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Journal of Responsible Innovation

ISSN: 2329-9460 (Print) 2329-9037 (Online) Journal homepage: http://www.tandfonline.com/loi/tjri20

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To cite this article: Evelien de Hoop, Auke Pols & Henny Romijn (2016) Limits to responsible innovation, Journal of Responsible Innovation, 3:2, 110-134, DOI: 10.1080/23299460.2016.1231396

To link to this article: http://dx.doi.org/10.1080/23299460.2016.1231396

Published online: 22 Sep 2016.

JOURNAL OF RESPONSIBLE INNOVATION, 2016
VOL. 3, NO. 2, 110–134
http://dx.doi.org/10.1080/23299460.2016.1231396

Routledge
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RESEARCH ARTICLE

OPEN ACCESS

Limits to responsible innovation

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ABSTRACT

Responsible Innovation (RI) is a young field of research that has nevertheless had remarkable successes in dissemination within academic and political circles. However, there is relatively little awareness of its limits, blind spots and situations in which it cannot be used for actual innovation trajectories. Without such awareness, there is a risk that RI may get hollowed out and turned into a tool for 'greenwashing'. To examine RI's limits, we present a case study on biofuel innovation in Hassan, South India. This case study demonstrates that there are important barriers that may make it difficult to conduct innovation according to RI values. In particular, we highlight the following factors that emerge from our case study and need more attention in order to be included and adequately theorised in the RI literature: material barriers to innovation, engagement with abandoning or reducing existing practices as a consequence of innovation, power differences and dependencies, (un)clear demarcation of responsibilities, strategic behaviour and, lastly, different, diverging and even contradictory interests. We demonstrate that such factors may obstruct the possibility to innovate in a responsible way, leading us to our core observation that RI should be about innovating responsibly – or not innovating at all.

ARTICLE HISTORY
Received 29 May 2015
Accepted 27 August 2016

KEYWORDS
Responsible innovation; biofuels; global south; power; stakeholder involvement

1. Introduction

Research and innovation are vital for progress, increasing human welfare and solving societal challenges. At least, that is the common claim within the neoliberalist modernisation paradigm adopted by many Western countries (e.g. Grossman and Krueger 1995). 'Innovation' in this paradigm is mostly conceptualised as technical, economically profitable and inherently good (Blok and Lemmens 2015). Yet research and innovation do not automatically lead to a societally desirable and ethically acceptable combination of profits, societal welfare and environmental sustainability: the 'division of labour' model where universities do research, businesses innovate and citizens and consumers automatically benefit has been criticised on a number of grounds.

Van den Hoven (2014) gives the Dutch examples of the smart electricity meter and the electronic patient record system, two cases where top-down, large-scale technical

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innovations were initially rejected by the public. Both projects have since been restarted, but their initial failures represent a substantial investment of effort and money, and they are hardly exceptions to the rule. Clashes between scientists/innovators and public stakeholders regarding biotechnology, nanotechnology and new energy technologies such as biofuels and shale gas have raised the demand for *legitimisation* of research and innovation. More generally, Funtowicz and Ravetz (1993) have argued that many current challenges to society are characterised by high complexity, much uncertainty and strong value disagreements. They claim that expert-driven disciplinary science is poorly equipped to deal with these kinds of challenges and rather advocate systemic, interdisciplinary research, abandonment of the fact-value distinction and participation of public stakeholders. In short, it has been argued that tackling current societal challenges requires new ways of doing research and innovation. This has led to the development of various approaches such as participatory design, (Constructive) Technology Assessment and Value-Sensitive Design (VSD); a recent addition is Responsible (Research and) Innovation (RI).

Responsible Innovation (RI) is a relatively young field of research that has nevertheless had remarkable successes in dissemination. It has its own journal, conferences and book volumes and RI as a praxis is promoted by policy-makers. In the EU, it is a cross-cutting issue under the Horizon 2020 research program, and part of the mission of the Directorate-General for research and innovation of the European Commission 'to bridge the gap between the scientific community and society at large'.[1] In the UK, it is adopted by the Engineering and Physical Sciences Research Council (EPSRC) as a framework of high-level principles that its activities and funded research should be aligned with.[2] In the Netherlands, it is a separate funding scheme of the Netherlands Organisation for Scientific Research (NWO) that has been created as part of the government's policy to stimulate the Dutch 'top sectors'.

RI is hardly a consolidated approach, but one definition that is often quoted is that by von Schomberg (2011, 9), who defines Responsible Research and Innovation as

> a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).

This process can be assigned various characteristics: Stilgoe, Owen, and Macnaghten (2013), for example, argue that it at least requires *anticipation*, *reflexivity, inclusiveness* and *responsiveness* on the part of the researchers and innovators. Anticipation is needed to foresee potential risks, dangers and public worries. Reflexivity is needed to remain aware of one's own assumptions, values, role in and responsibility for society as a researcher or innovator. Inclusiveness is needed for legitimation, public acceptance and bringing in a diversity of insights and values. Responsiveness is needed to ensure that all of this properly affects the research or innovation trajectory rather than being just another form of window-dressing.

Different actors characterise RI in very different ways: as an 'ideal', a 'concept', a 'strategy', a 'discourse' or a 'discipline or field of study' (Koops 2015, 3). Of course RI can be all of these things, though the background we have just sketched suggests that the motivation for RI research is ultimately pragmatic: it should yield us methods to apply its characteristics to real innovation processes (Davies, Glerup and Horst 2014; Van Oudheusden

2014). In this paper, we predominantly focus on RI as a process or method; procedural norms have received more attention and are more developed in the RI literature than substantive norms related to innovation outcomes, although the product- and process-based approach has also been combined (e.g. Thorstensen and Forsberg 2016; Koops 2015). Furthermore, whether or not a project adheres to (or could ever adhere to, considering reality's divergence from an ideal situation) RI's ideal norms is regarded as an issue that does not have a universal answer, and as such we refrain from making a full judgement on this matter. Instead, we limit ourselves to point out situations that may severely threaten RI.

Current discussions in literature that explicitly identifies itself as RI focus mostly on its possibilities and scope for applications to specific cases: so far, there is relatively little work on RI's limitations and failures, and what we can learn from them. In this paper we take a critical look at RI as a process that goes beyond its applicability in particular cases, to identify general factors that limit application of the RI concept to innovation processes, both with regard to the contexts in which innovation can take place and the kinds of innovations that it can be applied to.

Given the popularity of RI and the ethical as well as societal benefits of making innovation more responsible, let us explain why we would take this critical stance. Our intention is to identify circumstances in which it may be difficult or impossible to make an innovation process take place responsibly, even when a serious attempt is made to follow RI norms. Without an awareness of its limits, blind spots and situations in which it simply cannot be applied, there is a risk that many applications of RI values will nevertheless not yield innovations that are responsible in any sense of the word. Our motivation for this investigation is pragmatic as well: we think that the worst thing that can happen to RI is not that it fails, but that it is hollowed out and turned into a tool for 'greenwashing' irresponsible innovations and unjustifiedly preserving companies' reputation.[3] Awareness of factors that can complicate or break down the RI process can help to avoid this when operationalising RI principles.

