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CHAPTER 2

OBJECTIVES AND POTENTIALS OF CIRCULAR AGRICULTURE

Chapter 2: Objectives and potentials of Circular Agriculture

This chapter explores the objectives and potentials of CA, focusing on its role in improving the profitability of agricultural production, creating new job opportunities and fostering economic development. It examines how the principles of circularity can enhance resource efficiency, reduce production costs, and increase yields, thereby improving the overall profitability of agricultural operations. Additionally, it explores the potential for CA to stimulate economic growth by creating new job opportunities and supporting the development of sustainable agricultural value chains. Through an analysis of the economic benefits and opportunities associated with CA, this chapter aims to empower stakeholders to embrace circularity as a pathway to prosperity.

2.1. Exploration of the objectives of Circular Agriculture

The traditional linear model of agriculture – extracting resources, production, consumption, and waste disposal – is increasingly unsustainable. It depletes natural resources, pollutes ecosystems, and contributes to climate change. Circular agriculture (CA) offers a paradigm shift, mimicking a closed-loop system found in nature. It emphasizes resource efficiency, waste minimization, and the creation of byproducts that become inputs for other processes.

According to Shebanin (2024), shifting towards a circular economy offers advantages for enterprises. Through reassessing business models, production methods, and product design, companies embracing circularity can notably diminish expenses associated with materials, energy, and waste management. Consequently, this can result in heightened profitability and a strengthened competitive edge. This approach is reflected in the new Circular Economy Action Plan adopted by the European Union, which is a key element of the European Green Deal and a new strategic direction for Europe's sustainable development, New circular economy action plan for the European Union. The sustainability principles identified in the plan include improving durability, reusability, renewability and maintainability, addressing the presence of hazardous chemicals in products and increasing the content of recycled products. These new rules and initiatives have been developed with the participation of businesses and stakeholders and will be implemented by the European Commission to support sustainable development.

Circular agriculture (CA) emerges as a promising solution, aiming to create a closed-loop system that minimizes waste and maximizes resource efficiency. This review identifies and defines the key objectives of CA. We review the last 4 years of the EU and researchers' views on CE and discuss how these objectives interlink and serve as guiding principles for developing and implementing CA practices.

2.1.1. Key objectives of circular agriculture based on United Nations Department of Economic and Social Affairs (2021):

1. **Minimize external inputs:** This means reducing reliance on fertilizers, pesticides, and other resources brought in from outside the farm system.
2. **Close nutrient loops:** Nutrients are cycled within the farm instead of being lost to the environment. Manure and compost are used to replenish soil fertility, reducing the need for chemical fertilizers.
3. **Regenerate soils:** Practices that improve soil health and fertility are prioritized. This can involve techniques like cover cropping, crop rotation, and reduced tillage.
4. **Minimize environmental impact:** Circular agriculture aims to reduce pollution, conserve water, and protect biodiversity.
5. **Reduce resource requirements:** By minimizing waste and maximizing resource efficiency, circular agriculture lowers the overall ecological footprint of farming.
6. **Reduce land use:** Efficient practices can potentially decrease the amount of land needed for food production.
7. **Reduce chemical fertilizer and waste:** This objective can significantly improve environmental health and reduce greenhouse gas emissions.
8. **Promote smallholder farming:** Circular practices are often more suited to smaller farms that can integrate diverse crops and livestock.
9. **Improve food security and nutrition:** Diverse production systems lead to a wider variety of nutritious food.
10. **Create rural jobs:** Circular agriculture's labor-intensive nature can revitalize rural economies, especially for women.
11. **Reduce barriers to entry for women in agriculture:** Lower input needs in circular agriculture can empower women to participate more actively in farming.
12. **Promote sustainable development:** All aspects of the food system, from production to consumption, are designed to minimize environmental impact and ensure long-term sustainability.

Overall, according to United Nations Department of Economic and Social Affairs (2021) circular agriculture strives for a closed-loop system that minimizes waste, maximizes resource efficiency, and promotes environmental and economic well-being.

2.1.2. Key CE objectives for a circular agriculture based on Velasco-Munoz (2021):

1. Eliminate Waste and Pollution:

- Reduce soil contamination by minimizing the use of chemical fertilizers, herbicides, and pesticides.
- Develop and implement alternative pest control methods like biological control systems.
- Promote integrated crop-livestock systems where animals can reduce the need for herbicides and provide organic fertilizer.
- Conserve water resources by minimizing agricultural water use and preventing water body degradation.

2. Maximize Resource Use:

- Extend the value of products, co-products, and by-products throughout the supply chain.
- Utilize technological advancements to find new uses for agricultural waste:
- Bioenergy production
- Soil amendment and bio-fertilizers
- Livestock feed

3. Regenerate Natural Systems:

- Implement regenerative agriculture practices that:
- Improve soil health and fertility
- Reduce greenhouse gas emissions
- Increase carbon sequestration in soil and plants
- Minimize soil disturbance
- Enhance water storage capacity

By focusing on these CE objectives, according to Velasco-Munoz, etc. (2021), circular agriculture can create a more sustainable and resource-efficient agricultural system and achieve system-wide efficiency in resource use within agriculture.

