



EMPOWERING CONSUMERS IN THE CIRCULAR ECONOMY: STRATEGIES FOR SUSTAINABLE AGRI-FOOD SYSTEMS IN THE REPUBLIC OF NORTH MACEDONIA

Katerina Bojkovska *

University "St. Kliment Ohridski", Faculty of Biotechnical Sciences, North Macedonia

Abstract: The transition to a circular economy (CE) in North Macedonia's agri-food sector is essential for achieving sustainability and resource efficiency. This study explores consumer-centric strategies that emphasize reducing, reusing, and repairing (3Rs) to minimize waste and promote sustainable consumption. Using a mixed-methods approach, the research integrates quantitative consumer surveys (n=500) with qualitative interviews (n=30) and case studies of successful CE initiatives. Secondary data from government reports and industry publications were also analyzed. Findings reveal moderate consumer awareness of CE principles, with 72% familiar with local food systems but only 50% aware of reuse and repair strategies. While 35-40% of consumers are willing to pay up to a 5% premium for sustainable products, economic constraints limit broader adoption. Key barriers include lack of awareness (40%), higher costs of sustainable products (30%), and limited availability (25%). Regression analysis confirms that consumer awareness ($\beta = 0.58$, $p = 0.002$) and economic incentives ($\beta = 0.42$, $p = 0.01$) significantly influence CE adoption. The study highlights the need for affordable solutions, education campaigns, and stronger policy frameworks to encourage consumer participation. A multi-stakeholder approach, engaging consumers, businesses, and policymakers, is vital for advancing a sustainable agri-food sector in North Macedonia.

Keywords: Circular economy, consumer-centric strategies, agri-food sector, sustainability, food waste reduction.

1. INTRODUCTION

The agri-food sector is one of the most resource-intensive industries, significantly impacting the environment through food waste, excessive packaging, and inefficient resource use. As global concerns over sustainability grow, the transition toward a circular economy (CE) has become a priority for many countries, including North Macedonia. The circular economy model promotes reducing, reusing, and repairing (3Rs) as core principles to minimize waste,

* Corresponding author: katerina.bojkovska@uklo.edu.mk

Katerina Bojkovska, ORCID: 0000-0002-8651-4621

maximize resource efficiency, and extend product lifecycles. Unlike the traditional linear economy model of "take, make, dispose," a circular economy emphasizes closing the loop through sustainable practices, thereby creating a regenerative system that minimizes environmental impact.

In North Macedonia, where agriculture contributes significantly to the economy and employment, integrating circular strategies into the agri-food sector presents both opportunities and challenges. The sector is a cornerstone of the country's economy, supporting rural development, food security, and livelihoods. However, it also faces pressing issues such as inefficient resource use, high levels of food waste, and limited infrastructure for sustainable practices. Traditional linear consumption patterns—characterized by production, use, and disposal—must shift toward more sustainable practices that involve consumers as active participants. This transition requires a combination of consumer awareness, supportive policies, and business innovations to encourage responsible consumption, waste reduction, and product longevity.

Consumer behavior plays a pivotal role in driving the transition to a circular economy. As end-users of agri-food products, consumers have the power to influence production and consumption patterns through their choices and practices. However, achieving this shift requires a deep understanding of consumer attitudes, awareness, and willingness to adopt sustainable behaviors. This paper focuses on consumer-centric strategies that prioritize reducing, reusing, and repairing as key pillars of a circular economy in North Macedonia's agri-food sector.

The primary objectives of this research are to:

- assess the current state of circular economy practices in North Macedonia's agri-food sector,
- identify barriers and opportunities for implementing consumer-centric CE strategies, and
- propose actionable solutions to engage consumers in sustainable practices.

By addressing these objectives, this study aims to contribute to the growing body of knowledge on circular economy implementation in developing economies, with a specific focus on the agri-food sector.

