SOCIETY OF WOOD SCIENCE & TECHNOLOGY

Competitive Advantage for the Forest-based Sector in the Future Bioeconomy – Research Question Priority

BIOPRODUCTS BUSINESS

Eric Hansen[1]*, Hans Fredrik Hoen[2], and Erlend Nybakk[3]

Abstract

A multi-stage Deplhi-study was undertaken to explore key research questions and priorities regarding competitive advantage in the bioeconomy for the forest-based sector from the perspective of Nordic forest economics researchers. The study started with a brainstorming event undertaken in plenum among the 62 participants at the Biennial meeting of the Scandinavian Society of Forest Economics (SSFE) at Oscarsborg, Norway 26th-27th of May, 2016. This was followed up by a two-round Delphi-study, with the first round in August-September 2016 and the second round in November 2016. The initial brainstorming during the SSFE 2016 meeting resulted in five named categories of key future research questions; Innovation & Innovation Systems, Collaboration, Culture, Consumers/Customers, Environmental Scanning and with a sixth category termed Miscellaneous. In a first Delphi-round, respondents were asked to add new questions, edit or delete existing questions, and propose category changes. In the second Delphi-round, respondents were asked to give priority to categories, sub-categories and individual research questions. Overall, research questions relating to policies for innovation and consumer attitudes/preferences received the highest priority. Cross-sector collaboration by forest industry companies, a highly visible topic in the bioeconomy discourse, received surprisingly low priority, especially given its sparse coverage in the existing literature. Finally, an exploratory literature review was conducted to select and illustrate forest sector research relevant to the categories of research questions identified in this study.

Keywords: bioeconomy, competitive advantage, Delphi, research questions

1.0 Introduction

The dramatic change associated with globalization and the high economic growth of developing nations, especially China, may pale in comparison to the potential change accompanying a shift to the bioeconomy. The bioeconomy is an economy primarily based on renewable and recyclable resources (Roos 2016) and a new era described as, "…the next wave in our economic development (Kutnar 2016 p. 2)." The forest-based sector (FBS) has long dealt with significant negative environmental impacts of its operations, making major improvements over recent decades. However, climate change and a societal shift towards an economy with large cuts in net emissions of greenhouse gases presents a potentially prosperous pathway towards enhanced future competitiveness of the FBS. Careful management of forest ecosystems and production of renewable materials may be a recipe for a highly successful future for the FBS, yet there is much still unknown regarding how the sector will embrace this opportunity (Ollikainen 2014, Roos and Stendahl 2015).

Development and growth of the bioeconomy presents an opportunity for FBS firms to diversify product offerings and move away from heavy reliance on stagnant markets for mature products. It is an opportunity for the sector to move from being seen as an "extractive" sector to an "attractive" sector in the eyes of global, environmentally oriented investors and consumers (Toppinen et al. 2017a). The common theme for bioproducts is an expected or perceived superior environmental profile compared to alternatives based on fossil resources.

1 Professor of Forest Products Marketing, Department of Wood Science and Engineering, Oregon State University, 119 Richardson Hall, Corvallis, OR 97331.
2 Professor Forest Economics and Management, Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, POBox 5003, N-1432 Ås, Norway.
3 Professor of Innovation and Entrepreneurship, Kristiania University College, PB 1190 Sentrum, 0107, Oslo, Norway.
* Corresponding author: Email: Eric.Hansen@oregonstate.edu; Tel.: 541-737-4240.

BioProducts Business 3(2), 2018, pp. 15-28. http://biobus.swst.org.
https://doi.org/10.22382/bpb-2018-002

Some claim that the industry must transform in order to be a player in the new markets of the bioeconomy (Chambost et al. 2009), but there are many hurdles along the path to transformation. Perhaps most significant is a traditional culture in a mature industry that tends to rely on low costs to be competitive (Bull et al. 2015, Pätäri et al. 2011, Chambost et al. 2008). What, in practice, might a more competitive FBS look like? With this question in mind, we sought to identify the key research questions regarding competitive advantage in the bioeconomy for the FBS from the perspective of Nordic forest economics researchers. Research leading to insights regarding future competitive advantage is essential to informing the transformation efforts of FBS companies as they strive to enter the future bioeconomy.

Surprisingly, despite its common use in the literature, the term competitive advantage has not been concretely defined within the forest sector literature. This has led to an effort to summarize recent research focused on competitive advantage to gain a better understanding of the issue (Korhonen et al. 2018). While a precise definition is often missing in the literature, the key issue for competitiveness or competitive advantage is that, "… competitiveness implies that companies are able to produce goods and services more efficiently and/or effectively than their competitors (Iraldo et al. 2011 p.212)." Competitiveness has also been described as the capability to capture the market (Gupta et al. 2016). In practice, competitive advantage is what allows a company to be successful in the market. That advantage can arise from such factors as lower costs, strong brands, better service, etc. It is expected that development of the bioeconomy will result in increased demand for bio-based raw materials, especially wood. Increased demand for its raw materials means that the FBS will require enhanced competitiveness to retain viability.