2.1.3. Objectives of circular agriculture based on Marinova & Bugaeva (2022):

1. **Minimize waste:** A core principle is to create a closed-loop system where everything is reused or recycled, eliminating waste.
2. **Mimic natural processes:** Circular agriculture aims to emulate nature's regenerative cycles, promoting sustainability.
3. **Maintain soil health:** By returning nutrients to the soil through organic fertilizers, circular agriculture promotes soil fertility and productivity.
4. **Reduce reliance on external inputs:** The system should minimize dependence on external resources like fertilizers and focus on closed-loop nutrient cycles within the farm.
5. **Decouple food production from environmental harm:** Circular agriculture strives to achieve food production that minimizes negative impacts on the environment, such as water pollution and greenhouse gas emissions.
6. **Implement localized solutions:** While some general principles apply, circular agriculture acknowledges the need for adaptable and context-specific approaches based on local conditions.

These objectives paint a comprehensive picture of circular agriculture's potential to create a sustainable food system. By focusing on closed-loop cycles, resource efficiency, and environmental protection, circular agriculture offers a promising path towards a more resilient and future-proof agricultural landscape, adaptable to diverse local conditions.

2.1.4. CE objectives for circular agriculture based on the five principles outlined in Hoogstra and etc. (2024):

1. Safeguard the Health of Agro-ecosystems:

- **Protect and regenerate biodiversity:** Maintain healthy populations of plants and animals within agricultural systems.
- **Minimize environmental pollution:** Avoid or reduce pollution from agriculture, such as nutrient runoff and greenhouse gas emissions.
- **Maintain regenerative capacity:** Use natural resources at a rate that allows them to replenish themselves.

2. Minimize Waste:

- **Avoid unnecessary production:** Focus on producing only what is essential for human needs.
- **Prevent food waste:** Implement strategies to minimize food loss and waste throughout the supply chain.

3. Prioritize Human Needs:

- **Direct biomass towards human consumption:** Use agricultural resources primarily to feed people rather than animals.
- **Feed animals with inedible biomass:** Utilize food scraps or other human-inconsumable materials for animal feed.

4. Maximize Resource Use:

- **Recycle by-products and residuals:** Repurpose agricultural waste streams like crop residues and manure back into the food system for productive use.
- **Prioritize highest-value use:** When recycling by-products, prioritize uses that extract the most value from the material.

5. Minimize Energy Use:

- **Reduce overall energy consumption:** Optimize processes to minimize the energy required for agricultural production.
- **Utilize renewable energy sources:** Prioritize renewable energy sources like solar or wind power to reduce reliance on fossil fuels.

These five CE objectives provide a framework for developing and evaluating circular agriculture initiatives. They emphasize resource efficiency, environmental protection, and prioritizing human needs within the agricultural system.

Common CA Objectives:

In conclusion, the UN prioritizes minimizing external inputs and closing nutrient loops within the farm system. Velasco-Munoz et al. (2021) broaden the scope by including waste reduction throughout the supply chain. Marinova & Bugaeva (2022) and Hoogstra et al. (2024) both emphasize prioritizing human needs. This includes directing biomass towards human consumption and utilizing inedible biomass for animal feed. Hoogstra et al. (2024) provides a more detailed framework with five CE objectives, encompassing safeguarding ecosystems, minimizing waste, prioritizing human needs, maximizing resource use, and minimizing energy use. **Overall, these convergent objectives paint a clear picture of what CA strives to achieve: a closed-loop system that minimizes waste, maximizes resource efficiency, protects the environment, and prioritizes human needs.**

Circular agriculture (CA) is gaining traction as a promising approach to achieving a more sustainable and resource-efficient food system. This conclusion analyzes key objectives

highlighted by various sources, revealing both commonalities and points of divergence. So Common CA Objectives are:

1. **Minimize Waste and Pollution:** All sources emphasize reducing waste generation and minimizing environmental pollution from agriculture. This includes reducing reliance on chemical inputs, promoting integrated crop-livestock systems, and conserving water resources.
2. **Maximize Resource Use:** Extending the value of agricultural products, co-products, and by-products is crucial. This involves utilizing technological advancements for bioenergy production, soil amendments, and animal feed.
3. **Maintain/Regenerate Natural Systems:** Improving soil health and fertility, reducing greenhouse gas emissions, and enhancing water storage capacity are all highlighted as vital for long-term sustainability.

2.4. Showcase examples of economic development

The current food system doesn't work for everyone, and it certainly doesn't work for the environment. Industrial farming has turned agriculture into a leading source of greenhouse gas emissions and pollution, and is driving the extinction of species, farms are moving very slowly to resource-efficient farming. The Circular Economy is gaining traction in academia, industry, and policy making as an alternative model that minimises resource depletion, waste, and emissions. To implement the concept on the organisational level, business models are an important leverage (Geissdoerfer, Pieroni, Pigosso & Soufani, 2020).

A circular economy in which products have multiple lifecycles requires business models articulates the logic of how an organization creates, delivers, and captures value to its broader range of stakeholders while minimizing ecological and social costs.

Business models can be understood as a structured management tool used to present the company's organisational structure and value creation processes. Circular business models are key levers for the implementation of a circular economy.

