FROM GAP TO OPPORTUNITY: REGULATORY VOIDS AS SPACES FOR EXPERIMENTATION AND INNOVATION FOR SUSTAINABILITY

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Abstract

The article addresses the complex dynamics underlying regulatory experimentation and participatory regulatory processes for sustainable innovation in the agri-food sector. These experiences are investigated in their potential to promote a better understanding of the risks and opportunities associated with innovation, better legitimise its adoption, and stimulate responsible experimentation. The article first reviews relevant theories, such as critiques to techno-solutionism and literature on regulatory pluralism and experimentalism, and transnational administrative law doctrine, to stress the need for multiple instruments and viewpoints in shaping innovation. The case study analysis builds on the experience of the Horizon project AWARE, driving innovation in the field of aquaculture from refined wastewater through a pilot based in Southern Italy. The article also engages with a review of other case studies from the Global South shedding light on experiences of sustainable innovation for the benefit of vulnerable communities and related regulatory modalities. The 'capabilities approach' is discussed to frame the context through the lens of 'just' experimentalism in the sector. In conclusion, the article develops a reflection on way forwards that encompass co-governance approaches and a 'right to innovation through experimentalism' which entails not only access to innovation but also the opportunity to participate in shaping innovation.

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TABLE OF CONTENTS

1. Introduction

The mounting socio-environmental challenges that today society is facing have mobilised governmental actors, researchers, businesses, and civil society in the search for innovative solutions to address these challenges. However, frequently, regulatory systems struggle to cope with the fast pace of innovation.

While regulatory gaps persist, bottom-up forms of experimentation from innovators multiply and push to shape the creation, adoption, and governance of innovation. These forces can give an impetus to the legislator in envisaging new intervention strategies, tackling regulatory vacuums in a constructive and participatory manner and enacting innovation-friendly regulations. Such dynamics demand a thorough analysis in order to be leveraged for greater societal benefits.

Starting from this argument, the contribution analyses:

I. How 'experimentalism' in partially unregulated environments can steer innovation-friendly regulations (addressed primarily in Paragraphs 4 and 5).

II. What role can the involvement of stakeholders play, in terms of contributing to regulatory processes with their knowledge (discussed primarily in Paragraph 6).

III. How regulatory experimentation and participatory regulatory processes can benefit vulnerable communities in

exercising their 'right to innovation', specifically in the field of innovation in the agri-food sector (explored primarily in Paragraphs 7, 8 and 9).

By tackling these questions, our study addresses the complex dynamics underlying regulatory experimentation processes and participatory approaches. These dynamics are explored in order to investigate whether these experiences can promote a better understanding of the risks and opportunities associated with innovation, better legitimise its adoption, and stimulate responsible experimentation. The aim of our study is to bridge the long-standing conversation on regulatory experimentalism with theories on just sustainable innovation and on the role of vulnerable groups in this process. We take as primary field of study the agri-food sector responding to an identified gap stemming from the fact that current scholarly and practitioners' discussions on regulatory experimentalism mostly focus on the field of digital innovation. However, we believe that the agri-food sector has great potential for proving the relevance of regulatory experimentalism especially for the benefit of those communities that depend on this sector.

The illustrated questions will be addressed through a combination of literature review and case study analysis. We first review relevant theories (Paragraphs 2 and 3), including sociological and philosophical critiques to techno-solutionism, in order to challenge a reductionist approach to tackling current socio-environmental issues through purely technological interventions. We also explore literature on regulatory pluralism and experimentalism, and on transnational administrative law, to acknowledge the complexity and multi-level nature of regulatory processes. We discuss this literature in the context of the relevant legal doctrine public law of innovation, both from a European perspective and from the Global South. We then investigate the role of vulnerable communities in engaging with innovation and the regulation thereof. We explore forms of collective and experimental governance of innovation aimed at steering innovation to benefit such communities. Lastly, we draw on the 'capabilities approach' in order to frame the concept of 'just' experimentalism and innovation in the agri-food sector.

The article builds on multi-case study analysis starting from the experience of the Horizon-funded project AWARE, driving innovation in the field of aquaculture from wastewater through a

pilot based in Southern Italy. From this localised case with a European breadth, we broaden our lens encompassing a review of other case studies from the 'South' shedding light on experiences of sustainable innovation for the benefit of vulnerable communities and related regulatory approaches. The 'South' is here understood not only as the geographical Global South, but also potentially the 'South of the Global North'[1]. For example, Southern Italy can be considered to a certain extant the 'South of the North' as it faces challenges associated with climate change such as water scarcity and desertification that bring it closer to some non-European Mediterranean countries generally considered part of the Global South (i.e., Northern African and Middle Eastern countries). In the conclusion, we reflect on a possible 'right to innovation through experimentalism' that entails not only access to innovation but also an opportunity to *participate* in shaping such innovation processes.

2. Shaping innovation: from techno-solutionism to pluralistic regulatory processes

Innovation is multiplying at a fast pace, offering solutions that – if properly shaped and steered towards social benefit – could help society at large in responding to crucial challenges such as climate change, water scarcity, energy transition, and growing food demand. Social benefit in this context is considered – drawing on the Nagoya Protocol on Access and Benefit Sharing, a 2010 supplementary agreement to the 1992 Convention on Biological Diversity – as the fair and equitable access to the benefits arising from the utilization of certain resources, including by *appropriate access* to such resources and by *appropriate transfer* of relevant technologies, taking into account all rights over those resources.

The access of vulnerable communities – understood broadly as socio-economically fragile, rural, and historically disadvantaged communities – to the opportunities arising from these resources and technologies is at centre of social justice discourses and raises several dilemmas. Without a fair sharing of the benefits deriving from innovation, persistent situations of inequality would just be reinforced.

[1] A. Berti Suman, *Striving for Good Environmental Information: Civic Sentinels of Oil Pollution in the South of the North*, 17 Law Env't & Dev. J. 1 (2022) 5.

Sætra in the curated book "Technology and Sustainable Development: The Promise and Pitfalls of Techno-Solutionism" depicts the environmental challenges "threatening to drastically alter the trajectory of our future as a species" that society is currently experiencing[2]. Sætra connects these challenges to a fervid deployment of human intelligence aimed at ideating and crafting technologies to respond to such challenges. These efforts are conducted by a diversity of actors, including "researchers, developers, and businesses"[3]. As Sætra puts it, technology is often "heralded as the cure for our ills"[4], which suggests a tendency to 'techno-solutionism', that is the idea that technology can and should be used to solve the challenges faced by society.

Morozov engages with the solutionism trend, arguing that it fundamentally entails a faith in technology, but also a tendency to perceive, analyse and respond to social phenomena through the belief that challenges can be essentially managed through technological efficiency[5]. However, as Müller stresses, technology is not just an instrument that can be domesticated for human purposes, as it shapes the way society approaches such challenges, the solutions and opportunities perceived, and even societal relations[6]. This argument supports the quest for ensuring that vulnerable communities are included in the processes of shaping and regulating sustainable innovation.

Sætra poses an important question: "Does technology provide us with the means to solve sustainable development?"[7]. The answer is not straightforward essentially because "technology can be both an enabler and inhibitor of sustainable development". Moreover, a nuanced understanding of 'sustainability' is needed beforehand. The United Nations' report "Our Common Future" written by the Brundtland Commission in 1987 highlighted how sustainability goes beyond the environmental dimension, as it also

[2] H. Sætra, *Introduction: The Promise and Pitfalls of Techno-solutionism*, in H. Sætra (ed.) Technology and Sustainable Development: The Promise and Pitfalls of Techno-Solutionism 1 (2023).
[3] Ibid, 2.
[4] Ibid.
[5] E. Morozov, *To save everything, click here: The folly of technological solutionism* (2013).
[6] C. J. Müller, *Prometheanism: Technology, digital culture and human obsolescence* (2016).
[7] H. Sætra, *Introduction: The Promise and Pitfalls of Techno-solutionism*, cit. at 2, 5.

embraces the need to intervene on social challenges such as inequality and poverty, and includes both economic and ethical issues related to, for example, access to innovation and inclusive economic growth[8]. Forms of epistemic, environmental, and even racial injustices can be perpetrated if an over-reliance and blind embracement of techno-solutionism prevails.

Sætra advances another pressing question: "What are the core values we seek to reach through sustainable development and the use of technology?"[9]. Societal agency is key for steering technology developments in ways that promote those values that individuals and collectives recognise as fundamental, affirms Sætra, citing a critique to techno-solutionism developed by philosopher Næss[10].

Moving to the regulation of innovation, an important consideration is the acknowledgement that the barriers that often prevent innovations for sustainable development from becoming a reality are often not technological but economic, regulatory, political, social, and behavioural ones. The incapacity to identify these barriers to innovation could lead to shortcomings in the deployment of innovative technologies and to the failed uptake by society. Regulatory disconnects indeed often stem from the assumption that innovation for sustainability can be regulated in a space that is free from external influences, and in a controlled environment, whereas – in reality – often the opposite occurs. A series of forces, actors, values, agendas, strategies surround the development of technologies. Such complex constellation of interests, practices and agents must be considered for a comprehensive approach to regulation. In addition, spaces of dialogue and encounter must be envisioned to ensure that the experimental phases surrounding technological development become an integral part of its regulatory process.

At this stage, also a definition of regulation is useful. Black frames regulation as "the sustained and focused attempt to alter the behaviour of others according to standards or goals with the

[8] G. Harlem Brundtland et al., *Our Common Future: Report of the World Commission on Environment and Development*, United Nations General Assembly Document A/42/427 (1987).
[9] H. Sætra, *Introduction: The Promise and Pitfalls of Techno-solutionism*, cit. at 2, 6.
[10] H. Sætra, *Introduction: The Promise and Pitfalls of Techno-solutionism*, cit. at 2, citing A. Næss, *Økologi, Samfunn, Livisstil* (1999).

intention of producing a broadly identified outcome or outcomes, which may involve mechanisms of standard-setting, information-gathering and behaviour-modification"[11]. Leenes argues that "to regulate means to weigh interests and the outcome of this process can hardly ever satisfy all"[12]. Leenes embraces Black's conceptualisation of regulation, as an activity that is essentially *pluralistic*, moving "beyond the state as the sole regulator and which includes other modalities of regulation"[13]. However, as Infantino and Bussani stress, the state remains both "a major developer and tester of new technologies" and a prime driving force "in shaping the law regulating technology"[14].

