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**Multi-stakeholder perspective: The potential of mushroom cultivation
alongside forestry activities**

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Abstract

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Abstract:

Challenges of such as biodiversity loss and unsustainable food systems are interconnected. Forests and forest fungi have important roles in the safeguarding of biodiversity. This study aimed to provide insights on mushroom cultivation opportunities alongside forestry activities using environmental expert opinions, individual forest owners' perceptions and attitudes of mushroom picking hobbyists.

Environmental experts, individual forest owners, and mushroom picking hobbyists were selected as key stakeholder for investigating the viability of mushroom cultivation alongside forestry activities. The potential of mushroom cultivation alongside forestry activities was elicited within the theoretical framework of stakeholder theory, corporate social responsibility, sustainable business, and insights from behavioral theories. The data was collected through qualitative interviews and a short survey. The analysis method for the data was thematic analysis.

Six themes emerged from the data, showing practical implications that have important implications for the viability of mushroom cultivation alongside forestry activities, and touch upon environmental, economic, legal, social, educational and other practical aspects.

Mushroom cultivation services could support and enhance forest biodiversity and offer additional income opportunities for forest owners. From a corporate social responsibility perspective selling mushroom cultivation services to forest owners represents an opportunity to support biodiversity of forests. Turning mushroom cultivation into sustainable business opportunity requires careful consideration of practical implications.



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Tiivistelmä:

Biologisen monimuotoisuuden väheneminen ja kestävämmän ruokajärjestelmä haasteet ovat kytköksissä toisiinsa. Metsillä ja metsän sienillä on tärkeä rooli biologisen monimuotoisuuden turvaamisessa. Tämän tutkimuksen tarkoituksena oli antaa tietoa sienten viljelymahdollisuuksista metsätalouden ohella hyödyntämällä ympäristöasiantuntijoiden mielipiteitä, yksittäisten metsänomistajien käsityksiä ja sienestysharrastajien asenteita.

Ympäristöasiantuntijat, yksittäiset metsänomistajat ja sienestysharrastajat valittiin keskeiseksi sidosryhmäksi tutkittaessa sienten viljelyn liiketoimintamahdollisuuksia metsätalouden rinnalla. Sienten viljelymahdollisuuksia tutkittiin sidosryhmäteorian, yritysten sosiaalisen vastuun, kestävä liiketoiminnan ja tiettyjen käyttäytymisteorioiden teoreettisessa viitekehyksessä. Tutkimuksen aineisto kerättiin laadullisilla haastattelulla ja lyhyellä kyselyllä. Tietojen analysointimenetelmä oli temaattinen analyysi.

Tutkimustuloksista nousi esiin kuusi teemaa, jotka osoittivat sienten viljelyliiketoiminnalle käytännön mahdollistavia tekijöitä. Näillä tekijöillä on tärkeä vaikutus sienten viljelyn taloudelliseen kannattavuuteen metsätalouden ohella. Löydetyt tekijät ovat ympäristöön, talouteen, lainsäädäntöön, yhteiskunnalliseen, sekä koulutukseen liittyviä, ja näiden lisäksi löydettiin muita huomioitavia näkökohtia.

Sienten viljely palvelut voisivat tukea ja parantaa metsien biologista monimuotoisuutta ja tarjota lisätulon mahdollisuuksia metsänomistajille. Yritysten sosiaalisen vastuun näkökulmasta sienten viljely palveluiden myynti metsänomistajille tarjoaa mahdollisuuden tukea metsien biologista monimuotoisuutta. Sienten viljelyn muuttaminen kestäväksi liiketoimintamahdollisuudeksi edellyttää käytännön mahdollistavien tekijöiden huolellista tarkastelua.

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1. INTRODUCTION

1.1 Motivation of the study

1.1.1 Co-creation in sustainability science

Co-creation is an increasingly important approach in pursuing sustainability solutions. In co-creation, different actors participate in solving predefined issues and reformulating problems (Chambers et al, 2021). This master's thesis has been based on a co-creative approach, supported by the Co-Creation Lab organized by Helsinki Institute of Sustainability Science (HELSUS). The lab is a facilitation and cooperative process organized to develop master's students' theses, based on the real-world societal challenges and also involving businesses and public sector actors (University of Helsinki, 2021). The topic of the master's thesis has been framed by the corporate challenge as articulated by the forest company UPM: *The role of biodiversity in the acceptability of forestry and the role of current forestry practices in safeguarding biodiversity.*

The motivation of this study is based on UPM's suggestions considering the provided challenge. In further detail, UPM propounded that the topic could consider insights from for example the following questions: "What biodiversity issues are linked to acceptability of forests? UPM has many activities to enhance biodiversity in our forestry operations – are our practices sufficient or do we need to do more? If we need to do more, what would that be?" Through the master's thesis' results, UPM is hoping to find new solutions to better safeguard biodiversity, better understand the acceptability of forestry, and get new ideas on communicating about biodiversity. Additionally, food economy and consumption master's studies, and master's thesis author's personal interests towards mushrooms have impacted the topic formulation. UPM's interests towards biodiversity and forestry related topics are various, and their representative staff member approved this topic suggestion with a curious mindset.

In the planning phase, mushroom cultivation opportunities alongside forestry activities became the most interesting framework, and it finally ended up becoming the basis of this master's thesis. The topic of this master's thesis is the potential of mushroom cultivation alongside forestry activities, and the focus is on the selected stakeholders' perceptions, opinions, and attitudes towards mushroom cultivation in Finnish forests. This is tightly related to improving the acceptability and sustainability of forests and forestry operations and offers ideas for better safeguarding biodiversity and enhancing the versatile use of forests.

1.1.2 Challenges of biodiversity maintenance and current food systems

Biodiversity maintenance in forest ecosystems

The corporate challenge set by UPM is based on forests' biodiversity issues. According to Convention on Biological Diversity (2006), "biological diversity' means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Biodiversity and ecosystem conservation, and the sustainable use of semi-natural ecosystems support ecosystem services. Ecosystem services are "the ecological characteristics, functions, or processes that *directly or indirectly* contribute to human wellbeing: that is, the benefits that people derive from functioning ecosystems" (Costanza et al, 2017, 3). Ecosystem services consist of the benefits that ecosystems provide to people (Bishop, 2012). Examples of ecosystem services are climate regulation, soil formation, nutrient cycling, and food production (Costanza et al, 2017). Biodiversity, ecological resilience, and ecosystem functions are prerequisites for the existence of ecosystem services, which lead to economic and social benefits for people. These benefits are valued as social and economic well-being influencers on societal, organizational, and individual levels. Simultaneously, humans have impact on ecosystems' functions and biodiversity, which affects ecosystem services. If ecosystems get stressed and cumulative effects reach certain levels, the changes in the ecosystem and related services may be dramatic.

Fungi (i.e. mushrooms) are crucially important to the forest ecosystem's proper functioning, and they have significant ecological relevance in most ecosystems (Tomao, Bonet, Castaño & de-Miguel, 2020; Bässler et al, 2021). Fungi have been used as bioindicators of environmental health (Mukhtar, Lin, Wunderlich, Cheng, Ko & Lin, 2021). Beneficial symbiotic relationships between land plants and fungi contribute to the survival of land plants (Mukhtar et al, 2021). In a literature review-based study, Tomao et al (2020) found that there is a positive relation between tree stand structure and fungal diversity. The impacting factors include canopy cover and basal area of the stand, which is especially relevant with the mycorrhizal species (Tomao et al, 2020). Diversity and abundance of deadwood are features that positively relate to richness of wood-inhabitant fungi (Tomao et al, 2020). The diversity of both wood-inhabiting and mycorrhizal fungi is positively related to the tree species diversity (Tomao et al, 2020). For the wood-inhabiting fungi the tree species diversity is even more important than the amount of accessible deadwood or other environmental factors (Tomao et al, 2020).

Ecosystem services are increasingly recognized for the benefits they deliver to companies that are dependent on natural capital in their production. Businesses are dependent on critical ecosystem provision services, such as freshwater, fiber, and ecosystem's waste treatment (Winn & Pogutz, 2013). Similarly, findings of D'Amato, Wann, Li, Rekola, and Toppinen's (2016) study support the increasing relevance for companies in natural resource-dependent business to understand the sustainability issues of the sector. Forest industry depends on multiple ecosystem services, that include climate regulation and nutrient recycling (Bishop, 2021).

Financial objectives are challenging the forestry practices in Finland, and in many cases, it seems that biodiversity and environmental aspects are secondary to economic issues (Kröger & Raitio, 2017). Biodiversity losses, depletion of resources, climate change and population growth are challenging Finnish forest policy (Kröger & Raitio, 2017). Forest management industry has significant impact on the mushroom wellbeing (Wolfslehner et al, 2019; Tomao et al, 2020). Various studies show that silvicultural practices, by modifying microclimatic conditions and modifying stand characteristics, could have impact on fungal communities (Tomao et al, 2020). Past research has shown that sporocarp community composition and diversity could be negatively affected by forest thinning (Tomao et al, 2020). Despite this, fungal community may be considerably resilient and resistant to forest management's disturbance in the low-impact forest harvesting operations (Tomao et al, 2020). A better understanding of the effect of silvicultural practices on fungal community dynamics and diversity is required to improve more sustainable forest management practices (Tomao et al, 2020).

In Ranacher, Lähtinen, Järvinen and Toppinen's (2017) study, most of the Finnish responders agreed on the importance of forests as supporters and regulators of ecological services. With the growing awareness of environmental issues, forests' value for carbon storage, protective functions against natural hazards including floods, and climate change mitigation, have increased forests' meaningfulness to people (Ludvig et al, 2020). Non-wood forest products (e.g. mushrooms, berries) are important objectives in the multi-functional forest management and sustainable forestry, which has been noted in several international agreements and processes that are related to biodiversity, climate change, and forestry (Wolfslehner, Prokofieva & Mavsar, 2019).

Innovation in food systems

In addition to UPM's corporate challenge, this study has been motivated by the current food systems. Food is a fundamental need for subsistence (Ekins & Max-Neef, 1992). Food systems globally are facing multiple interlinked environmental challenges, such as biodiversity loss, climate change, food availability, and the overuse of chemicals (Kuokkanen et al, 2018; Wolfslehner et al,

2019). The scarcity of resources, including food and water, is increasing (Lehnert, Giannopapa & Vaudo, 2016). The decreasing land availability for agriculture increases the urgency of improved management solutions (Lehnert et al, 2016). Because of these challenges, changes in production and consumption practices are necessary for achieving food-related sustainability (Kröger & Raitio, 2017). Finland is one of the countries that has ambition to promote the economy through green technologies for the sake of protecting natural resources (Lehnert et al, 2016). Innovations are crucial in adapting to changing environments (Wolfslehner et al, 2019, 77). For this purpose, Finland aims to incorporate a green understanding into the relations between both private and public sectors (Lehnert et al, 2016). Sustainability transitions need innovations that take into account production and consumption practices (Kuokkanen, Uusitalo & Koistinen, 2019). This master's thesis focuses on mushroom cultivation, which possibly has potential as sustainable food production innovation.

In order to being able to satisfy the future generation's needs, agri-food supply chains have to give up the currently inefficient practices and focus on sustainable production (Banasik, Kanellopoulos, Bloemhof-Ruwaard & Claassen, 2019). This change requires tools that support sustainability focused decision making in the food production practices (Banasik et al, 2019). Domestic food production and sustainable farming practices are seen as examples of solutions for food related sustainability issues (Lehnert et al, 2016). Consumers' evolving and changing expectations offer new opportunities for business models (Kuokkanen et al, 2019). For example, in Europe, there is a growing demand for organic and locally produced foods which are seen as authentic, natural, healthy or pure (Wolfslehner et al, 2019). Rosi et al (2017) promote in their research for the future studies to focus on such things as the choice of seasonal and locally grown products, as well as processing and agricultural techniques, which could have positive impact on the environment. In forests, mushrooms are seasonal products, and they can be locally grown.

In Finland recycling organic waste and side streams, vegetarian food, and farmer's financial sovereignty are considered as ways to reaching food production's sustainability (Kuokkanen et al, 2018). Meat's excessive consumption is one of the biggest environmental issues in the food system (Kuokkanen et al, 2019). Implementing increasing amount of non-meat-based protein sources to the diet could be one way to reduce the negative environmental effects that are being caused by the meat industry (Sande et al, 2019; Prusaczyk, Earle & Hodson, 2021; Rosi et al, 2017). From the nutritional perspective, mushrooms' nutritious value is noticeably good when comparing to for example meat (Sande et al, 2019). Mushrooms have low caloric value, absence of cholesterol and ubiquity, and high content of proteins and fibers (Sande et al, 2019; Piippo & Salo, 2020). In the restriction diets, such as veganism and vegetarianism, mushroom consumption is an important substitution of meat-based

products, because of mushrooms' protein, fiber, and fat composition (Sande et al, 2019). Mushrooms have potential of becoming an even more central element in the human diet.

1.2 Research objective and research questions

Based on the UPM's corporate biodiversity related challenge and food systems' innovations, this master's thesis seeks to provide insights on the potential of mushroom cultivation as part of forest company's business activities. *The aim of this master's thesis is to explore and better understand opinions and perceptions of forest industry related stakeholders' about mushroom cultivation alongside forestry activities.* In this master's thesis, mushroom cultivation as part of business activities alongside forestry activities means, that individual forest owners are offered products or services that enable growing mushroom species in Finland's forests. Such mushroom cultivation services are currently not mainstreamed in the forest industry activities.

The business potential of non-timber forest products is highly underutilized in Europe (Wolfslehner et al, 2019), and the same applies in Finland (Tikkanen, Takala, Järvelä, Kurttila & Vanhanen, 2020). In Europe, the main non-wood forest products collected in the wild and transferred through supply chains to end users are resins, greeneries, fruits, nuts, mushrooms, berries, medicinal plants, and aromatic plants (Wolfslehner et al, 2019). There are increasing research efforts that aim to enhance the utilization of non-timber forest products (Tikkanen et al, 2020). Common arguments supporting the importance of non-wood forest products include the decreased profitability of traditional timber-based forestry and increased consumer demands for wild foods (Wolfslehner et al, 2019). Edible mushrooms are one of the most valuable non-wood forest products in Europe, because of their possibilities within the food and tourism sectors (Wolfslehner et al, 2019). Previous studies have shown that mushroom cultivation could be seen as a feasible business opportunity (Wolfslehner et al, 2019; Piippo & Salo, 2020). Like many other non-wood forest products, mushroom cultivation as part of business activities could benefit from different kind of innovations that are related to processes, products, organizations, marketing, policies, institutions, and social aspects (Wolfslehner et al, 2019).

The studies that have focused on big companies' sustainability are indicating, that sustainability has and will be having significant impact on company strategies (Dyllick & Muff, 2016). This means that company's stakeholders' concerns and perspectives are increasingly relevant to companies. Moreover, in a diverse network of public, corporate, and private stakeholders, attention should be paid to the interaction between urban and rural stakeholders, and on support structures for improving the facilitated communication considering non-wood forest products sector (Wolfslehner et al, 2019).

The multi-stakeholder perspective thus offers versatile points of view for the purposes of this study. The idea was to gather information from different perspectives, and the collected data was used to define some of the characteristics of mushroom cultivation as part of sustainable business activities. Buhmann, Jonsson and Fisker (2019) argue that broad stakeholder consultation increases the successfulness of social development goals, which include the local needs and human rights.

The results of this study aim to offer information and perspectives from selected stakeholders involved in mushroom cultivation in Finnish private forests. This master's thesis focuses on three selected stakeholder groups, which are environmental experts, individual forest owners (customers), mushroom picking hobbyists (communities). The selection of the included stakeholder groups was based on UPM's stakeholders, that are presented on their webpages (UPM, 2021). The relevance of these stakeholders will be further explained in the theoretical part. The data collection of this master's thesis included semi-structured and structured interviews, and a short survey.

This master's thesis seeks to address to the following research question: from multi-stakeholder perspective: *what is the potential of mushroom cultivation alongside forestry activities in private land in Finland?* The research question was broken down to three sub questions (SQ):

SQ1: How do environmental experts assess the potential of mushroom cultivation?

SQ2: What kind of perceptions do individual forest owners have regarding mushroom cultivation alongside forestry activities?

SQ3: What are the attitudes of mushroom hobby pickers towards cultivated mushrooms?

To the knowledge of this master's thesis' author, there are no previous studies that have focused on mushroom cultivation as part of business activities alongside forestry activities in Finland including the perspectives of stakeholders. As this topic has been studied very little, the idea is to perform a preliminary exploration. This master's thesis will contribute to filling the existing research gap by providing preliminary information about the possibilities and business opportunities of combining forestry services and mushroom cultivation services.

1.3 Research structure

In the introduction chapter, the motivation, research objectives, and research questions of the study have been presented. The following chapter explains the study background, that consists of ecological and technical foundations of mushroom cultivation. In the second chapter, basic information about forest mushrooms, mushroom cultivation techniques, commercial potential of mushrooms, and

everyman's rights are introduced. Study background is utilized in the discussion along with the theoretical framework. The third chapter is about theoretical framework, which is based on four different theory categories. The first of these theories, stakeholder theory, justifies the relevance of different stakeholders as research subjects. Next, corporate social responsibility (CSR) and sustainable business are used to explaining the companies responsibilities in the society, and how the companies are expected to include societal needs into their decision-making processes. This part of the framework helps to evaluate the mushroom cultivation's business activities' sustainability aspects and provides answers to the question of how sustainable these cultivation activities could be. Finally, the last part of the theoretical framework consists of insights from behavioral theories. These insights are used to explain the stakeholders actions and provide guidelines for sought behavioral changes that could be expected from stakeholders in mushroom cultivation business.

The fourth chapter presents the research materials and methodology. Here, all of the selected interviewees of the two stakeholder groups, environmental experts and individual forest owners, are introduced in detail. Additionally, the interview structures and contents are presented. Also, the short survey that was targeted to the mushroom picking hobbyists will be introduced. After presenting the research data, the research methodology is introduced in detail. This master's thesis uses thematic analysis for interpreting the results. The fifth chapter shows the results of the research interviews and survey. These results are presented one stakeholder group at a time. The final part of the fifth chapter is about the validity and reliability of the collected research data.

Based on the results, study background, and theoretical framework, the sixth chapter discusses the results of the research. First, mushroom cultivation alongside forestry activities is discussed from the corporate social responsibility perspective. After this, mushroom cultivation's sustainability is discussed from three viewpoints, which are social, environmental, and economic sustainability. Next, practical implications that should be taken into account or could help enabling mushroom cultivation alongside forestry activities are presented. These implications concern environmental, economic, legal, social, educational aspects, and other practical enablers. Finally, the limitations and suggestions for future research are discussed, leading to the conclusions that are presented before acknowledgements.

2. STUDY BACKGROUND

This chapter presents the ecological and technical foundations of mushroom cultivation. The aim of this section is to explain the basics of forest mushrooms' functioning, their relevance as a source of income, and currently known mushroom cultivation practices. In addition, everyman's rights are briefly introduced.

