 'Natural potential versus nature development'</td>
<td>Develop tools to assess how soil characteristics relate to type of nature. Develop tools to assess options for intervening. Develop a shared language.</td>
</tr>
<tr>
<td>Naturalness</td>
<td>'Information about soil life currently not used' 'Interest in resilience and the potential of soils to recover' 'Natural potential versus nature development'</td>
<td>Develop tools to assess how soil characteristics relate to type of nature. Develop tools to assess options for intervening. Develop a shared language.</td>
</tr>
<tr>
<td>Malleability of nature</td>
<td>'Information about soil life currently not used' 'Interest in resilience and the potential of soils to recover' 'Natural potential versus nature development'</td>
<td>Develop tools to assess how soil characteristics relate to type of nature. Develop tools to assess options for intervening. Develop a shared language.</td>
</tr>
<tr>
<td><strong>Hobbyist gardening</strong></td>
<td>'Experimenting with soils and see what works well' 'Use eyes and hands' 'curious and exciting to know how soils work'</td>
<td>None</td>
</tr>
<tr>
<td>Naturalness</td>
<td>'Experimenting with soils and see what works well' 'Use eyes and hands' 'curious and exciting to know how soils work'</td>
<td>None</td>
</tr>
<tr>
<td>Experience</td>
<td>'Experimenting with soils and see what works well' 'Use eyes and hands' 'curious and exciting to know how soils work'</td>
<td>None</td>
</tr>
</tbody>
</table>
methodology and felt about the discussions and results.

The process results are particularly interesting to reflect on the challenge of involving potential future users in the absence of actual practical applications. How did the participants perceive the information about ecogenomics they were provided with? How did they feel about early involvement? And, did our methodology stimulate interaction between and learning of participants in this early stage? Below we reflect on these questions.

*Introducing ecogenomics*

Almost all participants indicated that ecogenomics developments were new to them and that they learned about ecogenomics in the focus groups. The way the topic was adapted and introduced to the different groups seemed to be sufficient with regard to the knowledge level of the participants. Several participants commented that they found the introduction about ecogenomics clear and informative, and that it gave them enough input for considering these developments from their own perspective. Interestingly, also from participants with little to no scientific background (e.g. farmers and hobbyist gardeners) we received no signals that the information was too complicated. In two cases we received feedback that the information was presented too brief. One participant from a soil company stated:

‘*Given the low knowledge level of the participants, the information about ecogenomics was rather limited and therefore it is difficult to imagine what ecogenomics aims for.*’

The information provided to the participants was indeed limited since there are currently few concrete ideas about the future of ecogenomics. As a result, the focus groups had a strong ‘visioning character’. Some participants did not feel comfortable in this situation. A civil servant commented:

‘*I need more information about what ecogenomics researchers are actually developing. That would make it easier to talk concretely about the practical use and necessity.*’

*Early involvement*

With the design of the focus groups we aimed to stimulate critical reflection on ecogenomics from the participants’ perspectives. Interestingly, not all participants were enthusiastic about discussing ecogenomics in this early stage. Some participants from soil companies expressed that they felt uncomfortable to discuss ecogenomics in the focus group. In their evaluation forms they repeatedly
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indicated that ecogenomics is currently far from practical application, and not directly of use to their companies. They therefore were reluctant to discuss ecogenomics in this phase and rather see more concrete boundary conditions and focal points for the research before discussing it. As one participant stated:

‘In my opinion you first need to make tools and policies before experimenting with new tools in practice.’

There seems to be some friction between long-term focus of ecogenomics developments, and the short-term focus of soil companies. A participant from a soil company stated:

‘We explicitly focus on short-term solutions to soil-related problems.’

On the other hand, another participant from a soil company emphasized the importance of involving companies with a more short-term vision in the technology development process:

‘In my view I was able to make a valuable contribution. Companies always approach new techniques and research methods from practice: the market. That is a crucial link which is often ignored. A lot is invented without thinking about the desirability and feasibility.’

Other participants also embraced the future oriented character of the meeting. A civil servant stressed:

‘I understand we are at the beginning of a new era, and I am curious what discoveries and developments the future holds.’

Most of the participants that filled in an evaluation form were of the opinion that addressing practical issues in an early phase of science and technology developments is important. They often stressed that this was one of the reasons why they enjoyed the meeting.

