



CropBooster-P

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Executive Summary

This report sets out the concepts and framework that have been used to support the development of a Responsible Research and Innovation (RRI) Strategy for a future crop-yield research programme, specifically the CropBooster Programme. All major funding programmes are aware of the need to ensure that research activities they are funding engage with ethical aspects, and define the responsibilities of the researchers and research collaborators. Setting out responsibilities also entails setting out and embedding inclusive and responsive research and innovation approaches within funding approaches. As such, an initial RRI framework has been set out for the “The CropBooster Programme”. This approach sets out the concepts and proposes some ways in which important research principles can be embedded within the future research programme.

The European Commission (EC) supports ethically sound practice and approaches across their research programmes; through their overarching policies they support research that is conducted with and for society and research that is delivered under an Open Science framework. One of the mechanisms for supporting ethically robust and socially responsible research is to set out and enact an ethical framework to support the research work, which can be done by operationalizing a Responsible Research and Innovation (RRI) Strategy. Therefore a future, large EC-funded mechanism focusing on the development of an innovative and comprehensive crop-yield research programme needs to set out a plan for the implement of an approach that incorporates important RRI elements.

In line with the current EC approaches to embedding RRI, a future CropBooster Programme will ensure that a core of six RRI elements are included, specifically (i) Research Ethics and Integrity; (ii) Gender Equality, Diversity and Inclusion; (iii) Open Science and Access; (iv) Science Communication and Education; (v) Societal, stakeholder and publics engagement including co-design and (vi) Supporting governance and policy-making. These core elements have been translated for the CropBooster Programme with a special focus on the societal, stakeholder and publics engagement with a co-design element, which has been an important element of the work of CropBooster-P and notably informs the CropBooster Programme going forward. These six RRI elements will be further operationalized by encouraging four RRI processes of reflexivity, inclusiveness, transparency and responsiveness within the CropBooster Programme.

The role and importance of ‘Engagement’ is highlighted and discussed within the RRI Strategy report. The importance of engagement with publics and stakeholders is set out, highlighting the three key aspects of why engagement in science policy, science research planning and research practice is encouraged and supported by any CropBooster programme. Engagement can be characterised as an (1) inherent responsibility, as also emphasised by the EC policies on engagement, (2) an activity that builds trusted and trusting partnerships, and (3) finally as an activity that can deliver important benefits for the research agenda and process through the provision of diverse knowledge sets, wider range of insights and different framing visions. The importance of



engagement is demonstrated within the CropBooster Programme Implementation plan and has been set up by the work of a number of the CropBooster-P workpackages.

In terms of the six core elements, a number of aspects have been specified for the CropBooster Programme. In terms of **Research Integrity and Ethics**, this element is translated as supporting excellence in research practice, high levels of integrity in research, and ensuring that appropriate research ethics processes are in place. Support for high standards of research integrity will be ensured through programme activities related to sharing standards of excellence in experimental design and adhering to legal and regulatory responsibilities, such as under the Nagoya Protocol (Regulation [EU] No 511/2014). These activities also include opportunities to discuss issues of research reproducibility and questionable research practices (QRPs), and the establishment of an Ethics Advisory Board (EAB) and an ethics team within the Programme to support ethics review and oversight. The CropBooster Programme will use and have access to a series of ethics tools and training programmes. Funded projects within the CropBooster programme will be required to produce an ethics statement in line with Horizon Europe Self-Assessment requirements. The CropBooster will also develop possibly opportunities to embed ethics-related research activities within funding activities.

Operationalizing **Equality, Diversity and Inclusion (EDI)** is achieved through clear EDI policies for the CropBooster Governance Structures, i.e. the General Assembly, Governing Board and Executive Team. This would include a policy on gender parity, inclusivity in terms of backgrounds and disciplines, as well as equity principles through clear policies on decision-making, openness and access to the decision-making bodies for all members. EDI aspects also include policies on science recruitment and career development. The CropBooster Programme will support initiatives such as the Declaration on Research Assessment (DORA) principles (<https://sfdora.org/>) across the activities of the programme and each partner will confirm and exchange information on EDI approaches to ensure standards and support dialogue.

Promoting and embedding **Open Access and Open Science** policies will involve the adoption of the current EC policies on Open Science as articulate in the Horizon Europe policies as well as demonstrating how the CropBooster Programme is implementing the FAIR principles (<https://www.go-fair.org/fair-principles/>) so that data can be Findable, Accessible, Interoperable and Reusable (FAIR). This work within the CropBooster Programme will examine what best practice data management and publication strategies can be further developed for the crop science sector. Innovative ways to create 'Open Crop Science' will also be supported as part of the wider research agenda.

