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Chapter 27
Inclusion and Resilience in the Bioeconomy

Lotte Asveld

Abstract New technological developments such as CRISPR-Cas, advanced genetic sequencing and the digitalization of agriculture offer promising prospects to realize the potential of a sustainable bioeconomy. At the same time, enormous challenges abound such as the pressure on biodiversity and the associated risk of pandemics, climate change and the ever-increasing global economic inequality. The bioeconomy can play a beneficial role in this; however, this will only be possible if the bioeconomy is developed on the basis of inclusion. In this chapter I will explain the relevance of inclusion for the bioeconomy and describe some of the sociotechnical developments where inclusion should be realized in order to build a resilient and sustainable bioeconomy. These developments include biosphere capacity, global biobased value chains, digital genetic resources and the digitalization of agriculture. I will conclude with the question of who bears responsibility for an inclusive bioeconomy.

Keywords Inclusion · Resilience · Agency · Global value chains · Digital sequence information · Digitalization of agriculture

1 Introduction

The bioeconomy is an appealing concept that integrates the promise of economic prosperity with that of ecological stability, by replacing fossil resources with biomass. Recent advances in bioengineering such as CRISPR-Cas and other synthetic biology approaches offer novel pathways to modify micro-organisms into high-performing production platforms for a wide range of products (Straathof et al. 2019). The use of digital sequence information (DSI) promises unlimited access to a wide range of promising biological production pathways. At the same time, digi-

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talization of agriculture allows for highly efficient and sustainable production of biomass to feed these novel micro-organisms.

Such increasingly advanced technologies give rise to questions about economic justice, resembling issues that emerged when genetic modification first arrived on the scene. Who will benefit from these sophisticated technologies? Who will own and distribute them? How will they affect global economic inequalities, especially considering the fact that a lot of the biomass will be sourced from the global south and processed in the global north? And how can they contribute to sustainability and the protection of biodiversity?

In this chapter I want to stress that social and economic inclusion in global biobased value chains can help to develop a sustainable as well as resilient bioeconomy. I consider this issue to complement the question of the desirability of a particular technology, policy or agricultural production system per se. This implies that the desirability of biobased applications should be determined based not only on the specific (social, economic, environmental) impact that it has on a specific region but also on how it has come about and whether the associated value chains have been developed in line with the needs, values and knowledge of local biomass producers and (potential) local consumers of biobased products. I claim that when a biobased application is developed in an inclusive manner, it is more likely to be sustainable in a broad sense and is also likely to lead to more resilient biobased value chains. In this chapter I will discuss specific avenues to realize such inclusion.

I will first discuss the notion of inclusion and its general relevance to a resilient bioeconomy. I will elaborate my claim about the central importance of inclusion with reference to four themes: biosphere capacity, reliability in value chains, control over genetic resources and digitalization of farming.

2 Inclusion

The concept of inclusion has gained attention as an element of the approach of responsible research and innovation where it refers to the engagement of a wide range of voices in the development of new technologies in order to increase both the legitimacy and the acceptance of innovations (Stilgoe et al. 2013), thereby moving away from an innovation system dominated by technological experts. In this approach, inclusion is mainly considered to be a process where several stakeholders can provide input on the desirability of the design of a specific innovation. Such inclusion is generally seen as a prerequisite to achieve societally desirable outcomes (Sonck et al. 2017).

Other authors focus more specifically on inclusion as an outcome of innovation, rather than as a prerequisite. In the context of the bioeconomy, inclusive innovation has been defined as a ‘new way of doing things (that) may improve the lives of the most needy’ (Bryden et al. 2017). In this approach, the actual benefits of an innovation take central stage. This focus on improving the livelihoods of the most vulnerable is also prominent in the approach of inclusive agricultural value chains (Devaux et al. 2016) and inclusive innovation for development in general (Heeks et al. 2014). These latter approaches show a development from solely offering products tailored to the most needy (e.g. frugal innovation) towards more comprehensive tactics in which also the living conditions and general well-being of vulnerable groups are taken into account (Ros-Tonen et al. 2019).

Since the transition to a sustainable bioeconomy comprises complex changes in the global south as well as in the global north, I think that inclusion should be as wide-ranging as possible. So inclusion should benefit the most needy, but it should also take into account the perspectives of those in the global north. Therefore I understand inclusion as the fair distribution of risks and benefits associated with a specific socio-technological development (such as the biobased economy), implying that any relevant technological or economical is designed while taking into account the values, knowledge and interests of all actors involved.