This paper proceeds to explore the limits of RI in the following way. In Section 2, we compare the RI framework to three research fields with similar aims: western participatory approaches to innovation, which include several predecessors of RI, development studies research into innovation in the global South, and actor-network theory (ANT). This allows us to identify several issues that are (as yet) underconceptualised in RI, such as the role of material barriers to innovation and the influence of unequal power relations, and show why these issues should be taken into account by RI. In Sections 3–5, we move from theory to practice by presenting a case study on biofuel innovation in the Indian Hassan Bio-Fuel Park. Here we show that, even if innovators demonstrate support for RI values, innovations may nevertheless fail to proceed in a responsible way – or even at all. Thus, based on this empirical study, we argue that the issues identified in the other research fields will not 'automatically' be discovered and resolved when RI values are adhered to, but require separate attention. In Sections 6 and 7, with the help of our case study we work out these issues that limit the application of RI processes, and possible ways to deal with them, in more detail. Our core observation here is that RI is not about 'innovating responsibly': it is about 'innovating responsibly – *or not innovating at all*'. Conceptualising RI in this way makes clear that not innovating should always be a possible outcome of an RI process, which raises hitherto unasked questions regarding which factors make it likely that an irresponsible innovation process continues.

2. Family resemblances: insights from related research fields

The RI literature is not the only body of literature in which dimensions like anticipation, reflexivity, inclusion and responsiveness play a major role (Stilgoe, Owen, and Macnaghten 2013). Rather, the RI literature overlaps first of all with approaches like participatory design, constructive technology assessment (CTA) and VSD. These bodies of literature are reviewed in order to identify insights from similar yet more mature bodies of literature from which RI may benefit. Secondly, there is a clear resemblance with strands of development studies literature that deal with innovation, in the broad sense of the word (e.g. Shove and Pantzar 2005), in and for developing countries. Innovation-related work within the development studies literature has engaged with issues of anticipation, reflexivity, inclusiveness and responsiveness for decades (cf. Stilgoe, Owen, and Macnaghten 2013) and could therefore serve as a source of inspiration for literature on RI. Thirdly, the theoretical approach of ANT deals with issues of inclusion and responsiveness as well, in a way that may be rather different to RI. However, we argue that its way of looking at 'the world' can in fact be valuable to analysing RI, particularly to understand the role of materiality and *how*, instead of *whether*, innovation may become responsible. In the following paragraphs, we briefly survey these three bodies of literature and highlight some of the insights that may be of use to deepen the theoretical basis of RI and provide pointers for attention in our RI analysis in the following sections.

With regard to the first set of literature, Fisher et al. (2015) highlight that RI could benefit from socio-technical integration, drawing on, for example, Human Practices (reforming expert practice by introducing alternative values, voices and methods), VSD (augmenting local expertise by supplementing skills and considerations), Toolbox Project approach (skill-based learning within local problem frames) and Socio-Technical Integration Research and CTA (problematise existing practices and commitments). At the same time, these older bodies of literature have also been critically scrutinised. For example, one of the key issues that has been highlighted in relation to the 'politics of design' approach is the difficulty of creating technology that meets the needs of the target group when operating within existing, consolidated power structures (Pols and Spahn 2014). In their review of the literature on CTA, Genus and Coles (2005) highlight that there are often large differences in participants' ability to express themselves, and that power differences – or the ability to influence a technological development – can take many shapes. VSD has been criticised for a lack of regulation when one has to deal with competing values that cannot be reconciled or intractable disagreements (Manders-Huits 2011). Yetim (2011) argues that such situations ought to be solved by active reflection on those competing values in order to choose 'the most important one' – a solution which may not always be satisfactory and according to some falls outside the ideals of value-sensitive and participatory design. As such, the issue has been highlighted repeatedly but remains unresolved, while the RI literature interestingly has barely acknowledged that this difficulty should be dealt with.

The second set of literature with which RI shares considerable conceptual groundwork is different kinds of work on innovation in and for the global South. Korten's (1980) seminal work on the learning process approach highlighted that technological innovations for development projects were much more likely to be successful if there was room for learning not only from successes but especially from problems throughout the project.

These observations are valuable if one wants to deepen Stilgoe, Owen, and Macnaghten (2013) dimension of reflexivity. Bond and Hulme (1999) write that process approaches during the 1980s engaged with topics like experimentation, adaptation-based learning, participation, flexibility, building local capacities and organic expansion, many of which also figure prominently in the RI literature. However, the authors lament the subsequent narrowing of focus in this literature on participation during the 1990s, arguing that participation alone will not make technological innovation for development successful. Anthropologists warned about elite capture in community-driven projects that prevent them from benefiting the truly poor (e.g. Dasgupta and Beard 2007). One can infer from this that RI, if it does not start paying attention to unequal power relations and situations in which irreconcilable diverging interests come up, risks becoming similarly hollow.

In this connection we should also consider the Bottom-of-the-Pyramid (BoP) literature that came up in leading American business schools during the 2000s (e.g. Prahalad and Hart 2002) in response to a general political move away from government- and NGO-led development towards pro-poor development driven by the (western) private sector. After a few years of BoP projects that pushed low-cost, low-margin products to a mass of low-budget consumers while failing to make profits, the realisation dawned that BoP strategies should emphasise innovation as a participatory co-creation process, harnessing entrepreneurial talent within communities for the creation of local income-earning opportunities through business development (Simanis and Hart 2008). 'Inclusive' partnerships between transnational corporations, local communities and other societal stakeholders became a favoured way of working, and continuous co-learning based on participatory reflexivity and responsiveness became widely advocated – very similar to current-day RI approaches. However, these so called 'BoP 2.0' approaches still have not cracked the 'code to success' (Cañeque and Hart 2015). Projects typically encounter a range of social, institutional and material barriers to innovation reminiscent of the power and interests-related obstacles encountered in the earlier-mentioned process approaches, while beneficiaries, if any, frequently turn out to be the middle classes rather than people living below the poverty line (Sesan et al. 2013). Cañeque and Hart (2015) now propose to expand the focus towards a broader 'ecosystem' view of BoP projects, but one could ask whether this strategic zooming out is not in fact a variation of the one-sided pursuit of participation in the 1990s. The difficult implementation problems encountered by both appear to be strikingly similar. An interesting example of otherwise rare work engaging with RI and the global South suggests that these same roadblocks are also an issue in RI. Based on discussions between UK-based and Brazilian scholars, Macnaghten et al. (2014) write that for RI to be useful in the global South without becoming a neo-colonial instrument, a number of changes have to be made. These include paying explicit attention to questions of the politics of complex economic inequalities and power relations, opening up the current focus on emerging and potentially disruptive advanced technologies to include technologies that are relevant for day-to-day life in Brazil, including the explicit recognition that in some cases it might be preferable not to innovate at all, and the need to consider responsibilities in a more systemic way instead of as an issue placed at the level of the individual actors. We argue that these issues are not only specifically important in the global South as Macnaghten et al. (2014) seem to suggest. Just as we argue that the existing development studies literature

has important contributions to make to the RI literature, we also claim that our case study from Hassan district, Karnataka, India, highlights a range of important problems that RI cannot yet address, whether in the South or in the North.

