THE UNIVERSITY OF SOPRON
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Doctoral (PhD) dissertation theses

THE ECONOMIC CHARACTERISTICS OF CONTINUOUS COVER FOREST MANAGEMENT IN BEECH AND TURKEY OAK FORESTS AT PILIS PARK FORESTRY COMPANY

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SOPRON

2017.

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1. Subject Realization

The continuous forest (Dauerwald) and continuous cover forest management (Dauerwaldwirtschaft) concepts originated in Germany in the twentieth century; acceptance of these concepts has increased due to the problems encountered in evenly-aged, rotation forests (storms, pest damage, etc.).

Continuous cover forest management appeared in Hungary in the early 1990s following the formation of the international Pro Silva movement in Slovenia in 1989. Unlike rotation forest management, continuous cover forest management, when provided the appropriate site and tree stand conditions, avoids the clear cut and final cut result of evenaged, less mixed, homogenous tree stands.

Forestry legislation in Hungary has acknowledged and followed these changes by incorporating aspects connected to continuous forest cover (1996) into its regulations and, later, formulating specific expectations (2009) under the pressure of nature conservation.

Incoherent terminology, divergent views, and legal regulations led to disputes that brought the very introduction of continuous cover forest management into question over concerns regarding the sites, tree composition, wildlife density, and accessibility conditions of Hungarian forests. The subject is still topical, especially concerning the applicability of the continuous cover forest management in different forest types. Some professionals have recommended continuous cover forest management for montane beech forests; they also consider the method inappropriate for tree species that have a high light demand. There is general, widespread domestic opinion that continuous cover forest management provides weaker economic performance than rotational forest management does.

The dissertation focuses on the economic comparison of rotation forest management and continuous cover forest management with two essentially different tree stand types located in the territory of Pilis Park Forestry Company: beech (*Fagus sylvatica* L.) forests in good-quality sites, and Turkey oak (*Quercus cerris* L.) forests in poor quality sites.

2. Research Objectives

The research focused primarily on the economic aspects of continuous cover forestry management during the transition period and compared this to the rotation forest management method commonly used in domestic practice. This required the establishment of a national nomenclature (logical model) in accordance with international terminology and a summary of silvicultural framework conditions applicable to the introduction of continuous cover forest management in Hungary. The unavailability of national complex economic models based on the practical experiences and data regarding the introduction of continuous cover forest management posed difficulties for the economic investigation.

The formulation of research objectives:

- To introduce which factors make it difficult to implement continuous cover forest management in Hungary.
- To standardize the nomenclature in Hungarian to enhance clarity and consistency in the application of a professional glossary for continuous cover forestry by utilizing international nomenclature (German, English), the terminology published by IUFRO (International Organization of Forestry Institutes) and domestic literature sources.
- Increment and basal area determination (living stock) by the diameter groups, the diameter structure, and the mixture ratio are all crucial aspects when implementing continuous cover forest management. Discovering through which means these data can be generated is essential.
- The operational implementation of continuous cover forest management must be based on practical conditions and guidelines; organizational conditions, operational silvicultural fundamentals, and a complex system of operational control must be defined.
- It is necessary to evaluate and compare continuous cover forest management and rotation forest management from an economic perspective using practical models, in a 2nd yield-class beech forest within Pilis Park Forestry Company.

- It is necessary to evaluate and compare continuous cover forest management and rotation forest management from an economic perspective using practical models in a 4th yield-class Turkey oak forest in the Gödöllő Hills area within Pilis Park Forestry Company.
- Using a case study to introduce that the stand structure within continuous cover forests offers greater stability and a higher degree of economic (financial) advantage in the event of a natural disaster when compared to the even-aged stand structure found in rotation forests.

3. Research Hypotheses

H1: The causes for professional opposition and aversion to continuous cover forest management are multifaceted; many factors jointly play a role in this.

H2: Hungarian nomenclature can be standardized using the international nomenclature (German, English) and IUFRO terminology.

H3: The structure of continuous cover forestry can be characterized by descriptive and quantifiable parameters and can be integrated into the work of the forest manager in relation to these parameters.

H4: Incorporated in a complex system, the operational introduction of continuous cover forest management can be successfully implemented in suitable production site conditions.

H5: Continuous cover forest management is not an economically inferior alternative in beech forests at either the stand- or estate-level.

H6: Continuous cover forest management is not an economically inferior alternative in Turkey oak forests at either the stand- or estate-level.

H7: Continuous cover forests have greater structural stability, which makes them more resistant to physical stresses; this provides significant economic benefits.

4. Research Methods

The following methods were employed in the first part of the research:

- collecting international and domestic sources of literature;
- an analytical and comparative assessment of international and national literature on the continuous cover forest management from the historical, terminological, silvicultural and methodological perspectives required for economic analysis;
- the procuring, gathering, and organizing of domestic and international experiences during field trips concerning the practice of continuous cover forest management;
- setting up operational experiments in the beech and Turkey oak forests located in the territory of Pilis Park Forestry Company by elaborating a conditionality system suitable for large-scale operations.

