

Physical Soil Protection in Harvesting Operations

-

Insights from Production-, Industrial- and Institutional Economics

Dr. Oliver Thees, WSL

50th FORMEC Symposium
25th – 29th September 2017
Brasov, Romania



Swiss Federal Institute for Forest, Snow and Landscape Research WSL

Soil protection in forestry – situation/background

European soil policy:

- European soil charta, 1972



- Implementation of a European soil protection strategy, 2012



Forest operations:

- Important element of sustainability concepts and highly relevant for forest practice

E.g., Switzerland:

- Political issue, public awareness
- Informal norms and sanctions
- NFI: no extreme damages
- Major Investments, additional costs

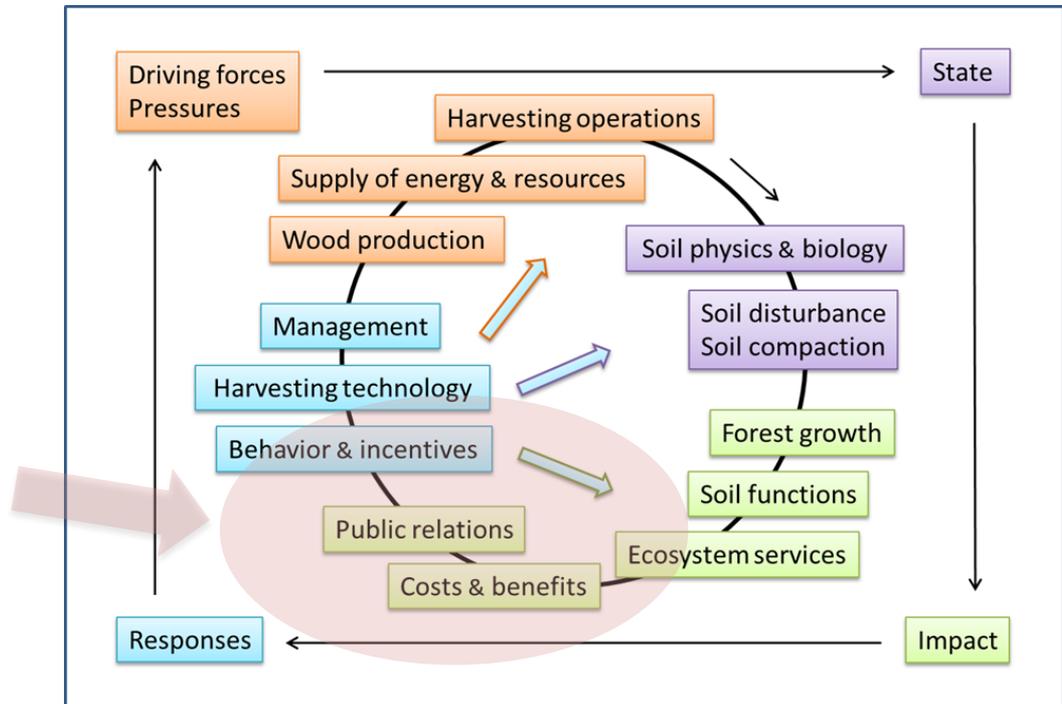


Soil protection in forest research

Main focus: physical and biological state and impact (especially tree growth) including technical aspects of the harvesting systems

Little research on the economic relations and the economical consequences (exception erosion)

A comprehensive economic analysis is lacking



The DPSIR indicator framework (Driving Forces, Pressure, State, Impact and Response) for describing the interactions between society and the environment – applied to economic dimensions of soil protection in forestry, especially soil compaction (EEA 1999, modified)

Three economic perspectives

1. The **production economic perspective** examines the impact on **production costs**
 - on the **enterprise level**.
2. The **industrial economic perspective** focuses on **competition** implications
 - on the **sector level**.
3. The **institutional economic perspective** concentrates on **incentives**
 - on the **human actor level**.