As innovative technologies multiply, also regulation does. Indeed, new regulations seem to be steadily and insistently demanded as soon as a new technology emerges[15]. However, often regulation fails to reconcile those interests and concerns that pushed actors to exactly request regulatory interventions[16]. Therefore, the regulatory process should not be a simplistic matter of putting a new technology in an existing or new normative frame but rather a complex process where a multiplicity of questions must be addressed such as "who is to intervene, who (or what) to address, through which (combination of) means (e.g., law, norms, architecture, markets)"[17]. In the subsequent paragraph, this pluralistic understanding of the regulatory process is disentangled building on theories of regulatory pluralism and regulatory experimentalism.

3. The complexity of regulating: between pluralism and experimentalism

In the previous paragraph, we argued that the process of regulating innovation for sustainability is inherently complex. In

[11] J. Black, *Critical reflections on regulation*, 27 Austl. J. Legal Phil. 26 (2002).
[12] R. Leenes, *Regulating new technologies in times of change*, in L. Reins (ed.), Regulating New Technologies in Uncertain Times (2019), 6.
[13] Ibid, 12.
[14] M. Infantino & M. Bussani, *The Law of the Algorithmic State in Central and Eastern Europe. Introduction to the Special Issue*, 17 IJPL 2 (2025), 448.
[15] R. Leenes, *Regulating new technologies in times of change*, cit. at 6.
[16] Ibid.
[17] Ibid.

addition, we showed that technological innovation is only part of the solution to current socio-environmental challenges. Lastly, we stressed the need to ensure vulnerable communities' access to the benefits arising from innovation and their participation in innovation-friendly regulatory processes.

Sociological and philosophical critiques to a solutionist approach to technology and innovation enabled us to stress the value of considering a plurality of actors and forces. Næss discusses the importance of a "localized approach to technology" which can bring about "great variation in technology and the production of these technologies"[18]. This approach can have multiple benefits, such as "the enhanced ability to *adapt technology to local needs* but also how increased diversity in technologies might generate fertile ground for innovation and continuous development" [emphasis added to quote][19].

A localized approach to innovation calls upon also the need to diversify the strategies to regulate such progresses, by including in the regulatory process a multiplicity of local actors that will have to face the consequences, including the benefits and challenges posed by an innovation. An interesting example of an approach to technology and innovation that embraces diversity is the "radical indigenous Lo-TEK", a design movement which aims to re-discover and re-integrate indigenous philosophy and know-hows in designing sustainability interventions[20]. Indigenous solutions – inherently technological – are regarded as less complicated and more reflective of local needs[21]. Interestingly, this movement was particularly interested in, among other sectors, the field of organic food production and cooperative forms of living and producing[22], resonating with the focus of our study.

We believe that it is worth introducing at this stage the concept of 'regulatory pluralism' which stresses the need to rely on

[18] A. Næss, *Økologi, Samfunn, Livisstil. Bokklubben dagens bøker* (1999), cited in H. Sætra, *The Role of Technology in Alternatives to Growth-Based Sustainable Development*, in H. Sætra (ed.) Technology and Sustainable Development: The Promise and Pitfalls of Techno-Solutionism (2023) 257.
[19] Ibid.
[20] J. Watson, *Lo-TEK: Design by radical indigenism* (2020) cited in H. Sætra, *The Role of Technology in Alternatives to Growth-Based Sustainable Development*, cit. at 17
[21] Ibid, 258.
[22] A. Smith, *The alternative technology movement: An analysis of its framing and negotiation of technology development*, 2 Human Ecology Review 106 (2005).

a combination of regulatory instruments and approaches, coming from different actors, to respond to today's socio-environmental issues[23]. Gunningham and Sinclair argue that, when a variety of actors enter the regulation arena, different perspectives are introduced. The widening of the actors allowed within regulatory processes may improve regulation (for example by enriching the evidence base on which decisions are taken with different inputs) but may also turn out to be counterproductive (when, for example, it undermines the legitimacy of appointed decision-makers or creates informational overloads)[24].

Verbruggen, building on Black's concept of 'regulatory enrolment'[25] tackles specifically situations of 'regime complexity' where "the capacity for regulatory governance is dispersed among a variety of actors, none of which holds such a central position in the regulatory arena that they can unequivocally determine outcomes"[26]. Interestingly, Verbruggen contextualizes his reflection in the – here fitting – sector of food safety and food regulation and explores public, private and other actors' pushes to enter the regulatory arena.

The regulatory pluralism lens may help justifying and supporting initiatives aimed to open regulatory spaces to a multiplicity of actors. The complexity of today's societies, the proliferation of wicked problems, the abundance of information, uncertainty over the future, misinformation, populism, and polarisation demand new approaches to regulating[27]. Such approaches – we will argue – should embrace a civic right to access and benefit from innovation but also to *participate* in its shaping

[23] N. Gunningham et al., *Smart Regulation: Designing Environmental Policy* (1998).
[24] N. Gunningham & D. Sinclair, *Regulatory Pluralism: Designing Policy Mixes for Environmental Protection*, in P. S. Menell (ed.) Environmental Law (2002) 49, 50.
[25] J. Black, *Enrolling Actors in Regulatory Systems: Examples from UK Financial Services Regulation*, 1 Public Law 63 (2003).
[26] P. Verbruggen, *Understanding the "New Governance" of Food Safety: Regulatory Enrolment as a Response to Change in Public and Private Power*, 5 Cambridge J. of Int. & Comp. L. 418, 419 (2016).
[27] J. Millard, M. Manzoni & S. Schade (eds.), *Impact of digital transformation on public governance* (2023) JRC133975.

including through regulation[28]. Regulation is indeed "itself a product of different framings and ideational power dynamics"[29].

Public law scholar Boscolo captures the need for flexible, revisable, and adaptive approaches to regulation. Boscolo argues that today's socio-environmental transitions activate 'non-linear evolutionary processes' which are hard to predict and to regulate through rigid traditional approaches[30]. More flexible regulatory approaches would be apt to "govern uncertainty"[31], an indispensable feature that regulations should have to steer processes of adaptation to increasingly complex and unpredictable socio-environmental stresses. As argued by public law scholars Bussani et al. in the context of innovation in the EU agenda, the precautionary principle is a "basic pillar of regulatory choice under conditions of radical uncertainty"[32]. Both precaution and innovation are driving forces behind regulatory interventions.

Regulatory experimentalism and more specifically the concept of a right to innovation can be read in the context of a 'common core' that according to public law scholar Della Cananea[33] would exist in European administrative laws, to the point that this core can be of interest for other contexts, including the Global South[34]. Della Cananea, for example, refers to lessons for

[28] A. Berti Suman, *Striving for Good Environmental Information: Civic Sentinels of Oil Pollution in the South of the North*, cit. at 1, 4 also discusses regulatory pluralism in relation to another 'new' right, that of a civic right to contribute environmental information, discussing a case from Southern Italy.

[29] M. Bussani, G. Della Cananea, C.M. Radaelli & G. Taffoni, *Regulation and Innovation in the European Union: The European Commission and the Council in the early stages of the policy process,* CoCEAL Working Paper Series n. 1, Issue 1/2021, 9-10. For the relationship between food and power, see also https://thenew.institute/en/media/the-elephant-at-the-table-policy-pathways-to-confront-power-in-food-systems/introduction.

[30] E. Boscolo, *Relazione Introduttiva: L'Urbanistica nella Stagione delle Transizioni* (Ambientale e Digitale), in A. Bartolini et al. (eds.), Transizione ambientale e digitale: effetti sul governo del territorio (2023), 1.

[31] Ibid, 1.

[32] M. Bussani, G. Della Cananea, C.M. Radaelli & G. Taffoni, *Regulation and Innovation in the European Union: The European Commission and the Council in the early stages of the policy process,* cit. at 28, 6.

[33] G. della Cananea, *The 'Common Core' of Administrative Laws in Europe: A Research Agenda*, CoCEAL Working Paper Series n. 1, Issue 1/2017.

[34] G. della Cananea, *A New Comparative Research on Administrative Laws in Europe: Implications for Latin America*, CoCEAL Working Paper Series n. 6, Issue 2/2019.

administrative law systems of Latin American countries[35]. In arguing in favour of identifying common principles in administrative law, the author starts from an inquiry of administrative procedure, building on the work of Latin American public law scholars such as De Enterria[36] and Brewer Carias[37].

4. Experimental approaches to regulation

A complementary angle to that of regulatory pluralism is the concept of 'regulatory learning' in experimental spaces. This approach highly resonates with Kolb's 'experiential learning' theory[38] which stresses the key role of experiences in shaping the learning process. A policy brief by the Joint Research Centre of the European Commission and the European Network of Living Labs offers a useful overview on the array of experimentation spaces that can support regulatory decision-making and learning[39].

The brief defines regulatory learning as "the collection and use of any evidence or knowledge that is relevant to current or future regulatory policy, generated in the process of experimenting with an innovative solution"[40]. The brief was followed in 2023 by a European Commission's Staff Working Document, launched under the New European Innovation Agenda, that reviews available experimentation tools (e.g., regulatory sandboxes, testbeds and living labs) and showcases existing examples of participatory regulatory process from Europe and beyond[41].

The brief categorizes regulatory learning dynamics as 'top-down', i.e., initiated by a regulatory authority that seeks evidence from the field in which a specific innovation will intervene and

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[35] Ibid.

[36] E. Garcia de Enterria, *Reflexiones sobre la Ley y los principios generales del Derecho en el Derecho Administrativo*, Rev. de Admin. Pub. 40 (1963).

[37] A. Brewer Carias, *Les principes de la procédure administrative non contentieuse. Etude de droit comparé (France, Espagne, Amérique Latine)* (1992).

[38] D. Kolb, *Experiential Learning: Experience As The Source Of Learning And Development* (1984).

[39] K. Kert, M. Vebrova, S. Schade, *Regulatory learning in experimentation spaces* (2022) JRC130458.