2.1 Forest mushrooms

This master's thesis uses the word "mushroom" as an indication for the visible part of the fungi. Mushroom is the fruit body of the fungi (Korhonen & Penkkimäki, 2012; Dann, 2017, 14; Carluccio, 2004). Typically, fruit body consists of a stem and a cap (Dann, 2017). This visible part might only appear for a relatively short period of time (Dann, 2017), because fungi exist most of the time only underground. There are multiple environmental factors that are driving fungal productivity (Morera, Martínez de Aragón, Bonet, Liang & de-Miguel, 2021; Sande et al, 2019). While the mushroom's mycorrhizal hyphae exist underground regardless of environmental factors, fruit body's forming is dependent on the weather and other environmental circumstances (Von Bonsdorff et al, 2014; Wolfslehner et al, 2019; Collado et al, 2019). Mukhtar et al (2021) found in their study that fungal community composition varies less among land cover types than climate zones. Their study concludes that climate change will significantly influence the overall fungi community diversity (Mukhtar et al, 2021). In addition to environmental circumstances, the fruit body size is affected by nutrient resource availability and thermoregulations (Bässler et al, 2021). For the fruit body to formulate, most mushrooms require water and warm temperatures (Korhonen & Penkkimäki, 2012). Because of all of the varying impacting factors, mushroom harvests depend on the year (Turunen & Soininen, 2017).

Mushroom picking is a recreational ecosystem service (Niemelä et al, 2010), and it is commonly seen as an autumn activity in Finland, but some edible mushrooms grow during spring and summer (Turunen & Soininen, 2017; Dann, 2017). It is possible to pick edible mushrooms from Finnish forests and buy cultivated or naturally grown mushrooms from grocery stores (Piippo & Salo, 2020). Most of the mushrooms are picked for personal utilization purposes (Piippo & Salo, 2020). In addition to people's mushroom picking activities, the fruit body is a central factor in fungi's dispersal and reproduction (Bässler et al, 2021; Carluccio, 2004). According to previous research, mushroom picking has proven to have no impact on fungal communities (Tomao et al, 2020).

Fungi have three main ways to acquire energy: a. saprotrophic fungi that live on decaying matter (Turunen & Soininen, 2017); b. mycorrhiza fungi living in a symbiosis with some plant through

mushrooms' mycorrhizal hyphae; and c. parasite fungi, which means that they are stealing the energy from a living plant or animal, and they are not giving anything in return (Korhonen & Penkkimäki, 2012) (Carluccio, 2004; Korhonen & Penkkimäki, 2012; Turunen & Soininen, 2017). Saprotrophic fungi are organisms that derives or feed on nourishment from decaying organic matter, and this way fungi is able to gather the remaining energy for its own consumption and release nutrients back to the nature (Korhonen & Penkkimäki, 2012). Without saprotrophic fungi, natural forests would be filled with undecayed fallen trees, and the forest floor would contain significantly less nutrients (Korhonen & Penkkimäki, 2012; Carluccio, 2004). Most of the edible mushrooms belong to the mycorrhiza mushroom group, and they commonly exist in symbiosis with trees (Turunen & Soininen, 2017).

2.2 Mushroom cultivation practices

In addition to environmental circumstances, mushroom production also depends on other factors. These impacting factors include forests' tree stand characteristics (Wolfslehner et al, 2019). A reliable supply of mushrooms is difficult to provide from small fragments of forest land, and it requires coordinated production from a large area (Wolfslehner et al, 2019). Each mushroom species has its own preferences considering the cultivation methods (Carluccio, 2004). Because of this, there are different techniques to cultivate mushrooms, which include field cultivation, compost cultivation, attach fungi to trees, and mushroom cultivation on decaying matters (Piippo & Salo, 2020). One way to execute mushroom cultivation is when mushroom parts are being grafted to the tree stumps or tree trunks, which provide energy and nutrients for the mushroom's development (Piippo & Salo, 2020). One kilogram of tree chump can produce approximately 200 grams of mushroom (Piippo & Salo, 2020). For example, shiitake (*Lentinula edodes*, in Finnish: siitake) is grown in birch alder and oak logs (Piippo & Salo, 2020). After two to three years of cultivation, fungi produces its fruit body (Piippo & Salo, 2020).

It has been scientifically proven to be possible to cultivate saprotrophic mushrooms (Turunen & Soininen, 2017; Carluccio, 2004). The truffle (*Tuber*, in Finnish: tryffeli) that grows underground, has been successfully cultivated in Finland by Juva's truffle center, where the truffle's mycelium has started growing along with the oak trees (Turunen & Soininen, 2017). Tinder mushroom (*Fomes fomentarius*, in Finnish: taulakääpä) has been planted on living trees (Piippo & Salo, 2020). Commonly cultivated mushroom, button mushroom (*Agaricus bisporus*, in Finnish: herkkuseini), grows typically wild in North American grass fields (Scott & Gaya, 2020). In turn, there are no known successful experiments of cultivating mycorrhizal mushrooms (Turunen & Soininen, 2017; Carluccio, 2004). For example, funnel chanterelle (*Craterellus tubaeformis*, in Finnish:

suppilovahvero) which is a relatively common edible mushroom that grows wild in the Finnish forests, is difficult to cultivate because of its mycorrhizal way of growing (Scott & Gaya, 2020).

In 2016, Natural Resource Institute Finland, has established a SceneProt project to inspect the mushroom cultivation's possibilities in the Finnish forests (Piippo & Salo, 2020). The mushrooms that have been included to this project have been picked from Finnish forests, and they include oyster mushroom (*Pleurotus ostreatus*, in Finnish: osterivinokas), sheathed woodtuft (*Kuehneromyces mutabilis*, in Finnish: koivunkantosieni), conifer tuft mushroom (*Hypholoma capnoides*, in Finnish: kuusilahokka), wood cauliflower fungus (*Sparassis crispa*, in Finnish: kurttusieni), and chaga (*Innotus obliquus*, in Finnish: pakurikäätä) (Piippo & Salo, 2020). It has been noticed that chaga can be cultivated in birch stands that have little or no value for timber production (Wolfslehner et al, 2019). Chaga is being used as tea made from a sterile conk which forms on the tree (Wolfslehner et al, 2019). All around Finland during the last few years, birch trees in several privately owned forests have been inoculated using plugs containing chaga's mycelia (Wolfslehner et al, 2019). This development may change the forest management practices towards supporting the creation of conks (Wolfslehner et al, 2019). Chaga's cultivation is an example of a promising business opportunity for individual forest owners.

In the indoor mushroom cultivation production premises, disposal of spent mushroom substrate is costly because of the high transportation volumes (Banasik et al, 2019). A more significant amount of negative environmental impact comes from energy consumption, of electricity and gas (Dorr, Koegler, Gabrielle & Aubry, 2021). This means that efforts to reduce energy consumption altogether, or improvements in energy efficiency, could have significant positive impact on the mushroom production's environmental sustainability (Dorr et al, 2021). The increasing pressure and challenges on forests demand for sustainable innovations (Gabay & Rekola, 2019). Mushroom cultivation burdens the environment relatively little, because mushroom cultivation can use agricultural and forestry waste (Cateni et al, 2021), and it requires considerably small amount of care (Piippo & Salo, 2020). Compared to in-door mushroom cultivation, mushroom cultivation alongside forestry activities is likely to have a lower environmental impact due to lowered energy consumption.

2.3 The commercial potential of mushrooms

Economically, cultivated mushrooms are more significant than the naturally grown mushrooms (Piippo & Salo, 2020). Usually, mushrooms are cultivated for human consumption, and edible mushrooms' cultivation is a successful business (Piippo & Salo, 2020). About 24 percent of the global mushroom cultivation is operated in the European Union region (Piippo & Salo, 2020). Mushroom

cultivation has potential of being an additional business opportunity alongside forestry and agriculture processes because tree stumps, tree trunks, and sawmill waste are suitable to being mushroom cultivation's substrates (Piippo & Salo, 2020). In many areas where traditional forest management is no longer profitable, the value of mushrooms can exceed the income obtained from timber (Wolfslehner et al, 2019).

Historically, wild products have had an important role as commercial products and as part of the households' consumption purposes (Wolfslehner et al, 2019). For ages, forests have provided shelter, food, energy, different materials, medicine and inspiration for people (Gabay & Rekola, 2019; Piippo & Salo, 2020). Mushrooms are being utilized medically for example in some antibiotics (Piippo & Salo, 2020). Nowadays, the diversity of different nutritive mushroom species have several potential utilization purposes worldwide (Sande et al, 2019). These utilization purposes include personal consumption, and sales of regional, niche, and experimental products (Wolfslehner et al, 2019). Mushroom picking can be an experiential product, for example by letting tourists go on a guided mushroom picking tour. The development of forest products has led to the uprising of experimental services that are related to personal use, such as hobby crafts and cooking, that are also very often related to regional tourism (Wolfslehner et al, 2019). In their study, Rantala and Puhakka (2020) found that engaging with recreational environments in many ways has impact on their well-being, and the time spent together in nature is valued. Their research supports the possibilities of mushroom picking as an experimental product. As territorial products, rare mushroom species could be sold in the local grocery stores, which would not be for sale anywhere else. Some mushrooms can be seen as niche products, for example because of their health-related benefits. The biggest mushroom yields can be sold in mass markets throughout Finland, or to other countries.

Furthermore, edible non-wood forest products are increasingly important raw materials for the food industry (Wolfslehner et al, 2019). Mushrooms are utilized in the production of several foods, for example citric acid, some alcohol-based beverages, and some yeasts (Piippo & Salo, 2020). Several mushrooms contain ingredients that are beneficial for human skin and hair, hence making the mushrooms a valuable ingredient in cosmetics (Piippo & Salo, 2020). Mushrooms can also be utilized to dye natural materials (Piippo & Salo, 2020; Turunen & Soininen, 2017).

Internationally mushrooms have become an important part of human's diet and it has been noted, that mushrooms can be an excellent source of food (Carluccio, 2004). In Finland, consumers have started to notice mushrooms as a valuable source of nutrients and some health benefits, and mushrooms have become a part of basic diet (Piippo & Salo, 2020; Cateni et al, 2021). Because of their nutritious value and health benefits, mushrooms are considered as superfood (Piippo & Salo, 2020). Mushrooms

contain vitamins, minerals, fatty acids, phenols, fibers, and different acids (Piippo & Salo, 2020; Cateni et al, 2021). Because of their nutritional value, mushrooms have an important part in human nutrition (Sande et al, 2019). Some mushrooms are suitable for human diet, and some can be lethal (Carluccio, 2004), and edible mushroom's nutritional value and taste are at their best right after picking (Piippo & Salo, 2020). Consumers' interests towards locally produced foods and utilizing naturally grown foods have led to rising demands considering mushrooms (Piippo & Salo, 2020).

2.4 Everyman's rights

Finland is one of the few European countries that has exceptionally permissive access rights, that are called everyman's rights (Tikkanen et al, 2020; Dann, 2017; Wolfslehner et al, 2019; Rantala & Puhakka, 2020; Turunen & Soininen, 2017). These rights allow anyone to freely access public and private land and collect resources other than timber, fish, and game. This means that everyone is allowed to pick mushrooms from anyone's land with the everyman's rights, for their own consumption or for business purposes (Tuunanen, Tarasti & Rautiainen, 2012).

The collection and use of non-wood forest products is part of personal well-being and collective forest culture (Wolfslehner et al, 2019). Because the mushroom picking is often viewed as a traditional use right, this can be an obstacle to improving forest innovation and management related to mushroom cultivation in Finland (Wolfslehner et al, 2019). However, some limitations apply to everyman's rights, for example the immediate area of a living premises is off limits, injuring growing trees is not allowed, and it is forbidden to bother the landlord's land use. Additionally, everyman's rights do not allow people to enter landlord's garden or cultivation fields (Metsähallitus, 2021; Ympäristöhallinnon yhteinen verkkopalvelu, 2013; Tuunanen et al, 2012). The part of forest that has been put to special use for mushroom cultivation should thus be clearly separated from natural forest parts in order to stop the everyman's rights from applying in this specific area (Tuunanen et al, 2012). Homes are protected by regulations regarding domestic privacy, which entail that people cannot come too close to anyone's home, but the law does not define, how close to someone's house can people pick mushrooms (Tuunanen et al, 2012).

3. THEORETICAL FRAMEWORK

This section presents the theoretical framework of this master's thesis. The framework is based on sustainable business's definition, stakeholder theory, corporate social responsibility, and insights from behavioral theories.

3.1 Stakeholder theory

In order for the enterprises to survive, they must take their stakeholders' interests into account and be able to understand the society's expectations (Frolova & Lapina, 2014). Stakeholders are groups or persons that have, or claim to have, rights, interests or ownership in a corporation and its activities, in the present, past, or future (Clarkson, 1995). These claimed interests or rights can be moral, legal, collective, or individual (Clarkson, 1995). In the stakeholder theory, corporations are viewed as organizational entities, through which several participants accomplish multiple, and sometimes disagreeing purposes (Donaldson & Preston, 1995). The theory is explaining a wider range of factors than only saying that organizations have stakeholders (Donaldson & Preston, 1995). The purpose of stakeholder theory is to explain and guide the operations and structure of the corporation (Donaldson & Preston, 1995). Businesses can use stakeholder theory to develop broad strategic solutions (Hörisch, Freeman & Schaltegger, 2014).

Clarkson (1995) divides stakeholders into primary and secondary stakeholders. Clarkson (1995, 105) defines primary stakeholders as "a group... without whose continuing participation the corporation cannot survive". Primary stakeholder groups include for example suppliers and customers. If any of these primary stakeholder groups withdraws because of dissatisfaction, the damages can be serious to the company. Thus, a corporation can be defined as a complex primary stakeholder group system. When it comes to primary stakeholder's values and wealth, these are not automatically financial, but instead there is a range of factors that are explaining the stakeholder satisfaction. Secondary stakeholders are "those who influence or affect, or are influenced or affected by, the corporation, but they are not engaged in transactions with the corporation and are not essential for its survival" (Clarkson, 1995, 107). There can be situations where some secondary stakeholder is of crucial importance and requires more attention than usual (Hörisch et al, 2014). Media is one example of secondary stakeholders. Secondary stakeholders are able to participate in building the public opinion, that can be either in favor or in opposition to a corporation's performance. In some cases, secondary stakeholders can have opposing and conflicting interest with the primary stakeholders. Because of this, these groups are able to cause significant damage to a corporation. (Clarkson, 1995)

The central core of the stakeholder theory is normative, and recognizing the moral obligations and values is the fundamental base of stakeholder management (Donaldson & Preston, 1995). Moral norms are based on moral concepts, which are about for example one's welfare, another's rights, and justice or fairness considerations (Kaiser, Ranney, Hartig & Bowler, 1999). When the stakeholder theory is used in a normative way, this means that the theory is used to interpret the function of the corporation, which includes the identification of philosophical or modal guidelines for the management of corporations (Donaldson & Preston, 1995). A normative theory attempts to interpret the function of investor-owned corporation from philosophical and moral perspectives (Donaldson & Preston, 1995). Normative approach's justifications attempt to underlie concepts such as group or individual rights, utilitarianism, or social contract (Donaldson & Preston, 1995). Hörisch et al (2014) highlight that no matter what the normative core is, it is about managing stakeholder relationships, and not to confuse it with managing stakeholders in a manipulative way.

As corporations manage their relationship with ecosystems, they encounter conflicts and governance challenges. These challenges can include finding acceptable forms of joint engagement among different stakeholders and considering perceptions of justice and fairness. Innovative decision-making tools are required to be able to meet the needs to monetizing ecosystem services and overcome the challenges considering different stakeholders' conflicting values. (Winn & Pogutz, 2013)

Sustainability management perspective enables the value of sustainability becoming a mutual interest source for all stakeholders. From sustainability management perspective, there are some challenges that are related to stakeholders. These challenges include getting the stakeholders to agreeing with the sustainability agendas and creating mutual sustainability interests between different stakeholders. All stakeholders are able to fulfill some cooperation function around sustainability, and it may require regulation and incentives that are guiding the stakeholders' interests towards being aligned with sustainability goals. Additionally, it is relevant to find ways of revealing existing and creating new possibilities for sustainability-based value creation for stakeholders. Despite all of the good intentions, finding mutual interests for all stakeholders can still be difficult. (Hörisch et al, 2014)

3.1.1 An example of stakeholders listed by a forestry company

Corporations should be able to recognize their stakeholders and their stakes, and also the role of managers and management within the stakeholder model (Donaldson & Preston, 1995). Different stakeholder frameworks are required when dealing with different kind of businesses (Hörisch et al, 2014). UPM (2021) lists the following stakeholders as their main stakeholders: customers, employees, financiers and investors, suppliers, authorities and key-decisionmakers, the media, non-

governmental organizations, and local communities. UPM acknowledges that well-functioning stakeholder engagement is essential for their success. UPM's stakeholders expect such things as financial success, growth, and stability. Today's business executives find sustainability strategies necessary from the competitiveness perspective, and they assume that sustainability's strategic meaning is growing (Dyllick & Muff, 2016). Environmental performance and social responsibility are important factors in UPM's long-term success. UPM states on their webpages, that they consider different stakeholders perspectives, depending on business focus, region and individual stakeholder groups.

3.1.2 *The selected forestry company's stakeholders*

It is not feasible to aim to study all of UPM's stakeholders. Stakeholders with similar interests can be categorized to the same stakeholder group (Clarkson, 1995). For this master's thesis' purposes, three stakeholder groups were selected based on the following rationalizations.

The first stakeholder group is formed by *environmental experts*. They can be seen as company's secondary stakeholders (see: Clarkson, 2019), because they have the ability to impact the company's image, and this way their business' success. These experts have been chosen from the forest industry and those kind of organizations that are in close correlation with forest industry companies. The selected experts are working at UPM, Natural Resource Institute Finland (in Finnish: Luonnonvarakeskus, Luke), and The Finnish Innovation Fund Sitra (in Finnish: Suomen itsenäisyyden juhlarahasto, Sitra). Environmental experts are able to provide valuable insight on the mushroom cultivation business opportunity. According to the experts, mushroom picking hobbyists have a significant role as unprofessional experts in the mushroom field.

The second group are *individual forest owners*, which are forest industry's customers for what concerns management services. Customers are company's primary stakeholders (see: Clarkson, 2019). The forest owner's ability to determine the management goals of their property's forests is crucial for encouraging production on non-wood forest products and promoting product innovation and domestication (Wolfslehner et al, 2019). In order for mushroom cultivation business to succeed, individual forest owners' behavior in terms of such activities to their forests' management is an important factor.

The final selected stakeholder group are *mushroom picking hobbyists*, who represent one of UPM's stakeholder communities. These communities are company's secondary stakeholders (see: Clarkson, 2019). In year 2010, 43 percent of Finnish adults stated that they are picking mushrooms on their free

time (Piippo & Salo, 2020). Mushroom picking hobbyists are regular forest users, and the changes that are planned to the forest could have impact on their mushroom picking experience. Nature itself is not a stakeholder, but some stakeholders can represent it as intermediaries and make sure that environment's needs are considered in decision making (Hörisch et al, 2014). It is relatively common that non-wood forest product producers and pickers do not participate in organized political actions, because of lack of the organizational capacity, or due to the lack of institutional vehicles which would enable their views and opinions to being shared, expressed, and consolidated (Wolfslehner et al, 2019). Because of the forests' value to mushroom picking hobbyists, it is necessary to include their attitudes to this study. Mushroom cultivation requires investments; therefore, it is valuable to study the mushroom pickers' willingness to participate in covering these costs.

