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Economic effectiveness of sustainable forest management

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ABSTRACT: The article deals with economic aspects of sustainable forest management. The analysis stems from Plíva's typological system. Several hundreds of variants were calculated for forest silviculture profitability classified according to management intensity, target management system, proportion of ameliorating and improving species, proportion of natural regeneration, and set of forest types. The results show a possibility of labour saving and also marked differentiation of the effect of wood production function depending on natural and production conditions and management intensity.

Keywords: economic effectiveness; sustainable forestry management; management intensity; forestry production gross profit; evaluation

The implementation of sustainable forest management belongs to the priorities of national forest policy and the whole forestry community. Discussions on principles of near-natural management systems grow intensive and the issue is treated by all interested parties to a smaller or larger extent. However, the implementation of this goal is complicated by a continual escalation of two contradictory principles: a decreasing economic profitability of forest production on the one hand and a growing stress to provide environmental services by the forest sector on the other hand. This dilemma can mainly be noticed in the case of management of marginal and submarginal forest stands and properties. Achieving profitability belongs undoubtedly (apart from finishing the restitution process and stabilisation of forest health conditions) to cardinal issues of the sector. Detailed analysis of the present situation has been complicated by difficulties with the acquisition of input data (namely values). Little attention has also been paid to further development of economic inputs and outputs of the sector and to the prognosis of the sector's economic situation. Finding or seeking a certain ecological-economic management optimum belongs among priority issues of the forest sector.

Probably time has come to use all hitherto knowledge presented so far and distributed at various levels and to establish a programme which would assess single ideas, proposals and opinions complexly and systematically and would design an integrated set of technological and economic parameters of sustainability principle, namely:

– measures and procedures of forest ecosystem restoration and conservation,
– analysis and proposal of further differentiated and optimum logging, hauling, and regeneration technologies complying with sustainability principles,
– analysis of economic impacts of transformation of the present forest management model into a near-natural one.

MATERIAL AND METHODS

The Department of Economics and Forestry Management of the Faculty of Forestry and Environment started to solve the above-mentioned issues within Project No. EP 9217 *Prognosis of Economic Impacts of Near-natural Forest Management* funded by the Ministry of Agriculture of the Czech Republic, and Project No. MSM 414100006 *Multiple-Purpose Forest Management under Limiting Social-Economic and Natural Conditions* funded by the Ministry of Education, Youth and Sports of the Czech Republic.

Table 1. Management intensiveness in ecological network (by Plíva 2000)

Set of forest types																									
	transitional			extreme			exposed			acid			fertile				pseudogley				waterlogged			alluvial	
	W	C	X	Z	Y	J	A	F	N	M	K	I	S	B	H	D	V	O	P	Q	T	G	R	L	U
9 Dwarf pine	A	4.0	**–5.0**	1							1		PP										1		
	B	2.5	–3.5	–5							–3.5		management intensiveness – MI										–5		
				6							4.5		EP										6		
8 SP	C	0.5	–2.0	1	1.5		3	3	3	1.5	3		3				3			2	1	4	1		
										–1	0.5		0.5				–1.5			–1.5	–3.5	–0.5	–4.5		
	D	–2.0	–0.0	–5	–4.5		–2.5	–2.5	–2.5	2.5	2.5		2.5				4.5			3.5	4.5	4.5	5.5		
				6	6		5.5	5.5	5.5																
7 beSP	D–E	–2.5		1.5	2		4	4	3	2	3		3	4.5			5.5	5	4	2.5	2.5	5	3		
			– –							0.5	1.5		2	3			2	2.5	1.5	0	–1	1.5	–1.5		
	E	–3.0	5.0	–4	–3.5		–0.5	–0.5	–1.5	1.5	1.5		1.5	1.5			3.5	2.5	2.5	2.5	3.5	3.5	4.5		
				5.5	5.5		4.5	4.5	4.5																
6 spBE				1.5	2.5		5	5.5	3	2	3	4	5	6	5.5	6	6	5.5	4.5	3		5	4.5	3.5	
								1.5		1	2	3	4	5	4.5	4.5	4	3.5	2.5	1		2	1.5	–1(–3)	
				–3.5	–2.5		1		–1	1	1	1	1	1	1	1.5	2	2	2	2		3	3	4.5	
				5	5		4	4	4																
5 firBE	4.5	3		1	2.5	2.5	4.5	5	3	1	4	4	5	6	5.5	6	6	5.5	4.5	2.5	2	5	2	5	6
										0	3	3	4	5	4.5	4.5	4	3.5	2.5	0.5		2		2	2
	1.5	–1		–4	–2.5	–2.5	0.5	1	–1												–1		–1		
	3	4		5	5	5	4	4	4	1	1	1	1	1	1	1.5	2	2	2	2	3	3	3	3	4
4 BE	4.5	2.5	1	1	2.5		4	5	3	1	4	4	4.5	5.5	5.5	6	6	5	4	2		5	5		
										0	3	3	3.5	4.5	4.5	4.5	4	3	2	0		2	2		
	1.5	–1.5	–4	–4	–2.5		0	1	–1																
	3	4	5	5	5		4	4	4	1	1	1	1	1	1	1.5	2	2	2	2		3	3		
3 oakBE	4.5	2	1	1	2		3.5	4.5	2.5	1	3	3	4	5	5	5.5	6	5	3.5	2	2	4.5	3	5	6
										0	2	2	3	4	4	4	4	3	1.5	0		1.5	0	2	3
	1.5	–2	–4	–4	–3		–0.5	0.5	–1.5												–1				
	3	4	5	5	5		4	4	4	1	1	1	1	1	1	1.5	2	2	2	2	3	3	3	3	3