To the best of our knowledge, this research is the first of its kind in the FBS-literature. We rely on the collective expertise of a professional body of forest economists from across Europe, but especially from the Nordic countries. The Nordic region of Europe, where the FBS plays a significant role in national economies, is highly focused on development of the bioeconomy. In practice this means that governments and researchers currently have a high interest and engagement in the bioeconomy (e.g., Pelli et al. 2017, Gabrielsson et al. 2010). The concept of the bioeconomy, research on the topic, and governmental policies supporting it can be argued to be centered in Europe (e.g., FSTP Undated, EC 2011) and forest economists have a traditional interest in industry competitiveness issues (e.g., Uusivuori 2002). In addition, a recent article emphasizes the need for social science research to further develop the bioeconomy (Kleinschmit et al. 2014). Therefore, our objective for this research is to provide an up-to-date and well-informed description of competitive advantage research priorities for a FBS aspiring to a bright future in the bioeconomy.

2.0 Methods

The overall process for identifying and prioritizing research questions is depicted in Figure 1. Identification of key research questions regarding competitive advantage for FBS firms in the future bioeconomy began as part of the May 2016 Biennial Meeting of the Scandinavian Society of Forest Economics (SSFE). SSFE has a 60-year history as a research-network. The SSFE-board consists of one member from each of the four Nordic countries: Denmark, Finland, Norway and Sweden. Following a presentation on the topic, the 62 participants were divided into 13 groups of four or five and assigned the task of identifying the "Key future research questions regarding competitive advantage in the bioeconomy." The authors assembled, eliminated duplicates, and separated the proposed research questions into the categories shown in Table 1.

The categories in Table 1 were reported to the meeting participants. A detailed list of the original 32 items is provided in Appendix A. Participants were notified that a Delphi-process would be used, involving the full mailing list of the SSFE, to further develop the research question set. Delphi is a multi-stage survey technique designed to gain agreement or consensus among a group of experts on a particular issue (Keeney et al. 2011, Linstone and Turoff 2002). The Delphi method includes several rounds of inquiry and feedback of statements of earlier rounds while reconsidering the topic (Landeta 2006, Linstone and Turoff 2002, Toppinen et al 2017b). The number of panelists typically varies from a few to 50 and the experts are selected due to their expertise and knowledge on the topic (Hatcher and Colton 2007). The method is proven to be useful to seek new perspectives, and furthermore, achieve consensus among multiple respondents (Linstone and Turoff 2002). In our case, the group work completed at the SSFE meeting essentially substituted for a first Delphi round.

The Delphi process was modeled after studies in medical science designed to develop research priorities (e.g., Tiernan et al. 2014, Simpson et al. 2014, Stefanidis, et al. 2012, Keeney et al. 2011) as well as recent forestry studies (Näyhä and Pesonen 2012, Panwar and Hansen 2009, Pätäri et al 2016, Toppinen et al 2017b). Delphi is a tool that involves seeking the input of a group in an iterative fashion. The number of stages utilized may vary based on the problem at hand and the number of iterations are generally left to the judgement of the researchers (Keeney et al. 2011).

In the first round of the Delphi process the categorized list of research questions, as presented in Appendix A, was sent in a Microsoft Word document to each individual on the mailing list of SSFE as of May 2016 (total number of 277 individuals minus 15 incomplete addresses). Each member was requested to, using the Track Changes function, add research questions and/or edit or delete the existing questions. In addition, they were invited to change the categorization or propose new categories. The request was sent on August 15th, 2016 and several rounds of reminders followed. The first round was closed on October 3rd and the author team consolidated the responses, using their judgement to resolve any conflicting opinions among respondents. A total of 29 individuals responded to our request corresponding to a response rate of approximately 11%. Although several additional categories were proposed by respondents, there was little consistency among suggestions, so we chose to maintain the original category set. There were many new research questions suggested, resulting in a list of 140 items. After careful consideration we deleted a total of nine items because we could not understand the authors' meaning. Once we reached consensus on the remaining 131 items (Appendix B) we did a complete copy-edit of the items for English usage and to assure they were in the form of a question.

Given the large number of items that were added, we chose to add sub-categories to facilitate the next round of data collection. In other words, we introduced sub-categories in order to create "bite-size" chunks or sets of items that respondents could evaluate, rather than being faced with an endless list of 131 items. Creation of sub-categories and assignment of each item was an iterative process among the authors including three rounds of reallocation taking place. This resulted in the reassignment of 22 items to categories where they better fit. Once in agreement with the sub-categories and

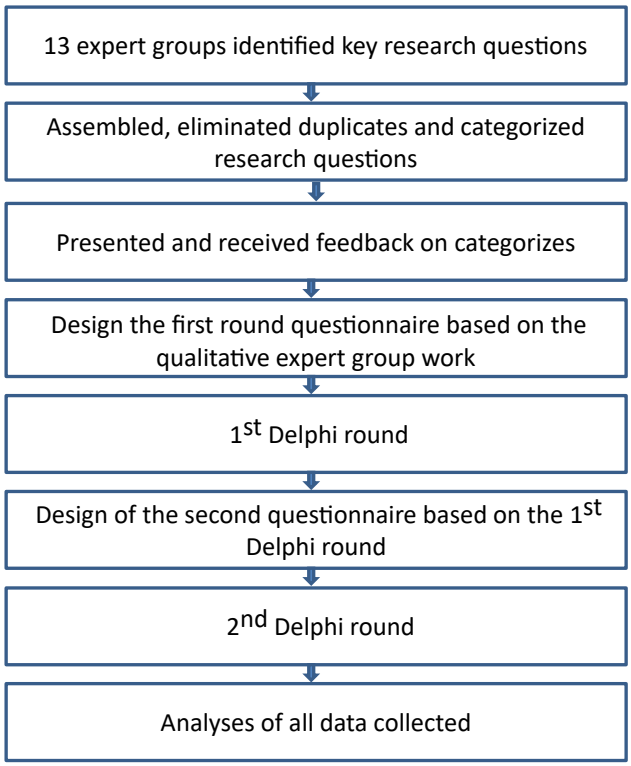

Figure 1. Modified Delphi Process.

