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BIOECONOMY

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# HOW TO MAINSTREAM SUSTAINABILITY AND CIRCULARITY INTO THE BIOECONOMY?

A compendium of bioeconomy  
good practices and policies



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Marta Gomez San Juan and Anne Bogdanski

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# CONTENTS

Foreword	v
Acknowledgements	vi
Abbreviations and acronyms	vii
Summary	ix
<hr/>	
<b>1. Introduction</b>	<b>1</b>
1.1 Background	1
1.2 Objectives and audience	2
1.3 Why is it important to mainstream good practices and policies into strategy development?	3
<hr/>	
<b>2. Methodology and structure of the review</b>	<b>5</b>
2.1 Illustrating the bioeconomy definition	5
2.2 Outlining the structure of the review	8
2.3 Defining good practices and policies and screening sources against FAO criteria	14
2.4 Analysing the objectives of the good practices and policies under review	17
<hr/>	
<b>3. Review of good practice and policy sources</b>	<b>21</b>
<hr/>	
<b>4. Discussion of the results</b>	<b>73</b>
4.1 Coverage of themes under the bioeconomy definition	74
4.2 Compliance with FAO criteria	76
4.3 Relevance to sustainability objectives in bioeconomy strategies	79
<hr/>	
<b>5. The way forward</b>	<b>83</b>
Approach to integrate good practices and policies in bioeconomy strategies and action plans	84
Step 1. Define what is considered to be a good bioeconomy practice and what is not	86
Step 2. Select potential good bioeconomy practices tailored to context-specific objectives	86
Step 3. Implement the identified good practices and policies for a sustainable and circular bioeconomy	87
<hr/>	
<b>References</b>	<b>89</b>
<hr/>	
<b>References of the Table 1</b>	<b>92</b>
<hr/>	
Annex 1. <b>SDG targets covered by sustainability objectives proposed in bioeconomy strategies (Box 3)</b>	<b>110</b>
<hr/>	
Annex 2. <b>Template for documenting local good bioeconomy practices and policies</b>	<b>116</b>

# TABLE, FIGURES AND BOXES

---

## TABLE

- |    |  |    |
|----|--|----|
| 1. | Compilation of sources of good bioeconomy practices and policies | 24 |
|----|--|----|
- 

## FIGURES

- |        |  |    |
|--------|--|----|
| 1.     | Stages in the development of a good practice or policy   | 15 |
| 2.     | Summary of the definition and criteria of a good practice or policy used for the review  | 16 |
| 3.     | Structure of table 1 that uses bioeconomy themes to classify the 250 reviewed sources of good practices and policies (with hyperlinks to the relevant pages)                             | 23 |
| 4-10.  | Number of sources in Table 1 covered by sub-category, topic and sub-topic of the bioeconomy  | 75 |
| 11-14. | Percentage of reviewed sources that provide enough, medium or not enough evidence of impact to comply with FAO good practice and policy criteria   | 78 |
| 15.    | Number of sources in each sub-category that provide enough evidence of impact to fully comply with FAO good practice and policy criteria (20% of total sources - Dark grey in Figure 11) | 78 |
| 16.    | Coverage of the four dimensions of bioeconomy objectives (Box 3) in the sub-categories of Table 1  | 80 |
| 17.    | Relevance of common sustainability objectives proposed in bioeconomy strategies (Box 3) to the 250 reviewed good practice and policy sources   | 81 |
| 18.    | Steps to integrate good practices and policies in bioeconomy strategies and action plans   | 85 |
- 

## BOXES

- |    |  |    |
|----|--|----|
| 1. | FAO's work to guide countries in the development of strategies and programmes on sustainable bioeconomy              | 2  |
| 2. | Bio-based services considered in the review  | 13 |
| 3. | List of strategy objectives of the bioeconomy and examples of links with the Principles and Criteria and SDG targets | 18 |
-

# FOREWORD

More than 60 countries and regions now have bioeconomy or bioscience-related strategies aimed at the sustainable production, utilization, conservation, and regeneration of biological resources. For the last 6 years FAO has been at the forefront of global efforts to advance the development of a sustainable and circular bioeconomy, when 62 Ministers of Agriculture at the Global Forum for Food and Agriculture gave the Organization a mandate to coordinate international work on bioeconomy to enhance food and nutrition security worldwide.

The development of an economy that is based on biological resources should be sustainable and account for and address important trade-offs. It is therefore vital that countries promote sustainable practices and policies in a coherent way across and within economic sectors.

This compendium of 250 sources of good bioeconomy practices and policies gives guidance on how to integrate sustainability and circularity into the development of a sustainable bioeconomy. For the purpose of this compendium, an established good practice must have objective evidence of impact and meet five specific criteria: proven, sustainable, replicable, participatory and feasible. Good practices should underpin enabling policies that are levers of beneficial change. We hope the compendium will serve as a reference point for the global bioeconomy community.

As an important contribution to the Decade of ambitious action to deliver the Sustainable Development Goals by 2030, the compendium emphasizes the important role of bioeconomy to promote sustainable consumption and production patterns needed to transform agri-food systems. Bio-based technological, organizational and social innovations are central to addressing global inter-connected challenges of climate change, biodiversity loss, environmental degradation and pollution.

“We need a global transition towards better production, better nutrition and a better environment to ensure a better life while leaving no one behind. Such a transition requires a radical transformation that can be achieved through bioeconomy”, emphasized FAO Director-General, QU Dongyu, in his address at the 2020 Global Bioeconomy Summit. This compendium also informs further development of the Bioeconomy for Sustainable Food and Agriculture Priority Program Area from FAO’s new Strategic Framework 2022-2031 demonstrating the pressing need for the Organization to continue supporting our Members in the development of bioeconomy practices, policies, strategies and plans.



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# ABBREVIATIONS AND ACRONYMS

<b>BAT</b>	Best Available Technique
<b>BBI JU</b>	Bio-Based Industries Joint Undertaking
<b>CAC</b>	Codex Alimentarius Commission
<b>CBD</b>	Convention on Biological Diversity
<b>EC</b>	European Commission
<b>ECLAC</b>	United Nations Economic Commission for Latin America and the Caribbean
<b>EIP-AGRI</b>	European Innovation Partnership ‘Agricultural Productivity and Sustainability’
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>GBS</b>	Global Bioeconomy Summit
<b>IACGB</b>	International Advisory Council on Global Bioeconomy
<b>IEA</b>	International Energy Agency
<b>IPBES</b>	Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services
<b>IPIFF</b>	International Platform of Insects for Food and Feed
<b>ISBWG</b>	International Sustainable Bioeconomy Working Group
<b>ISO</b>	International Organization for Standardization
<b>OECD</b>	Organisation for Economic Cooperation and Development
<b>OIE</b>	World Organisation for Animal Health
<b>SDG</b>	Sustainable Development Goal
<b>WBCSD</b>	World Business Council for Sustainable Development



# SUMMARY

The purpose of this Compendium is to provide a resource that outlines **250 sources of good practices and policies** that can be potentially useful for translating bioeconomy strategies into sustainable and circular actions. Rather than covering a single specific topic, the literature review summarized in **Table 1** includes the **entire continuum of economic sectors** that have a stake in biological knowledge and resources. This includes the production, utilization, conservation and regeneration of all biological resources in land and marine ecosystems, from crops, animal products and wood products to yeasts, microbes or bacteria.

The Compendium is a reference document on the current status of good practice and policy knowledge on bioeconomy, providing links to websites, online resources, initiatives, programmes and reports. It can be used as an operative tool to support countries in identifying good practices and policies which can help achieve sustainability objectives of bioeconomy strategies and therefore track progress and learn from experience. This sourcebook highlights the wide range of aspects that are included in the concept of the bioeconomy and identifies aspects where guidance is lacking and should be further developed. The Compendium also identifies those sources of good practices and policies that contribute to meeting sustainable bioeconomy objectives. Finally, it analyses the extent to which the sources of good practices and policies fulfill FAO's definition and can therefore be recommended as models. In this Compendium, an established good practice or policy is the one that has objective evidence of impact and meets the five FAO good practice and policy criteria: **proven, sustainable, replicable, participatory and feasible** (see **Figure 2**).

The results revealed that there are very few sources that cover all aspects of the definition of bioeconomy at the same time. There are also no existing guidance documents on how to combine good practices and policies from different

sectors in ways that support the implementation of an **integrated, coherent bioeconomy**. Efforts should be made to gain a better understanding of the possible interlinkages among sectors that articulate different good practices and policies under the umbrella of the bioeconomy to contribute to greater sustainability and circularity. Results from the review also highlight the importance of ensuring the quality of good practices and policies by applying sound criteria and robust methodologies.

The Compendium also emphasizes that, to define what a good bioeconomy practice or policy is, it is necessary to also consider the sustainability objectives it addresses, which will greatly depend on the context. Countries usually define objectives in their bioeconomy strategies, and are often aligned to broader areas, such as resource use efficiency, health and nutrition, opportunities and risks from bio-innovations, environmental pollution and social inequalities. Being an **inherently multisectoral** process that involves potential synergies and trade-offs among different sustainability objectives, the implementation of bioeconomy strategies presents greater challenges than activities that are focused on a single sector.

In general, results show that the sources of practices and policies do not consider social, economic, environmental and governance objectives in an integrated manner. Future guidelines should consider practices and policies to jointly address all dimensions of sustainability to **balance the trade-offs** that may lead to unsustainable systems. The review also indicates that, overall, assessments often do not fully show whether practices and policies have enough evidence of impact to be recommended as models that can contribute to sustainability objectives of the bioeconomy.

To address this gap, a **context-specific approach**, presented in Chapter 5, has been developed to help policy makers, private sector, investors and other stakeholders

identify good practices and policies that can support the development and implementation of sustainable and circular bioeconomy strategies, programmes and action plans to reach strategic objectives, particularly with regards to the common **sustainability objectives of bioeconomy** strategies identified in the 2019 FAO report, *Towards sustainable bioeconomy – Lessons learned from case studies* (Gomez San Juan, Bogdanski and Dubois, 2019). Taken together, this Compendium and the 2019 report, provide practical guidelines and resources that can support decision-makers and stakeholders in bioeconomy systems to make progress towards achieving sustainable and circular outcomes.

This Compendium contributes also to international efforts that aim to provide data

and resources for **evidence-base decision making**, such as the International Advisory Council on Global Bioeconomy (IACGB), which, in its 2020 communiqué, urged to strengthen good practices and policies in order to advance the global bioeconomy (IACGB, 2020). In agri-food systems, a transition from a fossil-based economy to a bioeconomy happens at three levels: **technological, organizational and social**.

Building on the Aspirational Principles and Criteria for Sustainable Bioeconomy (FAO, 2021), FAO provides guidance documents to support the development and implementation of sustainable bioeconomy strategies and programmes. This Compendium constitutes one of these guidance documents, as a key instrument to achieve sustainable production and consumption patterns.

# INTRODUCTION

## 1.1 BACKGROUND

Countries are becoming increasingly aware of the finite nature of fossil resources and the need to adopt more sustainable consumption and production patterns. Almost sixty countries have already called for a paradigm shift from an economy based on fossil resources to an economy that is based on renewable biological resources (GBC, 2020a). Biological resources include crops, forests, livestock, aquatic flora and fauna and microorganisms. Biological resources also encompass new bioprocesses and technologies that facilitate the production of higher value-added products and allow for a diversification of products. However, the transition to an economy based on renewable biological resources needs

to be made in a sustainable way that contributes to the Sustainable Development Goals (SDGs), the Paris Agreement and other Multilateral Environmental Agreements.

To this end, FAO seeks to improve global guidance on sustainable and circular bioeconomy by providing a selection of good bioeconomy practices and policies (hereafter referred to as ‘good practices’) to its Member Countries (**Box 1**). These good practices relate to the various stages of the bioeconomy: the production, utilization and conservation of biological resources; processing and manufacturing and use; and end-of-life options. These practices will support a sustainable transition to greater diversification and higher added value for existing biological resources and bioeconomy production pathways. This Compendium considers the bioeconomy as an integrated whole and outlines the opportunities that the bioeconomy can bring to sustainable development.

FAO has a longstanding tradition of compiling and sharing good practices with its Members. This is part of the FAO mandate to serve as a knowledge and learning organization. For FAO, an established good practice is a practice for which there is objective evidence of impact, and meets five specific good practice criteria: proven, sustainable, replicable, participatory and/or feasible. Learning from what has already been done to document good bioeconomy practices and policies is an important part of guiding countries towards a sustainable, circular bioeconomy. FAO has already documented lessons learned from 26 bioeconomy case studies in the report *Towards sustainable bioeconomy – Lessons learned from case studies* (Gomez San Juan, Bogdanski and Dubois, 2019). This 2019 report showed that good bioeconomy practices vary from case to case, as the context is a key determinant for whether a practice is successful and sustainable or not. Hence, this follow-up document suggests that bioeconomy practices and policies be tailored to the specific context, and proposes a methodology for countries to identify existing and potential good practices and policies in order to implement a sustainable and circular bioeconomy.

Often, in the context of the bioeconomy, the concept of sustainability is limited to the replacement of fossil resources for biological resources. However, the efficient use of biological resources, bio-innovations and the valorization of biological systems, and social and environmental health and well-being are being taken more and more into consideration when designing bioeconomy strategies. Sustainability

should be understood in the wider context of the SDGs. In 2016, FAO developed a set of Aspirational Principles and Criteria for Sustainable Bioeconomy in close collaboration with the International Sustainable Bioeconomy Working Group (ISBWG). These Principles and Criteria, together with the SDGs and common bioeconomy strategy objectives (see **Box 3**), provide a reference framework for this Compendium.

## 1.2 OBJECTIVES AND AUDIENCE

The purpose of this Compendium is to provide a resource that outlines some of the good practices, related policies and examples that can be potentially useful for mainstreaming sustainability and translating sustainable and circular bioeconomy strategies into actions. In addition, the Compendium identifies sources of good practices and policies that contribute to bioeconomy strategy objectives. It also analyses them against good practice and policy criteria and highlights the aspects where guidance is lacking and should be further developed. The Compendium is a reference document on the current status of good practice and policy knowledge on bioeconomy, providing links to websites, online resources, initiatives, programmes and reports.

### ■ BOX 1. FAO'S WORK TO GUIDE COUNTRIES IN THE DEVELOPMENT OF STRATEGIES AND PROGRAMMES ON SUSTAINABLE BIOECONOMY

Building on the Aspirational Principles and Criteria for Sustainable Bioeconomy (FAO, 2021) (Box 3), FAO's project provides guidance documents to support countries in developing and implementing sustainable, bioeconomy strategies, policies and programmes.

This Compendium constitutes one of these guidance documents. It aims to provide guidance to select and implement practices and policies that support sustainability and circularity in the implementation of the bioeconomy.

It is linked to other project work areas, including lessons learned from case studies, monitoring and evaluation of the bioeconomy and strategy development tools.

This report and the overall projects target policy-makers of FAO member states who seek to develop bioeconomy sustainably. As this cannot be done in isolation, FAO's work on bioeconomy also addresses the private sector, academia, civil society and consumers.

The Compendium further outlines and analyses the extent to which:

- ▶ existing literature covers different themes that are relevant to the bioeconomy;
- ▶ the existing good practice and policy compilations correspond to the FAO definition of good practice, and can therefore be recommended as a model; and
- ▶ the good practices and policies address the objectives of bioeconomy strategies, including sustainability and circularity.

Finally, the Compendium proposes a context-specific approach that policy-makers can follow in the planning and implementation phases of bioeconomy strategy development. It starts from defining and selecting bioeconomy good practices and policies, to mainstreaming them the development of a sustainable bioeconomy. The proposed approach also addresses strategic objectives, particularly with regard to the common sustainability objectives of bioeconomy strategies identified in the 2019 FAO report, *Towards sustainable bioeconomy – Lessons learned from case studies* (Gomez San Juan, Bogdanski and Dubois, 2019) and summarized in **Box 3**. Taken together, this Compendium and the 2019 report, provide practical guidelines and examples to support stakeholders in local bioeconomy systems to make progress towards achieving sustainable and circular outcomes. The approach can be used as an operative tool for policy makers of FAO member states to mainstream sustainability in the development and implementation of bioeconomy strategies, programmes and action plans.

## 1.3 WHY IS IT IMPORTANT TO MAINSTREAM GOOD PRACTICES AND POLICIES INTO STRATEGY DEVELOPMENT?

The implementation of good practices, and the policies that promote them, is generally seen as a sound way to achieve sustainability objectives. For instance, the Organisation for Economic Co-operation and Development (OECD) stresses the transfer of good practices in bio-innovations to advance agricultural productivity in a sustainable way (Diakosavvas and Frezal, 2019). While sustainability is often considered at the monitoring stage, when actions have already been implemented, the *ex-ante* identification of existing and potential good practices and policies could be used in the design of the strategy and action plan, as a way to prioritize actions that align with bioeconomy strategy objectives and sustainability goals.

This underlines the importance of international cooperation and the constant exchange of experiences. Continuously capitalizing on experience can build the evidence base for the bioeconomy and identify potential issues. For instance, Philp and Winickoff (2018) warned of possible trade barriers for bio-based products globally. Also, in a survey led by Issa, Delbrück and Hamm (2019), experts emphasized that bioeconomy strategies need to address rises in world-market prices for plant-based food and primary forest conversion that are due to increases in land used to produce feed, for bioenergy crops, or crops for bio-industrial use, which currently together sum almost half of world's arable land use.

The bioeconomy and circular economy both seek to optimize product design and resource use efficiency while maintaining the same or improved levels of material functionality (IACGB, 2020). But, according to de Schoenmakere *et al.* (2018), both concepts are currently still loosely connected, especially with respect to aspects of product and infrastructure design and collaboration between stakeholders in the system. The European Environment Agency (EEA) also considers that there is a lack of knowledge on synergies between practices and policies for the bioeconomy and the circular economy and has called for a change in regulations and policies that allow for more and better collaboration (de Schoenmakere *et al.*, 2018).

The importance of bioeconomy platforms, databases, events and other means of communication and dissemination has been recognized by numerous conferences, publications and strategy documents. For instance, the 2017 Canadian strategy document *Forest Bioeconomy Framework for Canada* highlights the advantages that the establishment of a bioeconomy hub can deliver to ensuring continuous learning from best practices and supporting cooperative approaches to the bioeconomy (GBC, 2018a).

The International Advisory Council on Global Bioeconomy (IACGB), in its 2020 communiqué, urges the strengthening of good practices and policies, building on existent knowledge for the way forward with the global Bioeconomy (IACGB, 2020). The Council already acknowledged in 2018 that showcasing examples from around the world can be used to inspire politicians to support sustainable and circular bioeconomy development and recommended to organize a structured exchange of policies and practices among the global bioeconomy community (IACGB, 2018, p.3).

Coordination and the exchange of good practice and policy are also happening inter-regionally, for example among the Nordic European countries, countries in Eastern Europe and Eastern Africa, and in countries in Latin America and the Caribbean (GBC, 2018a). For instance, the Economic Commission for Latin America and the Caribbean (ECLAC) recommends

that, to achieve the SDGs, international policy should support the dissemination of proven and widely accepted good practices in the bioeconomy (Rodríguez, Rodrigues and Sotomayor, 2019). It also states that inclusive decision-making processes are important for the identification of good practices and that good practice and quality certification is essential for communicating the benefits and risks of bio-innovations and new bio-based products.

To answer the increasing number of international calls for action, this Compendium proposes a context-specific approach to define, select and mainstream good practices and policies that countries can use to address strategic and sustainability objectives of their bioeconomy growth strategies.



# METHODOLOGY AND STRUCTURE OF THE REVIEW

## 2.1 ILLUSTRATING THE BIOECONOMY DEFINITION

This review of bioeconomy-related good practice and policy sources is based on the definition of bioeconomy that was adopted at the 2020 Global Bioeconomy Summit:

*Bioeconomy is the production, utilization, conservation, and regeneration of biological resources, including related knowledge, science, technology, and innovation, to provide sustainable solutions (information, products, processes and services) within and across all economic sectors and enable a transformation to a sustainable economy (IACGB, 2020, p.14).*

Going more in depth under each aspect of the bioeconomy definition, this review has considered the following concepts.

### **Biological resources and biological material**

Article 2 of the 1992 Convention on Biological Diversity (CBD, 1992) notes that the term ‘biological resources’ includes “genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity”. Biological resources from which products and services are obtained are used in the bioeconomy as raw materials. This report not only considers crops, forests, land and aquatic animals and microorganisms, but also the production, utilization and conservation of other ‘biological material’ including cells, parts of cells, RNA, DNA and protein stocks, tissues, seeds, germplasm, peptides, enzymes, and any biologically active compound or material containing genetic information and capable of reproducing itself

or being reproduced in a biological system (Law Insider Dictionary, 2020).

## Knowledge

‘Knowledge’ is the fact or condition of knowing something with familiarity gained through experience or association with or understanding of a science, art, or technique (Merriam-Webster Dictionary, 2020). Another word used for this purpose is know-how. Biological knowledge and knowledge from nature allow to understand those biological principles that underpin the activities in the bioeconomy. Examples include knowledge of biological sequences, protein structures, gene functions or plant physiology.

## Science

‘Science’ can be defined as something that may be studied or learned (Merriam-Webster Dictionary, 2020). Core sciences, both modern and traditional, that pertain to the bioeconomy include agricultural engineering, agronomy, biochemistry, bioinformatics, biology, ecology, food safety, forestry, genetics, green chemistry, microbiology, synthetic biology, and computing and information sciences (Connelly *et al.*, 2020). It is worth highlighting the key role of life sciences play in stimulating innovations in the bioeconomy. As defined by the CBD, the biosciences add value to products and services in the bioeconomy, and its digital dimension, such as genomics, proteomics, bioinformatics, is crucial (CDB, 2010). At the same time, however, it is important to emphasize that the bioeconomy thrives on interdisciplinarity and includes the humanities and social sciences.

## Scientific research

Scientific research refers to those studies conducted for the purpose of contributing towards science by the systematic collection, interpretation and evaluation of data, and should be systematically planned before performing them (Çaparlar and Dönmez, 2016). Bioeconomic activities are driven by research and innovation in the life sciences, enabled by technology innovations in engineering and in computing sciences enable this. Automated and network-connected instruments allow the collection and analysis of large amounts of data (Connelly *et al.*, 2020).

## Technology, biotechnology and industrial biotechnology

Technology refers to the practical application of knowledge in a particular area (Merriam-Webster Dictionary, 2020), in this case in the area of biological resources. A science-based and knowledge-intensive technology that holds special interest for the bioeconomy is ‘biotechnology’, which is defined in Article 2 of the Convention on Biological Diversity (CBD, 1992), as “any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use”. Biotechnology is a broad term that includes a range of uses in several stages of the value chain, from low-tech to high-tech. It is used for genetic improvement of plants and animals to increase efficiency; for plant and animal disease diagnosis; for producing nutritionally-enhanced and longer lasting foods with reduced losses; for the characterization and conservation of genetic resources for food and agriculture; in genome sequencing; in nuclear techniques; or for soil improvement (FAO, 2020a). All these technologies are complementary, as long as they are powered by science and evidence on addressing different global challenges.

Biotechnology is also used in numerous processes for the production of food and feed, such as fermented foods, pharmaceuticals, vaccines, chemicals, plastics, energy and other bioproducts. For instance, today, 100% of vitamin B2 on the global market is produced by fermentation using industrial biotechnology (WBCSD, 2020). These processes are known as ‘industrial biotechnology’ or white biotechnology, and they encompass technologies used in biorefineries (Laibach, Börner and Bröring, 2019). Industrial biotechnology utilizes microorganisms or components of microorganisms like enzymes for efficient biotechnological conversion and to synthesize desired substances and chemical building blocks (Van de Velde *et al.*, 2015). Lastly, biotechnology refers also to the technology that prepares raw biological materials (cells, microorganisms, and their components) for use in these processes (FAO, 2020a; Kircher, Bott and Marienhagen, 2020). Modern biotechnology uses digital sciences and data to optimize

and upscaling all these applications. The bioeconomy is driven in part by the convergence of technologies and applications at the interface of disruptive physical, digital and biological sciences.

## Innovation

FAO defines 'innovation' as the process by which individuals, communities or organizations generate changes in the design, production or recycling of goods and services, as well as changes in the surrounding institutional environment, to increase effectiveness, competitiveness, resilience to shocks or environmental sustainability. It can be considered both doing things differently and/or doing different things. In agri-food systems, innovation, may be institutional or may relate more to knowledge or to practice, is intended to foster transitions towards sustainability, thereby enhancing food security and nutrition (FAO, 2018a; HLPE, 2019). In this report, Category 1 includes good practices for the development of innovations, particularly good practices in research and development (e.g. good laboratory practices).

## Information

Whereas knowledge refers to the fact or condition of knowing something, the term 'information' refers to the acquisition of knowledge – knowledge obtained from investigation, study or instruction (Merriam-Webster Dictionary, 2020). In the bioeconomy, great importance is accorded to education and research in their strategies, programmes and action plans, as vector forces of the bioeconomy.

## Product, process and service

A product is something produced or something that is marketed or sold as a commodity (Merriam-Webster Dictionary, 2020).

A process is a continuing natural or biological activity or function (e.g. breathing). In agriculture, soil microorganisms are used for bioremediation and bio-sequestration processes. In industry, a process can be a series of actions or operations conducting to an end, or a continuous operation or treatment especially in manufacture (Merriam-Webster Dictionary, 2020). The term 'bioproduct' encompasses all products made from biological resources, and includes food, feed, biofuels and bio-based

products. The term 'bio-based products' refers to products that are wholly or partly derived from biomass and other biological resources, which are not used for food, feed and fuel.

A service is the occupation or function of serving or contributing to the welfare of others (Merriam-Webster Dictionary, 2020). Biological resources can be involved in the application of microbiological and biotechnological processes and the delivery of ecosystem services. The products and services in the bioeconomy make use of bio-based processes, carried out by microorganisms, animal and plant cells and their components such as DNA, RNA and enzymes. Applications range from more traditional approaches concerning low-tech innovation, such as microbial fermentation in industry, to more advanced technology-driven approaches such as bionics, artificial intelligence (AI), and carbon capture (WBCSD, 2020).

# 2.2 OUTLINING THE STRUCTURE OF THE REVIEW

This subchapter presents the structure and key terms used to systematically search for bioeconomy-related sources of practices and policies, based on the definition of bioeconomy.

The 250 collected sources are classified in **Table 1** under three main categories, as can be seen in scientific research, technical knowledge and policies. These categories are further classified into subcategories, topics and subtopics follow the different themes under the bioeconomy definition presented in chapter 2.1. The structure below has hyperlinks that point to the correspondent section in **Table 1** for cross-referencing purposes.

<b>1. DISCOVERY AND DOCUMENTATION OF BIOLOGICAL PRINCIPLES FOR THE BIOECONOMY</b>	
1.1 BASIC SCIENTIFIC RESEARCH	
1.2 APPLIED SCIENTIFIC RESEARCH	
<b>2. APPLICATIONS OF KNOWLEDGE, SCIENCE, TECHNOLOGY AND INNOVATION IN THE VALUE CHAIN</b>	
2.1 PRODUCTION OF BIOLOGICAL RESOURCES	
2.1.1 PRODUCTION OF BIOLOGICAL MATERIALS (CELL AND MICROORGANISM CULTURES)	2.1.4 URBAN AND PERI-URBAN AGRI-FOOD SYSTEMS
2.1.2 LAND AND WATER MANAGEMENT	2.1.5 MULTISECTORAL SOURCES
2.1.3 CROP, MEDICINAL PLANTS, LIVESTOCK, INSECT, FISH AND FORESTRY PRODUCTION	
2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES	
2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL	
2.2.1.1 Handling biological materials (seeds, plants, microorganisms and their genetic resources)	2.2.1.2 Handling agricultural produce, residues and losses
	2.2.1.3 Handling waste
2.2.2 PROCESSING AND MANUFACTURING	
2.2.2.1 Food and feed	2.2.2.5 Medicinal and pharmaceutical products of biological origin
2.2.2.2 Wood products	2.2.2.6 Multisectoral sources, including biorefineries
2.2.2.3 Bioenergy	2.2.2.7 Biological services (use of biological data in biosafety and medicine)
2.2.2.4 Biochemicals, biomaterials and bioplastics	
2.2.3 DISTRIBUTION AND CONSUMPTION	2.2.4 CIRCULARITY (REPLACE, REDUCE, REUSE, RECYCLE AND RECOVER)
2.3 CONSERVATION AND REGENERATION OF BIOLOGICAL RESOURCES	
2.3.1 MAINTAINING THE DIVERSITY OF GENETIC RESOURCES WITHIN SPECIES AND BETWEEN SPECIES	2.3.3 MAINTAINING THE FUNCTIONING OF ECOSYSTEM SERVICES
2.3.2 MAINTAINING THE DIVERSITY OF ECOSYSTEMS	
<b>3. PROVIDING SUSTAINABLE SOLUTIONS (INFORMATION, PRODUCTS, PROCESSES AND SERVICES) WITHIN AND ACROSS ALL ECONOMIC SECTORS AND ENABLING A TRANSFORMATION TO A SUSTAINABLE ECONOMY (I.E. THE ENABLING ENVIRONMENT)</b>	
3.1 MIXED POLICIES (REGULATORY, ECONOMIC, VOLUNTARY, OTHERS)	
3.2 REGULATORY INSTRUMENTS	
3.3 MARKET-BASED AND FISCAL INSTRUMENTS	
3.4 COLLABORATION ACROSS SECTORS AND STAKEHOLDERS	
3.5 COMMUNICATION	
3.5.1 INFORMING POLICY MAKERS (M&E SYSTEMS AND EVIDENCE-BASED DECISION MAKING)	3.5.3 INFORMING SPECIFIC STAKEHOLDER GROUPS (INDUSTRY, RURAL AND COASTAL POPULATION, CIVIL SOCIETY)
3.5.2 INFORMING FINAL CONSUMERS AND THE GENERAL PUBLIC	

## 1. DISCOVERY AND DOCUMENTATION OF BIOLOGICAL PRINCIPLES FOR THE BIOECONOMY

This category includes sources that describe practices used in basic and applied research. The sources contain literature on the documentation and discovery of biological principles, which can be later used for applied research to develop technologies or techniques, such as knowledge-intensive technologies used in the production, the management and interpretation of biological data or bioinformation and their application in research and discovery (Laibach, Börner and Bröring, 2019). This category refers to the less tangible aspect of the bioeconomy and includes practices outside the productive value chain that cut across the other subcategories.

### 1.1 BASIC SCIENTIFIC RESEARCH

Much of the progress in biological science over the last 50 years is the direct consequence of the work of thousands of scientists whose primary goal was understanding the fundamental working of living things. Without basic research, applied research is difficult.

Practices for basic research in life sciences include laboratory practices used for understanding the fundamental elements of plant, animal and microorganism biology; exploring the roles and relationships between these elements; and discovering new microbial strains, bioproducts and drugs. These practices also include the creation and sound management of databases for public knowledge, analysis and modelling; research to unlock the potential of the microbiome and apply it to further research, bioprospecting and process optimization.

### 1.2 APPLIED SCIENTIFIC RESEARCH

This category includes the application of research in life sciences, analysis and data for concrete bio-based products or services. The utilization of life sciences for the bioeconomy is being increasingly data-driven. Scientific activities benefit greatly from using available research studies, databases, and customized data analysis (National Academies of Sciences, Engineering, and Medicine, 2020a). In particular, omics data and related technology are used to explore the roles,

relationships and actions of the various types of cell molecules (Foresight, 2015). Omics data refer to 'big data', this is used for genomics, proteomics, metabolomics, ionomics and several other 'omics'. For instance, in the identification of gene codes (e.g. with high-throughput sequencing) for crop resistance to stress and pathogens and for animal health, as well as genetic engineering. Also, the analysis of human health and interactions with various factors, including nutrition and the environment, and the pharmacological uses of substances found in plants and plant cultures (Zörb *et al.*, 2018). Multi-omics technologies significantly contribute to the understanding of the composition of microbiomes, their networks of interactions, and their functions such as reducing antimicrobial growth promoters, improving soil carbon sequestration, and preventing diet-related non-communicable diseases. This contributes to more diversified, efficient and resilient agri-food systems (Trivedi *et al.*, 2021).

The analysis and interpretation of omics and big data is currently mostly done by bioinformatics. An example is the analysis of DNA and protein sequences and structures to characterize their linked functions. Innovation in biosciences is steadily growing. Bioinformatic science is of great value for the bioeconomy because it can provide practical information for developments in production for medicines, food and other purposes (Jiménez-Sánchez and Philp, 2015; Zörb *et al.*, 2018). Biofoundries provide infrastructure and technology to accelerate research in the field of synthetic biology. The Global Biofoundries Alliance aim to develop common protocols and standards (Hillson *et al.*, 2019). The Internet of Things is used in systems biology and in other fields to improve efficiency, where databases, data analysis and digital simulation are employed for automatization and optimization of the process, such as in cell cultures (National Academies of Sciences, Engineering, and Medicine, 2020a).

## 2. APPLICATIONS OF KNOWLEDGE, SCIENCE, TECHNOLOGY AND INNOVATION IN THE VALUE CHAIN

This category includes practices in the application of biological knowledge, sciences, technologies and innovations that support the

production, utilization and conservation of biological resources. Sources under this category are classified by their stage in the value chain: production; utilization (aggregation, processing, distribution, consumption and circularity); and the conservation of biological resources for the provision of bio-based products and services. These stages have been adapted from the FAO guiding principles for the development of sustainable value chains (FAO, 2014a). The elements considered under each stage of the value chain are described below.

## 2.1 PRODUCTION OF BIOLOGICAL RESOURCES

This section includes practices used in cell and microorganism cultures as well as practices used in agriculture, forestry, fisheries and aquaculture to improve biomass and agri-food systems. It also encompasses land and water management practices and urban agriculture. Examples include safety control of incoming starting materials for cell cultures, synthetic biology, sustainable soil management, precision agriculture, modern farming techniques, the use of indigenous climate-resilient crops, the application of bio-based inputs used in the production stage (e.g. biocides), organic fertilizers, bio-based mulching films and bio-based lubricants and oils for machinery. The sources are classified into the following subcategories:

### 2.1.1 PRODUCTION OF BIOLOGICAL MATERIALS (CELL AND MICROORGANISM CULTURES)<sup>1</sup>

### 2.1.2 LAND AND WATER MANAGEMENT

### 2.1.3 CROP, MEDICINAL PLANTS, LIVESTOCK, INSECT, FISH AND FORESTRY PRODUCTION

### 2.1.4 URBAN AND PERI-URBAN AGRICULTURE SYSTEMS

### 2.1.5 MULTISECTORAL SOURCES

<sup>1</sup> The selection and culture of biological material (e.g. synthetic biology) is considered under category 2.1.1. Their storage, classification and acquisition under category 2.2.1. Their utilization as feedstocks, inputs or inoculums for bioproduct manufacturing (e.g. medicine, antibiotics) is under category 2.2.2. And the study of related disciplines (e.g. genetic engineering), and associated data and information management (e.g. microbial genomics, metabolomics) are considered under Category 1.

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

This category includes practices associated with the utilization of biological resources, including biomass from plants and animals, and microorganisms and enzymes in biotechnological processes as inputs or intermediate products for the manufacturing of bioproducts and services in different stages of the value chain.

### 2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL

Practices described in these sources refer to the steps taken after the cultivation, production and culture of biological resources, and before their processing or manufacture. This category refers to the activities linked to the acquisition and collection of biomass from primary production for its better management. It also includes: activities related to the acquisition and collection of biological materials to be stored in gene, cell or seed banks; the aggregation of biomass from different sources (e.g. the gathering of unused biomass residues and the collection of unavoidable losses); activities in sorting, managing, storing, bulking, pre-processing and pre-treatment when appropriate, as well as provision and supply; and the collection, handling, storage and supply of biological materials including genetic resources that contribute to *ex-situ* conservation of biodiversity.

#### 2.2.1.1 Handling biological materials (seeds, plants, microorganisms and their genetic resources)

#### 2.2.1.2 Handling agricultural produce, residues and losses

#### 2.2.1.3 Handling waste<sup>2</sup>

### 2.2.2 PROCESSING AND MANUFACTURING

This category includes practices used during the processing stage, where biological materials, such as enzymes, bacteria and other microorganisms are used to produce bioproducts (e.g. medicinal products and food additives), sometimes together with plant or animal biomass (e.g. bioplastics). These practices generally refer to the design and implementation

<sup>2</sup> This subcategory could also be considered under the broader category 2.2.4 (Circularity). However the sources are more relevant to the acquisition and aggregation stage of the value chain since they concern mainly the collection and sorting of waste materials.



of processing plants and biorefineries, particularly distributed biorefineries and integrated biorefineries that synthesize multiple types of bioproducts from multiple sources of biomass (Jiménez-Sánchez and Philp, 2014). They can also include the use of big (bio-) data for optimizing bio-based processing and circularity processes. Biochemistry and green chemistry disciplines are also included in this category. This category also encompasses the manufacturing of bioproducts and the provision of bioservices, including in the health sector for prevention, diagnosis and treatment (e.g. sensors and diagnosis services, or bioinformatics used for biomedical services). Despite bioeconomy includes inter-sectoral activities, the sources in this category are classified by sectors, which correspond to the end products and services, for ease of reference. More information on biological services can be found in **Box 2**.

2.2.2.1 Food and feed

2.2.2.2 Wood products

2.2.2.3 Bioenergy

2.2.2.4 Biochemicals, biomaterials and bioplastics<sup>3</sup>

2.2.2.5 Medicinal and pharmaceutical products of biological origin

2.2.2.6 Multisectoral sources, including biorefineries

2.2.2.7 Biological services (use of biological data in biosafety and medicine)

### 2.2.3 DISTRIBUTION AND CONSUMPTION

This category covers the distribution and consumption of products and services. Examples include the use of software to optimize truck route design; improvements in infrastructure (e.g. clusters) to lower the cost of logistics; and improvements in consumption patterns, including food loss and waste, food packaging, the reduction of single-use plastics, repair and reuse, and eco-design. This category can include the direct consumption of unprocessed biomass, either for some foods or some forms of bioenergy (e.g. direct combustion).

### 2.2.4 CIRCULARITY (REPLACE, REDUCE, REUSE, RECYCLE AND RECOVER)

This category includes practices in the circular bioeconomy that replace, reduce, reuse,

<sup>3</sup> Textiles are covered under 2.2.1.3. (Handling of waste); 2.2.3. (Distribution and consumption); and 2.2.4. (Circularity).

recycle and recover material and energy. This encompasses microbial and biotechnological processes carried out during all stages of the value chain. At the design stage, examples include replacing single-use plastics by bio-based, easily biodegradable plastics); at the manufacturing stage, recovering material and energy; and at the end-of-life stage, recycling and recovery processes, wastewater treatment with microalgae, an safe management and disposal of animal carcasses and contaminated materials that can create disease outbreaks, the enzymatic hydrolysis of waste that preserves more nutrients than chemical methods, or sewage treatment with microorganisms.

## 2.3 CONSERVATION AND REGENERATION OF BIOLOGICAL RESOURCES

This category includes practices that affect the state of biological resources (i.e. biological diversity within species, between species and of ecosystems) and the functioning of the ecosystem and the provision of ecosystem services<sup>4</sup>. These practices contribute to *in situ* conservation and the curbing and reversing of the depletion of natural resources as well as the regeneration of ecosystems. They reduce pollution, the erosion of biodiversity, water depletion and soil degradation. It encompasses practices related to tourism, particularly ecotourism and tourism in national parks or protected areas, that depend on the conservation of biological resources.

### 2.3.1 MAINTAINING THE DIVERSITY OF GENETIC RESOURCES WITHIN SPECIES AND BETWEEN SPECIES

### 2.3.2 MAINTAINING THE DIVERSITY OF ECOSYSTEMS

### 2.3.3 MAINTAINING THE FUNCTIONING OF ECOSYSTEM SERVICES

<sup>4</sup> Ecosystem services can be classified into provisioning ecosystem services of essential goods (e.g. food and healthy diets, water, timber and fibre); regulating ecosystem services (carbon sequestration); supporting ecosystem services (e.g. soil water retention) and cultural ecosystem services (e.g. eco-tourism).

### 3. PROVIDING SUSTAINABLE SOLUTIONS (INFORMATION, PRODUCTS, PROCESSES AND SERVICES) WITHIN AND ACROSS ALL ECONOMIC SECTORS AND ENABLING A TRANSFORMATION TO A SUSTAINABLE ECONOMY (I.E. THE ENABLING ENVIRONMENT)

This category lists sources that describe enabling environments that allow for the provision of useful information, products, processes and services across sectors. It includes practices that increase the uptake of bioproducts, bring ideas and projects forward, and generally make bioeconomy activities work. They cut across all the previous subcategories. This category includes the use of policy instruments, including regulatory and economic instruments, and communication and voluntary support measures used to provide bio-based products, processes and services<sup>5</sup>.

The sources are classified into the following subcategories:

#### 3.1 MIXED POLICIES (REGULATORY, ECONOMIC, VOLUNTARY, OTHERS)

Sources in this category include policy practices in different areas, such as command and control (regulatory) instruments, economic and fiscal instruments, infrastructure and service instruments, and voluntary policy actions.