However there is ample evidence that inclusion as a process is not always feasible. Relevant stakeholders may be unavailable, reluctant to participate (Sonck et al. 2017), not capable of standing up for their own needs and values due to cultural, economic or biophysical hurdles (Ostrom 2005) or because of socio-economic or institutional incentives that hinder openness, for instance for researchers who find it hard to discuss uncertainties in their work publicly (Wickson and Carew 2014) or commercial actors who need to protect private interests (Blok and Lemmens 2015). These are serious barriers that should be addressed to achieve true inclusion. These barriers point out that inclusion is more than a participation exercise, but also requires capacity building and institutional support (Postal et al, 2020b). Without the right conditions, the laudable aim of inclusion could instead lead to an empty legitimation stunt that serves only the interests of the most powerful. In the remainder of the chapter, I aim to point to some socio-technological avenues within the bioeconomy that offer openings for true inclusion.

3 Biosphere Capacity

A major issue that permeates all political and scientific evaluations of the bioeconomy is the carrying capacity of the biosphere. With biosphere I refer to all living parts of the earth. How much biobased resources for human consumption are this biosphere able to sustain? The Covid-19 pandemic has put a spotlight on the ecological risks of the current agro-industrial complex. By pushing the frontiers of our agricultural system further into previously undisturbed ecosystems, we risk allowing pathogens to escape from their ecological niche (Wallace 2016). Can we realistically feed, clothe, warm, transport, cool, etc. ourselves to a considerable part based on sustainably produced biomass?

3.1 How to Assess Sustainability?

Two major issues stand out here: how to assess the sustainability of particular products and how to assess the sustainability of the bioeconomy as a whole? First is the question about how to reliably ascertain that biobased applications and the associated value chains are sustainable. Different models rely on different indicators and assumptions and hence will lead to varying output (Matthews et al. 2019). Allocation of CO_2 emissions for woodchips has for instance been a major issue in the debate concerning the sustainability of burning these woodchips. Should these CO_2 emissions be allocated to the place of origin of the woods, or the place where the woodchips are burned? A similar discussion arose around the inclusion of ILUC effects of biomass for biofuels. Should indirect land use change be taken into account or should it not? (Asveld 2016) This variance in assumptions and indicators is problematic for a sustainable bioeconomy. Various actors can shape sustainability assessments according to their needs. This undermines the credibility of a sustainable bioeconomy.

Second, such models to account for sustainability usually rely on specific indicators that are easy to quantify such as CO_2 emissions or land use. Therefore they necessarily leave out many aspects that are hard to quantify or that are related to a specific biobased application in very complex ways, such as local socio-economic effects (Flipse 2014; Parada et al. 2017), or aspects of uncertainties relating to future developments (Matthews et al. 2019). Models that focus on quantifiable indicators are not suitable to answer what *kind* of bioeconomy is most sustainable in a broad, holistic sense. Should a sustainable bioeconomy be able to compete with the fossil economy in terms of productivity? In other words, does sustainable equate efficiency? Or should sustainability instead focus on ecological stability, social impact and technological appropriateness, meaning that we do not opt for high-tech solutions if they do not fit the local cultural and economic context, even if that means biomass will not be utilized in the most efficient way?

3.2 An Inclusive Understanding of Sustainability

What is needed is a shared understanding of the ecological and economic underpinnings of the bioeconomy (Veraart and Blok 2020). Various conflicting perspectives on the bioeconomy exist, ranging from a kind of business as usual approach in which the economy continues to grow but based on biomass instead of fossil resources to an economy that seeks to minimize the use of bioresources in order to assure a healthy economy within the ecological, planetary boundaries (Richardson 2012; Vivien et al. 2019). A possible way to deal with this is the application of a constructive form of sustainability assessment that allows for the integration of a wide range of perspectives to achieve an interdisciplinary, anticipatory type of sustainability assessment (Matthews et al. 2019). Such an approach can be considered more inclusive than the current, prevalent methods of sustainability assessment.

A shared understanding of sustainability should encompass the perspectives of both stakeholders in the global north and the global south. The bioeconomy presents a new frontier in our relationship with natural resources that requires a solid philosophical underpinning with regard to environmental values. What does natural mean to us? Does it have a specific value in itself that should be cherished or is it simple resources that should be exploited for all its magnificent bounty? What does sustainability imply? Can it imply that sometimes we prioritize the interests of non-human animals and nature over human interests? How can we build a fair and prosperous world within the ecological limits that we are facing?

