
RRI and Value Chain Collaboration for Innovations Reducing Food Waste

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Abstract: To prevent food waste effectively, there is a need for a systemic approach and collaborative innovation in the food value chain. This paper analyses such collaboration from the perspective of responsible research and innovation (RRI). In RRI, not only the outcomes of innovation, but the processes of innovation, are of significance. Responsible research and innovation processes are often operationalised in terms of

anticipation, inclusion/engagement, reflection and responsiveness. In this paper we assess from a national survey, interviews, and a workshop how engagement is being practiced and perceived in the Norwegian food value chain. Our findings suggest that actors in the Norwegian food value chain to some extent have practiced engagement in collaborative innovations to reduce food waste. However, this collaboration could be more ambitious concerning the extent and mode of engagement.

Keywords: Responsible Research and Innovation; RRI; engagement; food waste; value chain collaboration; collaborative innovations

1 Background

Food waste is universally agreed as an environmental, social, and economic problem. Food waste reduction requires action at all levels in the food value chain (FAO 2019): the consumer level, company level and the level of governmental and non-governmental institutions that contribute to regulating the system. As part of the new pervasive focus on the Sustainable Development Goals (SDGs), companies are increasingly working to reduce their food waste, as food waste is included in target 12.3 under SDG 12: “By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along the production and supply chains, including post-harvest losses”. This is done either through more effective handling of waste that is produced or by preventing waste generation in the first place. In Norway the government and actors in the food value chain have signed an agreement to reduce food waste by 50 percent by 2030, and even going further than the SDG 12.3 on several points.

Reduction of food waste cannot depend on individual companies' actions alone, as this might simply shift the generation of waste from one to other parts of the food value chain. Rather, to prevent food waste effectively, a systemic approach and collaborative innovation, including regulatory, technological, social, process and market innovations, in the food value chain are required (Dahabieh et al. 2018). In the negotiated industry agreement, one of the duties is that partners are to seek collaboration in the value chain. However, such

collaborative innovations can often generate new uncertainties related to potential for economic loss, lack of consumer acceptance, uneven distribution of burdens and benefits across the food value chain, potential weakening of a company's competitive situation, etc. (Reardon et al. 2017, Zilberman et al. 2017). Thus, in order to anticipate potential challenges, reduce risk and secure broad involvement, a Responsible Research and Innovation (RRI) approach appears timely and appropriate (Owen et al. 2012, von Schomberg 2012).

RRI can be conceptualised as research and innovation that 1) has a specific focus on addressing significant societal needs and challenges; 2) actively engages and responds to a range of stakeholders; 3) anticipates potential problems, identifies alternatives and reflects on underlying values; and 4) acts and adapts according to 1–3 (Wickson & Forsberg 2015). In many cases, RRI implies curbing innovative actions that create new scientific uncertainties and value conflicts, especially related to emerging technologies (see e.g., Stilgoe 2016). However, RRI's function in generating societally positive innovative effects is held to be what distinguished RRI from the earlier ELSA studies (Ethical, Legal and Social Aspects of technology, see Zwart, Landeweerd and van Rooij, and Forsberg 2015). This harmonises well with collaborative innovations across diverse societal stakeholders to reduce food waste, as in this context we see innovations, with their inherent uncertainties, as desirable – and indeed necessary - for the food value chain to become more responsible and sustainable. As reducing food waste is an important societal goal, it would be irresponsible *not* to engage in innovation. But in an RRI perspective, it must be done right. RRI emphasises the importance of collaboration of all actors involved in innovation. While the SDGs embrace broad partnerships generally, RRI focuses more specifically on partnerships in research and innovation. Prima facie, RRI is thus a relevant perspective for addressing the challenge of responsible, collaborative innovation concerning food waste reduction in the food value chain.

2 Current understanding

Nevertheless, there is not much evidence on RRI practices in the food value chain, not to say collaboration for food waste reduction. Substantial RRI efforts have been directed towards emerging agricultural technologies (see e.g., Gremmen et al. 2019), such as biotechnology (see e.g., Chaturvedi et al. 2016). Contributions regarding more incremental innovations in the food chain are

more scarce, but we can name some: Blok et al. (2015) present an interesting study on mutual responsiveness in the Dutch food industry; Blok et al. (2017) explore the role of ethical considerations in companies' decisions to engage in innovations for healthier foods; Garst et al. (2017) discuss the role organizational motives play in product innovations for healthy food; and Haen et al. (2015) present an interdisciplinary design tool for public engagement which was used in two dialogue workshops on novel foods and naturalness.