#### 3.2 REGULATORY INSTRUMENTS

Sources include command and control instruments to ensure that requirements set by a policy, international convention or any other mechanism are met.

<sup>5</sup> It should be noted that there are sources in other categories that also include policy practices or practices to be developed by governments, such as “city governments advance infrastructure to enable local food sourcing and the return of organic fertilisers to peri-urban farms” in category 1.1.2.4 (Circularity). Also, there are practices for the enabling environment that are carried out by non-government stakeholders, such as innovative business models that companies can put in place; initiatives to market new products and to attract capital; forms of collaborative agreements between private sector stakeholders; strategies to develop a value chain for crop residues; activities carried out by learning institutions; and practices carried out by financial institutions such as providing financial tools to reduce risks and stimulate the transition to a bioeconomy or to steer capital towards businesses leading the shift towards a circular bioeconomy. These practices are included in the other categories, for example circular business models are in category 1.1.2.4 (Circularity).

#### 3.3 MARKET-BASED AND FISCAL INSTRUMENTS

This category includes financing and support policies, such as public procurement, funding mechanisms and other policy that support the commercialization of new products and attract capital fund research projects.

#### 3.4 COLLABORATION ACROSS SECTORS AND STAKEHOLDERS

Bioeconomy is more than the sum of the sectors and refers to bio- and agri-food systems as a whole. Policy practices under this category facilitate a positive interaction and collaboration between bioeconomy sectors and stakeholders to advance the development of a sustainable bioeconomy and align different policy levels. This category covers information sources on policies intended to create opportunities for dialogue and cross-sectoral collaboration. This can include collaboration among public sector entities and departments for inter-ministerial coordination and policy coherence; collaboration between the private sector and public sector to increase bioeconomy competitiveness; and cross-sectoral interaction and cooperative actions between different stakeholders (e.g. establishing clusters through public sector support).

#### 3.5 COMMUNICATION

This category includes policy practices to support different stakeholders to make informed decisions.

##### 3.5.1 INFORMING POLICY MAKERS (M&E SYSTEMS AND EVIDENCE-BASED DECISION MAKING)

This subcategory includes awareness-raising activities related to the transition to a sustainable bioeconomy, as well as practices for monitoring and evaluation that are used for evidence-based policy making and reporting on progress towards broader sustainability targets, including the SDGs.

##### 3.5.2 INFORMING FINAL CONSUMERS AND THE GENERAL PUBLIC

Practices in this subcategory support evidence-based consumer choices, increase the uptake of bioproducts and raise awareness on the impacts of behaviour, for example through publicity campaigns or encouraging public dialogue.



### 3.5.3 INFORMING SPECIFIC STAKEHOLDER GROUPS (INDUSTRY, RURAL AND COASTAL POPULATION, CIVIL SOCIETY)

This subcategory includes practices to providing information to specific audiences, including industrial stakeholders and companies, to

increase their sustainability; and to rural stakeholders and farmers to build trust. It also includes education, training and capacity development of these stakeholders.

## BOX 2. BIO-BASED SERVICES CONSIDERED IN THE REVIEW

The term 'services' in this report includes different aspects under different categories: the provision of services, as opposed to the provision of products, which are applied outside the value chain, are considered under category 2.2.2.7 (Biological services), and include for example biosafety control and medical applications, such as a diagnoses and medicals test based on biomarkers.

Those services that are applied in biomass production, such as soil microbiome applications, are under category 2.1 (Production of biological resources), and those applied in processing, such as biotechnological manufacturing using microorganisms, are under category 2.2 (Utilization of biological resources to provide products and services). The services provided through the sustainable use and conservation of biological resources (i.e. ecosystem services), are considered in category 2.3 (Conservation of biological resources) and include tourism services.

Also, services related to transport, wholesale, retail, accommodation and food services (restaurants and delivery services) are considered under 2.2.3 (Distribution and consumption) and to some extent 2.2.4 (Circularity) and 2.1.4 (Urban and peri-urban agricultural production). The wealth of these services in the bioeconomy can be seen in the Joint Research Centre (JRC) report *How big is the bioeconomy?* (Kuosmanen *et al.*, 2020). The services that relate to public policy, businesses or communication to the public or capacity development of stakeholders is considered under category 3 (Provision of information, products, processes and services across all economic sectors aiming toward a sustainable economy).

Biological services in biosafety and medicine including biomarkers, biosensors, medical tests and diagnosis, or the use of big data and statistical data.

Biosafety practices and technologies are at the interface between environment, health, and bio-based production. They benefit from the rapid advancements in the fields of life sciences and computing sciences (e.g., genome data, cloud computing and material sciences). These practices, tools or technologies contribute to biosafety in each dimension (e.g. the identification of toxicity, pathogens, anti-microbial resistance). This is particularly important when there is risk of irreversible consequences, such as gene diffusion, persistent pollution, and invasive species (Foresight, 2015). Examples of biosafety practices are the detection and control of toxic chemicals, pollution and presence of pathogens and invasive species; the surveying and monitoring of concentrations of microorganisms; and the analysis of the presence of bacteria and drug-resistant genes.

Practices related to medicine include those linked to prevention (e.g., the collection, aggregation and analysis of large genomic and personal health data to reduce the response time and to save costs). These practices use biological engineering and omics data analyses in strategies that take a holistic view of health, by integrating nutrition, lifestyles, the environment, behaviour and well-being. They include nutrigenomics and nutrigenetics, metabolomics and other environmental factors such as climate change. Practices related to medicine are also connected diagnoses. Common applications include biosensors and bio-compounds used in monitoring and detection (e.g., instant tests for rapid identification of bacteria to stop pathogen propagation and cure diseases, or biologically sensitive field-effect transistors for detection). Practices related to medical treatment include omics data applications that support the identification of new treatments, as they can identify molecules in humans, plants, animals or bacteria that could be used to manufacture bioproducts (e.g., pharmaceuticals or nutrients) or tailor treatments to the genetic makeup of patients, as in some microbiome-based therapies.

## 2.3

# DEFINING GOOD PRACTICES AND POLICIES AND SCREENING SOURCES AGAINST FAO CRITERIA

This chapter presents the methodology used to screen the most relevant sources and compilations of good practices and policies across all activities that contribute to the bioeconomy.

Practices are considered ‘good’ when they demonstrate an improvement from a previous situation or minimize the impacts of a negative activity. They are generally seen as the most effective way to achieve a specific objective (SDC, 2013). Examples of different types of ‘good’ practices include: ‘good laboratory practices’ that ensure biosafety; ‘good agricultural practices’ that regenerate soil systems or protect biodiversity; ‘good manufacturing practices’ that do not harm the environment or contribute to circularity in urban agri-food systems; ‘good policy practices’ that are inclusive or promote sustainable investment that contribute to the modernization and development of rural areas.

Initially, stakeholders sometimes find it easier to identify what is generally accepted as ‘not good’, because it can lead to a quick response. For instance, some public mechanisms in the primary sector are focused on banning ‘bad’ practices, such as burning agricultural residues in dry areas prone to forest fires. These restrictions can be complemented by incentives for the implementation of good practices that contribute to address similar sustainability objectives (e.g., sustainable soil management practices).

Some of the case studies in the 2019 FAO report *Towards Sustainable Bioeconomy – Lessons Learned from Case Studies* served to illustrate what sustainability can mean in the context of

bioeconomy both at private and public sector levels (Gomez San Juan, Bogdanski and Dubois, 2019). The lessons from the case studies clearly show that sustainability is not something that happens automatically.

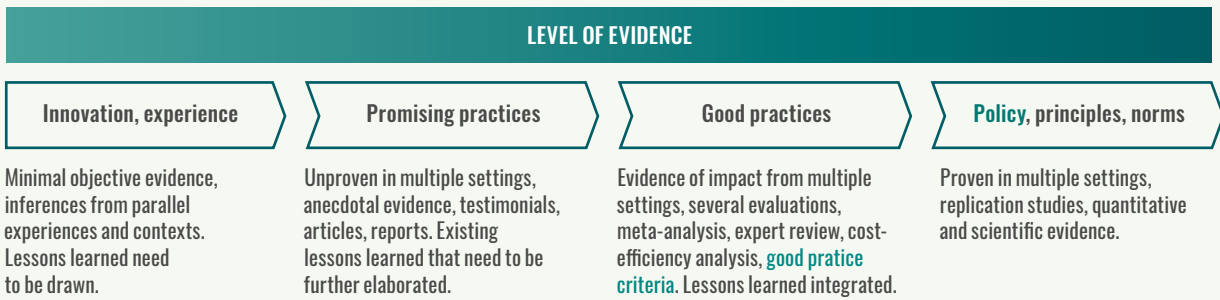
In general, good practices and good policies are considered the ‘best fit’ within the circumstances of a country, sector or organization, so it is crucial to carry out local flexible multistakeholder processes in the selection of what is ‘good’ (OECD, 2006; Marchetti *et al.*, 2014). The specificity of the context should be considered when defining a good practice or policy. The Communiqué of the Global Bioeconomy Summit (IACGB, 2018) states that good practices should be proven and broadly accepted, and their promotion should be done through an inclusive decision-making process. Building on existing experience (referred to as experience capitalization or ‘systematization’) is an iterative process through which an experience (with its successes and failures) is identified, valued and documented by local stakeholders. This systematic process allows for the learning of lessons and the identification of good practices, which can in turn be modified and improved and may be adopted by others (FAO, 2013a). **Annex 2** provides the FAO template for carrying out an experience capitalization process that is tailored to the bioeconomy. The template can be used by both public sector representatives from a given country and private sector representatives.

This Compendium uses the FAO Good Practice Standards (FAO, 2020b), which define a good practice as “a successful experience that has been proven to work well and has produced good results in different contexts and can therefore be recommended as a model. It deserves to be shared so that a great number of people can adapt and adopt it”. Therefore, an established good practice is the one that has objective evidence of impact (see **Figure 1**) and meets five good practice criteria (highlighted in red in **Figure 1**).

As can be seen in **Figure 1**, innovations and promising practices are not considered to be established good practices since they do not provide enough evidence of impact. These practices are not mature enough and have not been replicated or up-scaled.

**FIGURE 1.**

**STAGES IN THE DEVELOPMENT OF A GOOD PRACTICE OR POLICY**



Source: Adapted from FAO (2016a)

On the other side of the spectrum, the enabling environment for the implementation of good practices should be considered. It is generally difficult to separate a good practice from the policy that promotes it, as both go hand in hand. In fact, many sources include both practices and policies. A good practice becomes a policy, principle or norm, once it is institutionalized and embedded in an enabling environment. These are represented in **Figure 1** in the last stage in the development of a practice, with the highest level of evidence of impact.

In selecting the sources for this Compendium, key words, which set the boundaries of the bioeconomy, and search criteria, which were derived from the definition of a good practice, were taken into account.

**a The search key words were used to pre-select sources that relate to the bioeconomy.** These key words were taken from the elements of the bioeconomy definition (Subchapter 2.2).

The bioeconomy strategy objectives (**Box 3**) were also used as key words along with the ten major bioeconomy sectors. The objectives and the major sectors were identified from the 2019 FAO report *Towards Sustainable Bioeconomy – Lessons Learned from Case Studies* (Gomez San Juan, Bogdanski and Dubois, 2019). The compilation includes as much as possible sources that cover more than one sector.

The recursive search of sources on the Internet was complemented by information on good practices and inputs from the ISBWG and FAO experts from different areas of work.

**b The following search criteria were used to make the final selection of sources of good practices.** They were derived from the FAO Good Practice Standards, which includes the FAO definition of good practices and the FAO good practice criteria (see **Figure 1**).

**b.i the level of evidence of impact:**

A good practice integrates evidence of impact from multiple settings, several evaluations, meta-analyses, expert reviews, cost efficiency analyses and risk assessments. The practice should meet five good practice criteria (section b.ii) and include lessons learned from its implementation.

According to the FAO Good Practice Standards (FAO, 2016a and 2020b), to fully capture a good practice, it is necessary to initiate the documentation process at the earliest stages when the practice is still a potential innovation. However, this would go beyond the scope of this already comprehensive review of sources of established good practices.

The sources are outstanding publications and databases. They include compilations of good practices, such as reports, manuals, regulations, protocols, codes of practice, handbooks, certification schemes, subsidies for good practices, collections of scientific articles on good practices. The sources were selected according to their relevance, and guidelines from international organizations and internationally agreed portfolios of good practices were given

priority. The vast majority were published between 2010 and 2021. The sources from earlier dates were included in **Table 1**, when no more recent sources were found.

In the literature review, there are more reports prepared by international organizations than scientific articles. This is because reports normally provide a wider set of good practices that can be replicated in different contexts, since they receive input of multiple stakeholders who understand the consequences and bottlenecks on the ground. Scientific articles normally describe a specific practice and sometimes include a context-specific application and a concrete impact.

Some relevant circular economy and green economy sources are included because of the limited work on circular bioeconomy-specific good practices in related areas. Country-level publications are included, if they consider global references for good practices. Finally, good practices shared through communities of practice were not included in this review because they are shared through mailing lists, on-line fora, blogs, and are not easily available.

Compilations of examples and case studies were included only when they present good practices in the form of lessons learned or recurring success factors that can be considered as the building blocks of a good practice, since this means that they have been proven successful in different contexts and have enough evidence of impact. The

titles of sources not only include ‘good practices’ but also ‘key areas of action’ or ‘recommendations’, because often the sources that have the term ‘good practices’ in their title actually refer only to examples and case studies, while those reports that include good practices based on sound evidence are often titled ‘key areas of action’, ‘guidelines’ or ‘manuals’.

A policy refers to a good practice that has become norm, has been institutionalized and is embedded in an enabling environment. Therefore, this compilation includes good practices that refer not only to the implementation of technologies but also to policies (i.e. last stage in the development of a practice, ideally with the highest level of evidence of impact).

**b.ii good practice criteria:**

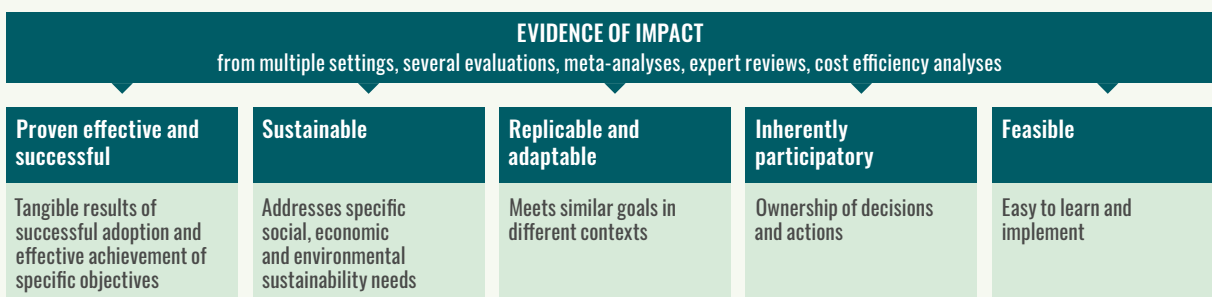
The criteria for which a practice or policy is considered ‘good’ are presented in **Figure 1** and further expanded in **Figure 2**. All sources reviewed in this Compendium fulfil at least two criteria.

The FAO Good practice criteria are:

- **Proven effective and successful**  
A good practice been successfully adopted, it is at a mature stage, and has had a positive impact on individuals and/or communities. It has either been proven viable over time or has produced tangible results as the most effective way in achieving specific objectives. Therefore, a good practice addresses one or more of the bioeconomy strategy objectives (see **Box 3**).

**FIGURE 2.**

**SUMMARY OF THE DEFINITION AND CRITERIA OF A GOOD PRACTICE OR POLICY USED FOR THE REVIEW**



Source: Adapted from FAO (2016a and 2020b)

- Socially, economically and environmentally sustainable  
A good practice meets current needs, in particular the essential needs of the world's poorest areas, without compromising the ability to address future needs. A good practice should make it possible to continue producing, using and conserving biological resources in the future (e.g. good soil management helps to maintain soils that will continue being useful for agriculture in the future). In this way, the practice contributes to all dimensions of sustainability, including governance issues. **Box 3** shows the bioeconomy strategy objectives used in the classification of sources and examples of links between them and the Principles and Criteria and SDG targets.
- Replicable and adaptable  
A good practice should be scalable and have the potential for replication. It should therefore be adaptable to similar objectives in varying situations (i.e. be adaptable at the national level while contributing to achieving global goals). In the bioeconomy, it is very important to consider regulatory barriers in the implementation of a practice in different countries (e.g. for the use of waste).
- Inherently participatory  
Participatory approaches are essential, as they support a joint sense of ownership of decisions and actions. This is particularly important in the bioeconomy because “Ensuring an inclusive decision-making process in the promotion of good practices contributes to using biological resources for the benefit of society and the planet” (IACGB, 2018, p.4). This is especially significant with regard to the issue of competition between biomass end-use sectors. Selecting the right practices, including the right technologies and the right policies, is key in the prioritization of biomass uses and bioeconomy interventions.
- Feasible  
Feasibility is the basis of a good practice. The practice must be easy to learn and implement.

## 2.4 ANALYSING THE OBJECTIVES OF THE GOOD PRACTICES AND POLICIES UNDER REVIEW

A good bioeconomy practice and policy should contribute to the Aspirational Principles and Criteria of a Sustainable and Circular Bioeconomy (ISBWG, 2021) and the SDGs. Bioeconomy strategies often directly or indirectly aim to address several sustainability objectives at the time. For example, the German bioeconomy strategy explicitly addresses the SDGs (BMBF and BMEL, 2020).

The definition of a good practice or policy already includes criteria that refer to sustainability and strategic goals. Criterion 1 ‘Proven effective and successful’, which refers to the ability of a good practice to achieve specific objective, criterion 2 ‘Sustainable’ that means that the good practice contributes to address specific sustainability needs, and criterion 3 ‘Replicable and adaptable’, which mentions that a good practice is adaptable at national level, while fulfils similar objectives globally.

Furthermore, when mainstreaming good practices and policies into bioeconomy strategies, programmes and action plans, it is of the utmost importance to assess whether the selected good practices match the sustainability objectives of the bioeconomy strategy.

In this compendium, the sources of good practices and policies were selected because they contribute to the transition towards a sustainable and circular bioeconomy. They contribute to the achievement of the bioeconomy strategy objectives that are presented in **Box 3**. **Table 1** includes the links to these bioeconomy strategy objectives, represented by number codes. **Box 3** also shows examples of links between the bioeconomy strategy objectives, the Principles and Criteria and SDG targets.



**BOX 3. LIST OF STRATEGY OBJECTIVES OF THE BIOECONOMY AND EXAMPLES OF LINKS WITH THE PRINCIPLES AND CRITERIA AND SDG TARGETS**

Fifteen common bioeconomy strategy objectives were identified in the 2019 FAO report *Towards Sustainable Bioeconomy – Lessons Learned from Case Studies* (Gomez San Juan, Bogdanski and Dubois, 2019) and are used in **Table 1** to classify sources. Good bioeconomy practices and policies allow the mainstreaming of sustainability and

circularity to achieve strategy objectives, the Principles and Criteria (see Box 1) and SDGs. The fifteen objectives are below, together with examples of links with some Principles and Criteria (FAO, 2021) and SDG targets<sup>6</sup>, and the correspondent sustainability dimension (social, economic, environmental and governance).

**1. To safeguard food security** SOCIAL DIMENSION

- a. Criterion 1.1 (Food security and nutrition are supported)
- b. SDG2 (Zero hunger, targets 2.4 and 2.a), SDG3 (Good health and well-being, target 3.4) and to some extent SDG12 (Sustainable consumption and production, target 12.3)

**2. To substitute fossil-based or unsustainably sourced products with sustainable bioproducts** ENVIRONMENTAL DIMENSION

- a. Criterion 1.2 (Sustainable intensification of biomass production is promoted) and Criterion 9.1 (Consumption patterns of bioeconomy goods match sustainable supply levels of biomass)
- b. SDG12 (Sustainable consumption and production, targets 12.6 and 12.c) and to some extent SDG7 (Affordable and clean energy, target 7.2)

**3. To incentivize the sustainable and efficient use of biological resources while protecting biodiversity, water and the soil** ENVIRONMENTAL DIMENSION

- a. Criterion 2.1 (Biodiversity conservation is ensured), Criterion 2.3 (Water quality and quantity are maintained, and, as much as possible enhanced), and Criterion 2.4 (The degradation of land, soil, forests and marine environments is prevented, stopped or reversed)
- b. SDG2 (Zero hunger, target 2.5), SDG12 (Sustainable consumption and production, targets 12.2 and 12.c), SDG14 (Life below water, targets 14.1 and 14.4), and SDG15 (Life on land, targets 15.2, 15.3, 15.5 and 15.6)

**4. To mitigate and adapt to the effects of climate change and reduce environmental pollution** ENVIRONMENTAL DIMENSION

- a. Criterion 2.2 (Climate change mitigation and adaptation is pursued)
- b. SDG13 (Climate action, target 13.2) and SDG12 (Sustainable consumption and production, target 12.4), and to some extent SDG1 (No poverty, target 1.5), SDG3 (Good health and well-being, target 3.9) and SDG 11 (Sustainable cities and communities, 11.6)

**5. To increase profitability by adding value to biomass** ECONOMIC DIMENSION

- a. Criterion 3.1 (Economic development is fostered)
- b. SDG8 (Decent work and economic growth, target 8.2) and SDG9 (Industry, innovation and infrastructure, target 9.b), and to some extent SDG2 (Zero hunger, target 2.3)

<sup>6</sup> For a description of the SDG targets see **Annex 1**.

**6. To create and secure employment through in situ value addition and enhance rural and urban economic resilience** ECONOMIC DIMENSION

- a. Criterion 3.2 (Inclusive economic growth is strengthened)
- b. SDG5 (Gender equality, target 5.a) and SDG8 (Decent work and economic growth, target 8.5), and to some extent SDG14 (Life below water, target 14.2) and SDG15 (Life on land, target 15.9)

**7. To promote actions that contribute to the revitalization and development of rural areas** ECONOMIC DIMENSION

- a. Criterion 3.3 (Resilience of the rural and urban economy is enhanced)
- b. SDG7 (Affordable and clean energy, target 7.b) and SDG11 (Sustainable cities and communities, target 11.a), and to some extent SDG2 (Zero hunger, target 2.a)

**8. To support vulnerable stakeholders who act as guardians of natural resources, including low-income communities, smallholder agricultural producers and indigenous peoples** SOCIAL DIMENSION

- a. Criterion 1.3 (Adequate land rights and rights to other natural resources are guaranteed) and Criterion 4.2 (Resilience of biomass producers, rural communities and ecosystems is developed and/or strengthened in rural areas)
- b. SDG15 (Life on land, target 15.6 and 15.9) and SDG1 (No poverty, target 1.3) and to some extent SDG10 (Reduced inequalities, targets 10.1)

**9. To move towards a more circular bioeconomy** ENVIRONMENTAL DIMENSION

- a. Criterion 5.1 (Resource use efficiency, waste prevention and waste re-use along the whole bioeconomy value chain are improved); Criterion 5.2 (Food loss and waste is minimized and, when unavoidable, its biomass is reused or recycled); Criterion 4.1 (The sustainability of urban centers is enhanced)
- b. SDG6 (Clean water and sanitation, target 6.3 and 6.4), SDG9 (Industry, innovation and infrastructure, target 9.4), SDG11 (Sustainable cities and communities, target 11.6), SDG12 (Sustainable consumption and production, targets 12.3, 12.4 and 12.5) and SDG13 (Climate action, target 13.1)

**10. To promote synergies and reduce trade-offs between biomass uses, while meeting the growing demand for food and non-food goods** GOVERNANCE DIMENSION

- a. Criterion 6.1 (Policies, regulations and institutional structures relevant to bioeconomy sectors are adequately harmonized), Criterion 6.2 (Inclusive consultation processes and engagement of all relevant sectors of society are adequate and based on transparent sharing of information)
- b. SDG8 (Decent work and economic growth, target 8.3), SDG16 (Peace, justice and strong institutions, target 16.7) and SDG17 (Partnerships for the goals, target 17.14), and up to some extent SDG1 (No poverty, target 1.b)

**11. To establish local fair and equitable value chains or webs by increasing inclusiveness and information flows** ECONOMIC DIMENSION

- a. Criterion 8.1 (Local economies are not constrained but rather expanded through the trade of raw and processed biomass, and related technologies)
- b. SDG10 (Reduced inequalities, target 10.3) and SDG17 (Partnerships for the goals, targets 17.11 and 17.17)

**12. To promote a transparent monitoring system for bioeconomy development and compliance with national and/or international sustainability targets**

GOVERNANCE DIMENSION

- a. Criterion 6.3 (Appropriate risk assessment and management, monitoring and accountability systems are put in place and implemented)
- b. SDG12 (Sustainable consumption and production, targets 12.6 and 12.b), SDG16 (Peace, justice and strong institutions, target 16.6) and SDG17 (Partnerships for the goals, target 17.19)

**13. To support research, development and innovation and put it into practice to accelerate the deployment of sustainable bioeconomy**

SOCIAL DIMENSION

- a. Criterion 7.1 (Existing knowledge is adequately valued and proven sound technologies are fostered) and Criterion 7.2 (Knowledge generation and innovation are promoted)
- b. SDG3 (Good health and well-being, target 3.b), SDG4 (Quality education, targets 4.4 and 4.b), SDG9 (Industry, innovation and infrastructure, targets 9.5 and 9.b) and SDG17 (Partnerships for the goals, target 17.6), and to some extent SDG2 (Zero hunger, target 2.5), and SDG14 (Life below water, target 14.a)

**14. To position the country as an international leader in the bioeconomy and improve its global competitiveness in trade and research**

GOVERNANCE DIMENSION

- a. Criterion 10.1 (Cooperation, collaboration and sharing of resources, skills and technologies are enhanced when and where appropriate) and to some extent Criterion 8.1 (Local economies are not constrained but rather expanded through the trade of raw and processed biomass, and related technologies)
- b. SDG10 (Reduced inequalities, target 10.6) and SDG17 (Partnerships for the goals, targets 17.7, 17.9 and 17.16) and to some extent SDG12 (Sustainable consumption and production, targets 12.8 and 12.a)

**15. To promote sustainable consumption and raise the awareness and acceptance among consumers and manufacturers about the goods and services provided by the bioeconomy**

SOCIAL DIMENSION

- a. Criterion 1.4 (Food safety, disease prevention and human health are ensured) and Criterion 9.2 (Demand-side and supply-side market mechanisms and policy coherence between supply and demand of food and non-food goods are enhanced)
- b. SDG3 (Good health and well-being, target 3.4), SDG8 (Decent work and economic growth, target 8.4), SDG12 (Sustainable consumption and production, targets 12.1 and 12.7), SDG13 (Climate action, target 13.3) and SDG17 (Partnerships for the goals, target 17.14)



# REVIEW OF GOOD PRACTICE AND POLICY SOURCES

This chapter presents the results of the review of 250 selected sources of bioeconomy practices and policies. Apart from providing a database of documented good practices and policies that can be used for implementing bioeconomy strategies, programmes and action plans, this review is used in Chapter 5 to discuss gaps and limitations in existing literature.

**Table 1** follows the structure of the previously cited bioeconomy definition of the 2020 Global Bioeconomy Summit (IACGB, 2020) and outlined in Subchapter 2.2. There are three overall categories and a number of subcategories, topics and subtopics. These are shown in **Figure 3**, which presents a summary of the structure of the review based on the bioeconomy definition. It has hyperlinks that point to the correspondent section in **Table 1** for cross-referencing purposes.

The table lists the title, author, year and web-link of each literature source. The complete citations for the sources are in 'References of the

Table 1'. Sources under each category are ordered starting from the newest. Sources from the same year are ordered alphabetically by author.

The table provides a brief description of the publication and, when relevant, the audience and stakeholders addressed by the source. The table also indicates the original purpose or objectives of the source and the corresponding bioeconomy strategy objectives in number codes (see **Box 3**, Subchapter 2.4). The table also lists some examples of the practices and policies included in the publication.

Lastly, the 250 sources are analysed to indicate the extent to which they comply with the FAO definition and criteria presented in Subchapter 2.3, that is, if the practices and policies comply with five criteria (proven, sustainable, replicable, participatory and feasible) and if there is evidence of successful impact (from multiple settings, several evaluations, meta-analyses, expert reviews, cost efficiency analyses and risk assessments).

The analysis has only considered those criteria and evidence of impact that are explicitly reported by sources. A colour code in **Table 1** (light grey, grey and dark grey) gives a quick idea of whether they comply with FAO's definition and criteria, which allows to state that they possess the characteristics of a good practice or a good policy.

As indicated in **Figure 3**, light grey indicates that the sources do not provide enough evidence of impact. The sources marked in grey provide some evidence of impact and meet only up to three criteria. The sources marked in dark grey show enough evidence of impact and meet four or all five criteria. This colour code aims to indicate the level of detail of the methodology that the sources provide to assess the impact or effectiveness of practices and policies. It does not indicate which are the best sources within each category. All sources are equally valid, and the selection of the most successful practices or policies would depend on the local context. The approach presented in Chapter 5 has been developed to help countries identify successful bioeconomy practices and policies to reach strategic and sustainability objectives.

**Table 1** does not gather all existing sources, but rather serves to illustrate the wealth of information that exist pertaining to the different aspects of bioeconomy. Even if this Compendium follows the structure of the FAO definition (Subchapters 2.1 and 2.2), it does not mean that each category in **Table 1** contains all related existing sources and all possible good practices and policies, but a selection of them. Moreover, there are sources that can fall under more than one category. For instance, good practices related to the use of wastewater in agriculture can be under 'reuse/recycle' and under 'agricultural production', in particular in urban and peri-urban areas (Winpenny *et al.*, 2010); so in this Compendium they have been included in the latter, because the majority of good practices contained in the sources refer to farming practices.

This Compendium summarizes some of the main compilations of good practices and policies. The table should be considered as part of an ongoing effort that can be complemented with additional sources over time, especially given the continuous calls for good practices and policies by international organizations, initiatives, conferences and summits.

**FIGURE 3.**

**STRUCTURE OF TABLE 1 THAT USES BIOECONOMY THEMES TO CLASSIFY THE 250 REVIEWED SOURCES OF GOOD PRACTICES AND POLICIES (WITH HYPERLINKS TO THE RELEVANT PAGES)\***



\* the graphs show the share of sources collected in each sub-category

The sources in the three categories present a colour code indicating the level of evidence provided

Not enough evidence of impact provided    Medium level of evidence of impact provided    Enough evidence of impact provided

Source: Prepared by the authors

TABLE 1.

COMPILATION OF SOURCES OF GOOD BIOECONOMY PRACTICES AND POLICIES

(Full reference entries in pp. 91-109)

1. DISCOVERY AND DOCUMENTATION OF BIOLOGICAL PRINCIPLES FOR THE BIOECONOMY		
1.1 BASIC SCIENTIFIC RESEARCH		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Best practices in science (CASBS, 2020)</b>	The source provides good practices in science through a compilation of academic publications, news articles and online resources. ▶ <b>Source objectives:</b> To increase the validity and credibility of scientific research and to reduce the risk that scientific practices become compromised ▶ <b>Bioeconomy Strategy Objectives:</b> 13	<ul style="list-style-type: none"> <li>▶ qualitative and quantitative research are judged against standards by which they become true and trustworthy;</li> <li>▶ analyses of the robustness of results through the use of statistical tools;</li> <li>▶ repetition of the methods and protocols employed in a study to determine whether the initial findings are robust and/or generalizable</li> </ul>
<b>Scientific Integrity Principles and Best Practices: Recommendations from a Scientific Integrity Consortium (Kretser et al., 2019)</b>	The source provides good practices for instilling scientific integrity, as a mechanism for consensus to operate in a rapidly changing research environment. ▶ <b>Source objectives:</b> To foster a culture of integrity in the scientific process, including evidence-based policy ▶ <b>Bioeconomy Strategy Objectives:</b> 12,13	<ul style="list-style-type: none"> <li>▶ identify ways to strengthen the peer review process;</li> <li>▶ publish unanticipated findings that meet standards of quality and scientific integrity;</li> <li>▶ encourage reproducibility of research through transparency</li> </ul>
<b>Guidelines on Genomics Research (NVK, 2018)</b>	The document includes good practices for genomic research and mapping of the human genome. ▶ <b>Source objectives:</b> To ensure that genomics research prioritizes respect for the research participants' autonomy, safety and well-being ▶ <b>Bioeconomy Strategy Objectives:</b> 6,13	<ul style="list-style-type: none"> <li>▶ notification to the competent authority;</li> <li>▶ collaboration with external partners;</li> <li>▶ informed consent and contact to research participants;</li> <li>▶ genetic counselling</li> </ul>
<b>Best practices for analysing microbiomes (Knight et al., 2018)</b>	The article gives a review of good practices for performing a microbiome study, from microbial communities in the mammalian gastrointestinal tract to those in the soil. Practices are related to the experimental design, choice of molecular analysis technology, methods for data analysis and the integration of multiple omic datasets. ▶ <b>Source objectives:</b> To improve compatibility among data sets in marker genes and metagenomes, obtain more insight from microbiome data sets ▶ <b>Bioeconomy Strategy Objectives:</b> 2,6,13	<ul style="list-style-type: none"> <li>▶ details of the collection process should be recorded in the experimental metadata;</li> <li>▶ re-visit early experiments and potentially re-analyse the data with updated tools;</li> <li>▶ standardize to be able to compare like the international human microbiome standards;</li> <li>▶ employ best practices for standards; carry out compositional data analysis</li> </ul>
<b>Fundamental Techniques in Cell Culture Laboratory Handbook (ECACC, 2018)</b>	This handbook provides a wealth of information on cell culture for research, from the sourcing of cell lines, safety and laboratory design, to aspects of cryopreservation quality control and cell line authentication. It includes protocols for the use of induced pluripotent stem cells and for growing cells in 3D cell culture and areas of growing importance to cell culture research. ▶ <b>Source objectives:</b> To guide the use of cell cultures for life science research, including the reduction of risks of cell line misidentification and cross contamination ▶ <b>Bioeconomy Strategy Objectives:</b> 2,13	<ul style="list-style-type: none"> <li>▶ aseptic techniques in laboratories and cell-banks to avoid microbial contamination;</li> <li>▶ cryopreservation and storage of cells: quality control practices and contamination avoidance;</li> <li>▶ monitor lab environment where cell cultures are prepared;</li> <li>▶ safety cabinets, filters and other material should be checked every 6 months to ensure efficiency</li> </ul>
<b>The National Centre for Biological Sciences' Guidelines on Good Research Practice (NCBS, 2015)</b>	The document includes good research practices in the biomedical area, including on humans and other animals. It covers issues such as openness, ethical practice, intellectual property, conflicts of interest, supervision and training and publications. ▶ <b>Source objectives:</b> To ensure integrity and rigour in research ▶ <b>Bioeconomy Strategy Objectives:</b> 12,13	<ul style="list-style-type: none"> <li>▶ conduct scientific review in respect of proposals that involve human stem cells or animals;</li> <li>▶ materials and equipment should be decontaminated according to specified health and safety practices including an approved risk assessment</li> </ul>
<b>Genomic, Proteomic, and Metabolomic Data Integration Strategies (Wanichthanarak, Fahrman and Grapov, 2015)</b>	The paper provides methods and tools for the integration of metabolomic with genomic and proteomic data in order to inform the conservation and utilization of genetic resources. ▶ <b>Source objectives:</b> To improve the robust interpretation of experimental results ▶ <b>Bioeconomy Strategy Objectives:</b> 12,13	<ul style="list-style-type: none"> <li>▶ bioinformatics and analysis of big data;</li> <li>▶ biochemical pathway and empirical correlation-based methods;</li> <li>▶ biological network-based integration</li> </ul>

## 1.1 BASIC SCIENTIFIC RESEARCH

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Code of Good Scientific Practice (PRBB, 2014)</b>	<p>The source is intended to be a code of good scientific practice of the centres of the Barcelona Biomedical Research Park (PRBB). It includes good practices in recording, documentation, storage, custody, and sharing of data and biological or chemical materials arising from research, as well as other good practices in supervision, publication and scientific activities.</p> <p>► <b>Source objectives:</b> To ensure high-quality research and prevent problems of integrity</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 6,13</p>	<ul style="list-style-type: none"> <li>► monitor the working conditions of trainees and ensure that they receive appropriate health and safety training;</li> <li>► when knowledge and technology is exchanged or provided to private enterprises, public interests must be priority;</li> <li>► seek technology transfer advice to ensure that appropriate intellectual property rights agreements are negotiated in projects promoted by industry</li> </ul>
<b>Genome analysis: a laboratory manual. Vol. 4 (Green et al., 1999)</b>	<p>This report from the includes good laboratory practices to clone, manipulate, analyse, and sequence large segments of DNA, and relate sequence to phenotype variation.</p> <p>► <b>Source objectives:</b> To ensure correct techniques and methods in molecular biology research and development</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,13</p>	<ul style="list-style-type: none"> <li>► meiotic mapping in humans;</li> <li>► genetic and comparative mapping in mice;</li> <li>► identification and analysis of DNA polymorphisms;</li> <li>► DNA markers for physical mapping;</li> <li>► somatic cell genetics and radiation hybrid mapping</li> </ul>

## 1.2 APPLIED SCIENTIFIC RESEARCH

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Guidelines for BIO Members Engaging in Bioprospecting (BIO, 2020)</b>	<p>This source includes good practices to conduct of bioprospecting (i.e. the discovery and collection of genetic resources existing <i>in situ</i> or in maintained in an <i>ex situ</i> collection).</p> <p>► <b>Source objectives:</b> To raise awareness and help on risks that could arise in the conduct of bioprospecting activities</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,6,13,14</p>	<ul style="list-style-type: none"> <li>► obtain prior informed consent from the providing party to collect and use regulated genetic resources lawfully controlled or held by the providing party;</li> <li>► conduct the research on collected genetic resources in the territory of the contracting party from which such resources have been collected</li> </ul>
<b>Best practice in research – Overcoming common challenges in phyto-pharmacological research (Heinrich et al., 2020)</b>	<p>The source presents good research practices in pharmacology, toxicology and pharmacokinetics of bioactive preparations, extracts and natural products. It includes elements for design, the methods used and reporting practices.</p> <p>► <b>Source objectives:</b> To provide a common view on what constitutes good pharmacological research on bioactive preparations derived from natural sources</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,3,5,13</p>	<ul style="list-style-type: none"> <li>► justify the use of animals (including insects) or other organisms (bacteria) in the context of novelty of the research;</li> <li>► consider the relevance of <i>in vitro</i> or <i>in silico</i> models for different research questions;</li> <li>► when using animals, use 3Rs (refinement, reduction and replace) to diminish the number of animals needed in animal experimentation and improve animal welfare</li> </ul>
<b>Digitalisation in the bioeconomy: Convergence for the bio-based industries (OECD, 2020a)</b>	<p>This source provides good practices to apply converging technologies and digitalization in the bioeconomy.</p> <p>► <b>Source objectives:</b> To digitalize the activities of the bioeconomy and bio-based industrial processes</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 5,6,10</p>	<ul style="list-style-type: none"> <li>► integrate engineering design with biotechnology to unlock commercial potential;</li> <li>► use automation in synthetic biology to address test-phase obstacles;</li> <li>► use blockchain for benefit sharing and protecting sensitive information: develop cell-free synthetic biology;</li> <li>► use augmented reality for smart manufacturing</li> </ul>
<b>Role and management of soil biodiversity for food security and nutrition; where do we stand? (El Mujtar et al., 2019)</b>	<p>This paper describes state-of-the-art practices to analyse the relations between agricultural management, soil biodiversity and food production.</p> <p>► <b>Source objectives:</b> To increase evidence on the impact of soil biodiversity on food security and nutrition</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,13</p>	<ul style="list-style-type: none"> <li>► use biotechnological methods to analyse the impacts of agricultural practices on taxonomic and functional diversity of soil organisms;</li> <li>► conduct studies of soil-plant interactions that co-regulate plant growth and defences, or affect food nutritional quality and safety</li> </ul>
<b>A Practical Guide to Bio-inspired Design (Hashemi Farzaneh, 2019)</b>	<p>The source covers good practices in planning a bio-inspired design project, abstraction, search, analysis and comparison, and transfer of analogies in innovative product development. In addition, ten examples show how to apply bio-inspired design, also called biomimicry.</p> <p>► <b>Source objectives:</b> To explain the application of bio-inspired design in the development of innovative technical products</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,6,13</p>	<ul style="list-style-type: none"> <li>► use bio-inspired procedures for developing hypotheses and for data collection;</li> <li>► flow-oriented modelling;</li> <li>► search in catalogues of biological principles;</li> <li>► formulation of different analogy types</li> </ul>