Table 1. Categorization of Research Questions Developed at the 2016 Biennial Meeting of SSFE.

Innovation & Innovation Systems[1]	(5 research questions)
Collaboration	(6 research questions)
Culture	(4 research questions)
Consumers/Customers[2]	(6 research questions)
Environmental Scanning	(5 research questions)
Miscellaneous	(6 research questions)

[1] abbreviated in text as "Innovation"
[2] abbreviated in text as "Consumers"

item assignment, we created an electronic questionnaire designed to assess the priority of each research question (item). Once again we went to the complete mailing list of SSFE with the request for each individual to rate each item on a 5-point scale ranging from 1=low priority to 5=high priority. Respondents also ranked categories as well as sub-categories with respect to importance. In total we received 32 complete responses in this second round for a response rate of 12.1%.

An informal literature search was conducted based on the final categories and sub-categories identified in this research. Example articles (limited to refereed journals) were selected via Google Scholar searches and the knowledge of the authors. The purpose of this exercise

was for illustration only. The results provide perspective on whether and how the current literature addresses the various categories, especially in the context of the bioeconomy.

3.0 Results and Discussion

Researchers completing the online questionnaire represented the following countries: Denmark – 1, Finland – 9, Iceland – 2, Norway – 7, Sweden – 8, and "other" – 5. The other categories consisted of the United States, Estonia, Germany, France, and Italy. Table 2 provides overall means for both categories and sub-categories. Given the small differences among means relative to standard deviations, it is unlikely that there are pronounced statistical differences among categories. Only for one sub-category, namely *Policies for innovations*, the mean score is more than ± 1 standard deviation away from the expected mean of 3.0. Still, we believe the relative ratings provide some insight into the priority that Nordic forest economists place on various categories of research questions. *Consumers [Consumers/Customers]* and *Innovation [Innovation & Innovation Systems] a*re the categories that appear to have higher priority with *Policies for Innovations* and *Consumer Attitudes/Preferences* receiving the highest priority within each of these two sub-categories. Furthermore, the category *Innovation* has the lowest standard deviation (0.48) and *Policies for Innovations* has the lowest standard deviation (0.51) among the sub categories, indicating a consistency in the ranking of this (sub) category.

Table 2. Overall Means for Categories and Sub-categories.

Categories and Sub-Categories	Mean	SD
Innovation [Innovation & Innovation Systems]	**3.37**	**0.48**
Organizing and facilitating processes	3.47	0.53
Efficiency and effectiveness of processes	3.17	0.68
Policies for innovations	3.67	0.51
Misc	3.09	0.75
Collaboration	**3.27**	**0.67**
Cross-sector	3.40	0.80
General collaboration	3.14	0.75
Misc	3.19	1.02
Culture	**3.26**	**0.79**
Customer orientation	3.28	0.94
Misc	3.24	0.76
Consumers [Consumers/Customers]	**3.41**	**0.73**
Attitudes/preferences	3.48	0.76
Communication	3.35	0.90
Misc.	3.32	0.82
Environmental Scanning	**3.31**	**0.67**
Change	3.49	0.87
Risk	3.47	0.80
Sustainability	3.22	0.81
Misc	3.23	0.77
Misc.	**3.03**	**0.75**

The mean scores for the 131 research questions range from a high of 4.28 and a low of 2.47 (Table 3 & Appendix B). Only four of the top scored questions had a mean more than ± 1 standard deviation away from the expected mean of 3.0. At the opposite end, none of the lowest rated questions had a mean score more than ± 1 standard deviation away from the expected mean of 3.0. Table 3 shows the top ten research questions based on their mean score. This does not imply statistically significant differences between these questions and the other 121 questions, but is instead provided as an illustration of the types of research questions that were given a high priority by respondents.

Similar to overall results, *Innovation* and *Consumers* were the most common categories represented within the top 10 research questions. Nine of the ten research questions represented these two categories while one research question belonged to (cross-sectoral) *Collaboration*. The most common sub-categories represented by research questions in Table 3 are, *Innovation: Policies for Innovation* and *Consumers: Attitudes and Preferences*. How policy and consumer attitudes and perceptions impact the ability of the FBS to effectively compete in the bioeconomy are thus of high interest among Nordic forest economists.

Somewhat surprising is that various research questions related to collaboration were not rated as a higher priority. Discussions and forums around the bioeconomy heavily emphasize cross-sector collaboration as a means for the FBS to become more competitive. While some work shows an industry with a positive attitude toward collaboration (Hämäläinen et al. 2011) other work shows industry lacking collaboration, even within the sector (Orozco et al. 2013).

Tables 4-8 provide an overview of the various categories and sub-categories, combined with a selection of examples of recent FBS articles in the area. Selection of articles in Tables 4-8 is based on informal Google

Table 3. High Priority Research Questions Regarding Competitiveness in the Bioeconomy.