[40] Ibid, 2.

[41] See https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/new-commission-staff-working-document-sheds-light-experimentation-spaces-regulatory-learning-2023-07-25_en.

based on this evidence the authority shapes a new or revised regulatory measure. 'Bottom-up' regulatory learning refers instead to the situation in which a regulatory insight emerges spontaneously from innovation deployed in an experimentation space[42]. A good example of this second scenario will be offered by the AWARE case study, in which lessons are learned from confronting regulatory obstacles in practice and on the ground.

Experimental regulatory approaches are needed to harmonize innovative solutions with regulatory frameworks, that are often complex, overlapping and layered across EU, national, regional and local levels. Disruptive innovations may indeed "be subject to unsuited regulatory frameworks or fall outside them altogether, which may hamper the development and deployment of innovation and weaken investor and consumer confidence"[43]. Tackling these barriers through regulatory learning in experimentation spaces may require regulatory change, but it is also conceivable that at the end of the process it results that no regulatory intervention is needed[44].

The brief also includes findings from interviews conducted with research and innovation practitioners. The types of concerns voiced by these actors are insightful. Innovators for example ask, "How do regulators interpret the rules in relation to innovative solutions not specifically foreseen by the current regulatory framework?". Regulators on their side pose the questions on "What are the new regulatory needs to foster innovative solutions and business models while safeguarding social values and protecting the public?". Lastly, citizens want to know the effects of such innovations and regulations on their daily life and demand transparency in this process[45].

Timely, the brief also discusses "the joint value that the actors involved in innovation creation, adoption, and governance may derive from collaboration within different experimentation

[42] K. Kert, M. Vebrova, S. Schade, *Regulatory learning in experimentation spaces*, cit. at 27. See also Box 2 for examples of top-down and bottom-up regulatory learning in experimentation spaces.
[43] Ibid.
[44] Ibid.
[45] Ibid, 3.

spaces, such as test beds, living labs, and regulatory sandboxes"[46]. This collaboration becomes even more essential over technologies that raise public concern, where civic scrutiny and meaningful public engagement can open a needed discussion on the social value, impact, and governance mechanisms that society envisages for a certain technology and its deployment[47]. The current research and innovation framework at the EU level, particularly through the Horizon Europe programme, acknowledges the importance of a meaningful citizen engagement in regulatory experimentation and promotes spaces where this engagement can take place.

Despite the promises, regulatory experimentation comes with challenges, as highlighted by academic literature on regulatory sandboxes[48], which interestingly points to the impact of regulatory sandboxes on the increasing collaborative dimensions of public law. Foreseeable risks include that of regulatory capture due to the close collaboration between regulators and regulated actors, and the risk of violating traditional administrative law principles, such as transparency, legality and proportionality.

The cited brief also highlights potential limitations of experimental regulatory spaces. Among these issues particularly relevant are the high costs in terms of (financial, human and time) resources; the low impact in cases where non-regulatory barriers to innovation are more determinant than regulatory ones; the low scalability and replicability of the results of experimentation when such results are too context-specific; the potentially confusing outcomes generated when regulatory flexibility creates market fragmentation at the EU level; the possible concerns associated with a preferential treatment granted to certain innovators and innovations over others, creating unfair competition and prioritising certain interests over others[49].

[46] Ibid, 1. See also Table 2 offering an overview of experimentation spaces and their typical features.
[47] Ibid, 2.
[48] S. Ranchordas & V. Vinci, *Regulatory Sandboxes and Innovation-friendly Regulation: Between Collaboration and Capture*, 1 IJPL 1 (2024).
[49] Ibid, 4.

5. Epistemic considerations in shaping regulatory processes: insights from territorial governance

Regulatory experimentation may be useful both in terms of process and in terms of inputs: as the cited brief argues, regulatory learning processes "offer a setting in which different stakeholders can build constructive relationships of *knowledge exchange* and *trust*, which contributes to improving regulatory governance of innovation" [emphasis added to quote][50]. The insights gathered through such experimentation spaces can help promote epistemic diversity in the regulatory process. Comprehensive stakeholder engagement interventions can both contribute to inform regulations with evidence from the ground and from practice, and increase the legitimacy of innovation and its regulation, augmenting their chances of uptake among the public[51].

A specific dimension where these approaches may unfold is the urban context through what we can frame as 'urban experimentalism'. The recommendations of the discussed brief by the Joint Research Centre point to the need to "explore the multi-level governance aspects' of regulatory experiments and to deploy these experiments at different administrative levels"[52]. We understand this indication as including the regulation of innovation at the urban level.

A good example is offered by Italian legal doctrine on public law of innovation in relation to territorial *multi-level* governance. This area is a constitutionally concurrent legislative matter that encompasses a set of interrelated functions, involves a variety of institutions, and demands the intervention of cross-cutting and transversal competences[53]. On this arena, the administrative principles of subsidiarity, adequacy, competence, loyal cooperation, consistency, and simplification (should) steer interventions, including regulatory ones[54]. The methodology of 'co-planning' consisting of the active and equal participation of

[50] Ibid.

[51] Ibid. See also Box 1 of the brief offering an overview of the recognition of regulatory experimentation spaces in EU policy.

[52] Ibid.

[53] C.A. Barbieri, *Principi e Norme Generali del Governo del Territorio e la Pianificazione. Un vuoto legislative da colmare*, in A. Bartolini et al. (eds.), Transizione ambientale e digitale: effetti sul governo del territorio (2023), 92.

[54] Ibid, 93.

institutional and other actors is key here to inform and steer regulatory action[55].

Experiences of urban experimentalism through stakeholder engagement and knowledge sharing have been systematized in the 'Co-City Protocol' by Foster and Iaione[56]. The protocol offers insights and a roadmap on how to shape co-governance mechanisms that encourage collaboration among at least five typologies of stakeholders (citizens/civil society organizations and innovators, schools and universities, businesses, public authorities, and the environment)[57,58]. The protocol aims at encouraging an active role of local communities as key players in the production, delivery, and management of urban assets or local resources, through innovative forms of cooperation. The protocol is currently being applied in local contexts, including in that of the AWARE project. The Protocol supports 'mission-oriented' and place-based innovations[59] aimed to promote local sustainable development, as well as inclusive regeneration of underprivileged urban areas[60]. Furthermore, the Protocol advance the principle of 'Technology Justice' in governing urban challenges[61].

The importance of multi-level governance of innovation including through regulatory coordination is evident in the field of spatial data, for example. The 2007 INSPIRE Directive established common rules for spatial information infrastructures across the EU, with the aim to ensure the exchange, sharing, access, and use of spatial data according to uniform and interoperable standards. It did so through the creation in each Member State of spatial information infrastructures that are compatible and usable in cross-

[55] Ibid.

[56] S. Foster & C. Iaione, *Co-Cities: Innovative Transitions Toward Just and Self-Sustaining Communities* (2022).

[57] S. Foster & C. Iaione, *The City as a Commons*, 34 Yale L. & Pol'y Rev. 281 (2016).

[58] S. Foster & C. Iaione, *Ostrom in the City: Design Principles and Practices for the Urban Commons,* in D. Cole, B. Hudson, J. Rosenbloom (eds.), Routledge Handbook of the Study of the Commons (2018).

[59] C. Iaione, *Just Sustainable Innovation: Shared Systemic Stewardship as Governance Impact of Sustainable Investment?*, 1 Munus 37 (2024).

[60] S. Foster & C. Iaione, *Co-Cities: Innovative Transitions Toward Just and Self-Sustaining Communities*, cit. at 40.

[61] C. Iaione, E. de Nictolis, A. Berti Suman, *The Internet of Humans (IoH): Human Rights and Co-Governance to Achieve Tech Justice in the City*, 13 Law & Ethics. Hum. Rts. 263 (2019).

border contexts. Only an effort of *regulatory multilateralism* enabled the creation of such a joint spatial infrastructure across the EU. However, this innovation still struggles to be fully implemented in practice and to benefit territorial realities, for example in the Italian contexts, due to a series of socio-political barriers, as literature argues[62]. The case of spatial data reinforces the argument that regulatory innovation should be brought to local contexts to really benefit local communities.

6. The AWARE project and its regulatory challenges

The water sector – a sector considerably affected by today socio-environmental challenges – offers interesting opportunities for regulatory experimentalism, co-governance of innovation, and meaningful stakeholder engagement. For example, a study by Kristic et al.[63] in this issue looks at the application of Environmental, Social, and Governance (ESG) Standards within the water utilities sector, for achieving an Integrated Water Resources Management, regarded as essential for equitable and sustainable water resource management. The article frames the problem through the lens of Urban Commons and the Co-City theory[64], bringing Ostrom's principles to the city[65], and proposes a co-governance model based on collective stewardship, community engagement and equitable resource distribution. The study draws insights from empirical case studies located in geographically and socially different contexts, from the United Kingdom to Southern Italy to Nairobi, Kenya[66].

Other studies in the field discuss stakeholder engagement for tackling public uptake barriers and for addressing regulatory voids or uncertainties in relation to innovation in the water sector. Drawing on the experience of the FIT4REUSE project[67] (funded

[62] G. Avanzini, *Digitalizzazione e decisioni territoriali*, in A. Bartolini et al. (eds.), Transizione ambientale e digitale: effetti sul governo del territorio (2023), 101.
[63] M. Kristic, S. Sabatucci & I. Mugabi, *Winning the water battle with Sustainable Co - Governance: evidence from water utilities companies*, in this Issue.
[64] S. Foster & C. Iaione, *Co-Cities: Innovative Transitions Toward Just and Self-Sustaining Communities*, cit.
[65] S. Foster & C. Iaione, *Ostrom in the City: Design Principles and Practices for the Urban Commons*, cit.
[66] M. Kristic, S. Sabatucci & I. Mugabi, *Winning the water battle with Sustainable Co - Governance: evidence from water utilities companies*, cit.
[67] See webpage at https://fit4reuse.org/.

under the EU program Partnership for Research and Innovation in the Mediterranean Area - PRIMA), Berti Suman and Toscano[68] explored how technical solutions for utilizing non-conventional water resources in the Mediterranean agricultural sector must face challenges related to public acceptance and regulatory barriers. Further, Berti Suman and others[69] discussed the advent of the EU Water Reuse Regulation in the Mediterranean region, focusing the attention on policy and legislative adaptations which are needed to address non-conventional water resources utilisation in agriculture, also shedding light on the complex stakeholders' engagement processes behind these interventions.