3.2 Corporate social responsibility and sustainable business opportunities

Corporate social responsibility (CSR) is about balancing companies' environmental, economic, and social responsibilities (Panwar & Hansen, 2007). Dahlsrud (2008) has defined five most commonly used dimensions that consider CSR. These are stakeholder, environmental, social, economic, and voluntariness dimension. Stakeholders are strongly connected to CSR, because one of its significant elements is to put emphasis on the stakeholders' perceptions and needs as part of the society. The relationship between organizations and society is strongly related to the CSR (Frolova & Lapina, 2014). Society and stakeholders expect the businesses to include social issues in their decision making (Dyllick & Muff, 2016). In terms of responsibility typologies, the companies' responsibilities can be based on moral and legal obligations (Halme & Laurila, 2009). CSR exist everywhere within the corporate world (Dahlsrud, 2008). It has always been a part of businesses because of the stakeholder relationships, regulations, and also because of its social, economic, and environmental impacts (Dahlsrud, 2008).

CSR principles are commonly coherent with such principles as organizational commitment, stakeholder or society needs, quality management, and continuous business improvements (Frolova & Lapina, 2014). These principles are apparent in the organization's policy, values, and process management (Frolova & Lapina, 2014). Halme and Laurila (2009) conclude in their study that the financial performance can be affected by the type of CR actions in the company. CSR management tools are needed to support successful business strategies (Dahlsrud, 2008). Frolova and Lapina (2014) conclude in their study that in the future, organizational awareness of CSR strategy implementations will increase, and it becomes an even stronger part of organizations' policy and

culture (Frolova & Lapina, 2014). In CSR, the responsibility practices can vary depending on their focus (Halme & Laurila, 2009).

Globalization has caused the CSR to become a more relevant subject of focus, because the businesses have gotten bigger and their operations have become more complex, new legislation being established, and new stakeholders are taking interest in the multi-national companies (Dahlsrud, 2008). Multinational companies have been able to take advantage on the globalization and the differing moral and legislative environments, which has led for the societies to increase their interests in the corporate responsibilities (CR) (Halme & Laurila, 2009). Reaching global sustainability requires CSR on a global level (Panwar & Hansen, 2007).

Halme and Laurila (2009) have defined three types of CR, which are philanthropy, CR innovation, and CR integration. Philanthropy's emphasis is on such things as sponsorship, employee voluntarism, charity, and donations. CR Innovation is about developing new business models that are supposed to solve environmental and social problems. An example of CR Innovation is eco-efficient improvement that cuts costs and reduces company's negative environmental impact. CR Integration focuses on making the existing core business operations, such as product quality and R&D investments, more responsible. In terms of stakeholder management, CR Integration is mainly about those responsibilities that consider the primary stakeholders. The most significant difference between CR Innovation and Integration is, that innovations are about new businesses and integration is about improving the existing ones. All of the three types of CR, that Halme and Laurila introduced, are linked to each other and in correlation.

CR theory acknowledge the meaning of corporate responsibilities and their impact on human rights. Additionally, CR theory acknowledges the companies' meaning in terms of sustainable societies. According to Buhmann et al (2019), due diligence requires businesses to find opportunities to contribute to human right fulfilments. Due diligence can be seen as a management approach that views human rights as management issue, and it helps companies to identify different opportunities to contribute to society. In order to succeeding in the human rights related improvements, companies should assess stakeholder needs and contextual human right issues. Stakeholder involvement provides possibilities and increasing potential to contributing value to society.

Social development goals suggest that business's management approach could view human rights as a risk management issue, and also as an indicator that helps companies to detect opportunities to contribute positively to the society. Buhmann et al (2019) present an idea of "doing no harm" and "doing more good" for the corporations. This means that as part of social development, companies

ought to avoid harming societies and aim to improve its members' and nature's wellbeing. The good can be reached by identifying societal needs. When these needs have been identified, companies can start planning strategies that aim to fulfill human rights and needs. By building administrative capacity in collaboration with local authorities, companies could support individuals' access to public goods.

There is a strong link between CSR and sustainable business, as they have substantially similar environmental, social and economic goals. Sustainability management studies have great emphasis on the role of businesses. According to Dyllick and Muff (2016), business sustainability has been widely associated with the creation of ecological, social, and economic value. Corporations have significant amounts of knowledge and insight about sustainability issues. They also have the resources to address these issues. This is supported by the fact that increasing number of executives are reporting increasing commitment to sustainability. Noticeably, corporations are not the only significant actors in the field of global sustainability.

When planning a sustainable business model, there are several aspects that should be considered. As the companies are taking the sustainability concerns under consideration, it is also necessary to evaluate the long-term aspects. For example, issues such as resource renewal rates and scarcity, demographic developments, urbanization, climate change's time lags, and ozone depletion require the long-time horizon. Additionally, environmental, social, and economic capital should all be considered fairly. Positive contributions to the planet and society are required in order to being a truly sustainable business. Linking global sustainability challenges to business contribution allows the assessment of business's value for the planet and society. (Dyllick & Muff, 2016)

Dyllick and Muff (2016) have defined three levels of business sustainability from 1.0 to 3.0. They define business sustainability 3.0 as truly sustainable business. In sustainable business 3.0, sustainability challenges become business opportunities. In addition to the sustainable business features that have been achieved on levels 1.0 and 2.0, such as sustainable operational effectiveness and improved products and services, business sustainability 3.0 requires for the companies to ask themselves even more challenging sustainability questions. In other words, companies in the 3.0 are aiming to improve the society's sustainability actively. In business sustainability 3.0, companies are responsive members of society, and they are seeking ways to improving societal sustainability issues and the well-being of the planet significantly. The traditional inside-out business approach is turned around into outside-in and making a positive contribution and serving common good become the main purpose. This outside-in perspective could be the key for companies in the development towards sought sustainability. Business sustainability 3.0 is not a one-size-fits-all kind of concept. Different

companies are able to contribute differently, depending on their resources, purposes, strategies, and between different industry sectors. Mushroom cultivation may be a feasible business opportunity, and it depends on the company of whether or not it is going to look for business models to seize this prospect.

3.3 Insights from behavioral theories

In this master's thesis, behavioral theories are used to explain potential customers' (individual forest owners) tendency and willingness to pay for mushroom cultivation, and their feelings of responsibility towards biodiversity. Individual behaviors in the context of forestry could mean for example buying particular trees from a nursery, using a citizen science mobile phone application, or having a walk in the woods. Also, broader forestry activities such as woodland management or creation can be considered as forms of forestry related behavior. Woodland management and creation can involve several individuals and components, which makes defining the individual's forestry behavior rather challenging in this context. Because of this, it is meaningful to decide whether woodland creation is the subject of study, or if the woodland creation process is cut down into smaller behavior related actions. Woodland creation could include such behaviors as identifying land for planting, seeking and taking advice, learning the employment of planting contractors and relevant regulations. From the individual behavior perspective, behavior change in the forestry context could mean that land managers apply to new grant schemes, obtaining new technologies, and starting to do new kind of exercise in the forest. (O'Brien et al, 2017)

Ecological behavior as a function is based on people's ecological behavior intentions, and these intentions are based on responsibility feelings, environmental knowledge, and environmental values (Kaiser et al, 1999). Pro-environmental behavior means behavior that actively seeks to reduce the environmentally negative impacts (Kollmuss & Agyeman, 2002). Pro-environmental behaviors are often dependent on favorable institutional infrastructure factors, which include for example public transportation and recycling (Kollmuss & Agyeman, 2002). In their study, Barr, Shaw and Gilg (2011) found that for most research group participants their behavioral commitment to sustainable lifestyles was a question of cost, convenience, and effort. For the most committed participants, environmentally friendly behavior was a lifestyle matter (Barr et al, 2011). Gender and years of education have been found to influence pro-environmental behavior (Kollmuss & Agyeman, 2002).

When exploring pro-environmental behaviors, it is common to assume that those who behave pro-environmentally tend to have some moral or altruistic reasons for doing so, but this assumption does not always apply (Jackson, 2005). Pro-environmental behaviors can also be motivated completely

by self-serving interests (Jackson, 2005). Additionally, the behavior could be motivated by caring about other's expectations to not act in anti-social ways (Jackson, 2005). People's conventional norms are grounded in social traditions or customs, appeals to authorities, and the need for social appreciation (Kaiser et al, 1999). In environmental decision making, feelings of personal obligation, for example responsibility, appear to be promising indicators of positive environmental behavior (Kaiser et al, 1999).

People's values and experiences with nature may affect their behavior. Jackson (2005) argues that Paul Stern is one of the most experienced constructors of social-psychological models that consider pro-environmental consumer behavior, who has constructed for example the value belief norm theory. In Stern's value belief norm theory, personal moral norms and pro-social attitudes are significant indicators of pro-environmental behavior. The theory hypothesizes, that if a person holds strong biospheric or altruistic values, this person is more likely to accept new environmental paradigm. Awareness of the environmental consequences correlates positively with new environmental paradigm and is likely to lead into environmentally friendly outcomes. The Stern's theory's hypothesis suggests that specific beliefs and values influence behaviors in differing contexts. Emerging changes can impact the value systems in the communities, and they may become catalysts of bigger changes (Sarkki et al, 2019). In their study, Sarkki et al (2019) found that Metsähallitus should respect more the local stakeholders' wishes for multi-functional uses of State forests.

In the theory of reasoned action, the factual environmental knowledge approximates attitude towards environmental values and ecological behavior as an approximation of social norms (Kaiser et al, 1999). In their study, Ranacher et al (2017) found that some of their survey's responders lacked conceptual knowledge considering ecological services. The majority of the responders felt that it was necessary to have information on the considered ecological service issues, for them to be able to assess the impact of forest sector business. Based on these results, clearer communication strategies are needed to increase public understanding of industrial practices' impacts on ecosystems and this way to improve social license to operate for forest operations.

Behavior change interventions are important in many challenges that the society is facing (Michie, van Stralen & West, 2011). It is possible to get people to make positive changes to their behavior by small-scale interventions (O'Brien et al, 2017). Behavior change interventions have been defined as sets of activities designed to change the targeted behavior patterns (Michie et al, 2011). O'Brien et al (2017) argue that integrating behavior theory with forestry practices could enable a deeper exploration of interventions to address key societal changes. They have found that forestry related sustainability problems, such as improving tree health and encouraging selection of climate friendly species could

be overcome with additional intervention designs. In addition, as seeking for solutions for different environmental and societal issues, interests towards focusing policy related interventions have increased. Regulations and other established mechanisms seek to encourage particular behaviors considering woodlands as part of tree planting, sustainable harvesting practices, and healthy lifestyle (O'Brien et al, 2017). Behaviors may be made up of several related component activities, and it is not easy to evaluate the impact of interventions to the behavior without extensive monitoring and data evaluation (O'Brien et al, 2017).

Kollmuss and Agyeman (2002) argue that questions about people's environmental behavior and barriers that prevent pro-environmental behavior are very complex. According to Michie et al (2011), when applying only one or few behavioral theories to guide the behavior intervention, they can hardly cover all the possible influences. This is why it is more beneficial to include and consider a wider range of theories, which are able to bring differing perspectives to the process. When choosing the most effective intervention alternative that is supposed to change behavior, it is logical to start the intervention's planning process with a model of behavior. This model is supposed to include internal aspects, such as physical and psychological, and the external environment. Such behavioral model faces different kinds of objections, that include that the area is too complex and ill-defined to be able to provide scientifically based framework, and it is not likely to be able to address all the details that are impacting the intervention. For this behavioral models' successfulness, it is required to apply to every intervention that could be or has been developed, and the model's defined categories should be able to be linked to specified behavior change mechanisms. (Michie et al, 2011)

Selecting a suitable theory sets an important, evidence-based guideline for developing interventions (Gainforth, Sheals, Atkins, Jackson & Michie, 2016). Michie et al (2011) have introduced the Behavioral Change Wheel, which has been formulated from existing classifications, and it covers the concepts that have been previously considered relevant in terms of behavioral change. The Wheel links potential behavioral targets to interventions. The aim of the Wheel is to provide an efficient tool for choosing the kinds of interventions that are likely to be applicable for the behavioral target, in a given population and context. The strength of the Wheel is that it easily fits to different kind of contexts. The Behavioral Change Wheel approach is based on casual analysis of behavior, and it starts with the question: what conditions internal to individuals and in their social and physical environment need to be in place for a specified behavioral target to be achieved? The Wheel is an evidence- and theory-based tool that allows a wide range of different users to select and design policies and interventions accordingly with analysis of the behavior, the targeted behaviors, and the policies and interventions to change these behavior mechanisms (Michie et al, 2011; Gainforth et al, 2016). When

using the Wheel, the aim is to identify what needs to change in order for the behavioral target to be reached, and what kind of interventions are likely to be effective change makers.

In the Behavioral Change Wheel, psychological and physical capability, social and physical opportunity, and automatic and reflective motivation are in the center. These are defined as sources of behavior. Around these, there are the intervention functions, which include restrictions, education, persuasion, incentivization, coercion, training, enablement, modelling, and environmental restructuring. Policy categories are on the outer side of the wheel. These include fiscal measures, guidelines, environmental and social planning, communication and marketing, legislation, service provision and regulation. (Michie et al, 2011)

4. MATERIALS AND METHODS

4.1 Research data

This master's thesis focuses on three stakeholder groups, which are environmental experts, individual forest owners, and mushroom picking hobbyists. The primary data collection methods used in this master's thesis research were qualitative semi-structured interviews with mushroom experts, structured interviews with individual forest owners, and a short survey for mushroom picking hobbyists. Interviews were held between April and July 2021, and the mushroom picking hobbyists' survey answers were collected between June and July 2021. All interviews were held remotely via online meeting platform, Zoom, partly because of the global pandemic situation. Another reason for organizing these interviews remotely on Zoom was the convenience of the platform's recording opportunities. All data was collected in Finnish and later translated to English for this master's thesis.

4.1.1 Environmental experts: semi-structured interviews

Environmental experts' perceptions were studied to provide wider perspectives on the viability of mushroom cultivation alongside forestry activities. The purpose of including experts to this master's thesis was to cover some gaps that were left due to the limited selection of stakeholders. The three interviewees got selected from relevant industry fields and with the help of peer recommendations. The selected experts were working at UPM, Luke (Natural Resource Institute Finland), and Sitra (the Finnish Innovation Fund Sitra). All of these selected experts were able to provide valuable and highly educated information considering mushroom cultivation.

All of the three interviewees were contacted via email. The interview candidates were told that the interview would be part of a master's thesis study at the University of Helsinki. They were explained that the master's thesis is about mushroom cultivation and related services as a sustainable business activity alongside forestry activities. The candidates were told that the interviews' aim was to explore mushroom cultivation's opportunities and the experts' thoughts considering its possibilities. They were told, that if they accept the invitation, the interview would be recorded, and the interviewee's identity would remain anonymous in the results. Moreover, they were told that despite the anonymity, their affiliation and role would be presented in the master's thesis. The interview candidates were informed that they could ask additional and further questions from the master's thesis' author at any point of the process. All of the three interview candidates responded affirmatively to the interview

invitation. The environmental expert interviews were conducted as semi-structured interviews. The environmental experts' and their interview information are introduced in Table 1.

Table 1. Environmental expert's (EX) titles, and interview information.

Affiliation	Interviewee's alias	Role	Date	Length of interview	Recorded or not
UPM	UPM EX	Supply Chain Manager	19.4.2021	About 1 hour	Not. Extensive notes replaced the recording.
Sitra (The Finnish Innovation Fund Sitra)	Sitra EX	Leading expert in the Climate and Nature Solutions team	14.5.2021	1 hour 3 minutes	Recorded. Material was transcribed.
Luke (Natural Resource Institute Finland)	Luke EX	Leading researcher	19.5.2021	52 minutes	Recorded. Material was transcribed.

The themes for the expert interviews are also presented in the Appendix 1. In the expert interviews, the main purpose was to gather relevant information about mushroom cultivation's environmental aspects, business opportunities, and the potential of Finnish forests as a source of food. During these interviews, the benefits of mushroom cultivation from the economic, environmental, and other perspectives were of special interest. Because of the semi-structured approach, each expert's interview content depended on the experts' specialty and knowledge considering mushroom cultivation.

4.1.2 Individual forest owners: structured interviews

Individual forest owners' thoughts and perceptions were studied through structured interviews. There were five interviewees, who were recruited to the interviews through personal network. All of the interviewees owned forest in Finland. The interviewees were contacted via email, and this is how they received the basic information considering the interview. In the interview invitation email, the interview candidates were told that the interview would be part of a master's thesis at the University of Helsinki. They were explained that the master's thesis studies mushroom cultivation and related services as a sustainable business activity alongside forestry activities. The candidates were told that the interviews' aim was to study forest owners' perceptions and thoughts considering mushroom cultivation services. The candidates were also informed, that if they accept the invitation, the interview would be recorded, and the interviewee would remain anonymous in the results, which meant that they cannot be identified at any point of the master's thesis process. Furthermore, they

were told that despite the anonymity, some non-sensitive information would be collected in the final phase of the interview. The collected demographics included age, gender, level of study, and current profession. If the interview candidates had any questions at any point of the process, they were informed that they could ask additional and further questions from the master's thesis' author. All of the five interview candidates responded affirmatively to the interview invitation. The demographics of the selected interviewees' are explained in Table 2.

Table 2. Individual forest owners' (FO) information.

Interviewee's alias	Age	Gender	Level of study	Profession
FO1	57	Male	Bachelor's degree	Environmental expert in the field of forestry
FO2	48	Male	Bachelor's degree	Customer relations director in the field of insurance
FO3	27	Female	Master's degree in business economics	Expert in the field of accounting
FO4	55	Female	Master's degree in agricultural and forestry sciences	Expert in the field of business management consulting
FO5	57	Male	Master's degree, graduate engineer	Entrepreneur in the field of insurance

Table 3. Interview information of individual forest owners.

Interviewee's alias	Date	Length	Recorded and transcribed
FO1	5.7.2021	20 minutes	Yes
FO2	1.7.2021	17 minutes	Yes
FO3	12.7.2021	19 minutes	Yes
FO4	21.6.2021	14 minutes	Yes
FO5	4.6.2021	19 minutes	Yes

Individual forest owner's interview related information is explained in detail in Table 3. All interviewees were asked the same questions, and they were informed that if they require specifications to the stated questions, they were allowed to ask clarifying questions at any point of the interview. Before starting the interview, the interviewees were briefly reminded of the aim of the interview and the topic of the master's thesis. It was also mentioned that the interviewer would avoid discussing with them during the interview recording. The interview was divided into five main categories. Within those categories the questions were formulated. The categories were general questions,

mushroom cultivation's pros and cons, environment related questions, social questions, and economy-related questions. The interview questions are listed in the Appendix 2.