The third set of literature that we analyse here is ANT. Alongside RI, ANT as discussed by Latour (2004, 2005), Callon (1986a, 1986b, 2006, 2007) and Mol (1999, 2002) has informed how the authors have understood, approached and engaged with our observations in the field. The two approaches share some important interests and ANT can be useful to deepen our understanding of RI. For example, Voeten et al. (2013) have used ANT to provide detailed understanding of why some innovators acknowledge responsibility where others do not. They argue that ANT helps to study informal institutions and the role of materiality, by which they mean the (non-intentional, for non-humans obviously do not have intentions) behaviour of everything that is material, in network development. We are primarily interested in ANT because of its overlap with RI in terms of its focus on inclusion. However, inclusion, for ANT, takes a different shape than in RI: ANT is particularly well-known for its symmetrical approach to humans and non-humans. The category 'non-human' includes everything which is material but not human: animals, things, reports, etc. Inclusion, then, becomes the inclusion of both humans and non-humans in a similar way: humans and non-humans both can and should be able to modify the situation at hand (e.g. an innovation process) through the relations those humans and non-humans have with others (Latour 2004). The process of becoming (or, in RI-language: the innovation process) is a political process in which both humans and non-humans participate. This allows us to study the role of materiality, and how materiality enables, shapes and especially blocks innovation at times: the role of material barriers to innovation are put on equal footing with ethical/social/economic/psychological barriers to innovation that arise from the human domain. Indeed, we also draw on Tania Murray Li's (2008, 2014) work to highlight that entities such as land figuring as a resource (or as a natural area, a 'wasted space', etc.) is not an intrinsic quality of the land. Instead, land being a resource arises from the assemblage (of discourses, technologies and materials such as tools, micro-organisms and the soil) that co-constitute the land and which turn it into a resource. This shifts our focus from linear causality towards agency that is distributed across a range of connected entities.

Secondly, ANT takes an interesting approach to the RI-concept of responsiveness through the combination of its concepts of translation and performativity. The concept of translation, which refers to attempts by an actor to enrol others into its network by changing those others' identities, characteristics and/or behaviours, helps to see when and how initially divergent interests are being changed, through persuasion or perhaps coercion (Callon 1986a). Callon (1986b) has used this concept for his case study on the failed innovation process of the electric vehicle in the 1970s in France. He highlights that the success of translation is never a given but depends on the capacity of an entity's network to define and enrol new entities. For example, the agency stimulating the development of the electric vehicle, the 'electricité de France' (EDF), failed to enrol car company Renault into its network as the maker of car bodies because EDF was unable to position itself as an 'obligatory point of passage': creating a situation in which Renault, in order to continue to exist, must join EDF's ventures. Translation is intimately related to the concept of performativity as, for example, proposed by Callon (2007) in his

studies on economics and markets. 'The market' as defined in theory is not a state of nature, something that is simply out there. Neither is EDF's understanding of 'the most desirable path of innovation for electric vehicles' a state of nature. Rather, such theoretical representations of the world are performative. They are brought into being through practice. The practices performed on the basis of these theoretical representations of, for example, 'the world's economic mechanisms' may (or may not, if translation fails to be successful) create those mechanisms. To understand the creation of such worlds, we need to 'trace how the webs of heterogeneous material and social practices produce them' (Law 2009, 151). While enriching the way we look at and understand our case study, ANT can make a specifically interesting contribution to the concept of responsiveness in RI: in ANT, responsiveness is not something to strive for, but it is always already there in the webs of practices that can be observed during an innovation process. The question then is not *whether* these practices are responsive to barriers to and new ideas for their innovation project, but *how* they (come to) respond.

3. Methodology

The empirical material presented in this paper is largely based on ethnographic fieldwork carried out over a period of six months, from October 2013 until March 2014 in various villages in Hassan district, Karnataka, India by the first author of this paper. This fieldwork was carried out with the aim of understanding how farmers and biofuel researchers working at Hassan Bio-Fuel Park engaged with the biofuel project in the area. Furthermore, such qualitative, observation-based fieldwork helps to elucidate the role of a wide range of human and non-human actors, and how their agency is distributed across the relations those actors have with others. Most of the fieldwork consisted of informal, repeated visits to farmers in their homes and while at work in the field. This ethnographic work entailed participant observation of harvesting biodiesel oilseeds and a wide range of other farm work, as well as lengthy, informal conversations with farmers in their fields or homes. During these conversations, farmers spoke about their farming practices, their engagement with the Bio-Fuel Park and a host of other issues that came up in relation to these topics which sometimes were unexpectedly important to understanding these farmers' points of view. In addition, the first author accompanied Hassan Bio-Fuel Park's field staff on their first visits to villages, during which the field staff had the aim of encouraging its inhabitants to join the project.

Saturation, or the point at which no new themes or insights occurred (cf. Guest, Bunce, and Johnson 2006), was ensured in three ways. Firstly, while fieldwork engaged with approximately 200 individuals in total, around 15 farming families were visited regularly throughout the fieldwork period, discussing similar topics at different points in time with them until no new points of view were mentioned by them.[4] Secondly, incidental conversations with people who were not followed throughout the fieldwork served to triangulate the observations made with the first group of people. Thirdly, whenever possible, the same topic was discussed both in theory (at respondents' homes, just talking) and in practice. For example, the advantages and disadvantages of spending a lot of time collecting oilseeds were discussed while drinking tea at a farmer's home as well as while actually doing this work out in the fields. In addition, the first author observed meetings of the village councils and sessions organised by field staff of Hassan's biofuel research centre for farmers, both in

the villages and in the research centre, and had numerous conversations of varying length with the research centre's research and field staff. Furthermore, 14 semi-structured interviews were carried out with researchers and politicians based in Hassan and in Bangalore, the capital of Karnataka state. These interviews were combined with observations at two stakeholder meetings organised by politicians in Bangalore and Delhi. In order to understand the views of both farmers and field staff working at Hassan Bio-Fuel Park on the author's observations, discussions about these observations took place to a limited extent during fieldwork, avoiding steering their behaviour and answers to the questions asked by the first author. In October 2015, more in-depth discussions were possible during a return visit to some of the villages in which fieldwork was carried out. This provided extra insights on farmers' reflections on the project.

4. Biofuel production Hassan – in theory

In India as well as globally, interest in *Jatropha curcas* as a biodiesel feedstock soared to great heights in the early years of the twenty-first century, only to crash spectacularly just a few years later (Kant and Wu 2011) as it was discovered that the 'wonder-crop' struggled to give commercially attractive yields, even with substantial inputs (van Eijck et al. 2013; Axelsson, Franzén, and Ostwald 2012). More importantly, high expectations from Jatropha production had led to problems like land grabbing (Baka 2014; Lahiri 2009). Companies ran away from contracts with smallholder farmers as soon as news on disappointing yields started spreading (Ariza-Montobbio et al. 2010). The fact that Jatropha grown for commercial biodiesel production requires sizeable inputs of water, fertilisers and pesticides (Rajagopal 2008) raises serious questions over whether it delivered the 'green fuel' solution that airline carriers such as KLM and Lufthansa had claimed it to be (Bryce 2013).