Supporting an innovative approach to **Science communication and education** within the CropBooster Programme is an important cross-cutting activity. Approaches and support will be provided through the overall programme and activities will be encouraged within the research activities themselves. Traditional as well as non-traditional communication approaches will be



supported, as set out in the Communication Strategy (Deliverable 5.5). Researchers will also be encouraged to engage in science education activities that support the research area as a whole. Some of the activities supported in the future research programme may have multiple roles combining communication, education and engagement goals, and researchers will be supported to identify these opportunities. Support and training will be underpinned by the CropBooster Programme Management and Governance structures.

Developing activities that support **Societal, Stakeholder and Public Engagement** and co-design have been an important element of the work of the CropBooster-P. The mapping of stakeholder and public perspectives and expectations have been important part of the CropBooster work in workpackage 2 (see the details below). This has resulted in the development of a number of approaches to support understanding and development of a social licence for a future research programme. The RRI approach sets out the importance of the work through the articulation of the underpinning principles that support Stakeholder and Public Engagement plans for a Future CropBooster programme, emphasising the instrumental, trust-relational and ethical arguments.

As well as conducting high quality research an important part of any research programme is to have a strategic approach on how research can **Support Governance and Policy-making**. This involves both the consideration of how research planning can result in impact and policy-relevant evidence, but also how the research outcomes can be presented in accessible and transparent ways that can support and inform policy-making. Any approach involves not only principles of transparency and openness, but also clarification of limitations and uncertainties within any dataset or research finding. The future CropBooster programme will work to develop trustworthy approaches to the provision of science-based evidence for policy-making and analysis, drawing on current EC and European Parliament Initiatives.

Alongside the embedding of the six common elements, common procedural aspects of RRI will also be operationalized through a CropBooster Programme, encouraging four processes: reflexivity, inclusiveness, transparency and responsiveness. This will be operationalized through the CropBooster Programme processes related to: (a) Policies; (b) Processes and (c) People. These aspects will be further developed as the CropBooster Programme is implement and should be seen as cross-cutting when considered alongside the common six elements of RRI. The **'Policies'** component would involve ongoing RRI-related review of all CropBooster Programme policies to ensure all six RRI elements are implemented and that policies demonstrate **transparency** and **inclusivity**. The **'Processes'** component will be implemented through the RRI activities and **responsiveness** approaches within the programme governance structures, for example through the funding review process, through the research reporting processes and through the activities of the Ethics workpackage and EAB work.



Finally, the **'People'** component is intended to ensure that the programme recognizes the activities and contribution of the people with this programme, creating spaces to facilitate **reflexivity** in management and research activities. The CropBooster Programme would provide reflectivity spaces that would consider how researchers and research managers can be supported when conducting research, and also consider how to nurture research cultures that support wellbeing. This component would be reviewed and considered by the Governing Body and the Executive Committee of the Programme but can also be supported by grass-root activities at a project level.

The combination of the six elements and the four RRI processes will support the development of a Responsible Research and Innovation approach within the future CropBooster Programme.

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Table of Contents

1	Introduction.....	7
1.1	Purpose and Status of this report.....	7
1.2	CropBooster and a Future EC Large Crop-yield improvement Programme.....	8
1.3	Role of RRI Strategy	8
2	RRI Concepts	9
2.1	Responsible Practice and Ethics in Biosciences	9
2.2	Responsible Research and Innovation (RRI) and EC.....	10
2.3	Concepts of Responsible Research and Innovation (RRI)	11
3	RRI Framework and Engagement	13
3.1	Why engage with publics?	13
3.2	Many Groups: Understanding stakeholders and publics	15
4	Building Blocks for an RRI CropBooster Framework.....	18
4.1	Overarching RRI Framework.....	18
4.2	Research Ethics and Integrity	18
4.3	Equality, Diversity and Inclusion.....	19
4.4	Open Access and Open Science	19
4.5	Science communication and education.....	19
4.6	Societal, Stakeholder and Public Engagement	20
4.7	Policies, Processes and People in RRI approaches	20
5	Conclusion	21
6	References.....	22



Responsible Research and Innovation Strategy for a Future EC Large Crop-yield Programme

1 Introduction

This report sets out the concepts and framework that have been used to support the development of a draft Responsible Research and Innovation (RRI) Strategy for a future crop-yield research programme. In this first section the purpose of the report is discussed (section 1.1) and this is then linked to the development of this strategy in relation to the aim of the CropBooster-project work which is setting out a suite of tools that will support the development of a future large EC crop yields and quality improvement programme (section 1.2). Finally, the role of the RRI strategy will be confirmed (section 1.3) before the concepts and then framework for RRI in CropBooster are discussed (in sections 2 to 4).

1.1 Purpose and Status of this report

All major funding programmes are aware of the need to ensure that research activities they are funding engage with ethical aspects, and clearly define the responsibilities of the researchers and research collaborators, as well as embedding inclusive and responsive innovation approaches. Within the funding mechanism of the European Commission (EC), there is clear focus on ensuring ethically sound practice and policies as well as ensuring research is conducted with and for society. One of the mechanisms for supporting ethically robust and socially responsible research is to set out and enact an ethical framework to support the work, this can be done by defining a Responsible Research and Innovation (RRI) Strategy. Therefore, any future large EC-funded mechanism focusing on the development of an innovative and comprehensive crop-yield research programme will need to set out and implement a RRI strategy.