Circular business models contribute to a circular economy by adhering to the circular economy's three fundamental principles:

- Design out waste and pollution;
- Keep products and materials in use;
- Regenerate natural systems.

Circular business models are fundamentally different ways of producing and consuming goods and services. They can drive the transition to a more efficient use of resources and a circular economy, thereby significantly reducing the negative environmental impact of economic activity.

"A circular business model is how a company creates, captures, and delivers value with the value creation logic designed to improve resource efficiency through contributing to extending useful life of products and parts (e.g., through long-life design, repair and remanufacturing) and closing material loops" (Nußholz, 2017, p.12).

A circular economy business models based on longevity, reuse, repair, upgrade, refurbishment, renewability, capacity sharing and dematerialisation (Accenture 2014; Wallace, et al. 2015; Piscicelli, L., & Ludden, G., 2016).

Different authors have proposed various lists of '*circular business models'* (also referred to as '*innovative*' or '*resource efficient*' business models). Piscicelli, L., & Ludden, G. (2016) compares the classifications and adopted by Accenture (2014), Bakker et al. (2014), Kiørboe et al. (2015) and REBUS (2015) in Table 1. The authors grouped them under the broad categories of 'product-based', 'service-based', 'sharingbased' and 'supply chain-based' circular business models (OECD, 2018).

Table 2. Circular business models (Piscicelli, L., & Ludden, G., 2016; OECD, 2018)

Categories of circular business models	Authors and source				
	Accenture, 2014	Bakker, et al., 2014	Kiørboe, et al. 2015	REBUS, 2015	OECD, 2018
PRODUCT-BASED	Product life extension a. Resell b. Repair/Upgrade c. Remanufacture	Classic long life	Product design model	Long life	Product life extension
		-	Reuse	Incentivised return & re-use	-
		-	Repair	-	-
	-	Hybrid model	-	-	-
SERVICE-BASED	Product as a service	Performance model	Service- and function based models	Product Service System	Product Service System

			-	Dematerialised services	-
		Access model	-	Hire & Leasing	-
	-	-	-	Made to order	
SHARINGBASED	Sharing platforms	-	Collaborative consumption	Collaborative consumption	Sharing models
SUPPLY CHAIN - BASED	-	-	-	Made to order	-
	Circular supplies	-	Recycling and waste management	-	Circular supply
	Resource recovery a. Re-/upcycle b. Waste as a resource c. Returning byproducts	-	-	Asset management	Resource recovery
	-	Gap exploiter model	-	Collection of used products	-

Five Business Models for the Circular Economy from a Policy (OECD, 2018) perspective was headline:

- Circular supply models, by replacing traditional material inputs derived from virgin resources with bio-based, renewable, or recovered materials, reduce demand for virgin resource extraction in the long run.

- Resource recovery models recycle waste into secondary raw materials, thereby diverting waste from final disposal while also displacing the extraction and processing of virgin natural resources.
- Product life extension models extend the use period of existing products, slow the flow of constituent materials through the economy, and reduce the rate of resource extraction and waste generation.
- Sharing models facilitate the sharing of under-utilised products and can therefore reduce demand for new products and their embedded raw materials.
- Product service system models, where services rather than products are marketed, improve incentives for green product design and more efficient product use, thereby promoting a more sparing use of natural resources (OECD, 2018, p.4).

Circular business models operate in different parts of the value chain (Figure 1) and not all circular business models are necessarily new. Recycling, reuse, and repair have existed for millennia. The sharing of under-utilised household possessions also has a long history, and the provision of access to products, rather than ownership of them, is not so different from traditional product leasing. What is new is the growing diversity and sophistication of these business models, as well as the range of sectors they are adopted in.

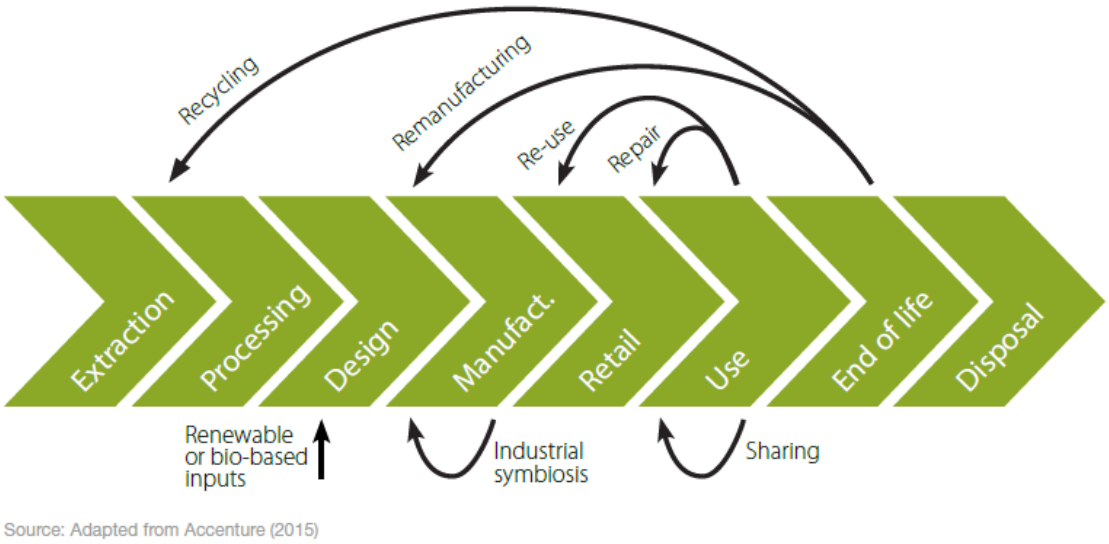

Figure 1. Circular business models operate in different parts of the value chain (Accenture (2015); OECD, 2018)

Circular business models, by closing resource loops and by slowing and narrowing resource flows, can reduce the environmental footprint of economic production and

consumption. But the environmental potential of circular business models is clear, but risks remain.