Set of forest types	transitional			extreme			exposed			acid			fertile				pseudogley				waterlogged			alluvial	
	W	C	X	Z	Y	J	A	F	N	M	K	I	S	B	H	D	V	O	P	Q	T	G	R	L	U
2 beOAK	4 / 1 / 3	2 / −2 / 4	1 / −4 / 5	1 / −4 / 5			2 / −2 / 4		2 / −2 / 4	1 / 0 / 1	2 / 1 / 1	2 / 1 / 1	3 / 2 / 1	4 / 3 / 1	4.5 / 3.5 / 1	4.5 / 3.5 / 1.5	5 / 3.5 / 1.5	4.5 / 3 / 1.5	3 / 1 / 2	2 / 0 / 2				6 / 4 / 2	
1 OAK		2 / −2 / 4	1 / −4 / 5	1 / −4 / 5		2 / −3 / 5	2 / −2 / 4		2 / −2 / 4	2 / 1 / 1	1.5 / 0.5 / 1	2 / 1 / 1	3 / 2 / 1	4 / 3 / 1	4 / 3 / 1	4.5 / 3 / 1.5	5 / 3.5 / 1.5	4.5 / 2.5 / 1.5	3 / 1 / 2	2 / 0 / 2	2 / −1 / 3	2.5 / −0.5 / 3		6 / 4 / 2	6 / 4 / 2
0 PI		1.5 / −2.5 / 4	1 / −4 / 5	1 / −4 / 5	2.5 / −2.5 / 5				2.5 / −1.5 / 4	1 / 0 / 1	2 / 1 / 1							4 / 2 / 2	2 / 2	1 / −1 / 2	1 / −2.5 / 3.5	4.5 / 1.5 / 3	1 / −4 / 5		

A cardinal background material for project elaboration was the work of Plíva (1998) [*Methods and Intensity of Forest Management According to Forest Type Groups (FTG)*] elaborated for the Ministry of Agriculture of the Czech Republic in 1998 as well as the same author's work *Intensity of Management with Respect to Ecological Characteristics of Forest Type Groups* presented in 2000 and quantification of operational parameters elaborated by M. Sloup. The goal of Plíva's work was to draw up a guideline for the application of FTG in differentiated forest management based on a sustainable management concept as well as its effectiveness.

The author links up to his own works for broadly envisaged management complexes and he modifies the respective data to the new concept, he determines them for selected FTG, and amends them with new information for multi-purpose use. FTGs are combined according to the intensity and purpose of management.

Based on the comparison of potential production of target composition (PP) with a degree of the system's environmental functions significance (EP) five degrees of management intensity (IM) are created with several types of target management defined by nature characteristics and major target species. Both these broadly envisaged units provide comprehensive orientation in basic principles, however they do not substitute FTG neither management set of stands.

As the author states, the work deals with an assessment of real possibilities of sustainable forest management implementation with respect to the current forest conditions and also the valid legal regulations. The author claims that contrary to the frequently presented and fairly simplified idea of generous transformation of present mostly monocultural types into mixed and optimally structured stands this work transforms the conditions into more real ideas and more achievable targets.

In this work management intensity forms a basic framework for grouping FTG according to intensity.

Active impacts of a stand upon the environment are expressed by its environmental functions, i.e. positive influences of the forest upon its environment. Their synergetic action within an FTG constitutes then the ecological potential (EP) similarly like the production function (value of production) determines the production potential (PP) of the FTG.