On the subject of value chain collaboration and RRI in the food sector, there is a special issue of *Journal of Food Engineering* from 2017 where the editorial is called *Responsible research and innovation in the food value chain* (Silva et al. 2017), but the papers in the special issue are more related to technical contributions rather than discussions of RRI. If we look outside the food sector some contributions mention value chains or supply chains, but only in the context of more general discussions of RRI in industry, and not as a specific object of study. Examples here are found for instance in the 2017 – 2018 special issue of *Sustainability* on 'RRI in industry' (see the editorial, Martinuzzi et al. 2017) and in the special issue on 'Responsible innovation in the private sector' of *Journal on Chain and Network Science* (see the editorial by Scholten and Blok, 2015). In their book, Pavie et al. (2014) recommend thinking of the value chain as an ecosystem (p. 70), but they do not go into much detail on how or provide the evidence behind this.

With this brief review we see that from an RRI perspective, there is a need for a better understanding of collaboration in the value chain for ensuring responsible innovation for reducing food waste. This collaboration can include collaborating on market innovations (alternative ways to sell food), business model innovation (e.g., new ways for food delivery), process innovations (e.g., production processes in the food industry), technological innovation (e.g., innovations in ICT systems for better, real-time registration of demand), packaging innovation (e.g. new packaging materials), product innovations (e.g., smaller portions or products with longer shelf life) and more.

It is usual in RRI to distinguish between responsible research and innovation outcomes and a responsible research and innovation process. Clearly, the intended collaboration to reduce food waste in the value chain is meant to have a responsible outcome. However, in an RRI perspective collaborative

innovations should also be done in a responsible process. RRI process dimensions are often conceptualised as anticipation, inclusion, reflection and responsiveness (AIRR, see e.g., Stilgoe et al. 2013). It is not equally clear how collaborative innovation in the food value chain relates to these dimensions.

Research question

There are several research questions that should be addressed related to responsible, collaborative innovation in the food value chain. How do companies collaborate? What are the barriers and drivers for collaboration? To what extent can technological solutions enable collaboration? Is there (sufficient) trust in the food value chain for substantial food waste reduction innovations? To what extent are consumers perceived to be a chain link that should have an integrated role in collaborative food waste reduction-oriented innovations? How do food value chain collaborators engage in anticipation of future changes in consumption patterns, regulation, food production practices, etc.? To what extent are actors willing to take economic risks to achieve significant societal gains in reducing food waste? How (if at all) are the RRI process dimensions practiced in ongoing value chain collaborations? Where is there room to improve the practice of anticipation, inclusion, reflection and responsiveness in such collaborations? What is the potential role of increased collaboration for innovations in the food value chain to further reduce food waste in the food value chain as a whole? With whom and how do companies engage to ensure responsible outcomes in food waste reduction?

In this paper, we can only address a few of these questions and our selection is based on both the overall interest of the research project the study is part of (see below) and the most prominent findings from the empirical material. The overall research question is thus: *With whom and how do companies engage for responsible innovation for food waste reduction?* This means that we focus on the *engagement* aspect of the RRI process dimensions in this contribution.

Engagement in an RRI context has recently been described in the following way: “Associated with the historical decline in the authority of expert, top-down policymaking and the inclusion of new voices in the governance of science and technology, we are asking researchers and organisations here to engage in meaningful deliberation, dialogue and engagement with a wide range of stakeholders and publics on the visions, impacts and broader socio-economic

questions associated with particular research and innovation initiatives. Partially, such inclusion seeks to facilitate the articulation of radical new meanings through deliberation on the distinctive set of social, economic, political and ethical questions that a new technology would bring into being, and partially to open up the framing of issues that may challenge entrenched assumptions and commitments.” (Macnaghten, 2019, p. 15) This reflects that RRI mostly has been targeting public research and innovation, for instance, in larger funding programs on potentially controversial emerging technologies. Stilgoe et al. (2013) also connect engagement (or ‘inclusion’, which is most often used interchangeably) with concepts that are more common in the private sector such as open innovation, user-centered design and networked innovation. These approaches may have lower ambitions regarding the radical opening up of assumptions and commitments but can still be relevant.

With more knowledge of the engagement aspect, further studies can explore more in depth whether and how such engagement is conducted in an anticipatory, reflexive and responsive way.