Our case study builds on the experience of the EU Horizon programme-funded project AWARE[70], launched in 2022. The project aims to remove the barriers that prevent treated wastewater-based aquaculture from becoming a European reality. It created Europe's first demonstration-scale aquaponics plant for agricultural purposes, aimed at producing fish and vegetables suitable for human consumption, by implementing an innovative, highly resilient and sustainable approach. In this paragraph, we discuss the AWARE case whereas in the subsequent paragraphs we discuss other cases where technological innovations in the water sector have been deployed in combination with experimental regulatory schemes, in particular in the Global South. We then return to the European context to search for comparable regulatory experiences in the field of wastewater reuse.

The AWARE project involves numerous partners, from academic to institutional actors, also encompassing sectorial associations such as the European Aquaculture Society. The analysis of the regulatory framework and the involvement of stakeholders is curated by Luiss Guido Carli University, with the

[68] A. Berti Suman & A. Toscano, *Public Acceptance of Water Reuse for Agriculture in the Wake of the New EU Regulation: Early Reflections*, 18 Env't & Plan. L.J. 225 (2021).
[69] A. Berti Suman, L. Garcia Herrero, S. Lavrnic, M.C. Sole, A. Toscano, M. Vittuari, *The advent of EU Water Reuse regulation in the Mediterranean region: policy and legislative adaptation to address non-conventional water resources utilisation in agriculture*, 48 Water Int. 839 (2023).
[70] See webpage at https://www.aware-eu.eu/the-project/. The project is funded by the HORIZON-CL6-2022-FARM2FORK-01 call - Fair, healthy and environmentally-friendly food systems from primary production to consumption. Author Anna Berti Suman is currently working on the project in the framework of Work Package 5 led by Luiss Guido Carli University.

involvement of LabGov - Laboratory for the Governance of the City as Commons, which are bringing to the project insights from relevant experiences of co-governance of the urban commons and from applying just sustainable innovation principles.

The technological and innovation components are very prominent in the project, so do the regulatory barriers that the project faces. The field of innovation in the aquaculture sector is particularly interesting as the demand for aquaculture products is increasing in Europe, creating a growing opportunity for the sector. Authors in the field note that existing studies have demonstrated the benefits of aquaponic systems for the production of both plants and aquatic organisms, and its advantages in terms of economics and environmental protection[71]. However, freshwater aquaculture production has declined in Europe since the beginning of the 21st century, due to a lack of innovation, poor product diversity, seasonality, and – notably – strict environmental regulations. There is also the problem of missing scientific evidence on the safety, quality, economic feasibility, and social acceptability of the aquaponic-based value chain[72].

The AWARE project aims to boost the sector leveraging the potential of advancements in wastewater treatment technologies. An increased capacity to produce fish and vegetables for human consumption at European level will have numerous benefits including the possibility to produce food locally, a reduced impact on natural habitats, and the independence from the availability of fresh water which can enhance resilience to climate change. In addition, the project aims to respond to the needs outlined in literature, namely that of addressing the mistrust from the public in consuming fish or vegetables grown in reclaimed water; the need to verify the safety and advantages of such cultivation technique, and to establish guidelines for a safe and responsible use of reclaimed water in aquaponics[73].

The AWARE project deployed a Recirculation Aquaponic System (RAS) with a 'zero waste' approach, based on the reuse of wastewater, treated to the level of being comparable in terms of

[71] L. Cifuentes-Torres, G. Correa-Reyes, L. Mendoza-Espinosa, *Can Reclaimed Water Be Used for Sustainable Food Production in Aquaponics?*, 12 Front. iPlant Sci. 1 (2021).
[72] Ibid.
[73] Ibid.

quality to drinkable water, thanks to a biofilter acting as last barrier for any residual substance. Figure 1 below illustrates this process. The RAS system is integrated with monitoring technologies to improve the system's operation and its sustainability. The needed energy to fuel the system is around 7 kW and a dedicated photovoltaic system provides for part of its energy consumption. The RAS pilot is placed in a region that is particularly vulnerable to water scarcity: Puglia, South of Italy, in the city of Castellana Grotte, a site where some of the project partners are located.

The project identified several barriers that currently reduce the European potential of aquaculture in reclaimed waters. These barriers are i) technological: related to the functioning and sustainability of the system; ii) economic: related to the business model of this value chain; iii) regulatory: linked to fact that currently Italy and the EU lacks a regulatory framework that supports this technique; d) political: connected to the still scarce political support for the expansion and commercialization of this technique; e) behavioural: linked to the need to evaluate acceptance by end users, using a series of socio-behavioural analyses.

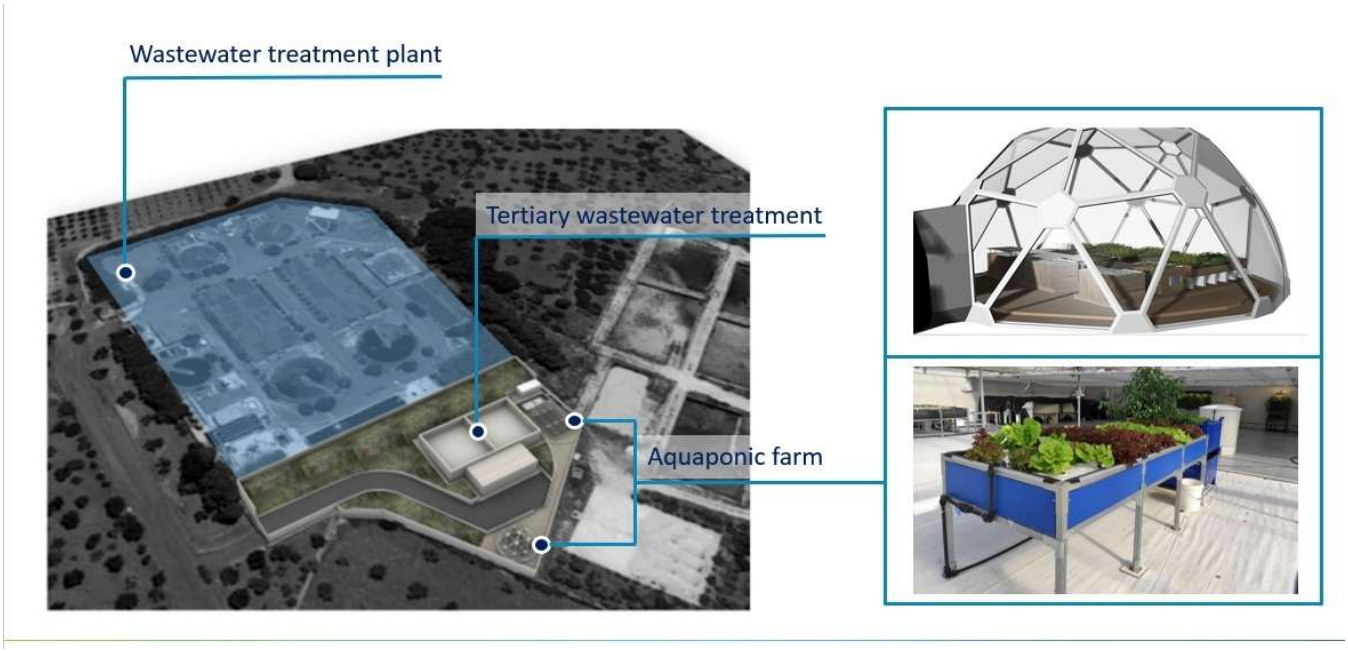

Figure 1 - The AWARE Recirculation Aquaponic System based on a 'zero waste' approach [source: AWARE project]

Throughout the project and with the specific case study at the Castellana Grotte plant, the AWARE consortium aims to: a) concretely demonstrate the effectiveness of technical solutions for efficient and sustainable aquaculture from reclaimed wastewater; b) increase the reuse of wastewater as a resource to be exploited where it is generated; c) create a new value chain at local level (*farm-to-fork* value chain) contributing to European economic growth and zero-waste urban agriculture; generating social, environmental and economic benefits; and demonstrating how this value chain can be scalable and transferable to other contexts; d) lay the foundations for a new regulatory and political framework to support European aquaculture.

Especially letter d) cited above is key for our study. Indeed, the AWARE project aims at contributing, first, to the Strategic Guidelines for a more sustainable and competitive EU aquaculture for the period 2021 - 2030[74], in line with the broader objectives of the European Green Deal. In addition, the project through its pilot in Puglia intends to offer evidence to inform the Italian national framework that has implemented these strategic EU guidelines, i.e., the National Strategic Plan for Italian Aquaculture 2021-2027[75]. Among the priorities of the Italian Strategic Plan, we find: scientific research and digitalization; consumer awareness and social acceptability; strengthening the strategic role of regional administrations; and – remarkably – community-led local development. We also identify objectives that are pertinent to our inquiry, namely "Strengthening institutional capacity and simplifying administrative procedures" and "Ensuring the development and sustainable growth of aquaculture through coordinated spatial planning and increasing site potential".

It should be noted that aquaculture, unlike fisheries, is not an exclusive EU competence, which highlights the need for multi-level governance of the sector. In addition, the EU recognizes that efficient coordination among rules and regulations is needed as there is a large body of EU legislation which aquaculture producers

[74] See *Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030* (COM (2021) 236 final), available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:236:FIN. See also the European Commission's webpage on aquaculture policy, https://oceans-and-fisheries.ec.europa.eu/policy/aquaculture-policy_en.

[75] See https://aquaculture.ec.europa.eu/country-information/italy.

must comply with[76]. This is why the European Commission issued non-binding strategic guidelines for EU aquaculture, which offered the basis for the development of specific national strategic plans for aquaculture[77], that are being issued by individual EU countries. The European Commission adopted the so-called 'open method of coordination' according to which national and EU-wide progresses proceed in parallel through the exchange of good practices among EU countries. Projects envisaging pilots developed at a local level but through an EU-wide coordination, such as the AWARE project, could be particularly insightful to share best practices and identify needs for further regulation.