Ranking	Sub-category*	Item	Mean	SD
1	4	What are the key regulations, policies, technologies, and socio-economic trends that affect the forest bioeconomy?	4.28	0.81
2	4	How do alternative scenarios with regulations, policies, technologies, and socio-economic trends affect the future opportunities of the forest bioeconomy?	4.16	0.92
3	14	How do consumers form attitudes around forests, forestry, forest products, and/or the bioeconomy in different consumer markets?	4.09	1.00
4	4	What types of policy environments foster innovations – and what types do not?	3.94	0.91
5	2	How can the uptake of innovations throughout society (end-users, industries, academia) be facilitated?	3.88	0.91
6	7	How can the forest-based sector better connect what is already ongoing in other sectors?	3.88	1.18
7	3	What can be learned from successful firms in terms of innovation and creativity?	3.84	0.99
8	14	What are the factors influencing changes in consumer preferences (e.g., the role of information)?	3.84	1.14
9	14	What impacts consumer preference for bio-based products?	3.81	1.15
10	16	How should environmental performance of products be measured and presented to enable industry and end-consumers to make sustainable choices?	3.81	0.90

*2=Innovation: Organizing and Facilitating Processes, 3=Innovation: Efficiency and Effectiveness of Processes, 4=Innovation: Policies for Innovations, 7=Collaboration: Cross-sector, 14=Consumers: Attitudes/Preferences, 16=Consumers: Misc.

Table 4. The Category "Innovation", Sub-categories (with the two highest ranked questions listed), a Description, and Relevant Publications.

Category: Innovation	General Description of Sub-category	Relevant Previous Publications
Organizing and facilitating processes		
How can the uptake of innovations throughout society (end-users, industries, academia) be facilitated?	Focuses on how research and development and innovation are organized, including ways of stimulating innovation.	Hansen et al. 2015 Romero et al. 2009 Klenk & Wyatt 2015
How can downstream customers, users and beneficiaries be involved in innovation?		
Efficiency and effectiveness of processes		
What can be learned from successful firms in terms of innovation and creativity?	Focuses on the impacts of research and development and where innovations are likely to come from.	Laukkanen et al. 2016 Hämäläinen et al. 2011 Bull & Ferguson 2006
How does R&D impact firm profitability?		
Policies for innovations		
What are the key regulations, policies, technologies, and socio-economic trends that affect the forest bioeconomy?	Focuses on how innovation can be supported in the policy environment.	Ludvig et al. 2016 Kleinschmit et al. 2014* White et al. 2013
How do alternative scenarios with regulations, policies, technologies, and socio-economic trends affect the future opportunities of the forest bioeconomy?		
Misc.		
How can investments be attracted and risks managed in the bioeconomy?	A broad set of research questions focused on innovation and not easily connected to the specified sub-categories.	Spetic et al. 2016 Li & Toppinen 2011 Albert 2007*
To achieve competitive advantage, what is the optimal interaction among humans, natural resources, and technology?		

* Articles specifically addressing bioeconomy.

Table 5. The Category "Collaboration", Sub-categories, a Description, and Relevant Publications

Category: Collaboration	General Description of Sub-category	Relevant Previous Publications
Cross-sector		
How can the forest-based sector better connect what is already ongoing in other sectors?	Focuses on how cross-sectoral collaboration can be encouraged	Rametsteiner & Weiss 2006 Rusko 2011 Ollonqvist 2008
What type of environments connect, create, and promote cross-sectoral integration?		
General collaboration		
What are the mutual benefits that may enable sectoral partnerships?	Focuses on how to better connect with other actors	Lehoux et al. 2014 Audy et al. 2012 Cheng & Sturtevant 2012
How do collaboration and interdisciplinarity interact?		
Misc		
How can the ideal, holistic of the bioeconomy, including a cradle-to-grave perspective and cross disciplinarity, be achieved?	A broad set of research questions focused on collaboration	de Loë et al. 2016
How can the cultural differences among research fields be bridged?		

Table 6. The Category "Culture", Sub-categories, a Description, and Relevant Publications

Category: Culture	General Description of Sub-category	Relevant Previous Publications
Customer orientation		
What can be done to encourage the entire value chain to be customer oriented?	Focuses on how to better connect with customers	Toppinen et al. 2013 Hansen et al. 2006 Rasmussen & Nybakk 2016
What makes some firms able to learn from and understand their customers?		
Misc		
How can a culture of entrepreneurship be established in a mature industry?	A broad set of research questions focused on culture	Kärnä et al. 2003 Li & Toppinen 2011 Kubeczko & Rametsteiner 2002
Does social responsibility lead effectively to competitive advantage?		

Table 7. The Category "Consumers", Sub-categories, a Description, and Relevant Publications

Category: Consumers	General Description of Sub-category	Relevant Previous Publications
Attitudes/preferences		
How do consumers form attitudes around forests, forestry, forest products, and/or the bioeconomy in different consumer markets?	Focuses on consumer attitudes, perceptions and buying decisions	Holopainen et al. 2014* Kozak et al. 2004 Gold & Rubik 2009
What are the factors influencing changes in consumer preferences (e.g., the role of information)?		
Communication		
How should firms communicate the benefits of biobased solutions to the public?	Focuses on how to communicate and the impact of media on consumers	Lähtinen et al. 2017 Wilson 2009 Aasetre 2006
How can we move from unidirectional communication to dialogue with the public?		
Misc		
How should environmental performance of products be measured and presented to enable industry and end-consumers to make sustainable choices?	A broad set of research questions focused on consumers	Hansen et al. 2015 Koskela 2015 Räty et al. 2012
How can customers be integrated into product and service design and other value co-creation activities?		