The ecological and production potentials affect the management intensity as quantitative indicators. As the two potentials act in relation to management intensity in reverse directions (with an increasing

Table 2. Total effect of wood production function and quantified non-wood forest functions according to sets of forest types (SFT) within ecological network of typology system (thousands CZK/ha/year) (variant: clear-cutting system)

Set of forest types																								
	transitional			extreme			exposed			acid			fertile				pseudogley				waterlogged			alluvial	
	W	C	**X**	Z	Y	**J**	A	F	**N**	M	K	I	S	B	H	**D**	V	**O**	P	Q	**T**	G	R	**L**	U
9 Dwarf pine																									
8 SP				10.5–5.7 SP	10.5–5.7 SP		6.5–5.7 SP	6.5–5.7 SP	10.5–5.7 SP	10.4–5.8 SP	11.4–6.6 SP		7.4–6.6 SP				7.6–6.8 SP			11.6–6.8 SP	6.5–5.7 SP	7.6–6.8 SP	10.5–5.7 SP		
7 beSP				10.5–5.7 SP	6.5–5.7 SP			9.4–8.9 SP	11.3–5.8 SP	11.4–6.6 SP	11.4–6.6 SP		7.4–6.6 SP	13.9 SP			11.1 SP	12.5 SP	7.4–6.6 SP	11.6–6.8 SP	7.6–6.8 SP	11.1 SP	11.6–6.8 SP		
6 spBE				10.6–5.8 SP	10.6–5.8 SP		12.2–11.5 SP	12.2–11.5 SP	13.8–9.0 SP	13.1–8.4 SP	13.1–8.4 SP	13.0–8.4 BE	12.7–12.9 SP	12.7–12.9 SP	13.8 SP	12.7–12.9 SP	13.8–13.0 SP	12.0 SP	13.7 SP	13.1–8.4 SP		11.1 SP	10.4 SP		
				5.1 BE	5.1 BE		9.8–11.4 BE	9.8–11.4 BE	13.0–8.4 BE	10.5–5.9 BE	13.8–11.4 BE		9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE								
5 firBE	6.8–6.2 OAK	9.0–8.4 BE		10.6–5.8 SP	10.6–5.8 SP	1.1 BE	12.2–11.5 SP	12.2–11.5 SP	13.8–9.0 SP	11.1–6.5 BE	9.7 SP	13.7 SP	12.7–12.9 SP	12.7–12.9 SP	13.8 SP	12.7–12.9 SP	13.8–13.0 SP	12.0 SP	13.7 SP	13.1–8.4 SP		11.1 SP	11.6–6.8 SP	6.8–6.2 OAK	
	9.8–11.4 BE			5.1 BE	5.1 BE		9.8–11.4 BE	9.8–11.4 BE	13.0–8.4 BE		9.0–8.4 BE	13.0–8.4 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE			10.8–6.2 OAK					
																				10.1–5.5 PI					
4 BE	9.8–11.4 BE	5.3–4.7 PI	1.1 BE	8.4–3.7 PI	4.4–3.7 PI		9.8–9.0 SP	12.2–11.5 SP	8.9 SP	9.3–4.7 PI	9.7 SP	13.7 SP	6.6–5.9 PI	12.7–12.9 SP	13.8 SP	12.7–12.9 SP	13.8–13.0 SP	12.0 SP	6.6–5.9 PI	9.1–4.5 PI		11.1 SP	11.1 SP		
		9.0–8.4 BE		5.1 BE	1.1 BE		9.0–8.4 BE	9.8–11.4 BE	5.3–4.7 PI	9.5–4.9 OAK	6.6–5.9 PI	10.6–5.9 PI	9.6–9.0 OAK	10.7–10.5 OAK	10.7–10.5 OAK	10.7–10.5 OAK	10.7–10.5 OAK	9.6–9.0 OAK	9.1–8.4 SP	9.5–4.9 OAK		6.8–6.2 OAK			
									5.5–4.9 OAK		9.0–8.4 BE	13.0–8.4 BE	9.0–8.4 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE		6.8–6.2 OAK						
									9.0–8.4 BE																