The AWARE project is also relevant to the present discussion as stakeholder engagement activities are seen as central to advance the regulatory change that the project wishes to inspire. The project mapped – as a first step towards engagement – policy-makers at local, regional and national level, water management authorities, international institutions, scientific and research institutions, civil society organisations, innovators, operators and farmers' organisations, funding bodies and thematic networks. The methods deployed for engagement include active stakeholder involvement and co-design of interventions. An example of an impactful stakeholder engagement intervention has been the organization of a Bootcamp on the theme of 'Just Sustainable Innovation' on May 14th, 2025, in Bari and Castellana Grotte. The Bootcamp involved more than 50 participants among students, young professionals, expert mentors and policy-makers in the co-design of innovative solutions to identified challenges related to sustainable water and food management in the Puglia Region. Figure 2 below depicts the site visit that occurred during the Bootcamp.

[76] For an overview of the regulatory and policy framework for aquaponics in the EU see T. Reinhardt, K. Hoevenaars & A. Joyce (2019), *Regulatory Frameworks for Aquaponics in the European Union*, in *Simon Goddek and others* (eds.), Aquaponics Food Production Systems (2019).

[77] See https://aquaculture.ec.europa.eu/country-information. See also a dedicated platform for promoting engagement and innovation of stakeholders in the Italian aquaponic sector, https://piattaformaitaqua.it/.

Figure 2 - The AWARE approach and key steps illustrated [source: authors]

Another valuable aspect of the AWARE project relates to the strategy adopted for addressing the existing regulatory barriers by promoting experimentalism in the context of regulatory gap. The aim of adopting this approach was to steer regulatory advancement through tests and exchanges with relevant stakeholders. Indeed, in order to deploy the pilot in Castellana Grotte, the consortium entered in dialogue (including through formal interpellations) with the Italian Ministry of Agriculture, the Ministry of Health, and the Ministry of the Environment, as well as with the local Regional Health Authority (ASL). The plant obtained authorization as an experimental facility for research purposes[78] (after registration in the Italian National Database of the Ministry of Health, as 'confined experimental plant') and aims to prove the safety and nutrition levels of the food produced in the facility to obtain an authorization

[78] Currently, the AWARE project operates under an exemption pursuant to Article 2, paragraph 3 of Regulation (EU) 2020/741, with authorisation from the Puglia Region (prot. AOO/075_0009442 of 03/08/2023). Pursuant to Article 2(9) of the same Regulation, the products obtained cannot be placed on the market during the experimental phase.

that enables commercialisation (thus insertion on the market) of the products from the plant (i.e., lettuce and fish).

The key regulatory void in this case is that aquaculture in treated wastewater is not yet a regulated field in the EU. Regulation (EU) 2020/741 establishing minimum requirements for water reuse, while defining a harmonised framework for water reuse in agriculture, does not explicitly cover aquaponic systems using treated wastewater. The same approach has been adopted by the Italian Presidential Decree on wastewater reuse, implementing Regulation (EU) 2020/741, which has been issued on November 5, 2025, by the Italian Council of Ministers, upon the proposal of the Minister of the Environment. The Decree is currently under discussion by the Italian Parliament.

The outlined gap creates regulatory uncertainty, hindering potential applications of this technique. Formally recognising the system as an unconventional irrigation method could allow it to be included in a specific regulatory framework, on a par with the practices already recognized in Regulation (EU) 2020/741, overcoming the current limitations experienced by the pilot scale. Furthermore, its regulation could specify the conditions (e.g., risk assessment, monitoring protocols) under which the suitability for human consumption of the vegetables and fishes produced would be determined.

From a legal perspective, the AWARE project is set in a rapidly evolving regulatory context regarding the reuse of refined waters. The project's results – demonstrating the suitability for human consumption of the vegetables and fish produced in this type of system – aim to offer evidence to steer the implementation of the discussed Regulation (EU) 2020/741. Furthermore, the project closely followed the progresses of Directive (EU) 2024/3019 of the European Parliament and of the Council concerning urban wastewater treatment. The Directive on one side sets more stringent standards and mandate unified prescriptions to Member States to prevent the adverse effects of urban wastewater discharge and the associated health hazards. On the other side, it fosters increased circularity introducing new requirements to recover valuable components from wastewater, including in agriculture. The Directive does not foresee a distinction, as hoped by the AWARE consortium, between *treated* and *refined* wastewater (the latter being the scenario of the water treated with the AWARE plant's system).

Overall, the project is both being influenced by the outlined regulatory framework and is contributing to promote its advancements.

In terms of policy impact, the AWARE project aims at contributing, first, to the Strategic Guidelines for a more sustainable and competitive EU aquaculture for the period 2021 - 2030, in line with the broader objectives of the European Green Deal. In addition, the project through its pilot in Puglia intends to offer evidence to inform the Italian national framework that has implemented these strategic EU guidelines, i.e., the National Strategic Plan for Italian Aquaculture 2021-2027, and that will have to implement the new EU legislative framework for urban wastewater. At the international level, projects like AWARE are contributing to the objectives of Agenda 2030, in particular Sustainable Development Goal (SDG) 2 - Zero Hunger and SDG 12 - Responsible Consumption and Production.

Interestingly, the project is trying to steer regulatory experimentalism by invoking article 36 of the Italian Law Decree no. 2020/76 which fosters technological innovation in the public sector. Although the article has mainly found application in the digital sector, it could be extended to the field of innovative agri-food technologies. Applying this article through an extensive interpretation, a more pervasive form of collaboration with the competent institutions could be justified and there would be impetus for regulatory interventions that are essential for supporting the project's advancements.

This interpretation would also be in line with Regional Law No. 4/2025 on Open Innovation and Artificial Intelligence in the Puglia Region, where the project's experimental site is located. Already in the project's Grant Agreement, a sort of 'duty to cooperate' from the competent public administrations is enshrined, when it is affirmed that institutions, regulatory agencies and political decision-maker are invited to collaborate with the project partnership to clarify the process and requirements in order to: i) obtain the necessary authorizations to start the pilot plant first in Italy pursuant to the applicable national and EU legal framework, and transfer its solutions to other contexts; ii) initiate a dialogue at political level on the inclusion of wastewater aquaponics in the long-term strategy of the EU (e.g., in the Common Agricultural

Policy, in the implementation of the EU Green Deal objectives) and transfer the implemented solution to other European regions.

Among the regulatory questions that are being addressed, worth mentioning are the following ones: can fish bred in the first European RAS, built as part of the AWARE project, be consumed in Castellana Grotte and, in general, in Italy? Can the reclaimed water after advanced tertiary treatment be considered of comparable quality that drinking water? Can this fish be consumed by citizens resident outside Italy, in an EU or non-EU country, recruited as volunteers in the framework of the AWARE project? Can this case be considered exempt from EC Regulation 178/2002 which establishes the key principles of food legislation and the applicable European and national regulatory framework? Such an exemption – it is argued – could be justified by an extensive interpretation of the article at issue, or by virtue of a right to innovation and the need of regulatory experimentalism to fill regulatory gaps.

Exploring such questions can be done through traditional exchanges in formal meetings but also through more advanced forms of regulatory dialogue. For example, the possibility of strategic partnerships that establish a continuous dialogue between the consortium, stakeholders and policy-makers could be key to these aims. Currently, the AWARE consortium has also secured a Memorandum of Understanding with the municipality of Castellana Grotte and the regional water authority (Acquedotto Pugliese), granting the utilisation of local wastewater for the project scope, as well as with the 'sister project' SAFE[79], facing similar regulatory hurdles. Such spaces and arrangements could be venues to discuss best practices, gather knowledge and establish trust bonds. In addition, also the possibility of creating a 'regulatory sandbox' to respond to the project's needs and fill regulatory vacuums, is being explored. The creation of trusted channels with regulatory authorities to exchange discussions about barriers and opportunities, and the exchanges with research and innovation projects facing similar challenges to those faced by AWARE are promising strategies to unlock the full potential of the project.

Differently from the Italian legislative context where the AWARE pilot is located, in other European jurisdictions, EU

[79] See https://www.primasafe.eu/the-project/.

Regulation 2020/741 has been transposed in a manner favourable to more extensive uses of wastewater. In particular, in Spain, Royal Decree 1085/2024 of October 22, 2024, transposes the Regulation on water reuse and amends various royal decrees governing water management in Annex I. It specifies the quality requirements for refined water intended for aquaculture, including the cultivation of aquatic animal and plant species, with the exception of filter-feeding molluscs. The Decree does not explicitly address hydroponics or aquaponics, but by allowing, subject to authorization, the use of treated water for agricultural irrigation and *fish farming*, it also seems to provide for the use of treated wastewater for aquaponics. In addition, the Decree establishes the possibility of providing for further applications for water reuse, provided that its quality and safety are guaranteed, ensuring the protection of public health and the environment. The administrative procedure to be followed to obtain authorization for such additional applications can also be taken as a model for Italy, in light of the provisions of Directive (EU) 2024/3019 on urban wastewater treatment, in particular Article 8 'Quaternary treatment' and Article 18 'Risk assessment and management', in which aquaculture sites using wastewater are listed as potentially risky for the environment and human health.

In France, Decree No. 2024-769 of July 8, 2024, authorizes the use of certain 'recycled' waters as an ingredient in the composition of final food products, provided that certain conditions are met. The decree was designed both to ensure water supply and to reduce the environmental impact of the agri-food industry. The decree also amends the Public Health Code by authorizing food companies to use certain recycled water as an ingredient; this applies to i) recycled water from raw materials and ii) water used during food preparation, processing, and storage operations, which is collected for reuse. The Decree also completes the regulatory framework for the production and use of wastewater generated by food companies and further treated. The Decree is accompanied by a ministerial decree defining the applicable quality requirements.

In conclusion, the regulation of aquaponics using refined wastewater and the suitability for human consumption of the resulting products would provide legal certainty for public and private entities interested in implementing aquaponic systems using refined wastewater. This would be a decisive step towards

water resilience especially in areas of Europe vulnerable to climate change and the promotion of new, more sustainable circular agri-food supply chains. The table below (Table 1) highlights the lessons that Italy – and other EU countries – can learn from the experience of Spain and France in implementing Regulation 2020/741.