* Articles specifically addressing bioeconomy

Table 8. The Category "Environmental Scanning", Sub-categories, a Description, and Relevant Publications

Category: Environmental Scanning	General Description of Sub-category	Relevant Previous Publications
Change		
Which are the possible new sectors that will be part of the bioeconomy as it evolves via cross-sectoral processes?	Focuses on the what and how of changes in the external environment	Pelli et al. 2017* Hurmekoski & Hetemäki 2013 Duchesne & Wetzel 2003*
What are the larger trends that promote or hinder transition to the bioconomy?		
Risk		
What are recommended strategies for the sector and individual firms to manage policy risks?	Focuses on accounting for and minimizing risk	Näyhä & Pesonen 2012*
How are innovations affected by environmental risks?		
Sustainability		
How will sustainability be defined in the future bioeconomy context?	Focuses on the role of sustainability in competitiveness and how to best address sustainability	Pätäri et al. 2016* Marchetti et al. 2015*
What are the contributions of forestry and the forest industry to economic and social sustainability?		
Misc.		
What are the environmental trade-offs in an efficient bioeconomy?	A broad set of research questions focused on environmental scanning	
How can we develop a better understanding of the dependence on local factors for the tradeoff among different services provided by the forest?		

* Articles specifically addressing bioeconomy.

Scholar searches and the judgement of the authors and is meant for illustration only. Still, we heavily emphasized bioeconomy in our searches, so we believe that this aspect of the existing literature is well-covered. Overall, (not specific to the bioeconomy) the categories and subcategories of research questions identified in this work are addressed in the existing literature. When specifically considering bioeconomy-focused work, coverage is less consistent with multiple categories and subcategories lacking representation.

Multiple bioeconomy articles are identified that represent the *Environmental Scanning* category, with *Sustainability* and *Change* sub-categories being best represented. The *Innovation* category is also well-addressed by bioeconomy focused research. Despite the emphasis on cross-sector collaboration in the bioeconomy discourse, we are unable to locate any research specifically addressing the bioeconomy and collaboration. The *Culture* category is equally unaddressed. We find only one article investigating consumers and the bioeconomy (Holopainen et al. 2014). There are articles that reference the green economy (e.g., Räty et al. 2012) or the bioenergy economy (e.g., White et al. 2013), which have conceptual overlap.

With the exception of Holopainen et al. (2014), Näyhä and Pesonen (2012), and Pätäri et al. (2016), the identified FBS/bioeconomy literature is conceptual in nature (Table 9). This reflects the early-stage nature of research

Table 9. Characteristics of identified forest-based sector, bioeconomy-focused literature.

Article	Country of Origin*	Article Type	Focus
Kleinschmit et al. 2014	Sweden	Conceptual	Broad forest sector
Albert 2007	Canada	Conceptual	Forest-based communities
Holopainen et al. 2014	Finland	Empirical	Retail consumers
Pelli et al. 2017	Finland	Conceptual/secondary	Services
Duchesne & Wetzel 2003	Canada	Conceptual	Canadian bioeconomy
Näyhä & Pesonen 2012	Finland	Empirical	Forest biorefineries
Pätäri et al. 2016	Finland	Empirical	Pulp and paper industry
Marchetti et al. 2015	Italy	Conceptual	Forestry

*Based on home institution of primary author

on the bioeconomy. The data for Näyhä and Pesonen and Pätäri et al. is expert opinion collected through a Delphi process while Holopainen et al. data comes from final consumers in a retail setting. Of the eight articles focusing on the bioeconomy, five are from Nordic Europe with four of these coming from Finland. Competitive advantage is directly addressed by Näyhä and Pesonen (2012) and referred to by Kleinschmit et al. (2014), indicating that this critical concept for the future of the FBS is insufficiently addressed by academia. The research questions identified in this work, along with the current work shown in Table 9 indicate a major knowledge gap and many opportunities for future research.

4.0 Conclusions

Policy-related topics received high priority among our respondents. Four of the top fifteen research questions are dealing with policy issues. This may reflect a tendency for economists to focus on policy issues and our results would likely have differed if a broader set of research fields were represented in our sample of respondents. Still, the 131 items represent a huge diversity in topics and it must be remembered that there were not large differences among item priorities. Despite the lack of coverage in the literature and the extent of emphasis it has received in bioeconomy policy documents, the low rating of collaboration topics was a surprising finding. Perhaps this topic and the approach to its study is rather unfamiliar to our respondents.

A potential limitation of our approach and results is that our respondents may have tended to prioritize research questions within their own expertise area rather than taking a broader view of where priorities should lie. We can only speculate about this issue since our methods did not allow for us to account for this potential issue. We can make no claims about representativeness of our sample and our response rates were low. However, as a first work of its kind, these results provide insight into a previously unexplored area, FBS competitive advantage and the bioeconomy. Even with these limitations, our results give indication of the likely research directions of Nordic forest economics researchers as well as identifies areas (e.g., collaboration) that may need extra emphasis for policy makers and funding agencies to assure broad coverage of the challenges facing the FBS as it faces entry into the bioeconomy. Given the nature of national and international policies as well as ongoing work within the field, we predict a significant increase in FBS bioeconomy-focused literature in the short term with a shift away from largely conceptual pieces to empirical work.