The distinction between different circular business models is clear in theory, but may be less so in reality.

A framework for conceptualising business models that has been acknowledged for its practical relevance is the "*business model canvas*" by Osterwalder and Pigneur (2010). The authors distinguish between nine business model elements: key resources, key partners, customer segments, customer relationships, channels, value proposition, revenue streams, cost structure, and key activities (Figure 2).

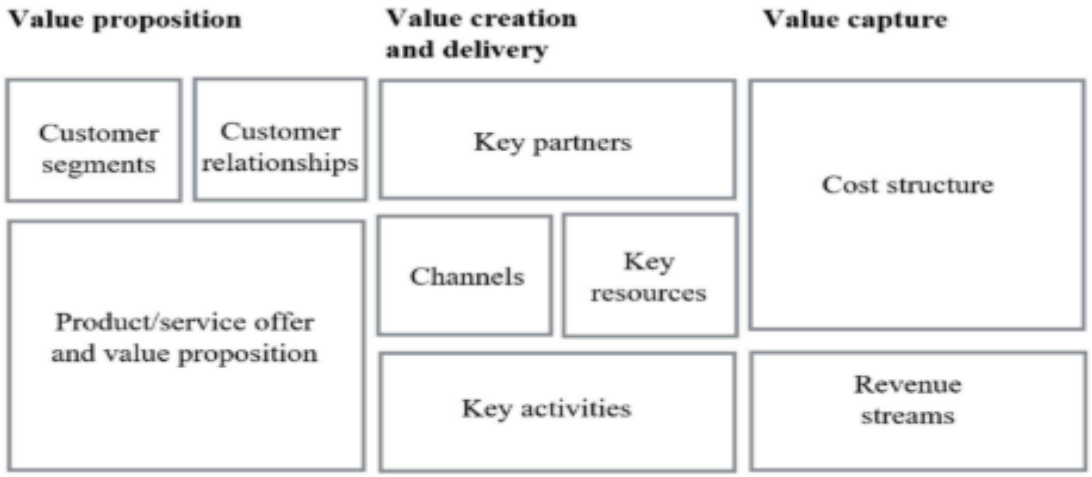

Figure 2. Business model conceptualisation, adapted from Osterwalder and Pigneur (2010).

By rethinking the three value dimensions, i.e., *what value is proposed, how value is created and delivered, and how value is captured* (Nußholz, 2017), business model innovation provides a more systemic approach for aligning the value creation logic of the company with circular principles. As Figure 3 illustrates, a circular strategy and the associated changes in material flows can be embedded into the value creation logic to aid its implementation. Aligning the three value dimensions and adjusting the configuration of business model elements can facilitate its operation.

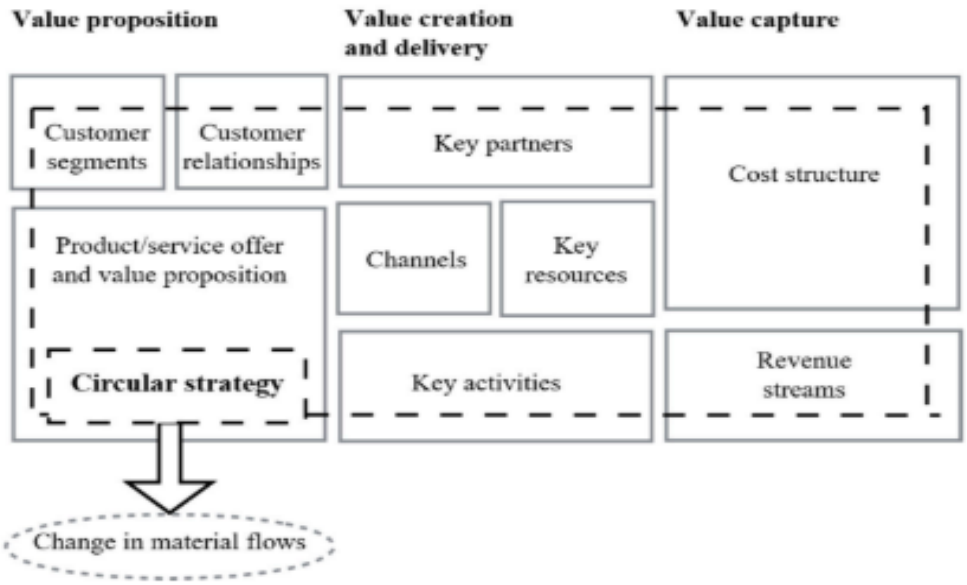

Figure 3. Illustration of embeddedness of a circular strategy in a business model (Nußholz, 2017)