Table 1 - Comparative lessons from legislative interventions on wastewater reuse in Spain and France

Country	Legislative reference	Key insights for the AWARE project	Gaps if any	Lesson for Italian legislation	Other comments
Spain	Royal Decree 1085/2024, of October 22, 2024, enacting the Regulations on water reuse and amending various royal decrees governing water management	Annex I.A the law specifies the Quality requirements for reclaimed water for aquaculture, including the cultivation of aquatic animal and plant species except filter-feeding molluscs. The law does not explicitly address hydroponics or aquaponics, but by allowing, subject to authorization, the use of treated water for agricultural irrigation and fish farming, it seems to also provide for the use of recycled wastewater for aquaponics.	Among the listed applications there is not explicitly aquaponics from wastewater, while it is foreseen the integration into industrial processes, in high-demand agricultural irrigation, in urban uses and for aquifer recharge. The Decree prohibits the use of reclaimed water for food businesses, except as provided for in Annex I.A.	In ensuring compliance with the EU Regulation 2020/741 additional water reuse applications can be foreseen, provided that quality and safety is guaranteed, ensuring the protection of public health and the environment. The precise administrative procedure for obtaining authorization for applications of reclaimed water can be taken as model to identify suitable procedures.	The scope of application of this regulation is broader than that established by Regulation (EU) 2020/741, which refers to reclaimed water intended for agricultural irrigation. The EU Regulation allows other uses beyond those envisaged in it. However, the provisions of Directive (EU) 2024/3019 on urban wastewater treatment should be considered in particular Article 8 Quaternary treatment and Art. 18 Risk assessment and management where aquaculture sites using wastewater are listed as potentially risky for the environment and human health.

France	Decree n° 2024-769 from July 8, 2024	Authorises the use of certain recycled water as an ingredient in the composition of final foodstuffs. Provided that all conditions are met, the new decree also authorizes "the use of certain recycled water as an ingredient in the composition of final food products." The Decree is designed both to secure the water supply and to reduce the environmental impact of the agri-food industry.	Not identified	The decree amends the Public Health Code authorising food companies to use certain recycled water as an ingredient; this is the case for: I) recycled water from raw materials and II) recycled process water: water used during food preparation, processing and preservation operations, which is collected for reuse. It also completes the framework for the production and use of wastewater generated by a food business and further treated.	The Decree is accompanied by an Order defining the applicable quality requirements.

7. Experiences of sustainable innovation for the benefit of vulnerable communities and related regulatory approaches

In order to explore relevant experiences of sustainable innovation that benefitted vulnerable communities and related regulatory approaches, we investigated various initiatives[80],

[80] The applied method involved scrutinizing official reports, databases such PubMed, Google Scholar, ScienceDirect, and specialized agricultural research databases (e.g., from national ministries of agriculture and other government agencies involved in setting policies, the UN Food and Agriculture Organization website and the World Economic Forum). The search was purposive, guided by the discussed theoretical frame and the identified research questions. We used relevant keywords (e.g., agricultural technology, sustainable farming, food experimentalism, rural development, farmers empowerment) in conjunction with parameters like the country name to obtain pertinent information. The

targeting qualitative (farmers' perceptions on the benefits of implementing sustainable farming practices, attitudes or feedback on initiatives, and usability of the new technologies) and quantitative (crop yields, use of fertilizer, pest control methods and impacts on vulnerable communities) data. We selected the most relevant initiatives, addressing issues of food insecurity, the adoption of innovative technologies and regulatory experiences, with an eye of lessons that could be valuable for the EU context. We were particularly interested in looking at cross sectorial collaborations among local communities, governments and the private sector to identify creative governance and regulatory approaches to attain food security through just approaches. Hereafter we discuss some of the most interesting experiences.

In the case of the *Floating Gardens of Bangladesh* traditional hydroponic techniques known as floating vegetable gardens are being revived to combat food insecurity exacerbated by climate change. These floating gardens, constructed from aquatic weeds like water hyacinth and paddy stalks, provide a reliable source of food even during monsoons. With two-thirds of the country being wetland, many areas remain underwater for up to eight months annually. The practice of floating gardens, known locally as Dhap or Baira, dates back 300-400 years and is common in districts like Gopalganj, Barisal, and Pirojpur. The gardens, recognized by the United Nations (UN) Food and Agriculture Organization as a globally important agricultural heritage system, do not require soil, reducing plant diseases and weeds. They are low-cost and environmentally friendly, with inputs entirely natural and sustainable, and improved food security. The revival of floating gardens has been supported by various government and civic initiatives. These floating gardens exemplify resilience against flooding, providing sustainable agricultural practices while promoting social and epistemic inclusion. Exploring their impact reveals how traditional knowledge merges with modern techniques to enhance food security and environmental protection, and to foster community empowerment, demonstrating a scalable model for other flood-prone areas. The institutional setting of this case is community-led, it is deeply rooted in traditional ecological and

limitations of this confined study depends on time and available resources, significantly restricting the ability to offer a full picture of the field.

ancestral knowledge systems that have evolved over centuries. The initiative aligns with the Bangladesh Climate Change Strategy and Action Plan of 2009, which encourages adaptation and sustainable agriculture[81]. Scholars discussing the case emphasize the relevance of legislative frameworks that foster grassroots innovations, claiming that they empower local farmers and improve resilience to climate change. This approach is recorded in agricultural and development literature as both traditional and revitalized by non-governmental organizations (NGOs) and government initiatives focusing on food security and resilient livelihoods[82].

The *e-Choupal initiative – India* established by the private company ITC Limited aims to bridge the gap between farmers and essential resources such as information, markets, and services through internet kiosks, thereby fostering agricultural entrepreneurship. The initiative yielded substantial benefits for vulnerable communities, particularly in terms of enhancing access to critical information, market prices, and agricultural inputs. This initiative supports smallholder farmers in remote regions by providing them with up-to-date information on crop prices, weather forecasts, and optimal farming techniques. In addition, by directly linking farmers with buyers through digital platforms, e-Choupal eliminates the need for intermediaries, ensuring equitable prices for farmers' products. Furthermore, e-Choupal facilitates the availability of high-quality inputs like seeds and fertilizers, leading to enhanced crop yields and increased revenue for vulnerable communities. The institutional setting of the case is it is a hybrid model that is primarily corporate-led by ITC Limited in collaboration with the local actors. At the State level, it is legally supported by the Agricultural Produce Marketing Committee Acts from early 2000s[83]. Literature stresses how e-Choupal helps farmers to sustain their lives while giving them more influence in

[81] See https://faolex.fao.org/docs/pdf/bgd163540.pdf.

[82] H.Md. Irfanullah, A. Adrika, A. Ghani, Z.A. Khan & Md.A. Rashid, *Introduction of floating gardening in the north-eastern wetlands of Bangladesh for nutritional security and sustainable livelihood*, 2 Ren. Agri. & Food Syst. 89 (2008).

[83] J. Chaliha & S. Bhattacharya, *ITC e-Choupal – Innovation for Large Scale Rural Transformation: A Success Story*, Asia-Pacific Association of Agricultural Research Institutions/FAO RAP (2014), available at https://www.apaari.org/wp-content/uploads/downloads/2015/01/E-Choupal-small.pdf. See also https://itforchange.net/sites/default/files/ITfC/e-Choupal.pdf.

negotiations through access to markets and information[84]. The regulatory opportunities and issues that come with these digital technologies show how important it is to have supporting laws that can help these initiatives thrive while making sure that all farmers have fair access to information and technology[85].

Seaweed farming - China and Korea posits that seaweed cultivation provides a multitude of advantages to vulnerable communities within the food sector. It serves as a sustainable source of income and sustenance for coastal populations, particularly in developing nations. Seaweed is abundant in nutrients and can be incorporated into a variety of food items, thereby bolstering food security and enhancing the nutritional intake of at-risk groups. Furthermore, seaweed farming promotes sustainable aquaculture methods, aids in the restoration of marine ecosystems, and generates employment opportunities for local communities, thereby bolstering their resilience and economic welfare. Seaweed farming leverages a range of technologies such as floating cultivation systems, automated monitoring devices, and processing equipment to optimize efficiency and productivity. The regulatory framework governing seaweed farming varies by country, encompassing regulations pertaining to farming licenses, environmental impact assessments, and food safety criteria. As noted by the FAO, China is legally supported by the Fisheries Law (1986, amended in 2000)[86]. Korea is backed by the Law on the Promotion and Support of the Seaweed (Laver) Industry[87]. Literature focuses on the balance of innovation and environmental sustainability, emphasising the importance of strong governance to enable the sector's growth, and regulatory experimentalism that facilitates the adoption of innovative technology and techniques in seaweed farming, resulting in more sustainable and resilient coastal

[84] G. Sharma & U.C. Swadimath, *Leveraging Technology for Inclusive Rural Development in India: Assessing the Impact of Digital Interventions on Socio-Economic Growth in Rural Communities*, in T. Manickam et al. (eds.), Addressing B5G and 6G Network Connectivity Issues in Rural Regions (2025).

[85] R. Chand, *Agricultural challenges and policies for the 21st century*, 2 NABARD Res. & Pol. Ser. 36 (2022).

[86] See https://www.fao.org/fishery/en/countrysector/naso_china.

[87] See https://collaboration.worldbank.org/content/sites/collaboration-for-development/en/groups/aquainvest-platform/documents.entry.html/2024/05/09/republic_of_korea-lawonthepromotionandsuppo-GFg3.html.

economies[88]. Furthermore, authors also point to the gender dimensions of seaweed cultivation speaking of 'feminist seaweed cultures' which acknowledges environmental ethics and entanglements between humans and seaweeds in feminist practices[89].