In the second part of the research, the results from the pilot experiments completed in the territory of Pilis Park Forestry Company were analyzed and evaluated. The first step of this process was to select identical yield-class forest subcompartments whose natural and financial data were provided by professional and administrative records. The complex economic models method, consisting of time domain and territorial serial models of forestry interventions, natural yields, and cost-yield data, was used to accomplish the economic analyses. The economic evaluation was completed on two levels for both tree species. On one hand, at the tree stand-level (small, private forest estates) with annuities and, on the other hand, at the operational, that is, estate-level (large forest estates) by comparison of annual financial coverage (operating annuities). In the latter case, the distortions caused by time and the interest rate factor were filtered, which is interesting from a large-scale forestry perspective.

One important argument for the introduction of continuous cover forest management is its lower risks and resistance to natural disasters. Therefore, a variant of the complex economic model modified with different intensities was also analyzed for both beech and Turkey oak to determine the consequences of the December 2014 ice damage.

5. Research Results, Conclusions, Theses and Recommendations

Over the past two decades, the role of continuous cover forest management has increased both nationally and internationally; thus, there is a great need to present the experiences and the resulting economic aspects.

An analysis of the literature sources proves that the refusal of, mistrust in and apathy toward continuous cover forest management has manifested from many sides, due primarily to the lack of experimental conditions and research results. Contrary to rotation forest management, continuous cover forest management lacks the support of many centuries of accumulated scientific results. Nevertheless, both scientific and professional successes had grown by the end of the 20th century. Economic studies in the method also accumulated, leading to a gradual acceptance of the practice.

Until the turn of the millennium, there were only a few experiments in Hungary of which to speak; however, when reviewing foreign and domestic literature, it became rather striking that the opinions and interest in the field of continuous cover forest management applicability reflected the same peaks and valleys as those found in Hungary. Research and education focused primarily on rotation high forest and coppice forest management, clear cutting and regeneration cutting, and even-aged tree stand problems. Professional initiatives of the 1920s and 1950s for continuous cover forests did not attain practical implementation, and only a few sample areas were established. Since the 1990s, however, continuous cover forest management has been on the forest management agenda.

Legislation followed this process, which not only provided an opportunity to begin continuous cover forest management, but also to hinder it with rigid regulations. The legal requirements that came into force in 2009 did not consider professional realities. The pressure of nature conservation obliged state forest management to implement continuous cover forestry in areas with unsuitable conditions. The need to amend this legislation was almost instantaneous, and in 2017, thanks to practical experience, the regulations became more lenient toward foresters. This proved that ensuring opportunities for flexible

implementation of regulations were more important than the mere act of drafting legislation.

Many misunderstandings and uncertainties associated with continuous cover forest management were also caused by the lack of reform in silvicultural systems and the related nomenclature in Hungary. Based on the definition found in the professional literature, continuous cover forest management can be identified with Dauerwald-management (permanent forest management). Selection forest is a continuous forest composed of shade tolerant tree species, which is difficult to develop in Hungary due to site conditions. The definitions and characteristics of continuous cover forests were determined by analysing foreign literature and incorporating domestic experience. The primary distinction between rotation forest management and continuous cover forest management is the utilization of the stand-level rotation age and final harvest areas applied to the former. By contrast, there is no stand-level harvesting age or final harvest area in continuous cover forest management; therefore, an uneven-aged, irregular stand structure is created that results in a more mosaic-like, horizontal stand structure at the continuous forests composed of light-demanding tree species. This thesis completes the existing forestry classification in Hungary by incorporating continuous cover forest management into it.

Until quite recently, the lack of transparency and knowledge, the complexity, and the uncontrollability of the system have all been barriers to the implementation of continuous cover forest management. After studying the literature sources and drawing upon the experiences gathered at the Pilis Park Forestry Company, the framework needed to initiate the large-scale pilot experiment was compiled and assembled. It is important to emphasize the appropriate acessibility, the silviculture practice required for continuous cover forest management, and the presentation of the organizational features. Simultaneous clarification of the previously discussed uncertainties and mistakes was completed with procedures sufficient to demonstrate the introduction of the experiment at the operational level. In addition to the existing geoinformatics standards, continuous cover forest management is much more transparent and more predictable than before. In continuous cover forestry, forest managers must develop continuous cover forest models that best suit their own

needs and characteristics. This, naturally, requires extra work, but based on the experience gained at Pilis Park Forestry Company, this extra investment in work is worthwhile. However, various obstacles can hamper the introduction of continuous cover forest management including site barriers, large game density, lack of accessibility, and problems arising from organizational structure and lack of training. When these obstacles are present, the introduction of continuous cover forest management cannot be implemented because of the increased probability of failure.

One of the obstacles blocking the introduction of continuous cover forestry - according to Hungarian public opinion - is the belief that it is costlier than rotation forestry. Therefore, the process and data of continuous cover forest management on beech and Turkey oak in Pilis Park Forestry Company were analysed to determine the validity of this belief.