One of the very few biodiesel projects in India that is still active at the time of writing is the Hassan Bio-Fuel Park, located in Hassan district, Karnataka state. Run by the University of Agricultural Sciences Bangalore and partly funded by the Karnataka State Biofuel Development Board (KSBDB), its promoters argue that their approach avoids all above-mentioned problems. The project's coordinator says he runs this project driven by an internal motivation to improve both the quality of the natural environment and people's lives, and, along with the other researchers working for the project, criticises other approaches to biodiesel production which only take the benefits for the natural environment into account while reducing the quality of life of people with very low incomes. He highlights that he keeps on going, despite challenges in securing sufficient funding and the fact that the project requires him to travel the four hour journey between Hassan and Bangalore at least once a week.[5]

Rather than focusing on *Jatropha* alone, the researchers and their field staff working at the Hassan Bio-Fuel Park distribute seedlings of five to seven different species to farmers, free of cost. As observed when visiting villages along with Hassan Bio-Fuel Park field staff, these farmers are advised to plant them only on the edges of their land or in their backyards, after having been informed about the fact that the oil from these trees can be used to run diesel engines. The field staff tell the farmers that, except during the first year, the trees would not need any inputs due to their vicinity to cropland and actively encourage farmers to participate in the project because of this low-care characteristic. An elaborate system of

mobilising farmers to collect oilseeds and sell them directly to the Bio-Fuel Park through the formation of 'biofuel associations' in each village is also part of the project. In short, the researchers and their field staff attempt to 'translate' farmers into people who grow these biofuel saplings on the edges of their lands, take moderate care of them, collect the seeds and sell them to the field staff.

The researchers or innovators who run this project do not explicitly present their project under the RI banner, but their conceptualisation of the project includes the four dimensions of RI as outlined by Stilgoe, Owen, and Macnaghten (2013). According to the project's coordinator and all other staff working at the research centre, the project is specifically focussed on developing an innovation (biodiesel production) that will lead to responsible outcomes: more income for small-scale farmers, the availability of a green fuel and avoiding negative impacts on people and the environment. As far as RI as a process is concerned, following Stilgoe, Owen, and Macnaghten (2013), there is a substantial amount of anticipation. For example, the project coordinator repeatedly stressed he wanted to avoid risk as much as possible for the farmers who participate in the project by making sure that the project never infringed on farmers' main source of income. He also dealt with a wide range of 'what if' questions with regard to the marketing of biodiesel by building up relations with different kinds of potential buyers of the biodiesel such as petrol company Bharat Petroleum, Bangalore's public transportation company BMTC and Boeing. Farmers also expressed anticipation and reflexiveness. For example, they said they only planted a limited number of oilseed trees on the edges of their land because they were not yet sure what to expect from these new species so they also kept space for trees of which they already knew the usefulness. In addition, they were reflexive about their choices to gather or not to gather oilseeds during a particular season, explaining these choices in great detail when asked about this during fieldwork. The project also aims to be inclusive, with an explicit focus on involving farmers and soliciting their feedback on the project during visits to villages, while events organised at the Hassan Bio-Fuel Park research station always included both formal (during plenary meetings) and informal (during lunch) farmer feedback sessions. This information is sometimes used to change the project. For example, during an informal conversation at the park's office, a senior researcher working at Hassan Bio-Fuel Park explained how farmers' complaints about a particular machine to extract oil from the harvested *Pongamia* seeds led to the design of a more robust machine: a clear example of being reflexive and responsive. This person had recently obtained his Ph.D. from the University of Agricultural Sciences in Bangalore, and strongly believed in the potential benefits farmers and the environment could gain from the project's innovative approach to the production of biodiesel. He also stressed that the project was still in its start-up phase, and that a lot needed to be learnt through experimentation and interaction.

5. Outcomes of the Hassan Bio-Fuel Park project

In practice, there are a lot of problems with this project. This section will outline material problems that become visible by following the life-course of a tree used for biodiesel production chronologically. To start, farmers were generally willing to plant saplings of various kinds of oilseed-producing trees and shrubs around their land or near their houses, but they did not become the kind of farmers that the Bio-Fuel Park was trying

to translate them into. For many farmers, the number of saplings that could be planted was limited: these spaces were also used to grow timber and fruit trees as well as bushes of various kinds for firewood and animal grazing. Hence, upscaling this project from growing just a few biodiesel trees or bushes during the experimental phase to growing 20, 30 or more on the land of one farmer would imply discontinuing these practices. Furthermore, very few saplings reached maturity due to a lack of water: the rains were not sufficient and most farmers resisted the suggestion of watering the saplings because during dry spells there was not even enough water for their household needs. Only saplings planted on the edges of (scarce) irrigated land survived. The assemblage (cf. Li 2014) of human farmers' practices and the non-human absence of sufficient quantities of water for irrigation as well as the presence of other, more useful trees together meant that farmers did not plant saplings in large numbers and that those saplings that were planted had trouble surviving. So together, these entities acted as a material barrier to biodiesel innovation. While farmers continued their farming practices as usual in response to these barriers, the responsiveness of the project's researchers was limited: they testified they could not solve these problems and instead put more effort into convincing farmers of the benefits they could gain from participating more actively even though farmers clearly said they did not gain much from growing biodiesel trees and collecting oilseeds.

Some of these biofuel trees and bushes had been present in the rural landscape for a long time, which means that mature specimens could be found as well, and which could therefore be a rich source of oilseeds. However, people noted that there were fewer and fewer of these trees. The following remark from a farmer, proudly presenting his still-standing mature *Pongamia* trees, is representative of a widely present attitude towards these trees:

> See, these are my *Pongamia* trees. My father planted them. They are nice, big. Every year I collect about one hundred kilos of seeds from the lot of them. But it is hard work. Nowadays, the people who earn money from brick-making offer a good price for the stems of these trees. I need some cash now. After I cut them and sell them, I am planning to grow silver oak [a fast-growing timber species popular in pulp- and paper industries]. No need for maintenance, and I will earn a lot of money when I cut them after ten years.

Silver oak trees are able to provide this farmer with good income within a reasonable timespan considering the growth rate of trees, and he has to do almost no work for this. Collecting oilseeds and preparing them for the market is a very time-consuming task. *Pongamia* characteristics made the tree not only a producer of oilseeds but also a producer of timber that the local brick-making industries desired. So changing conditions (e.g. higher wages to be earned as daily wages worker, a good market for the wood of these trees) meant that the overall trade in *Pongamia* seeds had reduced considerably over the past decade: traders in the region estimated that the volume of oilseed trade had dropped to only one fourth of what it used to be 10 years ago. While the oil from these seeds was originally mostly sold to soap producers located about 1000 km away, this product flow had declined. Since the onset of the Bio-Fuel Park project this had only decreased further because the Bio-Fuel Park bought up a lot of the seeds in the area while failing to increase oilseed production. This shows that achieving a sizeable production of biodiesel is difficult because such production would require 'exnovation' or

the abandonment of important existing practices: the production of soap, and the use of gardens and edges of cropland to grow a wide range of trees and shrubs for fruit, timber, fodder and firewood. Of course, innovation and concomitant exnovation are going on all the time, and farmers may exnovate long-standing practices themselves. However, a good RI process should anticipate and take into account what kinds of exnovations the innovation at hand would require at that point in time, and assess the (monetary and non-monetary) costs of such exnovation in relation to the potential benefits of the innovation for the stakeholders involved.