The purpose of the interview's first part was to provide information on the interviewees' general understanding on environment and food industry related sustainability, their thoughts considering these topics and willingness to participate in improving sustainability. The second part aimed to explore the interviewees' thoughts and perceptions considering the idea of mushroom cultivation business and operations. The intention of this was to find out about how easily the interviewees could start doing this kind of activity in their forests and what kind of factors would motivate them to start the cultivation. Also, the possible difficulties that could prevent them from starting mushroom cultivation were explored. In the third part, the interviewees' were asked about their willingness to participate in supporting forests' biodiversity by cultivating mushrooms.

The fourth part's aim was to explore the interviewee's interests towards mushrooms in general. The main idea was to distinguish their attitudes towards the possibility that someone else would pick the mushrooms that they have cultivated with effort. Also, the questions examined the interviewees' attitudes towards different kind of mushroom origins (cultivated or naturally grown). The final part was about economic aspects, and the aim was to examine the interviewees' willingness to pay for mushroom cultivation activities, and simultaneously supporting biodiversity. The interviewees were asked about their ideas considering the appropriate incentives to start mushroom cultivation. The aim was to study what kind of services or equipment the forest owners would be possibly interested to acquire and which kind of aid the forest owners might seek during the mushroom cultivation process.

4.1.3 Mushroom picking hobbyists: short survey

Mushroom picking hobbyists' perceptions were studied for this master's thesis through a short online survey, that consisted of seven questions. The survey was made using E-lomake survey tool. Everyone who defined themselves as mushroom picking hobbyists were invited to reply to the survey. The link for the survey was shared on social media platforms, selected university members' emails, and UPM's internal staff email. The responders were told that it was allowed to forward the survey link for other mushroom picking hobbyists. The responses were collected anonymously without any insights on the responders' demographics. Because the survey's topic was on the field of forest industry, the final question asked the responders whether they are working on this industry or not. The responders were able to respond the survey's question between 23rd of June and 15th of July 2021. The survey received a total of 294 responses.

The headline of the survey was “Questionnaire for mushroom picking hobbyists about mushroom cultivation alongside forestry activities”. Before answering the questions, responders were told that the survey’s results will be part of a master’s thesis at the University of Helsinki, and that the responses are anonymous. The responders were explained shortly about the concept of mushroom cultivation as follows: “In this master’s thesis, mushroom cultivation refers to such activities where mushrooms are being planted alongside with trees to the forest”. Responders were informed that if they have further questions considering the survey or the master’s thesis, they could contact the master’s thesis author via email. The survey questions are listed in the Appendix 3.

The aim of the survey was to study the mushroom picking hobbyists’ perceptions considering their, thoughts, willingness, and interests to pick cultivated mushrooms. For the mushroom cultivation business opportunity, it is relevant to understand people’s perceptions considering cultivated mushrooms. Mushroom picking hobbyists’ interests towards cultivated mushrooms could indicate, that mushroom cultivation business is accepted amongst this stakeholder group. The mushroom cultivation activities require monetary investments from the forest owners, and it is relevant to understand the mushroom picking hobbyists willingness to participate in these costs, since these people could potentially be interested in picking these cultivated mushrooms. In addition, it was relevant to study who should be responsible for forest biodiversity. The offered alternatives were Finnish citizens, people who actively spend time in the Finnish Forests, foreigner tourists, people who spend time in Finnish Forests, individual forest owners, forest industry companies, and the state with the taxes. Here, it was possible to select multiple choices. From mushroom cultivation business perspective, it is relevant to understand mushroom picking hobbyists’ thoughts about this matter, because the mushroom cultivation business’ success also relies on its stakeholders’ acceptance.

4.2 Thematic analysis

The analysis in this master’s thesis seeks to understand the perceptions, thoughts, and intentions of forest industry’s stakeholders, considering the mushroom cultivation services as part of business activities alongside other forestry services. Building on the theoretical framework, this master’s thesis’ analysis looks to the validity of mushroom cultivation services as a business opportunity from stakeholder perspective with the help of interviews and as survey. This master’s thesis uses thematic analysis as data analysis method. As a method, thematic analysis is for identifying and interpreting patterns of meanings, themes, within qualitative data (Clarke & Braun, 2017), dividing the data into categories based on the themes. In addition to qualitative interviews, the mushroom picking hobbyists’ survey had a possibility for free comments and close to 100 responses were recorded as

free comments. The inputs from these responses were analyzed with the method of thematic analysis. The findings of all stakeholders are first presented separately and further analyzed in a combined discussion.

According to Alasuutari (2011), to being able to make conclusions out of the research data, it is necessary to decide upon a clear study method. Study method is formed out of those practices and operations, that help the researcher to make observations from the data, and also the theoretical framework, within which the data observations can be processed and evaluated. After this process is done, the conclusions can be drawn from the processed data. When doing research on values, opinions, and how people understand some concepts, the data content is made into written formula, in which the interviewees are telling their own thoughts. When the aim is to do research on opinions and perceptions, the method is meant to focus on the content of the data, and not the single words and sentences. Thematic analysis can be used to identify patterns within and across data in relation to participants' perspectives, views, behavior, and practices (Clarke & Braun, 2017).

Nowell, Norris, White, and Moules (2017) have formulated six phases of thematic analysis, which are familiarizing with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. After familiarizing, the process of producing codes for the data can begin. The codes are meant to help the analysis process, assisting the researcher to find similarities and differences within the data. Coding helps to simplify specific characteristics of the research data. It is up to the researcher how many codes they want to create, and the chosen coding technique is consistently applied to all of the data. After coding, it is possible to find themes and subthemes with the help of the created codes. The idea of a theme is to unify and capture the nature of the experience into a meaningful, summarized form of presenting the key findings of the data. Themes form a framework for reporting and organizing analytic observations (Clarke & Braun, 2017). It is possible to use a variety of tools to help connecting different codes under applicable themes, for example diagrams or Excel (Nowell et al, 2017). In the phase of reviewing themes, new codes can be created, and some may be deleted. It is important that the researcher can clearly explain the creation of each theme. In the phase of defining and naming themes, the researcher makes a detailed analysis for each individual theme, explaining the story of these themes and how it relates to the research question(s). As the report is finally being produced, the outcome is meant to create an overall story about what the different themes reveal about the topic.

4.2.1 Analysis process of the master's thesis

The analysis process followed the six-step procedure that Nowell et al (2017) had defined. In the familiarization phase, all of the qualitative data was transcribed. The data was read through a couple of times. After this, the first impressions and thoughts were collected on PowerPoint. For generating initial codes, the transcribed data was printed out on paper. As the data was being read through carefully, all points were marked with the code that best fit the content. New codes emerged as the coding process went on. Different colors represented different codes. The used codes were money, values, law and regulations, environment, challenges, enablers, information, and mushroom picking hobby. After all of the codes were formed, the relevant citations were translated from Finnish to English and written on an excel sheet. The codes were presented at the top of the sheet and all research information classified in this code was written below it. All of the three different stakeholder groups were collected to the same Excel sheet, and they were separated from each other with the identification marks. The three experts were presented as Luke EX, Sitra EX, and UPM EX, individual forest owners were as FO1, FO2, FO3, FO4, and FO5, and the responses provided to the mushroom picking hobbyists' survey's second question were presented as MP(c) and MP(n).

After coding, the themes were searched from the coded research material. While reviewing themes, the research questions were considered as the main drivers of the relevant themes. The idea of the themes is to provide answers to the set research questions. On the Excel sheet, the codes were transformed into themes and the information below the discarded codes were rearranged below the remaining themes. As getting familiar with the data and the created codes, six apparent themes were brought up. These were economical, legal, environmental, educational, social, and practical enablers. Based on these six themes, the results are being presented in the following chapter.

Combining qualitative and quantitative research methods, which is called mixed methods approach, the data can offer better understanding of the topic (Tuomi & Sarajärvi, 2018). The short survey included four quantitative questions. However, despite the inclusion of these quantitative questions, the emphasis of this master's thesis has been on the qualitative methods. The aim was to receive at least one hundred responses, and the survey received 294 responses. The numeric results of the mushroom picking hobbyists' survey (questions 1, 3, 5 and 7) were analyzed using descriptive statistics.

5. RESULTS

This section presents the results of this master's thesis in terms of stakeholders' perspective. Six themes that emerged from thematic analysis of the data, including i. economic, ii. legal, iii. environmental, iv. educational, v. social, and vi. practical enablers and ideas. In the following subchapters, the results from the research data are presented one stakeholder group at a time.

5.1 Environmental experts

The first sub question (SQ1) focuses on the environmental experts as a stakeholder group. The question is: how do environmental experts assess the potential of mushroom cultivation? The experts explained several environmental aspects that should be taken under consideration when planning mushroom cultivation. Additionally, they offered insights on economic, legal, and social themes. For mushroom cultivation's practical enablers and arrangements, the experts offered their suggestions and opinions. Despite their somewhat differing perspectives, they hardly presented ideas or opinions that would have been contradicting with one another. The main results from the expert interview indicate, that mushroom cultivation can be a way to support forest biodiversity, and it has sustainable business potential.

5.1.1 Environmental

There are many environmental factors that impact the mushroom production. All experts provided examples of these required conditions. Expert from UPM explained that competition between the cultivated mushroom species and the forests' local species. Expert from Luke stated that it is important to have the mushrooms in such environment that supports the mushrooms' preferences. Luke's expert added that is not realistic to try cultivating such mushrooms in forests, where that mushroom species does not commonly exist, and mushrooms have preferences with the nutrients they want to gain from the environment. Luke's expert also commented that growing conditions of the cultivated mushroom have to be optimal to produce the fruit body, which the mushroom uses for reproduction. Expert from Sitra mentioned, that different mushroom species prefer certain tree species to partner with, and many of the good mushroom picking forests are under industrial forest management. Sitra's expert added that successful mushroom cultivation takes into account the impacting environmental factors.

Luke EX: "Every year is not ideal to produce mushroom fruit bodies, because of environmental condition."

Sitra EX: “The uncertainty of yearly harvests can be one factor that is stopping different actors from considering mushroom cultivation business.”

Saprotrophic and mycorrhizal mushrooms behave differently because of their differing conformations and preferences considering the environmental conditions. Expert from Luke mentioned that there is potential to combine forest use and saprotrophic mushroom's cultivation, for example by leaving tree stumps to the forests. Luke's expert also stated that saprotrophic mushrooms can benefit from industrial assistance, in a way that mushrooms are being manually grafted to decaying tree matters. Expert from Sitra confirmed that there are cultivation opportunities with saprotrophic mushrooms. Expert from Luke pointed out that saprotrophic mushrooms are a much more viable option for short term mushroom cultivation than mycorrhizal mushrooms, even though most of the commercial mushrooms are mycorrhizal mushrooms. Expert from Luke explained that most of the tree seedling's symbiotic mushrooms do not form fruit bodies. As an exception, expert from Luke explained that in Spain they have successfully cultivated saffron milk cap (*Lactarius deliciosus*, in Finnish: männynleppärousku) and some amounts of it have been brought to Finland, too. Saffron milk cap is a good mushroom for food purposes. Saffron milk cap can be planted along with coniferous tree seedlings. The challenge is that the saffron milk cap is used to Spanish environmental conditions, so it is not that easy to cultivate in northern countries.

The trees' age has significant impact on the area's fungal strain. Expert from Luke explained that in older forests there are many mycorrhizal mushrooms that also grow fruit bodies, and these mushroom species are not suitable for short-term mushroom cultivation. Luke's expert added that the lack of fruit bodies with young trees is explained so that tree seedlings are not able to maintain those mushroom species that grow big fruit bodies. Luke's expert also stated that popular edible mushroom species begin to flourish and grow fruit bodies in 50 years old forests, and many of the popular mycorrhizal mushroom species, such as boletes (*Boletaceae*, in Finnish: tatit), brittles (*Russula delica*, in Finnish: haperot), and milk caps (*Lactarius*, in Finnish: rouskut), require old trees for their fruit bodies to form. As an example of cultivation trials, expert from Luke was able to explain about one experiment that was recently conducted in Sweden. There chanterelle (*Cantharellus cibarius*, in Finnish: keltavahvero) were tried to be cultivated by outplanting inoculated tree seedlings, but despite many years of research it turned out to be rather unsuccessful.

Different mushroom species can behave differently, but there are some general guidelines that many mushroom species follow. Expert from Luke commented that most of the mushroom species live only underground, and for the mushroom it takes months to formulate the symbiosis with the tree's roots.

Forests benefit from fungi in several ways. Expert from Sitra explained, that trees and other plants benefit from the fungal communities, and there would be no trees without the support of fungi. UPM's expert confirmed, that mycorrhizal relationship between mushrooms and trees supports the tree growth, and because of this it is difficult to plant trees in such areas that are lacking the fungal community. UPM's expert added, that this difficulty of growing trees on wasteland is based on the lack of fungi's' and trees' mycorrhizal relationship. Luke's expert explained that mycorrhizal mushrooms provide nutrients for trees, and fungi are important in terms of forests' wellbeing. In addition, UPM's expert pointed out that fungi are also dependent on trees, so neither of these species could flourish without the support of the other.

Sitra EX: "Many fungi contribute to the growth of trees, wild herbs, and other plants. Without fungi these species would not flourish, either. Fungi are crucially important factors in the environment."

Luke EX: "Symbiotic mycorrhizal fungi have significant impact on tree growth and survival as trees are dependent on their symbiotic fungi."

UPM EX: "As new trees are being planted, the mycorrhizal relationship between mushrooms and trees supports the tree growth."

Fungi have environmental relevance, as they take part in protecting the forests from environmental changes. Expert from Sitra explained that strong and vibrant mushroom strains are the basis of all wellbeing in the forests. They added that the more diverse nature is, the more easily it can endure environmental changes, and fungi support for example ecosystem's resilience towards climate change. From biodiversity perspective, fungi have significant roles. Expert from Sitra explained that supporting and improving fungal diversity is only a positive thing for forests' health. They also stated that when forests' biodiversity is strong and there are many different species, new and aggressive species cannot that easily shake the local ecosystems. Luke's expert confirmed that the weaker the local biodiversity, the easier it is for harmful pathogens to start growing in the area.

Experts from Luke and Sitra highlighted, that people should not modify nature without considering the impacts that the modifications could have on the environment. Luke's expert noted that with foreigner species, there's a risk that they'd start acting unpredictably in the new environment. But it is more likely that the local species will dominate. Luke's expert stated that Mushroom species from Northern Europe can be seen as potential species to consider cultivation, and also other European species.

Luke EX: “It is not recommended to try and cultivate foreign mushroom species, because they might either cause damage in the local biosystem, or the foreigner species might not endure the local conditions at all.”

Mushroom picking does not seem to harm the future yields of mushrooms. Expert from Sitra explained, that no matter how much people pick mushrooms, future mushroom yields do not get harmed, and this is an important factor when it comes to considering sustainable food solutions. They added that despite the mushroom picking activities, fungal mycelium seems to remain viable. On the other hand, expert from Luke provided an example from Japan, where one mushroom species has become nearly extinct because of its overwhelming popularity.

Luke EX: “From Japan, matsutake has been such a popular forest mushroom that its crop has decreased significantly.”

5.1.2 Economic

Expert from Sitra stated that from both forest industry’s and society’s points of view, forest use should bring renewable resources that replace nonrenewable resources, ensure forest wellbeing, and that forests are in versatile use. Experts from UPM and Sitra found that there are vast opportunities considering non-wood forest products. Expert from Sitra mentioned the mushrooms’ potential as part of bioeconomy and circular economy. They highlighted that it is necessary to consider the different options to land use and have a holistic view on ecosystem services as the basis for all land use. Sitra’s expert added that globally there are vast opportunities considering food production’s integration to forest management practices. Cultivated mushrooms could become a viable export product. Sitra’s expert explained, that one of the industrial forests’ main goals is to produce timber, but forests can offer many other commodities for people as well. Expert from UPM mentioned, that vast amounts of consumable mushrooms remain unpicked in the forests. There is unutilized non-wood forest product capacity in the Finnish forests. Experts from UPM and Sitra highlighted that mushroom cultivation can be a viable business opportunity both economically and environmentally.

UPM EX: “Mushroom cultivation in Finnish forests can be a win-win situation economically and environmentally.”

Sitra EX: “Viable economy and well-being environment do not close each other out, but they can form a so called ‘win-win situation’.”

UPM’s expert had ideas considering the forests’ ability to produce food alongside forestry activities. Finnish non-wood forest products have potential of becoming an even stronger source of food for people around the world. Expert from Sitra agreed that there are food related opportunities.

Additionally, the expert from Sitra brought up that some mushrooms can be used for their medical value.

UPM EX: “Finnish non-wood products could have great opportunities in the global food production business.”

Sitra EX: “Mushrooms are important factors as future's food sources, but mushrooms can be easily forgotten because they live underground most of their lives.”

UPM’s expert noted that there are market related challenges that should be solved before starting viable mushroom cultivation business. Expert from Luke provided an example of industrially cultivated mushrooms, that are already bringing profit to the companies. This example was about button mushroom and oyster mushroom. They stated that these mushrooms can grow on wood chips and other decaying tree materials, and this is possible to be done at home, too.

Mushroom cultivation has business potential, that has been noticed by some actors and countries. Expert from Sitra pointed out, that Japan is an example of such country, where forest owners are making significant additional profit with mushrooms. Expert from Luke told that in Finland, there is a company called Kääpä Biotech is selling chaga that can be grafted to living birch trees in the forests. Chaga has health related effects to people. The chaga business has been recently growing.

Expert from Sitra explained that mushroom cultivation alongside forestry activities has not been done on large-scale, because of the segregation of industrial sectors. They added that most of the forest related innovations are based on wood-based forest products.

Sitra EX: “The problem has been that forest and food industries have been seen as separate sectors and combining these two has not been seen as an alternative.”

5.1.3 Legal

There are several laws and regulations that govern forest management. In addition to laws and regulations, expert from Sitra highlighted the importance of certificates. All of the regulations that are related to forest management, have impact on the mushroom cultivation. Expert from Sitra listed all of the most important laws that have impact on the forest management in Finland, These are Forest Act, Nature Conservation Act, Land Use and Building Act and Water Act. They added, that in addition to the laws there are certificates, that provide additional regulations to forest management.

Experts from UPM and Sitra brought up some of the challenges considering everyman’s rights and forest owners’ rights. It is necessary to understand the differing interests of mushroom picking

hobbyists and forest owners The expert from UPM highlighted that laws and regulations are required to support the forest owners' property rights. Sitra's expert noted that because of everyman's rights, people can personally take the modifications that are being done in the forests.

UPM EX: "One challenge, that impacts the mushroom cultivation business opportunities in Finland are the everyman's rights."

Sitra EX: "Everyman's rights should be discussed more because they influence the way how forests are being used."

UPM's expert provided some alternative solutions, that could be considered in the future. They commented, that because of the current everyman's rights, mushroom cultivation might require fenced areas and locks to protect the property. UPM's expert added that one option to consider are the mushroom picking permits that mushroom picking hobbyists could buy in the future.