1.2 CropBooster and a Future EC Large Crop-yield improvement Programme

The development of this strategy and other strategy documents within CropBooster-P aim to set out a suite of tools that will support the development of a future large EC crop yield, sustainability and quality improvement programme. The aim of any Crop Yield and Quality Improvement Programme (CYQIP; an informal name that will be used in this document) is to improve agricultural yields in order to support an increasing population and doing this in a sustainable and ethical justifiable manner. Any future programme will need to focus on crop yield, sustainability and quality, but it must also set out a work programme that is informed by a clear environmental improvement framework that moves crop production away from fossil fuel dependency towards the use of sustainable energy sources and a production approach that is oriented towards a more circular economy. In order to achieve this, key questions that need to be addressed include: how can new crop cultivars be developed to adapt to a wide range of environmental and structural changes, while remaining adaptability to climate change as a core driver of change? The need for crop improvement is not only focused on increased productivity and direct improvements in yields but must also on developing innovation approaches, which are ethically robust and socially acceptable.

One way of approaching this challenge and the need for improvements in crop production is to set out clear research funding approaches that can support new areas of research, which will provide future-proofed plant and crops. Any new innovations in crop production need to ensure that increases in productivity do not negatively affect nutritional quality or have result in unsustainable environmental impacts. When prioritizing which new crop varieties should be developed, or when focusing on improvements in existing crop productivity, all innovation will need to ensure not only that the use of natural resources is limited, but that systems are developed to replenish scarce resources that may be used within agricultural systems. The development and use of new crop science innovation technologies must not result in changes in agricultural production that has negative social, economic or environmental impacts.

In order to achieve these goals it is important to set out a research and innovation roadmap that clearly frames the nature of the problem that needs to be addressed, and then set out a series of approaches, in terms of crop science innovation, that will address these problems. The approaches must combine important areas of research, from plant science through to agricultural economics, agricultural engineering, rural sociology, bioinformatics and agriculture ethics. A multidisciplinary approach is needed in order to evaluate both quantitatively and qualitatively the approaches that may be able to best address the defined problems and support the development of sustainable and equitable food systems.

1.3 Role of RRI Strategy

The development of an RRI strategy that informs the structural and procedural aspects of a large-scale funding programme requires setting out an underpinning normative framework that considers



wider issues of ethics in research. Such an approach needs to ensure that a research programme has embedded processes and available tools that support key elements, and these were originally specific as: (i) research integrity and ethics assessment; (ii) gender equality, (iii) open science, (iv) engagement and co-design with different publics, (v) wider science communication and education, as well as (vi) support for science governance and public policy-making elements. Therefore, it is important to set out a clear strategy for how any funding programme which incorporates these important Responsible Research and Innovation elements building on what has been original specified and recommended by the EC (EC 2013; 2020).

There are many ways of defining the embedded ethics and RRI approaches within a research programme which could inform any future EC funded large crop yield improvement programme. This proposed strategy will, however, be grounded through an ethics framework which draws on the European Commission's original six-pillar RRI approach.

The strategy sets out an approach that can be used at an institutional level as an approach which informs funding strategies and funding evaluation. It also sets out an approach that recommends elements needed to embed RRI within funded projects. Finally, this RRI strategy will also set out an approach for an RRI process that can support the outcomes of any research programme, in terms of the outcomes of various funded projects, being fed into policy-making in terms of both national research funders and national policymakers as well as informing European Commission policymakers.

Before discussing the details of the RRI strategy for a future crop improvement programme, it is important to set out a number of key concepts and discuss the background to RRI approaches. The later sections (section 3 and 4) will then set out different ways in which an RRI approach can be operationalized. The next section therefore highlights the concept of RRI and its development over the last 15 years and how it has influenced some of the European Commission approaches to research funding. This is then followed by a more detailed discussion of the development of an RRI strategy for a future crop yield improvement programme and initially proposes some approaches and tools that may be used in the future.

2 RRI Concepts

2.1 Responsible Practice and Ethics in Biosciences

The discussion of responsibility in research is not new within the fields of the biosciences. Issues of ethical responsibility have been prominently discussed from the 1940s and although these earlier discussions were very much focused on ethically justifiable practice within the biomedical field, issues that arise within the biosciences have been prominently discussed since early work in the field of genetics (Berg et al, 1975). There has been notable discussion about the ethical issues raised by novel technologies in the fields of agriculture and food production. These have focused on



discussing substantive issues related to particular technologies and practices. Alongside this procedural and regulatory issues that relate to who gets to decide, who is involved and how risks and impacts should be evaluated, disseminated or discussed in a public policy sphere have also been a focused of notable debate. Previous approaches to these social and ethical issues, and how scientific practice and scientists might be set out and act responsibly, have focused on applying ethical analysis through research ethics review which is conducted by research ethics committees, technology assessments and risk assessment. However, this approach alone has notable limitations.