This paper explores consumer-centric strategies that facilitate the adoption of CE principles in North Macedonia's agri-food sector. It examines how consumers can drive sustainability through behavioral changes, product choices, and engagement in circular practices such as food waste reduction, sustainable packaging, and local food systems. Additionally, it evaluates existing policy frameworks, industry efforts, and barriers to implementation. Through case studies and empirical analysis, this study provides actionable insights into fostering a more resilient and resource-efficient food system.

The study employs a mixed-methods approach, combining qualitative and quantitative research. Data were collected through surveys, interviews with key stakeholders (farmers, consumers, policymakers, and business representatives), and case studies of successful CE initiatives in the region. Secondary data from government reports and industry publications were also analyzed to provide context.

The results reveal significant potential for reducing food waste, reusing packaging materials, and repairing agricultural equipment through consumer engagement and education. Key findings include the need for stronger policy frameworks, increased awareness campaigns, and incentives for businesses to adopt circular practices. The study concludes that a collaborative approach involving consumers, businesses, and policymakers is essential for fostering a sustainable and resilient agri-food system in North Macedonia.

By focusing on the role of consumers in the circular economy, this research contributes to the broader discourse on sustainable development in North Macedonia. It highlights the necessity of multi-stakeholder collaboration, incentives for circular business models, and targeted education campaigns to enhance consumer participation. Ultimately, the findings aim to support policymakers, businesses, and consumers in transitioning toward a more sustainable and circular agri-food sector.

By exploring the potential of consumer-centric strategies for a circular economy in North Macedonia's agri-food sector, this research seeks to pave the way for sustainable development, environmental preservation, and economic resilience in the region.

2. LITERATURE REVIEW

2.1. The Concept of Circular Economy in the Agri-Food Sector

The circular economy (CE) has emerged as a key framework for sustainable development, particularly in resource-intensive sectors such as agriculture and food production. According to the Ellen MacArthur Foundation (2013), the CE model seeks to minimize waste and maximize resource efficiency by emphasizing the principles of reducing, reusing, and recycling. In the agri-food sector, this involves strategies such as food waste prevention, by-product utilization, composting, and sustainable packaging (Kirchherr et al., 2017). Studies highlight that integrating circular principles into agriculture can improve environmental sustainability while also enhancing food security and economic resilience (Geissdoerfer et al., 2017).

The agri-food sector is one of the most resource-intensive industries, significantly impacting the environment through food waste, excessive packaging, and inefficient resource use. The transition to a circular economy is critical for addressing these challenges, as it promotes closing material loops, preserving natural capital, and fostering resilience through innovation (Ellen MacArthur Foundation, 2015). In North Macedonia, where agriculture contributes significantly to the economy and employment, integrating circular strategies into the agri-food sector presents both opportunities and challenges.

2.2. Consumer Behavior and Circular Economy Adoption

Consumer engagement is critical for the successful implementation of circular economy practices in the agri-food sector. Research indicates that consumers play a vital role in waste reduction by making informed purchasing decisions, supporting sustainable packaging, and participating in food-sharing initiatives (van Loon et al., 2020). However, studies also reveal several behavioral and psychological barriers, such as limited awareness, convenience preferences, and skepticism toward sustainable alternatives (Kanter et al., 2020).

In North Macedonia, consumer attitudes toward sustainability remain underexplored, making it essential to assess public perceptions and willingness to adopt CE practices. Research by Hobson and Lynch (2016) emphasizes the importance of consumer awareness, education, and engagement in fostering sustainable practices. However, barriers such as lack of information, convenience, and affordability often hinder the adoption of circular behaviors.

2.3. Food Waste Reduction and Consumer Participation

Food waste is a significant challenge in the global agri-food system, with studies estimating that nearly one-third of all food produced is wasted (Food and Agriculture Organization [FAO], 2019). Consumer habits, including improper food storage, over-purchasing, and lack of awareness about expiration dates, contribute to this issue (Aschemann-Witzel et al., 2015). Interventions such as educational campaigns, digital tools for food tracking, and incentives for responsible consumption have proven effective in other contexts (Gustavsson et al., 2018).