5.1.4 Social

Expert from Luke has noticed that a significant amount of mushroom related information relies on the mushroom picking hobbyists. UPM's expert has notices, that non-wood forest products have become increasingly popular amongst Finnish people. One reason for the increasing popularity could be interests towards a more self-sufficient lifestyle. Expert from Sitra stated that forest mushrooms provide opportunities for partial self-sufficiency.

Mushroom picking activities are one way of maintaining people's wellbeing. Expert from Sitra pointed out, that mushroom picking is an excellent activity from refreshment, mental health and physical health perspectives. Because of these reasons, Sitra's expert finds the ability for everyone to go to the forests valuable.

Sitra EX: "It is a valuable thing to have "Finnish forests open daily", and that everyone can enjoy the nature freely."

Responsible and sustainable forest management is meaningful for the future generations. Expert from Sitra highlighted that the future generation's needs should be considered when making forest related decisions.

5.1.5 Practical enablers and other ideas

Expert from Luke highlighted the importance of scientific research considering mushroom cultivation opportunities, by saying that when looking for cultivation mushroom species, it requires a dedicated

scientist or specialist who consistently does research on the cultivation opportunities and requirements. Expert from UPM is aware of some mushroom cultivation related research that has been done.

Luke EX: “For the cultivation business successfulness, it is necessary to screen and study different mushroom species, their environmental preferences and their fruitbody's forming supporting factors. All this is very complex.”

UPM's expert stated, that the challenge with mushroom cultivation is to get the grafted mushrooms to flourish. For mushroom cultivation's successfulness, it is necessary to consider the local environmental conditions of the cultivation area. Expert from Luke explained that if the mushroom cultivation starts in the tree seedling farm, the mushroom must cope with both the farm's conditions and the planting location's conditions. They added that when looking for mushroom species that can be cultivated in certain area, it is necessary to understand the ecological limitations.

People can modify the mushrooms' growing environment towards more ideal conditions. Expert from Sitra explained that existing technologies enable mushroom cultivation under industrial conditions by integrating mycorrhizal mushrooms to tree seedlings at the nursery garden. They added that the idea of this is to support the tree's viability during its first years in forest. Expert from Luke pointed out that for saprotrophic mushroom cultivation purposes tree stumps and fallen trees can potentially provide seedbeds. They noted that to maintain potential for the cultivation's successfulness, it is necessary to leave the tree stumps to forests and not remove them. Luke's expert also mentioned that mushrooms might not like direct sunlight as it may lead to extensive drying of the stumps.

Luke EX: “For saprotrophic mushroom cultivation purposes tree stumps and fallen trees can potentially provide seedbeds.”

Expert from Sitra stated, that mushroom cultivation could be done simultaneously with tree harvesting. Expert from Luke was able to provide one example of the practical implementations of mushroom cultivation, that to her knowledge has not been done yet.

Luke EX: “After cutting down forest, tree stumps have been left in the area, and saprotrophic mushrooms have been grafted to these stumps. This way it has been possible to cultivate some mushrooms, but I have not come across mushroom cultivation's commercialization.”

Expert from Luke was able to provide examples of mushroom species that have been cultivated to some extent. They noted that truffles are being cultivated in Finland to some extent. Another of Luke's expert's examples was chaga's cultivation, that happens with the help of making holes to standing trees and grafting chaga to these.

UPM's expert finds the current mushroom cultivation practices relatively inefficient. Experts presume that innovations and future development can bring more efficient mushroom cultivation practices. Expert from Sitra presumed, that the development process would take some time. Luke's expert stated, that in terms of developing mushroom cultivation techniques, there is a lot of potential for high-tech solutions.

UPM EX: "The currently known mushroom cultivation practices require a lot of manual work and time. For making the mushroom cultivation a viable business opportunity it is necessary to develop more efficient cultivation techniques."

Expert from UPM stated, that if mushrooms are being cultivated in the industrial forests, this does not cause harm to anyone or anything. The tree seedlings that the forest industry companies are selling to individual forest owners could be more valuable if the seedlings would include grafted mushrooms mycelium. The mushroom cultivation business opportunity can rely on different sort of mushrooms. For example, cultivating endangered mushroom species could be of interest to some consumers. Experts from UPM and Sitra suggested endangered mushroom species as one alternative for commercialized mushroom cultivation products. UPM's expert justified this by saying, that some customers might be willing to cultivate endangered mushroom species because they want to protect the biodiversity. Sitra's expert suggested, that the cultivated mushroom species could be of interest to customers for their culinary possibilities.

UPM EX: "The tree seedlings with grafted mushroom mycelium can be more valuable than the tree seedlings without them."

Sitra EX: "One kind of mushrooms that could be cultivated are threatened mushroom species. This is not currently being done."

5.2 Individual forest owners

The second sub question (SQ2) focuses on the individual forest owners as a stakeholder group. The research question is: what kind of perceptions do individual forest owners have regarding mushroom cultivation alongside forestry activities? Based on the interview results, forest owners are interested in the mushroom cultivation's income opportunities, and they would require more information considering the cultivation practices.

FO1, FO2, and FO4 told that they are interested in the mushroom cultivation alongside forestry activities. E told that mushroom cultivation alongside forestry activities sounds very interesting and is an excellent idea. C considered the thought of cultivating mushrooms to be not that interesting, and

that the thought of cultivating mushrooms felt distant. When being asked for the factors that could motivate the forest owners to start cultivating mushrooms, FO1, FO4 and FO5 stated that they are interested in the mushroom cultivation's business and profit-making opportunities. FO2 was hoping to get more information considering the topic, and FO3 stated that the lack of interest is the biggest obstacle that is standing on the way of considering mushroom cultivation. Almost all of the forest owners were able to mention several forest management practices which are being done in their forests. Only FO3 was unable to provide any examples.

Next, the different themes emerged from the forest owner interviews are introduced. These six themes were economic, legal, environmental, educational, mushroom cultivation's practical enablers, and social.

5.2.1 Environmental

All interviewed forest owners are willing to participate in supporting biodiversity. For this purpose, interviewee FO1 brought up existing certifications and voluntary forest protecting activities. FO2 suggested that forest biodiversity could be supported through efficient forest management planning, FO4's idea was to leave some trees to grow in the forest when the forest is being harvested, and FO5 suggested that forest owners could support biodiversity by planting multiple different plant species in the forest. FO3 was unable to provide examples.

All interviewed forest owners showed their concerns considering the current food production practices. FO1 and FO2 told that they are worried, FO3 and FO4 thought that improvements are necessary, and E stated that the current food production practices are unsustainable. Additionally, all of them were willing to participate in more sustainable food production. Meat production brought up differing opinions between forest owners. FO1 did not consider meat production as such a bad thing, when FO2 and FO5 thought that meat production is not sustainable.

FO1 and FO2 brought up the uncertain yields of forest mushrooms.

FO1: "My mushroom picking activities depend largely on the unpredictable yearly mushroom yields."

FO2: "If the mushroom harvesting season would be predictable, I could be able to go pick the mushrooms for personal consumption."

Some of the forest owners brought up environment related doubts considering mushroom cultivation. FO1 and FO5 have noticed that a significant number of wild mushrooms is left to the forests every

year. FO3 was wondering the functioning of mushrooms in the forest environment. FO4 stated that if the mushroom cultivation practices should not cause harm to the local environment.

FO3: “Don't the mushrooms just automatically grow in forest without any human interference?”

FO4: “As long as the mushroom cultivation does not harm the environment, and the mushrooms fit to the environment.”

From biodiversity perspective, FO1 considered mushroom cultivation as a way of supporting forests' species diversity. Similarly, FO2 thinks that efficient forest management planning can positively impact the biodiversity. FO4 is supporting the idea of protecting certain areas of the forests. FO2 and FO4 suggested that the species diversity could be supported by people. FO5 suggested that mushroom cultivation could be one way to support biodiversity in the forests.

FO1: “Mushroom cultivation can be done to protect biodiversity, there are hundreds of thousand species that support forests viability.”

FO5: “I can support biodiversity by growing other things additional to trees in my forest. Mushroom cultivation could possibly support tree growth. I'm interested in the mushroom cultivation activities because of biodiversity related benefits.”

5.2.2 Economic

When the forest owners were asked a more specific question of if they were willing to support forest biodiversity through mushroom cultivation, FO1, FO3, FO4, and FO5 responded yes and FO2 was unable to respond. FO1 is not willing to invest any additional money for the sake of forest biodiversity. FO4 is interested to protect forest biodiversity, but economic aspects should be considered. FO4 could invest small amount of money only to support biodiversity.

FO1: “Because there are already a lot of forestry related payments, extra investments to biodiversity are not welcome. But if the money invested is going to bring some profit through selling the cultivated mushrooms, or the mushrooms are picked for personal consumption, then the extra payments could be ok.”

FO4: “I am interested in protecting forest biodiversity through economic measures, but the costs should be reasonable. What's in it for me?”

FO5: “Only for the sake of biodiversity I would be willing to pay some small amount of money to mushroom cultivation. If there are some proved benefits to environment, it would not matter if there would not be additional economic profit.”

However, forest owner FO1 considered that income opportunities could work as a motivator to start mushroom cultivation. If mushroom cultivation would provide additional income, or at least zero balance economic outcome, FO1 is willing to start mushroom cultivation. Similarly, FO1, FO4 and FO5 find that economic factors are meaningful when it comes to investing money to biodiversity.

FO1: “If the income from the money invested to mushroom cultivation is at least 50/50 or a bit profitable, then it is ok.”

FO2: “I am interested to support forest biodiversity, if it's economically sensible.”

FO1 commented that mushroom cultivation’s profit-making opportunities could work as incentives. FO1 added, that if endangered mushrooms could be supported through mushroom cultivation, this may be another kind of incentive for starting the cultivation. FO4 suggested that the mushrooms’ commercialization opportunities could be enough as an incentive. Both FO1 and FO4 mentioned the cultivated mushrooms’ personal consumption opportunities as one incentive alternative. FO5 mentioned governments’ monetary support as an incentive alternative.

For forest owner FO3, mushroom cultivation is too expensive for their current economic status. FO3 is not willing to put any effort to mushroom cultivation practices but is still interested in mushroom cultivation’s profit-making opportunities. FO5 has doubts that consider the economic viability.

FO3: “I do not want to invest that much money to mushroom cultivation, I currently cannot afford it. But might in the future. I'm interested in the costs; how much mushroom cultivation requires monetary investment? If it's terribly difficult and requires extra work, then not interested. I don't want any extra work.”

5.2.3 Legal

Forest owners can be encouraged or directed to start mushroom cultivation activities in their forests with the help of legal regulations. FO1 and FO2 brought up certifications that could promote forest owners’ sustainable forest management practices. FO2 commented that certificates can make the forest owners seem like a responsible forest owner. FO2 and FO5 suggested targeted tax-based incentives that could motivate forest owners.

Forest owners were asked about their thoughts considering the everyman's rights. FO1 and FO4 felt like that these rights can endanger the forest owners' mushroom cultivation business opportunities. FO2 and FO5 did not think that everyman's rights are causing a threat, but still there should be some consideration on the aspect of who is benefiting from the forest owner's property. FO3 considered the everyman's rights to be only a good thing, and they would not mind if anyone picked the cultivated mushrooms from their forest. As a solution to possible conflicts, FO1 brought up mushroom picking permits.

FO4: "Who's property are cultivated mushrooms? Everyman's rights can be an issue when the mushroom cultivation plantation is close to a popular hiking trail."

FO5: "I don't mind if anyone goes to my forest and picks the cultivated mushrooms, but of course the lost expenses should not be too much."

FO1: "There is a long way to start to sell/rent mushroom picking permits. Forest owner organizations have suggested this. Somewhere in mid-Europe these sold permits are common."

5.2.4 Social

Most of the forest owners pointed out that they go either seldom or not at all to pick mushrooms, except FO1 told that mushroom picking is a regular activity. FO1, FO2, and FO3 would rather pick naturally grown mushrooms, and FO4 and FO5 do not care whether the mushrooms are cultivated or naturally grown. Despite their preferences, FO1 and FO2 are open to consider picking cultivated mushrooms.

FO1: "I would rather pick naturally grown mushrooms because it is a rewarding hobby to actually find them. It is not impossible for me to pick cultivated mushrooms, but if there are alternatives I'd pick naturally grown."

FO2: "I would rather pick mushrooms that have grown in natural environments. But if there would be cultivated mushrooms that are easily picked and safe, I could pick these too."

5.2.5 Educational

FO2 was hoping to get more information about sustainable food production. FO2 also thought that there is enough information that considers sustainable food production.

FO2: “I could participate in more sustainable food production if I would get more information. As a consumer I feel like that there is enough information available considering the sustainable everyday life choices.”

All forest owners were lacking knowledge considering mushroom cultivation, and they were hoping to get more information considering the topic. As a solution, FO2 suggested that forestry associations could provide and share information considering the topic.

FO1: “Concrete information is required.”

FO2: “I have not studied that much about ways to protect forest biodiversity. If I knew more about mushroom cultivation, I could be more interested about it. Information and other people's experiences could support me starting to do it. Forestry associations could share information considering the mushroom cultivation, and they could provide guidance.”

FO3: “I don't know what mushrooms are able to be cultivated, I guess mushroom cultivation is alright for the biodiversity, but I don't know anything about this topic. My lack of knowledge is preventing me from considering mushroom cultivation. If there was more information I could be interested. I would like to know what the benefits are. I could be under influence to choosing to start mushroom cultivation if it first was well justified. I need more info about the entire topic.”

FO4: “I would like to gain knowledge of what mushroom cultivation actually is? The pros and cons of mushroom cultivation should be explained to forest owners.”

FO5: “I don't know how mushrooms are cultivated. Education and advice would support mushroom cultivation intentions.”

5.2.6 Practical enablers and other ideas

Forest owners provided suggestions to the mushroom cultivation's business model. FO4 suggested that mushroom cultivation services could be a part of forest industry companies. They added that forest industry's forest management planning could include mushroom cultivation activity planning. FO2 was hoping that it would be possible to use some local workers and mushroom pickers. FO2 also stated that if a larger amount of forest owners would join, the mushroom cultivation could be easier to manage.

Forest owners pointed out that they could buy the following products or services that would help them with mushroom cultivation: tree seedlings with grafted mushroom's mycelium or mycorrhizal hyphae

(roots), help with choosing appropriate tree species, planting the mushrooms in the forest, and providing tools for mushroom's self-cultivation. FO3 and FO4 were hoping for a rather wholesome service package, that would not require any effort from themselves. FO2 pointed out that mushroom cultivation practices should not exclude the traditional forestry activities.

FO1: "There could be tree seedlings for sale that have grafted mushroom species' roots."

FO3: "I would not cultivate mushrooms by myself. There should be a very wholesome service package. If mushroom cultivation is made easy, then I'm interested. I don't want to bother with mushroom cultivation. Time is a limiting factor."

FO4: "It would be nice if there would be a wholesome cultivation package that could be bought."

FO2: "If mushroom cultivation would not exclude the original forestry activities, and regular forestry is still doable alongside. If the forest area can be used to both growing trees and mushroom cultivation, that is the most ideal solution. If mushroom cultivation would require its own area, I could do it in a small, limited area - still depending on the expenses."

5.3 Attitudes of mushroom picking hobbyists

The third sub question (SQ3) focuses on the mushroom picking hobbyists' stakeholder group. The question is: what are the attitudes of mushroom hobby pickers towards cultivated mushrooms? According to the short survey, mushroom picking hobbyists seem to have relatively strong attitudes towards mushroom cultivation and everyman's rights. Additionally, many of the mushroom pickers feel very fond of the experience of hunting and finding wild mushrooms.

Table 4. The answers to the survey's second question, which was: Cultivated mushrooms are often found in industrial forests, in which the environment may look different in comparison to the naturally grown mushrooms' environment. How would you feel about picking cultivated mushrooms?

The alternatives for the question	The number of responses out of the total of 294	The identification alphabets for the response group
a) I would rather pick naturally grown mushrooms.	146	MP(n)
b) It does not matter whether the mushroom that I pick are cultivated or naturally grown.	148	MP(c)

The first question received 146 responses to the alternative “I would rather pick naturally grown mushrooms” and 148 responses to “I do not care if the mushrooms are naturally grown or cultivated” option. The distribution of the responses is presented in Table 4. Further in this master’s thesis, those who responded the alternative a) are referred as MP(n) (mushroom picker, naturally grown), and those who responded the alternative b) are referred as MP(c) (mushroom picker, cultivated). Mushroom picking hobbyists were able to clarify their responses to the first questions and 106 of the responders left a comment.

The MP(c) responders commented that bigger number of mushrooms from industrial forest is more important factor than getting the authentic natural environment experience. Some responded that cultivated mushrooms are acceptable as long as they do not harm the overall biodiversity or ecosystem. One responder commented that the mushroom picking experience is similar with both types of mushrooms. Another responder stated that natural forest are more pleasant places for mushroom picking, but as long as it is allowed to pick both kind of mushrooms, this person would not care whether the mushrooms are cultivated or not. For one responder cultivated mushrooms could be additionally picked alongside with naturally grown mushrooms.

Those of the MP(n) were often commenting, that they prefer naturally grown mushrooms because of the thrill of finding them, and that they enjoy the natural environment and find it relaxing. One responder commented that it would be boring to pick cultivated mushrooms, and another responder highlighted that mushroom picking is also about the authentic experience in the natural environment. Some responders were worried that cultivated mushrooms would harm the environment. One responder compared picking cultivated mushrooms with picking strawberries from cultivated strawberry fields. One responder says that they prefer naturalness in general.

The mushroom picking hobbyists were asked, would they be willing to willing to pay a small fee for mushroom picking, which would be used to supporting biodiversity? This fee could directly or indirectly be allocated to the individual forest owners, who are organizing the mushroom cultivation practices in their forests. Out of the 294 responders, 89 (a little bit over 30 percent) replied that they’d be willing to pay this small fee, and the rest were not willing to pay anything for picking mushrooms. The other 205 (a little bit under 70 percent) would not be willing to pay this small fee. In the fourth question, those who responded that they would be willing to pay a small fee were asked to share the amount they could be willing to pay. The average amount that the 31 percent was willing to pay was 37 euros per season, and the variation was between five to one hundred euros per season. Figure 1 illustrates the division of the answers considering the willingness to pay the small fee.

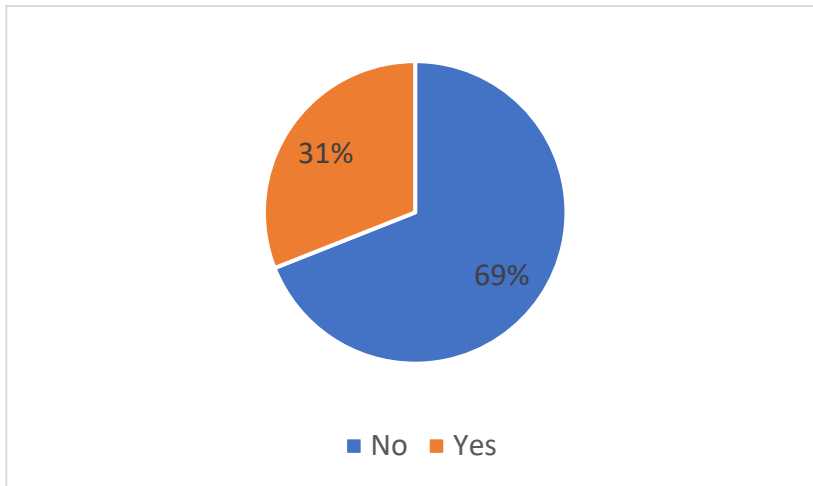


Figure 1. The distribution of answers to the question number three: Would you be willing to pay a small fee for a mushroom picking permit?