Recognizing the need to move beyond just a traditional ethical review, a number of important tools and approaches to 'open up' the ethical discourse around the biosciences have been developed over the years. These have been developed for application to new areas of biotechnology development. However, these have tended to be applied on a one-off basis or within individual projects rather than being applied consistently across either a wider area of research or within large research programmes. In large-scale programmes within the European Commission the application of these tools and processes was previously referred to as 'ELSA programs', with ELSA standing for ethical, legal and social aspects. Alongside this there has been increasing motivation and requirements to engage different stakeholder groups and publics at every stage of the process of biotechnology development, recognizing the importance of including different individuals and groups' visions and social expectations in the development of new Bioscience technologies. Initiatives such as the UK Concordat on Engaging the Public with Research (RCUK, 2010) that is applied by all research institutes across the UK exemplifies this engagement imperative requirement.

The assessment and engagement agendas have further led to work in the area of "ethics by design" or embedded ethics approach and the development of an EC-centric approach referred to as 'Responsible Research and Innovation' (RRI). This new overarching approach was the result of recognising the need to find opportunities to integrate important aspects of ethical analysis, technology assessment and impact assessment, and wider stakeholder and public engagement. It is also complemented by work across the field of applied ethics that incorporates wider engagement activities alongside ethical analysis with a particular focus on developing empirical ethics approaches, such as evaluating stakeholder aspirations and concerns. Combining the tools from ethics and engagement work, and the policy framing of RRI within research programmes, are important steps in demonstrating that ethos of publicly funded science is being designed and conducted for and with society.

2.2 Responsible Research and Innovation (RRI) and EC

RRI is now a core agenda within European research policies. The RRI agenda as a political agenda has emerged from some of the original discussions of ethical and social responsibility set out in 2001 Science and Society Action Plan which was developed to improve the connection between science and European citizens. Further work in 2007, under the 7th Framework programme for Research



and Technological (FP7), was carried out under the Science in Society (SiS) programme, which set out as its main objective the need to 'foster public engagement and a two-way dialogue between science and civil society' (EC, 2012). The development of a framework for Responsible Research and Innovation has been the focus of SiS since 2010, where applying a RRI approach refers to societal actors working together during the whole research and innovation process in order to better align both the process and its outcomes, with the values, needs and expectations of European Society (EC, 2012).

2.3 Concepts of Responsible Research and Innovation (RRI)

Several working definitions of RRI have emerged (e.g. Douglas and Stemerding 2013; Owen et al. 2012; Stahl et al. 2014;). A prominent advocate of RRI is EC officer Rene von Schomberg (2011) who proposes that RRI is a transparent and interactive process that spans and acknowledges mutual responsibility across different actors, with the aim of addressing the 'right impacts' (von Schomberg 2011, p.2), and focusing on ethical acceptability, sustainability and societal desirability in order to achieve key positive impacts (Riberio et al, 2017). A useful definition that highlights the essence of RRI has been proposed by Stahl et al. (2014), where they state that RRI encompasses '*all aspects of the discourse concerning the question of what can be done in order to ensure that science, research, technology and innovation have positive, socially acceptable and desirable outcomes*' (Stahl et al. 2014, pp.76).

The RRI agenda was more explicitly set out in the Rome Declaration on Responsible Research and Innovation in Europe in 2014 (which builds on the earlier 2009 Lund and 2013 Vilnius Declarations). The core of the RRI agenda set out in Rome Declaration, 2014, focuses on EU citizens' rights so that decisions in research and innovation must consider the principles on which the European Union is founded, i.e. the respect of human dignity, freedom, democracy, equality, the rule of law and the respect of human rights, including the rights of persons belonging to minorities. This also extends to respect for animals and the wider biota as set out in Conventions and Directives, and has been translated in the European Commission Horizon 2020 RRI strategy, encompassing 6 'key' themes;

- Engagement
- Gender Equality
- Science Education
- Open Access
- Ethics
- Governance

These overarching key themes can then be operationalized through policies, guidance, criteria and wider activities.