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Appendix A. Original Categorization of Research Questions Prior to Delphi Process

Categories and Research Questions
Innovation & Innovation Systems
Is it more effective to seek innovations within established companies or startups?
How to organize R&D for more support on competitive advantage?
How do regulations, policies, technologies, and socio-economic trends affect forest bioeconomics?
Why are the established R&D platforms ineffective?
How to stimulate creativeness in a business context – innovative, out-of-the-box thinking
Collaboration
How to create inter-sectoral integration/overcome resistance (e.g., plastics)
Where to find cross-sectoral connections?
How to “open up” to new sectors like health care?
How to better integrate with other sectors to maximize potential value of the firm’s service positions?
The role of collaboration and interdisciplinarity?
Why the lack of collaboration?
Consumers/Customers
How are consumer preferences changing regarding “greener solutions”?
How to communicate to the public?
How are attitudes formed around forestry?
What are the factors influencing change in consumer preferences?
What additional value customer would experience from bioeconomy-based products/services, now and in future?
How to make customers willing to pay for being biobased?
Environmental Scanning
What are the signals of gradual change?
Building better foresight on risks and possibilities in political environment, including strategies to manage policy risks.
Sustainability monitoring, circular economy, and how to reveal the bioeconomy in statistics/data.
What is happening in the competing sectors?
What are the promising products from a sustainability perspective?
Culture
How to get the entire value chain customer oriented?
What makes some companies able to learn from and understand their customers?
How to be more responsive to global developments?
How can a company manage both “traditional” and “new” products and markets?
Misc.
How can big data and ICT be better utilized to drive market innovations and market development?
How to produce “sustainable” products efficiently?
Finding competitive advantage through available raw materials, development of new technology, and cost-efficient operations.
How to assess competitive advantages (methodology)?
What can be learned from successful companies?
How should risk be viewed/accounted for in business models?

Appendix B. Full Set of Research Questions, Including Means and Standard Deviations

Ranking	Category*	Item	Mean	Std
1	4	What are the key regulations, policies, technologies, and socio-economic trends that affect the forest bioeconomy?	4.28	0.81
2	4	How do alternative scenarios with regulations, policies, technologies, and socio-economic trends affect the future opportunities of the forest bioeconomy?	4.16	0.92
3	14	How do consumers form attitudes around forests, forestry, forest products, and/or the bioeconomy in different consumer markets?	4.09	1.00
4	4	What types of policy environments foster innovations – and what types do not?	3.94	0.91
5	2	How can the uptake of innovations throughout society (end-users, industries, academia) be facilitated?	3.88	0.91
6	7	How can the forest-based sector better connect what is already ongoing in other sectors?	3.88	1.18
7	3	What can be learned from successful firms in terms of innovation and creativity?	3.84	0.99
8	14	What are the factors influencing changes in consumer preferences (e.g., the role of information)?	3.84	1.14
9	14	What impacts consumer preference for bio-based products?	3.81	1.15
10	16	How should environmental performance of products be measured and presented to enable industry and end-consumers to make sustainable choices?	3.81	0.90
11	20	How will sustainability be defined in the future bioeconomy context?	3.72	1.28
12	21	What are the environmental trade-offs in an efficient bioeconomy?	3.72	1.22
13	19	What are recommended strategies for the sector and individual firms to manage policy risks?	3.71	1.10
14	14	How do firms become aware of consumer preference changes regarding “greener solutions”?	3.69	1.03
15	18	Which are the possible new sectors that will be part of the bioeconomy as it evolves via cross-sectoral processes?	3.66	1.15
16	7	What type of environments connect, create, and promote cross-sectoral integration?	3.66	1.00
17	7	What are the emerging new sectors (e.g., nano, space) or emerging future needs (e.g., wellbeing, security)?	3.66	1.10
18	8	What are the mutual benefits that may enable sectoral partnerships?	3.66	0.87
19	2	How can downstream customers, users and beneficiaries be involved in innovation?	3.63	1.10
20	2	How can big data and ICT be better utilized to drive market innovations and market development?	3.61	1.02
21	19	How are innovations affected by environmental risks?	3.61	0.99
22	2	How can R&D be organized for more effective support of competitive advantage?	3.59	1.07
23	4	How can policy design impact innovation systems, thereby stimulating industrial transformation?	3.59	0.98
24	11	What can be done to encourage the entire value chain to be customer oriented?	3.59	1.29
25	16	How can customers be integrated into product and service design and other value co-creation activities?	3.59	1.24
26	12	How can a culture of entrepreneurship be established in a mature industry?	3.58	1.23
27	2	How can mature forest firms be organized to become more innovative and open-minded?	3.56	1.13
28	5	How can investments be attracted and risks managed in the bioeconomy?	3.56	0.91
29	11	What makes some firms able to learn from and understand their customers?	3.56	1.22
30	18	What are the larger trends that promote or hinder transition to the bioconomy?	3.56	1.34
31	2	What are effective ways of stimulating creativeness in a business context, such as innovative, out-of-the-box thinking?	3.56	1.13
32	4	What is the role of public support to facilitate successful innovation systems?	3.55	1.03
33	14	Are customers willing to pay for being biobased, and at what level?	3.55	1.26
34	20	What are the contributions of forestry and the forest industry to economic and social sustainability?	3.53	1.39
35	14	How can we identify motivation drivers of sustainable consumption and ways how to encourage consumers’ behavioral change?	3.53	1.08
36	23	What can be learned from successful firms (including other sectors and other types of operations) or society structures?	3.53	1.24
37	18	What are possible sources of radical changes in the external environment?	3.53	1.27
38	23	What is the role of digitalization in a future bioeconomy?	3.52	1.23
39	19	How are environmental change and risk influencing policy making?	3.52	1.23
40	12	Does social responsibility lead effectively to competitive advantage?	3.50	1.16
41	12	How can attitudes and behavior be included in innovation and innovative systems to understand the possibility to change the culture of traditional systems (e.g., the use of alternatives like viscose, plastics)?	3.50	1.19
42	7	What conditions are needed to “open up” to new sectors like health care?	3.44	0.98
43	16	What are additional values customers would experience from bioeconomy-based products/services, now and in the future?	3.44	1.24
44	21	How can we develop a better understanding of the dependence on local factors for the tradeoff among different services provided by the forest?	3.44	1.01