The fifth question was about the mushroom picking hobbyists' opinion considering to whom does the responsibility of protecting biodiversity belong to in Finland? The responders were able to mark any number of actors. Each of the state with the help of taxes, forest industry companies, individual forest owners, and Finnish citizens received over 200 responses. Both people who spend time in Finnish forests and tourists received less than 100 responses. The sixth question received 23 written responses, where the responders were asked to specify if they had picked the "other, who?" option in the question five. Seven of the responders were saying that the responsibility belongs to everyone. The other responses included mentioning foreign investors, volunteering citizens, private companies benefiting from the environment, and organizations. The specific amounts to the fifth question are presented below in Figure 2.

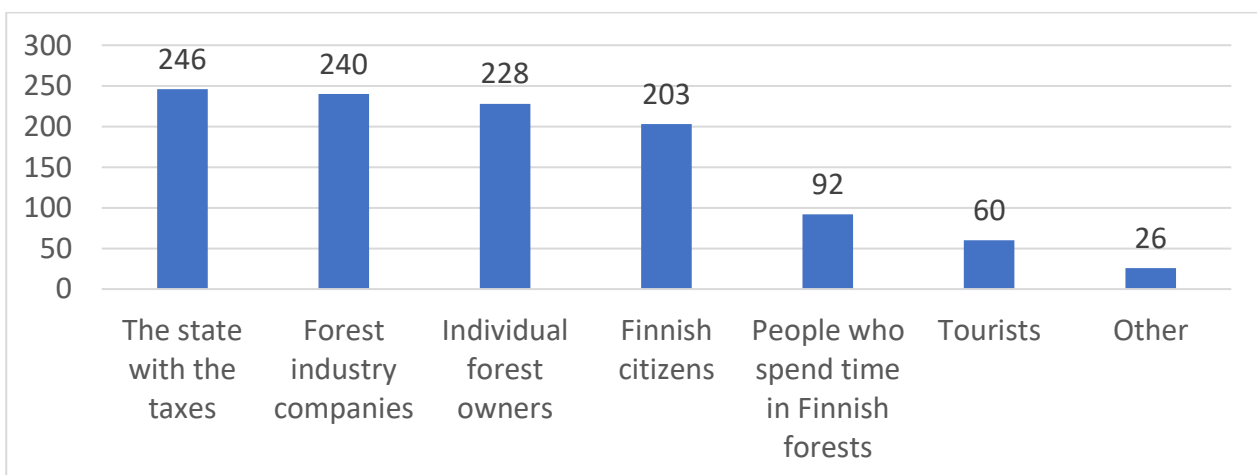


Figure 2. The distribution of answers to the question number five: To whom does the responsibility of protecting forest biodiversity belong to in Finland? Responders were allowed to mark as many actors as the responder considered relevant.

Next, the four themes that emerged from the responses for the second question are introduced. These were economic, legal, environmental, and social.

5.3.1 Environmental

Out of the MP(c)'s, some responded that mushroom cultivation activities seem like a sensible way to exploit the forests. On the other hand, some of the MP(n) found cultivated mushrooms unpleasant and threatening. One of the cultivated mushrooms' supporter commented that industrial forest's utilization and diverse exploiting activities are good. Another MP(c) commented that it would be great if there would grow mushrooms in the monotonous industrial forest. On the other hand, the MP(n)'s provided relatively strong responses against the cultivated mushrooms. One of the commented, that they don't want cultivated mushrooms to forests.

Some of the mushroom picking hobbyists expressed their thoughts and concerns considering the environmental effects that mushroom cultivation could have in the local environment. Some of the MP(c) commented, that mushroom cultivation should not harm the environment. One of the MP(n) commented that it would be unnatural to modify nature through mushroom cultivation. Several of MP(n) commented, that they prefer the forests in their natural conditions, and because of this they do not want people to cultivate mushrooms in the forests. Some of the MP(n)s stated that they cherish biodiversity, and they do not want people to temper it. In addition, some of the MP(n)s were worried that mushroom cultivation alongside forestry activities would increase the number of industrial forests. The unreliability of mushroom's yearly yields was brought up in some of the comments. Also, one of the mushroom picking hobbyists noted, that there are many mushroom species that cannot be cultivated.

MP(c): "Mushroom cultivation is alright as long as it does not harm ecosystem's natural functioning."

MP(n): "Mushroom cultivation cannot justify cutting down natural forest environments."

5.3.2 Economic

Two of the MP(n) were concerned about the negative effects that commercialization of cultivated mushrooms could bring. One of them commented that there's a risk that additional income from mushroom cultivation could increase cutting down forests. The other one commented that it is possible that if mushroom cultivation becomes a business, it has negative impact on the biodiversity.

5.3.3 Legal

Some mushroom picking hobbyists brought up the everyman's rights, and their thoughts and concerns considering these rights. One of the MP(c) commented, that if it is allowed to go to mushroom cultivation forests, they would go there and pick the mushrooms. What came up from the responses was that some of the mushroom picking hobbyists did not seem to be fully aware about the extent of the everyman's rights. One of the MP(c) commented that they do not think that cultivated mushrooms can be picked by everyman's rights. One of the MP(n) commented that everyman's rights on the cultivation field might cause trouble. Three of the mushroom picking hobbyists highlighted, that they don't want to lose the everyman's rights to pick mushrooms from forests.

5.3.4 Social

After responding to the first question, that was about the preferences considering cultivated and naturally grown mushrooms, some mushroom picking hobbyists amplified their opinions. Many of those mushroom picking hobbyists who had chosen that they prefer naturally grown mushrooms commented that they enjoy the mushroom hunt and get excited for the feeling of finding mushrooms. Even some of the MP(c) commented that they rather pick naturally grown mushrooms. For many of the mushroom picking hobbyists the authentic nature experience was an important part of mushroom picking.

MP(c): "If picking the cultivated feels the same as naturally grown, it does not matter which type I pick."

MP(n): "Walking in nature, natural environment is part of the experience."

MP(n): "Industrial forest is a dull place."

MP(n): "The excitement of finding, like treasure hunting."

MP(c): "If the mushrooms' nutrients and taste remain the same, it's ok to pick cultivated kind."

Some of the MP(n)'s compared the cultivated mushrooms to different activities, like fishing from a fish tank and picking strawberries from a field.

MP(n): "Picking cultivated mushrooms would be as exciting as fishing from a tank."

MP(n): "Picking cultivated mushrooms is like picking strawberries from a field."

MP(n): "Mushroom picking is a hobby, picking cultivated mushrooms would be work."

MP(n): “If I picked cultivated mushrooms, it would not be different to buy them from the store.”

5.4 Validity and reliability

In literature on methods, the reliability of a research is commonly addressed with validity and reliability (Tuomi & Sarajärvi, 2018). Validity means that the research has been done on those aspects that were promised in the beginning of the master’s thesis, and reliability means the reproducibility of research results (Tuomi & Sarajärvi, 2018). There are several differing views and understandings considering the reliability assessment of qualitative research (Tuomi & Sarajärvi, 2018). In qualitative research, the reliability of the research relies on the author of the study (Kananen, 2017). Tuomi and Sarajärvi (2018) have listed the aspects that they find meaningful in the assessment of reliability, which are used in this section as the reliability assessment criteria of this master’s thesis. These are the aim and the purpose of the research, personal relations to the research topic, data collection, the research’s informants, the relationship between the researcher and the informants, duration of the research, research analysis, reliability of the research, and research reporting. In addition to these assessment criteria the research is assessed as a whole, and the coherence between the different parts of the study is important (Tuomi & Sarajärvi, 2018). As presented in Table 5, most of the validity and reliability criteria that have been set by Tuomi and Sarajärvi (2018) have been fully met.

When doing research, respondents are sensitive to the way in which questions are formed (Jackson, 2005). In this master’s thesis research, the individual forest owners responses might have been impacted by the interview questions. It is also possible that questionnaire reveals the intentions of a given study, and this has impact on participants’ responses (Kaiser et al, 1999). It is possible, that any of the interviewees or mushroom picking hobbyists survey responders have formulated their answers based on their perceptions on the intentions of this study. Gender and years of education are the two demographic factors that have been found to influence pro-environmental behavior (Kollmuss & Agyeman, 2002). In the higher socio-demographic classes, environmental attitudes are often higher than in the lower ones (Jackson, 2005). It should be taken into account that this research has had a limited number of interviewees, and this has impacted the diversity the interviewees’ demographic factors.

Table 5. How the criteria of the meaningful aspects in the assessment of reliability have been met.

The aspects in the assessment of reliability:	How the criteria was met:
The aim and the purpose of the research	UPM expected to find new solutions to better safeguard biodiversity. The aim was to explore the possible interests towards mushroom cultivation's potential as a sustainable business opportunity alongside forestry activities.
Personal relations to the research topic	The research topic was based on the corporate challenge set by UPM. Master's thesis author's personal interests towards mushrooms have impacted the topic formulation. The author of this master's thesis did not work at UPM, and there were no additional requirements from UPM that would have impacted the author's judgement considering the research.
Data collection	The data collection included recorded interviews and a short survey. Interviews were conducted remotely and individually in Finnish. All interviewees had received information on the purposes of the interview via email, and they had been informed of their anonymity. One of the environmental expert interviews was not recorded because of technical difficulties, instead extensive notes were made to replace the transcript.
The research's informants and the relationship between the researcher and the informants	Each environmental expert was selected based on UPM's recommendations, benefiting snowballing approach with the further expert recommendations. The five individual forest owners were selected from personal network. The short survey that was targeted to mushroom picking hobbyists was shared within personal network, social media, and HELSUS Co-Creation Lab's members.
Duration of the research	The planning of the research began in February 2021. The environmental experts were interviewed during April-May. The private forest owner interviews were conducted during June-July. The mushroom picking hobbyist survey received responses during June-July.
Research analysis	For the qualitative data, research analysis has been based on thematic analysis. Quantitative survey responses were analyzed using descriptive statistics. The analysis methods of this master's thesis have been reviewed and approved by HELSUS Co-Creation Lab.
Reliability of the research	Environmental experts were offered a chance to read through and comment the parts of the interview that were planned to be included in the master's thesis. This phase was included to the process to ensure that the experts allowed the parts of the interview to be published and that those parts would not have any factual mistakes. All made some specifications to the suggested parts of the interview. The different stakeholder perspectives offered versatile points of view to the research question, providing reliable preliminary results on the subject.
Research reporting	This research has been reported according to the structure of scientific research.

6. DISCUSSION

In this chapter the sub questions are synthesized, and the research question is analyzed and discussed. The research question of this master's thesis is: what is the potential of mushroom cultivation alongside forestry activities in Finland? Here in the discussion, this question is analyzed within the set theoretical framework.

6.1 Mushroom cultivation alongside forestry activities from the perspective of corporate social responsibility

Because Corporate Social Responsibility (CSR) is closely related to the relationship between society and organizations (Frolova & Lapina, 2014), it is worthwhile to discuss mushroom cultivation business opportunity from the perspective of this theory. CSR's significance in society is substantial, because of companies' social, economic, and environmental impacts (Dahlsrud, 2008; Buhmann et al, 2019). All of the three sustainability dimensions (environmental, social, and economic) have an important meaning in a successful society. As all businesses, mushroom cultivation products and services would have some effect on the economic, environmental, and social dimension.

Stakeholder and society needs are examples of the main principles driving the CSR (Frolova & Lapina, 2014). In their study, Ludvig et al (2020) found that no single forest owner, entrepreneur, or manager could achieve the desired outcome on their own, and different forms of co-operation is required in order to achieving shared forestry goals. As stakeholders are involved to the business's planning processes, there is increased potential to contribute value to society (Buhmann et al, 2019). This master's thesis has focused on three groups of forest company's stakeholders (experts, forest owners, and mushroom picking hobbyists), who have offered their perceptions, thoughts, and ideas considering mushroom cultivation as a business opportunity. The results of this study provide valuable insights for those companies, who may consider mushroom cultivation services as a business opportunity.

Out of the 294 mushroom picking hobbyists, 240 (82 %) responded that the shared responsibility of forest biodiversity in Finland belongs to forest industry companies, and 228 (76 %) of them responded that it also belongs to individual forest owners. From improvement perspective, adding mushroom cultivation product and service package to forest industry's business can be viewed as one opportunity to develop company's relation to CSR further. As Halme and Laurila (2009) have presented corporate responsibility (CR), it consists of three different types which are philanthropy, innovation, and

integration. These three types do not close each other out, but it is possible to define which one of these is the most dominant in the particular business case. It can be argued that CR innovation is the most obvious type in the case of mushroom cultivation business opportunity. As Halme and Laurila define it, innovation is about developing new business models that are meant to solve environmental and social problems. In the interviews, experts from UPM and Sitra highlighted the edible non-wood forest products' potential from the food production related innovations perspective. Sitra's expert gave another example, that the sold cultivation mushroom species could be of culinary interest to some customers. Moreover, mushroom cultivation as part of business activities could be based on different kind of mushrooms. Experts from UPM and Sitra suggested, that the sold cultivation mushrooms could for example be endangered or threatened mushroom species.

Food related issues are global challenges. One part of CR are the corporations impact on human rights, and due diligence drives businesses to find opportunities to contribute positively to human rights (Buhmann et al, 2019). This includes avoiding harm to societies and developing ways to improve society's wellbeing. By exploiting a larger share of forest potential, forest industry companies may be able to build a profitable business, and simultaneously provide solutions to some of the global challenges. Mushroom cultivation could be one solution to global food related issues, as experts from UPM and Sitra suggested in their interviews. Sustainably cultivated mushrooms could provide nutritious food for local people, and they could also be exported to other countries.

Another development target in the CR is nature's wellbeing (Buhmann et al, 2019). Some of those mushroom picking hobbyists who do not care whether the mushrooms are cultivated or naturally grown, highlighted that the mushroom cultivation is acceptable as long as it does not harm the environment or biodiversity. Similarly, experts and some of the forest owners supported the relevance of environmental factors in mushroom cultivation related decision making. Because nature itself is not a stakeholder (Hörisch et al, 2014), it is of worth that some stakeholders bring up the environmental side to the stakeholders' discussion.

Finland has extensive forest cover (Kröger & Raitio, 2017), and the timber industry has a long traditions and significant economic importance (Tikkanen et al, 2020). The long-term Finnish forest policy has been to maintain forest productivity for economic profits that support the Finnish welfare system and economy (Kröger & Raitio, 2017). On the other hand, there is a growing interest towards re-wilding forests, which aims to conserve biodiversity and increase naturalness by re-establishing ecological processes (Wolfslehner et al, 2019). This re-wilding involves areas with autonomous ecological processes and development of more nature-analogue forest systems that are responding to the emerging demands for different types of ecosystem services (Wolfslehner et al, 2019). Some of

the mushroom picking hobbyists were worried that mushroom cultivation would lead to an increase in industrial forests. For example, one of them stated that the number of industrial forests should not increase, and another one stated that it is not natural that people keep modifying forests. However, as experts from Sitra and UPM confirmed, mushroom cultivation does not automatically harm the environment as long as it is organized sustainably.

With public stakeholders, the stakeholder issues may consider conservation of materials and energy, environmental assessments of capital projects, and social investment and donations (Clarkson, 1995). Despite good intentions of finding consensus, stakeholders may disagree on how things should be managed. Corporate success has been traditionally measured through wealth-based indicators and from only one stakeholder group's perspective, the shareholder (Clarkson, 1995). Nowadays, it is expected that companies consider several stakeholders' perspectives. Stakeholder theory and sustainability management view ethical issues as interlinked to the businesses (Hörisch et al, 2014). Managers cannot maximize returns to the shareholders and ignore the other stakeholders' interest, and the company must take into count also other stakeholders' interests (Clarkson, 1995). The possible contradictions between stakeholders' interests should be solved fairly with ethical choices and judgement (Clarkson, 1995). Because the environment is common property and available to all people, everyone's consumption of natural resources affects other people (Kaiser et al, 1999).

When considering starting mushroom cultivation business, it is necessary to evaluate the conflicting economic interests of different stakeholders. The most apparent contradictions appeared between individual forest owners and mushroom picking hobbyists since some mushroom picking hobbyists were completely opposing the idea of mushroom cultivation in the forests. Another contradiction appeared in the mushroom picking hobbyists' survey, where almost 70 percent of them responded that they would not be willing to participate in covering any of the mushroom cultivation's costs. In addition to forest industry companies, other operators should consider a wider range of stakeholder needs. For example, Metsähallitus should respect more the local stakeholders' wishes for multi-functional uses of State forests (Sarkki et al, 2019).

UPM's expert brought up the possibility of starting to sell mushroom picking permits, which would answer to the individual forest owners' needs to compensate their investments to mushroom cultivation. On the other hand, majority of the mushroom picking hobbyists stated that they are against mushroom picking fees. About half of the mushroom picking hobbyists stated that they would rather pick naturally grown mushrooms, and some of the forest owners had similar thoughts. Although many are interested in picking cultivated mushrooms, it is important to consider the way how the mushroom cultivation areas are organized, and that people have the possibility of choosing

to pick naturally grown mushrooms. Some mushroom picking hobbyists were worried about the possible changes that the mushroom cultivation activities might bring to the forests. It is expected that mushroom cultivation would have some impact on its surroundings, and the cultivation's organizer should consider these possibly contradicting interests.

Mushroom cultivation business activities are not automatically a profitable business idea. It is commonly acknowledged that changing the business focus to the common good might be a challenge for existing commercial business (Dyllick & Muff, 2016). In many cases businesses face financial losses when they engage in radical sustainability strategies (Dyllick & Muff, 2016). For the food system to be sustainable, agri-food supply chains need more than the economic validation that comes from for example profit (Banasik et al, 2019). Some of the mushroom picking hobbyists stated their worries towards the impacts that mushroom cultivation might have on the forest environment. One of them was worried that mushroom cultivation's commercialization would increase the forest harvesting. The more economic profit individual forest owner would aim to receive from their forest, the more the mushroom cultivation can have impact on the tree harvesting. Environmental experts provided examples of mushroom cultivation techniques, where tree stumps are left to the forest after the harvest. This technique does not automatically require more frequent forest harvesting, but if this kind of mushroom cultivation becomes the main activity of a certain forest, this could have significant impact on cutting down the trees.

The issue of access rights to the forests was brought up from the research data, given Finland's particular legislative framework. One way to execute CR is helping the individuals' access to public goods (Buhmann et al, 2019). According to the survey, mushroom picking hobbyists appreciate the opportunity of moving freely in the forests and relying on the everyman's rights. Expert from Sitra found mushroom picking and spending time in forests good for people's health. In turn, some of the individual forest owners were concerned about their property rights. If mushroom cultivation would be conducted in a forest, it might require some protection from mushroom picking hobbyists. Otherwise, individual forest owners' investments would not be economically profitable to them. On the other hand, some of the interviewed forest owners stated that they would not mind if anyone would go and pick the mushrooms that they have cultivated. In fact, they would only be happy if someone was consuming the otherwise rotting mushrooms.