3 Research design

In this paper, we present preliminary results from a research project that aims to provide a comprehensive diagnosis of food waste to unlock capacities for responsible innovation in the Norwegian food sector (the BREAD project - Building Responsibility and Developing Innovative Strategies for Tackling Food Waste)¹. The BREAD project’s goals are to promote the integration of RRI and corporate social responsibility (CSR) through ‘best practices’ at the company level; work out innovative solutions to reduce food waste; involve citizens as well as consumers in reflecting on the societal responsibility of food sector companies; and initiate a broad and lasting learning process across levels, opening up a broader reflection and scrutiny of assumptions and values, gathering insights to theorize possible drivers of responsible innovations in the food sector. The project works with an industry based and institutionalized partnership platform (Matvett) that was established in 2012 for the purpose of preventing and reducing food waste on behalf of food producers, retailers, wholesalers and the private food service sector. This partnership platform is in itself a responsible innovation, but further collaborative actions for responsible

¹ The BREAD project is funded by the Research Council of Norway, grant no. 299 337.

innovation will be developed in the project, partly through the engagement of Matvett. Collaboration is thus an essential interest in the project; practically through the role of Matvett and scholarly through the engagement part of RRI.

The research design of the part of the BREAD project presented here includes a workshop with Norwegian food companies, and a pilot interview study with 5 companies representing different parts of the Norwegian food value chain. In addition, we make use of a national survey targeting companies in the food value chain in Norway that was carried out in another project commissioned by Matvett.

Early in the project, a workshop with 24 representatives of companies having signed the industry agreement on halving food waste by 2030, held on October 28 2020, identified key issue for further investigation in the project. The workshop consisted of plenary presentations, group discussions, and short reports back to the plenary. In the introduction, four scenarios Matvett had had developed for the food waste situation in 2030 were presented, namely the consciousness scenario, the technology scenario, the nudging scenario, and the austerity scenario. The overall questions for discussion were: 1) Consider your own company and sector: how can the goal of halving food waste by 2030 be achieved in light of the scenarios?; and 2) What is required of collaboration between the actors in the value chain, public authorities and consumers to achieve the goal of halving food waste by 2030 in light of the scenarios? The workshop resulted in a report with recommendations, approved by the workshop participants.

The interview study discussed here was a pilot study that included five interviews with large companies from three parts of the Norwegian food system: food industry (n=2), retail (n=1) and the hospitality sector (n=2). In the broader study, we will aim to include companies with both high versus low ambitions for food waste reduction and high versus low levels of actual food waste reduction, determined through information provided in the interviews. In the pilot study, we chose the actors we expected to provide rich material on the topic, based on earlier experiences with these companies. In addition to the mentioned workshop, years of research and practical engagement on the topic of food waste of the project partners guided us to the overall research questions in the project as well key topics for the interviews. The interviews were semi-structured and

were conducted during the autumn of 2020. The interview guide covered 7 key issues including background information, strategic direction, internal measures and processes, value chain/collaboration, involvement of consumers/guests, external factors and innovation. We did not ask the companies directly about RRI, as we did not expect them to be aware of this concept. Instead, we asked about their food waste related innovation activities and engagement with other value chain actors and consumers, in order to be able to extract RRI relevant information.

The interviews were coded in the Dedoose software for mixed methods data analysis. The coding was done inductively, but as the interviews were structured around the key issues, these account for central codes in the analysis along with codes that appeared inductively from the material. The Dedoose software allows (among other things) for code counting and code co-occurrence, which will be discussed below. Quotes are translated from Norwegian by the authors.

In addition to the workshop and the interviews, the data collection also draws upon a national survey mapping companies' work with food waste. The survey was tailored to the four main divisions of the food value chain: producers, wholesalers, retailers and the hospitality sector. This means that the questions were not entirely similar, and analyses across the four sectors are difficult. The four target groups also differ substantially in terms of the number of targeted companies and response rates. For instance, there are only three large companies among retailers (the large retail chains), which all responded, but many companies in the hospitality sector (909 companies) with a very low response rate (11%). A few questions from the survey are relevant for this paper, and here only frequencies are reported.

4 Findings

Directions forward

In the workshop organised in October, the following main headlines for furthering food waste reduction in the food value chain were extracted from the group presentations:

1. Need to engage with the consumer level

2. Respect the value of the food
3. The development of technology must be adapted to industry needs
4. Increase collaboration in the value chain
5. More openness and sharing needed in the value chain
6. Emphasize other factors than just price, e.g., sustainability
7. Food waste as part of product and market innovation
8. Need involvement of other stakeholders
9. Think holistically
10. Matvett should take the lead on ambitious projects

The interviews provided more in-depth information on these points.

In general, the workshop and interviews highlight that the included companies perceive innovations to reduce food waste as important. This is also clear from the industry survey, where 100 % of the retailers confirm this, 93 % of the food industry, 91 % of the hospitality sector and 100 % of the wholesalers.