Examples of economic development related to circular agriculture

Farmers on their way to circularity (Dagevos & Lauwere, 2021). to explore how Dutch farmers perceive circularity and what kind of implications ca has for their production practices Dagevos & Lauwere (2021) selected thirteen types of farms in Netherlands were the Dutch government has expressed the ambition to establish circular economics in the Netherlands in 2050. the types of farms included varying from a conventional pig farmer with a small plus for animal welfare and production of sustainable energy to biodynamic (bd) multifunctional farms with livestock, crops, nature conservation, a farm shop and/or webshop and care. in between scientists found a conventional pig farmer who made use of residuals flows of the food industry, a conventional broiler farm with high-tech solutions to reduce ammonia emissions, smart cooperation between livestock and conventional arable farmers, a bd dairy farm and an organic mixed farm with dairy cattle and arable crops, a farm with special livestock, an outdoor pig farm and a bd pig farm and a nature-inclusive mixed farm with dairy cattle and arable crops, and a community farm. in addition, three of the farmers who were not certified organic or bd (the outdoor pig farm, the farm with special livestock and the community farm) claim to go beyond the organic standard but did not want to certify to avoid administrative burden and additional costs (Dagevos & Lauwere, 2021).

Table 3. The motives of farmers to choose for a particular (transition) path link circular agriculture and prefer to rely on technological solutions (Dagevos & Lauwere, 2021)

Excerpts from the interviews	Type of farm
Because of a car accident and problems with my immune system and all kinds of allergies, I started to gain more in-depth knowledge about food. As a result I lost trust in food from retailers and decided to start producing my own food and keeping my own animals. My father owned some parcels of forest and there I could start.	BD outdoor pig farmer
My farmer's heart was violated very much... As an agricultural contractor I once worked on the tractor for 48 h. Nobody had their own labour anymore and because of the use of pesticides and artificial fertiliser, the farms became larger and larger. I realised that these developments are not future proof, and that I did not want to be part of it as a farmer if it has to be like this.	BD multifunctional farmer 1
I wondered whether they needed a producing farmer here who produces as efficiently as possible for the world market, or a farmer aligned to the society who also asks society 'What do you want from me?' And I decided to turn to the side of society.	BD multifunctional farmer 2
I am a dedicated newcomer in agriculture. If you do not want to become the largest food producer, you should become the most sympathetic one. Expansion in livestock farming will go on, but if you do not want to join that tendency, you have to invent something special.	Farmer with special livestock
I have always liked short food supply chains because in that way there will be some money left for the farmer. The ignorance of the consumer struck me. I wanted to do something about that. My wish is that finally 100% of the consumers become more aware of how their food is produced.	Community farmer
I am a bit of a developer. Someone who thinks about new systems. How can we better use the land and protect nature? I just like to think about these things. And how it can be put into a business model. But some things cannot be expressed in money. It is also about the fun of being a farmer.	Cooperating farmer
We have 500 sows at the new location and we have a permit to build a new stable for meat pigs. But we do not want to build a conventional stable because we need to install an air washer then and we do not want that. Therefore, we talked about joining a project about separating manure into a thick and a fluid fraction, which aims to reduce ammonia	Conventional pig farmer 1

emission, and making manure more suitable for fermentation and production of gas.	
I noticed little understanding for food producers. I wanted to show the role of pigs in the food system. In that way, I hoped to receive more societal approval. I started feeding the pigs with residual flows from the food industry within a 100 km radius, instead of feeding them soy from abroad.	Conventional pig farmer 2
We opted for writing a business plan that aimed at "and-and" solutions directed towards cost price, environment, animals and people. We also looked specifically for a solution for the vans that drive back and forth between our farms.	Conventional broiler farmer

The researchers also aimed to determine how circular are farms in practice. All farmers with (more or less) alternative methods have taken several measures to contribute to CA. However, some farmers express their inadequacy in realizing production processes and a business model that was completely circular. None of the interviewed farmers believed that it was possible to become 100% circular, and there were clear differences in intentions and opinions regarding the goal of becoming as circular as possible. Various quotes could be provided to illustrate the different opinions of the interviewees.

Table 4. Circularity of farms in practice (Dagevos & Lauwere, 2021)

Excerpts from the interviews	Type of farm
The farm is not completely circular yet, and I hardly know how to make further improvements. The inputs come from the region, that is, from the Netherlands and Germany. The farm is neither climate neutral nor energy neutral, and I do not know how to change that either. I use "blue diesel" for my tractor that is made out of food waste and labelled CO_2 neutral. I do realise though that using this type of diesel is possible because not many farmers use it. When more farmers would use blue diesel, there would not be enough of it.	BD dairy farmer
The farm is not completely circular: Feed is imported and, by selling meat, nutrients are taken away from the farm which do not come back. I am idealist but it is good as it is.	BD outdoor pig farmer
Our credo is to decrease the cycle as much as possible, preferably at the own farm. We try to be as local as possible, both with respect to external inputs and our supply of meat. How circular can you be? Although we	Outdoor pig farmer