6.2 Sustainability aspects of mushroom cultivation business opportunity

Business sustainability is about ecological, social, and economic values (Dyllick & Muff, 2016). Sustainable businesses consider and evaluate long term aspects, such as resource renewal rates and scarceness, demographic developments, urbanization, climate change's time lags, and ozone depletion (Dyllick & Muff, 2016). As Dyllick and Muff (2016) define sustainability, a company can be truly sustainable only when it is contributing positively to the planet and society. When planning a sustainable mushroom cultivation value chain, including different stakeholders to the planning process can support the environmental and economic outcomes (Banasik et al, 2019).

In their study, D'Amato, Veijonaho and Toppinen (2020) found that there are six sustainability-related business model archetypes among Finnish circular bioeconomy-focused small and medium enterprises. These identified types are about waste valorization, dealing with energy and material efficiency, use of renewable materials, social and environmental stewardship, scaling-up of sustainable solutions, and sufficiency. The results of their study indicate that developing new value chains with stakeholders is one way to enhance businesses' capabilities. According to their interviewees, value capture for societal stakeholders and environment included creating competitive advantage and extra incomes for key partners. This value could mean improved consumption choices and quality of life for users, job creation, and reduced environmental and societal impact in the total life cycle of the product. Out of the six sustainability related business model types, mushroom cultivation could be about dealing with energy and material efficiency, social and environmental stewardship, and scaling up of sustainable solutions.

In Dyllick's and Muff's (2016) definition of business sustainability there are three levels. The third level represents the highest level, and here the sustainability challenges become business opportunities. The companies' evolving towards truly sustainable business (3.0) requires the following: the economic, environmental, and social concerns are equally included to the strategy, value creating takes people, planet and profit into account, and the organizational perspective shifts from inside-out to outside-in. Companies that are on the business sustainability level 3.0 aim to improve the society's sustainability actively. In fact, this sort of companies no longer focus on their own success, but they prioritize the society's needs and common good goals.

Mushroom cultivation services and products could be organized the way that this business model would meet the sustainable business 3.0 expectations. Environmental experts from UPM and Sitra argue that forests benefit from fungi, as well as fungi benefit from forests. Sitra's expert pointed out

that fungi are crucially important factors in the environment. In addition, Sitra's expert explained how the fungi have wider environmental relevance, because they participate in ecosystem's resilience towards climate change and other harmful factors. UPM's expert stated that mushroom cultivation in Finnish forests can be a win-win situation environmentally and economically. By starting mushroom cultivation related business there are prominent opportunities of making it an environmentally viable business model.

Dyllick and Muff (2016) note that it could be a huge challenge for large businesses to embrace the required changes to achieving business sustainability 3.0. Becoming a truly sustainable business is a challenge, particularly for commercial companies. There are limits for businesses to becoming truly sustainable, that include the strong shareholder focused value creating. Another challenge is the financial markets' short-term oriented spirit, as the sustainability strategies require longer time periods. Solving sustainability challenges can be seen as a strategic matter, just like many other business challenges. There is room for commercial businesses to become truly sustainable, even though this requires fundamental changes to the corporations' practices and processes. The positive outcome of business sustainability 3.0 could be that society starts seeing corporations as valuable contributors to the society's and planets' best interests.

6.2.1 Environmental sustainability

Forest management practices should be adapted and improved with the aim to consider highly valuable ecosystem services and non-wood forest products (Wolfslehner et al, 2019), including mushrooms. Studies have shown that fungi are vital to the forest ecosystem's proper functioning, and they have significant ecological relevance in most ecosystems (Tomao et al, 2020; Bässler et al, 2021). As experts from Sitra, UPM, and Luke explained in their interviews, many fungi contribute to the growth of trees, wild herbs, and other plants. Fungi have important role as they support the ecosystems viability. Expert from UPM pointed out, that cultivating mushrooms in forests does not cause harm to anyone or anything. Experts from Sitra highlighted the importance that fungi have in protecting the forests from the damaging effects of environmental changes, such as climate change. Sitra's expert explained, that supporting fungal diversity is only a positive thing for forests' health. Two forest owners stated that planning the forest use efficiently, utilizing the forest floor in versatile ways and leaving parts of the forest untouched are ways to support forest biodiversity.

One of the individual forest owner suggested that forest biodiversity could be supported by cultivating mushrooms. Mushrooms are suitable for recycling of agro-industrial wastes (Cateni et al, 2021), therefore mushrooms can take part in minimizing wastage. This way, mushroom cultivation could be

viewed as an environmentally sustainable activity in forests. When attaining the sustainable management of waste, recycling drivers such as monetary incentives are implemented to influence consumers' recycling behavior, and this may enhance consumer behavior (Abila & Kantola, 2019). Monetary incentives could be applied in the mushroom cultivation to encourage individual forest owners to start sustainable mushroom cultivation in their forests.

Trees benefit from the presence of mushrooms. Every tree has its own specific partner mushroom, that formulates the symbiosis with the tree (Turunen & Soininen, 2017). Collado et al (2019) found in their study correlation between tree growth and saprotrophic mushroom biomass, and this correlation was less frequent with mycorrhizal mushroom biomass. Without saprotrophic fungi, natural forests would be filled with undecayed fallen trees, and the forest floor would contain much less nutrients (Korhonen & Penkkimäki, 2012; Carluccio, 2004). One of the forest owners stated that mushroom cultivation could be a way to support forest biodiversity. All of the environmental experts confirm the importance of the mushrooms to the trees. Expert from Sitra stated, that trees do not grow without the support of mushrooms. Expert from Sitra explained, that mycorrhizal mushrooms provide viable nutrients for trees.

Every year, some of the mushrooms are left unpicked to the forests. Korhonen and Penkkimäki (2012) highlight that only some percentages of the entire mushroom yields are being utilized yearly, and most of the mushrooms are left to the forests. In Finland, a yearly mushroom yield is something between 1,5 and 4 milliard kilograms, and out of this, some amount between 2 to 10 million kilograms is harvested (Piippo & Salo, 2020). This means that out of edible mushroom yield, only about 1 – 3 percent of mushrooms is being harvested per year (Piippo & Salo, 2020; Tuunanen et al, 2012). In the interview, expert from UPM stated that there are significant amounts of forest mushrooms that are not being utilized. Similarly, two of the forest owner brought up this phenomenon. Expert from Sitra believed that the uncertainty of mushroom yields might be one factor that could be stopping people from starting mushroom cultivation. One of the forest owners commented, that they are not able to pick the mushrooms from their forest to his use because of this unpredictability. It is not clear, if the mushroom cultivation would increase the amount of picked mushrooms or would there be even more unpicked mushrooms left in the forests. In order to tackling this challenge, mushroom harvesting practices should also be developed further.

6.2.2 Economic sustainability

The mushroom consumption has been increasing, which has made the mushrooms an economically important business worldwide (Sande et al, 2019). The interviewed UPM's expert has noticed this

development. If increasing demand for products is not dealt with an effective response of increasing the sustainable production of the raw material, the market could face a problem of critical decrease due to overharvesting and crippling the natural production potential (Wolfslehner et al, 2019). Food production has various sources of uncertainty, that include demand patterns and production yields (Banasik et al, 2019). In their study, Tikkanen et al (2020) found that the key challenges that consider the growth of non-timber forest product sector are small domestic markets, distances to larger markets, the smooth availability of raw materials, and the lack of planned and consistent cooperation networks through the value chain. They conclude that when the non-timber forest products' production and service portfolios have been organized, more focus is required to be put on the end-product marketing, financial cooperation arrangements and image building, in order to making the business profitable. By harnessing the potential of forests as cultivated mushroom production fields, this can be one way of responding to the increasing demands. Mushroom cultivation in forests could be one way to uphold mushroom-based food production, but the production related challenges should be first faced.

Market organization, trade trends, and pattern of consumption of non-wood forest products are of great importance to promote mushrooms' sustainable production, to manage their demand and supply, and generating additional sources of income from forests, while supporting rural development (Wolfslehner et al, 2019). Despite the challenges, it does not mean that new markets cannot emerge (Wolfslehner et al, 2019). Expert from Luke talked about a company called Kääpä Biotech, that has been operating in Finland and the company is cultivating and selling chaga. This example indicates that there is potential for other kind of mushroom cultivation businesses. With sufficient business planning and innovation, it is possible to develop incomes from non-wood forest products (Wolfslehner et al, 2019). Expert from Luke pointed out that in Japan, forest owners are making significant economic profit from mushrooms, in addition to timber harvesting. Experts from UPM and Sitra find that mushroom cultivation business opportunity has potential of being sustainable and economically profitable.

Similarly, UPM's expert stated that in order to making mushroom cultivation business profitable, there are many market related challenges that should be solved first. Expert from Sitra pointed out, that majority of forest related innovations are based on timber material, and non-wood forest products are rarely even considered. In the forest sector, many ecosystem services have little or no significant economic impact, because they are largely based on societal and cultural benefits, or pertain to landscape maintenance, air pollution reductions and many other often free to use reusable services (Ludvig et al, 2020, 2). Other than timber, there are relatively few opportunities for developing new

mass market products from resources in the forest (Wolfslehner et al, 2019). The biggest reason for this is that forests are managed on long time scales, and this makes it difficult to react to rapidly evolving market opportunities (Wolfslehner et al, 2019).

The agri-food chain faces different kind of demands, that come for example from the strict delivery contracts with customers, quality requirements, and safety regulations (Banasik et al, 2019). Simultaneously, mushroom production faces many uncertainties, including demand patterns and production yields, which are making the decision making more complicated (Banasik et al, 2019). Some of the interviewed environmental experts, individual forest owners, and mushroom picking hobbyists brought up the uncertainty of the yearly yields of mushroom fruit bodies. In agri-food supply chains, all of the required information is not always available in the beginning, and the various uncertainties that include market risks, production yields, fluctuating demand, and process, are part of the agri-food supply chain's default uncertainty (Banasik et al, 2019). If the important sources of uncertainty are ignored, the agri-food supply chain might lead to lower environmental and economic performance (Banasik et al, 2019). This resource related uncertainty is clearly apparent with mushroom cultivation, because of the mushrooms reliance on the environmental conditions, as experts from UPM, Sitra, and Luke have explained. There is no consensus of the most optimal mushroom production practice (Banasik et al, 2019). This is because the production faces the uncertain yields of mushrooms and fluctuating demand (Banasik et al, 2019). Banasik et al (2019) conclude, that it is crucial to account for the main uncertainty courses in order to optimizing production decision making, because this leads to positive results both in economic and environmental performance.

6.2.3 Social sustainability

For ages, forests have had an important place in people's lives as sources of for example food, energy, and inspiration (Gabay & Rekola, 2019). For people, picking non-wood forest products is part of well-being and collective forest culture (Wolfslehner et al, 2019). From the social well-being perspective, natural environments and shared nature experiences offer an opportunity for social interaction and strengthening bonds within communities (Rantala & Puhakka, 2020). Mushroom picking is a traditional outdoor leisure activity in many European regions (Wolfslehner et al, 2019). Sitra's expert stated that mushroom picking is a nice hobby that lowers blood pressure. This way, mushroom picking can impact positively public health. Sitra's expert highlights, that it is a valuable thing to have the free access to Finnish forests.

People have become increasingly interested in the locally produced and naturally grown foods, which has led to the rising demand for forest's mushrooms (Piippo & Salo, 2020). The expert from UPM has noticed these increased interests and demands towards mushrooms. One mushroom picking hobbyists commented that walking in nature is part of the mushroom picking experience and one of the individual forest owners finds mushroom picking as a rewarding hobby. If mushroom cultivation would lead to increasing interests towards mushroom picking, this could have positive impact on people's health. Because of this, mushroom cultivation could be socially sustainable. On the other hand, it is possible that cultivated mushrooms' picking would become somebody's work, and less people would go pick their own mushrooms.

Mushroom cultivation represents one sustainable business opportunity within innovative food systems. It could provide solutions to sustainable and meatless food development. According to Dyllick and Muff (2016) sustainable food business is expected to consider poverty, nutritious food innovations, consumption, production, and waste in a sustainably positive manner. On the other hand, mushrooms can be a more significant part of a healthy diet in the developed countries, because mushrooms contain several nutrients that are important and healthy for people (Piippo & Salo, 2020; Cateni et al, 2021; Sande et al, 2019). Two of the interviewed individual forest owners brought up the current unsustainability of meat production. If the role of mushrooms in the human diet increases, this could be one way to decrease unsustainable meat production and replace this with the nutritious mushrooms.

6.3 Practical implications for enabling mushroom cultivation alongside forestry activities

In this master's thesis, there are six different categories that are viewed as practical implications for enabling mushroom cultivation alongside forestry activities, that should be considered before starting sustainable mushroom cultivation. These six are based on the themes that were brought up from the research data, and they are i. environmental, ii. economic, iii. legal, iv. social, v. educational, and vi. practical enablers and other ideas. In this subchapter, all of these are analyzed separately, starting with the environmental implications. In each of the enabler themes, the data from all three stakeholder groups is discussed in a joint manner. Consensuses and disagreements between the three stakeholder groups are discussed.

6.3.1 Environmental

There are several environmental factors that are impacting fungal productivity (Morera et al, 2021; Sande et al, 2019). Wild mushroom production is largely dependent on the weather conditions, climate, and other factors that are related to forest stand characteristics (Wolfslehner et al, 2019; Collado et al, 2019). In the boreal forest biomes, the predicted density of saprotrophic mushrooms depends highly on autumn temperature and precipitation (Collado et al, 2019). Because of environment's influence, mushroom yields depend on the year (Turunen & Soininen, 2017). In late summer and early autumn, water availability has impact on the mushroom yields and seasonal wood production, because both of these are sensitive to the limited-water availability (Collado et al, 2019). Typically, the best fruit body producing mushrooms are grown on fallen branches (Piippo & Salo, 2020). Expert from Luke confirmed that different mushrooms require different kind of living conditions. Expert from Sitra highlighted, that different mushroom species require different trees to partner with. Additionally, expert from UPM brought up the competition between local species and cultivation mushrooms. These mushroom species specific preferences and limitations about the environmental factors should be carefully considered before cultivation.

The two main types of mushrooms, saprotrophic and mycorrhizal mushrooms, behave differently in the nature. One of the mushroom picking hobbyists commented, that there are many valuable mushroom species that cannot be cultivated. Funnel chanterelle is difficult to cultivate because of its mycorrhizal way of growing (Scott & Gaya, 2020). Expert from Luke brought up the struggles of trying to cultivate funnel chanterelle as an example of mycorrhizal mushroom cultivation's challenges. However, it is possible to cultivate saprotrophic mushrooms (Turunen & Soininen, 2017; Carluccio, 2004). Experts from Sitra and Luke confirmed that saprotrophic mushrooms have cultivation potential. Chaga can be cultivated in birch stands (Wolfslehner et al, 2019). As expert from Luke stated, chaga is currently being cultivated in Finland. Sitra's expert provided another example of a potential mushroom species for cultivation, which is saffron milk cap. If a company decides to start offering mushroom cultivation services, it seems to be justified to focus on some saprotrophic mushroom species. Further research is required to confirm the viability of each individual mushroom species for its suitability for mushroom cultivation practices in Finnish forests.

6.3.2 Economic

Some of the pro-environmental behaviors can be motivated completely by self-serving interests (Jackson, 2005). Four out of five individual forest owners stated that they are interested in mushroom

cultivation's profit-making opportunities. As timber revenues decrease, attention is often turned to other sources of income than are available in forests (Wolfslehner et al, 2019). For this purpose, new innovations are offering solutions (Wolfslehner et al, 2019). For example, mass markets of timber by-products such as bark for mulch and animal bedding have emerged as additional income opportunities for forest owners (Wolfslehner et al, 2019). Finnish food authority (Evira) has listed 23 mushroom species that are allowed to be for sale in Finnish supermarkets, which makes these mushroom species commercial (Korhonen & Penkkimäki, 2012). Also, some cultivated mushroom species are allowed to be for sale (Korhonen & Penkkimäki, 2012). Only some of these commercial mushrooms have significant economic value, for example some bolete mushroom species (Korhonen & Penkkimäki, 2012). It is possible to organize the mushroom cultivation in a way that it could produce additional income to the forest owner. Still, it is important to remember that the environmental conditions will impact the yearly mushroom yields. If the cultivation's revenue exceeds expenditure, this would be economically profitable.

There is a lot of potential for innovative production and marketing of non-wood forest products if the economic system and policy environment provide effectual incentives for entrepreneurship and business generation (Wolfslehner et al, 2019). One suggestion is to build a system of wild mushroom picking permits for recreational harvesting as an additional service provided by tourist agencies of hotels (Wolfslehner et al, 2019). Permit system could regulate mushroom picking in a protected area (Wolfslehner et al, 2019). In the 1970s in Italy, high harvesting pressure on mushrooms led to the introduction of restrictions on mushroom collection (Wolfslehner et al, 2019). Similarly, UPM's expert and one forest owner brought up the possibility of developing a mushroom picking permit system in Finland, and this way mushroom picking hobbyists would pay for the picked mushrooms. On the other hand, many of the mushroom picking hobbyists were opposing this kind of change to everyman's rights. As discussed in the chapter 6.1, these kind of stakeholder contradictions should be handled fairly.

6.3.3 Legal

Expert from Sitra listed the most significant laws that have impact on forest management and mushroom cultivation alongside forestry activities. These were Forest Act, Nature Conservation Act, Land Use and Building Act and Water Act. Legislative framework can cause challenges for businesses (Tikkanen et al, 2020). It is important to be familiar with the applying laws and regulations. Income generation opportunities depend on a set of public policies that are dealing with for example property rights, labor and fiscal legislation, rural development, industrial supply chains, and tourism

(Wolfslehner et al, 2019). EU regulation concerning novel foods and ingredients could become a barrier to non-wood forest products' commercialization (Wolfslehner et al, 2019). Forest owners must be aware of many exception rules. For example, if the mushroom cultivation's production is being maximized at the expense of timber products, Finnish Forest Centre (Metsäkeskus) must be informed if this kind of special cutting type is intended (Wolfslehner et al, 2019).

Sustainable forest management certificate is a recent market-based instrument that is meant to encourage sustainable forest management (Wolfslehner et al, 2019). There are also many other certificates, such as organic certification, wild certification, environmental performance certification, and quality of food safety certification, that all are aiming to explain the sustainability of certain processes (Wolfslehner et al, 2019). Sitra's expert pointed out that different forest certificates have significant roles in forest management. One of the forest owners mentioned that certificates are a way of motivating forest owners to manage their forests in a certain way. This forest owner also told that he has applied some forest certificates to his forest management practices.