## 1.2 APPLIED SCIENTIFIC RESEARCH

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Manual on Mutation Breeding - Third edition (FAO and IAEA, 2018)</b>	The source includes good practices for crop improvement using induced mutation and mutation breeding techniques. ▶ <b>Source objectives:</b> To underpin 'green' sustainable food production for safeguarding food security and meeting environmental challenges caused by climate change, such as resistance to pest and diseases and tolerance to abiotic stresses ▶ <b>Bioeconomy Strategy Objectives:</b> 1,4	<ul style="list-style-type: none"> <li>▶ to combine several major resistance genes into new cultivars in order to achieve broad resistance;</li> <li>▶ genomic selection, which uses comprehensive marker information to calculate breeding values for complex crops traits;</li> <li>▶ X- and gamma- rays are the safest radiation types for inducing mutation in tissue culture, as compared to chemical mutagens</li> </ul>
<b>Innovation and exploration through cutting-edge microbiome research (EC, 2017a)</b>	The publication presents good practices in the development of innovations using the microbiome research. Unravelling the microbiome complexity offers opportunities for innovation, since the microbiome has essential impacts on food production and the human health. ▶ <b>Source objectives:</b> To show the potential that the microbiome offers for a food and nutrition revolution, including the way the resources are managed ▶ <b>Bioeconomy Strategy Objectives:</b> 1,5,13	<ul style="list-style-type: none"> <li>▶ increasing knowledge on symbiont-host interactions facilitates the future development and use of environmentally friendly insect control solutions;</li> <li>▶ using metagenomic DNA sequencing and bioinformatic pipelines to analyse the presence of bacteria and drug-resistant genes in wastewater and its uses for irrigation</li> </ul>
<b>Emerging Policy Issues in Synthetic Biology (OECD, 2014a)</b>	The source provides an overview of synthetic biology practices in different sectors and surrounding policy issues. ▶ <b>Source objectives:</b> To develop synthetic biology applications in a way that contribute to address society challenges ▶ <b>Bioeconomy Strategy Objectives:</b> 2,6	<ul style="list-style-type: none"> <li>▶ bioremediation;</li> <li>▶ environmental sensing;</li> <li>▶ pharmacogenomics and personalized medicine;</li> <li>▶ agricultural applications;</li> <li>▶ biological noise control;</li> <li>▶ DNA sequencing;</li> <li>▶ protection of databases</li> </ul>
<b>Proteomic and Metabolomic Approaches to Biomarker Discovery (Issaq and Veenstra, 2019)</b>	The book presents standard operating procedures in discovery of biomarkers for disease diagnosis, selection of treatment regimens, and therapeutic monitoring. It covers good practices for sample selection, preparation, and storage, as well as data analysis and modeling. ▶ <b>Source objectives:</b> To leverage biomarkers to improve accuracy and reduce errors in research ▶ <b>Bioeconomy Strategy Objectives:</b> 13	<ul style="list-style-type: none"> <li>▶ proteomic and mass spectrometry technologies for biomarker discovery;</li> <li>▶ tissue sample preparation for proteomic analysis;</li> <li>▶ serum and plasma collection;</li> <li>▶ affinity targeting schemes for biomarker research;</li> <li>▶ protein and metabolite identification</li> </ul>
<b>General Guidelines and Quality Assurance for Cytogenetics (Hastings <i>et al.</i>, 2012)</b>	The source provides a framework for quality assessment of constitutional, acquired and molecular cytogenetic investigations. ▶ <b>Source objectives:</b> To assist in the development of national standards and regulations for cytogenetic practices and reduce differences throughout Europe ▶ <b>Bioeconomy Strategy Objectives:</b> 12,13	<ul style="list-style-type: none"> <li>▶ fluorescence <i>in-situ</i> hybridization;</li> <li>▶ microarray;</li> <li>▶ clinical records and storage;</li> <li>▶ data protection and confidentiality</li> </ul>

## 2. APPLICATIONS OF KNOWLEDGE, SCIENCE, TECHNOLOGY AND INNOVATION IN THE VALUE CHAIN

## 2.1 PRODUCTION OF BIOLOGICAL RESOURCES

## 2.1.1 PRODUCTION OF BIOLOGICAL MATERIALS (CELL AND MICROORGANISM CULTURES)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Biosafety and biosecurity in Synthetic Biology: A review (Gómez-Tatay and Hernández-Andreu, 2019)</a>	<p>The source includes biosafety and biosecurity measures.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To prevent risks to public health and the environment</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ physical biocontainment measures (engineering design of equipment, process and production plants) and biological biocontainment means, such as inducible systems, auxotrophy and cellular circuits;</li> <li>▶ establishment of decision-making authorities</li> </ul>
<a href="#">WHO Good Manufacturing Practices for Biological Products. Annex 3, Technical Report Series No. 996 (WHO, 2016a)</a>	<p>The source presents science and technology practices in the manufacturing, control and testing of biological products, including the use of animals. Biological products include antigens, vaccines, blood products, hormones, enzymes, animal immune sera, tissue therapies, biopharmaceutical products, and any other product derived from cells, tissues or microorganisms. Manufacturing procedures include growth of strains of microorganisms and eukaryotic cells; the extraction of substances from biological tissues; including human, animal and plant tissues, and fungi; recombinant DNA (rDNA) techniques; hybridoma techniques; propagation of microorganisms in embryos or animals. The manufactured biological products are produced to be used either as starting materials and preparations (including seed lots, cell banks and intermediates) or as the finished product.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To maintain consistency in biological medicinal product quality, minimizing the variability characteristic of living materials and their active substances and reduce the risk of contamination and cross-contamination in the manufacturing, control and testing of biological products</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,13,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ incoming starting materials should be sampled to prevent contamination and cross-contamination;</li> <li>▶ care should be taken to prevent and monitor infections in source/donor animals;</li> <li>▶ animals, biological agents and tests carried out should be appropriately identified to prevent any risk of mix-up and to control all identified hazards</li> </ul>
<a href="#">Best Practices for the Pilot-Scale Cultivation of Microalgae (White et al., 2015)</a>	<p>The report covers good practices for setting a pilot plant for microalgae cultivation including strain selection, preparation, maintenance and automation of production systems, nutrient sources and addition; harvesting microalgae biomass; and biomass valorization. It also includes links to detailed protocols, techniques and methodologies.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To describe recommendations for pilot-scale microalgae culture, harvesting and processing</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13</li> </ul>	<ul style="list-style-type: none"> <li>▶ selecting and maintaining microalgae and cyanobacteria for cultivation; preparation and inoculation of pilot systems;</li> <li>▶ monitoring and automation of control parameters during culturing;</li> <li>▶ harvesting by centrifugation, flotation, filtration, sedimentation and flocculation</li> </ul>
<a href="#">Production and validation of a good manufacturing practice grade human fibroblast line for supporting human embryonic stem cell derivation and culture (Prathalingam et al., 2012)</a>	<p>The source presents good manufacturing practices of clinical-grade human embryonic stem cells, which are further used in regenerative medicine for cellular therapies and cell transplantation treatments in many severe diseases.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure optimization and safety in the process of manufacturing human embryonic stem cells used for cellular therapies and cell transplantation</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ use culture media free of animal products for immunogenic and pathogenic considerations;</li> <li>▶ carry out biosafety tests;</li> <li>▶ document the chain of custody of the material sent to laboratories;</li> <li>▶ design a quality management system (QMS) for the biomanufacturing facility, including standard operating procedures (SOPs) and record forms to cover all procedures and equipment used in this cell line-production process</li> </ul>



2.1 PRODUCTION OF BIOLOGICAL RESOURCES		
2.1.2 LAND AND WATER MANAGEMENT		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Good Practices of the International Land Coalition (LC, 2020)</b>	<p>The source is a database of good practices that includes concrete solutions to land and water tenure issues. Case studies include practices implemented to overcome specific challenges.</p> <p>► <b>Source objectives:</b> To achieve 10 commitments for people-centered land governance, which includes diverse tenure rights and locally managed ecosystems</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 8</p>	<ul style="list-style-type: none"> <li>► conduct training to water users' associations for irrigation;</li> <li>► use traditional systems such as 'Sasi' for natural resource conservation and management</li> </ul>
<b>Healthy soils to cool the planet. A Philanthropic Action Guide (Taylor, 2019)</b>	<p>This guidance document focuses on good agricultural practices that build and restore healthy soils for soil carbon sequestration. It also presents other 'game-changers', including practices for composting, peatlands management, ecological restoration and green infrastructure as well as irrigated rice and some financial incentives. The document also includes a list of good policy practices on page 10 including farm waste management regulations, carbon pricing revenues, tax policy, zoning of land, investment incentives. This document is recommended by the 4x1000 initiative.</p> <p>► <b>Source objectives:</b> To promote healthy soils that improve carbon sequestration</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,4</p>	<ul style="list-style-type: none"> <li>► keep the soil covered;</li> <li>► diversify the biology of the soil through natural inputs;</li> <li>► prioritize deep rooted and perennial crops to enhance soil carbon retention; limit the use of synthetic fertilizers, pesticides and herbicides;</li> <li>► maintain living root systems to support underground fungi and soil microbes</li> </ul>
<b>Land Management Practices for Carbon Dioxide Removal and Reliable Sequestration (The National Academies of Sciences, Engineering, and Medicine 2018)</b>	<p>The document presents land management practices for carbon dioxide removal, which includes uptake and storage. This publication also summarizes the state of knowledge on policies and incentives on soil carbon sequestration and forest carbon storage activities. It chronicles the presentations and discussions from workshops.</p> <p>► <b>Source objectives:</b> To remove and sequester carbon from the atmosphere</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,4</p>	<ul style="list-style-type: none"> <li>► reforestation, afforestation, reducing deforestation;</li> <li>► improved forest management; application of biochar (charcoal made from organic matter) to the soil;</li> <li>► reducing forage consumption by grazing;</li> <li>► employing practices that improve soil health</li> </ul>
<b>The Voluntary Guidelines for Sustainable Soil Management (FAO, 2017)</b>	<p>The document includes principles and practices for sustainable soil management that are to be applied on a context-specific basis. However, the document does not provide detailed recommendations. The guidelines were endorsed by FAO Council in 2016 and include generally accepted, practically proven and scientifically based principles and their corresponding practices.</p> <p>► <b>Source objectives:</b> To improve soil quality to address different soil threats (degradation, erosion, contamination, salinization or alkalization, sealing and compaction)</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► irrigation with drippers or microsprinklers;</li> <li>► monitoring of soil moisture or loss of water via evapotranspiration;</li> <li>► increase soil organic matter and soil water contents;</li> <li>► improve and protect soil biodiversity;</li> <li>► foster soil nutrient balance and cycles</li> </ul>
<b>Best Practices Guidelines for Managing Water in Bioenergy Feedstock Production (IEA, 2015)</b>	<p>The document includes water management practices that can contribute to ensure sustainable biomass production systems and prevent environmental degradation. It also references other compilations of good practices (e.g., FAO, United States Environmental Protection Agency, United States Department of Agriculture Natural Resources Conservation Service, and scientific journals).</p> <p>► <b>Source objectives:</b> To maintain water quality, protect water resources and control erosion and sedimentation</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► streamside management zones to buffer the potential adverse effects of agricultural and silvicultural practices on adjacent surface water quality;</li> <li>► consider all the factors that may affect the watershed when planning aquatic ecosystem projects in streams, lakes, riparian areas and wetlands</li> </ul>
<b>Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests (FAO, 2012a)</b>	<p>The guidelines include requirements that countries, implementing agencies, organizations of farmers and other stakeholders are encouraged to implement. It is an internationally accepted standard for responsible practices. The Guidelines were endorsed by the Committee on World Food Security at its Thirty-eighth (Special) Session on 11 May 2012.</p> <p>► <b>Source objectives:</b> To improve governance of tenure of land, fisheries and forests</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 8</p>	<ul style="list-style-type: none"> <li>► apply environmental safeguards;</li> <li>► land consolidation and land banks;</li> <li>► use hold good faith consultation with indigenous peoples before initiating any activity affecting the resources for which they hold rights</li> </ul>



2.1 PRODUCTION OF BIOLOGICAL RESOURCES		
2.1.2 LAND AND WATER MANAGEMENT		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Coping with water scarcity. An action framework for agriculture and food security (FAO, 2012b)</a>	The source includes good practices to respond to water scarcity. ▶ <b>Source objectives:</b> To reduce pressure on water resources ▶ <b>Bioeconomy Strategy Objectives:</b> 3	<ul style="list-style-type: none"> <li>▶ macro-economic water accounting; reduce water losses;</li> <li>▶ improve crop water productivity;</li> <li>▶ reducing losses in the food chain;</li> <li>▶ assess the full range of benefits and costs;</li> <li>▶ use systematic and comprehensive decision criteria</li> </ul>
<a href="#">Sustainable land management in practice (Liniger et al., 2011)</a>	The document includes good practices for sustainable land management in field applications for sub-Saharan Africa. These guidelines build on the World Overview of Conservation Approaches and Technologies (WOCAT) standardized methodology. ▶ <b>Source objectives:</b> To increase land productivity (water, soil, plants and micro-climate); improve livelihoods (costs and benefits, input challenges for land users); and improve ecosystems (prevent and mitigate land degradation and rehabilitate degraded lands, improve biodiversity) ▶ <b>Bioeconomy Strategy Objectives:</b> 3	<ul style="list-style-type: none"> <li>▶ semi-circular bunds;</li> <li>▶ cross-slop barriers;</li> <li>▶ agroforestry;</li> <li>▶ vegetative strips;</li> <li>▶ rainwater harvesting;</li> <li>▶ green manuring;</li> <li>▶ rotations including legumes</li> </ul>
<a href="#">Best Practices for Terrestrial Sequestration of Carbon Dioxide (National Energy Technology Laboratory, 2010)</a>	The source summarizes good soil management practices that can maximize carbon storage in vegetation and soil. ▶ <b>Source objectives:</b> To build and restore healthy soils to increase carbon sequestration ▶ <b>Bioeconomy Strategy Objectives:</b> 3,4	<ul style="list-style-type: none"> <li>▶ reclamation of mine lands;</li> <li>▶ forest management such as reforestation;</li> <li>▶ grasslands and rangelands management such as controlled grazing;</li> <li>▶ agricultural lands practices such as no-till farming;</li> <li>▶ management of arid soils;</li> <li>▶ restoration of wetlands</li> </ul>
<a href="#">WHO Guidelines for the safe use of wastewater, excreta and greywater (WHO, 2006)</a>	The source provides good practices for health protection in the use of wastewater in volume II 'Wastewater use in agriculture' and volume III 'Wastewater and excreta use in aquaculture'. ▶ <b>Source objectives:</b> To protect public health ▶ <b>Bioeconomy Strategy Objectives:</b> 3,15	<ul style="list-style-type: none"> <li>▶ wastewater application techniques such as localized irrigation and cessation of irrigation;</li> <li>▶ pathogen die-off before consumption; wastewater treatment with low-rate biological systems;</li> <li>▶ quantitative microbial risk analysis;</li> <li>▶ assessing the risks from chemical contaminants</li> </ul>

2.1 PRODUCTION OF BIOLOGICAL RESOURCES		
2.1.3 CROP, MEDICINAL PLANTS, LIVESTOCK, INSECT, FISH AND FORESTRY PRODUCTION		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Good practices in promoting decent rural employment (FAO, 2020c)</a>	The source includes good practices from around the world that contribute to improving the availability and/or quality of rural jobs, particularly in agriculture. ▶ <b>Source objectives:</b> To have a positive effect on employment issues among target beneficiaries; ensure the sustainability of these positive effects; and support the replication of these effects by other organizations in other contexts for the benefit of other groups ▶ <b>Bioeconomy Strategy Objectives:</b> 7	<ul style="list-style-type: none"> <li>▶ a dual-track approach to address water scarcity composed by 'cash transfer' to cistern owners to participate in the construction/rehabilitation of their own structures;</li> <li>▶ training to local farming households and agronomists on good agricultural and water management practices</li> </ul>
<a href="#">e-Agriculture good and promising practices (FAO, 2020d)</a>	The source presents good practices on the use of information and communications technologies (ICTs) for agriculture, collected by the e-Agriculture Community of Practice and its partners through an experience capitalization approach. It uses FAO methodology (described in Chapter 3). ▶ <b>Source objectives:</b> To strengthen the use of digital technologies in agriculture ▶ <b>Bioeconomy Strategy Objectives:</b> 7,11,13	<ul style="list-style-type: none"> <li>▶ remote sensing;</li> <li>▶ digital communication model for social behavior change;</li> <li>▶ drones for community monitoring of forests</li> </ul>
<a href="#">Sustainable Forest Management Toolbox Technical modules (FAO, 2020e)</a>	The source is a database of Sustainable Forest Management (SFM) good practices. ▶ <b>Source objectives:</b> To maintain and enhance the multiple values of forests through human interventions ▶ <b>Bioeconomy Strategy Objectives:</b> 3	<ul style="list-style-type: none"> <li>▶ forest restoration and rehabilitation;</li> <li>▶ integrated pest management;</li> <li>▶ silviculture in natural forests;</li> <li>▶ mangrove ecosystem restoration and management;</li> <li>▶ management of non-wood forest products (e.g. medicinal plants, wild game, insects, rubber, gums, resins, chemicals)</li> </ul>

2.1 PRODUCTION OF BIOLOGICAL RESOURCES		
2.1.3 CROP, MEDICINAL PLANTS, LIVESTOCK, INSECT, FISH AND FORESTRY PRODUCTION		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>Technical Guidelines for the implementation of the International Code of Conduct on Pesticide management (FAO and WHO, 2020)</b></p>	<p>The source provides guidelines for different aspects for the implementation of the Code of Conduct on Pesticide management and the associated environment and social standard. These aspects are legislation, policy, registration, compliance and enforcement, distribution and sales, use of pesticides, application equipment, prevention and disposal of obsolete stocks, surveillance and monitoring and observance. Relevant guidelines include the guidelines for the registration of microbial, botanical and semi-chemical pest control agents for plant protection and public health uses, and, regarding the use of pesticides; the guidelines on good practice for aerial and ground application of pesticides, which are used by standards and certification schemes for biomaterials; and the 2020 guidelines for personal protection when handling and applying pesticides.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support countries in the implementation of the Code of Conduct on Pesticide management in order to reduce risks related to pesticides and harmonize practices worldwide</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,4,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ while many biopesticides can be used without personal protective equipment, a minimum equipment such as gloves and eye covers should be used;</li> <li>▶ immuno-suppressed personnel should avoid application of microbial pesticides;</li> <li>▶ users should follow label directions with the understanding that all chemical pesticides are toxic and avoiding contact or contamination of self, others and the environment</li> </ul>
<p><b>Guide on Good Hygiene Practices for European Union (EU) producers of insect as food and feed (IPIFF, 2020)</b></p>	<p>This document prepared by the International Platform of Insects for Food and Feed (IPIFF) focuses on good practices in the production of insects destined for human consumption, (e.g. whole insects and processed insect meals), including when incorporated into processed products, or parts of insects and their derived products. It also covers the production of insects as feed for food producing animals, including terrestrial livestock (e.g. poultry and pig species) or farmed fish, as well as feed for pet food animals.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To help insect producers for food and/or animal feed to achieve a high level of consumer protection and animal health through the production of safe food and feed</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 1,2,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ Control of overall growing environment;</li> <li>▶ biosafety;</li> <li>▶ harvesting practices;</li> <li>▶ killing and post killing practices; storage, packaging, labelling and transport practices;</li> <li>▶ Hazard Analysis and Critical Control Points (HACCP) implementation</li> </ul>
<p><b>International instruments on the use of antimicrobials across the human, animal and plant sectors (WHO, FAO and OIE, 2020a)</b></p>	<p>The document provides a comprehensive list of existing international instruments that provide standards related to the use of antimicrobials. It covers practices in human, animal and plant sectors across the antimicrobial life cycle. It also highlights exiting gaps pretraining circular bioeconomy. For instance, no guidance exists for the disposal of antimicrobials specifically.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> to guide both the implementation of existing instruments and to inform discussions and direction for future</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 15</li> </ul>	<ul style="list-style-type: none"> <li>▶ marketing approval procedures that define for which indication the antibiotic should be used and how to label medicines that come to the market;</li> <li>▶ treatment guidelines that provide evidence-based recommendations on the treatment of certain syndromes;</li> <li>▶ guidelines for manufacturers and inspectors that cover environmental aspects of manufacturing for the prevention of antimicrobial resistance</li> </ul>
<p><b>The International Code of Conduct for the sustainable use and management of fertilizers (FAO, 2019a)</b></p>	<p>Endorsed by the FAO Conference in its 41st session, the document provides a voluntary set of practices in the use and management of fertilizers that contribute to sustainable agriculture and food security from a nutrient management perspective.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> <ul style="list-style-type: none"> <li>▶ enhancement of global food production and food security;</li> <li>▶ preservation of fundamental ecosystem services</li> <li>▶ maximization of economic and environmental benefits;</li> <li>▶ reduction of negative impact of excess nutrients in ground and surface waters;</li> <li>▶ minimization of negative effects and potential toxicity of contaminants in fertilizers;</li> <li>▶ improvement of food safety, diets, nutritional quality and human health</li> </ul> </li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,9,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ correct and/or manage soil conditions that prevent crop response to plant nutrient additions or limit nutrient cycling;</li> <li>▶ promote nutrient recycling and the use of reused and recycled materials for application to soil</li> </ul>

## 2.1 PRODUCTION OF BIOLOGICAL RESOURCES

## 2.1.3 CROP, MEDICINAL PLANTS, LIVESTOCK, INSECT, FISH AND FORESTRY PRODUCTION

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Fourth International Symposium on Biological Control of Bacterial Plant Diseases – Abstracts (FAO, 2019b)</b>	<p>The document presents good practices for the sustainable control of plant pathogens. It covers the latest research results and developments in the biocontrol of bacterial plant diseases, including interactions between plants and microbiomes and use of genetics and genomics for innovative control practices.</p> <p>► <b>Source objectives:</b> To increase productivity, protect biodiversity and reduce pollution</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,3</p>	<ul style="list-style-type: none"> <li>► use of biopesticides and other biological control mechanisms for weeds;</li> <li>► evaluation of tannins respect to their biostimulant and antibacterial activity on tomato plants;</li> <li>► grafting and bacteriophage application to control bacterial wilt</li> </ul>
<b>Aquaculture development. Recommendations for prudent and responsible use of veterinary medicines in aquaculture (FAO, 2019c)</b>	<p>This guide includes good practices on the prudent and responsible use of veterinary medicines (antimicrobials and other chemotherapeutants) in aquaculture production, for government agencies, private-sector aquaculture producers and aquatic animal health professionals.</p> <p>► <b>Source objectives:</b> To support the implementation of the FAO Code of Conduct for Responsible Fisheries (CCRF), the FAO Action Plan on Antimicrobial Resistance 2016–2020, the Organisation for Animal Health (OIE) international aquatic animal health standards, the food safety standards of the FAO/WHO Codex Alimentarius and the One Health platform under the FAO/OIE/WHO Tripartite Collaboration on antimicrobial resistance</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,15</p>	<ul style="list-style-type: none"> <li>► monitoring of antimicrobial resistance;</li> <li>► tracking of antimicrobial usage;</li> <li>► assessing risk in different settings;</li> <li>► evaluating strategies to reduce antimicrobial resistance and maintain efficacy of antimicrobials</li> </ul>
<b>Tackling antimicrobial use and resistance in pig production: lessons learned from Denmark (FAO and Denmark Ministry of Environment and Food – Danish Veterinary and Food Administration, 2019)</b>	<p>This publication describes good practices to tackle the use of antimicrobials (specifically antibiotics) in the Danish swine sector through collaboration between stakeholders. Pig and poultry are the sectors that generally have the highest use of antibiotics.</p> <p>► <b>Source objectives:</b> To reduce the increasing number of deaths accompanied by rising costs in healthcare caused by antimicrobial resistance in human pathogens</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 15</p>	<ul style="list-style-type: none"> <li>► conduct a close surveillance of the use of antimicrobials at the farm level to provide a detailed understanding of antimicrobial usage;</li> <li>► make data on antimicrobial use and resistance in both animals and humans publicly available;</li> <li>► terminate growth promoters;</li> <li>► monitor antimicrobial resistance in zoonotic enteric pathogens isolated from food animals, meat and humans, as well as in commensal bacteria (e.g. <i>Escherichia coli</i>) from the intestinal tract of food animals and from meat samples using whole genome sequencing</li> </ul>
<b>Magic D4.1 Low-input agricultural practices for industrial crops on marginal land (Von Cossel <i>et al.</i>, 2019)</b>	<p>This deliverable of the MAGIC (Marginal Lands for Growing Industrial Crops) project presents a list of agricultural practices to meet specific land and climate constraints. The good practices in the source focus on low-input farms, organic farms and high nature value farms.</p> <p>► <b>Source objectives:</b> To achieve high productivity through low-input agriculture, while minimizing environmental impacts on marginal lands and avoiding land-use competition with food production</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,3,7,9</p>	<ul style="list-style-type: none"> <li>► no till;</li> <li>► cover soil with film;</li> <li>► thermal weeding;</li> <li>► bio-stimulators for priming of seeds or planting material;</li> <li>► biological pest control;</li> <li>► injection of fertilizer;</li> <li>► crop rotation for pest management;</li> <li>► micro-irrigation (drip irrigation);</li> <li>► terracing;</li> <li>► agroforestry</li> </ul>
<b>Good Practice Guidelines (GPGs) on National Seafood Traceability Systems (FAO, 2018b)</b>	<p>The document provides good practices in seafood traceability.</p> <p>► <b>Source objectives:</b> To prevent illegal, unreported and unregulated fish from entering supply chains</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 11</p>	<ul style="list-style-type: none"> <li>► develop a regulatory framework for illegal, unreported and unregulated fishing;</li> <li>► fleet management practices;</li> <li>► vessel monitoring systems;</li> <li>► set up and manage a catch documentation scheme;</li> <li>► verify the legality of the catch and implement fish accountability</li> </ul>

2.1 PRODUCTION OF BIOLOGICAL RESOURCES		
2.1.3 CROP, MEDICINAL PLANTS, LIVESTOCK, INSECT, FISH AND FORESTRY PRODUCTION		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Making forest concessions in the tropics work to achieve the 2030 Agenda: Voluntary Guidelines (FAO and EFI, 2018)</a>	<p>The publication includes good forest management practices that are implemented in line with concession investments in independent forest certification schemes. These good practices are also often included in guidelines for sustainable forest management prepared by the government.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> The forest concessions should meet eight principles for the sustainable management of public forests and specific recommendations for different stakeholders</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 11</li> </ul>	<ul style="list-style-type: none"> <li>▶ a minimum number of large trees are left for natural regeneration;</li> <li>▶ the annual allowable cut is respected;</li> <li>▶ the maximum number and volume of trees by species or group of species that can be harvested is calculated</li> </ul>
<a href="#">Emerging Opportunities for Synthetic Biology in Agriculture (Goold, Wright and Hailstones, 2018)</a>	<p>The source provides an overview of synthetic biology applications in agriculture.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To deliver transformative changes to agriculture, specifically to increase productivity and sustainability across primary industries</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 1,3,13</li> </ul>	<ul style="list-style-type: none"> <li>▶ biosynthesis of high value plant metabolites in microorganisms; biosensors;</li> <li>▶ gene drives and gene editing;</li> <li>▶ synthetic genomics</li> </ul>
<a href="#">Good Practices: Marginal lands for Growing Industrial Crops (MAGIC D7.1) (Panoutsou, Singh, and Christensen, 2018)</a>	<p>This deliverable of the MAGIC (Marginal Lands for Growing Industrial Crops) project describe good practices for rehabilitating marginal lands with industrial crops (e.g. switchgrass, giant reed, sunflower, cardoon, poplar, miscanthus and napier grass) and developing value chains. The source covers technical innovations and environmental innovations. It also includes socio-economic innovations and financial support mechanisms.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support innovation across the value chain: the efficient use of resources; sustainable and improved ecosystem services; the smooth operation of businesses and markets; and job creation</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,7,9,11,13</li> </ul>	<ul style="list-style-type: none"> <li>▶ land improvement by soil amendments, soil cover, drainage management, or contour tree lines;</li> <li>▶ erosion prevention practices;</li> <li>▶ nitrogen loss prevention;</li> <li>▶ apply water use efficiency technologies</li> </ul>
<a href="#">Good practice note: Improving animal welfare in livestock operations (Mousseau et al., 2014)</a>	<p>This World Bank Group publication covers good management practices in animal welfare in commercial livestock operations (dairy, beef, broiler chickens, layer chickens, pigs, and ducks) and aquaculture in intensive and extensive systems.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To reduce losses, increase productivity, and/or access to new markets (high quality and value market segments), with a responsible and forward-looking approach to traditional livestock production</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 11,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ allow all animals space to stand, stretch, turn around, sit, and/or lie down comfortably;</li> <li>▶ prevent overheating and excessive cooling;</li> <li>▶ minimize distance animals are transported;</li> <li>▶ select breeds for good health and suitability for both the environment/ climate and the system in which they are bred;</li> <li>▶ sick or injured animals should be treated or cared for as soon as possible</li> </ul>
<a href="#">Good Agricultural Practices for greenhouse vegetable crops: Principles for Mediterranean climate areas (FAO, 2013b)</a>	<p>This guidebook illustrates good practices in integrated greenhouse vegetable production and protection.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To promote sustainable agricultural intensification in line with the FAO 'Save and Grow' paradigm and to strengthen farming resilience to socio-economic and climate risks</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,3,4</li> </ul>	<ul style="list-style-type: none"> <li>▶ greenhouse climate control and energy use;</li> <li>▶ micro-irrigation;</li> <li>▶ soil fertility and plant nutrition;</li> <li>▶ integrated pest management to minimize the use of pesticides while reducing pests and diseases incidence in crops;</li> <li>▶ traceability and product labelling</li> </ul>
<a href="#">Good Environmental Practices in Bioenergy Feedstock Production (FAO, 2012c)</a>	<p>The document is a compilation and description of sustainable agricultural management and forestry practices that can be implemented by bioenergy feedstock producers to minimize the risk of negative environmental impacts from their operations.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> <ul style="list-style-type: none"> <li>▶ reduce potential competition with food production through increased productivity and income, greater availability of inputs and improved access to energy;</li> <li>▶ ensure that modern bioenergy delivers on its climate change mitigation potential; and</li> <li>▶ minimize the impacts on biodiversity and agrobiodiversity, and ecosystems (soil quality, and water availability and quality)</li> </ul> </li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,3,4</li> </ul>	<ul style="list-style-type: none"> <li>▶ precision agriculture;</li> <li>▶ soil cover;</li> <li>▶ integrated plant nutrient management;</li> <li>▶ pollination management;</li> <li>▶ rehabilitation of degraded lands</li> </ul>

## 2.1 PRODUCTION OF BIOLOGICAL RESOURCES

## 2.1.3 CROP, MEDICINAL PLANTS, LIVESTOCK, INSECT, FISH AND FORESTRY PRODUCTION

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Biotechnologies for Agricultural Development (FAO, 2011a)</b>	<p>The source covers good practices in biotechnology application in crop, forest, livestock, aquaculture and fisheries production and in food processing and food safety.</p> <p>► <b>Source objectives:</b></p> <ul style="list-style-type: none"> <li>► To alleviate hunger and poverty;</li> <li>► assist in adapting to climate change and maintaining the natural resource base</li> </ul> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,3,4</p>	<ul style="list-style-type: none"> <li>► creation of new genetic variation of plants with tissue culture, mutagenesis, interspecific hybridization;</li> <li>► bioinformatics;</li> <li>► sterile insect technique;</li> <li>► recombinant vaccines for animal health;</li> <li>► genome sequencing;</li> <li>► cryopreservation;</li> <li>► advanced forest biotechnologies; control in food fermentation processing;</li> <li>► detection and identification of pathogens and mycotoxins;</li> <li>► starter cultures as inoculants of fermentation processes;</li> <li>► control in food fermentation processing;</li> <li>► advances in microbial genetics</li> </ul>
<b>Guide to Good Farming Practices for Animal Production Food Safety (FAO and OIE, 2010)</b>	<p>The good practices presented in this report by FAO and the World Organisation for Animal Health (OIE) are intended to help competent authorities, particularly veterinary services, to assist stakeholders, including farmers, to develop animal production activities in a safe and responsible way. Good practices refer to general farm management, animal health management, veterinary medicines and biologicals, animal feeding and watering, and animal and product handling.</p> <p>► <b>Source objectives:</b> To address hazards and prevent diseases in animal production</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,8,15</p>	<ul style="list-style-type: none"> <li>► ensure that facilities and equipment are properly designed and maintained to prevent physical injury;</li> <li>► keep all treated animals on the farm until the relevant withdrawal times have expired;</li> <li>► maintain adequate separation</li> </ul>
<b>Code of practice to minimize and contain antimicrobial resistance (CAC, 2005)</b>	<p>This Codex Alimentarius Code of Practice is an international guidance document for producing, handling, using and regulating antimicrobials in food-producing animals.</p> <p>► <b>Source objectives:</b> To limit the spread of anti-microbial resistant microorganisms among animals to protect the health of consumers</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,15</p>	<ul style="list-style-type: none"> <li>► establish ADIs (acceptable daily intake), MRLs (maximum residue limit), and withdrawal periods for veterinary antimicrobial drugs;</li> <li>► request veterinary pharmaceutical industry to supply all of the information on the quality, safety and efficacy of drugs;</li> <li>► implement a health plan in cooperation with the veterinarian in charge of the animals that outlines preventative measures</li> </ul>
<b>WHO guidelines on good agricultural and collection practices for medicinal plants (WHO, 2003)</b>	<p>The source covers good practices for the appropriate cultivation and collection of medicinal plants and the recording and documentation of necessary data and information during their processing.</p> <p>► <b>Source objectives:</b> To ensure quality of herbal medicines in order to reduce risks of adverse impacts</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,15</p>	<ul style="list-style-type: none"> <li>► cultivate species that are registered in the national pharmacopoeia;</li> <li>► implement appropriate rotation plants selected according to environmental suitability;</li> <li>► avoid mechanical damage or compacting since it can lead to composting and lower the quality of the product</li> </ul>
<b>WHO Global Principles for the Containment of Antimicrobial Resistance in Animals Intended for Food (WHO, 2000)</b>	<p>The document covers good practices for the prudent use of antimicrobials, the surveillance of antimicrobial resistance and antimicrobial usage, prophylactic use of antimicrobials, and education, training and research.</p> <p>► <b>Source objectives:</b> To minimize the negative public health impact of the use of antimicrobial agents in food-producing animals while providing for their safe and effective use in veterinary medicine</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,15</p>	<ul style="list-style-type: none"> <li>► keep a health record for each treated animal or group of animals to support the choice of empirical therapy;</li> <li>► base decisions regarding registration of antimicrobials on scientific data;</li> <li>► supply antimicrobials only through authorized outlets, such as pharmacies on veterinary prescription, veterinary practices and feed mills</li> </ul>

2.1 PRODUCTION OF BIOLOGICAL RESOURCES		
2.1.4 URBAN AND PERI-URBAN AGRI-FOOD SYSTEMS		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Unlocking new value from urban biowaste (VALUEWASTE, 2020)</b>	<p>The VALUEWASTE project develops and promotes municipal biowaste management systems that give a second life to materials or resources contained in the biowaste.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To recover products with a market value that offsets the global cost of biowaste</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ grow insects in digestate from urban bio-waste treatment for the production of proteins for feed products;</li> <li>▶ produce microbial protein for food using methane resulting from urban bio-waste treatment;</li> <li>▶ recover nitrogen and phosphorus from urban bio-waste for use in agricultural fertilizer production</li> </ul>
<b>Cities and circular economy for food (Ellen MacArthur Foundation, 2019)</b>	<p>The report gives examples of practices at all stakeholder levels of the supply chain that can be implemented to drive transformation towards a regenerative and circular urban food system.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To build a circular economy for food in cities</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ restaurants and other food providers use food by-products for new biomaterials, medicines, or bioenergy;</li> <li>▶ city governments advance infrastructure to enable local food sourcing and the return of organic fertilizers to peri-urban farms</li> </ul>
<b>On-farm practices for the safe use of wastewater in urban and peri-urban horticulture (FAO, 2019d)</b>	<p>The document is the second edition of a training handbook for farmer field schools on the use of non-conventional waters in agriculture. It includes low-cost and low-tech on-farm wastewater treatment and reuse practices in agriculture including safe irrigation practices using wastewater.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To reduce health risks to farmers and consumers from using wastewater in agriculture</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 7</li> </ul>	<ul style="list-style-type: none"> <li>▶ use less contaminating irrigation methods;</li> <li>▶ stop irrigating several days before harvest;</li> <li>▶ use sedimentation ponds</li> </ul>

2.1 PRODUCTION OF BIOLOGICAL RESOURCES		
2.1.5 MULTISECTORAL SOURCES		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Best Practices Atlas (ENABLING, 2020)</b>	<p>The source includes good practices in the production, pre-processing and provision of biomass for bio-based products and processes. They are gathered within the project 'Enhance New Approaches in BioBased Local Innovation Networks for Growth' (ENABLING). The practices help to make maximal use of the biomass resources in each location and deliver enhanced economic value to farmers and rural communities.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To optimize the economic or technical performance of the supply of biomass for the bio-based Industry with practices that are evaluated based on different criteria (e.g. intersectoral, multi-actor or scalable)</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13</li> </ul>	<ul style="list-style-type: none"> <li>▶ biogas production combined with digestate fertigation;</li> <li>▶ agricultural residues are converted into pellets locally</li> </ul>
<b>Case studies on bioeconomy initiatives supported through European public funds (ENRD, 2020)</b>	<p>The source is a database of bioeconomy initiatives by the European Network for Rural Development (ENRD) Thematic Group on Mainstreaming the Bioeconomy. It includes good practices implemented by producers and their association to access European Union public funding (e.g. common agricultural policy funding under the European Agricultural Fund for Rural Development (EAFRD) and other funds).</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To promote rural development and the modernization of agri-food systems, and support youth in agriculture with case studies that have context-specific objectives</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 7</li> </ul>	<ul style="list-style-type: none"> <li>▶ buffer strips;</li> <li>▶ use of green energy produced from manure as electricity on the farm;</li> <li>▶ recovery of abandoned chestnut areas</li> </ul>



## 2.1 PRODUCTION OF BIOLOGICAL RESOURCES

## 2.1.5 MULTISECTORAL SOURCES

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Climate-smart agriculture: Practices (FAO, 2020f)</b>	<p>The source includes practices in the fields of integrated practices; crop production; livestock; forestry; urban and peri-urban agriculture; genetic resources and biodiversity; fisheries and aquaculture; land and water management; proactive drought management; energy; food loss and waste and nuclear techniques.</p> <p>► <b>Source objectives:</b> To address the three pillars of climate-smart agriculture (CSA):</p> <ul style="list-style-type: none"> <li>► sustainably increase agricultural productivity and incomes;</li> <li>► adapt and build resilience of livelihoods and ecosystems to climate change and</li> <li>► reduce and/or remove greenhouse gas emissions, where possible</li> </ul> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,4,8</p>	<ul style="list-style-type: none"> <li>► site-specific nutrient management;</li> <li>► conservation agriculture;</li> <li>► alternate wetting and drying;</li> <li>► integrated soil fertility management;</li> <li>► integrated manure management;</li> <li>► improved livestock genetics;</li> <li>► systems of rice intensification</li> </ul>
<b>Agroecology Knowledge Hub: Practices (FAO, 2020g)</b>	<p>The source includes profiles of 56 good practices retrieved from cases and experiences. Agroecology is understood as a social process leading to the continuous co-creation and reproduction of agricultural knowledge. The source also includes related publications with similar content on best practices and case studies.</p> <p>► <b>Source objectives:</b> To address the ten elements of agroecology:</p> <ol style="list-style-type: none"> <li>1. diversity</li> <li>2. co-creation and sharing of knowledge</li> <li>3. synergies</li> <li>4. efficiency</li> <li>5. recycling</li> <li>6. resilience</li> <li>7. human and social values</li> <li>8. culture and food traditions</li> <li>9. responsible governance</li> <li>10. circular and solidarity economy</li> </ol> <p>► <b>Bioeconomy Strategy Objectives:</b> 9,11</p>	<ul style="list-style-type: none"> <li>► reduced use of artificial chemical pesticides through an integrated phytosanitary approach;</li> <li>► adding basal manuring (compost and recycled manure) to soil</li> </ul>
<b>Knowledge Sharing Platform on Resilience (KORE) (FAO, 2020h)</b>	<p>The source is a database of good practices for building resilience to food insecurity and malnutrition in the face of shocks and stresses. The good practices are specific interventions in real-life cases that provide general recommendations. The source uses the FAO experience capitalization approach to upscale identified good practices to inform policies.</p> <p>► <b>Source objectives:</b> To address different shocks and crises happening in different contexts</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 7</p>	<ul style="list-style-type: none"> <li>► an innovative system for monitoring radionuclides in food and agriculture production;</li> <li>► pastoralist field schools</li> </ul>
<b>Technologies and Practices for Small Agricultural Producers (TECA) (FAO, 2020i)</b>	<p>The source is a database of agricultural technologies and practices, including success stories and case studies, to support small-scale producers. There are also exchange groups to facilitate knowledge exchange and help family farmers in the field.</p> <p>► <b>Source objectives:</b> To promote technologies and practices to address local challenges</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 8</p>	<ul style="list-style-type: none"> <li>► direct seeding equipment for tractors;</li> <li>► treating straw for animal feeding with the Beckmann method;</li> <li>► composting with burrow and pile methods;</li> <li>► raised bed lotus cultivation</li> </ul>