*2=Innovation: Organizing and Facilitating Processes, 3=Innovation: Efficiency and Effectiveness of Processes, 4=Innovation: Policies for Innovations, 5=Innovation: Misc., 7=Collaboration: Cross-sector, 8=Collaboration: General Collaboration, 9=Collaboration: Misc., 11=Culture: Customer Orientation, 12=Culture: Misc., 14=Consumers: Attitudes/Preferences, 15=Consumers: Communication, 16=Consumers: Misc., 18=Environmental Scanning: Change, 19=Environmental Scanning: Risk, 20=Environmental Scanning: Sustainability, 21=Environmental Scanning: Misc., 23=Misc.

Appendix B (continued)

Ranking	Category*	Item	Mean	Std
45	12	What should a firm do to effectively manage both "traditional" and "new" products and markets?	3.44	1.29
46	21	Given the available raw materials and future new technologies, what bioproducts could have competitive advantage over non-bioproducts, and at what volumes could they be produced?	3.44	1.16
47	4	Does policy uncertainty influence investment in product development/innovation?	3.41	1.16
48	16	How, utilizing new enabling technologies, is value created (co-produced and co-created) in the future bio-based economy?	3.41	1.34
49	21	Is the forest area sufficient to cope with all competing land use demands, including bioeconomy, production of traditional forest products, nature conservation, recreation, etc.?	3.41	1.27
50	15	How should firms communicate the benefits of biobased solutions to the public?	3.41	1.04
51	18	How can firms become better at managing policy risks?	3.39	1.17
52	15	How can we move from unidirectional communication to dialogue with the public?	3.39	1.15
53	23	What are useful methodologies to assess competitive advantages in more dynamic operating environments?	3.39	0.99
54	20	How can data be analyzed to effectively determine sustainability?	3.38	1.16
55	9	Can collaboration with business contribute to preserving ecosystem services and ensure competitiveness?	3.38	1.21
56	12	How can we move beyond linear, value-added chain processes to orchestration of value networks and to adaptive value systems which cannot be "managed" by a single player?	3.34	1.38
57	14	What is the overall legitimacy of the bioeconomy among members of the public?	3.34	1.10
58	14	How can heterogeneity in consumer preferences be accounted for?	3.34	1.23
59	14	How is value perceived and defined in a bioeconomy?	3.34	1.52
60	3	How does R&D impact firm profitability?	3.34	1.12
61	23	How can data be collected for improvement of integrated models of multiple-outputs production?	3.33	1.03
62	8	How do collaboration and interdisciplinarity interact?	3.32	1.30
63	14	What is the influence of sustainability as a product attribute on consumers' buying decisions and willingness-to-pay?	3.31	1.15
64	15	How significant is media influence on consumers' understanding and preferences?	3.31	1.20
65	20	What are the most promising recent advances in sustainability monitoring, circular economy, and statistics that biobased industries may use as information assets?	3.31	1.06
66	8	How can we solve competition and differences in status and power among firms that collaborate for common competitive advantage?	3.29	1.13
67	5	To achieve competitive advantage, what is the optimal interaction among humans, natural resources, and technology?	3.28	1.33
68	2	How can innovative ideas from individuals be promoted/supported/evaluated?	3.28	1.25
69	7	What kind of facilitation is needed to orchestrate effective co-creation across diverse actors?	3.28	1.08
70	11	Who are the users and beneficiaries, and how do firms connect with their activities, needs, and "realities"?	3.28	1.37
71	3	What are comparative strengths and weaknesses of established firms and start-ups when pursuing innovations?	3.25	0.95
72	7	What is necessary to better integrate with other sectors to maximize the potential of the firm's value proposition (tangible products and intangible services as solutions)?	3.25	1.24
73	23	How can we create new value propositions for bio-based products and services?	3.23	1.20
74	2	Is the innovation process creating disadvantages for SMEs with low capital investment potential?	3.22	1.10
75	2	What part do pre-understandings, information and social interaction play in establishing an innovative system for competitive advantage?	3.22	1.04
76	4	What hampers and facilitates circular economy thinking and practice?	3.22	1.26
77	12	How can forest owners be included in firm(s) thinking and acting?	3.22	1.31
78	21	How can we increase efficiency in collection of data on provision of non-market goods and services to improve documentation of environmental effects?	3.22	1.07
79	23	How should risk be viewed/accounted for in business models?	3.22	1.24
80	23	What is the importance of a competitive forestry and forest industry in peripheral/rural areas?	3.22	1.26
81	4	What are the main factors for promoting new business options among private forest owners?	3.22	1.29
82	18	What are signals for monitoring and understanding gradual change in the external environment and how can they be identified?	3.19	1.22
83	5	What might be the "unexpected partnerships" that would help identify promising business solutions?	3.19	1.28
84	7	How can resistance to cross-sectoral collaboration be overcome?	3.19	1.06
85	11	How can reverse use of customer data be used for improved customer orientation and customer value co-creation in wood products marketing.	3.19	1.20
86	23	How can we develop and implement effective, efficient and simple policy measures without loopholes?	3.17	1.34
87	23	What does "digitalization" already mean in the forest-based sector context?	3.16	1.32
88	20	How can the three dimensions of sustainability can be addressed in the bioeconomy?	3.16	1.25