realise that an electric van needs batteries, we like to buy an electric van, but at this moment we are still using diesel.	
The farm has more outputs than inputs, much more, and that does not bother me. Concentrate (grain and maize flower) is bought for the dairy cattle, because it is not possible to grow grain and maize on peaty soil and recreants do not like grain and maize because you cannot walk through it and you cannot look across the maize, and the recreants are my clients.	BD multifunctional farmer 2
Sustainability and circularity do not bother me much in daily practice. I try to be as sustainable as possible, but I realise and accept that not everything I do is "green".	Farm with special livestock
It also is possible to produce milk without concentrate but then the cows will produce about 5000 L of milk per year. That does not fit in our business model yet. However, farms which do not use concentrate inspire me. Maybe we will stop using it one day. To me, sustainable farming is a process, a way of life.	Organic mixed farmer
Well, every pig farmer will say that they contribute to CA because residual flows from the food industry are used already as pig feed, for example, citrus and soy pulp. Because of that, the cycle is already closed for quite a big part. In addition, we buy straw from an arable farmer and the manure goes back to the land.	Conventional pig farmer 1
An air washer is expensive and it does not produce anything but clean air, and you cannot sell clean air. So we asked ourselves: Is it possible to regain heat with the air washer? Now we not only regain heat but minerals as well. So now we have developed a system in which heat is available unrestrictedly, without using fossil fuels.	Conventional broiler farmer
We never use antibiotics, the broilers are never sick, there is enough heat, also during the winter and the farming system is better for animal welfare than at the most other farms with slower growing broilers. Slower growing broilers cost 40% more raw materials and the need for energy is much bigger (in that case gas is still needed). The consequences of that choice are; thus, far-reaching.	Conventional broiler farmer

Table 4 provides an overview, and we add information to it by combining it with the ten critical performance indicators for CA as identified by Erisman and Verhoeven (2020):

1. soil preservation;
2. closing nutrient cycles;
3. reduction of greenhouse gasses and ammonia;
4. sustainable energy;
5. maintenance of biodiversity;
6. nature conservation;
7. animal welfare;
8. animal health;
9. using residual flows from the food industry; and
10. contribution to regional economy and vitality of the rural area.

After analyzing the interview data and the available farmer websites, it was found that 13 farmers met the following criteria: Biodynamic or organic farming (5 farms); proper soil maintenance, preservation of organic matter (7 farms); closing nutrient cycles (7 farms); reduction of greenhouse gas (CO_2, CH_4, N_2O) and ammonia emissions (6 farms); sustainable energy (8 farms); support of biological diversity (8 farms); nature conservation (5 farms); improving animal welfare (ranging from a small plus to keeping animals according to their natural needs) (12 farms); antibiotics are used less (10 farms); using residual flows from the food industry (four farms); and contribution to the regional economy and rural vitality through a farm shop or online shop (9 farms).

Table 5. Farms included and meeting critical performance indicators for circular agriculture: 1 = soil preservation, 2 = closing nutrient cycles, 3 = reduction of greenhouse gasses and ammonia, 4 = producing sustainable energy, 5 = maintenance of biodiversity; 6 = nature conservation, 7 = animal welfare, 8 = animal health, 9 = using residual flows from the food industry, 10 = contribution to regional economy and vitality of the rural area (Dagevos & Lauwere, 2021)

Type of Farm		Critical Performance Indicators for Circular Agriculture									
	Adaptive or Alternative?	1	2	3	4	5	6	7	8	9	10
Community farm	Alternative	+	+			+		+	+	+	+
Biodynamic multifunctional farm 1	Alternative	+	+	+	+	+	+	+	+		+
Biodynamic multifunctional farm 2	Alternative	+	+	+	+	+	+	+	+		+
Conventional mixed nature inclusive farm	Alternative	+	+	+		+	+	+	+		+
Biodynamic outdoor pig farm	Alternative	+				+	+/−	+	+		+
Outdoor pig farm	Alternative		+		+	+	+/−	+	+	+	+
Farm with special livestock	Alternative						+	+	+	+	+
Organic mixed farm	In between	+	+	+	+	+	+/−	+	+		+
Biodynamic dairy farm	In between	+	+	+		+	+/−	+	+		
Cooperation between conventional arable and livestock farms	In between		+		+	+	+	+/−	+/−	+	+
Conventional broiler farm	Adaptive			+	+				+		
Conventional pig farm 1	Adaptive				+			+/−			
Conventional pig farm 2	Adaptive				+/−			+/−	+	+	

2.5. Insights for stakeholders

In order to create conditions for the wider application of circular business models, policy programs and measures are needed at various levels of the economy. In order to move faster to a significantly more circular and more efficient resource-using economy, where the negative impact on the environment related to economic production and consumption is significantly reduced, stakeholders will have to apply circular business models more widely.

It is important to be able to recognize the initiatives with true ransformative potential and prevent that the implementation of circular agriculture remains focused on merely optimization within the current system while more fundamental changes are needed to address the sustainability challenges. The concept of circular agriculture, as a guiding mission for food system innovations, lacks clarity and risks being used superficially without real transformative impact (Hoogstra, Silvius, de Olde, Candel, Termeer, van Ittersum & de Boer, 2024).