Moreover, we can only expect those that manage natural resources to do that sustainably, if their interests and values are reflected in the set-up of those value chains. It is of vital importance to the entire planet to protect biodiversity, and so far we haven't done such a great job (WWF 2020). Further loss of biodiversity increases the risks of a new pandemic (Quammen 2012). This presents an urgent need to present those living in biodiverse-rich countries with an economic, social and cultural incentive to protect biodiversity (Berkes et al. 2009). I believe that inclusive biobased value chains can present such an incentive because they can connect the sustainable management of natural resources with financial gains.

4 Resilient Value Chains

The above observation brings us to the first pressing issue facing the bioeconomy at present. There is a need to include local producers of biomass in order to achieve reliable and resilient biobased value chains, built on economic fairness (Asveld 2019). Global catastrophic events such as pandemics and climate change can have huge impacts on global biobased value chains. Inclusive value chains that build on local knowledge, values and interests, and that give agency to local actors, can be expected to be more resilient compared to value chains that rely on remote technical expert knowledge and control (Sumane et al. 2018). This will have beneficial effects in three ways: more resilience, more sustainability due to less uncertainty and commercially more viable value chains.

4.1 Resilience in Value Chains

Resilience refers to the ability of a system to respond to a threat or hazard (Doorn 2017). Resilience can occur in ecological systems but also in more broader socio-ecological systems (Walker et al. 2004). Resilience can come about through diversity (Rammel and Van de Bergh 2003), innovation, adaptive management and learning (Doorn 2017). Crucial to any system being able to respond to a threat or hazard is the agency of their social constituents (Brown and Westaway 2011). Therefore the resilience of global biobased value chains depends on the agency of the various actors involved.

Agency can be understood as the capability to shape one's own life. Amartya Sen has defined an agent as 'someone who acts and brings about change, and whose achievements can be judged in terms of her own values and objectives, whether or not we assess them in terms of some external criteria as well' (Sen 1999, p. 19). Only if all actors in a global biobased value chain can exercise their agency can such a value chain be sustainable and resilient. A high degree of autonomy amongst relevant participants helps to build institutions that can sustainably manage resources (Becker and Ostrom 1995).

4.2 Managing Uncertainties to Achieve Sustainability

Many uncertainties shroud how to develop sustainable and economically fair biobased value chains (Asveld and Stemerding 2017; Kamali et al. 2018). This is often the case because the chains usually span global networks yet biomass production takes place in distinct contexts (Meckenstock et al. 2016). There may be uncertainties about which crop is best suited to local conditions, what are local sustainable soil management practices, what processing technologies are feasible given the local circumstances, what are reliable local means of transportation and what is needed to convince producers of biomass to commit to a new biobased value chain (Robaey et al. forthcoming).

Including local stakeholders in the set-up of biobased value chains – taking into account their needs, values, wishes and knowledge – can help mitigate these uncertainties (Pretty 1995); local producers often have valuable knowledge about land management, their natural environment and the associated biomass (Sumane et al. 2018). This knowledge is indispensable for achieving a system that sustainably manages local resources (Folke et al. 2011). Numerous examples have shown that institutions based on intimate local knowledge and with the input of participants closely connected to the specific environment achieve better results compared to an imposed central authority or an orientation only on global market (Becker and Ostrom 1995). Many biobased value chains will be connected to the global market. The challenge lies in also connecting to the local realities of sustainable resource management. The interests of local producers can only be adequately recognized and taken into account when they have an actual chance to speak up (Postal et al. 2020). Including local biomass producers is thus expected to have both epistemic and moral benefits (Wals 2007). Epistemic benefits refer to the reduction of uncertainties, while moral benefits refer to the fair distribution of risks and benefits.

4.3 Commercially Successful Value Chains

Another advantage of inclusion is its potential contribution to commercial success. Currently, approaches to sustainable agriculture that focus mainly on technological aspects while neglecting local stakeholders often fail from a business perspective

(Hounkonnou et al. 2012). Such lack of inclusion has already negatively affected many biobased value chains, either because they failed economically (Hounkonnou et al. 2012) or because the biomass producers were not committed to deliver their produce to the biobased value chain (De Hoop et al. 2016; Balkema and Pols 2015). Inclusion, on the other hand, can lead to robustness and commercial success, for instance because a realistic expectation exists towards the capabilities of local stakeholders to invest and shoulder the associated risks (Devaux et al. 2016) or because they build on the prevalent skills and knowledge of local producers (Harper et al. 2015).