	Set of forest types																								
	transitional			extreme			exposed			acid			fertile				pseudogley				waterlogged			alluvial	
	W	C	**X**	Z	Y	**J**	A	F	**N**	M	K	I	S	B	H	**D**	V	**O**	P	Q	**T**	G	R	**L**	U
3 oakBE	9.8–11.4 BE	5.3–4.7 PI	1.1 BE	8.4–3.7 PI	4.4–3.7 PI	1.1 BE	9.8–9.0 SP	9.1–8.4 SP	8.9 SP	8.6–4.0 PI	6.8–6.2 OAK	9.1–8.4 SP	6.6–5.9 PI	12.7–12.9 SP	13.8 SP	12.7–12.9 SP	13.8–13.0 SP	9.6–9.0 OAK	6.8–6.2 OAK	5.5–4.9 OAK		11.1 SP	15.1 SP	6.8–6.2 OAK	
		5.5–4.9 OAK		5.1 BE	1.1 BE		9.0–8.4 BE	9.8–11.4 BE	5.3–4.7 PI	9.5–4.9 OAK	9.8–11.4 BE	9.8–11.4 BE	9.6–9.0 OAK	10.7–10.5 OAK	10.7–10.5 OAK	10.7–10.5 OAK	10.7–10.5 OAK	9.0–8.4 BE				6.8–6.2 OAK			
		9.0–8.4 BE							5.5–4.9 OAK		5.9–5.4 PI	5.9–5.4 PI	9.0–8.4 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE	9.9–9.6 BE								
									9.0–8.4 BE																
2 beOAK	6.8–6.2 OAK	5.3–4.7 PI	3.8–3.1 OAK	7.8–3.1 OAK			5.3–4.7 PI		9.3–4.7 PI	8.6–4.0 PI	10.8–6.2 OAK	6.8–6.2 OAK	6.8–6.2 OAK	9.6–9.0 OAK	9.6–9.0 OAK	9.6–9.0 OAK	9.6–9.0 OAK	9.6–9.0 OAK	10.8–6.2 OAK	9.1–4.5 PI		6.8–6.2 OAK			
		5.5–4.9 OAK					5.5–4.9 OAK		9.5–4.9 OAK	9.5–4.9 OAK	9.9–5.4 PI	5.9–5.4 PI								4.6–9.8 OAK					
1 OAK		5.3–4.7 PI	3.8–3.1 OAK	3.8–3.1 OAK		3.8–3.1 OAK	5.3–4.7 PI		5.3–4.7 PI	5.9–5.3 PI	6.8–6.2 OAK	6.8–6.2 OAK	6.8–6.2 OAK	9.6–9.0 OAK	9.6–9.0 OAK	9.6–9.0 OAK	9.6–9.0 OAK	9.6–9.0 OAK	6.8–6.2 OAK	9.1–4.5 PI				11.7–12.0 OAK	11.7–12.0 OAK
		5.5–4.9 OAK					5.5–4.9 OAK		5.5–4.9 OAK		5.0–4.5 PI	5.9–5.4 PI							6.1–6.0 PI	9.5–4.9 OAK					
0 PI		4.3–3.8 PI	4.3–3.8 PI	4.3–3.8 PI	4.3–3.8 PI				9.2–4.6 PI	7.8–4.7 PI	8.5–4.0 PI							10.2–5.6 PI		10.2–5.6 PI	4.3–3.8 PI		8.3–3.8 PI		
																				7.8–4.7 PI					

management intensiveness class B
management intensiveness class C
management intensiveness class D
management intensiveness class E
management intensiveness class A

ecological function the management intensity drops down to the level of protection forest, in the production function vice versa) it is possible to determine management intensity by comparing the potentials in the FTG (deducing EP from PP). Moreover both potentials have a comparable extent, they encompass the whole scale of potential possibilities of all FTGs in 6 degrees.

Starting from protection forests on one end with the exclusion of a more intensive production activity (not excluding cultivation) and forests the extra productivity of which allows the most intensive forms of management five groups were determined by associating FTGs with approximately the same degree of management intensity. The groups were designated by A, B, C, D, E and were identified by colours. Target management systems as well as some stand alternatives were distinguished and characterised within each set of stands.

Target management systems classified according to management intensity

FTGs combined according to the same management intensity represent different natural conditions and therefore also varied target compositions. For example, a limited management intensity (group D) is given by the low productivity of some pine sites within the category M or by exposed location in categories N, C or by harsh climate in the 8th forest age class or by adverse conditions of water-logged soils (categories Q, T, R). On the contrary, the very intensive form of management (group A) is related to rich sites of midmountains as well as alluvial ecosystems.

Such a broadly understood relationship of natural conditions and the target composition determine several types of target management, identified by a principal species, within a certain management intensity (MI).

General principles are then suited to conditions of the management class for such determined target management classes (within a MI).

Plíva (1998) determines 5 classes of management intensity (MI) (see Table 1).