Value chain collaboration seen as key

'Value chain collaboration' is the code mostly tagged in these five interviews (47 tags). As value chain/collaboration only accounted for one out of seven overall topics, this stands out as an important topic. All five companies substantially addressed value chain collaboration. The code co-occurrence chart demonstrates that the most consistent code co-occurrence (n=11) was between 'value chain collaboration' and 'challenge/barrier'. The second most frequent code co-occurrence in the chart was between 'value chain collaboration' and 'future plans' (n=6). It is important to be cautious in interpreting these numbers as the number of interviews is so low. However, it does point to a trend we can explore qualitatively.

The perceived challenges in value chain collaboration are related to the different kinds of companies. The hotel chain mentioned that low frequency of food delivery to hotels lead to more food waste. The canteen chain stated that there is often a lack of communication to the canteens about events in the buildings, which can lead to scarcity or surplus of food. The canteen chain also revealed that the sometimes inadequate quality of the fresh fruits and vegetables received leads to waste. For smaller canteens, it is a problem that the minimum quanta they can order are too large, and more flexibility is needed. The food

industry corporation reported that the launch of a jam with shorter shelf life had failed (and the jam had to be disposed of) because it was placed without adequate visibility in the shops. There is a market push to launch new products, however, not all will succeed and there is no division of responsibility for the disposal of surplus products.

There are thus several examples where vertical collaboration (across different value chain links) in the value chain would be desirable. In addition, horizontal collaboration (across companies within the same value chain link) would reduce first-mover risk, and can lower a barrier to innovative actions on food waste reduction. The hotel chain representative suggested that an agreement among all major hotel chains in Norway of not including breakfast in the room price would mean they could leave out the buffet (which generates significant food waste) and instead offer a la carte breakfast. Alone, such an action would be economically risky. In other contexts, horizontal collaboration is not seen as equally desirable. The retail chain noted that reaching a consensus on actions might be difficult. Moreover, being a leader in food waste is a competitive advantage and more horizontal collaboration might challenge this position.

Collaboration partners

The above paragraphs suggest that an answer to the question *with whom* the companies would engage for responsible innovation, is primarily buyers and the closest suppliers. The buyers can be businesses or individual consumers. With regard to end consumers, they are mostly seen as a judge (consumer preferences determine what food waste reduction actions can be taken) or as a group that needs to be informed or cultivated related to food waste. The hotel chain has reduced plate sizes and introduced notifications in the buffets encouraging guests not to serve themselves with more food than they can eat. However, if guests or consumers reject the company because they prioritise abundance or variety of food choices more than avoiding food waste, this will be a strong barrier for the company.

Modes of collaboration

To the question of *how* companies engage with external parties in developing practices to reduce food waste, we can look at what the companies

present as good or best practices, and what they plan to do in the future. Several of the practices mentioned are related to collaborative innovations. Several actors expressed a desire for better communication across the chain links about the anticipated quantity of food needed, e.g., through the development of ICT solutions. Moreover, through dialogue, one link in the chain can inform and raise awareness of the waste generated in their link. For instance, a unit in the canteen company informed the building owner how much the disposed food accounted for in money paid by the owner. This was eye-opening for the owner and, thus, motivated better communication of expected variance in numbers of staff using the canteen, allowing the canteen to purchase more correct amounts of food.

New actors and technologies in the value chain

Over the last years, a new type of value chain actors has found its place, namely actors selling surplus food to reduced prices directly to consumers. They relieve both wholesalers and the food industry, and to a lesser extent, retailers, of food that would otherwise have been wasted. There are also 'apps' developed to inform consumers of where they can buy food at reduced prices that would otherwise have been wasted. These initiatives help companies across the value chain in their goal of halving their food waste by 2030.

From the conducted interviews, we have no information on whether consumers are involved in the companies' innovation stage, though the interviewed food industry company has such plans. It is remarkable that some of the companies perceive the need for disciplining actions, like removing trays so that guests don't help themselves to more food than they can eat. One might raise the question of whether the customers are not expected to act responsibly. If so, a question is if this is based on perception from the companies' side or actual rejection of responsibility from the customers' side.

We can compare the interview findings with the results from the industry survey. Here respondents were asked "What measures have the company introduced to reduce food waste?", and multiple replies were possible. One of the reply options was "Collaboration with other actors in the value chain to reduce food waste" and we see the following distribution in Table 1.

Table 1 Collaboration with other actors in the value chain to reduce food waste

<i>Retail</i>	<i>Food industry</i>	<i>The hospitality sector</i>	<i>Wholesale</i>
100 % (n=3)	38 % (n=21)	9% (n=7)	100 % (n=6)

Regarding the high number from retail and wholesale, we can note that these represent almost the full population. There are only a few retail and wholesale corporations in Norway, and they have a professional management with highly developed networks. The food industry, and especially the hospitality sector, is much more diverse, where some of the survey respondents are small companies (e.g., a local bakery) which are unlikely to engage in chain management. To reach these SMEs, intermediary organisations might be essential (see Arnaldi and Neresini 2019 for a discussion of such intermediary organisations in light of RRI).