Sistema Biobolsa - Brazil, Kenya, India, Indonesia, and *Mexico* proposes to innovate the agricultural sector by providing cutting-edge biogas systems that enable farmers to convert organic waste into renewable energy and organic fertilizer[90]. This system not only enhances agricultural productivity but also reduces greenhouse gas emissions and advocate for sustainable farming practices. Through the utilization of Sistema Biobolsa's technology, farmers can optimize food production while minimizing their environmental footprint[91]. Sistema Biobolsa offers cost-effective biogas systems to small-scale farmers, thereby fostering sustainable agriculture and entrepreneurship. It represents a sustainable and effective method of waste management while harnessing clean energy and enhancing agricultural productivity. The initiative functions across diverse legal systems, from Brazil's National Solid Waste Policy (Law 12.305/2010)[92] promoting biogas technologies, to Kenya's Climate Change Act of 2016 encouraging clean energy adoption[93]. In India, the Ministry of New and Renewable Energy introduced subsidies for installing small and medium-sized biogas plant[94]. Researchers emphasise the socioeconomic advantages of biogas technology for rural populations, such as enhanced livelihoods and a decreased need on conventional fuels[95].

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[88] L. Zhang et al., *Global seaweed farming and processing in the past 20 years*, 4 Food Production, Processing and Nutrition 23 (2022).

[89] C. Elgh, *Feminist Seaweed Cultures: Algae as Tool for Reshaping Aquatic Relationships Between Humans and Oceans*, 38 J. of Agri. & Env't Ethics, 12 (2025).

[90] See https://sistema.bio/.

[91] See https://oikos-international.org/sistema-biobolsa-addressing-challenges-of-climate-change-sustainable-agriculture-and-waste-management-in-mexico/.

[92] See https://braziliannr.com/brazilian-environmental-legislation/law-no-12305-brazilian-national-policy-solid-waste/.

[93] See https://climate-laws.org/document/climate-change-act-2016_7078.

[94] Ibid.

[95] F. Rodríguez, *Contested resources and south-south inequalities: What Sino-Brazilian trade means for the "low-carbon" bioeconomy*, in M. Backhouse et al. (eds.), Bioeconomy and Global Inequalities: Socio-Ecological Perspectives on Biomass Sourcing and Production (2021); see also

In *Productive Safety Net Programme (PSNP) - Ethiopia*, we can see a high involvement of the government in assisting its citizens to address poverty, food insecurity, environmental issues and climate change, through immediate relief measures complemented with strategies aimed at fostering sustainable development. The PSNP, launched in 2005, is a pioneering social protection initiative aimed at addressing chronic food insecurity and poverty among vulnerable rural populations. Its primary objectives are to provide immediate relief from hunger and to enhance long-term resilience and economic stability. The PSNP targets households that are prone to food shortages especially during the lean season, ensuring they receive timely and predictable support either through direct food transfer or cash payments. Direct support provides unconditional transfers to the most vulnerable groups, such as the elderly, disabled, and pregnant or lactating women, who are unable to participate in labour-intensive activities. The public works component engages able-bodied individuals in labour-intensive projects designed to build community assets and improve local infrastructure. These projects include soil and water conservation activities, road construction, irrigation schemes, and reforestation efforts. A key aspect of the PSNP is its alignment with Ethiopia's broader development strategies. The program is supported by a combination of government funding and international aid, requiring it to operate within a complex national and supranational regulatory landscape. PSNP operates under a strong institutional framework coordinated by the Ethiopian government, with significant financial and technical support from a consortium of development partners[96]. A study on the initiative demonstrated that those households that joined the PSNP improved their food consumption, livestock holding, housing conditions, and agricultural input utilization[97]. However, the same study revealed little community participation in the decision-making, payment

https://assets.publishing.service.gov.uk/media/5ab4d869ed915d78b9a459bf/TVC_Prioritisation_Report_final_to_DFID.pdf.

[96] See https://www.climatepolicyinitiative.org/gca-africa-adaptation-finance/case_studies/productive-safety-net-program-psnp-ethiopia-2/.

[97] K. Kassaw & M. Worku, *The contribution of productive safety net program for households food security and asset building in drought prone woredas of northeast Ethiopia,* 3 Heliyon (2024).

delays, poor consideration of gender matters and difficulties in the planning processes[98].

Kenya is currently experiencing a transformative agricultural revolution driven by digital farming platforms such as *DigiFarm, M-Farm*, and *FarmDrive - Kenya*, by leveraging technology to enhance productivity and sustainability for smallholder farmers. These platforms offer several services that address various challenges faced by farmers, including access to markets, finance, information, and inputs, thereby boosting food security and economic growth. Digital farming platforms provide an integrated suite of services through mobile applications. The farmers have experienced great impacts and benefits from the introduction of digital platforms such as increased productivity; by providing timely and accurate information, digital platforms help farmers optimize their farming practices, resulting in higher yields and better-quality produce. Economic empowerment through access to fair markets and financial services empowers farmers economically, enabling them to invest in better inputs and expand their operations. These platforms promote sustainable farming practices by providing advice on soil health, water conservation, and integrated pest management, contributing to environmental conservation. However, challenges such as digital literacy, internet connectivity, and initial setup costs remain: to overcome these, continuous investment in infrastructure and education is essential. Kenya's AgriTech platforms are supported by a national framework focused on tech and agriculture integration (under the 'Vision 2030' strategic plan[99]). Institutional support is primarily driven by private sector-led initiatives (mobile network operators Safaricom, investors, financial partners etc.) and collaborations with the Ministry of Agriculture[100]. Scholars advance a warning, as it is argued that open agri-food data projects tend to reproduce elements of 'data colonialism' extracting data with little consideration for the collective harms that may result, and embedding private-oriented values within universalizing

[98] Ibid.
[99] See https://vision2030.go.ke/about-vision-2030/.
[100] See https://www.safaricom.co.ke/media-center-landing/press-releases/safaricom-s-spark-fund-backs-agricultural-analytics-startup.

information infrastructures[101]. Literature also stresses how specifically in Kenya, a hub for digitalization on the African continent, data policy favours personal privacy while overlooking collective risks for smallholder farmers[102]. Such studies push for a regulatory framework that protect farmers' rights and fosters participatory data governance, addressing existing power imbalances as Kenya's digital agriculture is indeed influenced by private firms[103]. Overall, strong data-sovereignty rules and impact assessments are needed for better regulations in the field[104]. Grey literature underlines the potential of innovation in the digital agricultural sector for Kenyan youth's employment[105].

The *Greenhouse Village initiative - Cameroon* aims to promote sustainable agriculture by providing smallholder farmers with access to greenhouse technology. This initiative supports farmers in adopting modern farming methods, increasing crop yields, and strengthening food security, so that they are able to better regulate environmental conditions, optimize water usage, and protect crops from pests and diseases. The Greenhouse Village initiative also focuses on educating farmers on greenhouse management practices and connecting them with markets to improve their income and livelihoods. It presents a promising solution to enhance agricultural productivity and food security in the region. Vulnerable communities can access greenhouse technology through various channels such as charities operating in the agricultural sector, government initiatives promoting sustainable farming practices, and partnerships with private companies specializing in greenhouse technology. These avenues can provide training, resources, and support to help vulnerable communities adopt and benefit from greenhouse technology in Cameroon. Cameroon's agricultural policies and legal framework, including the Agricultural and Rural Development Strategy (2006–2015), foster

[101] M. Fairbairn & Z. Kish, *Setting data free: The politics of open data for food and agriculture*, 8 New Media & Soc. 1935 (2023).
[102] M.C. Canfield & B. Ntambirweki, *Datafying African agriculture: from data governance to farmers' rights*, 67 Development 5.
[103] Ibid.
[104] N.O. Okeyo, *Legal Prospects for Achieving Epistemic Data Justice for Rural Women in Tanzania and Kenya,* L 4 J. of Intell. Prop. & Info. Tech. Law 205 (2024).
[105] See https://www.nepad.org/blog/enhancing-digital-agriculture-strengthen-entrepreneurial-opportunities-kenyan-youth.

innovation through public–private partnerships. Institutional support for technology transfer aligns with national priorities for sustainable food production[106]. Grey literature notes how greenhouse ventures boost productivity and impact community livelihoods; however, clear guidelines and protections for land use, labour management and valorisation of local knowledge are essential[107].

Farmcrowdy - Nigeria is a revolutionary digital platform that serves as a bridge between farmers and investors, revolutionizing the way agricultural projects are funded. By utilizing cutting-edge technology, Farmcrowdy connects small-scale farmers in Nigeria with investors who are willing to provide financial support for various farming initiatives. This approach not only empowers farmers by giving them access to the needed funding and resources but also helps to improve their productivity and overall quality of life. The initiative is a hybrid approach with government and private institutions supports. It is legally backed by the Nigeria Start up Act of 2022, and on the Companies and Allied Matters Act of 2020[108]. Literature holds that digital agri-tech platforms – such as the discussed one – must ensure inclusive participation, equitable benefit-sharing, data sovereignty, and local capacity-building so that technological progress empowers farmers rather than reproduces dependency or 'data colonialism'[109].