MI A: Very intensive form of management
MI B: Intensive form of management
MI C: Moderate intensive form of management
MI D: Limited intensive form of management
MI D: Ecological alternative restricting the management to just necessary treatment

Basic approaches the following analysis of economic effectiveness stems from can be summarised into the following points:

- They follow closely on results of forest typology which induced in advance the idea of sustainable forest management;
- They strictly respect the differentiated management intensity with allowing more space to natural regeneration where artificial interventions are redundant;
- The effect of production functions is expressed in the value of potential production which is not related to the present stand conditions and composition;
- All calculations are performed for sound, undamaged stands.

Operational parameters of management

The classes of management intensity differ in a necessary extent of operations (activities) at the following stages:

in an established culture (for example):

- by the proportion of possible natural regeneration (conditioned by site quality, species composition of parent stand and technical measures),
- by the proportion of necessary artificial regeneration given mainly by:
  - the kind of regenerated species (price of plantings, planting technology, minimum number of plants per 1 ha),
  - an expected planting failure (need of afterplanting),
- the necessity (in the case of natural regeneration) or economic advantage (in the case of artificial one) to improve soil (mechanically, chemically, combination of both),
- after-harvest treatment of regenerated sites (control of damaged and improper advance regeneration, terrain grading after skidding, clearance of shrub layer, etc.),
- the need for slashwood cleaning (leaving it at the site, mechanical or manual piling, burning),
- the necessary tending of stands:
  - *protection from deer:*
    - chemical (repellent coating),
    - mechanical,
    - fencing (wood, wires),
    - individual protection (plastic),
  - *protection from weeds:*
    - mowing (whole area, striped, around single plants),
    - treading (around single plants),
    - chemical (whole area, striped, patches),
  - *protection from weevil:*
    - control,
    - direct protection (individual spraying of plantings).

Harvesting operations, wood market realisation and others were also analysed in the same detail.

The presented scheme of operational parameters was amended by data on total cost and timber sales classified according to management intensity, target management system, proportion of ameliorating and improving species, ratio of natural regeneration for clear-cutting (or shelterwood) system and for the present (or predicted) stand conditions.

Selection of criteria for management profitability assessment

A cardinal issue of the whole project is to select and calculate an appropriate index that would define the effect of forest production functions (wood production functions) as precisely as possible.

There is a wide range of indices:

- volume of production expressed as final mean annual increment (final MAI) or total mean annual increment (TMAI),
- volume of production expressed by total value mean increment (TVMI),
- volume of production expressed by mean value final increment (MVFI),
- average annual gross profit of forest production (GPFP),
- official prices of forest land and forest stands.

Value indices may be calculated as total, mean annual or capitalised.

These following indices seem feasible:

1. Index TVMI – in correspondence with Plíva's approach. If this index is preferred, we have to keep in mind the input data of Plíva's work are of older date and in any case it is necessary to use data recalculated for the present situation (because TVMI is constructed on the basis of market prices). Secondly, TVMI expresses the all-society effect of production in a better way.
2. Index GPFP (both total and annual). This index expresses the profit made by the forest owner from the exploitation of wood-production forest functions. On the other hand, this parameter seems the best basis for possible state's interest in forest management and then this category also bears the all-society aspect.

PROFITABILITY OF FOREST MANAGEMENT

Effect of production functions

The solution to the projects resulted in the elaboration of several hundreds of model calculations of forest management profitability, which stem from all available data (typological studies, yield tables, assortment tables, labour standards), and rich empirical experience of the research team.

The major aim of the project assignment was to define optimum silvicultural and logging measures based on typological data and to calculate economic effectiveness of forest management and to classify it theoretically and practically feasibly. The results proved the "set of forest types" to suit the best.

Based on the partial calculations the following variants of forest stand management profitability were elaborated (classified according to management intensity, group of forest types, management system, proportion of ameliorating and improving species, and proportion of natural regeneration):

1. Profitability of clear-cutting management system calculated on:
   a) present stand production,
   b) predicted stand production.
2. Profitability of shelterwood management system calculated on:
   a) present stand production,
   b) predicted stand production.

An overview of economic calculation results is shown in Table 3. Table 3 illustrates the decreasing effect of wood-production function and dropping labour inputs in dependence on dropping management intensity.

Effect of other production functions

Production of forest berries, their collection and use has a dual position and character in the Czech Republic. It belongs to positive externalities of both mediated market nature for its material contents and a non-market nature as a part of recreation activities. It namely includes products not related to standing timber – forest berries (bilberries, raspberries, cranberries, blackberries etc, mushrooms, medical plants and other) but the output also often consists in relaxation and recreation.