... help to identify and to systematise the economic effects of soil protection

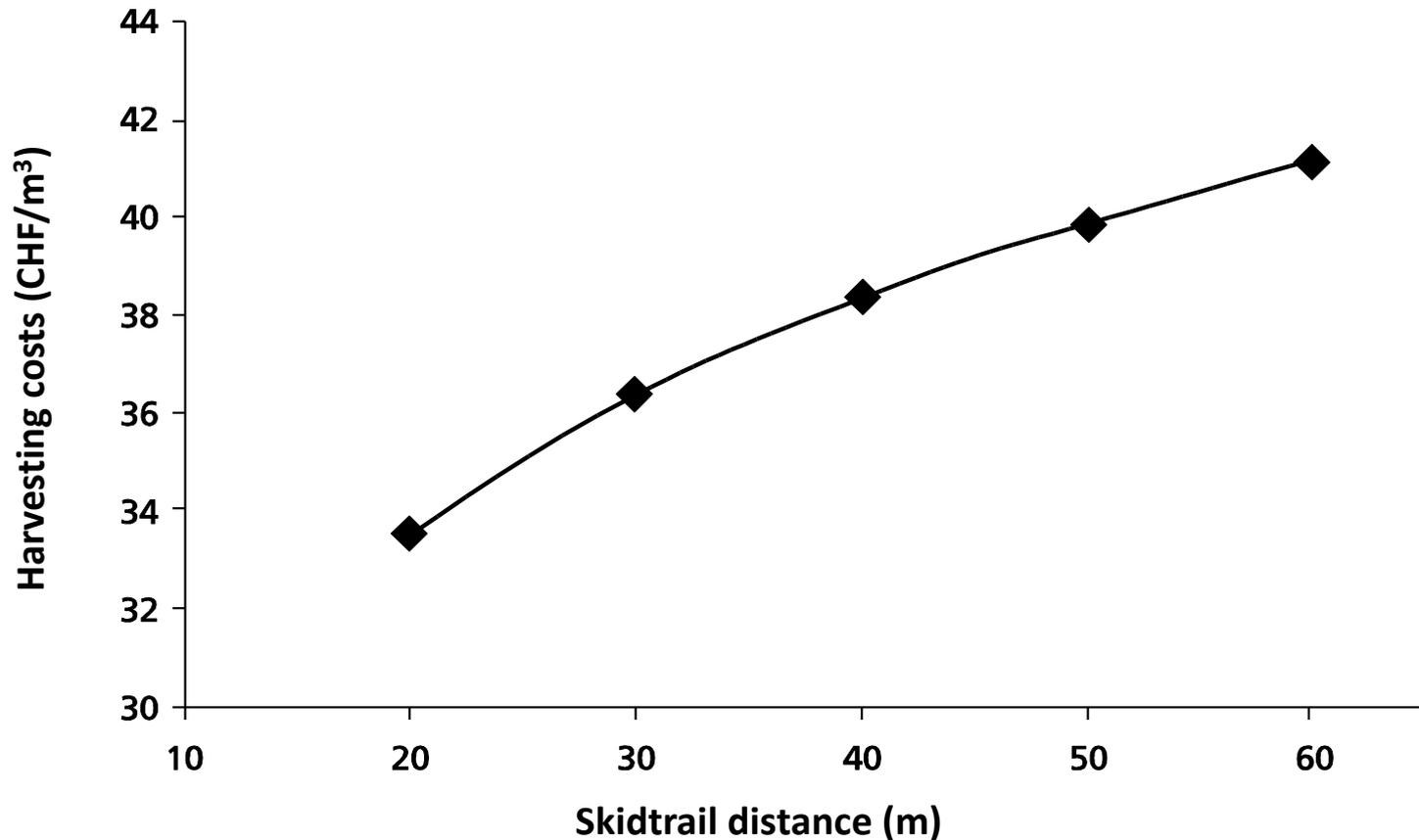
... allow a comprehensive analysis of the economic relations (complex systems)

... are crucial for an optimal implementation of soil protection

The production economic perspective

Harvesting costs of different skid trail distances

Model calculation, example, Switzerland, harvester/forwarder, spruce, total rotation time