2.1 PRODUCTION OF BIOLOGICAL RESOURCES		
2.1.5 MULTISECTORAL SOURCES		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Bioeconomy in the European Agricultural Fund for Rural Development. Projects Brochure (EAFRD) (ENRD, 2019a)</b>	<p>The source illustrates good practices in agricultural production systems included in funding proposals to the European Agricultural Fund for Rural Development (EAFRD) that can be considered good bioeconomy practices. The source provides examples, inspiration and criteria that rural communities and rural development stakeholders in Europe can use to access EAFRD funds to seize the opportunities offered by the bioeconomy.</p> <p>► <b>Source objectives:</b> To meet the objectives of the European Union bioeconomy (i.e. food security, sustainable natural resources management, reduced dependence on non-renewable resources, mitigating and adapting to climate change, and job creation)</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,2,3,4</p>	<ul style="list-style-type: none"> <li>► minimize food losses and waste;</li> <li>► implement 'climate smart' food systems;</li> <li>► promote alternative and more sustainable sources of protein for animal consumption;</li> <li>► promote waste management such as biogas plants;</li> <li>► consider reduced greenhouse gas emissions fully in the proposals;</li> <li>► maintain the value of products, materials and resources in the economy for as long as possible;</li> <li>► implement business models that keep biomass local as long as possible;</li> <li>► replace petrol-based and non-renewable materials with bio-based ones;</li> <li>► diminish environmental pressures and restore and enhance ecosystems' functions and biodiversity</li> </ul>
<b>Good Practices for Integrating Gender Equality and Women's Empowerment in Climate-Smart Agriculture (CSA) Programmes (FAO and CARE, 2019)</b>	<p>The document (page 61) provides a list of good practices of enabling environments and processes to design and deliver a gender-transformative climate-smart agriculture (CSA) project. The description of each practice includes available tools and methodologies for its implementation.</p> <p>► <b>Source objectives:</b> To promote gender equality and women's empowerment in CSA adoption</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 4,8</p>	<ul style="list-style-type: none"> <li>► analyse climate risks, differential vulnerability and capacity of people, ecosystems and institutions;</li> <li>► incorporate management of uncertainty and use of climate information by women and men</li> </ul>
<b>Successful experiences in bioeconomy (IICA, 2013)</b>	<p>The publication includes nineteen case studies (in Spanish) on biotechnology, biodiversity, agro-energy, eco-intensification (agricultural practices, bio-inoculants, bio-remediation, agropastoral systems), efficiency in the value chain (waste reduction) and eco-services (tourism, carbon credits water management).</p> <p>► <b>Source objectives:</b> Every case study presents good bioeconomy practices and applications to solve context-specific challenges for the development of the bioeconomy</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 15</p>	<ul style="list-style-type: none"> <li>► integration of trees in livestock paddocks;</li> <li>► use of high-quality pest-free potato seeds;</li> <li>► crop-rotation;</li> <li>► hilling</li> </ul>

2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES		
2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL		
2.2.1.1 Handling biological materials (seeds, plants, microorganisms and their genetic resources)		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>CETAF Best Practice on Access and Benefit-Sharing (Consortium of European Taxonomic Facilities, 2019)</b>	<p>The source includes good practices for in the acquisition of biological material; curation and data management; the conservation and storage of genetic resources; supply to third parties; benefit-sharing; institutional policies and procedures; staff training and awareness raising.</p> <p>► <b>Source objectives:</b> To conserve genetic resources and facilitate access to them in compliance with the 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13</p>	<ul style="list-style-type: none"> <li>► keep records of tissue and DNA subsamples congruent when physically separate;</li> <li>► track the use of biological material and any associated traditional knowledge that entered the collections;</li> <li>► take into account and reflect in mutually agreed terms indigenous and local community customary laws and community protocols</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL

## 2.2.1.1 Handling biological materials (seeds, plants, microorganisms and their genetic resources)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Best practices: Recommendations for repositories (ISBER, 2018)</b>	<p>The International Society for Biological and Environmental Repositories (ISBER) document provides good practices for human, biodiversity, environmental, and veterinary repositories. They cover standardized methods for collection, handling, storage, retrieval, and distribution of biological materials for research purposes, as well as DNA specimen access and collection, quality management, control and safety.</p> <p>► <b>Source objectives:</b> To support successful management and operations of repositories in order to increase availability of high-quality and fit-for-purpose biological and environmental specimens for research purposes</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13</p>	<ul style="list-style-type: none"> <li>► perform temperature mapping; maintain spare parts for critical equipment of the repositories;</li> <li>► identify resources for equipment repair and replacement when the repository is being established;</li> <li>► utilize a quality metric system as a way to measure the effectiveness of the quality assurance program;</li> <li>► follow external quality assurance programs once a year;</li> <li>► use cloud computing for data exchange;</li> <li>► use automated liquid-handling robotics</li> </ul>
<b>Transparent User-friendly System of Transfer (TRUST, 2016)</b>	<p>This source includes administrative good practices in culture collections, including practices to access microbial genetic resources, deposit them in conservation facilities, and manage their distribution and utilization. It is the result of a joint effort between several institutions that have decided to standardize their procedures. This document builds on the recommendations by the Micro-Organisms Sustainable use and Access regulation International Code of Conduct (MOSAICC). It also follows the legal obligations set by the 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity.</p> <p>► <b>Source objectives:</b> To study, distribute and utilize and facilitate access to microbial genetic resources; manage all related data; and ultimately achieve access and benefit sharing in order to best implement the 2010 Nagoya Protocol</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13</p>	<ul style="list-style-type: none"> <li>► work with 'registered collections';</li> <li>► keep files of correspondence when dealing with <i>ex situ</i> resource centres;</li> <li>► include indigenous or local communities as parties of an agreement;</li> <li>► link all databases and connect all relevant data to the referred item</li> </ul>
<b>Genebank Standards for Plant Genetic Resources for Food and Agriculture (FAO, 2014b)</b>	<p>These voluntary standards include scientific and technical best practices for seed genebanks, field genebanks and in vitro culture and cryopreservation.</p> <p>► <b>Source objectives:</b> To support the key international policy instruments for the conservation and use of plant genetic resources</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,13</p>	<ul style="list-style-type: none"> <li>► dry and store the seeds for long or short term;</li> <li>► monitor seed viability;</li> <li>► use computer-based systems for storing data and information;</li> <li>► standardize and calibrate collected data and present the results;</li> <li>► storage recalcitrant seeds hydrated; to assess water content, vigour and viability</li> </ul>
<b>World Federation for Culture Collections Guidelines (WFCC, 2010)</b>	<p>The guidelines prepared by the World Federation for Culture Collections (WFCC) provide a framework for the establishment, operation and long-term support of microbiological and cell resource centres. They support the implementation of the OECD 2007 Best Practice Guidelines for Biological Resource Centres.</p> <p>► <b>Source objectives:</b> To promote and develop collections of cultures of microorganisms and cultured cells, and increase their quality and delivery in order to underpin associated biotechnology growth</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13,15</p>	<ul style="list-style-type: none"> <li>► collectors are encouraged to register with the WFCC;</li> <li>► clients who wish to obtain cultures of non-indigenous pathogens may first have to obtain a permit to import, handle and store from the appropriate government department;</li> <li>► biological materials to be received and supplied should follow the spirit of the Convention on Biological Diversity</li> </ul>
<b>OECD Best practice guidelines for biological resource centres (OECD, 2007a)</b>	<p>The source set the standard for quality management in depositories of biological material and their collections, including guidelines for holding and supplying microorganisms and animal, plant and human-derived materials. It also covers biosecurity, building capacity, the preservation of biological resources and data management. The report includes how to establish national certification systems based on these good practices.</p> <p>► <b>Source objectives:</b> To support the quality management of collections</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13,15</p>	<ul style="list-style-type: none"> <li>► properly store preserved biological materials;</li> <li>► develop an incident response plan for biosecurity risk management;</li> <li>► stipulate in procedures the preparation techniques and revise them periodically;</li> <li>► classify microorganisms;</li> <li>► open all incoming microorganism parcels in a containment laboratory</li> </ul>

2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES		
2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL		
2.2.1.1 Handling biological materials (seeds, plants, microorganisms and their genetic resources)		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Guide to safety and quality assurance for organs, tissues and cells (Council of Europe, 2004)</a>	<p>This guide includes safety and quality assurance standards for procurement, preservation, processing and distribution for organs, tissues and cells of human origin (except blood) used for transplantation purposes.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure the quality of human organs, tissues and cells used for transplantation purposes</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 15</li> </ul>	<ul style="list-style-type: none"> <li>▶ organ, tissue and cell processing;</li> <li>▶ donor selection in line with procedures;</li> <li>▶ clinical evaluation and laboratory tests;</li> <li>▶ labelling and packaging</li> </ul>

2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES		
2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL		
2.2.1.2 Handling agricultural produce, residues and losses		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Voluntary Code of Conduct for Food Loss and Waste Reduction (CoC) (FAO, 2021)</a>	<p>The source includes actions and measures that countries national and sub-national authorities, food supply chain actors, the private sector, producer organizations, civil society organisations, academic and research institutions, and other relevant stakeholders should put in place in order to contribute to food loss and waste reduction.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To contribute to food loss and waste reduction</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,10,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ divert surplus or unsold /unmarketable food into new food products, animal feed or transform it into non-food products. When diverted to food and feed it should be ensured that all safety and quality requirements are met and seeking the highest possible nutritional value;</li> <li>▶ invest in science-based education and training to equip food supply chain actors with the technical, business management and entrepreneurial skills required to reduce food loss and waste</li> </ul>
<a href="#">Overcoming non-technical challenges in bioeconomy value-chain development: Learning from practice (Mertens, 2019)</a>	<p>This paper presents seven concrete good practices on how to develop a value chain for corn stover.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To overcome barriers to value chain development in order to valorize currently underutilized biomass sources and generate additional revenues</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 11</li> </ul>	<ul style="list-style-type: none"> <li>▶ set up an advisory committee;</li> <li>▶ go beyond biomass supply and processing by ensuring off-take of the end-product;</li> <li>▶ attract in-kind contributions and private capital when the production is at a later stage</li> </ul>
<a href="#">Innovative approaches for mobilisation of forest biomass for bioenergy (IEA, 2018a)</a>	<p>The document describes good practices and policies for the mobilization and valorization of forest biomass and residues. The recommendations are illustrated with case studies that describe challenges and opportunities for the development of successful business cases of mobilization of forest biomass for bioenergy. The case studies deal with supply, logistics, conversion, social, environmental, market and policy aspects.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To contribute to the global energy transition to renewable sources, and revitalize and diversify regional industrial networks in forest regions</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 11</li> </ul>	<ul style="list-style-type: none"> <li>▶ at least 25% of forest residues must remain behind on the forest floor and 75% can be utilized;</li> <li>▶ consider decisions on upstream harvesting operations (e.g. lop-and-scatter vs. whole-tree harvesting) in the management of the supply chain since they affect the availability and amount of recoverable biomass feedstock</li> </ul>
<a href="#">Code of practice for fish and fishery products (Codex Alimentarius Commission, 2016)</a>	<p>First adopted in 2003, this collection of good practices includes recommendations and standards for freezing and cold storage, as well as handling, of fish and fishery products on board fishing vessels and on shore. Of particular importance are those practices that can improve food waste management, reuse and recycling.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> Practices are classified under a range of different objectives (e.g. to facilitate cleaning and disinfection: minimize contamination). The practices are also in compliance with the recommendations of the 1995 Code of Conduct for Responsible Fisheries</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,10</li> </ul>	<ul style="list-style-type: none"> <li>▶ offal and other waste materials should be removed from the premises on a regular basis;</li> <li>▶ implement cold chain including chilled storage and frozen storage;</li> <li>▶ wash water should be at correct temperature for adequate separation of water-soluble proteins;</li> <li>▶ claws, leg tips and shell parts containing recoverable meat should be continuously separated from waste material</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL

## 2.2.1.2 Handling agricultural produce, residues and losses

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">European Guide to Good Hygiene Practices for the collection, storage, trading and transport of cereals, oilseeds, protein crops, other plant products and products derived thereof (COCERAL/COGECA/UNISTOCK, 2015)</a>	<p>The source provides good hygiene practiceS (GHP) for the handling of unprocessed and processed cereals, oilseeds, protein crops and other plant products as well as their co-products resulting from them (e.g. oils, meals and fats of vegetable origin) that are intended to be used as food and/ or feed. The document includes practices in different stages of the value chain, i.e. trading operations, collection/receipt operations for unprocessed products, storage, terminal handling operations, dispatch/delivery, transport operations and monitoring.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure the safety of the goods that each operator in the food/feed chain handles</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 15</li> </ul>	<ul style="list-style-type: none"> <li>▶ identify, register and control the delivery;</li> <li>▶ maintain and clean facilities;</li> <li>▶ ventilate food and feed materials;</li> <li>▶ include pest control and the risk of microbiological contamination to the products and facilities in the Hazard Analysis, Critical Control Points (HACCP) system</li> </ul>
<a href="#">Biosecurity guide for live poultry markets (FAO, 2015a)</a>	<p>This document includes good practices to decontaminate live bird markets. It covers biosafety issue of live animal markets.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To improving animal health, reduce avian influenza viruses and control other diseases</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 15</li> </ul>	<ul style="list-style-type: none"> <li>▶ after the birds have been unloaded, the crates should be moved to the washing area;</li> <li>▶ allow contact with the detergent on crate surfaces for at least one minute;</li> <li>▶ vehicle cleaning;</li> <li>▶ a well-constructed and maintained drainage system that keeps wastewater separated from poultry, customers and traders</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL

## 2.2.1.3 Handling waste

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Bio-waste generation in the EU - current capture and future potential (BIC, 2020)</a>	<p>The fourth chapter of this report provides good practices in bio-waste management.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To increase the capture and subsequent potential expansion of collection of food waste</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ residential food waste collection;</li> <li>▶ landfill tax where economic instruments aim to promote the collection of bio-waste;</li> <li>▶ separated collection of bio-waste in cities;</li> <li>▶ sustainably valorising bio-waste to provide new bio-based compounds for the chemicals, food-packaging and agricultural sectors</li> </ul>
<a href="#">Policy recommendations to improve food waste prevention and valorisation in the EU (Bos-Brouwers <i>et al.</i>, 2020)</a>	<p>This source presents good practices and policies to reduce food waste that focus on consumer behaviour, integrated supply chain policies and valorization.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To reduce food loss and waste with more integrated policies in order to achieve sustainable food systems in the circular economy</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,10</li> </ul>	<ul style="list-style-type: none"> <li>▶ increase availability of new products from surplus food;</li> <li>▶ prohibit supermarkets to waste edible food;</li> <li>▶ consider the real cost of natural resource use and the costs of food waste for the society when developing food waste regulations</li> </ul>
<a href="#">Good practice guidance (WRAP, 2020a)</a>	<p>The UK Waste and Resources Action Programme (WRAP) provides good practice guidelines for households, businesses, local authorities and waste managers in different areas such as: household food waste collections guide; collections, reprocessing and recycling of garden/green waste; guidance on collecting and sorting commercial and industrial organic waste for re-use; and how to make a re-use action plan.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To reduce waste disposal in landfill, and support recycling and re-use</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 4,9</li> </ul>	<ul style="list-style-type: none"> <li>▶ collect food waste in one load to minimize downtime;</li> <li>▶ separate more solid household waste, such as garden and food waste mixture, to be treated with thermophilic anaerobic digestion using the batch system or with in-vessel composting, and process less solid household food wastes with mesophilic anaerobic digestion using a continuous flow system;</li> <li>▶ control access to the liners when storing waste, so that the quality and quantity of stock can be maintained;</li> <li>▶ keep waste cooking oil and rendered animal fat separate as this can be collected if sufficient quantities are available and if the composition meets the criteria of the 2009 UK Biodiesel Quality Protocol</li> </ul>

2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

2.2.1 ACQUISITION AND AGGREGATION OF BIOLOGICAL MATERIAL

2.2.1.3 Handling waste

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Textile collection guide (WRAP, 2020b)</a>	<p>This source provides good practice guidance for collecting textiles to support local authorities and textile collectors, such as charities, waste management companies and textile merchants working in re-use and recycling. The source also provides good practices and technologies for sorting bulky textiles at the end-of-life stage. The guide is not specific to biological resources but it supports the implementation of the wider European Clothing Action Plan.</p> <p>► <b>Source objectives:</b> To divert textiles from the waste stream and generate benefits (e.g. reduce carbon dioxide emissions, employment creation and cost reductions)</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 4,9</p>	<ul style="list-style-type: none"> <li>► provide a provide re-use focused bulky clothing collection services, including transport, that keep clothing in good condition and can be re-used;</li> <li>► use charity shops as collection channels;</li> <li>► effective communication between collector and local authority staff for collection of the material to prevent storage issues when there are peaks;</li> <li>► co-collection of re-usable and recyclable textiles is necessary to fund the activity, since collecting recycling grade textiles in isolation would not be viable from any collection channel</li> </ul>
<a href="#">Recommendations and guidelines for a common European food waste policy Framework (FUSIONS, 2016)</a>	<p>This report outlines good practices and policies for food waste prevention and reduction in the European Union.</p> <p>► <b>Source objectives:</b> To support the development and implementation of a common European policy framework for food waste prevention</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 9,10</p>	<ul style="list-style-type: none"> <li>► address the waste of food linked to the presence of contaminants in food;</li> <li>► foster the use of former foodstuffs and by-products for feed production;</li> <li>► facilitate surplus food donation;</li> <li>► stimulate social innovation initiatives addressing food waste prevention and reduction such as the supporting the use of smart technologies</li> </ul>

2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

2.2.2 PROCESSING AND MANUFACTURING

2.2.2.1 Food and feed

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Best Environmental Management Practice for the Food and Beverage Manufacturing Sector (Dri et al., 2018)</a>	<p>The report describes good practices that can provide food and beverage manufacturers with guidance on how to improve their environmental performance.</p> <p>► <b>Source objectives:</b> Reducing environmental impacts; sustainable supply chain management; improving the design of the packaging; making operations more environmentally-friendly; improving transport and distribution operations; improving freezing and refrigeration; deploying energy management and energy efficiency throughout all operations; and avoiding food waste in manufacturing</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 4,15</p>	<ul style="list-style-type: none"> <li>► avoid food waste in manufacturing operations through value stream mapping;</li> <li>► assess the environmental impact of products and operations using life-cycle assessment tools to identify priority areas for action, or 'hotspots', and define a strategy for reducing the environmental impacts;</li> <li>► minimize the environmental impact of packaging (i.e. primary, secondary and tertiary packaging) throughout the product life cycle</li> </ul>
<a href="#">OECD-FAO Guidance for Responsible Agricultural Supply Chains (OECD and FAO, 2016)</a>	<p>These guidelines give good practices and recommendations to set up value chains, including model enterprise policies, frameworks and measures for risk mitigation. The document also refers to good practices in international standards and other documents (e.g. the World Organisation for Animal Health (OIE) standards for animal welfare; the International Finance Corporation (IFC) Good Practice Note on Animal Welfare in Livestock).</p> <p>► <b>Source objectives:</b> To help businesses meet existing standards and prevent risks of adverse impacts on the environment, and on social and human rights</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 11</p>	<ul style="list-style-type: none"> <li>► design and implement a strategy to respond to identified risks in the supply chain;</li> <li>► establish an operational-level grievance mechanism in consultation and collaboration with relevant stakeholders</li> </ul>
<a href="#">Status and trends of the conservation and sustainable use of micro-organisms in food processes (Alexandraki et al., 2013)</a>	<p>This report by the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) includes good practices on the use of microorganisms in food processing. It also includes good practices in the conservation of these microorganisms (silica gel and soil storage, microbial resource centres).</p> <p>► <b>Source objectives:</b> To secure and support the sustainable use of microorganisms in food processes and their conservation</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,5</p>	<ul style="list-style-type: none"> <li>► fermentation in a wide range of applications;</li> <li>► the use of microorganisms to produce food additives;</li> <li>► protective cultures;</li> <li>► the use of probiotics and functional foods for human health</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.1 Food and feed

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Good practices for the feed industry. Implementing the Codex Alimentarius Code of Practice on Good Animal Feeding (FAO and IFIF, 2010)</b>	<p>The document provides information on good manufacturing practices and feed safety standards. It is aimed at implementing the Codex Alimentarius code of practice on good animal feeding and national codes of practice, and it feeds the FAO-led Global Feed Safety Platform.</p> <p>► <b>Source objectives:</b> To assist producers and all stakeholders along the production and distribution chain to comply with regulatory frameworks</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 15</p>	<ul style="list-style-type: none"> <li>► care should be taken to minimize deterioration and spoilage at all stages of handling, storage and transport of feed and feed ingredients;</li> <li>► special precautions should be taken to limit fungal and bacterial growth in moist and semi-moist feed</li> </ul>
<b>Codex Alimentarius Food hygiene: Basic texts (FAO and WHO, 2009)</b>	<p>The source covers good hygiene practices (GHP) from primary production through to final consumption, highlighting the key hygiene controls at each stage. This publication also contains the most internationally used description of the Hazard Analysis and Critical Control Point (HACCP) systems and guidelines for its application.</p> <p>► <b>Source objectives:</b> To protect the health of consumers and ensuring fair practices in the food trade</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 11,12,15</p>	<ul style="list-style-type: none"> <li>► keep environmental hygiene;</li> <li>► clean and maintain facilities;</li> <li>► control food hazards;</li> <li>► identify control points</li> </ul>
<b>Good Manufacturing Practice in microbial food enzyme production (AMFEP, 1997)</b>	<p>The report includes good practices in the microbial food enzyme industry. It covers the production of enzyme strains, including operational parameters during fermentation and methods to recover the strains afterwards. The source includes laboratory, management and manufacturing practices.</p> <p>► <b>Source objectives:</b></p> <p>To ensure that enzyme preparations for the food industry are produced, packed and handled in a hygienic way, and the final products meet the criteria formulated by the WHO/FAO Joint Experts Committee on Food Additives (JECFA) and the Food Chemicals Codex (FCC)</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,11,12,15</p>	<ul style="list-style-type: none"> <li>► design all operations to avoid contamination, the formation of undesirable by-products, and deterioration and handling errors; include systems of quality control and quality assurance, employee qualifications, maintenance standards for equipment, control of raw materials and product stability;</li> <li>► control the microorganism selected for enzyme production and ensure pure culture and optimum enzyme productivity conditions during fermentation and control of the hygienic conditions throughout recovery and finishing of the enzyme preparations</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.2 Wood products

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Building sustainable forest-based value chains - lessons-learned from inspiring stories all over the world (FAO, forthcoming)</b>	<p>This publication presents a selection of private companies and illustrates good practices in developing value chains from sustainable natural, semi-natural or planted forests, including business models for value addition in the processing of wood-based products.</p> <p>► <b>Source objectives:</b> To improve private companies' economic, environmental and social sustainability</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 5,11</p>	<ul style="list-style-type: none"> <li>► cascading use of forest products;</li> <li>► turning a paper mill into a biorefinery;</li> <li>► strengthening forest product value chains in Small Island Developing States (SIDS);</li> <li>► family forestry</li> </ul>
<b>Good practice Database in wood-based value chains (WoodCircus project, forthcoming)</b>	<p>The European WoodCircus project will develop a database of good practices for SMEs in wood-based bioeconomy with a focus on to minimizing the generation of waste, recycling and promoting circularity. The database will be a result of assessments of trade-offs, sustainability and impact, and process performance evaluation.</p> <p>► <b>Source objectives:</b> To optimize the use of forest resources in all stages of value chains</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 5,11</p>	<ul style="list-style-type: none"> <li>► The good practices will include policy support actions, strategic research, and technological development and innovation</li> </ul>



2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES		
2.2.2 PROCESSING AND MANUFACTURING		
2.2.2.2 Wood products		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Wood products in the sustainable bioeconomy. Workshop summary report (FAO, 2019e)</b>	<p>The summary report and the presentations of the workshop include a summary of the discussion and exchange of good practices among participating countries and stakeholders.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To increase the potential contribution of wood products to the bioeconomy and improve the sustainability of value chains, including through indicators and monitoring, and raising awareness</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,12</li> </ul>	<ul style="list-style-type: none"> <li>▶ develop more standardized description categories for wood waste addressing possible uses and including a geoportal to geographically locate them;</li> <li>▶ achieve more homogeneous standardization between countries;</li> <li>▶ expand the use of innovative engineered wood products for new construction techniques;</li> <li>▶ provide training and develop new skills required in new wood product industries</li> </ul>
<b>Wood in Construction- 25 cases of Nordic Good Practice (Vestergaard Jensen &amp; Craig, 2019)</b>	<p>The report presents good practices in the use of wood in construction. They are defined by five trends (multifunctionality, saving time and costs, investing in scalability, pushing the boundaries, circular design), which were identified from a review 25 case studies. The good practices are presented as activities carried out by each case study and can be used as inspiration.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> The report uses 5 criteria and 15 sub-criteria to cluster the practices that contribute to:                             <ul style="list-style-type: none"> <li>▶ innovation</li> <li>▶ environmental benefits</li> <li>▶ social and local benefits</li> <li>▶ economic viability</li> <li>▶ partnerships</li> </ul> </li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,9,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ digital technology and forest data to drive intelligent felling and planting practices;</li> <li>▶ certification of 100% national products from small, local producers using low-carbon processes;</li> <li>▶ a continuous enzymatic hydrolysis process for waste that preserves more nutrients than chemical methods and utilizes most of the raw materials</li> </ul>
<b>Wood-Based Bioeconomy Solving Global Challenges (Ministry of Economic Affairs and Employment of Finland, 2017)</b>	<p>The report provides an overview of good practices in forestry, wood value chains, the use of new wood material ingredients, business models, consumer behaviour and innovations.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To reduce the depletion of natural resources and address the challenges caused by global warming</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,4</li> </ul>	<ul style="list-style-type: none"> <li>▶ use byproducts from paper mills (e.g. crude tall oil from pine wood pulping used in animal feed) where it acts as a natural anti-inflammatory agent and thus provides a way to reduce the use of antibiotics in poultry farming;</li> <li>▶ install new collective working practices to better establish an open innovation environment for research and development;</li> <li>▶ use intelligent machinery and wireless automated data-intensive solutions that optimize efficient logistic and information systems;</li> <li>▶ leave sufficient logging residue on site helps to return the nutrients to the soil and protects biodiversity hotspots</li> </ul>

2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES		
2.2.2 PROCESSING AND MANUFACTURING		
2.2.2.3 Bioenergy		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Best Practice Checklist: Operational Performance (Anaerobic Digestion and Bioresources Association, 2016)</b>	<p>The source includes good practices for the good management of an anaerobic digestion plant, including aspects to regulate biogas quantity, digestate quality and compliance with United Kingdom legislation.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To achieve a high standard of operational performance</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 5,9</li> </ul>	<ul style="list-style-type: none"> <li>▶ achieve biological stability;</li> <li>▶ employ suitably trained staff;</li> <li>▶ manage grit and plastics accumulation</li> </ul>
<b>NREL Bioenergy Assessment Toolkit (Milbrandt &amp; Uriarte, 2012)</b>	<p>The document presents a table (Table 9) with a compilation of existing sources of good practices for sustainable bioenergy production.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To assess the gaps and strengths of a given bioenergy project</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 5</li> </ul>	<ul style="list-style-type: none"> <li>▶ best practices for implementing a biodiesel program;</li> <li>▶ bioenergy environmental impact and best practices;</li> <li>▶ energy benchmark for wastewater treatment processes</li> </ul>



## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.3 Bioenergy

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Good socio-economic practices in modern bioenergy production (FAO, 2011)</b>	<p>The source is a FAO report that summarizes the most common good socio-economic practices being implemented by different examples or case studies of the private sector.</p> <p>► <b>Source objectives:</b> To ensure that modern bioenergy development safeguards food security, has little impact on limiting access to land and improves employment, wages and labour conditions, income generation, inclusion of smallholders, community development, energy security, local access to energy and gender equity</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 11</p>	<ul style="list-style-type: none"> <li>► mapping of customary land rights; adherence to International Labour Organization (ILO) Declaration on Fundamental Principles and Rights at Work and related conventions;</li> <li>► contracts with local goods and service providers</li> </ul>
<b>Report on good practices on integrated bioenergy planning (MAKE-IT-BE, 2010)</b>	<p>The report presents an analysis of sixteen private sector case studies, which was carried out to identify key factors that contribute to the success of the case studies. These recurring factors are considered as the building blocks of a good practice. The analysis of case studies includes quantitative indicators (e.g. reduction in carbon dioxide emissions, the number of jobs created).</p> <p>► <b>Source objectives:</b> Each case study has a different context and different objectives</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,3,5</p>	<ul style="list-style-type: none"> <li>► extensive stakeholder consultation;</li> <li>► having both supply and demand sides of the project involved from the outset</li> </ul>
<b>Good Practice Guidelines – Bioenergy Project Development and Biomass Supply (IEA, 2007)</b>	<p>Instead of good practices, the report presents barriers to implementation of bioenergy. The document lists issues that should be considered in bioenergy project planning and consultation.</p> <p>► <b>Source objectives:</b> To raise awareness of the potential barriers facing fuel suppliers, developers, planners, consenting authorities, policy makers and other stakeholders</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 5,15</p>	<ul style="list-style-type: none"> <li>► increase energy density per unit of volume for biomass transport;</li> <li>► effective risk management and establishment of demonstration plants;</li> <li>► integrated harvesting to obtain more biomass than is currently available</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.4 Biochemicals, biomaterials and bioplastics

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Guidance on Registration, Evaluation, Authorisation &amp; Restriction of Chemicals (REACH) (ECHA, 2020)</b>	<p>The source by the European Chemicals Agency (ECHA) compiles several guidelines for a range of essential processes for the registration, evaluation, authorization and restriction of chemicals, and for some specific scientific and/or technical methods. It also describes good practice for fulfilling the obligations.</p> <p>► <b>Source objectives:</b> To help stakeholders meet regulations on the registration, evaluation, authorization and restriction of chemicals</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10</p>	<ul style="list-style-type: none"> <li>► recovering substances from waste;</li> <li>► registration of intermediates;</li> <li>► provisions for polymers and monomers</li> </ul>
<b>Bioelectrochemical systems for a circular bioeconomy (Jung et al., 2020)</b>	<p>The paper provides an overview of microbial electrochemical systems (i.e. microbial fuel cells and enzymatic fuel cells that produce energy and basic and specialty chemicals using hydrogen-producing microorganisms isolated from waste and wastewater, such as animal waste). This technology is sometimes considered a carbon capture and use technology.</p> <p>► <b>Source objectives:</b> To contribute to the circular bioeconomy in waste-to-energy/chemical systems</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 4,9,13</p>	<ul style="list-style-type: none"> <li>► wastewater electrolysis;</li> <li>► microbial fuel cells (batteries);</li> <li>► co-produce hydrogen for energy and chemical platforms</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.4 Biochemicals, biomaterials and bioplastics

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Thermophilic bio-electro CO<sub>2</sub> recycling into organic compounds (Rovira-Alsina et al., 2020)</b>	<p>This paper looks at the capture and conversion of carbon-dioxide-saturated effluents from industrial sources into acetate and hydrogen. It is one of the publications of the European Union's Horizon 2020 project 'Bioreco2ver', which looks at photosynthetic and non-photosynthetic biocatalysts for the capture and conversion of carbon dioxide from industries into valuable platform chemicals.</p> <p>► <b>Source objectives:</b> To integrate carbon capture and utilization units into industries in order to obtain higher valuable compounds, optimize the performance and replace the required energy with renewable resources</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 4,9,13</p>	<ul style="list-style-type: none"> <li>► use the right mixed microbial culture for the required period of time;</li> <li>► use no-inhibitory micronutrients and enzymes to help acetate production;</li> <li>► use anaerobic sludge from a conventional wastewater treatment plant as the inoculum source for thermophilic microbial electrolysis cells reactors</li> </ul>
<b>Direct microbial transformation of carbon dioxide to value-added chemicals: A comprehensive analysis and application potentials (Irfan et al., 2019)</b>	<p>The paper lists applications of carbon dioxide transformation at laboratory and commercial level, and provides an overview of technological processes related to direct microbial transformation of carbon dioxide, factors affecting their efficiency in operation and a review of their economic feasibility.</p> <p>► <b>Source objectives:</b> To use microorganisms to perform direct fixation of carbon dioxide to biomass, which is then used as raw material for further microbial transformation</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,4</p>	<ul style="list-style-type: none"> <li>► chemical and enzymatic conversion;</li> <li>► biofixation;</li> <li>► microbial transformation of carbon dioxide using acetogens, methanogens and other microbes</li> </ul>
<b>Production of bioplastic through food waste valorization (Tsang et al., 2019)</b>	<p>The paper provides an overview of good practices in each step of the production bioplastic from food waste.</p> <p>► <b>Source objectives:</b> To valorize food waste through the production of value-added products</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 5,9</p>	<ul style="list-style-type: none"> <li>► use fermentation technologies based on pure and mixed cultures for pretreatment of the waste;</li> <li>► improve the recycling rate of food waste, especially for food waste from complex mixtures;</li> <li>► physical/acid treatment of industrial food waste mixture</li> </ul>
<b>Bioplastics: sustainable materials for building a strong and circular european bioeconomy (EC, 2017b)</b>	<p>The publication presents good practices for the circular production of bioplastics.</p> <p>► <b>Source objectives:</b> To support the development and use of bioplastics, and increase circularity in the current linear system of plastics production</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,9</p>	<ul style="list-style-type: none"> <li>► convert pentose-rich side-streams from biorefinery waste-streams into biopolymers;</li> <li>► formulate biodegradable bioplastic for food packaging applications;</li> <li>► harness the microalgae as raw material for the sustainable production of feedstock for chemicals and plastics</li> </ul>
<b>Processing of bioplastics. A guideline (Offers and Lack, 2016)</b>	<p>The source covers good practices concerning the processing of bioplastics. It has a corresponding database.</p> <p>► <b>Source objectives:</b> To support the uncomplicated application and trouble-free processing of bio-based plastics</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2</p>	<ul style="list-style-type: none"> <li>► injection moulding;</li> <li>► extrusion blow moulding;</li> <li>► fibre reinforcement;</li> <li>► profile extrusion;</li> <li>► pipe extrusion and co-extrusion</li> </ul>
<b>Best Practices Guidance for Nanomaterial Risk Management in the Workplace (Ostiguy, 2015)</b>	<p>The report includes good practices that reduce risks in the production and use of nanomaterials. Nanomaterials are used to improve the properties of a wide range of products in all sectors, from the manufacture of materials to medical diagnostics and treatment. Biological nanomaterials include lipids, peptides and polysaccharides that serve as chemical agents in medical imaging and drug delivery vectors, receptors and nucleic acids.</p> <p>► <b>Source objectives:</b> To reduce health and safety issues in handling nanomaterials in laboratories and industrial facilities that produce or incorporate them</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 15</p>	<ul style="list-style-type: none"> <li>► ventilation;</li> <li>► estimate exposure potential;</li> <li>► health risk control;</li> <li>► risk assessment</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.4 Biochemicals, biomaterials and bioplastics

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Compost production for use in growing media: A good practice guide (WRAP, 2014)</b>	<p>This report guide provides good practices on the production of quality composts that are consistently fit for purpose and on how they can be used in growing media.</p> <p>► <b>Source objectives:</b> To avoid contamination and maximize the quality of compost by providing guidance to compost producers, as they are the ones who make extra investment and are consequently likely to be the ones who can consistently deliver good products to this market</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,9</p>	<ul style="list-style-type: none"> <li>► minimization of physical contaminants in the finished product;</li> <li>► production of compost that is free from weed seeds;</li> <li>► product screening and testing</li> </ul>
<b>Status and trends of the conservation and sustainable use of microorganisms in agroindustrial processes (Chatzipavlidis et al., 2013)</b>	<p>This report by the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) includes good practices on the use of microorganisms in bioproducts processing, such as organic acids, chemical additives, pigments, enzymes, food additives, antibiotics, biofuels, solvents, bioplastics, mushrooms, compost and vermicompost. It also includes good practices in the conservation of these microorganisms (e.g. organic agriculture: culture collections)</p> <p>► <b>Source objectives:</b> To secure and support the sustainable use of microorganisms in agro-industrial processes; protect microbial biodiversity; and mitigate the impact of climate change on the diversity of microorganisms and their use in agro-industrial processes</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,5</p>	<ul style="list-style-type: none"> <li>► production of mushrooms using agro-industrial residues;</li> <li>► production of protein-enriched feed;</li> <li>► production of bio-plastics through lactic acid fermentation or bacterial polyester fermentation;</li> <li>► application of bionanotechnologies such as the use of nanotube membranes in the production of biofertilizers;</li> <li>► exploitation of the natural production of bacterial biofilms for fertilizing; production of bio-fertilizers;</li> <li>► production of bio-pesticides based on bacteria, fungi, viruses, yeasts and others</li> </ul>
<b>Good Manufacturing Practice for Producers of Cosmetic Products (ISO, 2007)</b>	<p>The source provides guidelines for the production, control, storage and shipment of cosmetic products.</p> <p>► <b>Source objectives:</b> To validate the compliance of business management system with the requirements of the European Cosmetics Regulation, and ensure access to the European market</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10,11</p>	<ul style="list-style-type: none"> <li>► avoid contamination of the product;</li> <li>► identify quality control points;</li> <li>► number the batch and label them properly for an easy identification on the production line</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.5 Medicinal and pharmaceutical products of biological origin

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Good manufacturing practices for the manufacture of herbal medicines. Annex 2 WHO Technical Report Series, No. 1010 (WHO, 2018)</b>	<p>This document covers good practices in the production and quality control of herbal medicines.</p> <p>► <b>Source objectives:</b> To ensure quality assurance and control in the manufacture of herbal medicines</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,5</p>	<ul style="list-style-type: none"> <li>► choose cleaning methods appropriate to the characteristics of the herbal materials being processed;</li> <li>► provide, maintain, monitor and record adequate store conditions for plants, extracts, tinctures and other preparations;</li> <li>► use identification test methods specific for the herbal material, herbal preparation or finished herbal product that are capable of discriminating between the required herbal material and likely potential substitutes or adulterants</li> </ul>
<b>Guidance for organizations performing in vivo bioequivalence studies (revision). Annex 9 WHO Technical Report Series, No. 996 (WHO, 2016b)</b>	<p>The source includes good practices in bioanalysis and bioequivalence studies conducted to demonstrate therapeutic equivalence by different pharmaceutical products. It considers elements of World Health Organization (WHO) good clinical practices, good laboratory practices, good practices for quality control and good manufacturing practices.</p> <p>► <b>Source objectives:</b> To safeguard the integrity and traceability of data, and ensure that medicinal products supplied for procurement meet WHO norms and standards with respect to quality, safety and efficacy</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10,13</p>	<ul style="list-style-type: none"> <li>► good data management and computer systems;</li> <li>► ensure safety and data integrity;</li> <li>► conduct bioequivalence studies;</li> <li>► develop inspection processes for the medicines;</li> <li>► conduct pharmacokinetic statistical calculations and reporting</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.5 Medicinal and pharmaceutical products of biological origin