The mentioned production has concurrent material and immaterial nature. The outputs are of physically material nature however some authors classify them into immaterial (social, off-market) outputs as a part of recreational functions.

Forest owners and forest visitors (pickers) consume them to a great extent themselves and do not realise them at the market. However, in such case they consume them cost free instead of similar products (namely of agricultural origin) produced intentionally and purchased at the market. Then their consumption concerns the market indirectly but significantly in our country. For the main, those

Table 3. Relationship of selected economic indices to management intensiveness class (in thousand CZK/ha) (variant: clearcutting management, present stands production)

Target management	Spruce					Beech				
Management intensiveness	A	B	C	D	E	A	B	C	D	E
Number of analysed variants	3	3	16	22	6	2	2	4	4	2
Wood sales (Planned final cutting)	1.361 (1,245)	1.235 (1,009)	1.235 (755)	980 (630)	691 (678)	1.238	1.099	1.356 (812)	1.099 (868)	145
Wood sales (Planned advanced felling)	219	133 (86)	113 (48)	46 (41)	0	147	99	87 (54)	79 (47)	0
Total costs of established culture	130	95 (88)	112 (56)	80 (52)	60 (42)	170 (102)	127 (86)	114 (77)	109 (74)	84 (57)
Total costs of logging	69 (64)	64 (63)	71 (58)	72 (60)	72 (70)	63	57	62 (55)	57 (50)	55
Overall total costs	289 (281)	221 (204)	225 (153)	168 (135)	138 (118)	304 (236)	233 (192)	211 (169)	204 (159)	149 (123)
Annual gross forest production profit (AAGFPP)	12.98 (10.98)	11.61 (8.36)	11.54 (5.06)	8.98 (4.68)	5.70 (4.39)	9.56 (6.57)	8.38 (5.85)	11.41 (4.12)	8.40 (4.76)	0.20 (–0.69)
Target management	Pine					Oak				
Management intensiveness	A	B	C	D	E	A	B	C	D	E
Number of analysed variants	0	2	40	32	7	4	2	2	2	2
Wood sales (Planned final cutting)*		795	790 (558)	600 (441)	487 (448)	2,004 (1.533)	1.309	945	766	517
Wood sales (Planned advanced felling)	0	47	74 (22)	25 (18)	0	112 (44)	50	24	11	0
Total costs of established culture	0	139 (120)	113 (57)	98 (52)	78 (5)	178 (107)	128 (87)	113 (77)	106 (72)	82 (57)
Total costs of logging	0	51	58 (47)	66 (46)	52 (50)	58 (47)	51	47	53	46
Overall total costs	0	228 (209)	197 (132)	177 (122)	133 (58)	298 (217)	225 (184)	200 (164)	180 (146)	141 (115)
Annual gross forest production profit (AAGFPP)	0	5.88 (4.16)	6.52 (2.70)	4.70 (2.02)	3.78 (2.06)	13.98 (6.89)	9.04 (5.40)	6.20 (3.74)	4.88 (2.27)	3.09 (0.78)

If there are two data within one MI and management type then the first one represents the maximum and the second one the minimum effect of other production functions

products pass through the market indirectly and affect the economic effectiveness of consumption and market. Therefore the mentioned commodities have the character of externalities of mediated market nature, they influence market relationships. They ought to be considered seriously in calculations of social-economic effectiveness of forest and forestry because their social-economic effect in the Czech Republic does not seem negligible.

Social-economic significance of the material aspect of non-wood production forest services can be evaluated namely on the basis of shadow market relationships, that is on the basis of shadow profit – shadow sales. Their material importance can be evaluated as a component of the block of so called health-hygienic forest services – non-recreational forest services. In abroad the assessment is namely done using the willingness-to-pay approach and most often with polling. However in Czech conditions still the expert assessment approach seems the most suitable with a substantial consideration of opinion and assessment of users of forest recreational services themselves, i.e. the inhabitants, indeed.

Based on an extensive research carried by the team of the FF CUA in Prague (see more in Šišák et al. *Monetary evaluation of social-economic importance of basic non-production forest services in the CR*, Final report, Project NAZV EP 921/99, Prague 2000) our calculations include also benefit from non-wood production forest functions in two variants:

1. in bilberry and cranberry forest type groups the effect of wood production function was increased by 4.9 thousand CZK per hectare per year,
2. in other forest type groups by 0.9 thousand CZK per hectare per year.

Result values are presented in Table 2 which shows the whole range of possible benefit of production functions (from the minimum benefit of pure wood-production function to the maximum of all production functions).