Interaction and learning

We specifically selected the focus group methodology as a site for social interaction to stimulate in-depth reflection. In particular the farmers, hobbyist gardeners and nature conservators stressed that they learned from each other’s perspectives in the meeting. The farmers that participated in the focus group repeatedly stated in their evaluation forms that the diversity of participants stimulated learning. As one farmer illustrated:

‘The diversity in background of the different participants made the meeting interesting.’

We received the same feedback from hobbyist gardeners. One of them stated:
‘The ideas and opinions of the other participants were clarifying and informative.’

A nature conservator highlighted how he experienced the discussion among each other about issues new to him:

‘What I liked where the different perspectives on ecogenomics that came up. Sometimes I did not directly know what someone was talking about, since I was unfamiliar with that way of thinking. That was very interesting to experience.’

Participants also indicated that in discussing ecogenomics from their own perspectives, they were able to make connections between science and practice. A civil servant illustrated this:

‘I feel that with this meeting we identified matches between basic science and soil policy.’

### 5.5 Discussion and conclusions

In the introduction we emphasized the challenges related to defining the relevant publics, recruiting participants and facilitating them to reflect on not yet existing technologies. Here we reflect on the extent to which we have been successful in addressing these challenges, and on the implications of our results for the future phases of the CTA process on ecogenomics.

#### Participant selection and recruitment

In the third case of the case study potential future users were identified based on the guiding visions expressed by the ecogenomics researchers. Their visions on relevant actors provided a starting point, but these might also be limited in perspective since they are unfamiliar with the actual practices, or have specific (strategic) goals. As a result, in our case we had to further specify or add certain actor groups. Reflecting back on our participant selection, it is clear that some areas of application seem closer related to ecogenomics developments than others. In the fields of soil pollution and agriculture for example, concrete needs were articulated, while this was not the case for hobbyist gardening. Although we feel our selection of future user groups was extensive enough in this phase, the selection of participants should constantly be reconsidered throughout the CTA process, as new developments might call for involving other groups of participants.

Recruiting participants posed a real challenge. It became clear that in an early
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Phase of technology developments, potential future users do not necessarily feel a need to participate. In some cases the early phase made people hesitant to participate, since: (1) they did not see a short-term relevance for their own work, (2) because they felt they would not be able to make a valuable contribution, or (3) they did not relate to the focus on soil life. The people that did participate felt challenged by the early phase of developments and the opportunity to critically discuss them from their experiences. These participants showed an interest in new developments, often relating to a desire to be innovative in their own field, or stemming from a personal interest and curiosity about the new developments. It could be argued that the resulting selection of potential future users that participated was not sufficiently broad, and certainly not representative for the fields of application. It might be that ‘early enthusiasts’ that participate substantially differ in their ideas and desires from ‘later adopters’ (Stewart and Williams 2005). However, in our opinion this does not have to be problematic in this phase. The participants were able to reflect in depth on ecogenomics based on their interests, experiences and curiosity. Within our selection of early enthusiasts there were also critical remarks regarding ecogenomics developments. Furthermore, it is important to realize that the participants provided a first contextualization from a practical perspective on which we can build in future phases by continuously broadening the actor network. This contextualization also allows for involving the public in the CTA process. It provides crucial input to reflect on whether, and how, the public will be affected by future ecogenomics developments, and on how aspects of acceptability, risks and control should be dealt with.

Using visions of ecogenomics researchers as input

In designing and evaluating complex deliberative processes, a challenging question is how to best provide lay participants with access to expert knowledge claims (Rogers-Hayden and Pidgeon 2007; Burgess and Chilvers 2006). This challenge directly applies to our case in which potential future users are involved well before products appear on the market and societal discussions are raised. We deliberately did not start the focus group discussions with presenting the ecogenomics researchers’ visions. The structuring of the focus groups was set up to first collect knowledge, ideas and perspectives on current practices and needs for the future. Subsequently, the discussion focussed on the guiding visions of the ecogenomics researchers, and the relation with what was discussed before. With this approach we aimed to reduce the risks of prior framing, i.e. presenting the positions and visions of only one group (in our case the visions of the ecogenomics
researchers) as the basic assumption (Rogers-Hayden and Pidgeon 2007). As a result, we identified not only perspectives on the ecogenomics researchers’ visions on ecogenomics, but also additional ideas about opportunities (e.g. linking up with the ‘different language’ of nature development/conservation) and limiting conditions (e.g. current rules and regulations that hinder optimal use of biological tools in practice) for ecogenomics that are currently not addressed within the Ecogenomics Consortium.