4.4 Challenges to Inclusive Value Chains

Several challenges exist to realize inclusion in global biobased value chains. Inclusion can only be meaningful if those who are to be included have a real choice. If producers of biomass have a choice, they have a better negotiation position and will be more able to withstand monopolistic tendencies (Harper et al. 2015). Inclusion without other options is not inclusion – it is coercion (Kleine et al. 2012).

Inclusion thus requires the capability to be included to begin with (Simpson and Basta 2018). This capability depends on actors having specific skills and access to resources, reliable infrastructure and education (Frediani 2010). For example, the capability of handling sophisticated technologies may be a prerequisite for the capability to be included in an advanced biorefinery. Or the capability to access relevant information at low costs (Becker and Ostrom 1995). It is difficult to truly include biomass producers and stakeholders who lack basic skills and resources. Possibly companies need to take actions beyond the private sphere and invest in public goods such as infrastructure and education.

Another challenge lies in the cultural differences between actors in a global biobased value chain. Many companies developing biobased applications come from Western countries, while many producers of biomass live in the global south. But also between partners from different countries in the global north or between partners from the global south. To ensure that a sufficient amount of trust emerges between various participants usually requires extensive time and effort (Lundy et al. 2005).

These challenges suggest that building inclusive biobased value chains asks a lot of commercial partners compared to using fossil resources. Such actors may need to build alliances with NGOs and governments to shoulder the burden collectively. However, once inclusive biobased value chains are up and running, they can be expected to be resilient and viable. They should be able to withstand catastrophic global events such as a pandemic, because the actors involved are autonomous and can proceed even when they are disconnected from their partners in the value chain.

5 Control over Genetic Resources

5.1 An Ongoing International Conflict

Another pressing issue for the bioeconomy is the use of digital sequence information (DSI). The development of ever faster genetic sequence technologies in combination with DNA synthesis and gene editing techniques such as CRISPR-Cas has rapidly increased the use of DSI. Digital sequence information consists of DNA information that can be spread via digital channels. A researcher can download genetic information from anywhere in the world and use it to modify or construct any organism. The use of DSI can greatly enhance the search for sustainable sources of energy, materials and medicine.

The use of DSI brings forth questions on the status and economic value of genetic information. How relevant is the origin of genetic information for determining how to share its economic value? Who can have access to the information and who reaps the benefits of this information? This question in turn ties in with diverging views on nature and how we should treat natural resources. As such, the issue of how to deal with DSI opens up fundamental questions that should be answered in order to reach a shared understanding of a desirable and sustainable bioeconomy.

The Nagoya Protocol on Access and Benefit Sharing issued by the United Nations and ratified by 114 parties stipulates that for any genetic resource used either commercially or academically, its origin has to be documented, and it may only be used when the country of origin has given its explicit consent through a material transfer agreement (MTA). Such a MTA contains conditions about the access and benefit sharing relating to the specific genetic resource. The supporting principle is that genetic information is a resource that belongs to the country of origin and that other actors cannot take this resource without due compensation (Bagley 2016).

The issue currently being discussed within the UN Convention in biological diversity is whether DSI should also fall within the scope of the Nagoya Protocol. Developing countries say it should because they want to protect their genetic wealth and demand an equal share in the possible benefits deriving from that wealth. Most developed countries instead claim that DSI should not fall under the Nagoya Protocol because it would be practically impossible to determine the origin of the many bits of genetic digital resources available (Rabitz et al. 2020). Imposing an access and benefit requirement to the use of DSI would set very high barriers for scientific development, while the use of DSI offers a great potential for the bioeconomy.

5.2 The Relevance of the Origin of Genetic Information

Three contentious issues stand out here. First is the question whether the origin of genetic information holds any specific relevance to the actual genetic code. The perspective of many bioengineers is that genetic code is comparable to computer code and that a cell is a programmable entity (Calvert 2012). In this view, the origin of the genetic code is completely irrelevant; all that matters is its function (Roosth 2017). However, others may argue that genetic information is actually only relevant within a specific biological context. That is where it has an impact and that is also how it was shaped in the first place. Such a perspective likely aligns more with the holistic vision of nature and environment as often found with indigenous people (Right to food and nutrition Watch 2018). One's view on this matter is connected to the second question about the value of the origin of genetic information.