To prevent this, policymakers need to make clear decisions about the future of food systems and further operationalize the term of circular agriculture. Hereby, instead of fixating on the label “circular agriculture,” it’s recommended to focus on the practices that align with

the desired food system direction. Different initiatives may use different terms, but they can all contribute to the broader mission of creating a more sustainable food system.

Measuring the circularity of the food production systems is the first step in the process of moving towards a circular food production system (Velasco-Muñoz et al., 2021). For this, it is necessary to know the level and the possibilities of circularity of each of the phases that make up the complete food production cycle.

Jauernig et al. (2020) argued for trying to find the common ground of different visions—more specifically here the "agrarian" and "industrial" visions of agriculture - and looking for compatibility rather than accentuating distinction, controversy and incongruence between perspectives. "We should not simply stick the label 'transformation' on any amendment to the status quo, or call each technological efficiency gain an 'innovation.' If the benchmark for the changes to which we aspire is not radically different to the one that has guided development solutions so far, humanity will not escape those strong path dependencies. At the same time, dismissing the role that incremental steps play in getting there means ignoring the insights that complex system research offers about patterns of change. So juxtaposing the two approaches as entirely separate strategies - a practice often used to discredit someone else's proposals—does not help. What helps is to keep each other challenged with respect to both the radicalness of the imagined outcomes (what do we deem possible) and the amount of change in this direction that the next, often little, steps could bring (what do we do to make it happen)"(Jauernig et al., 2020).

Policy can play an important role in addressing the market failures, policy incoherence, and status quo biases that currently hinder the competitiveness of these business models.

According to OECD (2018, p.4) policy can help to:

- Ensure that the full environmental costs of production and consumption activities are reflected in market prices.
- Improve collaboration within and across sectoral value chains. Fostering industrial symbiosis clusters, promoting online material marketplaces, establishing secondary raw material certification schemes, and, more generally, facilitation of cooperation within and across value chains may be worthwhile initial steps.
- Ensure that existing regulatory frameworks are coherent and fit for purpose, and not serving to preserve an existing status quo.
- Improve existing educational and information programs to provide individuals with a better understanding of the unintended consequences of their consumption choices. The use of behavioral insights and nudges, such as through labelling requirements, may be a promising way forward.
- Promote the supply of circular products ("supply-push measures") or demand for them ("demand-pull measures"). For the former this includes eco-design standards, strengthened extended producer responsibility (EPR) schemes, and the provision of

targeted R&D funding. Examples of the latter include differentiated VAT rates, recycled content mandates, product labelling standards, and green public procurement.

Circular agriculture (CA) presents a paradigm shift in agricultural practices, advocating for closed-loop systems that minimize waste and maximize resource efficiency. Beyond its environmental benefits, CA offers compelling economic advantages for stakeholders across the agricultural value chain. This chapter outlines practical insights and recommendations for stakeholders interested in maximizing the economic potential of CA.

Policy Development: Fostering an Enabling Environment

Government subsidies and tax breaks: Incentivize on-farm resource recovery practices like composting facilities and cover cropping through targeted subsidies and tax breaks. (Wallace, 2019; Badu-Nkansah, Opoku-Agyemang, Adu-Dapaah & Asare-Kumah, 2018).

Knowledge dissemination and extension services: Invest in farmer education programs and extension services to promote knowledge transfer and adoption of CA practices (Sumberg, & Hoffecker, 2017; Titton, Perretti, Bonneau & Münnich, 2012).

Research and development funding: Allocate public research and development funding towards CA innovations like nutrient recycling technologies and decision-support tools for farmers.

Investment Strategies: Seeding Economic Growth

Private sector investment: Encourage private sector investment in CA infrastructure, such as biorefineries for processing agricultural waste into valuable products.

Impact investing: Attract impact investors seeking opportunities that align financial returns with environmental and social benefits associated with CA.

Risk mitigation instruments: Develop risk mitigation instruments, such as crop insurance programs tailored to CA practices, to encourage broader adoption.

Collaboration Opportunities: Building a Circular Economy Ecosystem

Farmer cooperatives: Facilitate the formation of farmer cooperatives to share resources, knowledge, and best practices in implementing CA.

Supply chain partnerships: Encourage collaboration between farmers and food processors to develop and promote CA-produced products with premium pricing.

Public-private partnerships: Foster public-private partnerships to develop and implement comprehensive CA strategies across the agricultural sector.

Conclusion

By implementing these recommendations, stakeholders can create an enabling environment for CA adoption and unlock its full economic potential. Policymakers can establish supportive frameworks, while investors can channel resources towards innovative solutions. Collaboration among diverse stakeholders, including farmers, researchers, industry players, and policymakers, will be crucial in building a robust circular agricultural economy. As CA gains momentum, stakeholders who embrace this transformative approach are poised to reap the economic benefits alongside environmental and social rewards.

Key Takeaways from Showcase examples of economic development

Importance of Circular Economy:

The circular economy is emerging as a vital alternative to traditional industrial farming, aiming to minimize resource depletion, waste, and emissions. This model emphasizes designing out waste, keeping products and materials in use, and regenerating natural systems to reduce the environmental impact of economic activities.