At the same time, the Bio-Fuel Park Hassan project is influential in promoting the creation of a strong pro-biofuel policy in Karnataka state. Yet while this policy accommodates for projects such as the one in Hassan, it primarily facilitates and promotes large-scale plantation-type biodiesel projects. These are likely to attract the kinds of critiques mentioned at the start of this section, such as land grabbing and competing with food production for a range of inputs including land, fertilisers, water, and pesticides (Shashidara 2009) while the policy does not require the inclusion, anticipation and responsiveness that the project coordinator, who contributed heavily towards the making of this policy, claimed to be keen on (Shashidara 2009). For example, the large plantations promoted by the Karnataka policy have been repeatedly shown to exclude people from lands they used to have (informal) rights to, while the policy provides no measures to prevent such situations (e.g. Baka 2014). At the same time, Hassan Bio-Fuel Park itself did not result in RI from a product point of view either: farmers were not keen to produce more biodiesel feedstock because they said they had more remunerative income opportunities. As such, while the project did not have any seriously negative effects on people and environment in Hassan district, the project did not generate more income for farmers nor did it increase the availability of feedstock for the production of green fuel. To understand how this could have happened, and to study whether or how this project can be understood as RI from a process perspective, we extend our focus on the interaction between many of the different entities involved in the project: the process of innovation, or, in Law's (2009) terminology, the webs of heterogeneous material and social practices that produce reality.

6. Biodiesel production in Hassan as an innovation process

While the previous section focussed on barriers to RI emerging from the materiality of the specific innovation at hand, this section focusses on barriers that emerged during the innovation process. Hassan Bio-Fuel Park's researchers and field staff are the ones who provided knowledge and materials (saplings) to the farmers. They also paid the villagers for the seeds they collected – if farmers decided to sell to the researchers and not to traders on the weekly market. In some cases, they had access to government funding to reward farmers who planted a few saplings. In addition, farmers who associated themselves with these higher educated people got considerable social status by acting as spokespersons for the entire village. In other words: the researchers had a lot to offer which the farmers wanted: money, status, information. Farmers who engaged with the project usually tried to draw the researchers and their field staff into their network, translating them according to the farmers' needs and wishes: to be access points to knowledge and power, and of course providers of some money. At the same time, they rarely contributed

to the production of biodiesel as the project's staff wanted them to do. However, the researchers, trying to translate these farmers into their biofuel project, were the ones who took decisions on the exact shape of the project: in this respect they had a lot more power than any of the farmers. These observations clearly show that power dynamics and the role of interests that go beyond the specific innovation at hand (e.g. farmers' interests in access to money, status and information, which they tried to obtain by building connections with the projects' research and field staff) are crucial factors which may problematise a RI process.

Hassan Bio-Fuel Park's innovation process is tightly intertwined with the policy-arena in Karnataka. In the policy-making arena, both the researchers and farmers associated with Hassan Bio-Fuel Park had their own agendas. Researchers such as the project coordinator and his senior members of staff could present their work to policy-makers, which mostly took place behind closed doors according to both these researchers and policy-makers in Karnataka.[6] These researchers, as well as others working for private companies or public research institutions, were able to decide how to represent it: which information they did and did not give, and the conclusions they drew from their experiences. A limited number of farmers got invited to public meetings that were supposed to inform policy-making. They had some power over the way they told their story: while researchers and policy-makers attempted to translate farmers into their projects, farmers themselves also had their own projects into which they tried to translate the researchers and policy-makers. Examples of such projects included raising one's political and social standing in the village and gaining access to certain privileges. In these meetings, the roles to be performed by participating researchers, including those from Hassan Bio-Fuel Park, and farmers were clearly visible: the researchers provided knowledge based on their research. They were there to educate the public and politicians on the different possibilities associated with biofuel production. The farmers were there to testify that for them, the implementation of research results obtained by the researchers had been beneficial. Curiously, the reality of life is very different for (various kinds of) farmers than for researchers. Knowledge production based on the realities of life of farmers would look very different as a consequence. This would mean that different stakeholders in the project would be able to play the role of knowledge-producers – and indeed, in wicked problems and post-normal science it has been argued that expertise and knowledge production is not and should not be only the prerogative of the scientist (Norton 2005; Van Oudheusden 2014).

The above shows how there can be alignment in the interests and behaviour of the Hassan Bio-Fuel Park researchers and leading farmers, making them act in mutual agreement. However, such forms of strategic action, as a consequence of unequal power relations highlighted earlier in this paper, can also lead to actions that clash with each other or to actions that do not lead to the kind of sustainability which the project claims to be aiming for. Farmers generally told us – and farmers were well aware after we had spent some time in the villages that they could not get anything from us – that they did not really see the use of participating in the biodiesel project for the official purpose of oilseed production though there was not much harm in it for them either. Yet to the project's researchers and field staff some expressed considerable interest, in the hope of benefitting from the project's financial budget or from the oil press machines that were distributed to a few villages.[7] Farmers who were antagonistic to the project often did not speak up: they were in most cases less powerful in the village and did not want to

get on bad footing with their more powerful neighbours because of this topic. The project's researchers presented the whole project in a very positive way to policy-makers: they needed money to continue their work, which meant they had to create political support in order to obtain government funding. These observations are rather generic: they are part and parcel of any participative innovation project that needs to generate political support, as has been richly illustrated in the literature on participation in development projects (e.g. Bond and Hulme 1999). Because of the fact that these dynamics around the generation of political support play up in many RI-processes, and because this threatens both inclusiveness and responsiveness, they deserve more attention in the RI literature.

Another issue that could be observed in the activities of the Bio-Fuel Park project in Hassan, both in relation to farmers as well as in relation to politicians, is that there were many different, diverging and even contradictory interests at stake. Some farmers testified they participated to get the monetary reward offered just for planting saplings, others said they were mostly involved because of the prestige associated with being in direct contact with researchers, which could help them in their general political activities in the village or region. There were also a few farmers who participated because they genuinely wanted to raise these trees – though not always with the goal of collecting the trees' seeds but rather because they said they were curious how some of the newly introduced tree species would grow. A prevalent interest among all farmers was to diversify income and livelihood sources to maintain some resilience. This resulted in a preference for growing a range of crops on the edges of farmland for both monetary income and direct use like fruit, fodder and firewood. While the project's researchers said that augmenting farmers' income was among their priorities, their main interest was to get biodiesel (feedstock) production off the ground. As such, farmers and researchers had a common interest in planting a small number of saplings. But the most prominent interests of farmers and researchers clashed as soon as researchers tried to scale this up because this was not in the farmers' interests.