As the assignment of the above mentioned analysis assumes a priori optimum fulfilment of environmental forest functions this table should also give complex information not only on economic but also ecological-economic effectiveness of sustainable forest management in our country in required detail and differentiation.

However it is necessary to consider Table 2 provide information only on one possible management variant – a clear-cutting management system and on production of the present stands. Comparison of clear-cutting and shelterwood management systems, which is rather difficult, was not solved within this project, and would require a separate study that we will strive to submit to publishing.

Similarly important issue that would require a separate analysis concerns the question of predicted stand development and also the development of total prime costs in forestry.

These questions should be addressed by further hypotheses and analyses clarifying the profitability of sustainable forest management in the Czech Republic.

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Ekonomická efektivnost trvale udržitelného obhospodařování lesů

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ABSTRAKT: Příspěvek pojednává o ekonomických aspektech trvale udržitelného hospodaření v lesích. Analýza vychází ze zásad Plívova typologického systému a kvantifikace provozních parametrů, zpracovaných Sloupem. Bylo vykalkulováno několik set variant rentability pěstování lesních porostů v členění podle intenzity hospodaření, cílového hospodářství, podílu melioračních a zpevňujících dřevin, podílu přirozené obnovy a podle souborů lesních

typů. Dosažené výsledky ukazují jednak možnosti úspory vynaložené práce, jednak značnou diferenciaci efektu dřevoprodukční funkce v závislosti na přírodních a výrobních podmínkách a intenzitě hospodaření.

Klíčová slova: ekonomická efektivnost; trvale udržitelné obhospodařování lesů; intenzita hospodaření; hrubý zisk lesní výroby; oceňování

Jedním z prioritních úkolů státní lesnické politiky i lesnické veřejnosti je realizace trvale udržitelného obhospodařování lesů. Diskuse o principu přírodě blízkých způsobů obhospodařování nabývá na intenzitě a problematikou se více či méně zabývají všechny zainteresované strany. Uskutečňování tohoto cíle je komplikováno kontinuálně pokračujícím vyhrocováním dvou protichůdně působících procesů – na jedné straně klesající ekonomickou efektivností lesní výroby a na druhé straně rostoucím tlakem na poskytování environmentálních služeb ze strany odvětví lesního hospodářství. Toto dilema je markantní zejména v případě obhospodařování marginálních a submarginálních lesních porostů a majetků. Nalezení či hledání určitého ekologicko-ekonomického optima hospodaření patří mezi prioritní problémy odvětví lesního hospodářství. Pravděpodobně dozrála doba pro to, aby se využily všechny dosavadní zkušenosti, dosud prezentované a roztříštěné na různých úrovních, a založil se program, který by komplexně a systémově vyhodnotil jednotlivé názory, návrhy a ideje a zpracoval pokud možno ucelený soubor technologických a ekonomických parametrů principu trvalosti, tj. zejména:

– opatření a postupů obnovy a ochrany lesních ekosystémů,
– vyhodnocení a návrh na využití diferencovaných a optimálních těžebních, dopravních a obnovních technologií, splňujících kritéria trvalého hospodaření,
– vyhodnocení ekonomických dopadů transformace současného modelu hospodaření na model přírodě blízkého obhospodařování lesů.

Naznačené problémy začala řešit katedra ekonomiky a řízení lesního hospodářství Fakulty lesnické a environmentální České zemědělské univerzity v Praze v rámci výzkumného záměru Ministerstva školství, mládeže a tělovýchovy ČR č. 414100006 *Víceúčelové lesní hospodářství v limitních sociálně ekonomických a přírodních podmínkách.*

Kardinálním podkladem pro zpracování projektu byla práce Plívy *Způsob a intenzita obhospodařování lesů podle souborů lesních typů*, zpracovaná na objednávku Ministerstva zemědělství ČR v roce 1998, práce téhož autora *Intenzity hospodaření s ohledem na ekologické charakteristiky souborů lesních typů*, předložená v roce 2000, a kvantifikace provozních parametrů hospodaření, zpracovaná M. Sloupem.

Cílem práce Plívy bylo vypracovat metodický postup využití souborů lesních typů (SLT) pro diferenciaci obhospodařování lesa podle koncepce trvale udržitelného hospodaření i jeho efektivnosti.

Autor navazuje především na vlastní práce pro šíře pojaté hospodářské soubory s tím, že příslušné údaje přizpůsobuje této nové koncepci, upřesňuje je pro vybrané SLT a doplňuje o další informace pro víceúčelové využití. SLT sdružuje podle intenzity a cíle hospodaření.