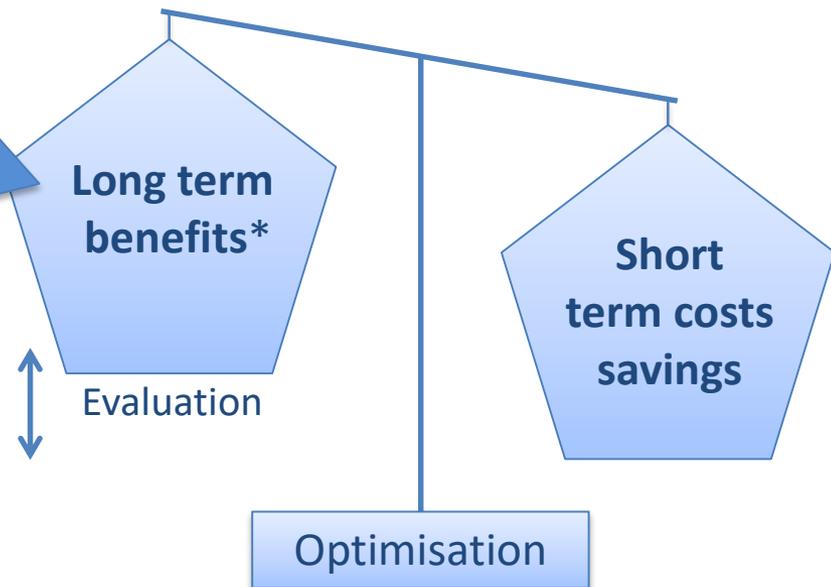
Jäger (2012)

The production economic perspective

Consideration of costs and benefits

*Avoiding possible soil damages caused by harvesting machinery:

- Growth losses
- Wood quality losses
- Revenue losses
- Risks of stand stability
- ...



The production economic perspective

Overview of cost-generating measures for physical soil protection from the perspective of a forest enterprise (Switzerland)

Management activity	Additional investments	Additional measures during individual logging operations	
		Fixed costs	Variable costs
Planning (enterprise)	Training of operations managers Mapping of soil sensitivity to vehicle impact Marking and documentation of the opening up	Determining alternative working areas	Increasing skid trail distance (>20m)
Steering (enterprise)	Training of machinery operators Software to assess soil trafficability Instruments to measure soil moisture Skidders with reduced wheel load	Suspension of work and transfer to alternative working areas Regeneration measures Controlling of operations	Machinery equipment*: Tyres of greater nominal width - Tyre pressure control system - Bogie tracks - Traction winch Reduction in passage of vehicles over soil, e.g. longer winching distance Skidding with reduced load or smaller, lighter machinery Switch from ground-based to cable-based harvesting systems
Monitoring (authority)		Inspections/prn sanctions	

Additional costs (CH)
0.5 - 5 CHF/m³

Bold, blue: basic measures ; * Specific soil-protecting machinery belonging to contractors

The industrial economic perspective

Focus on competition

Asking how the structure of a branch influences the market result

Switzerland (CH): oligopolistic structures on the demand side

Structural features (CH)

- High percentage of public forests (70%)
- Small scale enterprises (500 - 1000 ha)
- High percentage of certified forest

Impact (CH)

- Reduced competition
- Additional costs accepted
- No market power
- Hardly any passing of costs
- Certification is no big advantage

Good conditions for soil protection, forest owners bear the costs

The institutional economic perspective

Focus on incentives and control problems

Examines the effects of formal and informal rules on human behavior

Incentives forestry (CH)

- Legal regulations
- Special **principal-agent relation**: principal's (population) complaints about the agent (forest manager)
- Strong forestry professional ethos
- Green forest policy, high relevance of ES
- Initial and continuing education

Impact (CH)