Farm Africa is an organization that is committed to support farmers in East Africa to improve their agricultural practices, boost crop production, and strengthen food security in the region. The organization provides a wide range of services, including training, resources, and assistance to small-scale farmers, with a special emphasis on empowering women in sustainable food production and income generation. In order to function efficiently, Farm Africa must adhere to the regulatory framework that governs their

[106] See https://farmersreviewafrica.com/cameroonian-entrepreneur-leverages-climate-smart-greenhouses-to-stabilize-food-prices-amid-hikes/.
[107] See https://www.downtoearth.org.in/africa/africas-climate-adaptation-cameroons-emerging-mosaic-of-resilience-stands-out and https://ldn-advisory.com/our-projects/cameroon/.
[108] See https://startup.gov.ng/ and https://www.cac.gov.ng/wp-content/uploads/2020/12/CAMA-NOTE-BOOK-FULL-VERSION.pdf.
[109] M. Fairbairn & Z. Kish, *Setting data free: The politics of open data for food and agriculture*, cit. at 102.

operations, ensuring compliance with local agricultural laws and regulations in the countries where they operate. This entails following government policies on farming methods, land use, environmental conservation, and food safety standards. By adhering to these regulations, Farm Africa is able to effectively implement their projects while upholding legal and ethical standards. Furthermore, their initiatives must align with government policies and international development regulations to ensure transparency and accountability in their work. The impact of Farm Africa's projects on local communities in East Africa appears to be significant. Farm Africa operates within multiple national legal systems emphasizing agricultural modernization and rural development. The interventions must align with the host countries' policies on environmental management, land use, and sustainable agriculture, ensuring compliance and accountability across jurisdictions[110]. Farm Africa can be considered inserted within a governance trend that prioritizes farmer participation and open innovation in East Africa, which – according to literature – would prioritize private innovation, production, efficiency, and individual empowerment, in contrast to collectivist approaches to openness typical of agri-food social movements[111].

eVuna - Tanzania is a platform, which is revolutionizing the lives of smallholder farmers in East Africa by providing a wide range of crucial services, such as information, resources, access to credit, and market opportunities. With a user base of over a hundred thousand farmers actively engaged on the platform in East Africa, eVuna has empowered them to access valuable insights, obtain high-quality inputs, and connect with profitable markets, resulting in increased productivity and financial security. Over the past year, farmers using eVuna secured funding exceeding one million dollars, leading to an 80% increase in crop yields and a $600 rise in revenue per farmer. These tangible results demonstrate the effectiveness of eVuna in fostering positive change and prosperity within the agricultural sector across Africa. The platform is primarily a private sector initiative but also collaborates with Tanzania's institutional framework, under the National ICT Policy

[110] See https://www.farmafrica.org/wp-content/uploads/2024/06/farm-africa-annual-report-financial-statements-2022.pdf.
[111] M. Fairbairn & Z. Kish, *Setting data free: The politics of open data for food and agriculture*, cit. at 102.

(2016) and Agricultural Sector Development Programme (ASDP II), which support the integration of digital tools in agriculture[112]. Literature discussing digital innovation in Tanzania's agricultural sector points to the need of addressing epistemic data injustices especially experienced by rural women in this context[113].

Despite the outlined challenges, the discussed examples underscore the potential of innovation in the agri-food sector in Global South experiences, which are often backed by supportive institutional and regulatory frameworks. While North-South partnerships are frequently criticized for intensifying disparities, these cases shed light on the promises of South-South collaboration as a viable and equitable option. Experiences from Mediterranean countries located in the 'South of the North' such as the Puglia Region, Italy, should look at the presented lessons with interest. Table 2 included as annex to this article offers a comparative overview of the discussed initiatives analysed along relevant dimensions. Paragraph 8 that follows offers a comprehensive discussion of the studied cases in light of the research objectives.

8. Discussion: a just approach to experimentalism in the agri-food sector

The cases presented responds to calls that emerged in the literature, including from the Global South, to "reshape agrifood systems in ways that prioritize the marginalized, democratize access to technology, and foster an equitable distribution of benefits"[114]. Technology and innovation in these cases have been deployed to promote an inclusive rural transformation that considered and tackled the specific vulnerabilities of local communities[115]. In essence, these interventions have been leveraged as tools for social justice and environmental sustainability embracing a "model of development that is

[112] See https://openknowledge.fao.org/items/3c968a7c-f4c0-425e-82f1-672fac00bf48.
[113] N.O. Okeyo, *Legal Prospects for Achieving Epistemic Data Justice for Rural Women in Tanzania and Kenya,* cit. at 105.
[114] P. Lidder, A. Cattaneo & Mona Chaya, *Innovation and technology for achieving resilient and inclusive rural transformation*, 44 Glob. Food Sec. (2025), 100827.
[115] Ibid.

participatory, equity-sensitive and gender-responsive"[116]. Recalling the critique on techno-solutionism discussed at the opening of this article, we echo literature arguing that quick technological fixes will not attain these outcomes, as there is the need to support long-term processes that "incorporate critical inputs from local and traditional knowledge and are underpinned by supportive policies, and social and institutional reforms"[117].

The initiatives described can be analysed through the lens of the 'capabilities approach' – drawing on the work of Elinor Ostrom, Marta Nussbaum, Amartya Sen, Mariana Mazzucato, and Elias Carayannis, *inter alias* – a normative frame that posits that well-being can be understood in terms of human capabilities and their ability to function in contexts. The approach focuses on the *freedom to achieve well-being* as a matter of what people are able to do and to be. The daily and very situated cases discussed are useful to show the capability of communities, social actors and institutions to innovate when exposed to stressors and resources scarcity. One recurring theme both of the AWARE project and the discussed initiatives is the capability to turn a challenge – like food insecurity – into an opportunity for more sustainable agricultural and consumption approaches. Most initiatives reviewed do so through community and cross-sectorial engagement. They mobilise technological innovations with a primary 'just' objective, e.g., to tackle food insecurity, food waste and social vulnerability. Some of these initiatives show an epistemic justice dimension, integrating traditional knowledge with cutting-edge technology. Other initiatives just repurpose 'simple' existing technologies in view of new applications.

Several initiatives had tangible practical impacts for the engaged actors and visible economic benefits, some of which attained through strategic partnerships between governments, innovators and communities. To sustain such partnerships, the initiatives reviewed experimented with governance models such as community ownership in cooperative models, mission-oriented enterprises, and public-private partnerships. Some initiatives are aimed at short-term relief efforts, opposing others' long-term, sustainable development objectives. In both cases, the capabilities

[116] Ibid.
[117] Ibid.

of the beneficiaries are strengthened and activated for their greater agencies. Some initiatives show government and donor-led approaches contrasting with models that advocate for private sector-led investment or with community-based enterprises, differently from the AWARE project whose business model is dependent on EU funding for research and innovation.

Most of the initiatives experienced regulatory disconnects and had to deal with regulatory challenges, some of which turned these challenges into an opportunity, as occurring for the AWARE project. Other challenges include lack of access to technology, limited market access for the innovation, digital divide and limited internet connectivity in rural areas, resistance to changing traditional agricultural practices, infrastructural challenges impacting transportation and logistics, political instability affecting agricultural operations, conflicts over land ownership, hurdles in scaling up the initiative to reach more farmers in remote areas etc.. Navigating these challenges is crucial for the success and sustainability of these initiatives in effectively engaging vulnerable communities and promoting development.

9. Conclusion and ways ahead

The article contributed to disentangling the concept of 'Just Sustainable Innovation' discussed in this broader special issue highlighting the dimension of regulatory experimentalism and stakeholder engagement for a pluralistic governance of innovation, that benefit vulnerable communities specifically in the field of innovation in the agri-food sector. We reviewed real-world cases of projects from various 'Souths' understood as a multiplicity of places particularly stressed by climate change which is also causing food insecurity and water scarcity. Embracing critiques to techno-solution, we looked at situated innovation that went beyond being purely technological. For example, we looked at innovation including through technology that leveraged collective enterprises, strategic partnerships, epistemic pluralism, and a constructive and participatory approach to facing regulatory challenges.

As the theory reviewed suggests, regulation is inherently pluralistic and should encompass the plurality of actors currently engaged in facing the challenge of attaining food security and addressing water scarcity. Situated practices of resistance to

regulatory lock-ins should be devoted attention with the aim of integrating the capabilities of the actors on the ground in effective regulations. We propose to do so through a *co-design* approach, that can boost rather than restrict participatory spaces for the advancement of agri-food innovation. The shaping of agri-food policy and regulation should acknowledge the centrality of vulnerable communities, with their knowledge, visions, and practical needs, in order to ensure their access to the benefits arising from innovation and to adapt innovation to local needs.

We advise for a *co-governance* of the challenges associated with food insecurity and water scarcity based on collective stewardship, shared decision-making, community engagement, and equitable resource distribution as the way forward. This approach could be framed in legal terms in a 'right to innovation through experimentalism' that entails not only access to innovation but also an opportunity to participate in shaping such innovation processes. The right should entail active stakeholder involvement both in envisaging innovation but also in its implementation and regulation. We posit that also the co-design of the enabling infrastructures and processes, both material and immaterial, should be conceived in light of ensuring that diverse perspectives, knowledge systems and expertise are included and valorised in the regulatory outcome. We invite future research to engage with this promising concept, explore it across EU regulatory experiences, and compare it with practices from the Global South, building on existing comparative studies of transnational administrative law in the context of regulating innovation.

Annex - Table 2 - Comparative overview of reviewed initiatives from the 'Global South'

Name of the initiative	Location	Typology	Institutional Variable	Strategic partnerships	Sustainable funding	Community-based initiative	Partnership with vuln. communities	Reg. pluralism	Tech. advancement	Reg. experimentalism
PSNP	Ethiopia	Program and network	Government coordinated framework with donor support	X		X	X	X	X	X
Digital Farming	Kenya	Market relevance; Technological advancement	Private–public digital initiatives; backed by Vision 2030 and Data Protection Act (2019)	X	X		X		X	X
Floating Gardens	Bangladesh	Cultivation method; Community-based initiative	Grassroots initiative rooted in traditional knowledge; supported by BCCSAP (2009)		X	X	X		X	X
Greenhouse Village Farming	Cameroon	Community-based network; Collaborative initiative; Sustainable farming	Public–private agricultural innovation under Rural Development Strategy (2006–2015)			X		X	X	X

e-Choupal	India	Digital agricultural platform; Rural empowerment; Supply chain innovation	Corporate–community hybrid model; enabled by APMC Acts (early 2000s)	X				X	X	X
Seaweed farming	China Korea	Sustainable harvesting	Regulated by Fisheries Law (1986/2000) and Law on Seaweed Industry						X	X
Farmcrowdy	Nigeria	Agri-business network; Crowdfunding platform	Public–private model; supported by Start-Up Act (2022) and SEC Rules on Crowdfunding	X		X			X	X
Farm Africa Project	East Africa	Community based agriculture; Capacity-building program	NGO network aligned with national agricultural and environmental policies	X		X		X		X
Sistema Biobolsa	Brazil, Kenya, India, Indonesia, and Mexico	Sustainable farming; Renewable energy solutions	Supported by national clean-energy laws (e.g., Brazil Law			X		X	X	X

			12.305/2010; Kenya Act 2016)							
eVuna	Tanzania	Food security; Social venture	Private-sector digital platform; aligned with ICT Policy (2016) and ASDP II	X		X			X	X