In North Macedonia, localized strategies that align with cultural and economic factors could enhance consumer participation in food waste reduction efforts. For example, campaigns that raise awareness about portion control, proper storage, and creative use of leftovers can significantly reduce food waste at the consumer level (Stenmarck et al., 2016).

2.4. Sustainable Packaging and Reuse Initiatives

Packaging waste, particularly from plastic materials, poses a significant environmental threat. Research underscores the importance of sustainable packaging solutions, including biodegradable materials, reusable containers, and zero-waste shopping models (Napper & Thompson, 2019). Consumer willingness to adopt these alternatives is influenced by factors such as cost, availability, and perceived convenience (Dilkes-Hoffman et al., 2019).

In the European Union, regulatory frameworks promoting eco-friendly packaging have driven innovation, but North Macedonia still faces challenges in policy enforcement and infrastructure development (European Environment Agency, 2021). Reusable packaging, returnable containers, and secondary use of by-products (e.g., converting food waste into animal feed or bioenergy) are effective ways to close material loops (Mourad, 2016).

2.5. Policy Frameworks and Business Innovations in North Macedonia

Effective policy interventions and business models play a crucial role in facilitating the transition to a circular agri-food system. Studies show that government incentives, tax benefits, and extended producer responsibility (EPR) programs encourage businesses to invest in circular practices (Borrello et al., 2020). In North Macedonia, initiatives such as sustainable agriculture programs and waste management policies are gradually gaining traction, but gaps remain in enforcement and consumer participation (United Nations Development Programme [UNDP] North Macedonia, 2022).

Case studies from other European nations suggest that public-private partnerships and consumer-driven innovations, such as food-sharing platforms and community-supported agriculture, could be instrumental in advancing circular strategies. Additionally, EU integration efforts provide a platform for aligning North Macedonia's policies with broader European sustainability goals, including the European Green Deal and the Circular Economy Action Plan (Petrevska et al., 2020).

2.6. Challenges and Future Directions

Despite growing recognition of the circular economy's benefits, several challenges hinder its widespread adoption in North Macedonia's agri-food sector. Key barriers include lack of awareness, insufficient infrastructure, regulatory gaps, and resistance to behavioral change (Jurgilevich et al., 2016). Future research should focus on developing localized

solutions that address these obstacles while leveraging digital technologies, behavioral incentives, and policy innovations to enhance consumer participation.

The literature review highlights the critical role of consumer engagement in advancing the circular economy within North Macedonia's agri-food sector. While existing studies provide valuable insights into sustainable food systems, further research is needed to tailor circular strategies to the country's specific socio-economic context. Strengthening policy frameworks, fostering business innovation, and enhancing consumer awareness will be essential to achieving a sustainable and resilient food system.

3. DATA AND METHODOLOGY

This study employs a mixed-methods approach to comprehensively assess consumer-centric circular economy (CE) strategies in North Macedonia's agri-food sector. The research integrates both quantitative and qualitative methods to provide a well-rounded analysis of consumer behavior, industry practices, and policy frameworks related to reducing, reusing, and repairing in the sector.

3.1. Research Design

The research design combines qualitative and quantitative data collection methods to explore the current state of circular economy practices, barriers, and opportunities for consumer engagement in North Macedonia's agri-food sector. The mixed-methods approach ensures a holistic understanding of the topic by triangulating data from surveys, interviews, case studies, and secondary sources.

3.2. Data Collection Methods

3.2.1. Primary Data Collection

- Consumer Surveys

A structured questionnaire was distributed to 500 consumers across urban and rural areas of North Macedonia to assess awareness, attitudes, and practices related to circular economy principles. The survey covered topics such as:

- Awareness of food waste reduction, sustainable packaging, and repair initiatives,
- Willingness to pay for sustainable products,
- Barriers to adopting circular behaviors,
- Perceptions of government policies and business initiatives.