2.4 Approaches to Responsible Research and Innovation (RRI) in Research



There are several ways in which RRI has been taken forward more recently by researchers and RR developers, and also more formally by the European Commission in terms of research funding guidance and research on RRI approaches. Of course, alongside the six core themes, there are also a series of processes. As described by Forsberg et al (2021) RRI can be operationalized as five RRI policy keys (also called thematic elements) and four RRI process dimensions, central to current theoretical understandings of what constitutes RRI Practices (e.g. Owen et al. 2012; Stilgoe et al. 2013). One way that RRI can be implemented can be through five RRI Keys (listed below), with the addition of a clear governance dimension to ensure direct interaction with policy aspects are present. These six key dimensions can be defined as: (i) Ethics; (ii) Gender Equality and Diversity; (iii) Open Access and Open Science; (iv) Science Education; (v) Societal, Stakeholder and Public Engagement and (vi) Governance. All of these dimensions are influenced and taken forward through a number of processes. As part of an RRI framework, Forsberg et al (2021) has therefore proposed four process dimensions, which are further refined here as (a) Reflexivity; (b) Diversity and Inclusion; (c) Transparency; and (d) Responsiveness. These process dimensions are cross-cutting so that all of the six key dimensions can be support by processes of reflexivity acted upon by researchers, research groups and institutions.

Across EC funding programmes it has been claimed that although these principles and themes are being considered within some funding and research processes, as part of the development and implementation stages, the approaches to embedding RRI / ethical assessment and mapping impacts may be described as sporadic. Developing a plan to embed an RRI approach while a programme is being design and developed (i.e. before implementation) would be a notable mark of good practice. So, when taking forward an RRI agenda it is important that new developments within fields such as crop improvement embed core ethical principles of good research practice and consider the key themes of the RRI. Within this RRI framing that should support the development of a CropBooster Programme, a key area that is important when considering the development of research agendas is the theme ‘Societal, Stakeholder and Public Engagement’ and the intersection with the process of ‘Diversity and Inclusion’. The next section highlights the importance of engagement within science research programmes.



3 RRI Framework and Engagement

When considering the issue of Engagement and RRI it is valuable to support common understanding and this is also valuable for CropBooster community and how the nature and process of engagement will be dealt with in relation to crop improvement research. The aim of this section is to underpin the other work across the project on activities that includes or cross refers to engagement. How we frame and understand the topic of engagement can affect the way we communicate with our stakeholders and wider publics. The framing of engagement that underpins the work will shape the communication strategy and how we present as a group and individually within this work, and can affect the perspectives of those external actors who will formally interact with, evaluate, and informally criticize the work of any future CropBooster Programme.

CropBooster supports the development and embedding of a more participatory science governance approaches within the bio-economy which is in line with the principles and vision of the European Commission's innovation pathways. Of course, the value of engagement is not possible with a strong research sector which focuses on grand challenge problem and the practical application of scientific discoveries. In order for engagement approaches to be valued, valuable and integrated it is important to recognize methodological options and the theoretical basis of public engagement. In addition, it is important to highlight the assumptions embedded within these processes. So, it is useful in terms of the role of an RRI strategy report to set out some key aspects, which are relevant to agricultural research that underpins production and to highlight a multidisciplinary discussion of public engagement in the governance of science and technology.

A framework for the development of engagement approaches can be constructed along three main dimensions:

- The 'actors' we engage with and their stated and imagined roles;
- Our motivations to engage with publics and stakeholders; and
- The levels of engagement supported by our (engagement) activities.

These dimensions are set out in the sections below, and this leads to a series of RRI related questions that are intended to support the embedding of engagement activities with the CropBooster work and facilitate wider reflection on how we can support and enhance engagement in any future programme.

3.1 Why engage with publics?

Advances in scientific knowledge and technological innovation have resulted in significant social change over the centuries. The growing interest in engaging with publics has grown from the late 1990s, with the need to engage rooted in concern about a 'crisis of trust' in science and questioning of the handling of scientific and technological controversies by the State. Scholars such as Irwin



(2006) have claimed that science-related controversies such as food scares, BSE, and other controversies have contributed to an erosion in the relationship between science and society and affecting public responses to biotechnological change (Irwin 2006). Alongside the need to respond to this, there has been increased emphasis on and a support for public engagement initiatives through the drivers of (i) trust in science, (ii) utility, in relation to supporting the innovation process and finally (iii) a notion of an overall ethical responsibility to facilitate a wider opening up and democratization of science and policy, as seen in a number of EU initiative and Conventions.

Some have argued, such as Goven (2006), that reflecting and articulating the purposes of engagement is crucial. It is argued that alongside evaluating the strengths and limitations of engagement activities, it is important to be clear about and question the motivations behind any activities. Goven (2006) also argues that this should precede any promotion of public engagement. A number of engagement and science and technology studies have analysed different forms of rationales or motivations for conducting engagement activities related to science and technological innovation, (1) normative (2) instrumental or (3) substantive, which are set out in Table 5 (Marris and Rose 2010; Pallett 2012):