*2=Innovation: Organizing and Facilitating Processes, 3=Innovation: Efficiency and Effectiveness of Processes, 4=Innovation: Policies for Innovations, 5=Innovation: Misc., 7=Collaboration: Cross-sector, 8=Collaboration: General Collaboration, 9=Collaboration: Misc., 11=Culture: Customer Orientation, 12=Culture: Misc., 14=Consumers: Attitudes/Preferences, 15=Consumers: Communication, 16=Consumers: Misc., 18=Environmental Scanning: Change, 19=Environmental Scanning: Risk, 20=Environmental Scanning: Sustainability, 21=Environmental Scanning: Misc., 23=Misc.

Appendix B (continued)

Ranking	Category*	Item	Mean	Std
89	16	How can new markets, including contracts that account for multiple outputs, interdependence, long time horizons, and imperfect information be developed?	3.16	1.25
90	7	How do we identify and establish key cross-sectoral connections?	3.16	1.25
91	20	Can sustainability be regarded as a source of competitiveness?	3.16	1.19
92	19	How can foresight be used to better account for risks and possibilities in the political environment?	3.13	1.38
93	9	How can the ideal, holistic of the bioeconomy, including a cradle-to-grave perspective and cross disciplinarity, be achieved?	3.13	1.45
94	2	Why are the established approaches to R&D ineffective in nurturing innovations?	3.13	1.04
95	20	How can promising bioproducts and services from a sustainability perspective be identified?	3.13	1.24
96	7	How can a firm, rethink its service positions when integrating with other sectors?	3.09	1.23
97	23	What are the opportunities and constraints of the bio-based forest sector in a platform/sharing economy?	3.06	1.26
98	8	What are the promises and drawbacks of interdisciplinary collaboration?	3.06	1.22
99	9	How can the cultural differences among research fields be bridged?	3.06	1.19
100	5	Can increasing customer value, competitive advantage and resource efficiency through shifting from selling physical products to selling services help meet the triple bottom line?	3.06	1.32
101	11	What milieu models can be used for defining and predicting consumption behavior and respective market segments?	3.03	1.14
102	12	How can firms be more responsive to global developments?	3.03	1.20
103	16	How do location of production and location of consumption influence willingness-to-pay for bio-based products?	3.03	1.03
104	8	How can we handle a situation where a group of firms collaborate for common competitive advantage, but only one/some of the firm(s) experience(s) an advantage?	3.03	1.15
105	11	How should the forest sector be “branded” through “storytelling” and “identity” and other models to reach customers?	3.03	1.43
106	12	Is firm culture different in a bioeconomy compared to that of the present?	3.03	1.49
107	20	What are effective ways to monitor what is happening in competing sectors in terms of sustainability and CSR?	3.00	1.16
108	23	What are the keys to finding competitive advantage through available raw materials, development of new technology, and cost-efficient operations?	3.00	1.29
109	12	How are a competitive firm’s employees led in the service business era?	2.97	1.38
110	14	How, if at all, can consumer preferences be interpreted as valuations of environmental consequences of production modes?	2.97	1.09
111	3	How is R&D related to internationalization expansion paths of firms?	2.94	0.95
112	14	How will changes in forest visitation among the public impact their attitudes?	2.94	1.27
113	20	How can we produce “sustainable” products efficiently?	2.94	1.15
114	20	Is bioeconomy the most realistic and promising form of achieving higher levels of sustainability, compared to improving existing products and creating new materials?	2.91	1.40
115	23	How can we continuously link available raw materials, development of new technology, and cost-efficient operations?	2.90	1.30
116	3	How do R&D investments vary across business areas?	2.84	1.22
117	3	Is it more effective to seek innovations within universities, institutes, established firms or startups?	2.81	1.15
118	12	How can we identify profession-based prejudices that constrain strategies (such as carbon neutrality)?	2.81	1.12
119	16	What is forest knowledge among members of Generation Y?	2.81	1.33
120	23	What are the key SWOT factors for bioeconomy sectors?	2.81	1.40
121	23	Does the phenomenon competitive advantage change if it is an advantage for a) nature, b) society, c) a group of firms, d) a group of people, e) a single firm, b) an individual?	2.80	1.24
122	23	Is it possible to understand and/or define the phenomenon “competitive advantage” without considering for whom or what the competitive advantage is an advantage for?	2.77	1.23
123	5	Are current innovations connected to the bioeconomy capital intensive?	2.75	0.92
124	23	Are privacy concerns a hindrance to innovations and societal development?	2.74	1.15
125	21	What part does environmental scanning have in establishing competitive advantage?	2.74	1.09
126	5	Why has the fossil energy industry been extremely successful in terms of innovations?	2.69	1.33
127	23	Are there differences in forest management activities, organizational structure, economic tasks, etc., among large forest management organizations?	2.68	1.25
128	21	How (by whom) are ecolabels created, and how are they used by firms and in marketing?	2.65	1.31
129	23	How can web-based business games help to solve research questions in the field of social science?	2.61	1.26
130	23	What is the phenomenon “competitive advantage”?	2.53	1.34
131	8	What are the reasons for the historical lack of collaboration?	2.47	1.24

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