Intenzita hospodaření vytváří v této práci základní rámec pro sdružování SLT do skupin podle intenzity a shora uvedených zásad a opatření. Při shodné intenzitě hospodaření se tyto obecnější zásady a opatření více přizpůsobují cílové skladbě v „cílových hospodářstvích" (tab. 1).

Základní přístupy, ze kterých vycházelo hodnocení efektivnosti, jsou tyto:

– úzce navazuje na výsledky typologie lesů, která byla v předstihu nositelem myšlenky trvalosti obhospodařování lesů,
– striktně zohledňuje diferencovanou intenzitu hospodaření při ponechání více prostoru přirozenému vývoji lesa tam, kde jsou umělé zásahy nadbytečné,
– efekt produkčních funkcí je vyjádřen hodnotou potenciální produkce, která se nevztahuje k současnému stavu a skladbě porostů,
– všechny kalkulace jsou provedeny pro zdravé, nepoškozené porosty.

Jedním ze stěžejních problémů celého projektu byl výběr a kalkulace vhodného ukazatele, který by co nejpřesněji definoval efekt produkčních funkcí lesa (spíše ovšem dřevoprodukční funkce).

K využití se nabízí celá škála ukazatelů:

– objem produkce, vyjádřený jako průměrný mýtní přírůst (PMP) nebo celkový průměrný přírůst (CPP),
– objem produkce, vyjádřený celkovým hodnotovým průměrným přírůstem (CPPH),

– objem produkce, vyjádřený průměrným hodnotovým mýtním přírůstem (PMPH),
– průměrný roční hrubý zisk lesní výroby (HZLVr),
– úřední ceny lesních pozemků a lesních porostů.

Hodnotové ukazatele mohou být navíc kalkulovány jako celkové, průměrné roční či kapitalizované.

Perspektivní se jeví využití zejména:

1. ukazatele CPPH – v souladu s přístupem Plívy. Při jeho preferenci je ovšem třeba mít na paměti, že vstupy použité v jeho práci jsou staršího data a v každém případě je nutné použít údaje přepočtené pokud možno k současnému stavu (protože CPPH je konstruován na bázi tržních cen). Je nutné připomenout, že ukazatel CPPH vyjadřuje spíše celospolečenský efekt dřevoprodukční funkce lesa;
2. ukazatele HZLV (ať již celkového, či ročního). Tento ukazatel vyjadřuje efekt plynoucí vlastníkovi lesa z využívání dřevoprodukční funkce lesa. Tento parametr je zřejmě nejvhodnějším podkladem pro případný zájem státu na obhospodařování lesů, navíc má i tato kategorie aspekt celospolečenský.

Výsledkem řešení projektu bylo vypracování několika set variant modelových výpočtů rentability pěstování lesních porostů, které vycházejí ze všech dostupných podkladů (typologických prací, růstových tabulek, sortimentačních tabulek, výkonových norem) a bohatých empirických zkušeností širokého řešitelského kolektivu.

Hlavním smyslem projektového zadání bylo na základě typologických podkladů definovat optimální hospodářská opatření pěstební a těžební činnosti a vykalkulovat ekonomickou efektivnost pěstování lesních porostů v teoreticky schůdném a prakticky použitelném členění. Ukázalo se, že tomuto zadání nejlépe vyhovuje kritérium *soubor lesních typů*.

Na základě dílčích kalkulací byly zpracovány tyto varianty rentability obhospodařování lesních porostů (v členění podle intenzity hospodaření, souborů lesních typů, typu hospodářství, podílu melioračních a zpevňujících dřevin a podle podílu přirozené obnovy):

1. rentabilita holosečného hospodaření, vypočtená na základě:
   a) produkce současných porostů,
   b) predikované produkce porostů;
2. rentabilita podrostního hospodaření, vypočtená na základě:
   a) produkce současných porostů,
   b) predikované produkce porostů.

Celkový přehled výsledků ekonomických kalkulací je patrný z tab. 2 a 3.

Tab. 3 názorně ukazuje klesající efekt dřevoprodukční funkce a klesající vklady práce v závislosti na snižující se intenzitě hospodaření.

Jedním z konečných výstupů řešení projektů je tab. 2, ze které je patrné rozpětí ročního hrubého zisku lesní výroby (dřevoprodukční a ostatních kvantifikovatelných produkčních funkcí) v členění podle souborů lesních typů a cílového hospodářství. V tabulce jsou uvedeny limitní hodnoty tohoto agregovaného ekonomického parametru hospodaření.

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