5.3 The Value of the Origin of Genetic Information

This second questions refers to how the value of the origin of genetic information can be determined and how it should be rewarded. In other words, what is a fair distribution of benefits in the context of DSI? Is a given party entitled to receive access to benefits simply because some genetic resource happened to originate in their backyard, also when there is no physical impact on their territory from extracting that resources? Does it matter that some actors have more means to make a profit from the genetic resources than others? Do they owe other actors something because of that? It may be fair to say that the knowledge of indigenous people should be rewarded if that helped others to identify valuable genetic resources, but does that extend to their simply living next to some genetic resources they had not previously recognized as valuable?

However many developing countries see themselves as stewards of genetic wealth. Without their stewardship, genetic resources wouldn't have been available to begin with. As such it would be unfair to allow the developed countries, who have the capacity to exploit this wealth, reap all the benefits, particularly because DSI could lead to patented applications which would not be freely accessible to researchers in developed countries. This would prevent actors with less available technological means to exploit genetic resources, while actors in developed countries could reap all the benefits. Access to genetic resources should therefore be safeguarded (Rabitz et al. 2020). Additionally the sharing of both economic and non-economic benefits, such as profits, joint ownership of intellectual property rights, or funds for conservation, can provide an incentive for developing countries to safeguard local biodiversity, although the effectiveness of this remains up for dispute (Rosendal 2006).

5.4 Fair Sharing of Benefits

The third question again revolves around fairness. If countries or communities of origin should be rewarded for genetic information, what would be a fair reward? It has been notoriously hard to share benefits for genetic resources with indigenous communities (Schroeder and Lucas 2013). The existing international treaties such as the CBD and the Nagoya Protocol leave it up to countries to decide amongst themselves what a fair sharing of benefits amounts to (Morgera 2017). The continuing international disagreement over this issue has led developing countries to walk out on negotiations on the future global governance of biodiversity (Rabitz et al. 2020). This disagreement jeopardizes the effort to establish a common ground for the sustainable and fair use of natural resources. For the bioeconomy to move forward and realize its full potential, the issue of what fair sharing of genetic resources implies needs a robust and widely supported answer.

6 Digitalization of Agriculture

Precision agriculture and related technologies known as digital or smart agriculture hold the promise of making agriculture more productive and sustainable (OECD 2019). Digital agriculture comprises technologies such as artificial intelligence, robots and Internet of things and involves huge data processing (Wolfert et al. 2017). Think for instance of sensors that link to a 'smart' tractors that can respond to real-time input. Some authors see a possible link between such real-life data and more sophisticated genetic modification of plants, i.e. the design of crops might be better adapted to specific local circumstances (Clapp and Ruder 2020). This set of technologies is expected to improve efficiency within food production systems as well as post-farm monitoring and hence improve food security, safety and sustainability (Wolfert et al. 2017) as well as improving animal health (Rotz et al. 2019).

Questions have been raised about the impact of such technologies on the existing agricultural system. Critics fear that such large integrated systems will come at the expense of the autonomy of farmers, who are reduced more and more to small elements in a big digital agricultural production machine (Clapp and Ruder 2020). Other concerns involve the alienation between farmers and their animals (Blok and Gremmen 2018) and an increased industrialization of agriculture at the expense of agroecological practices (Rotz et al. 2019).

These developments raise many questions for agriculture in general, such as a need for new modes of governance (Wolfert et al. 2017) and the effects on skills of farmers, economics, knowledge and innovation systems, privacy and power relations (Klerkx et al. 2019). I want to point out here that digitalization of agriculture raises specific questions for the bioeconomy.

On the one hand, it might prove to be a vital element in the exploitation of agricultural residues. A main barrier to effectively using such residues often lies in conflicting interpretations about how much residue can be taken off the land. Another barrier lies in ensuring the quality of the biomass on offer (Asveld et al. 2015). Agricultural waste typically shows a lot of divergence in quality. It might be rotten or it might contain stones. Digital farming technologies can greatly enhance both the reliability and the efficiency of managing waste streams as feedstock for biobased production platforms. Soil quality can be monitored. If needed the amount of waste left on the field can be adapted. Residues can be scanned for cleanliness and overall quality.