These clashes move up a level if one thinks of the way in which this plays out in policy. Researchers' strategic presentation of their fieldwork to policy-makers fits their overall concern of securing sufficient funding for the Bio-Fuel Park, including funding that pays the researchers' salaries and secures their jobs. The outcome is that the Karnataka state biofuel policy goes against the interests of the average smallholder farmer in many ways: it promotes block plantations on government-owned land which is often used by farmers for various non-agricultural purposes. It promotes the large-scale cultivation of crops which, so far, has not been financially remunerative nor a stable form of side-income for farmers (Shashidara 2009). Enacting this policy would mean that many resources (not only time, but also water, fertilisers and pesticides, amongst others) have to be used for the production of biodiesel, resources which are scarce in the lives of farmers. This form of biofuel innovation clearly differs strongly from the activities taking place in Hassan, and so it has actually not undergone RI-style scrutiny. The narrative through which this takes place, according to policy-makers and the first author's own observations at stakeholder meetings, is: *Hassan Bio-Fuel Park shows that producing biodiesel in a way that is beneficial to people and the environment is possible. However, we need large amounts of biodiesel to blend with fossil diesel in order to meet current national and state-level policy-targets. Therefore, large-scale plantations are necessary.* Interestingly,

when we questioned the researchers about this outcome of their lobbying activities, they tended to defend the policy: to achieve sustainable biofuel production, it needed to be promoted as much as possible, they argued. For example, in order to interest policy-makers in their biofuel work, these researchers felt they had to appeal to big business's interests with their policy texts. This situation highlights that it is important to pay explicit attention to the existence of interests that diverge between and even within actors operating in different settings in which RI norms may or may not be followed. Without acknowledging the different interests of all parties that are affected by the innovation at hand, a solution that does justice to these different interests may never be found. Moreover, the different interests, once explicated, may clash in a way that is irreconcilable. In effect, this threatens, or at least limits, RI's dimension of responsiveness. This creates a theoretical and a practical challenge for RI: the theoretical challenge is how to determine when a lack of capacity for responsiveness renders RI impossible. Its practical counterpart is how to determine capacities for responsiveness of different actors, and what should be done if capacities for responsiveness are lacking.

The assumption made by these researchers seems to be that, once an innovation has been tried and tested through the application of RI values, its result can be extended unproblematically or scaled up, producing biodiesel in order to achieve environmental gains and improve the lives of smallholder farmers at a larger scale. This assumption, however, ignores the fact that applying a technology at different scales or in different contexts requires re-innovating to some degree, and thus again attention to process norms, as has been noted by development studies researchers (Evenson and Westphal 1995).

The interaction of researchers with policy-makers highlights another problem, namely, the lack of a clear demarcation of responsibilities. Concretely, Hassan Bio-Fuel Park's researchers played a major role in the creation of a policy that goes against the interests of the average smallholder farmer while these researchers said it was their goal to defend these farmers' interests through their work. Can they be held responsible for the consequences of their role in the policy-making arena? Holding them responsible for these consequences seems overly demanding – but not holding them responsible might create 'responsibility gaps' where ultimately no one takes up responsibility when farmers are disadvantaged by policy (Tempels and Van den Belt 2016). If such issues are not adequately theorised and addressed in the RI literature, this threatens the responsiveness and reflexivity of an RI process. With respect to the dimension of reflexivity, the lack of a clear demarcation of responsibilities is part of the need to reconceptualise the moral division of labour within science and innovation as highlighted by Swierstra and Rip (2007).

The significance of these observations, which have been summarised in Table 1, extends well beyond the context of Karnataka state, or India. In the Netherlands, too, many parties are interested in replacing a significant proportion of our fossil fuels with biofuels, and this vision cannot be realised without sustained significant imports of biofuels (Bindraban et al. 2009, 11). Despite the fact that biofuel imports from developing countries are relatively modest at the moment, EU biofuel policy has had clear negative impacts on those countries already (Diop et al. 2013). Also, discourse on 'unused land' and 'wasteland' (which is supposedly freely available to grow biofuel crops on without competing with food production) and 'win–win situations' has so far kept interest in biofuel imports from developing countries alive – a discourse set within unequal power relations and

Table 1. Barriers to responsible innovation.

Barrier to RI	Dimension of RI threatened (following Stilgoe, Owen, and Macnaghten 2013)	Engagement with this barrier
Material barriers to innovation	Responsiveness	Researchers and farmers in Hassan were aware of material barriers. Farmers limited their participation in the project. The project's researchers were unable to find a solution to the barriers identified, such as water shortages.
The price of exnovating an existing practice	Anticipation; responsiveness	RI literature, to the best of our knowledge, does not explicitly discuss the importance of taking the exnovation of existing practices into account in an RI process. Similarly, the researchers at Hassan Bio-Fuel Park and policy-makers in Bangalore showed very little concern with exnovation, while the farmers clearly did take this into account, leading to their partial participation in the project.
Power differences and dependencies	Inclusiveness	Both farmers and researchers argued they had no other option but to operate within existing power structures. They were all aware of the difficulties that these power structures created and sometimes used able to use them to their own advantage.
Lack of clear demarcation of responsibilities	Reflexivity; responsiveness	This barrier particularly applies to the effect of the project's researchers trying to generate political support. They did not acknowledge responsibility for potential negative effects of Karnataka's state's biofuel policy, to which they contributed as part of solidifying their position as biofuel experts deserving support from the political establishment.
Strategic behaviour	Inclusiveness; responsiveness	Similar to the way power differences and dependencies were engaged with, both farmers and researchers argued that they had no other option but to act strategically in order to make sure their needs would be met.
Different, diverging and contradictory interests	Responsiveness	Farmers and the project's researchers each dealt with this by giving their own interests higher priority than those of others. However, considering the material barriers to innovation encountered in this project, it would be very difficult and perhaps impossible to address the interests of all stakeholders to an extent that would keep these stakeholders interested in the project.

underlain with a great diversity in vested interests (Baka 2014; Borras and Franco 2012; Levidow 2012; Exner et al. 2015). Yet many of those developing countries are characterised by similar adverse conditions and constraints to RI that we highlighted for the case of the Hassan project. Indeed, while this empirical case can be used to draw lessons that may be of relevance to biofuel innovation projects and policies outside Hassan district, it is especially valuable in terms of the many reflections it offers to deepen the work on RI.

7. Discussion and conclusion

The case study clearly displays a number of factors that may limit or threaten RI. These factors include material barriers to innovation, the price of exnovation of competing practices and innovations, various factors related to the theme of stakeholder involvement, and the absence of theories on how to turn the decision to discontinue a particular innovation process into as much a valid outcome of an RI process as the decision to innovate in a

particular direction. As we argue, these factors need and deserve to be included and adequately theorised in the RI literature in order to move towards a framework that helps make innovation, if it should take place at all, more responsible.

7.1. Material barriers to innovation

First of all, the assemblage of an absence of sufficient quantities of water, limited availability of other inputs needed to grow biodiesel crops, and the presence of other trees that were more useful for farmers jointly formed a *material barrier to innovation* in Hassan. Material barriers may not only hamper the outcome of a specific innovation, but may also limit the possibilities for the innovation process: if there are no means available to enable stakeholders to engage with each other, or to practice anticipation or reflection, this may hamper RI as per Stilgoe, Owen, and Macnaghten (2013) process-based understanding thereof. It is important to learn to recognise such material barriers to innovation and to give this a place in the RI process: if these are not recognised but treated as technological problems that can be overcome using yet another set of technologies without going through the same 'RI process' for those problem-solving technologies, one can no longer say one is doing RI. Using actor-network's symmetrical approach to humans and non-humans is a valuable starting point to theorise this, and could be combined with Li's (2008, 2014) understanding of contingency and assemblage, highlighting that an entity's characteristics are not inherent qualities but arise from the assemblage that constitutes it. The practical experience portrayed in studies reflecting on attempts by corporations to carry out BoP projects may be a source of inspiration for dealing with a range of barriers to innovation as well, as these studies exemplify that assemblages of entities rather than single factors condition the opportunities for successful social innovation (Latour 2005; Andersen and Esbjerg 2012).