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>EU guidelines for good manufacturing practice for medicinal products for human and veterinary use Volume 4 (Annex 2 Manufacture of biological active substances and medicinal products for human use) (EC, 2012)</b></p>	<p>This document contains good manufacturing practice (GMP) for biological active substances and biological medicinal products for human use. They are manufactured from animal or plant sources (immunosera, vaccines, insulin, allergens extract); biotechnology, cell culture and fermentation (viral or bacterial vaccines, enzymes, proteins, non-viral vectors, plasmids, allergens); and human and animal sources (urine derived enzymes, hormones, tissue engineering products, somatic cell therapy).</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To guide the manufacture of medicinal products, the use of new manufacturing technology and concepts, and extend the reach of biological medicinal products</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,13,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ ensure control over seed lots and cell banks (e.g. ex-vivo gene transfer takes place in facilities with appropriate containment arrangements);</li> <li>▶ demonstrate that the growth promoting properties of culture media are suitable for its intended use;</li> <li>▶ control finishing activities such as mixing speeds, time and temperature controls, limits on exposure to light;</li> <li>▶ develop and document a sample testing strategy</li> </ul>
<p><b>Good practices for pharmaceutical microbiology laboratories. Annex 2 WHO Technical Report Series, No. 961. (WHO, 2011a)</b></p>	<p>The source covers good practices for pharmaceutical microbiology laboratories that are involved in environment of premises, validation of test methods, equipment, reagents and culture media, sampling, handling and identification, disposal, quality assurance and testing.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure quality control in pharmaceutical microbiology laboratories and the proper maintenance and distribution of substances</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13</li> </ul>	<ul style="list-style-type: none"> <li>▶ sterility testing;</li> <li>▶ detection, isolation, enumeration and identification of microorganisms (bacteria, yeast and moulds);</li> <li>▶ the testing for bacterial endotoxins in different materials and the environment, as well as in assays that use microorganisms as part of the test system</li> </ul>
<p><b>Manufacture of Medicinal Products Derived from Human Blood or Plasma. Annex 14 of the EU Guidelines for Good Manufacturing Practice for Medicinal Products for Human and Veterinary Use Vol. 4 (EC, 2010)</b></p>	<p>The source covers good practices in handling blood and blood products and manufacturing medicinal products. It includes quality management, traceability and post collection measures, premises and equipment, manufacturing, quality control, the release of intermediate and finished products, the retention of plasma pool samples, and the disposal of waste.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure quality and safety in the collection and testing of human blood and blood components for the manufacture of medicinal products</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ avoid placing routine manufacture at risk of contamination from viruses used during validation studies;</li> <li>▶ check that starting material imported from third countries must be in compliance with the quality and safety requirements;</li> <li>▶ data needed for full traceability must be stored for at least 30 years</li> </ul>
<p><b>WHO good manufacturing practices for active pharmaceutical ingredients. Annex 2 WHO Technical Report Series, No. 957 (WHO, 2010)</b></p>	<p>This document provides good manufacturing practices of active pharmaceutical ingredients for use in finished pharmaceutical products, including production, quality assurance and control, personal hygiene, sampling and testing. The source covers those ingredients manufactured by cell culture or fermentation, chemical synthesis, extraction, recovery from animal or plant sources and herbs, or by any combination of these processes.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure quality active pharmaceutical ingredients are used in processing and management</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ conduct equipment and environmental controls;</li> <li>▶ develop appropriate microbiological tests;</li> <li>▶ use harvest and purification procedures that remove cells while protecting the intermediate or active pharmaceutical ingredients from contamination; produce an impurity profile</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.6 Multisectoral sources, including biorefineries

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Project good practices (BIOREGIO, 2020)</b>	<p>The source provides good practices for promoting circularity, resource efficiency and bio-industries at the regional level. The practices come from bioeconomy private sector case studies in Europe. They prove evidence of their success and potential for learning or transfer. They are meant as an inspiration for preparing action plans. Each good practice addresses a challenge (e.g. the reduction of biowaste as a share of domestic waste of all households present on the territory).</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support the development of bio-based circular economy models; improve resource efficiency; and reduce the environmental impact of biowaste</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,13</li> </ul>	<ul style="list-style-type: none"> <li>▶ a cooperation network in the local grain value chain that aims at finding synergies, innovations and solutions for circular economy;</li> <li>▶ a shared methanation unit between farms that improves nutrient management</li> </ul>
<b>Best available techniques (BAT). Reference Documents (EIPPCB, 2020)</b>	<p>The source includes practices that seek improved environmental performance in several industrial and agricultural sectors in the European Union, particularly the prevention and reduction of emissions, that consider the costs and benefits. They are classified under energy efficiency, water consumption and wastewater discharge, harmful substances, resource efficiency, emissions to water, noise and odour. The BATs are published in reference documents, which are the conclusions of European Union decisions under the overall framework of the Directive 2010/75/EU of 24 November 2010 on industrial emissions (integrated pollution prevention and control). The BATs also consider different criteria that are listed in corresponding European Union directives (e.g., the use of low-waste technology, the use of less hazardous substance)</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To improve environmental performance in each sector, particularly the prevention and reduction of emissions</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,4</li> </ul>	<ul style="list-style-type: none"> <li>▶ for intensive rearing of poultry or pigs: use heating/cooling and ventilation systems and management that take into account animal welfare requirements; reduce the crude protein content by using a nitrogen-balanced diet and digestible amino acids; and identify risks of run-off by assessing the manure receiving land, soil type, climatic conditions, crop rotations and water resources;</li> <li>▶ for the production of pulp, paper and board: recover and use the low temperature streams from effluents and other waste heat for buildings, boiler feedwater and process water heating; recycle pigments; and monitor and continuously control the process water quality;</li> <li>▶ for the food, drink and milk industries: design and construct the equipment in a way that facilitates cleaning; include an energy efficiency plan in the environmental management system; and recover and (re)use yeast after fermentation</li> </ul>
<b>Natural fibers and fiber-based materials in biorefineries (IEA, 2018b)</b>	<p>The report includes a section on industrial case studies that cover good practices in biorefineries that use bio-based fibres from the same wood feedstock in the production of wood pulp, bioenergy and biochemicals that are used as sweeteners or for pharmaceutical purposes.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> Each case study has its own objective</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,13</li> </ul>	<ul style="list-style-type: none"> <li>▶ closed cycle and the optimal use of the raw material beech wood (e.g. extracting xylose on site from the spent sulfite liquor and hydrogenated later on to xylitol);</li> <li>▶ integrated and cost-effective cascading biorefinery system to refine sugar beet pulp and isolate high-value products</li> </ul>
<b>Sustainable design of biorefinery processes: existing practices and new methodology (Remi et al., 2017)</b>	<p>The source gives an overview of practices in developing life cycle assessments (LCA) for biorefineries to support decision making regarding their ecodesign and process optimization.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To address sustainability issues in the design of modern biorefinery plants</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,12</li> </ul>	<ul style="list-style-type: none"> <li>▶ use comparative LCAs to determine the best biomass feedstock and the most promising processing routes;</li> <li>▶ couple LCA to process simulation tools, such as process flow-sheeting, to identify main potential hotspots;</li> <li>▶ apply multi-objective optimizations to biorefineries for the evaluation of the most advantageous technologies and operating conditions;</li> <li>▶ support final decision making through the attribution of different weights to criteria and making of trade-offs using multi-attribute value theory method or by an analytical hierarchy process</li> </ul>

2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

2.2.2 PROCESSING AND MANUFACTURING

2.2.2.6 Multisectoral sources, including biorefineries

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Sustainable biorefineries, an analysis of practices for incorporating sustainability in biorefinery design (Palmeros Parada, Osseweijer and Posada, 2016)</a>	<p>The source covers good practices in life cycle assessments (LCAs) for the design of sustainable biorefineries. The article concludes that most LCAs are blind to contextual settings or stakeholder perspectives and more integral sustainability analyses are needed for biorefinery design.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To make more holistic and integral LCAs for biorefinery design</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,12</li> </ul>	<ul style="list-style-type: none"> <li>▶ carry out an analysis of human health impacts (e.g. related to the gradual termination of pre-harvesting burning) to complement common life cycle impacts (e.g. GHG emissions and energy use);</li> <li>▶ incorporate circular and sustainable impact categories to supply chain analysis, especially for logistic optimization;</li> <li>▶ use mass balances derived from the simulation process for calculating yields and productivities;</li> <li>▶ use indicators that are sensitive to both technology changes and stakeholders' perspectives when the assessment method requires the implementation of holistic multicriteria decision-making principles</li> </ul>

2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

2.2.2 PROCESSING AND MANUFACTURING

2.2.2.7 Biological services (use of biological data in biosafety and medicine)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">FDA Guidance on Conduct of Clinical Trials of Medical Products during COVID-19 Public Health Emergency (FDA, 2020)</a>	<p>The source includes good practices to conduct clinical trial during the COVID-19 public health emergency.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To assist in assuring the safety of trial participants, maintaining compliance with good clinical practice (GCP), and minimizing risks to trial integrity for the duration of the COVID-19 public health emergency</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 12,13</li> </ul>	<ul style="list-style-type: none"> <li>▶ obtain informed consent from patients in isolation;</li> <li>▶ trial modifications should address safety and seek to maintain integrity;</li> <li>▶ remote and digital assessments;</li> <li>▶ use risk-based approaches to prioritize sites for monitoring;</li> <li>▶ upload certified copies to a repository;</li> <li>▶ document any protocol deviation and missing data</li> </ul>
<a href="#">Antimicrobial movement from agricultural areas to the environment: The missing link. A role for nuclear techniques (FAO and IAEA, 2019)</a>	<p>This report includes nuclear techniques for monitoring antibiotics and antibiotic resistance in the environment.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To identify the impacts that antimicrobial resistance has on the environment and on public health and increase the knowledge on these impacts</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ bio-analytical quantification of antibiotics;</li> <li>▶ liquid chromatography;</li> <li>▶ determine the origin of antibiotic contamination;</li> <li>▶ calibrate with cultivated microorganisms</li> </ul>
<a href="#">The performance of antimicrobial susceptibility testing programmes relevant to aquaculture and aquacultural products (Smith, 2019)</a>	<p>This FAO technical paper addresses best practice guidelines for antimicrobial susceptibility testing of bacteria isolated from aquatic animals and their environments, carried out to provide guidance for clinical treatments of diseased animals. The guidelines are timely given the current attention given to antimicrobial resistance.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To provide guidance to countries with respect to standard susceptibility testing protocols, the quality control requirements and the respective interpretive criteria for bacteria isolated from aquatic animals</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 15</li> </ul>	<ul style="list-style-type: none"> <li>▶ use internationally standardized susceptibility testing protocols;</li> <li>▶ use epidemiological cut-off values that are agent-specific, protocol-specific and species-specific to facilitate categorizing</li> </ul>
<a href="#">Good Review Management Principles and Practices for New Drug Applications and Biologics License Applications (FDA, 2018)</a>	<p>The document provides good management principles and practices for the review of new drug applications, biologics license applications or efficacy supplements with clinical data.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure that the review process is managed in a consistent and efficient manner and enhances patients' timely access to important therapies</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 12,13</li> </ul>	<ul style="list-style-type: none"> <li>▶ establish review planning and timelines specific to the application;</li> <li>▶ provide clear and concise documentation of the scientific review and regulatory decision;</li> <li>▶ maintain effective communication between the review team and applicant</li> </ul>



## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.2 PROCESSING AND MANUFACTURING

## 2.2.2.7 Biological services (use of biological data in biosafety and medicine)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Guidelines for planning genomic assessment and monitoring of locally adaptive variation to inform species conservation (Flanagan, 2017)</a>	<p>The report includes good practices in conducting genomic studies of local adaptations to identify and monitor locally adaptive genetic variations.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To inform conservation actions and help conserve species at risk</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,12</li> </ul>	<ul style="list-style-type: none"> <li>▶ design the sampling and genotyping protocols;</li> <li>▶ assemble and align the sequence reads;</li> <li>▶ analyse the genomic assessment and identify adaptive variation;</li> <li>▶ make and assessment;</li> <li>▶ design the monitoring plan;</li> <li>▶ interpret genetic and other indicators for monitoring;</li> <li>▶ analyse monitoring data to detect temporal changes</li> </ul>
<a href="#">Guide to Delivering Phytosanitary Diagnostic Services (FAO, 2016b)</a>	<p>This International Plant Protection Convention guide provides good practices to support the establishment, operation and maintenance of diagnostic laboratories and services.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support national phytosanitary systems</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ diagnostic methods to detect and identify plant pests and diseases from metabolite analysis (mainly bacterial identification) through to DNA sequencing;</li> <li>▶ remote diagnostics for plant pests; reference collection for phytosanitary purposes containing fungi, parasitic plants, arthropods and other specimens</li> </ul>
<a href="#">Best Practices in Novel Biomarker Assay Fit-for-Purpose Testing (Lynch, 2016)</a>	<p>The paper includes good practices to evaluate the clinical or nonclinical utility of biomarkers, generally proteins.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure that biomarkers are robust and of acceptable quality</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 12,13,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ testing the efficacy of biomarkers utilized in drug development;</li> <li>▶ testing the safety of new therapeutic agents</li> </ul>
<a href="#">Guidelines for diagnostic next-generation sequencing (Matthijs, 2016)</a>	<p>The document and complementary material provide good practices to assist the laboratories in the implementation of next-generation sequencing.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support evaluation and validation of next-generation sequencing applications for the diagnosis of genetic disorders</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 12,13</li> </ul>	<ul style="list-style-type: none"> <li>▶ a simple rating system on the basis of coverage and diagnostic yield, should allow comparison of the diagnostic testing offer between laboratories;</li> <li>▶ next-generation sequencing should not be transferred to clinical practice without an acceptable validation of the tests according to the emerging guidelines;</li> <li>▶ the diagnostic laboratory has to take steps for long-term storage of all relevant data sets</li> </ul>
<a href="#">OECD Guidelines for quality assurance in molecular genetic testing (OECD, 2007b)</a>	<p>This report includes best practices for molecular genetic testing, including quality assurance, the monitoring of the quality of laboratory performance, the quality of result reporting, and education and training standards for laboratory personnel.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support the diagnosis of a particular disease or condition and predictive genetic testing</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 15</li> </ul>	<ul style="list-style-type: none"> <li>▶ molecular genetic testing should be delivered within the framework of health care;</li> <li>▶ personal genetic information should be subject to privacy protection and security in accordance with applicable law;</li> <li>▶ internationally accepted standard terminology and nomenclature should be adopted;</li> <li>▶ systems to monitor laboratory performance and address persistent poor performance should be in place</li> </ul>



## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.3 DISTRIBUTION AND CONSUMPTION

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Report of 2019 FAO Regional workshops on best practices to prevent and reduce abandoned, lost or discarded fishing gear in collaboration with the Global Ghost Gear Initiative (FAO, 2020j)</a>	<p>The report includes good practices for addressing fishing-related marine debris in particular abandoned, lost or discarded fishing gear. It also presents best available information that supports further development of best practices for the management of fishing gear, and provisions required within international instruments.</p> <p>► <b>Source objectives:</b> To reduce pollution from fish gear and increase understanding and awareness of the Voluntary Guidelines for the Marking of Fishing Gear (VGMFG) and relevant best practices as outlined in the Global Ghost Gear Initiative's Best Practice Framework for the Management of Fishing Gear (BPF)</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,4</p>	<ul style="list-style-type: none"> <li>► to use biodegradable materials, recovery programmes and intelligent devices to reduce their impact when they drift outside of their fishing zone and to minimize ghost fishing; encourage research on biodegradable and non-entangling fish aggregating device and incentivize their use with pilot projects;</li> <li>► include relevant good practices in eco-labelling assessments and accreditations and in fisheries management programmes;</li> <li>► use environmentally friendly marking technologies</li> </ul>
<a href="#">Guidance on consumer behaviour (WRAP, 2020c)</a>	<p>The source contains good practices for extending the life of textiles, from the improved use by consumers to the improved design by brands and retailers, to enhance the durability and quality of the clothing. The source also improves understanding that clothes, despite their condition, can often be re-used, repaired and up-cycled, and that organizations can gain revenue from selling 'bulk' textiles for re-use/recycling.</p> <p>► <b>Source objectives:</b> To encourage repair and ensure more clothing and non-clothing textiles are collected for re-use and recycling; and reduce the carbon, water and waste footprints associated with clothing supply, use and disposal</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 9</p>	<ul style="list-style-type: none"> <li>► consumers have the ability to repair or alter clothes;</li> <li>► second-hand clothing is used, either by consumers buying it or by textile merchants using it to produce new clothes;</li> <li>► producers of textiles design features such as classic cut and fit and built-in adjustability to promote comfort and a versatile fit, and use resilient fabrics, dyes and colours;</li> <li>► selection of fabric that improves social and environmental sustainability, reduces carbon, water and waste footprints, and extends clothing life</li> </ul>
<a href="#">Food Labels: Tricks of the Trade Our recipe for honest labels in the EU (BEUC, 2018)</a>	<p>This report by the European Consumer Organisation (BEUC) showcases misleading practices that food makers commonly use on labels across the European Union and that should be avoided.</p> <p>► <b>Source objectives:</b> To provide consumers with accurate information about the food they buy</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 15</p>	<ul style="list-style-type: none"> <li>► limit industrial products being labelled 'traditional', 'artisanal';</li> <li>► limit drinks and dairy with little or no actual fruit displaying fruit pictures;</li> <li>► limit breads, biscuits, pasta, and other products with barely any fibre labelled as 'whole grain'</li> </ul>
<a href="#">Nordic Best Practices relevant for UNEP 10-year framework of programmes on Sustainable Buildings &amp; Construction and Sustainable Food Systems (Nordic Council of Ministers, 2018)</a>	<p>The report includes practice cases covering sustainable lifestyles and education, sustainable public procurement, sustainable tourism, consumer information for sustainable consumption and production, sustainable buildings and construction, as well as sustainable food systems. The good practices are called 'sustainability impacts'.</p> <p>► <b>Source objectives:</b> Each case study has its own objective, and contributes to the overall objective of transforming global consumption and production patterns and food systems</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 9</p>	<ul style="list-style-type: none"> <li>► promote climate-smart building, which contributes to lower energy consumption and a healthy indoor climate;</li> <li>► raise people's awareness of nature and wildlife;</li> <li>► use of insects as sustainable food including insect feeding on certain types of side streams from the food industry;</li> <li>► encourage public kitchens to go organic</li> </ul>
<a href="#">Model guidance for the storage and transport of time- and temperature-sensitive pharmaceutical products (WHO, 2011b)</a>	<p>The source include good practices in the distribution, storage, quality management, heating, ventilating and air-conditioning, and other handling operations of pharmaceutical products, especially for vaccines and biologicals, that need a cold chain. The practices are based upon good practice documents from World Health Organization (WHO) and other international sources.</p> <p>► <b>Source objectives:</b> To ensure safe storage and distribution of time- and temperature-sensitive pharmaceutical products</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 15</p>	<ul style="list-style-type: none"> <li>► calibrate and verify control and monitoring devices;</li> <li>► monitor temperature in shipping containers;</li> <li>► clean road vehicles and containers;</li> <li>► keep record of temperature and humidity;</li> <li>► carry out environmental management of refrigerators</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.4 CIRCULARITY (REPLACE, REDUCE, REUSE, RECYCLE AND RECOVER)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>Critical success and risk factors for circular business models valorising agricultural waste and by-products (Donner <i>et al.</i>, 2021)</b></p>	<p>The article includes good practices in agro resources valorization. They are success factors of circular business models elucidated from 39 business cases of agricultural waste and by-product valorisation.</p> <p>► <b>Source objectives:</b> To contribute to a circular economy via eco-innovative business models that valorize agricultural unavoidable waste or by-products</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,5,9</p>	<ul style="list-style-type: none"> <li>► use optimal logistic model for in and out flows;</li> <li>► use local biomass resources based on long-term contracts for high security of supply;</li> <li>► joint investment in R&amp;D and demonstration plants;</li> <li>► development of local areas by exploiting old industrial sites that are decommissioned</li> </ul>
<p><b>Circular economy good practice dataset (EU, 2020)</b></p>	<p>The source includes good practices in different sectors and areas of circular economy including agriculture, food and bio-based industries. It looks at production, consumption, waste management, secondary raw materials, and innovation and investments. Sustainability criteria for the selection are also considered (e.g. sourcing sustainable feedstock, 'closing the loop').</p> <p>► <b>Source objectives:</b> To address challenges on behavioral change, the cross-border shipment of waste, price volatility, insufficient demand, the harmonization of European Union legislation</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 9</p>	<ul style="list-style-type: none"> <li>► a vertical constructed wetland with plants for treating greywater from handwash basins, showers, and laundries;</li> <li>► a process that allows extracting cellulose fibres from orange peel and spin them into biodegradable yarn;</li> <li>► a biopolymer made from waste cooking oil</li> </ul>
<p><b>Textiles for Circular Fashion. Part 1: Fibre resources and recycling (Harmsen and Bos, 2020)</b></p>	<p>The source is a booklet from University of Wageningen about options for better recycling of clothes. Of interest is the post-consumer recycling of garments, which is a significant challenge because of the heterogeneity of blended textiles.</p> <p>► <b>Source objectives:</b> To enhance sustainability in textile production, increase the recycling of clothes and increase efficiency in the use of resources in order to reduce the consumption of raw materials</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 9,13</p>	<ul style="list-style-type: none"> <li>► sort the non-wearable fraction of post-consumer textiles;</li> <li>► use physical, mechanical or chemical recycling for monomaterials;</li> <li>► dissolve cellulose for regenerated cellulose fibres;</li> <li>► design for disassembly;</li> <li>► stimulate the use of natural fibres as they are based on renewable resources and have good recycling options;</li> <li>► invest in research and development for a bio-based alternative for elastane that causes no problems during recycling</li> </ul>
<p><b>Potential Use of Earthworms to Enhance Decaying of Biodegradable Plastics (Sanchez-Hernandez, Capowiez, and Ro, 2020)</b></p>	<p>This paper includes good practices in the use of earthworms to address unfavorable environmental conditions for plastic polymer biodegradation in the soil. This includes conditions for plastic deterioration, microbial colonization, the production of polymer-degrading exoenzymes and mineralization.</p> <p>► <b>Source objectives:</b> To increase the biodegradation rate of biodegradable polymers in the field, and reduce plastic pollution in agro-ecosystems</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,9,15</p>	<ul style="list-style-type: none"> <li>► use soil alteration (bioturbation); enhance bioturbation by inoculating agricultural soils with soil-dwelling earthworms, where using biodegradable mulching films increases plastic debris in the soil;</li> <li>► use solid organic wastes decomposition (vermicomposting);</li> <li>► blend vermicompost with biodegradable plastic debris and solid organic wastes, which is complementary to the industrial or home composting of single-use biodegradable plastics</li> </ul>
<p><b>Technical brief on water, sanitation, hygiene and wastewater management to prevent infections and reduce the spread of antimicrobial resistance (WHO, FAO and OIE, 2020b)</b></p>	<p>This technical brief provides good practices on wastewater treatment and provides good policies to support their implementation.</p> <p>► <b>Source objectives:</b> To reduce antimicrobial resistance through activities related to water, sanitation, hygiene and wastewater management</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 15</p>	<ul style="list-style-type: none"> <li>► promote integrated manure management to reduce the negative impact on the survival of pathogens and the stability of antimicrobials and to prevent nutrient losses;</li> <li>► promote and incentivize investment in life cycle analysis, green technology and efficient operation of wastewater and sludge treatment within antimicrobial manufacturing operations for pollution control</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.4 CIRCULARITY (REPLACE, REDUCE, REUSE, RECYCLE AND RECOVER)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Viability of bio-based chemicals from food waste</b> (Wain <i>et al.</i> , 2019)	<p>This deliverable from the REFRESH (Resource Efficient Food and Drink for the Entire Supply Chain) Project includes good practices in using mixed post-consumer organic putrescible food waste to produce fuels and chemicals from and select bacterial strains for growth on food waste. The project includes noteworthy studies on a range of issues (e.g. safety, environmental and economic aspects of feeding treated surplus food to omnivorous livestock, the valorization of food surpluses and side-flows and citizens' understanding).</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To investigate and increase knowledge on the production of fuels and chemicals from mixed, post-consumer food waste and the selection of bacterial strains for growth on food waste</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,5,13</li> </ul>	<ul style="list-style-type: none"> <li>▶ identify specific strains of bacteria that can successfully utilize unavoidable food waste have been identified, genetically characterized and grown for production of fine chemicals;</li> <li>▶ genetic engineering of bacteria;</li> <li>▶ sequencing for optimization of protocols</li> </ul>
<b>Lessons and recommendations document to regional authorities and policy makers</b> (BIOREG, 2018a)	<p>The BIOREG Project (Absorbing the Potential of Wood Waste in European Union Regions and Industrial Bio-based Ecosystems) Project has produced a set of recommendations on classifying wood waste products, enhancing their collection, sorting waste, and recovering material and energy.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To influence bioeconomy strategies by realizing the potential of the sustainable valorization of wood waste</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,12</li> </ul>	<ul style="list-style-type: none"> <li>▶ lower landfilling through either banning waste likely to be recycled or recovered, or increasing the waste tax;</li> <li>▶ co-generation to recover energy and materials</li> </ul>
<b>Recommendations for industry stakeholders</b> (BIOREG, 2018b)	<p>The BIOREG (Absorbing the Potential of Wood Waste in European Union Regions and Industrial Bio-based Ecosystems) Project has produced a set of good practices for the use of wood waste.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support the sustainable valorization of wood waste and support the development of the wood value chain</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ recycle in consideration of the maximum levels of contaminants in the wood waste used in the composition of panels and finished products;</li> <li>▶ cascade use of biomass</li> </ul>
<b>The circular economy and the bioeconomy. Partners in sustainability</b> (de Schoenmakere <i>et al.</i> , 2018)	<p>The report covers good practices in production that can contribute to the transition to a circular bioeconomy. They are public and private practices regarding new materials and production methods and multipurpose crops. The practices valorize residues, biowaste treatment, and product and material lifespans.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> <ul style="list-style-type: none"> <li>▶ replace fossil-based products</li> <li>▶ expand farmland</li> <li>▶ intensify biomass production</li> <li>▶ source aquatic biomass</li> <li>▶ change consumer behaviour</li> <li>▶ separate biological and technical material cycles</li> <li>▶ improve nutrient balance</li> <li>▶ improve energy balance</li> </ul> </li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ biorefinery plants;</li> <li>▶ multipurpose crops;</li> <li>▶ biowaste treatment;</li> <li>▶ extending the lifetime of bio-based products;</li> <li>▶ renew and repair schemes for durable bio-based products;</li> <li>▶ composting and anaerobic digestion</li> </ul>
<b>Guidance on cascading use of biomass with selected good practice examples on woody biomass</b> (EC, 2018a)	<p>The document includes good practices taken from the private sector that provide inspiration on how the circular economy promotes the efficient use of bio-based resources, including the cascading use of biomass. It also includes other aspects including options for linking wood suppliers with buyers to improve mutual efficiency and competitiveness.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> Practices contribute to fulfill the cascading principles:                     <ul style="list-style-type: none"> <li>▶ sustainability</li> <li>▶ resource efficiency</li> <li>▶ circularity in every stream and at every step</li> <li>▶ new products and new markets</li> <li>▶ subsidiarity</li> </ul> </li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,11</li> </ul>	<ul style="list-style-type: none"> <li>▶ micro- and nano-fibrillated cellulose; multi-purpose materials offering diverse solutions across industrial sectors;</li> <li>▶ sulphite processing;</li> <li>▶ the ligno-sulphonate path to multi-product manufacturing</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.4 CIRCULARITY (REPLACE, REDUCE, REUSE, RECYCLE AND RECOVER)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Good and Best Practice Handbook for the collection of paper and board for recycling (ImpactPapeRec, 2018)</b>	<p>The Handbook is an output of ImpactPapeRec, a European Union Horizon 2020 project completed in March 2018. The handbook contains 34 good practices regarding operations; policy, legislative and economic aspects; monitoring and control; and information and communication.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> Practices address different areas of need corresponding to the most critical business questions concerning the collection of paper and board</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ user-friendly collection containers;</li> <li>▶ 'pay-as-you-throw' scheme;</li> <li>▶ filling level control for containers</li> </ul>
<b>Circularise: white paper (Licht et al., 2018)</b>	<p>The source is a circular economy protocol to build a decentralized information storage and communication platform to allow information exchange between participants in value chains.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To make circular economy function; increase the use of recycled content and decrease the use of virgin plastic; and create an open standard for sharing data about where resins or materials originate</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9,12</li> </ul>	<ul style="list-style-type: none"> <li>▶ blockchain for tracing plastics;</li> <li>▶ peer-to-peer technology;</li> <li>▶ cryptographic techniques (e.g. zero-knowledge proofs);</li> <li>▶ ring signatures;</li> <li>▶ immutable storage</li> </ul>
<b>Realising the circular bioeconomy (Philp and Winickoff, 2018)</b>	<p>The report presents good practices on waste utilization and biorefining. It also gives examples of negative/avoidable practices (e.g. illegal practices in raw materials trade and illegal logging).</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> The report presents the overall policy goals and sustainability goals, including the SDGs, that waste biorefining addresses. However, they are explicitly mentioned only in some of the cases. Examples are:                             <ul style="list-style-type: none"> <li>▶ rural job creation and regional development;</li> <li>▶ the reduction of pressure on land resources;</li> <li>▶ greenhouse gas emissions savings;</li> <li>▶ pollution prevention</li> </ul> </li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ turn bread waste to succinic acid;</li> <li>▶ turn fish waste to fish feed and cascading use;</li> <li>▶ turn gas to fish feed;</li> <li>▶ make electricity from wastewater through microbial electrolysis cells</li> </ul>
<b>Eight business cases for the circular economy (WBCSD, 2017)</b>	<p>The source includes business practices that managers can use to apply circular economy in their businesses and sectors, regarding returns on investment, cost-benefit ratios and other factors. Sixteen examples of private companies are presented in the report. Each company example touches on more than one of the eight business cases.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> The eight business cases fall under one of these three categories: accelerate growth, increase competitive advantage and mitigate risk</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ companies can insulate themselves against linear risks by purchasing circular supplies;</li> <li>▶ recovering resources at end of life;</li> <li>▶ partnering with the public sector</li> </ul>
<b>Good practice cases in practical applications of agro and forestry side-streams processing - AGRIFORVALOR project 2016-2018 (Kess et al., 2016)</b>	<p>The source compiles cases of practical applications and technologies at mature stage that valorize agricultural and forestry biomass sidestreams (e.g. bark, straw fibers, sewage sludge) into food, feed, functional materials and fine chemicals, fertilizers and fuel applications (e.g. olive-based leather tanning; textile and biopolymers from milk; sweetener from wood).</p> <p>The cases include good practices and drivers of success. The impact on sustainability is described, including the environmental benefits. There is an associated online database (<a href="http://www.agriforvalor.eu/sidestreams">www.agriforvalor.eu/sidestreams</a>).</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> Practices contribute to economic viability, improve effectiveness of the technique, contribute to environmental and economic sustainability, reduce waste and improve quality, reduce risks, among others</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 5</li> </ul>	<ul style="list-style-type: none"> <li>▶ integrated energy use;</li> <li>▶ recovery of phosphorus;</li> <li>▶ water reuse;</li> <li>▶ advanced filtering techniques to reduce emissions</li> </ul>

## 2.2 UTILIZATION OF BIOLOGICAL RESOURCES TO PROVIDE PRODUCTS, PROCESSES AND SERVICES

## 2.2.4 CIRCULARITY (REPLACE, REDUCE, REUSE, RECYCLE AND RECOVER)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Mapping study on cascading use of wood products (Dammer et al., 2016)</b>	<p>This report by Mondi Group and World Wide Fund for Nature (WWF) summarizes good practices and lessons extracted from an analysis of six countries.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To contribute to more resource efficiency and consequently reduce pressure on the environment</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ establish a reliable classification and sorting systems of post-consumer wood for functional recycling;</li> <li>▶ reduce bioenergy subsidies since the first use (material or energy) determines the final material flows;</li> <li>▶ look at a wide sweep of policies such as waste collection and management policies, sequestration measures, forest management strategies, resource efficiency strategies, regulations and energy policies</li> </ul>
<b>Biowaste biorefining: an issues paper (OECD, 2015a)</b>	<p>This report presents three good practices in biowaste use for biorefining and explains the issues surrounding their implementation and policy implications.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To use waste to reduce pressure on land and other natural resources</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 9</li> </ul>	<ul style="list-style-type: none"> <li>▶ cellulosic biorefining;</li> <li>▶ municipal solid waste biorefining;</li> <li>▶ capturing and fermenting industrial waste carbon and other gases to produce bio-based products using microorganisms</li> </ul>

## 2.3 CONSERVATION AND REGENERATION OF BIOLOGICAL RESOURCES

## 2.3.1 MAINTAINING THE DIVERSITY OF GENETIC RESOURCES WITHIN SPECIES AND BETWEEN SPECIES

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Voluntary Guidelines for the Conservation and Sustainable Use of Farmers' Varieties/Landraces (FAO, 2019f)</b>	<p>This report includes good practices for the conservation and sustainable use of plant genetic resources to improve resilience in farming systems and address the continuing reduction in the total number of different varieties grown and loss of diversity.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support countries to prepare national plans for the conservation and sustainable use of farmers' varieties</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 8,10</li> </ul>	<ul style="list-style-type: none"> <li>▶ undertake agro-botanic assessments and genetic data analysis;</li> <li>▶ verify and correct collected data on farmers' varieties/landraces;</li> <li>▶ identify criteria that indicate threats;</li> <li>▶ conduct a conservation gap analysis</li> </ul>
<b>Tropical fruit tree diversity: good practices for <i>in situ</i> and on-farm conservation (Sthapit et al., 2016)</b>	<p>The source covers agricultural practices to sustainably use and maintain the diversity of crop species worldwide.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support the maintenance of tropical fruit tree diversity <i>in situ</i> and contribute to sustainable livelihoods, food security and ecosystem services</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3</li> </ul>	<ul style="list-style-type: none"> <li>▶ community biodiversity management as an approach for realizing on-farm management of agricultural biodiversity;</li> <li>▶ identify and strengthen the roles and rights of custodian farmers;</li> <li>▶ use intraspecific crop diversity to manage pests and pathogens</li> </ul>
<b>Second global plan of action for plant genetic resources for food and agriculture (CGRFA and FAO, 2012)</b>	<p>The source includes globally-agreed good practices for conservation and sustainable use of plant genetic resources. It was prepared under the aegis of the Commission on Genetic Resources for Food and Agriculture (CGRFA) and adopted by the FAO Council on 29th November 2011.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support <i>in situ</i> and <i>ex situ</i> conservation and sustainable use of plant genetic resources for food and agriculture</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,8</li> </ul>	<ul style="list-style-type: none"> <li>▶ surveying and inventorying plant genetic resources for food and agriculture;</li> <li>▶ supporting targeted collecting of plant genetic resources for food and agriculture;</li> <li>▶ promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species</li> </ul>
<b>The state of <i>in situ</i> management (FAO, 2010)</b>	<p>The report includes good management practices for conservation and management of diversity in wild ecosystems, agricultural production systems and the interface between the two.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To increase awareness of plant genetic resources for food and agriculture and increase capacities for conserving and managing diversity <i>in situ</i></li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,6,10</li> </ul>	<ul style="list-style-type: none"> <li>▶ add value through characterizing local materials;</li> <li>▶ improve local materials through breeding and seed processing;</li> <li>▶ increase consumer demand through market incentives and public awareness</li> </ul>

## 2.3 CONSERVATION AND REGENERATION OF BIOLOGICAL RESOURCES

## 2.3.1 MAINTAINING THE DIVERSITY OF GENETIC RESOURCES WITHIN SPECIES AND BETWEEN SPECIES

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">In situ conservation of wild plant species. A critical global review of good practices (Heywood and Dulloo, 2005)</a>	<p>The source is an International Plant Genetic Resources Institute (now known as Bioversity International) and FAO report that describes various good practices of <i>in situ</i> conservation and the main steps needed for developing a conservation strategy for target species.</p> <p>► <b>Source objectives:</b> To provide guidance on choices while implementing conservation techniques and procedures and in conducting the experimentation required to adapt these to local operating conditions and target species</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► species-based and ecosystem-based approaches;</li> <li>► priority-setting for target species;</li> <li>► planning, design and setting up <i>in situ</i> conservation areas;</li> <li>► management and monitoring;</li> <li>► incorporating the conservation strategy into national biodiversity strategy and action plans</li> </ul>
<a href="#">Best practices for in situ conservation of economically important wild species (UNEP/GEF, FAO, IPGRI and DIVERSITAS, 2003)</a>	<p>The source includes good practices for planning of <i>in situ</i> conservation and incorporating include gender and other issues.</p> <p>► <b>Source objectives:</b> To maintain populations of plant species in their natural, agricultural or horticultural habitat, thereby maintaining the evolutionary processes that shape the genetic diversity and adaptability of plant populations</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► determine or infer the genetic structure of the priority species at the landscape level;</li> <li>► assess the conservation status of the target species and their populations; organize and plan specific conservation activities;</li> <li>► take into consideration gender in understanding the traditional management of genetic resources at the community level</li> </ul>

## 2.3 CONSERVATION AND REGENERATION OF BIOLOGICAL RESOURCES

## 2.3.2 MAINTAINING THE DIVERSITY OF ECOSYSTEMS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Globally Important Agricultural Heritage Systems (GIAHS) (FAO, 2020k)</a>	<p>The source covers sustainable agriculture heritage practices utilized in designated outstanding landscapes of aesthetic beauty located in specific sites that combine agricultural biodiversity, resilient ecosystems and a valuable cultural heritage. They are ancestral and unique agricultural systems that constitute the foundation for contemporary and future agriculture. They contribute to the dynamic conservation of biological resources and support well-functioning ecosystem services.</p> <p>► <b>Source objectives:</b></p> <ul style="list-style-type: none"> <li>► contribute to food and livelihood security</li> <li>► conserve globally significant agro-biodiversity</li> <li>► maintain local and traditional knowledge systems</li> <li>► represent cultures, value systems and social organizations</li> <li>► maintain stability in the landscapes and seascapes</li> </ul> <p>Each one also relates to several SDGs.</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,6</p>	<ul style="list-style-type: none"> <li>► the centuries-old practice of Qanat-based water management system for saffron cultivation in Iran;</li> <li>► a traditional ancient olive tree cultivation system, rain-fed, manually harvested, and deeply rooted in the area of Sénia, Spain including a manual of best practices for the olive oil production process using written and oral tradition since the 12th century;</li> <li>► a rice-fish system and its mulberry-dyke and fish-pond system in China</li> </ul>
<a href="#">Tourism for Development – Volume I: Key Areas for Action (UNWTO, 2018)</a>	<p>The document provides guidelines on implementing tourism practices that support the conservation of biological resources. The SDGs constitute the sustainability framework adopted by the report. At the end of the report cross-cutting policies and monitoring and evaluation tools are presented.</p> <p>► <b>Source objectives:</b> Good practices are classified by the five pillars of the International Year of Sustainable Tourism for Development (IY2017):</p> <ol style="list-style-type: none"> <li>1. Sustainable economic growth</li> <li>2. Social inclusiveness, employment and poverty reduction</li> <li>3. Resource efficiency, environmental protection and climate change</li> <li>4. Cultural values, diversity and heritage</li> <li>5. Mutual understanding, peace and security</li> </ol> <p>► <b>Bioeconomy Strategy Objectives:</b> 15</p>	<ul style="list-style-type: none"> <li>► using resources more efficiently;</li> <li>► conserving biodiversity and protecting the natural environment;</li> <li>► safeguarding and promoting cultural heritage</li> </ul>
<a href="#">IUCN Guidelines for privately protected areas (Mitchell et al., 2018)</a>	<p>The report gives guiding principles and best practices on all aspects of the establishment, management and reporting of privately protected areas.</p> <p>► <b>Source objectives:</b> Good practices are grouped under 34 principles aimed to enhance effectiveness and conservation</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► incorporate indigenous, local and traditional people and their knowledge, including traditional ecological knowledge into management where appropriate;</li> <li>► where a legal instrument is not possible, agreements should be renewable and the conservation intent should be in perpetuity</li> </ul>



2.3 CONSERVATION AND REGENERATION OF BIOLOGICAL RESOURCES

2.3.2 MAINTAINING THE DIVERSITY OF ECOSYSTEMS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Wilderness Protected Areas: Management guidelines for IUCN Category 1b protected areas (IUCN, 2016)</b>	<p>The report describes principles for wilderness management, which include good practices. These Guidelines are in line with previously published Best Practice Guidelines, Ecological Restoration of Protected Areas in 2012 by the World Commission on Protected Areas.</p> <p>► <b>Source objectives:</b> The practices for wilderness protection seek to improve several areas:</p> <ul style="list-style-type: none"> <li>► recreation and access</li> <li>► traditional ways of life</li> <li>► cultural and spiritual uses</li> <li>► education and science</li> </ul> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► work closely with indigenous peoples, tribes and local communities who can identify important cultural sites within a wilderness area to maintain cultural practices and avoid environmental degradation;</li> <li>► management practices should be adjusted to allow sacred and traditional practices to be observed wherever appropriate;</li> <li>► captive breeding of endangered species</li> </ul>
<b>High Nature Value Farming throughout EU-27 and its financial support under the CAP (Keenleyside et al., 2014)</b>	<p>Table 2.1 of the source gives examples of high nature value farming practices.</p> <p>► <b>Source objectives:</b> To provide maintenance of biodiversity and other environmental benefits</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,8</p>	<ul style="list-style-type: none"> <li>► low intensity environmentally sensitive maintenance techniques (e.g. cutting reeds, hedges, cleaning ditches);</li> <li>► spring sowing of crops;</li> <li>► crops grown on terraces;</li> <li>► encourage regeneration of characteristic native tree and shrub species</li> </ul>
<b>Guide for Sustainable Tourism Best Practices (Rainforest Alliance, 2010)</b>	<p>This manual presents good practices for corrective or improved measures to be implemented in tourist business management and operations. It covers many areas, with flora and fauna, natural areas and conservation and landscaped areas and gardens being the most pertinent for the bioeconomy.</p> <p>► <b>Source objectives:</b> To ensure that tourism causes the least possible impact; the quality of tourism products and its image are improved; and tourism business development becomes more efficient, and furthers social and economic development</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,6</p>	<ul style="list-style-type: none"> <li>► creating and maintaining biological corridors;</li> <li>► zoning to determine what areas can be used for tourism, protection, research, and other purposes;</li> <li>► building a composter that can be a simple ventilated wooden framework that rests directly on the ground with a cover to prevent fly proliferation</li> </ul>