Respondents were selected using stratified random sampling, ensuring representation across different demographics (age, gender, income, and education levels).

- Stakeholder Interviews

Thirty semi-structured interviews were conducted with key stakeholders, including:

- Farmers and producers (10): Insights into sustainable farming, food waste management, and packaging reuse,
- Policymakers (5): Discussion on existing CE regulations, incentives, and challenges,
- Business representatives (10): Adoption of circular business models, barriers to sustainable practices,

- Consumer advocacy groups (5): Role of education and awareness campaigns in promoting sustainability.

Interviews were analyzed using thematic analysis to identify common challenges and opportunities in implementing consumer-centric CE practices.

- Case Studies

Three case studies of successful CE initiatives in the agri-food sector were examined:

- A local farm cooperative implementing food waste reduction strategies,
- A startup focused on reusable packaging solutions,
- A community-supported agriculture (CSA) program promoting sustainable consumption.

3.2.2. Secondary Data Collection

- Government Reports & Policy Documents

Analysis of reports from the Ministry of Agriculture, Forestry, and Water Economy of North Macedonia was conducted to assess national strategies for sustainable agriculture. Additionally, EU integration documents related to CE policies in North Macedonia were reviewed.

3.3. Data Analysis Methods

3.3.1. Quantitative Analysis

Data from the consumer survey were analyzed using SPSS and Excel. The following statistical techniques were applied:

- Descriptive statistics (mean, median, mode) to summarize consumer awareness and behaviors,
- Chi-square tests to assess relationships between consumer demographics and CE adoption,
- Regression analysis to evaluate the impact of awareness and economic incentives on willingness to participate in circular economy practices.

3.3.2. Qualitative Analysis

Thematic analysis was used to interpret interview and case study data, identifying key themes such as policy gaps, economic barriers, and consumer engagement strategies. Content analysis of policy documents and government reports was conducted to assess regulatory frameworks supporting circular economy initiatives.

4. RESULTS AND DISCUSSION

This section presents the findings from the consumer survey, stakeholder interviews, and case studies. Data is summarized in tables and graphs, followed by a discussion of key themes related to consumer engagement in circular economy (CE) practices within North Macedonia's agri-food sector.

4.1. Consumer Awareness and Behavior Toward Circular Economy Practices

Table 1. Consumer Awareness of Circular Economy Practices (n=500)

CE Practice	Aware (%)	Not Aware (%)	Somewhat Aware (%)
Food waste reduction	65%	20%	15%
Sustainable packaging	58%	25%	17%
Repairing/reusing equipment	50%	30%	20%
Local food systems	72%	18%	10%

72% of respondents are aware of local food systems, the highest awareness level among CE practices.

Only 50% are aware of repairing and reusing agricultural tools and food packaging, indicating a need for more education on these aspects.

Food waste reduction has a moderate awareness level (65%), suggesting that campaigns have had some impact but need further reinforcement.

4.2. Willingness to Pay for Sustainable Products

To assess consumer demand for CE-friendly products, respondents were asked about their willingness to pay a premium for sustainably packaged or locally produced food.

Table 2. Willingness to Pay for Sustainable Products (%)

Extra Cost Willing to Pay	<5% Price Increase	5-10% Price Increase	>10% Price Increase	Not Willing
Sustainable Packaging	35%	10%	5%	50%
Locally Produced Food	40%	15%	5%	40%

35-40% of consumers are willing to pay up to a 5% premium for sustainably packaged and locally produced food, reflecting economic constraints.

Only 5-10% would pay more than a 10% premium, confirming affordability as a major concern.

50% of consumers are unwilling to pay any premium for sustainable products, emphasizing the need for cost-effective and incentive-based solutions.

4.3. Barriers to Adopting Circular Economy Practices

Survey respondents and interviewees identified key barriers to CE adoption.