Learning

Engagement in RRI is inherently connected to being open to learning and adaptation (Stilgoe et al. 2013). Four of the companies mentioned learning arenas, but these were mostly internally in the corporations. Only one company mentioned wider learning platforms, but this was not further specified in the interview. The same company stated that there is a potential for more collaboration across the food value chain but did not specify how. In the workshop, which included companies from different parts of the food value chain, several of the discussion groups indicated that they appreciated the chance to discuss with companies from other links in the chain and other sectors of the food system. As we saw from the 10 summary points from the workshop, openness and sharing was called for. But it should be noted that the workshop was framed in terms of responsible research and innovation, which might have affected the self-selection to the workshop; those who prioritised attending the workshop might be more dialogue oriented than the average in the sector.

Still, the data presented here indicate a perceived need for more engagement to overcome barriers causing food waste in the food value chain. Moreover, there is evidence that consumers are not held responsible for their

part in the generation of food waste, and they are not engaged in value chain discussions of measures for reducing such waste.

Experimentation is often connected to learning in RRI (Egeland et al. 2019). The hotel corporation mentioned that the Covid19 pandemic had necessitated experimentation. Consumers had accepted new routines in this situation and the corporation expressed hope that such experimental willingness would extend to food waste reduction experiments in years to come.

5 Discussion

Going back to the distinction between product/output and process responsibility we can suggest that existing food waste reduction innovation across the food value chain, such as communication systems, are responsible in terms of output or product characteristics. However, the RRI process dimension of engagement appears to be at a relatively embryonic stage. Though there are examples of collaboration, there is no evidence from this pilot study of a broader opening up of engagement, including consumers, where assumptions are critically discussed, and all part of the food chain (including consumers) are challenged to take a responsible stance.

It should be noted that the importance of collaboration in the value chain was a starting point and an assumption in the project. This partly explains the emphasis of this in the analyses. However, from the workshop and the interviews, it is clear that collaboration is perceived as important to progress toward the goal of halving food waste by 2030, as many low-hanging fruits in individual companies are already harvested. However, collaboration is seen as challenging.

One could argue that RRI, and especially the part asking for open questioning of values and assumptions, is not well adapted to innovation in the private sector. However, it is not only RRI asking for such opening up. Sustainable development, and the UN Sustainable Development Goals (SDGs), do request a more inclusive strategy on behalf of all actors having an impact on the world. In particular, SDG 17 (Partnerships for the Goals) explains that “A successful development agenda requires inclusive partnerships — at the global, regional, national and local levels — built upon principles and values, and upon a shared vision and shared goals placing people and the planet at the centre.”

(<https://www.un.org/sustainabledevelopment/globalpartnerships/>). Several of the major actors in the Norwegian food value chain are committed to the SDGs and as such there are several reasons for opening up collaborative innovation to a larger extent than today.

Our findings from this pilot study resonate well with Blok et al. (2015): “co-responsibility is not recognized in commercial food innovations in the private sector”. Are there reasons to believe that this finding is unique to the food value chain? Recent contributions to RRI in the private sector suggest that the situation is similar outside the food sector. Studying the ICT industry, Stahl et al. (2019) find that “public engagement is seen very much in terms of outreach to end users and not necessarily as the type of stakeholder involvement directed towards co-creation from the outset, which is the focus of the RRI public engagement pillar”. There is a need for more qualitative case studies in multiple sectors to assess the generalisability of the findings.

6 Conclusion

This paper has shed light on value chain collaboration as part of the distributed approach to responsibility advocated in RRI. From this limited study of the way the engagement dimension of RRI has been practiced in collaborative innovation for reducing food waste, we see from an RRI perspective that this collaboration could be more ambitious concerning the extent and mode of engagement. We have observed and documented how current collaborative innovation seems to focus on outputs rather than process. At the same time, there is a will among major actors to extend the collaboration. Thus, we suggest that this collaboration also should take procedural aspects into account, opening up assumptions and values, and creating mutual learning processes. We acknowledge that there are important barriers to such collaboration, where competitive edge and unevenly distributed economic risk are only two. Still, the generally recognised sustainability agenda seems to require more ambitious approaches.

The paper’s findings are relevant for further policy formation on food waste reduction, for outlining research and innovation priorities for public research and innovation programs and projects, as well as for private sector R&D.

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