7.2. The price of exnovation

Secondly, the Hassan biofuel project clearly showed that a sizeable production of biodiesel would require abandoning or reducing engagement with various existing practices, such as growing trees for timber, fruit, fodder and firewood, the practice of risk-spreading, working as a daily wages worker who earns more than someone collecting oilseeds, using the oilseeds for soap production, etc. Yet, what we dub *the price of exnovation* here is rarely conceptualised in RI, as highlighted by Blok and Lemmens (2015), even though innovation generally uses resources that were previously used for other purposes, makes existing technologies obsolete and thereby overthrows social and economic systems (Kroesen, Darson, and Ndegwah 2015). Conceptualising innovation as creative destruction, following Schumpeter (1942), presents us with the possibility that a proposed innovation can unavoidably destroy, seriously risk or sacrifice something that is so good, beneficial or otherwise so ethically valuable that the reasons for innovating will always be outweighed by the reasons against it. An example of these kinds of technologies are first-generation biofuels: many people have opposed using food crops for fuel on the grounds that having more fuel should never come at the cost of driving up food prices and exacerbating hunger (Gamborg et al. 2012; Pols and Spahn 2014). Clearly, innovation can only be responsible if it takes into account what has to be sacrificed during innovation,

which means that this should be adequately theorised in the RI literature. If the sacrifices are so large that they delegitimise the innovation process at hand, all those included in the RI process may come to abandon a particular test or innovation. Hence our observation that RI is at its core about innovating responsibly – or not innovating at all.

7.3. Stakeholder involvement

Thirdly, our account displays a range of problems related to stakeholder involvement and participation. This lies at the heart of the RI literature, for the term 'responsible' or 'responsibility' has been strongly tied up with this theme (Koops 2015) to the point where RI has even been defined in those terms (e.g. Taebi et al. 2014). As such, RI has been criticised for assuming that stakeholders will generally cooperate, try to align interests and harmoniously strive for consensus (Blok 2014; van Oudheusden 2014). This is understandable insofar RI has roots in Habermasian theories on procedural justice and deliberative democracy, which start with defining just norms for an ideal situation – in which stakeholders contain all those characteristics – and then investigate how these norms should be implemented in our non-ideal reality. However, reality, as these authors note, can be very different from the Habermasian ideal. Including this ideal as part of the theoretical basis of RI can thus at best make it difficult to carry out a successful RI process and at worst make it simply impossible. Indeed, our case study shows several ways in which stakeholders did not cooperate, try to align interests or harmoniously strive for consensus. For example, the project was full of *power differences and dependencies*. Researchers had power over the way they went about implementing the project, and farmers had to function within the boundaries set by the researchers. While farmers of course tried to stretch these boundaries, they were dependent on the researchers and their field staff for knowledge, seedlings and monetary compensation for their participation. Researchers were similarly dependent on policy-makers for various kinds of material and non-material support for the project, while the policy-makers were the ones who got to decide what Karnataka's biofuel policy would look like and how much support Hassan Bio-Fuel Park was to receive. These are just a few examples of the way power, or the ability to translate others into one's project, was unequally distributed in this particular case. Much of this cannot be changed very easily: power differences always remain, if only because certain parties such as the government have to turn the results of deliberation into policy and enact that policy, while others do not.[8] Indeed, it is in many cases questionable whether or how these unequal power relations should be changed. It is nevertheless important to take note of these unequal power relations because they play important roles in the innovation process, both directly as well as indirectly. For example, if one party is powerful enough to drive the innovation by itself, the prospects for RI are bleak. Examples include dictatorial governments (e.g. Kothari (2007) on the construction of Sudan's Merowe dam) and companies that have a powerful or monopoly position. Inspiration to theorise dealing adequately with power differences in a process of RI can be drawn from a range of sources which include, but are not limited to, the literatures on the politics of design and CTA which have frequently encountered power differences in innovation processes. According to Macnaghten et al. (2014) paying due attention to power structures is particularly important when trying to innovate responsibly in the global South.

While we argue that the role of 'knowledge producer' should be redefined and distributed differently across participating stakeholders, we also highlight problems associated with a *lack of clear demarcation of responsibilities*. In particular, we showed that it was unclear who was to be held accountable for Karnataka's biofuel policy, a result of both lobbying and policy-writing by researchers and the final policy proclamation by politicians. This situation can be characterised as a 'many hands problem' (Van de Poel et al. 2012), where many parties are involved in a decision yet none of them can reasonably be held individually responsible for its consequences. Without a clear demarcation of responsibilities, one may also encounter accountability problems as it is not always clear who, if anyone, should be held accountable for particular problems (Balkema and Pols 2015; Setiawan and Singh 2015; Voeten et al. 2014). This is likely to get worse if innovations have a large or global scope, meaning that there are many different stakeholders and anticipation and reflectivity are difficult; if the stakeholders are spread out or disorganised and thus may have difficulties participating or mobilising for an accountability procedure; and if the innovation is radically new, making it difficult to reasonably foresee its consequences ahead of time (Blok and Lemmens 2015; Macnaghten et al. 2014).

Another issue that can very clearly be observed in Hassan is that of *strategic behaviour*. Farmers tried to please researchers and policy-makers to get access to knowledge, money, status, etc. Researchers and their field staff presented the benefits of growing biodiesel crops to farmers in a particularly rosy way hoping that the farmers would start to cultivate and harvest these crops. While in an ideal deliberation process stakeholders are open and transparent about their motivations and reasons, this is clearly not the case in practice. While strategic reasoning does not have to make RI impossible, the chances of RI are low when one or more powerful parties have strong motivations to lie, present half-truths or hide vital information, and when checking their claims is difficult due to the need for specific expertise. A useful starting point for dealing with strategic behaviour is the literature on deliberative democracy, which has elaborated extensively on how to achieve high quality public deliberation (e.g. Chambers 2004; Mouffe 1999). Another source of inspiration may be Van Oudheusden's (2014) work, who acknowledges the role of strategic behaviour with the concepts of politics *in* deliberation and the politics *of* deliberation. This has to do with how the deliberative process is set up and how its results are used. This includes issues of who organises and moderates the process; who participates in the framing of the problem under discussion; who determines which parties are 'legitimate stakeholders' and what the motivation is for having a deliberative process in the first place (cf. Taebi et al. 2014).

Strategic behaviour does not only stem from power differences but also from the fact that stakeholders have *different, diverging and even contradictory interests* in the innovation process. In Hassan, interests were contradictory when biodiesel crops were not able to provide farmers with a secure and reasonably high income compared to other income-generating activities. This made it impossible for researchers to scale up biodiesel production. The theoretical umbrella for all these practical problems is what Blok (2014) has called the *stakeholder paradox*. Any decision process, including RI processes, gains more legitimacy as more affected parties are involved in the process. The paradox is that, if all those involved parties have clear viewpoints and problem framings, deliberation becomes meaningful but it will also become more difficult to achieve a consensus. Depending on the nature of the diverging or contradictory interests, it may be possible

for parties to alter their viewpoints through a good RI process, for conflicts to generate new ideas and options (Swierstra and Rip 2007) and for ideologically opposed parties to agree upon actions or policies that serve the interests of both (Norton 2005, Chap. 4). All of this, however, depends on the willingness of parties to be open to each other, to see the process as not only a venue for self-expression, but also as a way to get to know the other and as a means of self-evaluation (e.g. by understanding other parties' points of view or through other parties' appeals to an actor's self-interests).