The normative argument has been a strong argument across the EU in recent years. This is underpinned by the obligation to engage with those who are affected or have interests in science and innovation. So, although there has been widespread support for initiatives in democratic societies, particularly in countries such as Denmark, it is important to ensure the objectives and quality of the engagement activities meet these normative goals. A notable concern is that some engagement activities can be constructed to support limited or superficial dialogues and to reinforce the notion of a public that has limited scientific understanding, also referred to as 'public knowledge deficit' (Stilgoe et al. 2014). This 'deficit model' understanding of the issue assumes that a lack of trust by the publics or a negative public perception of science and technology is a direct result the public being misinformed about science and technology, i.e., that people who lack information on (the benefits of) science and technology tend to be opposed to these. Drawing on this assumption of a deficit ('deficit model'), public engagement initiatives gained popularity and it has been claimed that they were promoted in an attempt to increase public support of emerging science and technologies

This meant that, through public engagement (and somehow against the original objectives of the proponents of engagement), those claiming to hold the expertise for it, would create spaces, define rules, design and implement initiatives aimed at promoting participation of publics, yet they might be creating only a certain type of public involvement and support (Felt and Fochler 2010). Certainly, there is still a long-way to go in the transition from 'deficit' to 'democracy' in more participatory forms of scientific governance. What is often seen are engagement processes that can be described as hybrid attempts at democratising science, where both forms co-exist through different aspects of the engagement exercises (Irwin 2006). Despite the valid criticism, and recognised by Irwin (2006) himself, public engagement is still a social experiment.



3.2 Many Groups: Understanding stakeholders and publics

When considering who to engage with it is important to draw on the work of practitioners and researchers who have developed the theory and practice of public engagement. Some of the key groups of practitioners who have developed methods that are relevant for the biosciences and more specifically crop science and production are practitioners working in environmental management spatial planning and technology assessment.

An important approach is to apply stakeholder analysis methods to map those that affect or are affected by a specific technology or innovation area (Ross 2003; Reed et al. 2009). Some approaches can although helpful can result in all actors being referred to as 'stakeholders' so by using a stakeholder analysis approach, categories of stakeholders can be mapped and identified to support the engagement and wider work of a project. This is the approach that has been used in CropBooster across the WP activities, see Workpackage 2 and 3.

To further support the CropBooster work is it useful to highlight aspects of this work and set out some ways classifying different groups can be used. The use of terms such as publics, stakeholders, citizens, or affected or interested parties can be used interchangeably, however these groups are not a homogeneous mass of actors and it is valuable to note this. It is therefore important to be aware of and understand the definitions of these group. In some setting discussions such as in some corporate social responsibility literature and activities (CSR) the terms stakeholder and society can be used to refer to consumers in markets or as narrow definitions related to specific interests (Ihlen 2008). It is important to recognize these risks and the way terms can be used uncritically. This can lead to approaches that do not recognize the agency or power of some groups, such as using the term civil society which can regarded as only another 'group' without recognizing this collectives lack of power or voice in some circumstances particularly in relation to other groups such as the business sector. So, when developing engagement activities it is important to identify and identify three main dimensions of any engagement approach, specifically (i) Actors; (ii) Motivations and (iii) Levels.

The notion of 'actors' refers to those we engage and interact with. It is important to understand and be transparent about how we classify actors and their roles. As discussed above this recognises that the role of stakeholders and publics are not static or homogeneous. Setting out which actors are involved in engagement activities requires identify any context-dependent aspects that can affect the engagement activity.

Second **it is important to consider and be clear about** our motivations for engaging with different stakeholders and publics. There can be a wide range of objectives and reasons for engaging with different stakeholders and publics. These can range from requirements to instrumental motivations through to more normative perspectives.



The final dimension is the **level of engagement** that will be targeted by any activity. The levels of engagement supported by our (engagement) activities can vary depending on the reasons for the activity. There can be differences in the types of approaches used based on whether the activity is being delivered to inform, to consult, to be participatory or co-design with participants

It is important that CropBooster engagement activities are clear about all three of these levels and it is important that when defining actors that CropBooster activities consider 'publics' as stakeholder groups, as publics can be an overlooked part of society in aspects of agenda setting in science and technology development.

There are a wider range of terms that can be used to describe publics; these included for example, the general public, wider publics, interested public, end-users, consumers, citizens. Noting these terms by using the plural form of 'public', i.e., publics, is helpful when trying to capture these heterogeneous groupings. It is also important to note that individuals can also be part of the category publics and of the category stakeholder, these are not necessarily mutually exclusive categories. Some engagement specialists, such as Mohr et al (2013), have sub-categorized heterogeneous groups showing how sub-groups can be mobilized, for example for issues of common concern. It is important to recognize that publics can also be understood and categorized as political sub-categories (Varughese 2012). So, when planning public engagement activities it is important to understand how publics are being categorized and that acknowledge that any categorization can be dynamic and context-dependent. Aspects to recognize and include in an engagement approach are:

- 1) Giving attention on how engagement practice is being presented from the start and what are the assumptions in terms of the role of publics. This also applies to the involvement of specialists or defined 'experts'
- 2) Ensuring categories are not static and may be redefined by publics themselves.