In Finland, it is allowed by everyman's rights to cultivate mushrooms in forests (Tuunanen et al, 2012). On the other hand, secured land ownership and accessibility rights are important to sustainable livelihoods and the survival of forest communities (Gabay & Rekola, 2019). Everyman's rights do not allow people to enter landlord's garden or cultivation fields (Metsähallitus, 2021; Ympäristöhallinnon yhteinen verkkopalvelu, 2013; Tuunanen et al, 2012). The part of forest that has been put to special use for mushroom cultivation should be clearly separated in order to stop the everyman's rights from applying in this specific area (Tuunanen et al, 2012). It is allowed to put up a fence around the mushroom cultivation area, which indicates for forest users that they are not allowed to enter the cultivation area (Tuunanen et al, 2012). Only fertilizing the forest floor does not make the area off limits in terms of everyman's rights (Tuunanen et al, 2012). Four of the individual forest owners brought up their concerns considering the everyman's rights' impact on the mushroom cultivation. Similarly, experts from UPM and Sitra mentioned that these rights could cause difficulties. One of the mushroom picking hobbyists commented, that everyman's rights could cause contradictions between forest owners and mushroom pickers.

Laws and regulations have direct impact on people's behavior. Interests towards focusing policy related interventions have increased as solutions for different environmental and societal issues (O'Brien et al, 2017). Regulations and other established mechanisms aim to encourage particular behaviors considering woodlands as part of tree planting, sustainable harvesting practices, and healthy lifestyles (O'Brien et al, 2017). Conflicts of interests between different stakeholders should be resolved in accordance with the law. It is important, that different actors understand their rights

and responsibilities considering the forest use. It might also be necessary to develop legislation towards protecting the forest owners' property rights better, so that the forest owners could start utilizing their forest for economic purposes more efficiently. Involving a wide range of affected stakeholders in policy-making processes is crucial for developing effective, informed, and widely accepted policies that are reflecting real priorities and needs, and that are suitable for local environment (Wolfslehner et al, 2019). In addition, stakeholder inclusion in the decision making is important for safeguarding personal use rights (Wolfslehner et al, 2019). Therefore, considering different stakeholders' perspectives should be included in the legislative development processes.

6.3.4 Social

Modern forest products are more than just timber, and they include a range of ecosystem services such as tourism and recreation, landscape amenities and biodiversity conservation (Ludvig et al, 2020). Lately, the development of forest products has led to the uprising of experimental services that are related to personal use, such as hobby crafts and cooking, that are also very often related to regional tourism (Wolfslehner et al, 2019). Mushroom picking is an example of those activities that can be done in Finnish forests. A significant amount of mushroom picking hobbyists commented that they enjoy spending time in nature while picking mushrooms. Individual behaviors in the context of forestry could mean for example having a walk in the woods (O'Brien et al, 2017). Based on the research data, mushroom picking seems to be an important hobby for some people. For them, it is important to have the access to Finnish forests and the ability to pick mushrooms for their personal consumption.

Some people prefer naturally grown and picked mushrooms (Carluccio, 2004). Half of the mushroom picking hobbyists responded that they prefer naturally grown mushrooms over cultivated ones. Some of the individual forest owners stated that they prefer naturally grown mushrooms, but they would still be interested in picking cultivated mushrooms. This master's thesis does not explain comprehensively the reasons behind these preferences. However, according to some of the answers provided by mushroom picking hobbyists, they prefer naturally grown mushrooms because they enjoy the natural environment over industrial forests, and the drill of searching and finding mushrooms is pleasant.

In Stern's value belief norm theory, personal moral norms and pro-social attitudes are significant indicators of pro-environmental behavior (Jackson, 2005). If a person holds strong biospheric or altruistic values, this person is more likely to accept new environmental paradigm (Jackson, 2005). The ecological value theory hypothesizes that those who hold primarily self-transcendent values

engage more likely in pro-environmental behaviors than those who are holding primarily self-interested values (Jackson, 2005). Emerging changes can impact the value systems in the communities, and they may become catalysts of bigger changes (Sarkki et al, 2019). All of the individual forest owners show their interest towards protecting biodiversity, which indicated that at least partly their actions are based on self-transcendent values.

The Behavioral Change Wheel links potential behavioral targets to interventions (Michie et al, 2011). The aim of the Wheel is to provide an efficient tool for choosing the kinds of interventions that are likely to be applicable for the behavioral target, in a given population and context. In the Behavioral Change Wheel, psychological and physical capability, social and physical opportunity, and automatic and reflective motivation are in the center. Individual forest owners seem to have the motivation to start mushroom cultivation and this way support biodiversity. Some of them do not have the capability and would require a more holistic mushroom cultivation service package. Around these sources of behavior, there are the intervention functions, which include restrictions, education, persuasion, incentivization, coercion, training, enablement, modelling, and environmental restructuring. Based on their research data, to supporting forest owners' mushroom cultivation, such things as education, training, and enablement would seem to be necessary intervention functions. Policy categories are on the outer side of the wheel. These include fiscal measures, guidelines, environmental and social planning, communication and marketing, legislation, service provision and regulation. Pro-environmental behaviors are often dependent on favorable institutional infrastructure factors (Kollmuss & Agyeman, 2002). Because mushroom cultivation services are not offered to customers on a large scale, improvements in all of the policy categories could support forest owners' intentions to start mushroom cultivation.

Gainforth et al (2016) used the Behavioral Change Wheel in their study, that was about waste-related behaviors and effective interventions to change these behaviors. In their study, they found that most of the participants were motivated to recycle, but their motivation fluctuated depending on the psychological capability to recycle in the present context and physical opportunities to recycle. They summarized their results by saying that motivation, capability and opportunity influence recycling behaviors. Creating more opportunities to recycle, education and training to recycling practices, support the existing motivations to recycle and improve the recycling levels. Similarly, opportunities, education, training, and support may encourage individual forest owners to starting mushroom cultivation in their forests.

6.3.5 Educational

Noticeably, land use and environmental sectors have acknowledged the usefulness of behavior in relation to sustainable development (O'Brien, Marzano & Dandy, 2017). As well in terms of mushroom cultivation opportunities, people's behaviors are relevant. For many national and local governments, encouraging pro environmental behaviors has become a priority as they seek to address environmental challenges (Barr et al, 2011). Ecological behavior is based on people's ecological behavior intentions, and these intentions are based on environmental knowledge, responsibility feelings, and environmental values (Kaiser et al, 1999). Awareness of the environmental consequences correlates positively with new environmental paradigm and is likely to lead into environmentally friendly outcomes (Jackson, 2005). In their study, Ranacher et al (2017) found that some of their survey's responders lacked conceptual knowledge considering ecological services. The majority of the responders felt that it was necessary to have information on the considered ecological service issues for them to be able to assess the impact of forest sector business (Ranacher et al, 2017). Clearer communication strategies are needed to increase public understanding of industrial practices' impacts on ecosystems (Ranacher et al, 2017). It is possible that information from natural science may not be easy enough to understand from the viewpoint of those people who lack general knowledge of ecosystem functioning or forest sector business operations (Ranacher et al, 2017). Based on the individual forest owners' interview, most of them require more information considering mushroom cultivation. Some of them commented that additional information is a requirement for them to start to even consider mushroom cultivation practices in their forest.

Education can be one way of promoting behavioral change. As a concluding solution to promote increasing amount of plant-based ingredients in the diet, Prusaczyk et al (2021) suggested the combination of education and nudges to support this kind of change of behavior, which proved to be an effective alternative in their study. The education condition proved to be better than control, where the study group was educated about beef consumption's negative impact on the climate change (Prusaczyk et al, 2021). Similarly, Gainforth et al (2016) found that for example education and training to recycling practices, support the existing motivations to recycle and improve the recycling levels. Three of the forest owners stated that they do not know how mushrooms are cultivated. They would like to gain a better understanding of this topic. By increasing the forest owners' awareness about the mushroom cultivation practices, it is possible that they would become more eager to start doing this activity in their forests.

6.3.6 Practical enablers and other ideas

Individual forest owners and environmental experts had ideas considering mushroom cultivation's practical enablers. First of all, mushroom cultivation services could be a part of forest industry companies' services. Some of the forest owners hoped that mushroom cultivation could be a very wholesome service package, that would include planting the mushrooms, taking care of them, and picking the cultivated mushrooms for sale. In return, forest owners would receive some economic profit for the mushrooms that have been cultivated in their forest. One forest owner suggested that a group of forest owners could start cultivating mushrooms together.

Because forests' stand structure can be modified by silvicultural actions, forest management practices are able to contribute to enhancing mushroom yields. Notably, there are several impacting factors that affect mushroom yields alongside forestry activities, which include the optimal stand basal area, forest types, and area's ecosystems. Light thinning might boost the production of edible marketed fungi, which largely relies on using low-impact techniques that minimize soil damages. Since most of the mushrooms form mycorrhizal associations with forest trees and shrubs, upholding forest cover may support the production of edible mushrooms. A reliable supply of mushrooms is difficult to provide from small fragments of forest land, and it requires coordinated production from a large area. (Wolfslehner et al, 2019)

Piippo and Salo (2020) argue, that mushroom cultivation has potential of being an additional business opportunity alongside forestry and agriculture processes because tree stumps, tree trunks, and sawmill waste are suitable to being mushroom cultivation's substrates. Each mushroom species has its own preferred cultivation methods (Carluccio, 2004). There are different techniques to cultivate mushrooms, which include field cultivation, compost cultivation, attach fungi to trees, and mushroom cultivation on decaying matters (Piippo & Salo, 2020). When mushroom cultivation happens in forests, it usually requires special production means, such as tillage, uprooting, fertilizing and crop management (Tuunanen et al, 2012). One way to cultivate mushrooms is by putting parts of mushroom to the tree stumps or tree trunks (Piippo & Salo, 2020). Sitra's expert explained that chaga can be cultivated by making holes to standing trees. Many of the edible wild forest mushrooms grow in such places in the nature, where the forest floor has been grubbed (Turunen & Soininen, 2017). Expert from Sitra pointed out that many of the best mushroom picking forests are industrially managed. Expert from Luke sees viable potential in cultivating saprotrophic mushrooms with the help of tree stumps that are left to the forest for mushroom cultivation purposes.

6.4 Limitations and suggestions for future research

There are several aspects which require scientific research in order to making mushroom cultivation's business opportunity viable. Future studies could include such topics as analyzing active substances in mushrooms and trees, breeding of suitable plant varieties for cultivation, suitable cultivation techniques, developing processing methods for durable or marketable products, studying health effects of food and other goods, studying plant diseases, and studying public opinion and consumer trends (Wolfslehner et al, 2019). Similarly, the expert interviews confirmed that mushroom cultivation's techniques should be studied further. For the forest management to successfully support forests' mushrooms, it is necessary to do research on different forest management options that aim to provide alternative forest ecosystem products and services (Wolfslehner et al, 2019). Based on this master's thesis, mushroom cultivation has potential of becoming a sustainable business opportunity for forestry companies. Therefore, it would be worthwhile to study further the mushroom cultivation's business potential.

It is relevant to note that this master's thesis has its limitations. The master's thesis' aim has been to research forest industry's stakeholders' perceptions and opinions considering mushroom cultivation services as an additional service to other forest industry's services, within the defined theoretical framework. The selected theoretical framework has been limited to stakeholder theory, corporate social responsibility, and insights from behavioral theories. Thus, it would be interesting to study this topic further from the perspective of other suitable theories. Because this topic had not been extensively studied, this master's thesis has only been able to provide preliminary results.

It has not been the intention of this master's thesis to provide a complete business model for mushroom cultivation, thus this should be studied further to examine its possibilities. The excluded forest industry's stakeholder groups' opinions and perceptions, including employees and shareholders, are recommended to be studied in future research projects. In addition, the stakeholder groups that have been studied in this master's thesis should be included in the future studies with a larger variety in their demographic factors, since it would provide more diverse data. As limiting factors, it has been beyond the scope of this master's thesis to provide further details on the suitable mushroom species, specified cultivation techniques, or the price estimations of the discussed mushroom cultivation services. Further research should study the different mushroom species and their suitability for mushroom cultivation processes. Additionally, environmentally, economically, and socially sustainable mushroom cultivation practices should also be studied further, in order to be able to provide reliable estimations on the mushroom cultivation' sustainable business opportunities.

Lastly, to be able to make reconned price estimations and formulate a possible business model, the sustainability aspects and other implications should also be studied further at an adequate level.

7. CONCLUSIONS

This master's thesis is not only important for UPM, but it is a societal question if mushroom cultivation has a positive influence on forests and biodiversity, as a potentially sustainable business opportunity. The motivation of this master's thesis has been to answer to some of the societal challenges that emerged during the 2021 edition of the HELSUS Co-Creation Lab at the University of Helsinki, which also involved forest company UPM. The aim of the master's thesis has been to study biodiversity and food production related issues, which both have significant societal significance. In response to these challenges, this master's thesis addressed the potential for mushroom cultivation alongside forestry activities in Finland from the perspectives of acceptability of forestry, biodiversity conservation and food system innovations.

In conclusion, mushroom cultivation services alongside forestry activities can possibly be a sustainable part of forest industry's business activities, with potential of positive impact on the biodiversity. Out of the three dimensions of sustainability analyzed (environmental, social and economic), economic sustainability is the most unreliable factor. In order for mushroom cultivation to become a viable and sustainable business opportunity for forestry companies, it requires consideration of the practical implications addressed in this study. Hampering factors to the mushroom cultivation's business opportunity are Finland's legislative framework, companies' economic goals, environmental limitations, stakeholders' differing views, and other practical requirements. In addition, future research may bring up additional implications, that should also be considered.

As a sustainable innovation, mushroom cultivation alongside forestry activities could be part of the forestry company's corporate social responsibility acts. This requires considering different stakeholders' perspectives, and other responsibility demanding factors. Mushroom cultivation has potential of bringing additional income for individual forest owners. The results of this study indicate, that although individual forest owners have interests towards mushroom cultivation, they lack valuable knowledge, and they would like to receive more information on the topic. Similarly, mushroom picking hobbyists have strong attitudes and some misunderstandings towards mushroom cultivation practices. Educating different stakeholders about mushroom cultivation's benefits for the environment and different stakeholders is necessary. This has potential of increasing forest owners' interests towards mushroom cultivation and gaining mushroom picking hobbyists' trust. Individual forest owners' worries about unsustainable food production could be met by offering them sustainable

mushroom cultivation services and products, which could bring edible mushrooms for consumers, who in turn have become increasingly interested in locally produced wild foods.

For the mushroom cultivation businesses' feasibility, there are some aspects that require further research. Future research should consider the remaining gaps of other stakeholder groups and a larger sampling of those stakeholder groups that were selected for this master's thesis. The sustainability dimensions' applicability for mushroom cultivation requires further research with different study methods, since this master's thesis' has been limited to certain extent to qualitative methods. In addition, the practical implications for mushroom cultivation alongside forestry activities should be studied further, because this study has provided preliminary results. Along with the encouraging results of this master's thesis, the future research does matter for the developers of sustainable mushroom cultivation business model.

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In Espoo in October 2021

Ida Rantanen

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APPENDIX 1

Themes for semi-structured environmental expert interviews:

1. What do you know about forest mushrooms? How do forest mushrooms grow in the forest?
2. What do you know about mushrooms' commercial opportunities and mushroom related businesses?
3. How are forest mushrooms related to biodiversity?
4. What do you think about Finnish forests' potential as a source of food?
5. What do you know about mushroom cultivation in the forests?
6. What benefits does mushroom cultivation have to economy, environment, and other things?

APPENDIX 2

Individual forest owners, interview script:

First explaining the aim of the interview: To explore stakeholders' (individual forest owners) opinions and perceptions about mushroom cultivation alongside forestry activities.

General questions about global biodiversity & food production practices:

- As a forest owner, would you be interested to participate in supporting the forest biodiversity?
- If yes, do you know about the ways of supporting biodiversity? (please provide examples)
- What do you think about the current food production practices, are they sustainable? Would you be willing to participate in supporting food sustainably?
- Please describe: what kind of forestry activities do you implement in your forests?

Mushroom cultivation +/-:

- What do you think about mushroom cultivation alongside forestry activities?
- What would motivate you to start mushroom cultivation?
- What are some of the difficulties or challenges related to mushroom cultivation that would prevent you from doing it?

Environmental:

- Would you be willing to support forest biodiversity by mushroom cultivation?

Social:

- Do you go mushroom picking? (How often, how regularly?) Do you use mushrooms in your cooking?
- Considering every man's right, how do you feel about cultivating wild mushrooms in your forests?
- Would you prefer collecting naturally wild grown mushrooms to cultivated mushrooms?

Economic:

- Improving forest biodiversity might be associated with additional costs, for example for mushroom cultivation. Would you be willing to cover these costs? (How much of the costs you might cover?)
- If the mushrooms would be edible, would this increase the amount of money that you are willing to invest?

- Can you think of some solutions to encourage people to preserve biodiversity through mushroom cultivation?
- What kind of mushroom cultivation services/equipment could you be interested to buy i.e. from a forest industry company?
- How could forest industry help you with mushroom cultivation?

Demographics:

- Age, gender, study background, and current profession?

APPENDIX 3

Mushroom picking hobbyists, survey questions:

Survey for mushroom picking hobbyists about mushroom cultivation opportunities alongside forestry activities

Those who identify themselves as individual mushroom pickers are invited to respond to this survey. If you pick mushrooms occasionally or more often, welcome!

The results will be part of a master's thesis at University of Helsinki, faculty of agriculture and forestry.

You can forward the survey link to people you know, who identify as mushroom picking hobbyists.

Responses are anonymous.

Short description of mushroom cultivation:

In this research, mushroom cultivation means when for example tree seedlings are planted in the forest, and mushrooms are cultivated along with them. This is called mushroom cultivation alongside forestry activities.

The topic of the master's thesis:

Multi-stakeholder perspective: The business potential of mushroom cultivation alongside forestry activities

The survey is open for responses from 23.6. until 15.7.2021.

Additional information about the survey or the research can be requested from the thesis' author: ida.rantanen@helsinki.fi

1. Cultivated mushrooms are often found in industrial forests, in which the environment may look different in comparison to the naturally grown mushrooms' environment. How would you feel about picking cultivated mushrooms?

- a) I would rather pick naturally grown mushrooms.
- b) It does not matter whether the mushroom that I pick are cultivated or naturally grown.

There is no apparent difference between cultivated mushrooms and naturally grown mushrooms. If you are not familiar with the difference between the two types of forest, click the link to see the difference.

Natural forest looks like this, and the naturally grown mushrooms grow here. Click the link to see an example.

Industrial forest looks like this, and the cultivated mushrooms grow here. Click the link to see an example.

2. Would you like to specify your response to the previous question?

3. Would you be willing to pay a small fee to cover the costs of supporting biodiversity through mushroom cultivation? The payment would be similar with fishing permissions.

Yes

No

4. If you responded yes to the previous question, how much would you be willing to pay every year? Write your answer in numbers, and leave the euro sign out.

5. In your opinion, to whom does the responsibility of supporting biodiversity belong to in Finland?
It is allowed to pick several.

- a) Finnish citizens
- b) People who spend time in Finnish forests
- c) Tourists, who spend time in Finnish forests
- d) Individual forest owners
- e) Forest industry companies
- f) The state with the taxes
- g) Other, who?

6. If you picked "Other, who?" alternative in the previous question, who did you mean?

7. Are you working in the forest industry?

Yes

No