Caution, precaution

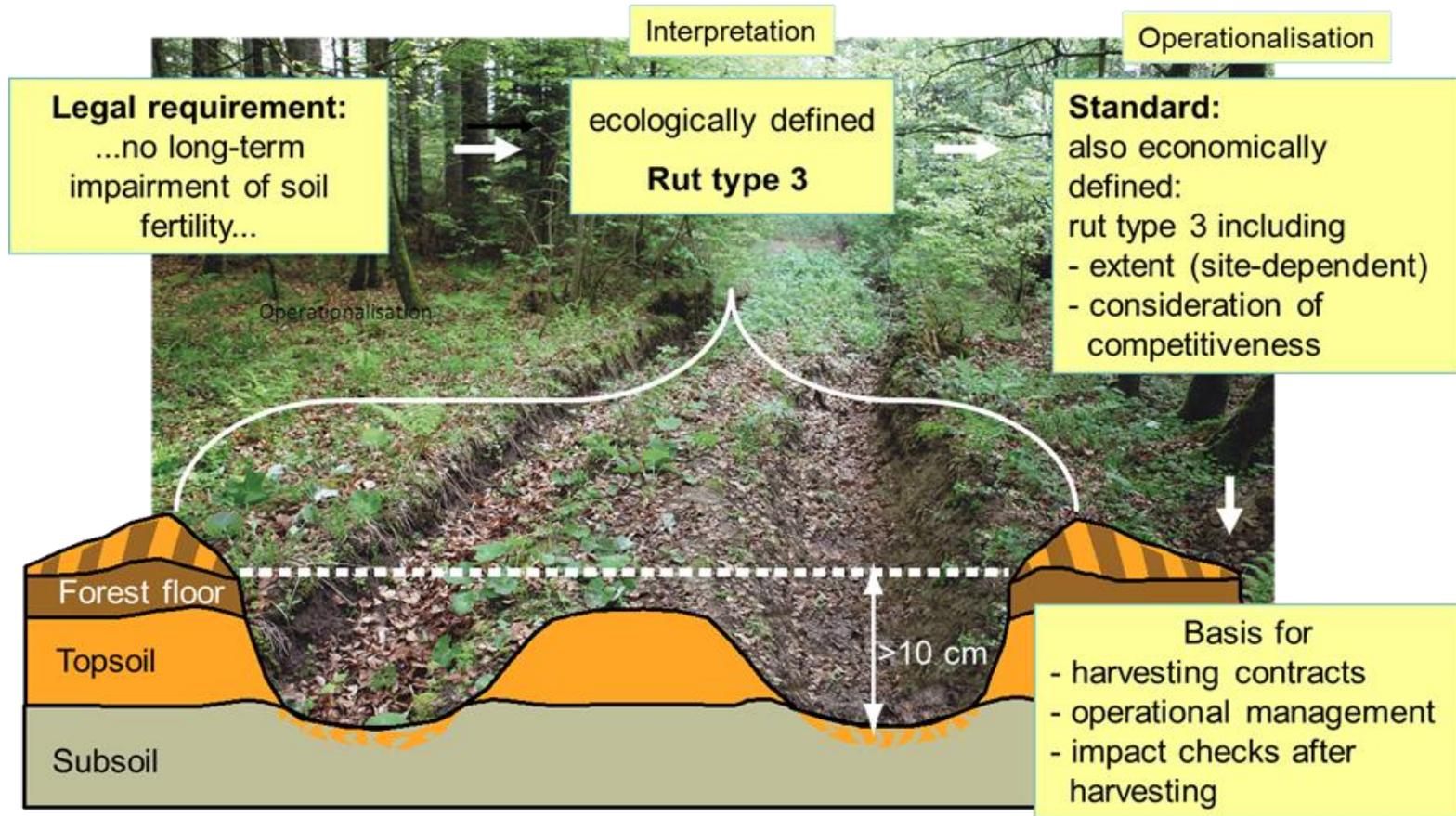
In case of disregarding soil protection:

- Trouble
- Effort
- Reputation losses
- Further awareness

State and society guarantee soil protection, soil protection becomes a norm

The institutional economic perspective

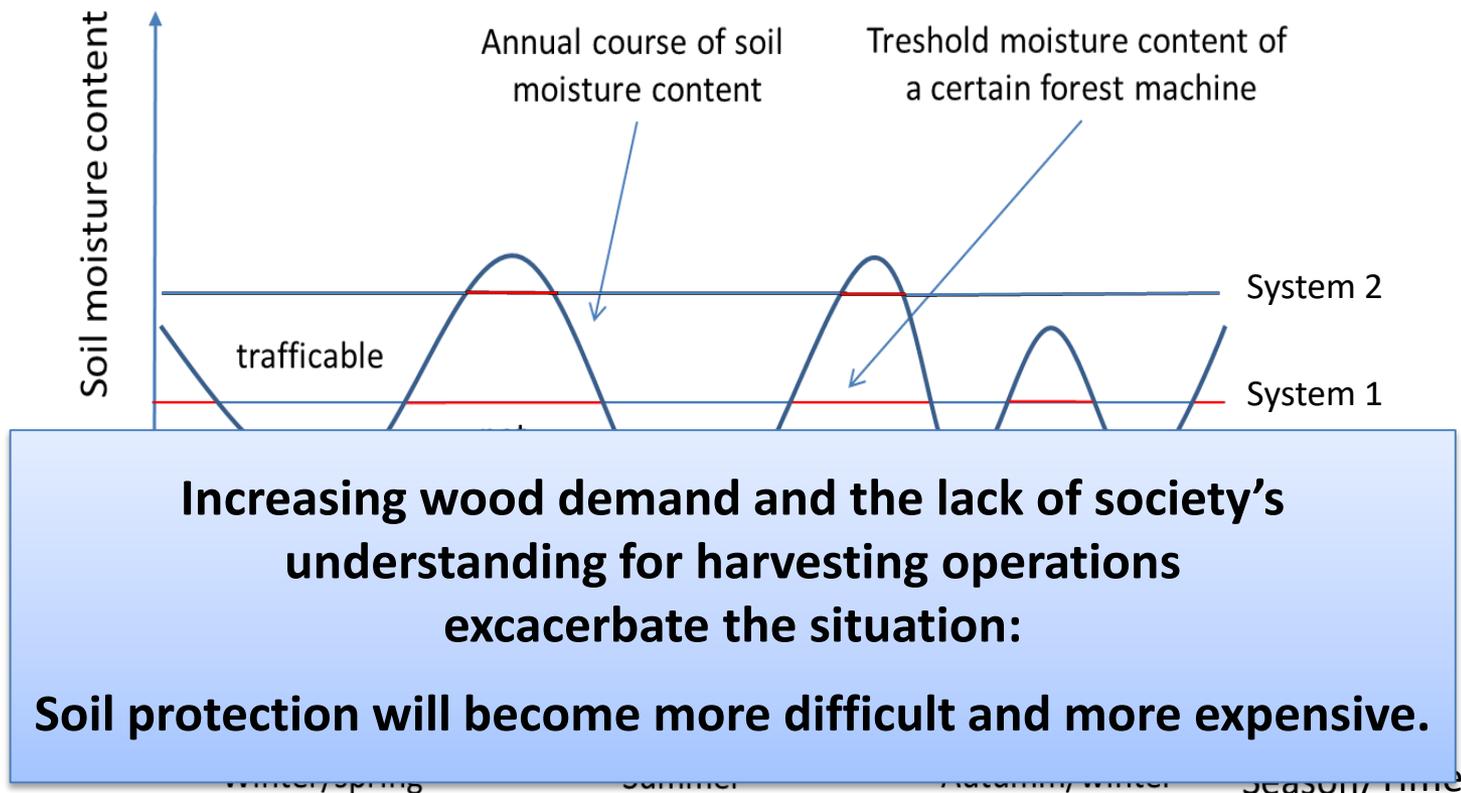
Concept for a quality standard on soil protection



Definition "Rut type 3" according to Lüscher et al. (2009, 2016): topsoil and subsoil disturbed, distinct bulges at the side.

Future challenges - climate change

Shorter harvesting period caused by poor terrain trafficability



Exemplary calculation of **soil-friendly operating days** for a certain groundbased machine on a certain soil under central European conditions 11

Conclusions

- Economic aspects of soil protection should be more considered - in science and in practise.
- The three economic approaches presented allow an overarching management of soil protection in forests.
- The potentials of improving efficiency in soil protection should be used.
- The long-term aspects of damages have to be taken into account.
- Soil protection should be balanced in the context of all dimensions of sustainability.