Table 3. Major Barriers to Consumer Adoption of CE Practices (%)

Barrier	% of Consumers Identifying as a Challenge
Lack of awareness	40%
Higher cost of sustainable products	30%
Limited availability of sustainable options	25%
Lack of government incentives	20%

40% of consumers cite lack of awareness as the biggest barrier, confirming the need for educational initiatives.

30% point to higher costs of sustainable products, suggesting that affordability plays a significant role in adoption rates.

Limited availability (25%) and lack of government incentives (20%) also hinder widespread adoption.

4.4. Stakeholder Perspectives on Circular Economy Practices

Insights from interviews with farmers, policymakers, and business representatives highlight systemic challenges and opportunities.

Table 4. Key Themes from Stakeholder Interviews

Stakeholder Group	Key Insights
Farmers (10)	Need better incentives for food waste reduction and packaging reuse. Some have started composting but require financial support.
Policymakers (5)	Lack of enforcement mechanisms for existing CE policies. Integration with EU regulations remains a challenge.
Businesses (10)	High initial costs deter investment in sustainable packaging. Consumer demand for sustainability is rising, but infrastructure is lacking.
Consumer Groups (5)	Educational campaigns are critical to shifting consumer behavior. Current awareness levels are still low.

Farmers and businesses emphasize the need for financial and policy incentives to invest in CE-friendly practices.

Policymakers acknowledge regulatory gaps and the slow pace of CE policy implementation.

Consumer advocacy groups stress education as a key driver in changing behavior.

4.5. Case Study Analysis

Three case studies were examined to illustrate successful circular economy initiatives.

Table 5. Summary of Case Studies

Case Study	Circular Economy Strategy	Impact
Local Farm Cooperative	Converts food waste into compost, reducing landfill waste.	Increased soil fertility, lower waste costs.
Reusable Packaging Startup	Offers refillable containers for bulk foods.	30% reduction in plastic packaging waste.
Community-Supported Agriculture (CSA)	Connects consumers directly with local farmers, reducing supply chain waste.	More consumer engagement and reduced food miles.

Examined case studies shows that successful models exist but require policy and financial support to scale up.

Local initiatives demonstrate the viability of food waste reduction and packaging reuse.

Consumers respond positively when given access to circular economy solutions.

4.6. Regression Analysis: Impact of Awareness and Economic Incentives on CE Adoption

A regression analysis was conducted to measure how awareness and incentives influence CE adoption.

Regression Model: Willingness to Engage in Circular Practices = $\beta_0 + \beta_1$ (Awareness) + β_2 (Economic Incentives) + ϵ

Variable	Coefficient (β)	p-value
Awareness Level	0.58	0.002**
Economic Incentives	0.42	0.01*

(**p < 0.05 significant, **p < 0.01 highly significant)

Awareness has the strongest impact ($\beta = 0.58$, $p = 0.002$), meaning better-informed consumers are more likely to adopt CE behaviors.

Economic incentives also play a significant role ($\beta = 0.42$, $p = 0.01$), supporting the need for financial policies to encourage sustainability.

4.7. Chi-Square Test: Relationship Between Demographics and CE Adoption

A chi-square test was conducted to assess the relationship between key demographic factors (age, income, and education) and willingness to adopt circular economy (CE) practices in North Macedonia's agri-food sector.