When involving publics in science and technology discussion and debates, it is important to be mindful how the engagement exercises can be constructed to explore the 'public issues' related to science and technology, such as how are the problems framed, what are future benefits, research investments, views on alternatives, etc, rather than narrowing discussions to purely technical or scientific risk matters (Wynne 2007).

3.3 Different ways to 'engage': Exploring levels and forms of engagement

The Aarhus Convention, which was adopted in 1998, distinguishes between citizens' access to information and citizens' participation in decision-making (UN Economic Commission for Europe 1998). The Convention states that the channels through which citizens' get informed (in this specific case, on environmental matters) include any form of written, visual, aural or electronic material. As for citizens' participation, the Convention states that citizens are allowed to comment on the plans,



programmes and policies proposed, being their input taken into account to inform these developments. As developed from practice in Impact Assessment (IA) processes, and in line with such a distinction, for any projects' implementation there are at least two different approaches through which publics get involved in decision-making: a consultative route and a more participatory one (see Roberts 2003). While a consultative approach sits together with more conventional forms of public information and education in the public engagement spectrum, a participatory approach lies towards the opposite end, suggesting more inclusive practices aimed at having a direct effect on overall decision-making

Many organizations focused on promoting engagement and training practitioners have put forward what are considered as core values and principles that govern public participation. The International Association for Public Participation (IAP2), for example, suggests a number of values for public engagement, including:

- Directly involving citizens in decision-making processes;
- Decisions take into account the publics' input, i.e. that this input influences the decision;
- Design of engagement itself is agreed and co-produced with publics;
- Publics are aware of how their input may affect the decision.

It should come as no surprise that by adding detail to the topic of public engagement with science and technology we ended up complicating the picture. As such we recognize that engagement is not at all straightforward both in theory and practice, however by posing a series of key questions that emerge from what has been discussed so far here, the next section proposes how Engagement can be a key thread with the application of RRI in CropBooster.

Setting out engagement concepts and then ways to apply these should strengthen any future funding programme.



4 Building Blocks for an RRI CropBooster Framework

4.1 Overarching RRI Framework

Drawing on the theoretical and contextual aspects identified above leads to a RRI framework that can be specified for a future CropBooster Programme. The core elements below are proposed in order to set out an RRI framework and to allow the development of a RRI framework that can be embedded within future research and funding approaches.

Key consideration for any strategy to embed RRI is to embed the core the defined elements of:

- Research Ethics and Integrity;
- Gender Equality, Diversity and Inclusion;
- Open Science and Access;
- Science Communication and Education;
- Societal, stakeholder and publics engagement including co-design and
- Supporting governance and policy-making.

Alongside this a number of processes, as described by Forsberg et al (2021) are also discussed, specifically the four process dimensions of: Reflexivity, Diversity and Inclusion, Transparency, and Responsiveness. These elements are set out below and discussed in relation to a future CropBooster Programme. These core elements have been translated for CropBooster Programme with a special focus on the societal, stakeholder and publics engagement with a co-design element, which has been an important element of the work of CropBooster-P and notably informs the CropBooster Programme going forward.

The role and importance of 'Engagement' is highlighted and discussed within the RRI Strategy report. The importance of engagement with publics and stakeholders is set out, highlighting the three key aspects of why engagement in science policy, science research planning and research practice is encouraged and supported by any CropBooster programme. Engagement can be characterised as an (1) inherent responsibility, as also emphasised by the EC policies on engagement, (2) an activity that builds trusted and trusting partnerships, and (3) finally as an activity that can deliver important benefits for the research agenda and process through the provision of diverse knowledge sets, wider range of insights and different framing visions. The importance of engagement is demonstrated within the CropBooster Programme Implementation plan and has been set up by the work of a number of the CropBooster-P workpackages.

4.2 Research Ethics and Integrity

In terms of the core six elements, a number of aspects have been specified for the CropBooster Programme. In terms of **Research Integrity and Ethics**, this element is translated as supporting



excellence in research practice, high levels of integrity in research and ensuring that appropriate research ethics processes are in place. Support for high standards of research integrity will be ensured through programme activities related to sharing standards of excellence in experimental design and adhering to legal and regulatory responsibilities, such as under the Nagoya Protocol (Regulation [EU] No 511/2014). These activities also include opportunities to discuss issues of research reproducibility and questionable research practices (QRPs) and the establishment of an Ethics Advisory Board (EAB) and an ethics team within the Programme to support ethics review and oversight. The CropBooster Programme will use and have access to a series of ethics tools and training programmes. Funded projects within the CropBooster programme will be required to produce an ethics statement in line with Horizon Europe Self-Assessment requirements. The CropBooster will also develop possibly opportunities to embed ethics-related research activities within funding activities.