Diverse Circular Business Models:

Circular business models are categorized into product-based, service-based, sharing-based, and supply chain-based models. Each model supports the circular economy by promoting practices such as product life extension, resource recovery, sharing platforms, and product-as-a-service approaches, all aimed at improving resource efficiency and sustainability.

Implementation in Agriculture:

The transition to circular agriculture is being explored by various types of farms in the Netherlands. These farms implement practices such as using residual flows from the food industry, reducing ammonia emissions, and integrating livestock and crop production to move towards more sustainable and circular farming methods.

Challenges and Realities:

While many farms are adopting circular practices, achieving 100% circularity remains challenging. Farmers face difficulties in fully realizing circular production processes due to factors like reliance on external inputs, limitations in technology, and the balance between economic viability and environmental goals. Despite these challenges, continuous efforts and innovative solutions are essential for progressing towards a circular agricultural system.

Ideas to Consider from Showcase examples of economic development

Adopting Circular Business Models Across Industries:

Businesses in various sectors can significantly benefit from adopting circular business models. These models focus on resource efficiency by extending the life of products through design, repair, remanufacturing, and reuse. Organizations should explore how to integrate circular principles into their operations to reduce waste and environmental impact.

Leveraging Technology for Sustainable Farming:

Technological innovations play a crucial role in advancing circular agriculture. Farms can utilize high-tech solutions to reduce emissions, such as ammonia, and improve resource efficiency. Investing in technologies for better waste management, sustainable energy production, and efficient resource use can drive the transition towards circular farming practices.

Promoting Collaboration Among Farmers:

Collaboration among farmers can enhance the implementation of circular agriculture. By sharing resources, knowledge, and best practices, farmers can collectively address challenges related to sustainability and resource management. Cooperative efforts can also lead to more efficient use of inputs and better integration of livestock and crop production systems.

Consumer Awareness and Involvement:

Increasing consumer awareness about the benefits of circular economy practices is essential. Consumers play a critical role in driving demand for sustainably produced goods. Educational initiatives and transparent communication about the environmental impacts of products can encourage more responsible consumption patterns and support circular business models.

Policy Support for Circular Initiatives:

Governments and policymakers should provide robust support for circular economy initiatives. This can include incentives for businesses adopting circular practices, funding for research and development in sustainable technologies, and creating regulatory frameworks that facilitate the transition to a circular economy. Policy support can accelerate the adoption of circular principles across industries and contribute to broader environmental sustainability goals.

Video material from Showcase examples of economic development

What is Economic Development?
https://www.youtube.com/watch?v=DRPioDFGWRQ
Differences between Economic Growth and Economic Development.
https://www.youtube.com/watch?v=fJ25w66DJCk

Key Takeaways from Insights for stakeholders

Policy and Economic Levels:

To facilitate the broader adoption of circular business models, it is crucial to implement policy programs and measures across different levels of the economy. Effective policies can significantly reduce the negative environmental impacts associated with economic production and consumption.

Clarity and Transformative Potential:

Circular agriculture (CA) must go beyond superficial implementation to achieve real transformative impact. It is essential for policymakers to define clear objectives and operationalize CA in a way that addresses sustainability challenges and drives fundamental changes in the food system.

Measuring Circularity:

The first step towards a circular food production system is to measure the circularity of each phase of the food production cycle. Understanding the current level and possibilities for circularity is necessary to identify areas for improvement and implement effective circular practices.

Collaboration and Investment:

Collaboration across the agricultural value chain and investment in circular agriculture infrastructure are critical for maximizing CA's economic potential. Public-private partnerships, farmer cooperatives, and private sector investments can drive innovation and promote sustainable practices, leading to economic, environmental, and social benefits.

Ideas to Consider from Insights for stakeholders

Policy Alignment and Support:

Governments should align regulatory frameworks to support circular agriculture (CA) and remove barriers that hinder its adoption. This can include subsidies, tax breaks, and targeted R&D funding to promote resource recovery, nutrient recycling, and sustainable farming practices.

Educational Programs and Knowledge Dissemination:

Investing in education and extension services for farmers is crucial. Comprehensive programs that disseminate knowledge about CA practices can accelerate their adoption and ensure that farmers are equipped with the necessary skills and information to implement these practices effectively.

Economic Incentives and Risk Mitigation:

Developing economic incentives such as impact investing, crop insurance tailored to CA practices, and premium pricing for CA-produced products can attract investment and reduce the financial risks associated with transitioning to circular agriculture.

Collaboration Across Sectors:

Building a robust CA ecosystem requires collaboration among diverse stakeholders, including farmers, food processors, researchers, industry players, and policymakers. Initiatives like farmer cooperatives and public-private partnerships can facilitate resource sharing, innovation, and the development of comprehensive CA strategies.

Practical Implementation and Measuring Progress:

Focus on practical implementation of CA by measuring circularity in food production systems. Stakeholders should prioritize identifying and scaling practices that contribute to sustainability goals, ensuring that circular agriculture initiatives have a tangible and measurable impact on reducing waste and improving resource efficiency.

Video material from Insights for stakeholders

How does circular agriculture contribute to biodiversity?
https://www.youtube.com/watch?v=RV77QBFFb-w
Explaining the Circular Economy and How Society Can Re-think Progress
https://www.youtube.com/watch?v=zCRKvDyyHmI

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