Table 6. Chi-Square Test Results

Demographic Factor	Chi-Square Value	p-value	Significance
Age	12.45	0.002**	Highly significant ($p < 0.01$)
Income Level	8.76	0.01*	Significant ($p < 0.05$)
Education Level	6.34	0.05*	Marginally significant ($p = 0.05$)

(**p < 0.05 significant, *p < 0.01 highly significant)

4.8. Key Findings and Discussion

- Age and CE Adoption:
 - o Younger consumers are significantly more likely to adopt CE behaviors ($p = 0.002$), likely due to higher environmental awareness and digital exposure to sustainability campaigns.
 - o However, purchasing power may be limited in this group, meaning their support for CE initiatives does not always translate into economic action (e.g., buying sustainable products).
- Income Level as a Determining Factor:
 - o Higher-income consumers are more likely to engage in CE practices ($p = 0.01$), possibly due to their greater ability to afford sustainable products, packaging alternatives, and waste-reduction efforts.
 - o Middle- and lower-income consumers may support CE in principle but struggle financially to participate, reinforcing the need for subsidies, discounts, and affordability-focused initiatives.
- Education's Limited but Relevant Influence:
 - o While education level is marginally significant ($p = 0.05$), suggesting that higher education levels contribute to greater CE awareness, it is not as strong a predictor as age and income.
 - o This indicates that awareness campaigns should target all education levels, not just highly educated consumers, to ensure broad engagement in CE practices.
- Implications for CE Strategies:
 - o Target younger demographics with low-cost, accessible CE initiatives (e.g., student-led sustainability programs, digital campaigns).

- Implement financial incentives (subsidies, tax breaks) to make CE adoption feasible for middle- and lower-income groups.
- Expand CE education efforts across all demographics, ensuring accessibility regardless of prior educational background.
- Discussion and Policy Implications
 - Consumer-Centric Strategies for Circular Economy
 - The results highlight a moderate to high awareness of CE practices, yet there is a disconnect between knowledge and action. Awareness campaigns and educational programs should be expanded to bridge this gap.
- The Role of Policy and Business Innovation
 - Policymakers must introduce incentives (tax breaks, subsidies) to encourage businesses and farmers to adopt circular practices.
 - Businesses should innovate in packaging and product design to meet growing consumer demand for sustainability.
- Strengthening Infrastructure for CE Implementation
 - Waste management systems should be upgraded** to support food waste reduction and recycling efforts.
 - Investment in sustainable supply chains (e.g., local food networks) can enhance consumer participation.
- Future research directions

Further studies should explore:

- The impact of digital tools (e.g., food waste tracking apps) on consumer behavior.
- Long-term behavioral shifts resulting from CE education programs.

This research results confirm that consumer engagement is essential for advancing a circular economy in North Macedonia's agri-food sector. While awareness is growing, significant barriers such as cost, availability, and policy gaps remain. A multi-stakeholder approach, combining consumer education, business innovation, and policy support, is needed to drive CE adoption.

5. CONCLUSION

This study highlights the critical role of consumer engagement in advancing a circular economy (CE) in North Macedonia's agri-food sector. While the findings reveal moderate to high awareness of CE principles, particularly in areas like local food systems, significant gaps remain in consumer knowledge and willingness to adopt sustainable practices, especially when economic constraints are a factor. The research underscores the importance of addressing key barriers such as affordability, limited availability of sustainable options, and insufficient policy support to foster widespread adoption of CE practices.

The study emphasizes the need for a multi-stakeholder approach that integrates consumer education, business innovation, and policy interventions. Affordable solutions are essential to make sustainable products accessible to all consumers, particularly in a context where economic challenges are prevalent. Education and awareness campaigns can bridge the gap between knowledge and action, empowering consumers to embrace reducing, reusing, and repairing practices. Additionally, stronger policy frameworks are needed to provide financial incentives, improve waste management infrastructure, and align with EU sustainability directives.

The success of local initiatives, such as food waste reduction, reusable packaging, and community-supported agriculture, demonstrates the potential for scalable and impactful CE

solutions. By fostering collaboration among consumers, businesses, and policymakers, North Macedonia can transition toward a more resilient, resource-efficient, and environmentally sustainable agri-food system.

In conclusion, this research contributes to the broader discourse on sustainable development by highlighting the importance of consumer-centric strategies in driving the circular economy. The recommendations provided aim to support North Macedonia in achieving its sustainability goals while addressing the unique challenges of its socio-economic context.

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