4.3 Equality, Diversity and Inclusion

Operationalising **Equality, Diversity and Inclusion** (EDI) is achieved through clear EDI policies for the CropBooster Governance Structures, i.e., the General Assembly, Governing Board and Executive Team. This would include a policy on gender parity, inclusivity in terms of backgrounds and disciplines, as well as equity principles through clear policies on decision-making, openness and access to the decision-making bodies for all members. EDI aspects also include policies on science recruitment and career development. The CropBooster Programme will support initiatives such as the Declaration on Research Assessment (DORA) principles (<https://sfdora.org/>) across the activities of the programme and each partner will confirm and exchange information on EDI approaches to ensure standards and support dialogue.

4.4 Open Access and Open Science

Promoting and embedding **Open Access and Open Science** policies will involve the adoption of the current EC policies on Open Science as articulate in the Horizon Europe policies as well as demonstrating how the CropBooster Programme is implementing the FAIR principles (<https://www.go-fair.org/fair-principles/>) so that data can be Findable, Accessible, Interoperable and Reusable (FAIR). This work within the CropBooster Programme will examine what best practice data management and publication strategies can be further developed for the crop science sector. Innovative ways to create 'Open Crop Science' will also be supported as part of the wider research agenda.

4.5 Science communication and education

Supporting an innovative approach to **Science communication and education** within the CropBooster Programme is an important cross-cutting activity. Approaches and support will be provided through the overall programme and activities will be encouraged within the research



activities themselves. Traditional as well as non-traditional communication approaches will be supported, as set out in the Communication Strategy (Deliverable 5.5). Researchers will also be encouraged to engage in science education activities that support the research area as a whole. Some of the activities supported in the future research programme may have multi-roles combining communication, education and engagement goals and researchers will be supported to see these opportunities. Support and training will be underpinned by the CropBooster Programme Management and Governance structures.

4.6 Societal, Stakeholder and Public Engagement

Developing activities that support **Societal, Stakeholder and Public Engagement** and co-design have been an important element of the work of the CropBooster-P. The mapping of stakeholder and public perspectives and expectations have been important part of the CropBooster work in workpackage 2 (see the details below). This has resulted in the development of a number of approaches to support understanding and development of a social licence for a future research programme. The RRI approach sets out the importance of the work through the articulation of the underpinning principles that support Stakeholder and Public Engagement plans for a Future CropBooster programme, emphasising the instrumental, trust-relational and ethical arguments.

An important part of any research programme is, as well as conducting high quality research, to have a strategic approach to how research can **Support Governance and Policy-making**. This involves both the consideration of how research planning can result in impact and policy-relevant evidence, but also how the research outcomes can be presented in accessible and transparent ways that can support and inform policy-making. Any approach involves not only principles of transparency and openness, but also clarification of limitations and uncertainties within any dataset or research finding. The future CropBooster programme will work to develop trustworthy approaches to the provision of science-based evidence for policy-making and analysis, drawing on current EC and European Parliament Initiatives.

4.7 Policies, Processes and People in RRI approaches

Alongside the embedding of the six common elements, common procedural aspects of RRI will also be operationalized through a CropBooster Programme, encouraging four processes of reflexivity, inclusiveness, transparency and responsiveness. This will be operationalized through the CropBooster Programme processes related to: (a) Policies; (b) Processes and (c) People. These aspects will be further developed as the CropBooster Programme is implement and should be seen as cross-cutting when considered alongside the common six elements of RRI. The **'Policies'** component would involve ongoing RRI-related review of all CropBooster Programme policies to ensure all six RRI elements are implemented and that policies demonstrate **transparency** and **inclusivity**. The **'Process'** component will be implemented through the RRI activities and **responsiveness** approaches within the programme governance structures, for example through the



funding review process, through the research reporting processes and through the activities of the Ethics workpackage and EAB work. Finally, the **'People'** component is intended to ensure that the programme recognizes the activities and contribution of the people with this programme, creating spaces to facilitate **reflexivity** in management and research activities. The CropBooster Programme would provide reflectivity spaces that would consider how researchers and research managers can be supported when conducting research, and also consider how to nurture research cultures that support wellbeing. This component would be reviewed and considered by the Governing Body and the Executive Committee of the Programme but can also be supported by grass-root activities at a project level.

The combination of the six elements and the four RRI processes will support the development of a Responsible Research and Innovation approach within the future CropBooster Programme.

5 Conclusion

The key elements that can underpin a RRI Strategy for CropBooster are set out. The proposed framework sets out the six elements of Research Ethics and Integrity; Gender Equality, Diversity and Inclusion; Open Science and Access; Science Communication and Education; Societal, stakeholder and publics engagement including co-design and Supporting governance and policy-making. These elements can be operationalized in any future programme and new tools and approaches can be used to support and evaluate their delivery. Alongside this the four process dimensions of: Reflexivity; Diversity and Inclusion; Transparency; and Responsiveness, can also be supported. The aim of all of these processes is to facilitate responsible research practices and innovation that results in the delivery of socially robust research and biotechnologies.



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