2.3 CONSERVATION AND REGENERATION OF BIOLOGICAL RESOURCES

2.3.3 MAINTAINING THE FUNCTIONING OF ECOSYSTEM SERVICES

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Types of Ecosystem Restoration (FAO and UNEP, 2020)</b>	<p>This source includes good practices in restoring different ecosystems, from forests and farmlands to freshwater, oceans and coasts.</p> <p>► <b>Source objectives:</b> To restore ecosystems</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► strengthening governance systems, such as secure tenure and participatory rangeland management;</li> <li>► tree planting needs to be done preserving natural habitats for species such as grassland-loving birds;</li> <li>► increased forest cover to reduce mountain erosion</li> </ul>
<b>Guide for Establishing and Maintaining Pest Free Areas (FAO, 2019g)</b>	<p>This International Plant Protection Convention document provides good practices on phytosanitary procedures in the implementation and maintenance of pest free areas and areas of low pest prevalence.</p> <p>► <b>Source objectives:</b> To overcome the challenges and maximize the impact of efforts to establish and maintain pest free areas</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,3,4</p>	<ul style="list-style-type: none"> <li>► ensure budget stability;</li> <li>► conduct public outreach;</li> <li>► provide availability of good survey and control tools;</li> <li>► promote open engagement with stakeholders and trading partners</li> </ul>
<b>RSPO Manual on Best Management Practices (BMPs) for Management and Rehabilitation of Peatlands. 2nd edition (Parish et al., 2019).</b>	<p>This Roundtable on Sustainable Palm Oil (RSPO) manual deals with the management of peat swamp forests and degraded peat sites. It also addresses landscape approaches, conservation and buffer zones, connectivity and ecological links and water management.</p> <p>► <b>Source objectives:</b> The practices aim to minimize GHG emissions and enhance sustainability. The manual also helps meeting the sustainability criteria included in three of the Roundtable on Sustainable Palm Oil (RSPO) Principles and Criteria for Sustainable Palm Oil and other elements, included the Indonesian Sustainable Palm Oil (ISPO) Principles and Criteria</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,3,4</p>	<ul style="list-style-type: none"> <li>► bury the bases of the replanted seedlings;</li> <li>► block drainage ditches;</li> <li>► weed twice a month;</li> <li>► take inventory of existing plants and incorporate this information into rehabilitation plans</li> </ul>



## 2.3 CONSERVATION AND REGENERATION OF BIOLOGICAL RESOURCES

## 2.3.3 MAINTAINING THE FUNCTIONING OF ECOSYSTEM SERVICES

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Guide on the production of assessments (IPBES, 2018)</b>	<p>This guide by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) includes good practices for the assessment of ecosystem services.</p> <p>► <b>Source objectives:</b> To strengthen the science-policy interface for understanding the dynamics in human-nature interactions</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► include indigenous and local knowledge systems in the assessment; consider capacity development;</li> <li>► work with key partners on the use of findings</li> </ul>
<b>Global Guidelines for the restoration of degraded forests and landscapes in drylands (FAO, 2015b)</b>	<p>This FAO report includes good practices in the restoration of degraded land. It also includes sound policies to create the right enabling environment and develop monitoring systems.</p> <p>► <b>Source objectives:</b> To build resilience and benefit livelihoods</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,8</p>	<ul style="list-style-type: none"> <li>► choose the most cost-effective restoration strategy;</li> <li>► protect and manage drylands;</li> <li>► assist natural regeneration</li> </ul>
<b>Bioremediation, an environmental remediation technology for the bioeconomy (Gillespie and Philp, 2013)</b>	<p>The paper shows good bioremediation practices and technologies for land decontamination such as ecogenomics.</p> <p>► <b>Source objectives:</b> To promote regulatory compliance, and increase the acceptance of new techniques</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,15</p>	<ul style="list-style-type: none"> <li>► air sparging;</li> <li>► genetic modification to improve the rate of biodegradation;</li> <li>► advent of -omics technologies (e.g. biosensors based on bioluminescence methods)</li> </ul>
<b>Ecological restoration for protected areas: principles, guidelines and best practices (IUCN, 2012)</b>	<p>The report presents good practices that provide guidance for stakeholders involved in implementing restoration of natural and associated values in protected areas. It includes examples that illustrate on-the-ground experiences with ecological restoration in and around protected areas.</p> <p>► <b>Source objectives:</b> To re-establish and maintain protected area values; to maximize beneficial outcomes while minimizing costs in time, resources, and effort; and to foster collaboration with partners, promoting participation and enhancing visitor experience</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,15</p>	<ul style="list-style-type: none"> <li>► restoration through improved ecosystem management;</li> <li>► restoration through improved species interactions;</li> <li>► restoration that involves collaboration in community-conserved protected areas</li> </ul>

**3. PROVIDING SUSTAINABLE SOLUTIONS (INFORMATION, PRODUCTS, PROCESSES AND SERVICES) WITHIN AND ACROSS ALL ECONOMIC SECTORS AND ENABLING A TRANSFORMATION TO A SUSTAINABLE ECONOMY (I.E. THE ENABLING ENVIRONMENT)**

**3.1 MIXED POLICIES (REGULATORY, ECONOMIC, VOLUNTARY, OTHERS)**

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>Universal Circular Economy Policy Goals (Ellen MacArthur Foundation, 2021)</b></p>	<p>The document provides policy measures that governments and businesses can apply and align to achieve their common objectives. They are applicable across sectors and local contexts.</p> <p>► <b>Source objectives:</b></p> <ul style="list-style-type: none"> <li>► Stimulate design for the circular economy</li> <li>► Manage resources to preserve value</li> <li>► Make the economics work</li> <li>► Invest in innovation, infrastructure, and skills</li> <li>► Collaborate for system change</li> </ul> <p>► <b>Bioeconomy Strategy Objectives:</b> 9</p>	<ul style="list-style-type: none"> <li>► implementing spatial planning policies to enhance material flow and use, and creating business opportunities such as industrial symbiosis;</li> <li>► incorporating circular economy principles into trade policies;</li> <li>► accelerating progress through measurement and use of data;</li> <li>► supporting blended finance solutions for physical and digital infrastructure, and innovation</li> </ul>
<p><b>Good Practice Guides (CBD, 2020)</b></p>	<p>This source from the Convention on Biological Diversity includes good practices for the utilization of biodiversity to prevent its long-term decline in a range of sectors and development themes: tourism for nature; sustainable forest management; pastoralism; drinking water; poverty alleviation; ecosystem goods and services; and human health. The good practices cover policy considerations, management tools, market-based instruments and capacity-building methods.</p> <p>► <b>Source objectives:</b> To support biodiversity conservation and poverty reduction</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,11,12,15</p>	<ul style="list-style-type: none"> <li>► implement payments for ecosystem (or environment) services financing schemes;</li> <li>► strengthen capacities of national planning authorities;</li> <li>► have institutional mechanisms in place to improve cooperation between different sub-national levels of jurisdiction;</li> <li>► encourage access and benefit-sharing (e.g. the user of genetic resources sets up laboratories or a drug manufacturing facility in the provider country);</li> <li>► legal and normative tools that affect sustainable tourism development (e.g. laws and codes on zoning and land-use and construction)</li> </ul>
<p><b>Policy: EU policies relevant to the bioeconomy - key strategies, legislations and action plans (EC, 2020a)</b></p>	<p>The source is a web page with all sectoral and horizontal policies at the European level, as well as national and regional levels, that contribute to bioeconomy. The source includes the policy practices used by the European Commission and by regions and individual countries to support bioeconomy, particularly funding mechanisms and to some extent regulations.</p> <p>► <b>Source objectives:</b> To meet the bioeconomy objectives of the European Union (i.e. food security, sustainable natural resource management, reduced dependence on non-renewable resources, mitigation and adaption to climate change, and job creation)</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,2,3,4,6</p>	<ul style="list-style-type: none"> <li>► dedicate funding at the European Union, national and regional levels and provide financial instruments for research;</li> <li>► use horizontal policies for regulating cross-cutting issues (e.g. water, industry, trade and internal markets);</li> <li>► dedicate funds for implementing good practices, such as the guarantee fund of the common agricultural policy (CAP) that provides green direct payments to farmers if they adopt practices (e.g. crop diversification, the maintenance of permanent grassland), and dedicate 5 % of arable land to 'ecologically beneficial elements' (e.g. fallow land, hedges and trees)</li> </ul>
<p><b>Global Bioeconomy Policy Report (IV): A decade of bioeconomy policy development around the world (GBC, 2020a)</b></p>	<p>The source includes a list of policy measures to promote bioeconomy that countries either address in their bioeconomy strategy or implement after the strategy has been adopted. They are measures taken from a review of policy documents and initiatives in bioeconomy policy in approximately 60 countries. It is the fourth of a series of policy reports.</p> <p>► <b>Source objectives:</b> To support the holistic implementation of bioeconomy strategies and policies and fulfil bioeconomy objectives</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 12,14</p>	<ul style="list-style-type: none"> <li>► use public-private partnerships for stimulating private sector research and development;</li> <li>► establish technological platforms and campuses of excellence for knowledge and technology transfer;</li> <li>► mobilize private capital for bioeconomy in thematic investment platforms;</li> <li>► establish programs and coaching for regulators and investors to support bioeconomy development</li> </ul>
<p><b>Designing Sustainability Governance for the Bioeconomy – a Global Expert Survey (GBC, 2020b)</b></p>	<p>The source provides the results from an expert survey on future trends and developments in the bioeconomy carried out every two years, as it is one of the signature outputs of the Global Bioeconomy Summit. The document includes policy instruments and associated practices for promoting good governance.</p> <p>► <b>Source objectives:</b> To support good governance in the bioeconomy</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10</p>	<ul style="list-style-type: none"> <li>► inter-ministerial and inter-regional cooperation;</li> <li>► public reporting and multistakeholder dialogue;</li> <li>► learning and adaptive policy;</li> <li>► bioeconomy advisory council</li> </ul>

## 3.1 MIXED POLICIES (REGULATORY, ECONOMIC, VOLUNTARY, OTHERS)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>The systemic challenge of the bioeconomy: A policy framework for transitioning towards a sustainable carbon cycle economy (Marvik and Philp, 2020)</b></p>	<p>This paper presents a matrix of bioeconomy innovation policies, at national and value-chain levels.</p> <p>► <b>Source objectives:</b> To stimulate the availability of bio-resources; to strengthen skills and technology base; to trigger investments in new manufacturing; and to increase sustainability and value creation</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10,15</p>	<ul style="list-style-type: none"> <li>► biomass sustainability assessment studies;</li> <li>► international trade agreements;</li> <li>► private investment stimulating policies;</li> <li>► tax on carbon emissions;</li> <li>► price subsidies and product tax policies</li> </ul>
<p><b>An overview of suitable regional policies to support bio-based business models (POWER4BIO Project, 2020)</b></p>	<p>The report presents an overview of policy instruments to support bio-based business models. It is one of the deliverables of the project 'POWER4BIO' (emPOWERing regional stakeholders for realising the full potential of European BIOeconomy), which also has an online catalogue of 'bio-based solutions', including insect production, microbial fermentation, etc. in Europe and beyond, including information on environmental and social indicators, as well as profitability. Both the source and the catalogue are part of an online 'bioeconomy strategy toolkit' (POWER4BIO Project, 2021).</p> <p>► <b>Source objectives:</b> To regulate and stimulate the sustainable development of the bioeconomy</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,10,11</p>	<ul style="list-style-type: none"> <li>► product norms and fuel standards; restrictions on use of soil improvers on agricultural land;</li> <li>► support of infrastructure development such as forest roads, biomass hubs or yards;</li> <li>► taxes for fossil fuels in energy production</li> </ul>
<p><b>A sustainable food system for the European Union (SAPEA, 2020)</b></p>	<p>This report by the Science Advice for Policy by European Academies (SAPEA) provides a full chapter on good policies and standards for food systems, and an extensive list of good practice examples.</p> <p>► <b>Source objectives:</b> To increase sustainability in the way food is produced and consumed</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 1,10</p>	<ul style="list-style-type: none"> <li>► fiscal measures;</li> <li>► mass media campaigns;</li> <li>► nutrition and menu labelling in retail settings;</li> <li>► school fruit and vegetables;</li> <li>► develop regulations for more sustainable packaging;</li> <li>► support areas of potential such as artificial intelligence, robotization and sensors, genetics and the valorization of co-products</li> </ul>
<p><b>Policy initiatives for health and the bioeconomy (Borowieck and Philp, 2019)</b></p>	<p>This OECD report includes good biotechnology and life science policies across bioeconomy as well as health and biomedicine. There is also an accompanying report with case studies.</p> <p>► <b>Source objectives:</b> To translate biomedical research into clinical research and care; and build new kinds of innovation ecosystems for bio-based products</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13,15</p>	<ul style="list-style-type: none"> <li>► translational research promoted by national health agencies strategies;</li> <li>► funding for public health centres that translate biomedical research into clinical research and care;</li> <li>► cross-border public-private consortia centred around health research and innovation, with clearly defined policy missions that provide guidance for diverse stakeholders;</li> <li>► matching grants requiring private-sector participation</li> </ul>
<p><b>Towards sustainable bioeconomy: lessons learned from case studies (Gomez San Juan, Bogdanski and Dubois, 2019)</b></p>	<p>The source provides good practices (called success factors) for the successful implementation of sustainable activities, value chains and policies in the bioeconomy. The success factors were identified from a review of 26 case studies (government programmes, private sector activities, development projects, and research and development and innovation activities). They can be considered as building blocks of good practices in the enabling environment.</p> <p>► <b>Source objectives:</b> Each case study includes the success factors that help address specific sustainability issues. They are also screened against sustainability objectives in the 24 Principles and Criteria agreed upon by the ISBWG as well as the SDGs</p> <p>► <b>Bioeconomy Strategy Objectives:</b> All, particularly 3,9,11</p>	<ul style="list-style-type: none"> <li>► collaboration between public sector entities for inter-ministerial coordination;</li> <li>► regulation of purchasing agreements; the promotion of a value web approach;</li> <li>► adoption of territorial and landscape approaches in national or local planning;</li> <li>► integration of sectors and levels in policy;</li> <li>► facilitate tests for biodegradability, compostability and disintegration of bioproducts;</li> <li>► public certification of sustainability schemes;</li> <li>► ensure the fair distribution of benefits among value chain actors;</li> <li>► provide incentives and establish supportive public mechanisms</li> </ul>
<p><b>Enabling the Advanced Bioeconomy through Public Policy Supporting Biofoundries and Engineering Biology (Kitney et al., 2019)</b></p>	<p>The document provides policy options to support engineering biology as an integral part of a bioeconomy.</p> <p>► <b>Source objectives:</b> To remove critical technical barriers of engineering biology to commercialization and increase the enabling roles of biotechnology for the bioeconomy</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13,14</p>	<ul style="list-style-type: none"> <li>► working with experts in national and international standards organizations, researchers, and the private sector to develop the necessary standards, technical and otherwise, in a cohesive manner;</li> <li>► derisking private sector investments in biofoundries through public-private initiatives;</li> <li>► supporting cross-disciplinary research and education to embed computer-aided biology</li> </ul>

3.1 MIXED POLICIES (REGULATORY, ECONOMIC, VOLUNTARY, OTHERS)		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Innovation ecosystems in the bioeconomy (Philp and Winickoff, 2019)</b>	<p>This report provides good policy practices for enabling biorefineries ecosystems and their value chains. There is an accompanying report with country case studies.</p> <p>► <b>Source objectives:</b> To build the industrial and innovation ecosystems and value chains needed to make a bioeconomy viable</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 14</p>	<ul style="list-style-type: none"> <li>► implement public funding in clusters and other public-private partnerships; use demonstrator plants;</li> <li>► remove regulatory barriers such as for using waste materials in biorefineries;</li> <li>► align policies such as in cascading;</li> <li>► balance supply- and demand-side measures</li> </ul>
<b>Baseline Report on the Integration of Sustainable Consumption and Production Patterns into Tourism Policies (UNWTO, 2019)</b>	<p>The report identifies good policy practices in sustainable consumption and production (SCP). The policy practices are classified into regulatory, economic and voluntary.</p> <p>► <b>Source objectives:</b> To support the tourism sector to contribute effectively to sustainable development and the SDGs</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 9,10</p>	<ul style="list-style-type: none"> <li>► enforce environmental legislation in SCP (regulatory instruments);</li> <li>► provide financial incentives, such as technology deployment for resource efficiency or support for the greening of products (economic instruments);</li> <li>► implement guidelines on resource use efficiency, awareness-raising programmes and SCP-relevant certification systems (voluntary instruments)</li> </ul>
<b>Research for a bio-based economy (BMBF, 2018)</b>	<p>The report provides an overview of policy practices that support enabling technologies and innovations.</p> <p>► <b>Source objectives:</b> To provide a suitable framework for research and development in order to increase synergies and contribute to the overall structural change needed for bio-based and sustainable economic activity</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10,13</p>	<ul style="list-style-type: none"> <li>► drive biodiversity research for conservation and sustainable use (e.g. the genetic cataloguing of species diversity, the implementation of innovative concepts);</li> <li>► fund consortia of scientific expertise aimed to develop and implement innovative animal welfare and health approaches;</li> <li>► invest in pilot and demonstration projects of biological processes (e.g. microbial fuel cells, artificial photosynthesis, universal production organisms)</li> </ul>
<b>Governance of the Bioeconomy: A Global Comparative Study of National Bioeconomy Strategies (Dietz <i>et al.</i>, 2018)</b>	<p>The paper includes good policy practices that countries can use to support bioeconomy activities. They are the result of an assessment of bioeconomy strategies in 41 countries. The authors distinguish between political support measures (enabling governance) and regulatory tools (constraining governance). The practices are focused on the former, but it is stated that the combination of the two is fundamental in setting up an effective governance framework for a sustainable bioeconomy.</p> <p>► <b>Source objectives:</b> The good policy practices contribute to promote countries' bioeconomies, in one of the four identified pathways: i) substitution of fossil fuels with bio-based raw materials; ii) productivity increases in bio-based primary sectors; iii) increases in efficiency in biomass utilization and iv) value creation and addition through the application of biological principles and processes separate from large-scale biomass production</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 6</p>	<ul style="list-style-type: none"> <li>► support the set-up of research facilities and fund research projects;</li> <li>► promote the set-up of bio-based clusters;</li> <li>► hold public dialogues to increase understanding of the functioning of the bioeconomy</li> </ul>
<b>Best practices in integrating primary production in the Bioeconomy value chains and boosting the development of the Bioeconomy in rural areas. (EC, 2018b)</b>	<p>The report resulted from a workshop on good policy instruments, including through available common agricultural policy (CAP) support, and successful business models to integrate farmers and forest owners into bioeconomy value chains. It includes examples of these practices in current national bioeconomy strategies and bioeconomy programmes.</p> <p>► <b>Source objectives:</b> To design and implement national bioeconomy strategies that consider the integration of primary producers in bioeconomy value chains</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 6</p>	<ul style="list-style-type: none"> <li>► allow no domination of anyone on the value chain;</li> <li>► promote regional clusters as the engines of bioeconomy development;</li> <li>► use digitalized methods to spread information and knowledge is important as bioeconomy represents a societal shift;</li> <li>► promote social science related research;</li> <li>► support the involvement of farmers in new value chains (e.g. financing the planting of new crops)</li> </ul>
<b>Meeting Policy Challenges for a Sustainable Bioeconomy (OECD, 2018)</b>	<p>The report includes a list of good policy practices based on country experience to address issues in implementation (policy implications) at the end of each chapter. Table 1 provides an overview of supply-side and demand-side mechanisms, and a mixture of both, based on literature, such as tax incentives for bio-based products; research and development subsidies; standards and norms; technology clusters; the removal of fossil fuel subsidies.</p> <p>► <b>Source objectives:</b> The good practices (recommendations) are answers to identified key global challenges in the bioeconomy, particularly the use of biomass as feedstock for future production, the design and building of biorefineries and the use of biotechnologies</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► governments could better gather field level data by providing incentives to farmers such as sponsoring programmes that train farmers in genomics and their application in agriculture</li> </ul>

## 3.1 MIXED POLICIES (REGULATORY, ECONOMIC, VOLUNTARY, OTHERS)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Biorefinery models and policy (OECD, 2017)</b>	<p>The document provides good policies in research and development, financing and regulatory options and opportunities for boosting biorefinery practices.</p> <p>► <b>Source objectives:</b> To advance in the development and implementation of advanced (integrated) biorefineries</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 14</p>	<ul style="list-style-type: none"> <li>► policy certainty within a country to avoid driving investments outside the country;</li> <li>► research subsidies that support the creation of create new knowledge required and the cadre of specialist people for such multi-disciplinary subject;</li> <li>► innovative financing instruments for biorefineries (e.g. green banks established with tax-payer money but operated on the lines of a commercial bank)</li> </ul>
<b>Building a sustainable bioeconomy: a framework for policy (OECD, 2016b)</b>	<p>This report provides an overview of all good policy practices for the bioeconomy in a single document. They include 'pull', 'push' and 'mixed' practices that support the creation of comprehensive policy frameworks by countries. In particular, Box 1 provides a list of good innovation policies.</p> <p>► <b>Source objectives:</b> To encourage more policy detail in bioeconomy strategies and the creation of national holistic policy frameworks</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10</p>	<ul style="list-style-type: none"> <li>► financing demonstration and full-scale biorefineries;</li> <li>► multi-level governance;</li> <li>► information campaigns for consumers;</li> <li>► fossil fuel subsidies reform;</li> <li>► promote standards and certification</li> </ul>
<b>Biomass for a sustainable bioeconomy: technology and governance (OECD, 2016b)</b>	<p>This document prepared by the Working Party on Biotechnology, Nanotechnology and Converging Technologies provides an overview of policies and practices that support sustainability in the bioeconomy.</p> <p>► <b>Source objectives:</b> To reduce overexploitation of natural resources in the use of biomass for the bioeconomy</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3</p>	<ul style="list-style-type: none"> <li>► sponsor programmes that train farmers in genomics;</li> <li>► use land planning such as agro-ecological zoning to expand production in areas that are agronomically, climatically and environmentally suitable to limit deforestation;</li> <li>► take a planned adaptive risk regulation approach</li> </ul>
<b>Milan Urban Food Policy Pact. Selected Good Practices from Cities (Forster et al., 2015)</b>	<p>The source includes examples of policy practices in the urban food sector, including the metropolitan regions or territories around cities. The good practices are clustered in the six thematic areas of the Framework for Action of the Milan Urban Food Policy Pact: enabling environment/governance; sustainable diets and nutrition; social and economic equity; food production; food supply and distribution; and food waste. The target audience includes mayors and their departmental staff. Each good practice includes results and lessons learned, detailing sustainability achievements.</p> <p>► <b>Source objectives:</b> To improve food policy and programmatic work in cities.</p> <p>The good practices support specific objectives related to local characteristics. Synergies between objectives are also highlighted.</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10,15</p>	<ul style="list-style-type: none"> <li>► certified healthy schools and improved supply of healthy food to fight obesity and preventing non-communicable diseases;</li> <li>► distribution of free coupons to people that must be spent at farmers markets;</li> <li>► develop urban farm on city-owned vacant lots</li> </ul>
<b>Decision support to enable bio-based materials policy (OECD, 2015b)</b>	<p>This document includes good practices on policy design to enable bio-based materials.</p> <p>► <b>Source objectives:</b> To achieve a 'level playing field' for bio-based materials</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10</p>	<ul style="list-style-type: none"> <li>► create mechanisms that avoid the issue of having thousands of different chemicals;</li> <li>► policies should trigger continuous innovation by the industry sector to develop improved bio-based alternatives;</li> <li>► policy design should ensure competitive selection processes;</li> <li>► policy for bio-based materials has to be flexible enough to cover a wide range of (bio-)technology readiness</li> </ul>
<b>Genomics and the bioeconomy (OECD, 2015c)</b>	<p>This issues paper for an expert discussion held in May 2010 provides a list of good policy practices on the use of genetics and genomics, and make the case for the political imperative to tackle societal challenges in human health and the environment.</p> <p>► <b>Source objectives:</b> To increase the contribution of biology to the global economy in a way that has a positive impact on people's lives in all countries</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13</p>	<ul style="list-style-type: none"> <li>► ensure that developing countries have the necessary capacity to realize the potential of the bioeconomy;</li> <li>► provide a sustained investment in basic life sciences research;</li> <li>► support the convergence of multiple scientific disciplines and platforms through the promotion of innovative ways of sharing precompetitive knowledge and through new methods of collaboration;</li> <li>► develop innovative governance frameworks</li> </ul>
<b>Biobased Chemicals and Bioplastics: Finding the Right Policy Balance (OECD, 2014b)</b>	<p>The report includes good practices for balancing policies between energy, fuel and material uses. Table 10 also provides examples of policies affecting the market penetration of biomaterials.</p> <p>► <b>Source objectives:</b> To create an enabling environment for the development of bioplastics</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10</p>	<ul style="list-style-type: none"> <li>► feed-in tariffs;</li> <li>► quotas and mandates;</li> <li>► tax incentives;</li> <li>► fossil fuel consumption subsidies</li> </ul>

## 3.1 MIXED POLICIES (REGULATORY, ECONOMIC, VOLUNTARY, OTHERS)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>Future potential of synthetic biology in bio-based production. Results of a Survey (OECD, 2014c)</b></p>	<p>The report gives good policies that support the use of synthetic biology in bio-based production.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To help accelerate delivery of commercial impacts of synthetic biology</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13</li> </ul>	<ul style="list-style-type: none"> <li>▶ put biosafety regulation in place without hindering innovation;</li> <li>▶ increase public understanding for benefits and risks;</li> <li>▶ provide targeted support to education;</li> <li>▶ implement coordinated federal government approaches based on synthetic biology to foundational and translational research, which result in loan guarantees, grants, and tax incentives for advanced manufacturing facilities</li> </ul>
<p><b>Exchange of good policy practices promoting Innovative/ Green Business Models (Bilsen et al., 2013)</b></p>	<p>The report, developed on behalf of the European Commission, includes good policy practices for supporting and promoting innovative and green business models. The policy practices cover both regulatory and market-based policies. They are classified into: classic green innovations, coordination benefit models, and product-service systems.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To promote green business models using indicators to measure performance (e.g. turnover generated, employment, increased eco-investments, reduced waste generation, higher recycling or reuse, and the valorization of production residuals)</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 4,6,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ feed-in tariffs;</li> <li>▶ clusters;</li> <li>▶ pilot projects;</li> <li>▶ certification schemes;</li> <li>▶ minimum energy performance standards</li> </ul>
<p><b>Policies for bioplastics in the context of a bioeconomy (OECD, 2013a)</b></p>	<p>This report provides good policies and practices that support the development of bioplastics, and provides country examples.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To favour the growth of the bioplastics industry and widen the applications of novel bioplastics</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 2,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ encourage market introduction;</li> <li>▶ provide investment-related subsidies;</li> <li>▶ introduce incentives for the use of process by-products;</li> <li>▶ implement quotas;</li> <li>▶ apply tariffs to protect domestic equivalent products;</li> <li>▶ provide incentives for farmers to improve feedstock production sustainably</li> </ul>
<p><b>Biotechnology for the Environment in the Future (OECD, 2013b)</b></p>	<p>The source provides good policy practices and measures in the field of environmental biotechnology.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To make the innovation cycle more effective and efficient in relation to the translation of research into products (and vice versa) in the field of environmental biotechnology</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13</li> </ul>	<ul style="list-style-type: none"> <li>▶ policies to limit the use of non-biodegradable plastic bags;</li> <li>▶ policies to promote wider use of renewable raw materials;</li> <li>▶ policies for biobased chemicals and bioplastics;</li> <li>▶ policies for contaminated land clean-up;</li> <li>▶ landfill tax as a driver for innovative environmental clean-up technologies;</li> <li>▶ legislation on monitoring the toxicity of wastewater;</li> <li>▶ policies for risk assessment and a landmark change in contaminated land</li> </ul>
<p><b>Working towards sustainable development: Opportunities for decent work and social inclusion in a green economy (Green Jobs Initiative and International Institute for Labour Studies, 2012)</b></p>	<p>The source includes good policy practices for supporting the greening of employment to achieve a sustainable development model and ensure gains in job quality, reductions in poverty and improvements in social inclusion.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure decent work and social inclusion</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 6</li> </ul>	<ul style="list-style-type: none"> <li>▶ carry out a tax reform and use revenues for skills development or improve social protection;</li> <li>▶ reinforce and tailor existing active and passive labour market policies;</li> <li>▶ implement social dialogue through information sharing and consultation, tripartite negotiations and collective bargaining</li> </ul>
<p><b>Policy Issues for the Development and Use of Biomarkers in Health (OECD, 2011)</b></p>	<p>This source includes good practices for marketing and regulating biomarkers and managing related knowledge. Biomarkers help to improve disease diagnosis, enhance the safety and efficacy of existing medicines and develop new medicines and targeted therapies. They offer potential to improve health outcomes and reduce total health care costs in the long term.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To enable biomarker research, discovery, development, commercialization and, ultimately, uptake in clinics</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13</li> </ul>	<ul style="list-style-type: none"> <li>▶ support large-scale networks and infrastructures for biomarker discovery and development;</li> <li>▶ adapt regulatory and reimbursement processes to the specificities of novel biomarker-based clinical tests</li> </ul>



## 3.1 MIXED POLICIES (REGULATORY, ECONOMIC, VOLUNTARY, OTHERS)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Reaping the Benefits of Genomic and Proteomic Research: Intellectual Property Rights, Innovation, and Public Health (National Research Council. 2006)</a>	<p>This report presents 13 good practices on technology licensing, data sharing, and research material exchanges that the scientific community and federal research sponsors can apply to support upstream research discoveries in biotechnology.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure that potential breakthroughs in genomic and proteomic research are not constrained by the increasingly complex web of intellectual property protections</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 13</li> </ul>	<ul style="list-style-type: none"> <li>▶ foster free exchange of data, information, and materials;</li> <li>▶ promote responsible patenting and licensing strategies;</li> <li>▶ adapt the patent system to the developing fields of genomics and proteomics;</li> <li>▶ facilitate research access to patented inventions through licensing and shielding from liability for infringement;</li> <li>▶ owners of patents that control access to genomic- or proteomic-based diagnostic tests should establish procedures that provide for independent verification of test results</li> </ul>

## 3.2 REGULATORY INSTRUMENTS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Legislative approaches to sustainable agriculture and natural resources governance (FAO and UNEP, 2020b)</a>	<p>This book includes good governance practices and legislative mechanisms encompassing water, land, forestry, fisheries, mining, petroleum and agriculture and rural development. They cover issues under social sustainability (e.g. indigenous peoples), environmental sustainability (e.g. biodiversity conservation) and economic sustainability (e.g. exploitation of resources). The publication also gives examples of national legislation, such as Namibia's Access to Biological and Genetic Resources and Associated Traditional Knowledge (No. 2 of 2017) that includes monetary and non-monetary benefits to local communities.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To offer broad guidance to countries in the regulation of their natural resources by illustrating how other countries have legislated on a particular issue</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 8,10,11,12</li> </ul>	<ul style="list-style-type: none"> <li>▶ recognize sustainable resources management in connection with land tenure;</li> <li>▶ establish a range of fees, taxes and charges that are then channeled back for forest management;</li> <li>▶ develop green economy strategies that look to increase the long-term value of wood products through resource-efficient production and circular economy (use of waste, reuse and recycling of forest materials, and regeneration after wood harvesting);</li> <li>▶ remunerate positive externalities through payments for ecosystem services</li> </ul>
<a href="#">ABS Elements: Elements to facilitate domestic implementation of access and benefit-sharing for different subsectors of genetic resources for food and agriculture (FAO, 2019h)</a>	<p>The source presents good practices to implement the Nagoya Protocol, which contributes to the fair and equitable sharing of benefits arising out of the utilization of genetic resources, including by appropriate access to them (third objective of the Convention on Biological Diversity, CBD).</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To assist governments considering developing, adapting or implementing legislative, administrative or policy measures for access and benefit-sharing</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 3,11</li> </ul>	<ul style="list-style-type: none"> <li>▶ to integrate the implementation of access and benefit-sharing measures into the institutional landscape, such as regulatory frameworks for biological control, pesticides and food safety and policies;</li> <li>▶ communication of, and awareness-raising regarding, access and benefit-sharing measures for potential providers and users of genetic resources for food and agriculture;</li> <li>▶ ex ante assessment and monitoring of the effectiveness and impact of access and benefit-sharing measures for genetic resources for food and agriculture</li> </ul>
<a href="#">Synthetic biology regulation and governance: Lessons from TAPIC for the United States, European Union, and Singapore (Trump, 2017)</a>	<p>The paper includes good governance practices for synthetic biology, including regulations on biotechnology and genetically engineered organisms.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To reduce risks and uncertainty arising from policy innovations</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 10,12,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ export control;</li> <li>▶ screening of synthetic biology research prior to public dissemination;</li> <li>▶ regulatory approval of experiments;</li> <li>▶ legislative instruments to increase accountability for decisions pertaining to technology governance</li> </ul>
<a href="#">The Biosecurity Approach. A review and evaluation of its application by FAO, internationally and in various countries (FAO and IPPC, 2016)</a>	<p>This guide by the International Plant Protection Convention includes biosecurity approaches applied in various international bodies and individual countries.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To ensure the safe use of new biotechnologies within a framework of biological risk management in food and agriculture</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 15</li> </ul>	<ul style="list-style-type: none"> <li>▶ the issuance of new norms or regulations by specific notifiable animal disease, so that specific biosecurity actions or programmes can be implemented under the overall animal health authority;</li> <li>▶ a combination of legal instruments from conventions to soft laws;</li> <li>▶ <i>ad hoc</i> cross-ministerial committees</li> </ul>



## 3.2 REGULATORY INSTRUMENTS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Guidelines for IFPMA Members on Access to Genetic Resources and Equitable Sharing of Benefits Arising out of their Utilization (IFPMA, 2016)</a>	<p>This report includes good practices that should be followed by companies engaging in the acquisition and use of genetic resources, and be followed by governments to provide the necessary legal environment.</p> <p>► <b>Source objectives:</b> To facilitate the sustainable use of genetic resources and, associated traditional knowledge and regulate the rights and responsibilities of users and providers of these resources in a transparent way; and support the implementation of the Convention of Biological Diversity (CBD).</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 8,11</p>	<ul style="list-style-type: none"> <li>► obtain prior informed consent;</li> <li>► establish focal points that establish clearly which indigenous groups or other stakeholders possess rights to authorize access to particular genetic resource(s) <i>in situ</i>;</li> <li>► develop a commitment to enter in good faith negotiations as to the terms of access and benefit sharing contracts with commercial entities</li> </ul>
<a href="#">The Legal Aspects of Implementing the Cartagena Protocol on Biosafety (Cordonier Segger, Perron-Welch and Frison, 2013)</a>	<p>This book includes good policy practices in the implementation of the Cartagena Protocol on Biosafety (CPB) to the Convention on Biological Diversity (2000) and its Supplementary Protocol on Liability and Redress (2010). The Protocol governs the international trade of living modified organisms resulting from modern biotechnology, including national regulatory regimes for biosafety and international laws on biosafety.</p> <p>► <b>Source objectives:</b> To implement the CPB through binding mechanisms in order to reduce environmental risks of modern biotechnology and facilitate decision making on the import of living modified organisms</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,8,11,12</p>	<ul style="list-style-type: none"> <li>► implement national biosafety frameworks;</li> <li>► conduct risk assessment and risk management;</li> <li>► take into account the biosafety clearing-house information exchange mechanism;</li> <li>► meet the CPB handling, transport, packaging and information requirements</li> </ul>
<a href="#">South Africa's Bioprospecting, Access and Benefit-Sharing Regulatory Framework. Guidelines for Providers, Users and Regulators (Department of Environmental Affairs, 2012)</a>	<p>The document includes 46 short-, medium-, and long-term monetary and non-monetary benefit-sharing options in Appendix 3. Appendix 5 presents key legislation relevant to the mandatory legal requirements of the Biodiversity Act, the Bioprospecting, Access and Benefit Sharing Regulations and other relevant laws.</p> <p>► <b>Source objectives:</b> To ensure that research benefits the communities or knowledge holders in tangible ways</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 8,13</p>	<ul style="list-style-type: none"> <li>► fees paid per sample collected;</li> <li>► sharing of research and development results;</li> <li>► joint ventures;</li> <li>► agreements are usually developed through an iterative process, involving comprehensive consultation, transparent negotiations;</li> <li>► the government decides whether the agreement is fair to all parties, reviews and assesses bioprospecting permit applications, provide guidance on the role of officials in assisting parties to negotiate and conclude agreements and set out how they are evaluated</li> </ul>

## 3.3 MARKET-BASED AND FISCAL INSTRUMENTS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Bio-based products - from idea to market. "15 EU success stories" (EC, 2019)</a>	<p>The document covers good practices for promoting the development and implementation of bioproducts markets. The practices are drivers of success in developing a product to a fully commercial level and are obtained through a SWOT analysis of 15 case studies.</p> <p>► <b>Source objectives:</b> They support profitability, market entry, and mobilization of critical external finance</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,5,11,14,15</p>	<ul style="list-style-type: none"> <li>► licensing agreements;</li> <li>► piloting helped convince potential but reluctant clients of the benefits of a bio-based hardener for coatings for automotive applications;</li> <li>► the design of a wound ointment that is based on local knowledge on spruce resin solution for treating wounds and burns</li> </ul>
<a href="#">Green public procurement good practices (EC, 2020b)</a>	<p>The online database presents good practices promoted by green public procurement in cases from Europe. The good practice cases are grouped by product or service sector, each of which has a set of criteria and associated verification means.</p> <p>► <b>Source objectives:</b> Green public procurement approaches help address specific environmental hotspots of the sector</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 6,11,15</p>	<ul style="list-style-type: none"> <li>► use rapidly biodegradable and not potentially bioaccumulative lubricants or regenerated oils for gardening machines;</li> <li>► avoid the use of peat as a soil improver;</li> <li>► purchase textiles made from fibres that are produced using fewer fertilizers, hazardous pesticides and production chemicals</li> </ul>
<a href="#">Policies impacting bio-based plastics market development and plastic bags legislation in Europe (Carrez et al., 2017)</a>	<p>The report outlines good policies promoting bio-based plastics. A section is dedicated to plastic bags.</p> <p>► <b>Source objectives:</b> To support the development of bio-based plastics</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 2,11</p>	<ul style="list-style-type: none"> <li>► public procurement;</li> <li>► mobilizing resources for research and development;</li> <li>► supporting scaling up activities;</li> <li>► investing in demonstrator facilities;</li> <li>► fiscal supports for feedstock</li> </ul>

## 3.3 MARKET-BASED AND FISCAL INSTRUMENTS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">Commission Expert Group Bio-based Products – Working Group on Public Procurement (EC, 2016)</a>	<p>The source gives fifteen good practices to increase the market uptake of bio-based products in public procurement, a demand-side industrial policy instrument. The types of public procurement include pre-commercial procurement, public procurement of innovative solutions and green public procurement. The document also considers the importance of accompanying policies, legislation, grants and loans. In addition to public procurement, the document looks at other demand-side industrial policy instruments for market uptake of bio-based products (e.g. standardization, awareness raising and labelling).</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To create jobs and economic growth through the promotion and uptake of bio-based products</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 6,11,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ hold promotional campaigns targeting specific materials, regions and sectors;</li> <li>▶ roll-out standards and labels, benchmarking and goal setting;</li> <li>▶ provide technical support to procurers;</li> <li>▶ carry out interventions on legislation</li> </ul>

## 3.4 COLLABORATION ACROSS SECTORS AND STAKEHOLDERS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<a href="#">The BBI JU SME landscape: driving impact and innovation (BBI JU, 2019)</a>	<p>The source includes good practices by bio-based small and medium enterprises in the Bio-based Industries Joint Undertaking (BBI JU), a public-private partnership.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To address social and environmental challenges while safeguarding industry sustainability; exploit new knowledge and technology; boost companies' reputation and gain greater visibility; enter new markets, and create new jobs; expand international network and alliances; and reduce the risk of investing in the development of new biotechnologies</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 11,14</li> </ul>	<ul style="list-style-type: none"> <li>▶ support the creation of new bio-based value chains;</li> <li>▶ increase the production of new bio-based building blocks and materials;</li> <li>▶ cooperate with companies from different sectors;</li> <li>▶ increase the maturity of key technologies for the bio-based industries;</li> <li>▶ contribute to generating positive environmental and socioeconomic impact (e.g. the creation of bio-based products with lower greenhouse gas emissions), improve resource efficiency in production process, and promote regional and local development</li> </ul>
<a href="#">Catalogue of instruments and measures for bioeconomy clusters (BERST, 2019)</a>	<p>The Catalogue provides good market practices and policies throughout Europe. Within this catalogue, there is a small database of good practices at the mature stage that have been implemented to foster the development of regional bioeconomies and clusters. They have been obtained from the qualitative analysis of case studies in the European Union, as well as from other countries such as Brazil, Colombia, Indonesia and Kenya.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> Each practice corresponds to regional bioeconomy objectives and their impact is assessed (e.g. building competitive bio-based industries)</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 10,14</li> </ul>	<ul style="list-style-type: none"> <li>▶ economic and financial instruments such as permits, subsidies and loans;</li> <li>▶ research, development and deployment measures;</li> <li>▶ regulatory instruments;</li> <li>▶ voluntary initiatives</li> </ul>
<a href="#">Participation of the agricultural sector in the BBI JU: business models, challenges and recommendations to enhance the impact on rural development (Folkesson-Lillo, Paredes Diaz and Hernando Calvo, 2019)</a>	<p>The report includes good practices on how to enhance the participation of the agricultural sector in the Bio-based Industries Joint Undertaking (BBI JU), a public-private partnership, and thereby support integration and coordination between farmers and bio-based industries.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To enhance and consolidate the participation of the agricultural primary sector in the bio-based sector and its value chains; help the sector reap the benefits of this participation; and maximize the positive impact of the public-private partnership on rural development</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 7,11</li> </ul>	<ul style="list-style-type: none"> <li>▶ allow projects to be proposed via a bottom-up approach;</li> <li>▶ focus on projects with higher final technology readiness level and that include not only technology used in biorefineries but also agricultural practices;</li> <li>▶ foster the inclusion of cooperatives or other forms of agricultural cooperation;</li> <li>▶ foster the role of facilitators to increase the participation of farmers (e.g. The agricultural European Innovation Partnership (EIP-AGRI))</li> </ul>