However promising such technologies might be, their actual contribution to a sustainable and resilient agriculture will depend on many factors, such as many other authors have already pointed out. They might help solve some of the barriers to an efficient bioeconomy, but they might also take away agency from the producers of biomass, and as argued above, such agency is indispensable for a resilient and sustainable bioeconomy (which does not necessarily equal an efficient bioeconomy).

7 Responsibilities

One last theme requires mentioning here, which is responsibility. Who is morally responsible for ensuring a resilient, sustainable and fair bioeconomy? In the case of building a sustainable, inclusive and resilient bioeconomy, the main type of responsibility is forward-looking responsibility, i.e. the responsibility to see to it that a certain end comes about (Van de Poel 2011). To assign a responsibility towards a specific end (such as a sustainable and inclusive bioeconomy) to an agent, implies that the specific agent has at least the capability to influence that end and that there is a causal relationship between the agent's actions and the envisioned ends (ibid.).

Governments and global governance bodies such as the UN have a large role to play as they provide the regulations and institutional backdrop against which the bioeconomy takes shape, as is also evidenced by the current debate on DSI and subsidies for bioenergy. They can influence global trading systems and local demand for biobased products. They should take this responsibility with a clear eye on public values such as sustainability, economic stability and health while at the same time taking into account the many uncertainties present in the developing bioeconomy.

They can do this by adopting a strategy of governance by experimentation, where they ensure learning trajectories for new biobased innovations that stimulate learning on institutional, moral and impact aspects (Asveld 2016). For instance, the variance in bilateral agreements around the use of material genetic resources can be seen as experiments of how a fair sharing of access and benefits can come about. From this variance, general lessons could be drawn to set the scene for experiments with agreements on the use of DSI.

A substantial responsibility also falls on the shoulders of biobased companies. Other than governments they do not carry the responsibility for the societal goal of achieving a sustainable, resilient and inclusive bioeconomy. However, through their innovation trajectories, they can exercise considerable influence on the composition of biobased products, extending to the design of associated feedstocks. It is a moral responsibility of companies to contribute societal goals, and they can do so through the choices they make in their innovation trajectories (Van de Poel et al. 2017).

Although the influence of companies is limited in some respects, as are their resources, there are still many instances in innovation trajectories that bring forth opportunities to respond to societal needs and concerns around biobased products, for instance in the choice of feedstock, partners or product portfolio (Sonck et al. 2020). Supporting broad societal goals can also be in the self-interest of companies, for instance when considering to invest in public goods in countries where they derive biomass from. If a company invests in local infrastructure or local educational facilities in a specific country, this can help build local capabilities for producing reliable and sustainable biomass. However, also companies themselves need specific capabilities to support an inclusive bioeconomy, such as the right tools and incentives to reflect on their own goals and stakeholder engagement (ibid.)

Additionally, producers of biomass also need to take on new responsibilities if the biobased economy is to be successful (Asveld et al. 2015). Farmers do not carry the moral responsibility to ensure the future of a sustainable biobased economy. However they can be held morally accountable for a sustainable farming system that stimulates biodiversity, if they have the capability to influence this system. Whether they indeed have this capability will differ per context and is also a much-debated issue politically. What I hope has become clear from the above overview that for a sustainable bioeconomy, farmers *should* have the capability to build a sustainable system for producing biomass for all kinds of purposes and that actors such as governments and companies have both a moral imperative and an interest in supporting this capability.

8 Conclusion

Inclusion is a central element in building a sustainable and resilient bioeconomy, especially in the light of catastrophic events such as a global pandemic. Inclusion can help to give agency to local stakeholders, which in turn will enable them to create sustainable, resilient and commercially viable value chains. Inclusion should also be a main consideration in the governance of genetic resources and in the employment of digital agriculture. This not only a moral imperative that may create economic justice, it is also instrumentally important. Without inclusion, the implementation of new technologies might create barriers to a sustainable bioeconomy by reducing agency of local participants in the bioeconomy.

Inclusion can only be meaningful when individuals have the capability to be included to begin with. If individuals do not understand what is asked of them, for instance, their answers are rather meaningless. Responsibility for inclusion implies that given actors such as governments invest in capabilities of relevant actors such as farmers to be included, such as proper education, infrastructure and platforms for participation. Such capabilities are essential to the success of a resilient, sustainable bioeconomy.

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