It could be argued that starting the discussions with current practices impedes creativity and a long-term perspective when thinking about needs and desires for the future and regarding ecogenomics. As a result of our approach, the needs for the future that were articulated during the focus groups closely relate to current practices. An exception is the plea for a stronger focus on soil biology in the different groups. This was often formulated as a long-term vision, given the rigid rules and regulations currently in place. This realistic nature of the visions could also be considered as an impediment to creativity, possibly suppressing more adventurous concepts (for a discussion on the potential role of science fiction in technology assessment see Miller and Bennett 2008). However, we experienced that grounding the discussion on ecogenomics in current practices made critical reflection possible. The importance of contextual analysis and the identification of underlying assumptions within vision assessment is also specifically emphasized by Grin and Grunwald (2000).

**Toward a frame-reflective discourse**

Nonexpert actors are not automatically equipped to enter a dialogue and bring in their own perspectives, ideas and concerns (Lengwiler 2008). With our focus groups we aimed to reduce asymmetry of knowledge between ecogenomics researchers and potential future users to a certain extent. Potential future users were facilitated to become acquainted with ecogenomics and reflect on it from their practice before entering a dialogue. In addition, these reflections provide ecogenomics researchers with insight in practices they are largely unfamiliar with. Ecogenomics researchers already expressed an interest in contextual aspects of ecogenomics, and in discussing their ideas with potential future users of ecogenomics and other actors (Roelofsen, et al. 2008). Reflexive engagement of ecogenomics researchers (the ‘midstream’) has been recognized as crucial when aiming to generate an impact on R&D processes (Fisher, et al. 2006). Participants of the focus groups also expressed an interest in discussing ecogenomics together with ecogenomics researchers. This commitment of both ecogenomics
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Researchers and potential future users is crucial for the success of the next phase in the CTA process (the dialogue phase).

Based on the focus group results we identified different frames of meaning from which the participants reflected on ecogenomics developments. Identifying and understanding these frames of meaning at this stage offers opportunities for designing a ‘frame-reflective discourse’ (Jelsma 2001). In the dialogue phase the aim is to facilitate both first-order learning on the level of problem definitions and solutions (resulting in incremental changes in problem-solving strategies) and second-order learning on the level of one’s own and others’ fundamental values and world views (resulting in deeper insight in problem structures and effective solutions) (Grin and van de Graaf 1996b; Grin and van de Graaf 1996a). The analysis of the frames of meaning presented in this chapter provides us with crucial information for designing an effective dialogue in which this mutual learning is achieved. However, it is important to realize that – given the restricted number of publics involved in this phase of the case study – additional frames of meaning might be present within society. In order to identify these frames, focus groups with citizens will be organized in which participants are facilitated to reflect on a broad array of potential futures for ecogenomics.

Furthermore, our results give a first insight in how the rigidity of the socio-technical regime of soil use might prevent successful introduction of ecogenomics tools in the future. Regimes are communities of actors that share a set of rules (e.g. the technological regime, science regime, user and market regime, policy regime and socio-cultural regime) (Geels 2004). A socio-technical regime comprises the regulative, normative and cognitive rules shared by these regimes (Geels 2004; Geels 2002). Within current practices regarding soil use we see strong links or shared rules between regimes. As an example, user practices regarding soil pollution and agriculture are highly regulated by rules and regulations from the governmental policy regime. In turn, these practices influence or reinforce the policy regime with established ways of working and own rules and expectations. Current rules and regulations in the policy regime, its effects on user practices, and the characteristics of these user practices (e.g. the disinterestedness of many farmers in sustainability of soils and positive soil characteristics) have often been mentioned by focus group participants as potential obstacles for implementation of ecogenomics tools in practice. In order for ecogenomics to be successfully embedded in society, the challenge for the Ecogenomics Consortium is to address these issues already in an early phase.
In the end, this deliberative process aims to result in the identification of (mis)matches between research, (policy and user) practice, and society, and the articulation of ways to realize the matches and overcome potential obstacles. Critical reflection on this process (its methodological and analytical steps, and unravelling the micro-level dynamics and interactions between participants) offers a valuable contribution to the ongoing debates on the need to open up participatory practices to a wide variety of perspectives, uncertainties and options (Chilvers 2009; Stirling 2008; Irwin 2006)