## 3.4 COLLABORATION ACROSS SECTORS AND STAKEHOLDERS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>Framework and good practices for multi-stakeholder and cross-sector interconnections (Kiresiewa, Gerdes and Hasenheit, 2019)</b></p>	<p>The document identifies good practices related to incentives that support multistakeholder and cross-sectoral collaboration based on a review of 18 successful examples with high replication potential.</p> <p>► <b>Source objectives:</b> To support multistakeholder and cross-sector collaboration in the bioeconomy; contribute to a better and more effective management and performance; and overcome challenges such as the limited integration of bioeconomy products in mainstream supply chains and the supply shortage of raw materials</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 11</p>	<ul style="list-style-type: none"> <li>► engagement instruments (e.g. meetings, pitch events and conferences);</li> <li>► collaboration between clusters (e.g. joint policy strategies to support their work transnationally);</li> <li>► support start-ups (e.g. competitions and innovation boot camps);</li> <li>► establishing working groups that bring a wide range of stakeholders and facilitate exchange of knowledge and ideas;</li> <li>► public funding (e.g. funding expert support to local government on key issues like circular bioeconomy)</li> </ul>
<p><b>A Guide to Intellectual Property Issues in Access and Benefit-sharing Agreements (WIPO, 2018)</b></p>	<p>These World Intellectual Property Organization (WIPO) guidelines provide good contractual practices on access and benefit-sharing agreements. Particular emphasis is placed on intellectual property rights related to the use of genetic resources. It covers different sectors including pharmaceuticals, biotechnology, agriculture, cosmetics, food and beverages. This report complements information in WIPO's online contracts database: 'Collection of Biodiversity-related Access and Benefit-sharing Agreements'.</p> <p>► <b>Source objectives:</b> To enforce intellectual property rights in the utilization of genetic resources and the sharing of benefits arising from their use</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 11</p>	<ul style="list-style-type: none"> <li>► use licensing agreements to set out certain permitted uses of materials or rights that the provider is entitled to grant;</li> <li>► include a good arbitration clause;</li> <li>► joint ventures and transfer of technology to facilitate innovation and manage research between large pharmaceutical companies, biotechnology companies and public research organizations</li> </ul>
<p><b>South-South and triangular cooperation on the bioeconomy (UNOSSC, 2019)</b></p>	<p>The report includes practices that show how developing countries are working together to foster bioeconomy solutions that contribute to the implementation of the Paris Agreement and the achievement of the SDGs. They demonstrate linkages between the bioeconomy, climate action and the SDGs. The practices are contained also in South-South Galaxy's online database.</p> <p>► <b>Source objectives:</b> To address climate change and foster sustainable development</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13,14</p>	<ul style="list-style-type: none"> <li>► undertake research on indigenous crops in the region and then transfer the technology and knowledge for optimizing and commercializing innovative, nutrient-dense snack foods using them (from University of Pretoria to other universities in the region);</li> <li>► the transfer of biotechnological solutions (use of microorganisms to correct soil acidity) between Brazil and Mali due to the similarities in the soil and climate</li> </ul>
<p><b>Examples of good practices reported by the BBI JU State Representatives Group (JRC-BBIJU-IEA survey, 2018)</b></p>	<p>The report identifies good practices and examples of these practices that support the deployment of the bio-based industrial sector at the national level. Some lessons learned and suggestions for future work, as reported by state representatives group members in 2017, are also presented in this report.</p> <p>► <b>Source objectives:</b> To support the bio-based industrial sector at national level through the deployment of the Bio-based Industries Joint Undertaking (BBI JU), a public-private partnership, and enhance the impact of the BBI JU initiative across Europe</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13,14</p>	<ul style="list-style-type: none"> <li>► networks, platforms, associations and clusters at the national level;</li> <li>► national funds for supporting bio-based industries;</li> <li>► mechanisms to boost the economic growth of regions;</li> <li>► mechanisms that promote synergies and the combination of different sources of funding;</li> <li>► widen participation (e.g. stakeholder dialogues with bio-based industries);</li> <li>► macroregional strategies to mobilize stakeholders and support the deployment of the bio-based industrial sector in the macroregions</li> </ul>
<p><b>Creating Networks for the Transition to a Bio-based and Circular Economy (BioSTEP, 2017)</b></p>	<p>The report includes good practices for effective stakeholder and public engagement in the circular bioeconomy gathered by the BioSTEP project (Promoting Stakeholder Engagement and Public Awareness for a Participative Governance of the European Bioeconomy).</p> <p>► <b>Source objectives:</b> To improve participatory processes and the network building that supports the transition to a bioeconomy</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 11</p>	<ul style="list-style-type: none"> <li>► expand the traditional 'triple helix' of university, industry and government organizations to also include civil society;</li> <li>► implement engagement tools that cover the areas of education and information, dialogue and co-production of knowledge;</li> <li>► provide intervention points for stakeholders and the general public in both the strategy design and in later stages (e.g. the implementation and the evaluation phases of a strategy)</li> </ul>

## 3.4 COLLABORATION ACROSS SECTORS AND STAKEHOLDERS

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>Nordic Bioeconomy 25 cases for sustainable change (Nordic Council of Ministers, 2017)</b></p>	<p>The 25 case studies presented in the document include success factors and good practices on how to support bioeconomy implementation with cross-sectoral collaboration between businesses.</p> <p>► <b>Source objectives:</b> The good practices report performance regarding five criteria for a sustainable and innovative bioeconomy:</p> <ul style="list-style-type: none"> <li>► sustainable use of natural resources</li> <li>► technological innovation</li> <li>► environmental benefits</li> <li>► societal benefits</li> <li>► business model innovations</li> </ul> <p>Each criterion has a related set of questions on what a good bioeconomy project or business model should live up to fully or partially</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 7,13,14</p>	<ul style="list-style-type: none"> <li>► platform that co-fund a number of projects to help small- and medium-sized enterprises in bringing innovations and products within biorefinery to the market;</li> <li>► farm sources hot water from a local borehole and electricity from a local hydropower plant;</li> <li>► companies form an industrial symbiosis where waste streams from one company are used as valuable raw materials for other companies in the area</li> </ul>
<p><b>Good practice guidelines for stakeholder and citizen participation in bioeconomy strategies (Davies et al., 2016)</b></p>	<p>The guidance document sets out a series of engagement good practices. It shows how participation should be designed and implemented. It builds on the BioSTEP project and on its follow-up project, BE-Rural (Bio-based Strategies and Roadmaps for Enhanced Rural and Regional Development in the European Union).</p> <p>Seven principles underpinning good practice in stakeholder and citizen engagement: (i) design and prepare engagement activities carefully, (ii) ensure transparency, integrity and respect for all perspectives, (iii) ensure that engagement makes a difference, (iv) review and evaluate engagement to improve practice, (v) tailor engagement to the national/regional bioeconomy, (vi) engage people on what matters to them, and (vii) learn from other sectors and countries.</p> <p>► <b>Source objectives:</b> To support stakeholders in the participatory development of bioeconomy strategies, roadmaps and business models</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 7,11</p>	<ul style="list-style-type: none"> <li>► engagement is understood in three forms, consultation, co-production of knowledge, or education/information provision;</li> <li>► bioeconomy councils and forums;</li> <li>► public communication and information campaigns;</li> <li>► open-ended citizen participation</li> </ul>
<p><b>State of the World's Forests. Forests and Agriculture: Land-use Challenges and Opportunities (FAO, 2016c)</b></p>	<p>Table 3.1 provides a list of good practices of coordination between sectors identified in various types of policy documents from a review made in 35 countries.</p> <p>► <b>Source objectives:</b> To achieve policy coordination</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10</p>	<ul style="list-style-type: none"> <li>► use of multistakeholder consultations, technical working groups, technical assistance and partners;</li> <li>► commissions or inter-ministerial committees to improve national dialogue on food security</li> </ul>
<p><b>Good practices in building innovative rural institutions (Herbel et al., 2012)</b></p>	<p>This FAO publication outlines good practices in building and strengthening rural institutions. The practices are based on examples of successful rural organizations and institutional arrangements that report on practices that provide a full range of services to small producers.</p> <p>► <b>Source objectives:</b> To empower small-scale producers and rural communities to improve food security and reduce poverty Specific objectives are:</p> <ul style="list-style-type: none"> <li>► to enhance access to natural resources and local governance;</li> <li>► to facilitate access to productive assets and markets;</li> <li>► to provide access to information and knowledge; and</li> <li>► to increase political capital.</li> </ul> <p>► <b>Bioeconomy Strategy Objectives:</b> 11</p>	<ul style="list-style-type: none"> <li>► self-help groups;</li> <li>► Farmer Field Schools (FFS);</li> <li>► peer to peer advice;</li> <li>► consultative forums;</li> <li>► contract farming;</li> <li>► public-private partnerships</li> </ul>

3.5 COMMUNICATION

3.5.1 INFORMING POLICY MAKERS (M&E SYSTEMS AND EVIDENCE-BASED DECISION MAKING)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<p><b>Recommendation of the Council on Assessing the Sustainability of Bio-Based Products (OECD, 2021)</b></p>	<p>The Organisation for Economic Co-operation and Development (OECD) Council adopted ten general practices for sustainability assessment of bio-based products in July 2012. It was developed after the 2010 workshop ‘Towards the development of OECD best practices for assessing the sustainability of bio-based products’, in which participants agreed that the OECD should develop a comprehensive set of good practices for the assessment of sustainability of bio-based products (e.g. use either an attributional or a contributory LCA). The set of good practices will be part of future OECD publications. In 2019-2020 OECD reviewed through a questionnaire and reported the extent of implementation of the Recommendation by the 36 adherent countries, and whether the Recommendation is still relevant or if the practices should be updated or strengthened to better address challenges and recent developments.</p> <p>► <b>Source objectives:</b> To recommend guidance for the development and implementation of the national frameworks for assessing the sustainability of bio-based products that take into consideration their environmental, economic and social impacts throughout the whole life cycle of bio-based products (cradle-to-grave)</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 4,12</p>	<ul style="list-style-type: none"> <li>► implement a third-party peer review; adopt international indicators that consider factors such as bio-based content, land used for feedstock production and impact on human and environmental health;</li> <li>► ensure the international consistency of approaches;</li> <li>► use methodology that allow for comparisons between various products to reduce trade barriers</li> </ul>
<p><b>Safeguarding the Bioeconomy. (National Academies of Sciences, Engineering and Medicine, 2020a)</b></p>	<p>The report describes good practices for presenting and communicating the results of a horizon scan and furthering work; connecting the results of the analysis to specific actions; and learning lessons from the past. Horizon scanning is a policy tool used for foresight purposes.</p> <p>► <b>Source objectives:</b> To provide advice and communicate research results in order to provide inputs to policy processes</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 10,12</p>	<ul style="list-style-type: none"> <li>► translate results in an accessible manner;</li> <li>► tailor reporting to policy interests; matching timing to political timeframes;</li> <li>► involve selected experts in the interpretation of results in order to increase policy relevance;</li> <li>► structure the results in a logical manner, whether by groups of issues identified or by relevant policy drivers; structure results according to different change drivers (e.g. political, economic, societal, technological, legislative, or environmental factors), or grouping them by themes that emerge from the scans themselves;</li> <li>► present the results of the scan in two formats: a long narrative summary providing an overview, broad implications, and specific policy implications, and a short and structured summary providing a few simple details of impacts, issues, and implications</li> </ul>
<p><b>The EU Repository of Nature-Based Solutions (OPPLA, 2020)</b></p>	<p>The source is a knowledge repository of good practices on nature-based solutions. It includes a wide range of sectors, applications and methods.</p> <p>► <b>Source objectives:</b> To bring together the latest thinking on natural capital, ecosystem services and nature-based solutions that bring more, and more diverse, nature and natural features and processes into the economy and contribute to the conservation, enhancement and restoration of biodiversity, ecosystems and ecosystem services</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,12</p>	<ul style="list-style-type: none"> <li>► scoping ecosystem services for impact assessments;</li> <li>► valuating ecosystem services;</li> <li>► natural capital accounting methods;</li> <li>► policy practices to manage synergies and trade-offs between ecosystem services</li> </ul>
<p><b>Developing good practice guidance for estimating land degradation in the context of the United Nations Sustainable Development Goals (Sims et al., 2019)</b></p>	<p>The article summarizes good practices to monitor land degradation conditions (e.g. accessing a wide range of data sources and using Earth observation and geospatial information) and to report on SDG indicator 15.3.1.</p> <p>► <b>Source objectives:</b> To assist countries to better understand their distribution and types of land degradation, and support countries to achieve their targets; and ensure technical soundness and consistency in estimation methods, and the comparability of results across countries and over time</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 12</p>	<ul style="list-style-type: none"> <li>► calculate both climate-calibrated and uncalibrated time series;</li> <li>► interpret land productivity change using three metrics based on time-series images: trend, state and performance</li> </ul>

## 3.5 COMMUNICATION

## 3.5.1 INFORMING POLICY MAKERS (M&amp;E SYSTEMS AND EVIDENCE-BASED DECISION MAKING)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Business and the Sustainable Development Goals: Best practices to seize opportunity and maximise credibility (Verles and Vellacott, 2018)</b>	The report includes good monitoring and evaluation practices for high-quality impact quantification and reporting of SDGs. ► <b>Source objectives:</b> To help the private sector define and deliver against strategies and targets laid out in the SDGs ► <b>Bioeconomy Strategy Objectives:</b> 12	► use the materiality concept to identify and prioritise SDG targets; ► use third-party auditors to verify the implementation and impact of a sustainability strategy; ► include value chain impacts in reporting
<b>Good practices for effective national communication mechanisms (FAO, 2015c)</b>	The document includes good practices obtained from an FAO/Convention on Biological Diversity (CBD)/ Organisation for Economic Co-operation and Development (OECD) Webinar on three International Databases on Biosafety: The FAO Genetically Modified Foods Platform (Codex Alimentarius Commission); the CBD Biosafety Clearing House (the 2000 Cartagena Protocol on Biosafety); and the OECD Biotrack Product Database (the OECD Working Group Harmonisation of Regulatory Oversight in Biotechnology and OECD Task Force for the Safety of Novel Foods and Feeds). ► <b>Source objectives:</b> To establish or improve national communication and coordination mechanisms on biosafety; increase public engagement in the regulatory processes of GMOs; support international cooperation in maintaining existing databases ► <b>Bioeconomy Strategy Objectives:</b> 10,12	► use effective national communication mechanisms; ► conduct public engagement and promote media participation to increase knowledge on regulations and risk assessments; ► increase the scope of and information on living modified organisms (e.g. microorganisms) in the existing databases; ► strengthen the links between existing databases and ensure that information is updated; ► implement national regulatory systems on genetically modified organisms (GMO) that follow conventional regulatory procedures (e.g. required labelling)
<b>Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning (Hardner et al., 2015)</b>	The document includes good practices for including biodiversity in impact assessments. It is accompanied by other related documents, such as a guiding document on 'Good Practices for the Collection of Biodiversity Baseline Data'. ► <b>Source objectives:</b> To support biodiversity-inclusive assessment and management planning in environmental and social impact assessments ► <b>Bioeconomy Strategy Objectives:</b> 3,12	► impact identification and characterization; ► assessment of impact consequence and risk; ► avoid the destruction of natural habitat by altering the project footprint; ► conduct a thorough study of the rehabilitation and restoration potential of a site as a part of management planning
<b>Best Practices for Integrating Ecosystem Services into Federal Decision Making (Olander et al., 2015)</b>	The source recommends good methodological practices for using benefit-relevant indicators. For example, a benefit-relevant indicator for water quality would not be 'nitrogen concentration' but the 'swimmable days times the number of people with ready access to the swim sites'. ► <b>Source objectives:</b> To move beyond ecological measures that are not explicitly linked to human benefits in order to make causal connections from proposed actions to outcomes valued by people ► <b>Bioeconomy Strategy Objectives:</b> 3,12	► use non-monetary multicriteria analytical methods; ► include social preference evaluation methods



3.5 COMMUNICATION		
3.5.2 INFORMING FINAL CONSUMERS AND THE GENERAL PUBLIC		
Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>The BioCannDo experience: Let's talk about bio-based products (BioCannDo, 2019)</b>	<p>The source includes ten good practices on how to communicate bio-based products and the bioeconomy to the consumers and society as a whole. It is intended to be shared with other communicators.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To making the fundamentals of the bioeconomy understandable to stakeholders outside the bioeconomy</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 14,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ include the explanation of uses, performance and benefits of bio-based products for creating awareness and acceptance among consumers;</li> <li>▶ select media content depending on the distribution and advertising budget;</li> <li>▶ establish a virtual dialogue with the readers as it fosters engagement with the public;</li> <li>▶ offer different levels of engagement in a network to increase outreach and impact;</li> <li>▶ be specific, for instance do not state that a product is biodegradable if no corresponding waste management infrastructure is in place or without explaining the specific conditions under which biodegrading takes place;</li> <li>▶ an innovative web site is the best way to stand out from other initiatives</li> </ul>
<b>Exploring the role of awareness-raising and communication in promoting the development of sustainable bioeconomy value chains (ENRD, 2019b)</b>	<p>The source discusses good practices for awareness raising and communication about the bioeconomy, particularly in rural areas.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To promote the development of sustainable bioeconomy value chains</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 11,14,15</li> </ul>	<ul style="list-style-type: none"> <li>▶ develop cross-border networking to upscale and connect bioeconomy initiatives across the European Union and globally;</li> <li>▶ rewarding and communicating best practices is important to raise awareness of the opportunities and products that emerge with bioeconomy;</li> <li>▶ use tools for communication and awareness raising (e.g. leaflets, social media, guidance, workshops and lectures);</li> <li>▶ add information that is locally relevant and appeal to consumers, decision makers and rural stakeholders, and makes links between technology, the sustainable resource base and the market to demonstrate opportunity along the value chain</li> </ul>
<b>ISEAL Code of Good Practice for Setting Social and Environmental Standards (ISEAL Alliance, 2014)</b>	<p>The source defines good practices for an equitable, open and transparent standard-setting process. It supports standards systems to achieve more positive social, environmental and economic impacts, while decreasing negative impacts. This code is used by bio-based certification schemes such as the Roundtable for Sustainable Biomaterials.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support standards systems to deliver positive social and environmental impact</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 11,12</li> </ul>	<ul style="list-style-type: none"> <li>▶ make explicit reference, such as on websites, to other relevant standards systems that are complying with good practices and are operating in the same sector, policy area and geographical regions and identify where approaches converge;</li> <li>▶ set participation goals for sector engagement that can be evaluated and updated over time;</li> <li>▶ carry out tests to assess the feasibility and auditability of requirements</li> </ul>
<b>Public Outreach and Education for Carbon Storage Projects (National Energy Technology Laboratory, 2013)</b>	<p>The source is a manual of good practices for public outreach and education. It is derived from the experiences of seven regional carbon sequestration partnerships.</p> <ul style="list-style-type: none"> <li>▶ <b>Source objectives:</b> To support the successful implementation of sustainable carbon dioxide storage projects</li> <li>▶ <b>Bioeconomy Strategy Objectives:</b> 4,11</li> </ul>	<ul style="list-style-type: none"> <li>▶ integrate public outreach with project management;</li> <li>▶ establish an outreach team;</li> <li>▶ conduct and apply social characterization;</li> <li>▶ develop an outreach strategy and communication plan;</li> <li>▶ develop outreach materials tailored to the audiences;</li> <li>▶ develop key messages;</li> <li>▶ tailor materials to audience</li> </ul>



## 3.5 COMMUNICATION

## 3.5.3 INFORMING SPECIFIC STAKEHOLDER GROUPS (INDUSTRY, RURAL AND COASTAL POPULATION, CIVIL SOCIETY)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Information and communications technologies (ICT) solutions (ICT-BIOCHAIN, 2020)</b>	<p>The source is a feedstock-specific database of best practices and new opportunities for digitalization to improve the efficiency of biomass supply chains. Developed by the Information and Communications Technologies (ICT)-BIOCHAIN project on bioeconomy digital innovation hubs, the database also includes solutions and tools related to the 'Internet of Things' and 'Industry 4.0'.</p> <p>► <b>Source objectives:</b> To use ICTs to increase the efficiency of biomass supply chains in bio-based industries</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 3,12</p>	<ul style="list-style-type: none"> <li>► near-infrared spectroscopy;</li> <li>► satellite positioning systems;</li> <li>► digital wireless data communication technology;</li> <li>► software solutions for logistics, accounting and optimization;</li> <li>► approaches to mapping bioresources; online trading platforms;</li> <li>► smart greenhouse technology systems;</li> <li>► machine learning, combined with data from drones</li> </ul>
<b>Advancing Open Science Practices: Stakeholder Perspectives on Incentives and Disincentives Proceedings of a Workshop—in Brief (National Academies of Sciences, Engineering, and Medicine 2020b)</b>	<p>The report presents good practices for open science from the proceedings of a public symposium. They include options for overcoming the barriers and challenges to open science and its functions.</p> <p>► <b>Source objectives:</b> To use open data for strengthened rigour and reliability; a greater the ability to address new questions; faster and more inclusive dissemination of knowledge; broader participation in research; the effective use of resources; improved performance of research tasks; and open publication for public benefit</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 12,13</p>	<ul style="list-style-type: none"> <li>► open infrastructures to advance discovery;</li> <li>► open biorepositories;</li> <li>► open early drug discovery;</li> <li>► intellectual property management compatible with open science;</li> <li>► dynamic publications and open peer review;</li> <li>► policies for long-term support of science;</li> <li>► incentives for openness</li> </ul>
<b>TAPipedia Discovery Space on Capacity Development for Agricultural Innovation Systems (TAP, 2020)</b>	<p>The source includes compilations of good practices for capacity development, including extension services and knowledge management related to agricultural innovation systems.</p> <p>► <b>Source objectives:</b> To support sustainable capacity development</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 8,15</p>	<ul style="list-style-type: none"> <li>► embedding learning in broader support strategies;</li> <li>► learning needs assessment works;</li> <li>► using flexible learning formats combining classroom training with e-learning, mentoring and study tours</li> </ul>
<b>Knowledge exchange and capacity building for the bioeconomy in rural areas. Briefing paper (Davies and Kah, 2019)</b>	<p>The report provides good practices for knowledge exchange and capacity building. It is part of the BE-Rural project (Bio-based Strategies and Roadmaps for Enhanced Rural and Regional Development in the European Union), which builds on the BioSTEP described in Subcategory 3.4. More results and guidance on good practices are expected.</p> <p>► <b>Source objectives:</b> To support knowledge exchange and capacity development of rural bioeconomy stakeholders</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 8,11</p>	<ul style="list-style-type: none"> <li>► mobilize a wide range of local and regional stakeholders to participate in knowledge exchange, and actively seek their views and engagement;</li> <li>► build a structured programme of knowledge exchange and engagement in order to support local and regional stakeholders to reach agreement to focus their efforts on specific thematic strengths;</li> <li>► target efforts on building capacities to support these strengths by accessing external funding to invest in human resources or business innovation projects</li> </ul>
<b>The Rutzolijirisaxik voluntary guidelines for the repatriation of traditional knowledge relevant for the conservation and sustainable use of biological diversity (CBD, 2018)</b>	<p>The document includes good practices for the repatriation of traditional knowledge relevant to the conservation and sustainable use of biological diversity and related information. It was adopted at the fourteenth Conference of the Parties (COP14) to the Convention on Biological Diversity (CBD).</p> <p>► <b>Source objectives:</b> To facilitate the recovery, restoration and management of traditional knowledge of biological diversity by indigenous peoples and local communities</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 8,11</p>	<ul style="list-style-type: none"> <li>► the digitization of collections to support repatriation should be done with the full and effective participation of indigenous peoples and local communities and recognize the challenges and benefits of making the collections publicly available;</li> <li>► consider special measures to address benefit sharing (e.g. seek prior and informed consent);</li> <li>► community-to-community exchanges and other community-driven initiatives should be supported as much as possible</li> </ul>
<b>Education and training for industrial biotechnology and engineering biology (Delebecque and Philp, 2018)</b>	<p>This source includes good practices in education in industrial biotechnology.</p> <p>► <b>Source objectives:</b> To support higher education to meet the required multi- and interdisciplinary skills needed in industrial biotechnology</p> <p>► <b>Bioeconomy Strategy Objectives:</b> 13</p>	<ul style="list-style-type: none"> <li>► combine teaching and research in masters courses;</li> <li>► re-design relevant science undergraduate degrees to serve as a platform for post-graduate study;</li> <li>► promote massive open online courses; have dedicated facilities for training in bioprocessing</li> </ul>

## 3.5 COMMUNICATION

## 3.5.3 INFORMING SPECIFIC STAKEHOLDER GROUPS (INDUSTRY, RURAL AND COASTAL POPULATION, CIVIL SOCIETY)

Source (with hyperlink)	Source description, objectives and corresponding Bioeconomy Strategy Objectives (Box 3, p.18)	Examples of good practices or policies included
<b>Engaging stakeholders and citizens in the bioeconomy: Lessons learned from BioSTEP and recommendations for future research (Gerdes <i>et al.</i>, 2018)</b>	The source provides good practices in stakeholder and public engagement in the bioeconomy. The practices include both consultative approaches and participatory approaches. The good practices consider education and information (informative participation), dialogue (consultative participation) and co-production of knowledge, in which experts, citizens and interest groups cooperate (functional participation). ► <b>Source objectives:</b> To engage the public and civil society organizations in moving towards participatory governance, building trust and making better decisions ► <b>Bioeconomy Strategy Objectives:</b> 11,15	<ul style="list-style-type: none"> <li>► develop two-way communication channels that go beyond providing information to stakeholders;</li> <li>► make a virtual exhibition of bio-based products;</li> <li>► carry out web-based stakeholder consultations;</li> <li>► use regional living labs, a public-private and people partnership, for the co-production of knowledge and user-driven innovations;</li> <li>► conduct a touring exhibition where visitors voice suggestions in a survey and an online exhibition with the same model</li> </ul>
<b>Good practices for building dynamical models in systems biology (Azeloglu and Iyengar, 2015)</b>	The source presents good practices in dynamic model-building processes that can offer a deeper understanding of information processing mechanisms in physiology, cell signaling and biological regulation. ► <b>Source objectives:</b> To support information processing and help improve the design of biological systems and models ► <b>Bioeconomy Strategy Objectives:</b> 12,13	<ul style="list-style-type: none"> <li>► error analysis;</li> <li>► proper parameterization;</li> <li>► unbiased parameter variation exercise;</li> <li>► run simulations without altering initial conditions</li> </ul>
<b>Healthy planet, healthy people: A guide to human health and biodiversity (Bridgewater, Reegnier, and Wang, 2012)</b>	This document is part of a collection of good practice guides prepared by Convention on Biological Diversity (CBD). It covers good practices in knowledge management of genetic resources, traditional medicine, sciences, including health science, human-wildlife interactions, ecosystem health and the psychological benefits of connecting with nature. ► <b>Source objectives:</b> To integrate health ethics into the conservation, sustainable use and the sharing of benefits of biodiversity ► <b>Bioeconomy Strategy Objectives:</b> 3,8,12,13,15	<ul style="list-style-type: none"> <li>► increase availability of traditional medicinal knowledge and recognize that it is a known, reliable and inexpensive choice for the cure of illnesses;</li> <li>► promote new studies to assess the effects of biodiversity on health;</li> <li>► increase understanding on how to reduce the use of antibiotics in people not expressing critical symptoms</li> </ul>
<b>FAO good learning practices for effective capacity development (FAO, 2012d)</b>	This source provides good practices to design, deliver and coordinate effective learning events and programmes, and evaluate the results and behavioural changes. ► <b>Source objectives:</b> To ensure that learning leads to sustainable capacity development ► <b>Bioeconomy Strategy Objectives:</b> 11,15	<ul style="list-style-type: none"> <li>► carry out an analysis of the context since the learning activity must be an appropriate response to capacity needs;</li> <li>► identify target audiences;</li> <li>► conduct learning needs assessments</li> </ul>

# DISCUSSION OF THE RESULTS

This Compendium provides a broad collection of information on the bioeconomy. It includes sources - 250 references in total - under three main categories: scientific research, technical knowledge and policies. The sources of good practices and policies were included and rated based on strict criteria, following the FAO definition of what constitutes a good practice. Their relevance to bioeconomy strategy objectives (outlined in **Box 3**) was also analysed.

The review clearly indicated that there are shortfalls with regards to good bioeconomy practices and policies, particularly concerning:

- ▶ the coverage of certain bioeconomy themes;
- ▶ the quality of good practices included in the compilations; and
- ▶ the coverage of common sustainability objectives proposed in bioeconomy strategies.

## 4.1 COVERAGE OF THEMES UNDER THE BIOECONOMY DEFINITION

In the different thematic areas within bioeconomy presented in Subchapter 2.2, most good practice work relates to technical knowledge in specific sectors. Most of this work can be found on the traditional bio-based sectors (e.g. good agricultural and livestock practices), similarly to the practices in scientific research. Efforts have been made to some extent to identify good practices in the biofuel sector, and these practices have mainly been promoted by dedicated biofuel certification schemes. However, there are few compilations of good practices on bio-based products (e.g. bioplastics and biopharmaceuticals), and there is much to be done in the processing and end-of-life stages of the value chain.

The Figures 4 to 10 present the results of the coverage of bioeconomy themes. They include a wide range of subcategories, topics and subtopics that are adequately covered in existing literature. It shows that the vast majority of sources compiled are on the production and utilization of biological resources (i.e., subcategories 2.1 and 2.2). Under the utilization subcategory, number 2.2.2 'Processing and manufacturing' is the most covered topic, particularly for biochemicals, biomaterials and bioplastics.

In Category 3. 'Providing sustainable solutions (information, products, processes and services) within and across all economic sectors and enabling a transformation to a sustainable economy (i.e. the enabling environment)', the most extensively covered subcategories are communication and mixed policies. Technologies can contribute to the efficient use of bioresources, but it is individual behaviour of consumers that will make the difference in making the transition towards

sustainability and circularity in the bioeconomy. These good sensitization practices and policies can be used to implement strategies for the adoption of technologies and for promoting behavioural change.

The least covered subcategories are regulatory instruments and economic and fiscal instruments. This may be because many of the sources include a mix of policy instruments and consequently, they are grouped under the subcategory 3.1 'Mixed policies (regulatory, economic, voluntary, others)'. These include for example, systems policy approaches to a sustainable bioeconomy; incentives for scaling up R&D funding for a sustainable bioeconomy; innovation and training for bioeconomy jobs; enabling a strong and resilient bio-industry; enabling frameworks for bioeconomy at the global, regional and national level; and supporting global partnerships and networks. Another explanation could be that there are not many national enforcement policies mechanisms for international sustainability standards. Also, policy implementation is highly context-specific, and to date little has been done to assess how different and individual policy instruments affect the promotion of or transition to the bioeconomy. For instance, to reduce environmental pollution and to support circularity some countries require to change existing policy practices, such as subsidies to certain agricultural inputs, fossil fuels or water use, depending on their context.

Basic and applied research is well documented. However, because these practices are not grouped under subcategories, topics and subtopics in this Compendium, fewer sources have been included than in other categories.

Lastly, the results revealed that very few sources and databases of good practices and policies simultaneously cover all elements included in the definition of the bioeconomy. There are also no existing guidance documents on how to combine good practices and policies from different sectors in a way that supports the implementation of a coherent bioeconomy. More research should be carried out to understand how to articulate different good practices and policies under the umbrella of the bioeconomy.

## FIGURES 4 – 10.

## NUMBER OF SOURCES IN TABLE 1 COVERED BY SUB-CATEGORY, TOPIC AND SUB-TOPIC OF THE BIOECONOMY

FIGURE 4. NUMBER OF SOURCES BY SUB-CATEGORY (Total = 250 sources)

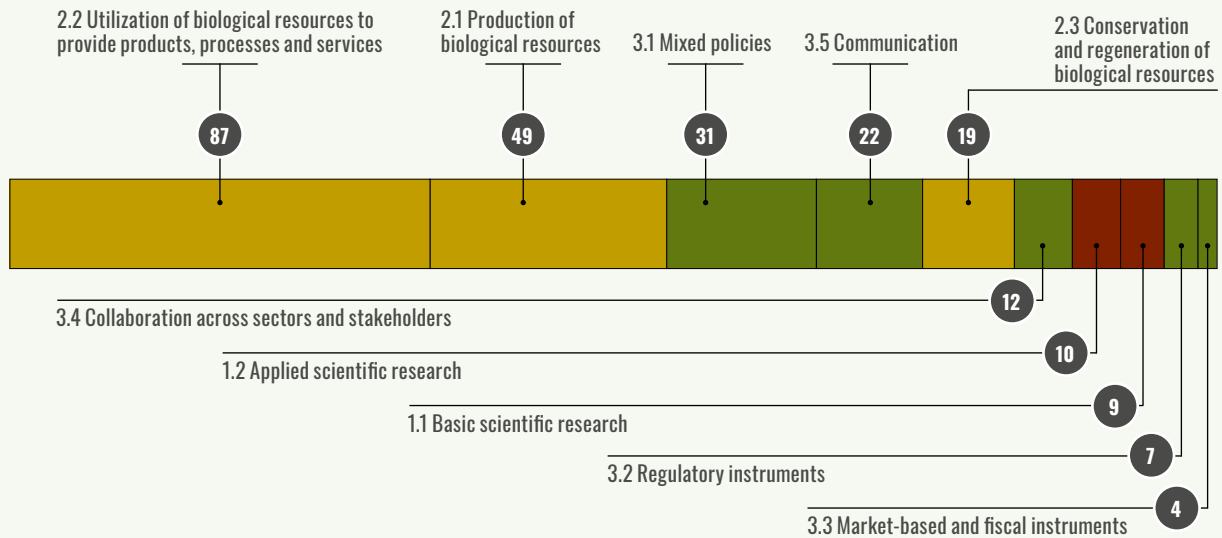


FIGURE 5. NUMBER OF SOURCES IN 2.1 BY TOPIC

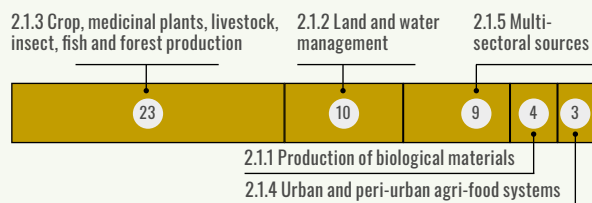


FIGURE 6. NUMBER OF SOURCES IN 2.2 BY TOPIC

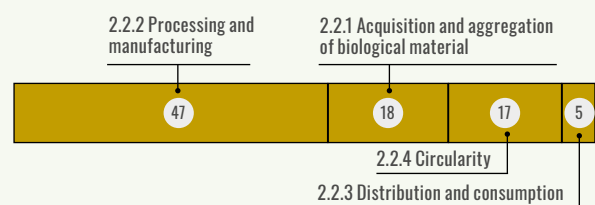


FIGURE 7. NUMBER OF SOURCES IN 2.2.1 BY SUB-TOPIC

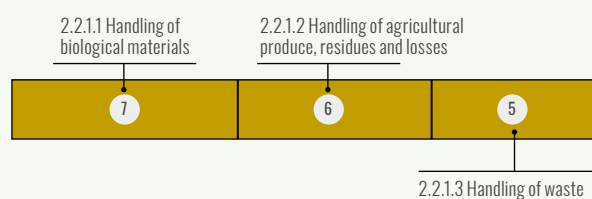


FIGURE 8. NUMBER OF SOURCES IN 2.2.2 BY SUB-TOPIC

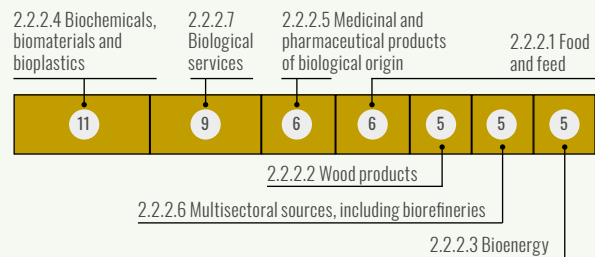


FIGURE 9. NUMBER OF SOURCES IN 2.3 BY TOPIC

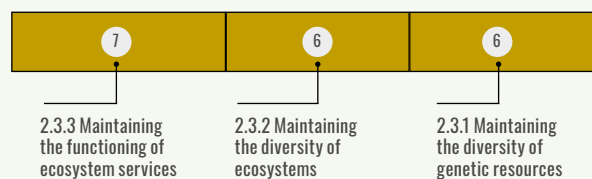
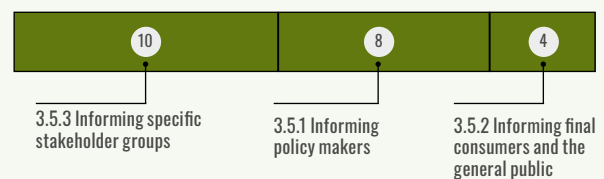


FIGURE 10. NUMBER OF SOURCES IN 3.5 BY TOPIC



Source: Prepared by the authors

## 4.2 COMPLIANCE WITH FAO CRITERIA

The interpretation of what qualifies as ‘good’ practice or policy varies widely. The analysis shows the bioeconomy areas in which more applied research or more upscaling is needed to determine the level of impact of the practices and policies. Only 20 percent of sources report a sufficient evidence of positive impact and effectiveness of the practices to be recommended as models using the FAO criteria (proven, successful, sustainable, replicable, and participatory).

Most of the sources that focus exclusively on bioeconomy are compilations of case studies that showcase bio-innovations and promising practices for the future bioeconomy, but do not analyse their impacts and effectiveness. Only an assessment of their implementation and success over time will determine whether they merit the label ‘good’. A similar result was obtained in a recent study by Biber-Freudenberger *et al.* (2020), which showed that most innovations labelled under the bioeconomy lack a systematic evaluation of their impact on sustainability. This lack of evidence can be a bottleneck in the implementation of bioeconomy strategies.

As the review has shown, good practices are defined by literature in many ways, and often the sources do not include what a good practice is meant to entail in a specific context to be labelled as ‘good’ or sustainable, or how to replicate and up-scale them. Even within the same source, different good practices may have different levels of evidence, and report different information. Many of the so-called good practices are in fact innovations or success stories, which should not be put on the same level as established practices and policies that have been proven to be sustainable and replicable over time and in different locations.

Some bioeconomy practices are not mature yet, and the sources are focused on presenting bio-innovations or showcasing examples and

case studies as a way of inspiration to others, particularly regarding bio-based processes (e.g. biorefineries, waste valorization). Many sources include a compilation of existing examples, from which they extract recurring lessons learned from several settings. When these ‘lessons’ are in fact good practices, they were included and clearly noted in the table. Even though there is not enough evidence of impact, they indicate common practices and policies that are being implemented in the bioeconomy, and this in turn can be a source of inspiration. It can also be used to identify those good practices that have been tested but still need further development.

On the other side of the spectrum, the review has shown that some good practices are already institutionalized at the policy level, for example the practices needed to access the European Agricultural Fund for Rural Development countries such as the use of green electrical energy produced from manure on farms. Other examples are included in certification schemes, such as the Roundtable of Sustainable Palm Oil, whose manual on peatland management includes concrete practices, such as integrated pest and disease management, the rehabilitation of leaning and fallen palms. Practices in the processing stage are often part of manuals linked to the concrete application of a technology. For the end-of-life of bioproducts, many good practices are imbedded in waste regulations. Some good practices are marked as dark green but still need policies and regulation to be implemented in the specific context, in particular topic ‘2.2.1.1 Handling biological materials (seeds, plants, microorganisms and their genetic resources)’.