7.4. RI is about innovating responsibly – or not at all

At the same time, there will be cases in which diverging interests turn out to be irreconcilable. This may occur due to disagreements on a fundamental level or on when too many different aspects of a problem clash, making meaningful progress impossible (see e.g. Bovenkerk (2012) on the biotechnology debate). Other barriers to RI, as identified in Table 1, may also make RI very difficult if not impossible. These include material barriers to innovation, the price of exnovating an existing practice and power differences and dependencies. This particular case study is in fact an example of innovation which has to cope with a combination of these three barriers. In the current economic situation, it is impossible to combine a profit-driven interest (both farmers and companies would want to earn money from labour and money invested) in biodiesel production using non-edible oil as feedstock with a sustainability-driven interest of replacing petro-diesel with environmentally-friendly biodiesel. Our observations as well as those by many others (e.g. Ariza-Montobbio et al. 2010; Kant and Wu 2011) suggest that financially viable biodiesel production from jatropha and pongamia for large-scale blending with petro-diesel requires the use of sizeable quantities of water, land, pesticides and fertilisers. These are also needed for food production as well as the production of soap, timber, fodder, etc. The production of pesticides and fertilisers as well as their use on agricultural land can have considerable environmental impacts. Indeed, the well-meant attempts by Hassan Bio-Fuel Park researchers to foster the cultivation of biodiesel crops in a way that aligns with farmers' interests and is environmentally benign so far have failed, as is evident from the lack of yields.

If, in the context of an assemblage of material barriers to innovation and the price of exnovating existing practices, interests cannot be reconciled to the point that some compromise can be reached, a valid outcome of an RI process as described by Stilgoe, Owen, and Macnaghten (2013) would be not to innovate, or to abandon the ongoing innovation practice. In this case study that would mean to discontinue attempts to produce biodiesel to be used for blending with petro-diesel. In other words: the option of discontinuing the innovation project altogether should be an explicit and possible option in the RI framework, including a careful RI-based consideration of possible effects of discontinuing the innovation project. It is important to highlight that we do not imply that a (social) scientist responsible for the RI process in innovation (if such a person has been appointed at all) should, when he/she deems this to be right, suggest to abandon the innovation. Indeed, following Stilgoe, Owen, and Macnaghten (2013), the role of the social scientist should rather be to safeguard the process and reflect on this process. In order to facilitate the decision to abandon the ongoing innovation process when appropriate, including this option in the RI framework is not enough. Rather, the framework should also take

power inequalities, strategic action and diverging interests much more seriously. Of course, diverging interests could lead to a situation in which no consensus can be reached on whether to innovate (and if so, how) or not to innovate (and if so, how to phase out whatever was already in place). This means that our core observation, namely that 'RI is about innovating responsibly – or not at all' should be the start of further thinking about this conundrum.

To close, we would like to note that there is another reason to consider not innovating as a possible outcome of an RI process that reaches back to the beginning of this paper, and that follows from the RI ideals themselves. EU-based innovation takes place in the political neoliberal modernisation paradigm that assumes that innovation in general is good for economic growth and societal welfare. However, both the neoliberal (Levidow, Papaioannou, and Birch 2012) and the modernisation (Derclaye 2012) aspects of this paradigm have been challenged, and it has been noted that 'the "gains of progress" also claim many casualties' (Rist 1999, 98). Considering whether 'innovating' is the right answer to a given problem is thus not just putting another option for action on the table: it is exhibiting reflexivity on the broader political context in which the innovation is suggested or even championed. Such reflexivity requires acknowledging that stakeholders may adhere to paradigms in which innovation and possibly also the problem at hand are conceptualised differently. This implies that following RI process norms and including those paradigms may sometimes lead to the conclusion that responsible stagnation (de Saille and Medvecky 2016), not RI, is the better course of action.

Notes

1. Opening statement of the 'about' section on the EC's 'Science with and for Society' programme, http://ec.europa.eu/research/swafs/index.cfm?pg=about (Accessed 27 June 2016).
2. http://www.epsrc.ac.uk/research/framework/ (Accessed 27 June 2016).
3. This worry is shared by RI researcher Jack Stilgoe in an interview with the Netherlands Organisation for Scientific Research (NWO) at http://www.nwo.nl/en/research-and-results/programmes/responsible+innovation/interview+jack+stilgoe (Accessed 27 June 2016). A similar view is expressed by Federico Vasen in his opinion piece '"Responsible innovation" is already too European'. http://www.scidev.net/global/innovation/opinion/responsible-innovation-european.html (Accessed 27 June 2016).
4. It is impossible to say how many people were followed intensely throughout this research, because it was never the case that individual farmers were followed, but rather families, of which some members were more involved in the research and others were less involved. These families were sometimes joint (extended) families sharing one household, while others consisted of parents and children only. This makes it difficult to come to a precise number.
5. The project coordinator was very hesitant to speak about the relations between his project and the state's party politics, and particularly his personal role therein. However, environmental activists whom the first author met in October 2015 told her that the project coordinator is an active member of one of India's political parties and that his work was not only driven by an interest to reduce climate change and improve the environment and the lives of marginalized people, but also by political considerations. Yet, we were unable to trace this any further due to his own silence on this topic and the absence of public documents (e.g. newspaper articles) on his activities. However, despite this potential political allegiance, the project can be characterized as aiming at responsible innovation both in discourse and in practice, as outlined below.

6. Within the Hassan Bio-Fuel Project, policy-makers can fund the project, and extend their political support, but they are not involved as active participants shaping the project. Therefore, this paper primarily focusses on the farmers and the researchers here.
7. While farmers living in villages that had received such a machine did not use it to produce oil for their own use, farmers were nevertheless interested in having such a machine. This was fuelled by a combination of curiosity, feeling proud to own a new machine and hoping that the machine would prove useful at a later stage. In one of the villages which had this machine, it also enabled farmers to demonstrate their capabilities to outside visitors as and when demanded by field staff guiding the outside visitors around in the area to show the Park's achievements.
8. Considering the importance of power differences and stakeholders' ability to partake in RI processes more generally, it would be useful to evaluate RI projects not only on the extent to which the process or its outcome could be considered responsible, but also on the extent to which a project resulted in more capacity for RI (in terms of skills learned by stakeholders, resources available to carry out RI processes, changed power dynamics, etc.) in the future. With regard to this paper's case study, the project predominantly entrenched existing power structures: those farmers who were already in charge of politics in their village got to extend their networks, while other farmers did not.

Acknowledgements

The authors would like to thank all members of farming families in Hassan district who participated in this research and the staff of Hassan Bio-Fuel Park.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research is part of the research programme 'Biofuels: sustainable innovation or gold rush?', funded by the Netherlands Organisation for Scientific Research (NWO) (award number 313-99-210).

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