The spatial ratio of beech tree species in the state forests managed by Pilis Park Forestry Company is 6%, but this is a sensitive area from a nature conservation and public welfare tourism perspective. The data gathered from over 600 hectares of beech forest since 2002 have allowed for the financial analysis of the initial period of continuous cover forest management and the comparison of rotation forest management. Thanks to the results obtained, it has been concluded that the transition to continuous cover forest management in the beech stands managed by Pilis Park Forestry Company is not economically disadvantageous.

The territorial share of Turkey oak at Pilis Park Forestry Company is 25%. Valkó Forestry Unit, located in the Gödöllő Hills, primarily employs clear cutting with artificial renewal, and regeneration cutting with natural renewal less frequently on its Turkey oak stands. However, the increasing cases of drought damage attributable to climate change and the cockchafer grub damage in the area have increased the costs of forest regeneration considerably, to the point that they are well above the national average. The damage caused during regenaration occurred mostly in the harvested areas; thus, it became obvious that these areas were suitable for the implementation of continuous cover forest management because this system avoid these harvested areas. Studies have shown that continuous cover forest

management in Turkey oak is not economically disadvantageous in these circumstances.

At the domestic level, it has been shown that continuous cover forest management is beneficial not only for beech stands in high quality conditions, but can also be a good alternative for Turkey oak stands in poor quality conditions. In addition, continuous cover forestry has proven to be a good decision from both a professional and economic perspective due to its effectiveness countering abiotic (drought) and biotic (cockchafer larvae) damages.

The economic analysis of the December 2014 ice damage justified the introduction of continuous cover forest management due to its risk-reducing role. Analyzing the consequences of the December 2014 ice damage revealed that there was a verifiable correlation between the age of the stands, their structural characteristics, and the intensity of the damage. Even-aged (young and middle-aged) stands were the most intensively damaged while more stable, thicker, older, or uneven-aged mixed stands were the least affected. An inherent characteristic of continuous forests is that the constant coverage the selected trees in the upper levels of the uneven-aged, multi-storied stand is less vulnerable to wind, snow, or ice damage. Models based on beech stands have been converted according to ice damage observations. As a result, the economic consequences of ice damage could be modelled, and these signified that continuous cover forestry in these areas significantly reduces ice damage for forest management.

When the economic features inherent in the continuous cover forest management implemented at Pilis Park Forestry Company is evaluated and compared to rotation forest management, it becomes clear that continuous cover forest management is an alternative that can provide opportunities for the successful management of expected climate change issues in some areas. It can also adapt to the needs of a society that has become more sensitive about the environment. Multi-aged, multi-stuctured, mixed, continuous forests will adapt better to climate change than even-aged, homogenous, less mixed rotation forests. The results of the ice damage examinations in beech stands directly and the drought damages in the Turkey oak stands indirectly point to this. However, obstructive factors must not be

ignored or discounted; in the event of considerable hindrances, other solutions should be chosen.

The research findings in the thesis have expanded the experience of introducing continuous cover forest management in Hungary, and form a basis for further research. It is important to emphasize that legislation must first provide opportunities to introduce continuous cover forest management since it is necessary to recognize the relationship between yield and increment, and to develop continuous cover forest models in different site and yield conditions for suitable tree stand types.

Further studies are required of the montane sessile oak, which the economic examinations of this study did not cover.

Theses

1. After reviewing the literature and the legal environment, it has been established that the domestic introduction of continuous cover forest management is largely obstructed by a lack of scientific substantiation as well as the reigning views most forestry authorities and foresters hold regarding the perceived unpredictability, uncontrollability, and opacity of continuous cover forest management. An inconsistent and error-laden regulatory environment is another key obstacle.

2. Based on the international and IUFRO SILVAVOC terminology and the domestic literature, the most appropriate term for the permanent cover forest management system is continuous cover forest management as well as new conceptual definitions and silvicultural (forest utilization - forest regeneration – forest resource management) classification were established.

3. The planning and evaluation models for continuous cover forestry executed in this thesis are suitable for the determination of continuous cover forestry goals and for the determination of the objective parameters of forest stand, the living volume and for the control based on the basal area distribution and diameter distribution.

4. The conditions and practical procedures developed for the introduction of continuous cover forest management are suitable for experimental implementation on an operating scale.

5. The use of complex economic models on beech stands has proven that the implementation of continuous cover forest management on 2nd yield-class beech stands located in the territory of Pilis Park Forestry Company is not inferior economically, at either the stand-level or the estate-level. This is due to the possibility of increasing the logging revenue and the possibility of reducing the cost of forest regeneration.

6. The use of complex economic models on beech has proven that the implementation of continuous cover forest management on 4th yield-class Turkey oak stands located in the Gödöllő Hills in the territory of Pilis Park Forestry Company is not inferior economically, at either the stand-level or the estate-level. This is due to the possibility reducing regeneration costs.

7. An examination of the ice damage that occurred in December 2014 determined that uneven-aged stands with older trees in the upper level are less prone to damage and provide more stable financial indicators from a forest management perspective. Stand structure that approaches the structure found in uneven-aged continuous forests are preferable because the damage they incur is significantly less than in even-aged, 10-60 year-old tree stands, as shown by the financial indicators.

6. Publications in the Dissertation Topic

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