**Figures 11 to 14** below show the percentage of sources with little, some and full compliance with FAO good practice and policy criteria described in section 2.3 (light grey, grey and dark grey, respectively). Light grey indicates sources that do not provide enough evidence of impact to arrive to the third level (see **Figure 1**), independently of the criteria they meet. Bright grey indicates sources that have enough evidence of impact and meet up to three criteria. Dark grey indicates sources that provide enough evidence of impact and meet four or

five criteria. There are fewer dark grey sources, for all categories and subcategories. The most compliant with FAO criteria are the good policy practices included in Category 3 'Providing sustainable solutions (information, products, processes and services) within and across all economic sectors and enabling a transformation to a sustainable economy (i.e. the enabling environment)' (see **Figure 15**).

Overall, there are few sources that provide concise methodologies to assess the impact and effectiveness of practices and policies, such as multiyear and rigorous monitoring. The methodologies used by the sources in this Compendium to define and assess good practices do not provide enough evidence of their impact. It can be concluded that there is limited knowledge on the scale at which these examples of good practices and policies are being implemented at the global level and can be therefore recommended as models.

Additional efforts are needed to develop compilations and databases of good bioeconomy practices and policies that: i) are defined using a comprehensive methodology and criteria; ii) have enough evidence of long-term success and effectiveness; and iii) include guidance on how they can be mainstreamed to support the implementation of sustainable and circular bioeconomy.

These compilations and databases should cover all bioeconomy themes and provide information in how synergies between actions in these different thematic areas could be harnessed. Understanding the synergies and trade-offs is critical for supporting decision making in the implementation of practices and policies that support a transition to a sustainable and circular bioeconomy. Few examples exist that show which positive impacts does a combination of different good practices and policies have on mainstreaming sustainability into the bioeconomy to make the shift to a more ecologically friendly economy and society.

The importance of sharing good bioeconomy practices has been globally recognized. In fact, the German Bioeconomy Council (GBC) proposes the creation of a multilateral bioeconomy policy platform, which, among other activities, would facilitate the exchange of best practices and

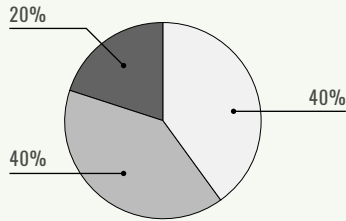
experiences to align objectives and efforts made worldwide and increase synergies (GBC, 2018a). The FAO-led ISBWG is a multi-stakeholder platform for international knowledge and experience sharing, including lessons learned, good practices and policies and potential benefits and risks of bio-innovations in agri-food systems,, such as the use of food loss and waste, plastic alternatives, microbiome applications, and alternative proteins (GBC, 2020a).



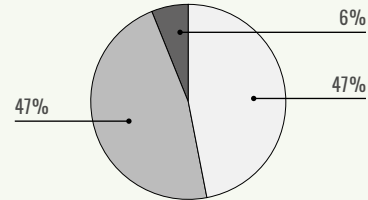
**FIGURES 11-14.**

**PERCENTAGE OF REVIEWED SOURCES THAT PROVIDE ENOUGH, MEDIUM OR NOT ENOUGH EVIDENCE OF IMPACT TO COMPLY WITH FAO GOOD PRACTICE AND POLICY CRITERIA**

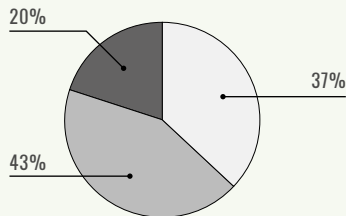
**FIGURE 11. TOTAL (250 SOURCES)**



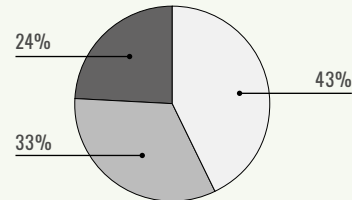
**FIGURE 12. CATEGORY 1 - DISCOVERY AND DOCUMENTATION OF BIOLOGICAL PRINCIPLES FOR THE BIOECONOMY (19 SOURCES)**



**FIGURE 13. CATEGORY 2 - APPLICATIONS OF KNOWLEDGE, SCIENCE, TECHNOLOGY AND INNOVATION IN THE VALUE (155 SOURCES)**



**FIGURE 14. CATEGORY 3 - PROVIDING SUSTAINABLE SOLUTIONS AND ENABLING A TRANSFORMATION TO SUSTAINABLE ECONOMY (I.E. THE ENABLING ENVIRONMENT) (76 SOURCES)**

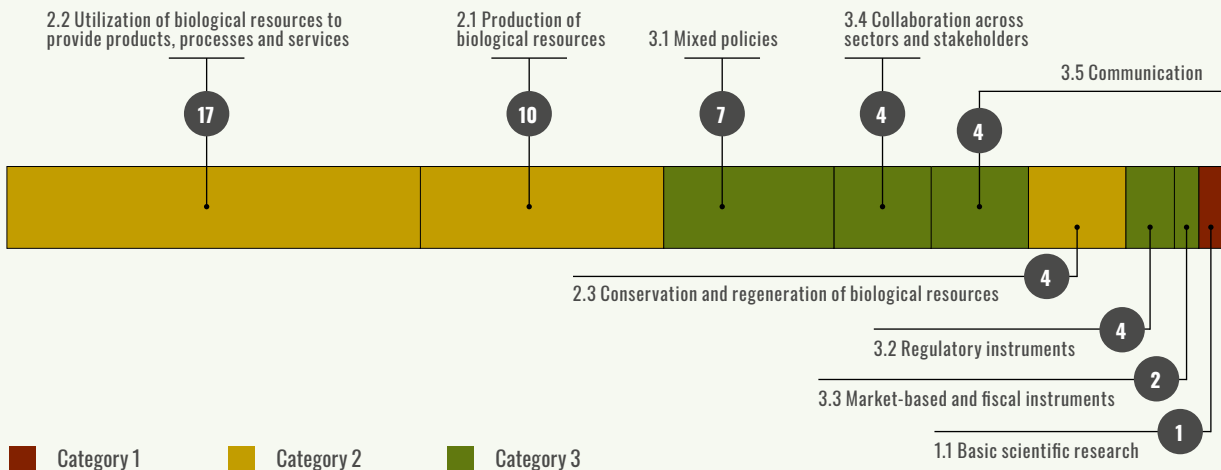


Not enough evidence of impact provided
  Medium level of evidence of impact provided
  Enough evidence of impact provided

Source: Prepared by the authors

**FIGURE 15.**

**NUMBER OF SOURCES IN EACH SUB-CATEGORY THAT PROVIDE ENOUGH EVIDENCE OF IMPACT TO FULLY COMPLY WITH FAO GOOD PRACTICE AND POLICY CRITERIA (20% of total sources - Dark grey in Figure 11)**



Source: Prepared by the authors

## 4.3 RELEVANCE TO SUSTAINABILITY OBJECTIVES IN BIOECONOMY STRATEGIES

In reviewing the bioeconomy strategy objectives addressed by the good practices and policies, **Table 1** identifies the sources that are the most relevant for sustainable and circular bioeconomy strategies, programmes and action plans. However, the results indicate that the sources in general do not consider the dimensions of sustainability in an integrated manner. Future guidelines should consider practices and policies that jointly address social, economic, environmental and governance issues. Otherwise, the trade-offs that are made to achieve different objectives may lead to overall unsustainable bioeconomy systems.

**Figure 16** shows the distribution of sustainability objectives across the different subcategories, clustered around four dimensions: social, economic, environmental and governance. In category 2. ‘Applications of knowledge, science, technology and innovation in the value chain’ where the environmental pillar is addressed by most sources in the three subcategories: 2.1 ‘Production of biological resources’; 2.2 ‘Utilization of biological resources to provide products, processes and services’; and 2.3 ‘Conservation and regeneration of biological resources’.

Also, in category 3. ‘Providing sustainable solutions within and across all economic sectors and enabling a transformation to a sustainable economy’ the sources are mostly associated with objectives of good governance since they relate to the enabling environment. Subcategory 1.1 (Basic scientific research) includes sources that address social objectives in relation to research and innovation (objective number 13 in **Box 3**). And Subcategory 1.2 ‘Applied scientific research’ already includes more environmental

and economic objectives. Not surprisingly, subcategory 3.1 ‘Mixed policies (regulatory, economic, voluntary, others)’ is the one that covers all objectives in the most balanced way, as policies normally try to achieve several goals at the same time.

As can be seen in **Figure 17**, the most covered social objectives are number 13 ‘To support research, development and innovation and put it into practice to accelerate the deployment of sustainable bioeconomy’ and number 15 ‘To promote sustainable consumption and raise the awareness and acceptance among consumers and manufacturers about the goods and services provided by the bioeconomy’.

Under the economic pillar, the majority of sources address objective number 11 ‘To establish local fair and equitable value chains or webs by increasing inclusiveness and information flows’.

The most covered environmental objectives are number 3 ‘To incentivize the sustainable and efficient use of biological resources while protecting biodiversity, water and the soil’ and number 9 ‘To move towards a more circular bioeconomy’.

Also, **Figure 17** shows that the governance objective number 12 ‘To promote a transparent monitoring system for bioeconomy development and compliance with national and/or international sustainability targets’ is the most relevant among the sources. Despite most policy instruments listed by sources are aimed to improve the coherence, alignment and transparency of already existing policies, as well as policy practices such as public procurement and public-private partnerships, there is also little experience on which policy mix would be appropriate for the bioeconomy.

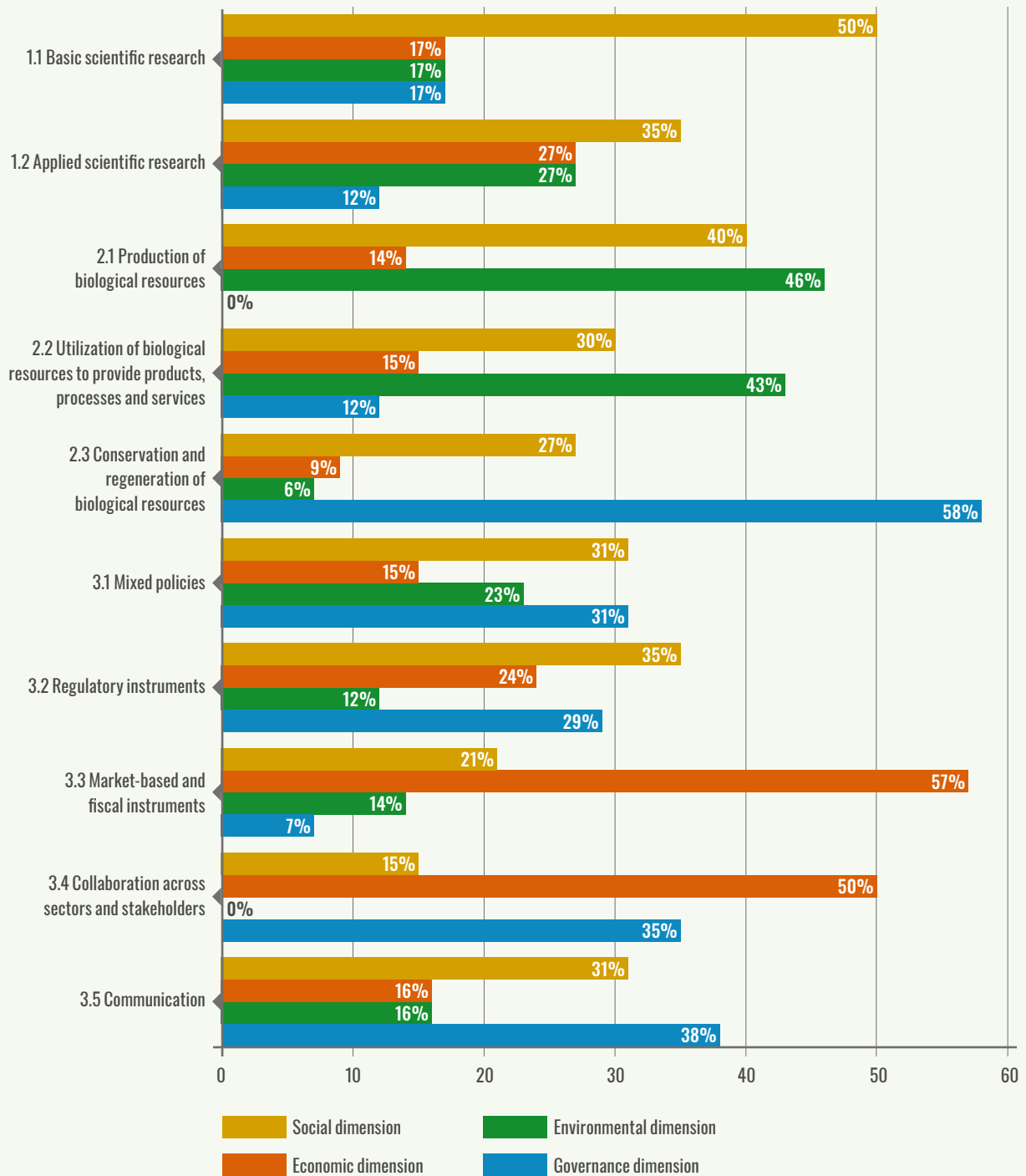
Overall, the three most covered objectives are number 3 ‘To incentivize the sustainable and efficient use of biological resources while protecting biodiversity, water and the soil’; number 13 ‘To support research, development and innovation and put it into practice to accelerate the deployment of sustainable bioeconomy’; and number 15 ‘To promote sustainable consumption and raise the awareness and acceptance among consumers and manufacturers about the goods and services provided by the bioeconomy’. Each of them represents around a 13 percent of the total sources (250 references).

By assigning one or more bioeconomy strategy objectives to each source of good practices and policies, this report takes a first step in developing a database or an online tool of good practices and policies for the bioeconomy.

However, further work should be carried out to extract and compile all the good practices and policies listed in all sources in **Table 1** and classify them by strategy and sustainability objectives.

**FIGURE 16.**

**COVERAGE OF THE FOUR DIMENSIONS OF BIOECONOMY OBJECTIVES (BOX 3) IN THE SUB-CATEGORIES OF TABLE 1**



Source: Prepared by the authors

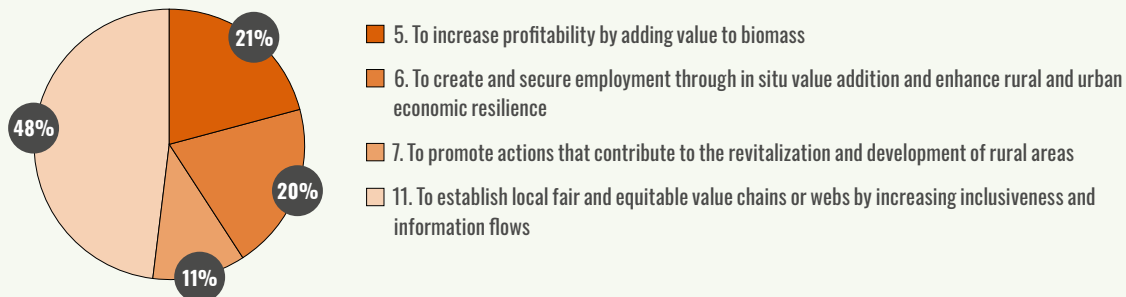
FIGURE 17.

## RELEVANCE OF COMMON SUSTAINABILITY OBJECTIVES PROPOSED IN BIOECONOMY STRATEGIES (BOX 3) TO THE 250 REVIEWED GOOD PRACTICE AND POLICY SOURCES

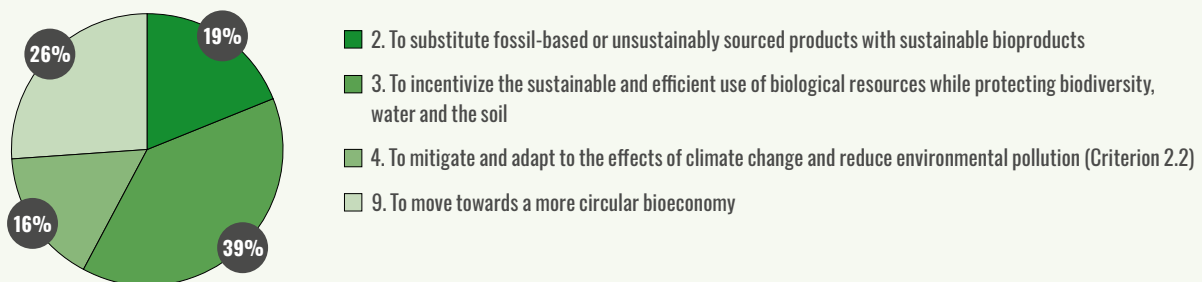
### SOCIAL OBJECTIVES COVERED BY THE COMPILATION



### ECONOMIC OBJECTIVES COVERED BY THE COMPILATION



### ENVIRONMENTAL OBJECTIVES COVERED BY THE COMPILATION



### GOVERNANCE OBJECTIVES COVERED BY THE COMPILATION



Source: Prepared by the authors



# THE WAY FORWARD

There is a tendency to produce good practice or good policy documents in ‘silos’, with the focus on specific areas and concepts. However, many of these good practices can be applied to broader areas. This Compendium includes good practices and policies in the broad bio- and agri-food systems continuum and frames them according to different specific stages and categories in the food and bioproducts value chains. This approach addresses broad sustainability issues, such as resource use efficiency, environmental pollution, health issues and social inequalities.

The literature review summarized in **Table 1** shows the importance of defining the bioeconomy and the themes it encompasses, as well as ensuring the quality of good practices with criteria and methodologies. It also shows that, to define what a good bioeconomy practice is, it is necessary to consider the objectives it addresses. Countries usually define objectives in their bioeconomy strategies, programmes and action plans, as well as other sustainable development pathways (e.g.

the good practices and prioritized actions of the Nationally Determined Contributions of the Paris Agreement that contribute to their targets). Therefore, good practices can be used for mainstreaming sustainability into national programmes, including bioeconomy strategies, programmes and action plans.

The sustainability objectives that a good practice addresses depend heavily on the context. Overall, the review indicates a lack of practices that support all the sustainability objectives for bioeconomy development. To address this gap, this chapter presents a context-specific approach to help countries identify good practices and opportunities that can support the implementation of sustainable and circular bioeconomy strategies, programmes and action plans to reach strategic objectives, particular with regards to the common sustainability objectives of bioeconomy strategies identified in *Towards Sustainable Bioeconomy – Lessons Learned from Case Studies* (Gomez San Juan, Bogdanski and Dubois, 2019).



Sustainable bioeconomy strategies, which are inherently multisectoral, face greater challenges than sustainable development strategies that target a single sector, as the implementation of sustainable bioeconomy involves trade-offs among different sustainability objectives. For instance, in *Good Environmental Practices in Bioenergy Feedstock Production* (FAO, 2012c), which is included in this Compendium, good practices are promoted to help farmers achieve greater yields and higher incomes so they can contribute to reducing land-use change and ultimately improve their food security. Practices included in this publication are multi-cropping systems, precision farming and crop protection. In this publication, there is only one objective: food security. The competition between bioenergy and food security was considered to be associated only with land use. This assumption greatly simplifies the equation. In the bioeconomy, many more relationships need to be considered to ensure that the implementation of good practices addresses sustainability issues.

## APPROACH TO INTEGRATE GOOD PRACTICES AND POLICIES IN BIOECONOMY STRATEGIES AND ACTION PLANS

Overall, the review shows that assessments often do not fully show whether practices and policies contribute to sustainability objectives of the bioeconomy. To address this gap, this chapter proposes a step-by-step approach that builds on existing evidence to define, select and mainstream good practices and policies that can support countries in the transition to a sustainable and circular bioeconomy and meet their bioeconomy strategy objectives. The approach also helps

policy makers to understand the complex concepts that bioeconomy encompasses and the challenges that may arise in the development and implementation of bioeconomy strategies, programmes and action plans.

This proposal responds to the recommendation made in the 2018 Global Bioeconomy Summit communiqué: “Supporting the promotion of proven and broadly accepted good practices in the production and the sustainable management of relevant natural resources as well as ensuring an inclusive decision-making process in that respect will significantly contribute to using biological resources more efficiently and for the benefit of society and the planet” (IACGB, 2018, p.10). In light of the COVID-19 pandemic, the 2020 Global Bioeconomy Summit communiqué further emphasized it: “In order to build back better with “bio”, we can draw on existing bioeconomy research and development, best practice examples from science, business and industry” (IACGB, 2020, p.9).

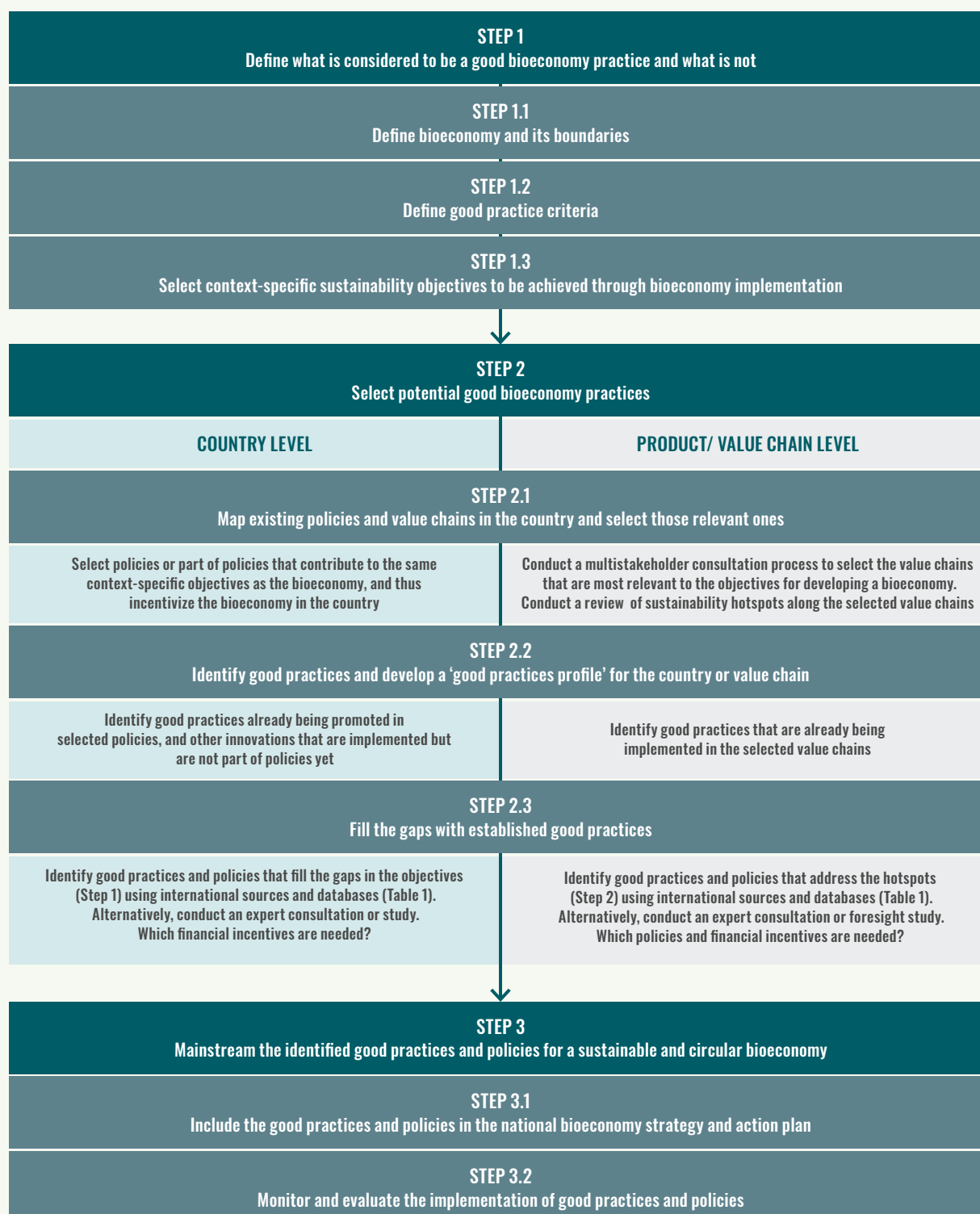
The difference between the bioeconomy and a single-sector approach is the coordinated effort that is required. Intersectoral, intergovernmental and international coordination is key to ensuring there as a common understanding of what sustainability means.

Collaborative interactions are particularly important for meeting the challenges that arise from the trade-offs that must often be made to reach a few sustainability objectives. An example is the European Innovation Partnership ‘Agricultural Productivity and Sustainability’ (EIP-AGRI), which holds expert consultations on specific areas of innovation and enabling technologies in the agricultural and forestry sectors. EIP-AGRI provides guidance to policy makers to target public support to the most promising innovation processes, and improves coordination of existing instruments to implement circular bioeconomy (EIP-AGRI, 2020). FAO can support in facilitating multistakeholder processes and provide capacity development for selecting and mainstreaming good practices and policies.

**Figure 18** summarizes the steps of the proposed approach that policy makers, private sector, investors and other stakeholders can

FIGURE 18.

## STEPS TO INTEGRATE GOOD PRACTICES AND POLICIES IN BIOECONOMY STRATEGIES AND ACTION PLANS



Source: Prepared by the authors

follow to identify ex-ante those practices and policies which can help achieve sustainability objectives of bioeconomy strategies and therefore track progress and learn from experience. Taken together, this Compendium and the 2019 FAO reports 'Towards sustainable bioeconomy. Lessons learned from case studies' and 'Indicators to monitor and evaluate the sustainability of bioeconomy' provide practical guidelines and resources that can support decision-makers in developing bioeconomy strategies and action plans.

## Step 1. Define what is considered to be a good bioeconomy practice and what is not

Within countries, key stakeholders select those good practices and policies that, when applied coherently, contribute to the transition to a sustainable and circular bioeconomy. When making this selection, it is important to have a clear definition of bioeconomy, follow good practice criteria and understand the strategy and sustainability objectives (**Box 3**) these practices will contribute to.

### Step 1.1 Define bioeconomy and its boundaries

The bioeconomy and the activities that drive its development in the country should be defined at the outset. Subchapters 2.1 and 2.2 of this report can be used to support stakeholders in defining bioeconomy and its boundaries. FAO, with its extensive expertise in bioeconomy, can also be called upon to provide support. Also, if there is a national bioeconomy strategy, it should be consulted, as it will generally contain, in addition to a context-specific definition of the bioeconomy, a vision and mission to be achieved.

### Step 1.2 Define good practice criteria

To define what is considered to be a good practice and what is not, the approach proposes using the FAO good practice methodology<sup>7</sup>, which goes beyond sustainability (see Subchapter 2.3).

<sup>7</sup> Countries can fine-tune this methodology. For instance, the criterion 'replicability' may not be a requirement for including a good practice in the bioeconomy strategy.

## Step 1.3 Select context-specific strategy and sustainability objectives to be achieved through bioeconomy implementation

The qualitative and quantitative objectives that are set out in the bioeconomy strategy must be achieved to realize the overall vision and mission. These objectives are used in this approach to identify good practices and policies that contribute to them. The practices are 'good' to the extent that they address the stated strategy and sustainability objectives. FAO (2021) and Subchapter 2.4 of this Compendium can be used as inspiration for common objectives in bioeconomy strategies.

## Step 2. Select potential good bioeconomy practices tailored to context-specific objectives

Two different levels of focus can be considered for identifying improvement opportunities in current practices and policies: the country level and a product/ value chain. An ex ante assessment is needed in both levels, to understand the country's context and its sectors as well as hotspots in a product value chain, exiting gaps and possible opportunities. Also, both levels include cross-sectoral interaction, since the country level considers the existing net of policies and industries operating in the country, and the product/ value chain level needs to consider for instance the material flows, i.e. the inputs and outputs shared between industries in a given production system.

### Step 2.1 Map existing policies and value chains in the country and select those relevant ones

A country mapping exercise is carried out to identify already existing policies and/or value chains that contribute to achieving the same context-specific strategic objectives as the bioeconomy. This exercise will create incentives for bioeconomy development in the country. Examples include policies and value chains that support the implementation of circularity. Sustainability hotspots in the value chains are also identified to help determine the most suitable good practices and innovations. The

mapping helps to understand where the gaps exist and where efforts should be directed. However, different policies may be identified that are not necessarily mutually supportive or consistent. The mix of selected good practices should consider these inconsistencies and seek to balance the trade-offs.

## Step 2.2 Identify good practices and develop a ‘good practices profile’ for the country or value chain

In this step, good practices that are already being implemented and promoted in the selected policies and/or value chains, if any, are identified. Other existing good practices and innovations that are being implemented and are in line with the bioeconomy strategy objectives, but are not yet part of policies or institutionalized, can also be identified to deepen this mapping exercise. This step can be carried out through interviews or multistakeholder consultation processes, and the template presented in **Annex 2** of this report can be used to gather inputs from private and public actors. Also, the Bioregional Strategy Accelerator Toolkit (POWER4BIO Project, 2021) is an online ‘bioeconomy strategy toolkit’ that supports regions, including the identification of good practices and policies.

The result should be a ‘good practice profile’ that gives a clear picture of the situation in the country. A possible structure of the profile is to classify the identified good practices by the 15 strategic objectives (**Box 3**) as well as the stage the practice has reached. This classification is helpful for taking future steps, and for identifying concrete practices that can fill the gaps in the relevant objectives.

## Step 2.3 Fill the gaps with established good practices

Strategic objectives or sustainability hotspots that are not correctly addressed by the compiled information on policies and practices constitute gaps that need to be addressed. At this stage, good practices to fill these gaps are identified. These can be either new policies or already existing practices and innovations that can be scaled-up.

The 2018 and 2020 Global Bioeconomy Summit communiqués also refer to the importance of identifying potential good practices (i.e.

innovations and promising practices) that are already demonstrating clear social, health and economic benefits to make improvement efforts in the bioeconomy (IACGB, 2018, and IACGB, 2020). In particular, an increased demand has been revealed by COVID-19 for innovation and new opportunities from the medical, agricultural, materials, energy and food research areas (IACGB, 2020).

**Table 1** includes global databases that can be used as reference. Countries in different stages in the development and implementation of their bioeconomy strategy can use the sources included in each one of the three categories (innovations, practices and policies) in the table. The sources are further classified by subcategories, topics and subtopics for easy reference.

However, the results of the review in this Compilation show that some bioeconomy sources in table 1 are focused on presenting bio-innovations or showcasing examples and case studies. Precaution should be taken when incorporating them into bioeconomy strategies, programmes and action plans since there is not enough evidence of impact and they should be taken only as a way of inspiration.

Also, any innovation, good practice or policy should be tailored to the local context. Countries can use the number coding for the bioeconomy strategy objectives in **Table 1** to prioritize these objectives in accordance with their own objectives. Alternatively, knowledge sharing with other countries, expert consultations, scenario development processes and research studies can be used to identify potential good practices and policies. Moreover a holistic trade-off assessment is needed for a bioeconomy practice to be considered sustainable (WBCSD, 2020).

At this stage, the user should also identify sources of financial support required for the implementation of the selected good practices and policies together with the prioritized actions.

## Step 3. Implement the identified good practices and policies for a sustainable and circular bioeconomy

There are different ways to implement the good practices and policies and fill the gaps with respect to strategy objectives and sustainability hotspots. The practices and policies should

be tailored to regional and local political environments, biophysical conditions and socio-economic contexts, as well as to the country's own bioeconomy definitions, comparative advantages and objectives for the development of a sustainable and circular bioeconomy.

These good practices may already be being applied in the country at a demonstration phase, but may not yet be institutionalized, or they may have been observed in other countries but not yet introduced into the country. Public efforts should focus on scaling-up and incentivizing their adoption, for example by putting in place the necessary regulations and financial incentives.

Once policies and value chains are aligned with a country's bioeconomy strategy objectives, their contribution to bioeconomy becomes more clear and good practices can be identified. Countries can then include these practices in their bioeconomy strategies, programmes and action plans, or in their monitoring and evaluation frameworks.

### **Step 3.1 Include the good practices and policies in the national bioeconomy strategy and action plan**

The identified good practices, including potential good practices or innovations, and the identified good policies can be included in bioeconomy strategies, programmes and action plans as key measures to promote the deployment of the bioeconomy. Examples of implementation measures to promote the bioeconomy include establishing a research fund, public-private partnerships; and using networks and communication platforms to raise awareness about bioeconomy and create momentum for its development. Recent research has shown that, while national bioeconomy policies currently widely promote R&D, infrastructure and capacity development, there is a gap in policy measures to strengthen framework conditions as well as international collaboration (WBCSD, 2020).

### **Step 3.2 Monitor and evaluate the implementation of good practices and policies**

The approach allows for the identification of potential practices that contribute to

sustainability and circularity of systems and value chains. These practices can then be monitored and analysed as an approximate way of measuring the development of the bioeconomy. Also, areas where further work is needed can be more easily determined and included in the national bioeconomy strategy and action plan, or in corporate business strategies. Countries and businesses can also use these results to prioritize topics in setting the agenda for further research.

The European Commission Joint Research Center and FAO collaborate to provide guidance on monitoring the sustainability and circularity of the bioeconomy. While indicators help to monitor ex-post progress toward sustainability, ex-ante assessments of the sustainability of innovations, practices and policies is an essential component of good governance.

For instance, natural capital accounting can support to make the right decisions between different policy and investment scenarios. For this reason, including practices and policies that are considered as 'good' according to FAO methodology when setting out the milestones of a roadmap or action plan can help in conducting a rapid assessment of the sustainability of the bioeconomy development.

Some countries can use good practices as a quality control mechanism. For instance, the German Bioeconomy Council recommendations suggest having an official registration and monitoring of good practice in commercial and academic applications of genome editing technologies (GBC, 2018b). It is also common to include good practices as part of guidelines, manuals and codes of conduct. Often, certification systems include the implementation of good practices. Notable example of promotion and monitoring of good practices is the European Union Common Agricultural Policy (CAP). The SDG framework also includes good practice proxy indicators, such as SDG Indicators 2.4.1 (Proportion of agricultural area under productive and sustainable agriculture); 12.4.2 (Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment) and 12.5.1 (National recycling rate, tons of material recycled).



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## ANNEX 1.

# SDG TARGETS COVERED BY SUSTAINABILITY OBJECTIVES PROPOSED IN BIOECONOMY STRATEGIES (BOX 3)



- ▶ **TARGET 1.3:** Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable.
- ▶ **TARGET 1.5:** By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.
- ▶ **TARGET 1.B:** Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions.



- ▶ **TARGET 2.3:** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
- ▶ **TARGET 2.4:** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.
- ▶ **TARGET 2.5:** By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed

and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.

- ▶ **TARGET 2.A:** Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.



- ▶ **TARGET 3.4:** By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.
- ▶ **TARGET 3.9:** By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
- ▶ **TARGET 3.B:** Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all.



- ▶ **TARGET 4.4:** By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.
- ▶ **TARGET 4.B:** By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries.



- ▶ **TARGET 5.A:** Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws.



- ▶ **TARGET 6.3:** By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
- ▶ **TARGET 6.4:** By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.



- ▶ **TARGET 7.2:** By 2030, increase substantially the share of renewable energy in the global energy mix.
- ▶ **TARGET 7.B:** By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support.



- ▶ **TARGET 8.2:** Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors.
- ▶ **TARGET 8.3:** Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services
- ▶ **TARGET 8.4:** Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead.
- ▶ **TARGET 8.5:** By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.



- ▶ **TARGET 9.2:** Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries.
- ▶ **TARGET 9.4:** By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
- ▶ **TARGET 9.5:** Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending.
- ▶ **TARGET 9.B:** Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities.



- ▶ **TARGET 10.1:** By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.
- ▶ **TARGET 10.3:** Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard.

► **TARGET 10.6:** Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions.



► **TARGET 11.6:** By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

► **TARGET 11.A:** Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.



► **TARGET 12.1:** Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries.

► **TARGET 12.2:** By 2030, achieve the sustainable management and efficient use of natural resources.

► **TARGET 12.3:** By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

► **TARGET 12.4:** By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

► **TARGET 12.5:** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

► **TARGET 12.6:** Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

► **TARGET 12.7:** Promote public procurement practices that are sustainable, in accordance with national policies and priorities.

► **TARGET 12.8:** By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

► **TARGET 12.A:** Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production

► **TARGET 12.B:** Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products

► **TARGET 12.C:** Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities.



► **TARGET 13.1:** Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.

► **TARGET 13.2:** Integrate climate change measures into national policies, strategies and planning.

► **TARGET 13.3:** Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.



- ▶ **TARGET 14.1:** By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.
- ▶ **TARGET 14.2:** By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.
- ▶ **TARGET 14.A:** Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.
- ▶ **TARGET 14.4:** By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum.



- ▶ **TARGET 15.2:** By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.
- ▶ **TARGET 15.3:** By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

- ▶ **TARGET 15.5:** Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.
- ▶ **TARGET 15.6:** Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed.
- ▶ **TARGET 15.9:** By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.



- ▶ **TARGET 16.6:** Develop effective, accountable and transparent institutions at all levels.
- ▶ **TARGET 16.7:** Ensure responsive, inclusive, participatory and representative decision-making at all levels.



- ▶ **TARGET 17.6:** Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism.
- ▶ **TARGET 17.7:** Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed.
- ▶ **TARGET 17.9:** Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the



sustainable development goals, including through North-South, South-South and triangular cooperation.

- ▶ **TARGET 17.11:** Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020.
- ▶ **TARGET 17.14:** Enhance policy coherence for sustainable development.
- ▶ **TARGET 17.16:** Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to

support the achievement of the sustainable development goals in all countries, in particular developing countries.

- ▶ **TARGET 17.17:** Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.
- ▶ **TARGET 17.19:** By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries.

# ANNEX 2.

# TEMPLATE FOR DOCUMENTING LOCAL GOOD BIOECONOMY PRACTICES AND POLICIES

This template, based on FAO’s experience capitalization process (FAO, 2016a) and tailored to the bioeconomy, helps local stakeholders from the private and public domains to identify, value and document good practices and policies in bioeconomy, including successes and failures towards sustainability and circularity, and allows the learning of lessons.



1.\* List one or several **good bioeconomy practices and policies** that you are familiar with:

.....  
.....  
.....



**Contact** details (name, title, organization, email) of the reporter:

.....  
.....  
.....



2.\* **Documents**

(information sheets, guidelines, websites, case studies, training manuals, videos, pictures, etc.)

.....  
.....  
.....



3.\* Are any of them being **implemented**? By whom? In which country, region, and/or province?

.....  
.....  
.....



4.\* Are any of them being **replicated**? In the same context? In different contexts?

.....

.....

.....

What are the key conditions for the successful replication and adaption of the practice or policy to another context/geographical area?

.....

.....

What are the key conditions for the successful replication of the practice or policy at a larger scale (national, regional, international)? Where can it be replicated?

.....

.....



5.\* Which are the **objectives/priorities** for implementing the good practice or policy? Or what are the specific **challenges** the practice or policy seeks to address?

.....

.....

.....



6.\* To what extent and why is the practice or policy institutionally, socially, economically and environmentally **sustainable**? To what extent and why is it **circular**? Which P&Cs does it address?

.....

.....

.....



7.\* What are the **success factors**/ conditions needed for the practice or policy to be successful?

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8.\* Has the practice or policy been **validated** with the stakeholders/ final users?

.....

.....

.....



9.\* Were the results and development improvements measured through **monitoring and evaluation**?

.....

.....

.....

\* Have you developed any **indicator/s**? If yes, which one/s? Is it useful in the event of replication?

.....

.....

.....

Do the indicator/s measure the contribution of the good practice or policy to **achieve targets** set in bioeconomy strategies, programmes or action plans and/or the SDG targets? Which ones?

.....

.....

.....

\* Required fields





In its 2020 communiqué, the International Advisory Council on Global Bioeconomy has urged to strengthen good practices and policies to advance the global bioeconomy. The transition from a fossil-based economy to a bioeconomy happens at three levels: technological, organizational and social. In particular, agri-food systems are key to achieve a shift to sustainable and circular production and consumption patterns, since they occupy the biggest share of the bioeconomy from an economic value added perspective as well as potential for discovery and innovation.

This Compendium outlines 250 sources of good practices and policies. It covers the entire continuum of economic sectors that have a stake in biological knowledge and resources. The Compendium therefore highlights the wide range of aspects that are included in the concept of the bioeconomy. Being an inherently multisectoral process that involves potential synergies and trade-offs among different sustainability objectives, the implementation of bioeconomy strategies presents greater challenges than activities that are focused on a single sector.

The report shows how good practices and policies contribute to translate bioeconomy strategies into coordinated actions for the achievement local priorities and sustainability goals, while addressing global issues. Overall, the review shows that assessments often do not fully show whether practices and policies have enough evidence of impact to be recommended as models that can contribute to sustainability objectives of the bioeconomy. To address this gap, a context-specific approach, which is described in Chapter 5, has been developed to assist countries in evidence-based decision making on policies and investments for the bioeconomy. It helps to identify good practices and policies ex-ante, which can help achieve common sustainability objectives of bioeconomy strategies that were presented in the 2019 FAO report, *Towards sustainable bioeconomy – Lessons learned from case studies*.

Taken together, this Compendium and the 2019 report, provide practical guidelines and resources that can support decision-makers and stakeholders in bioeconomy systems to make progress towards reaching sustainable outcomes.

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