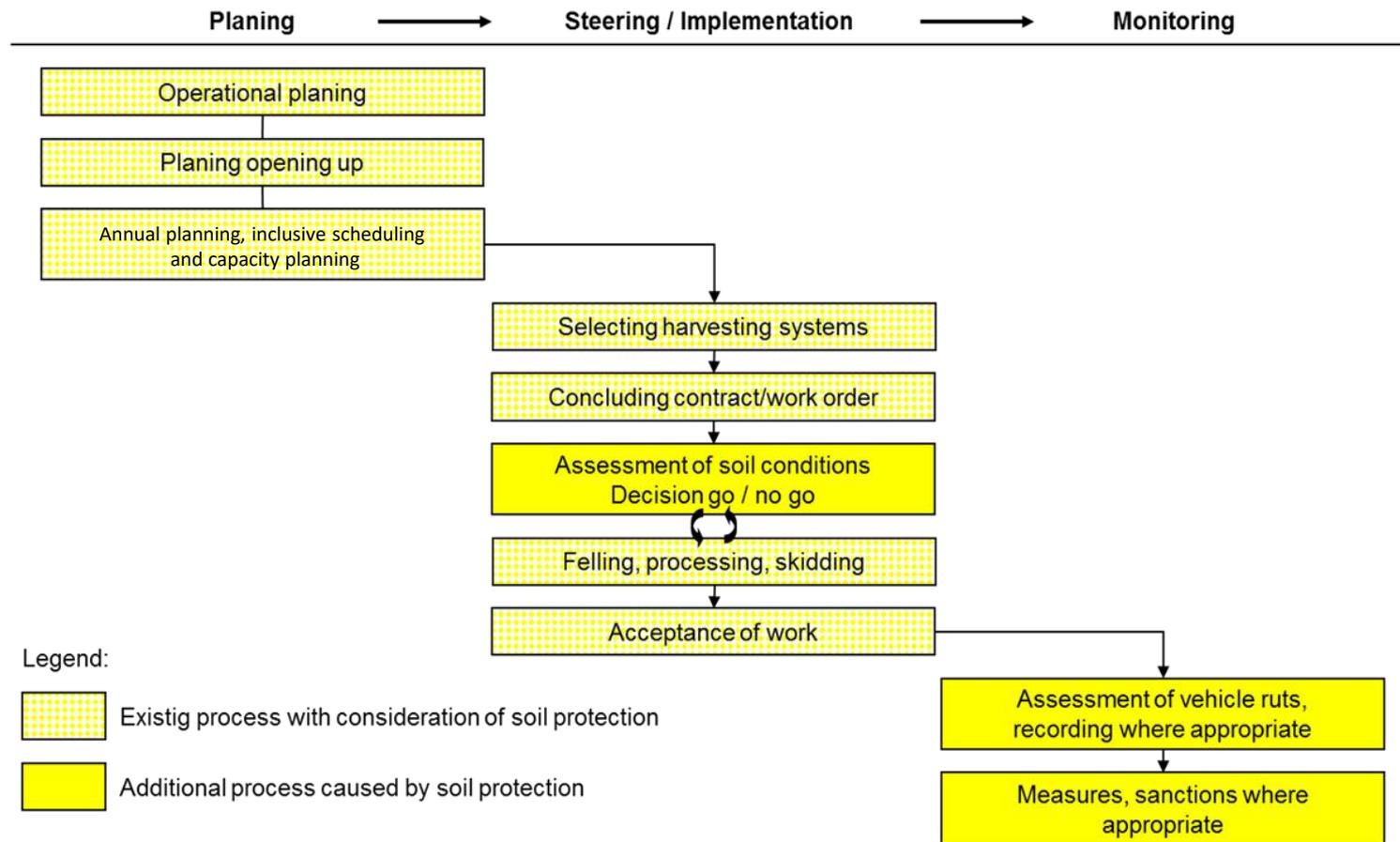
Thank you for your attention!

Complex system

- Soils are heterogenous natural systems
 - Effectiveness of soil protection measures often uncertain: invisible, longterm impact
 - Costs of measures (often)
 - difficult to determine
 - rather high
 - not scrutinised
 - born by forest owners
 - affect the competitiveness
 - Benefits of measures (more) difficult to quantify
- Strong interdependences of private and public goods
- Public interest affects decision making and behavior of forest managers

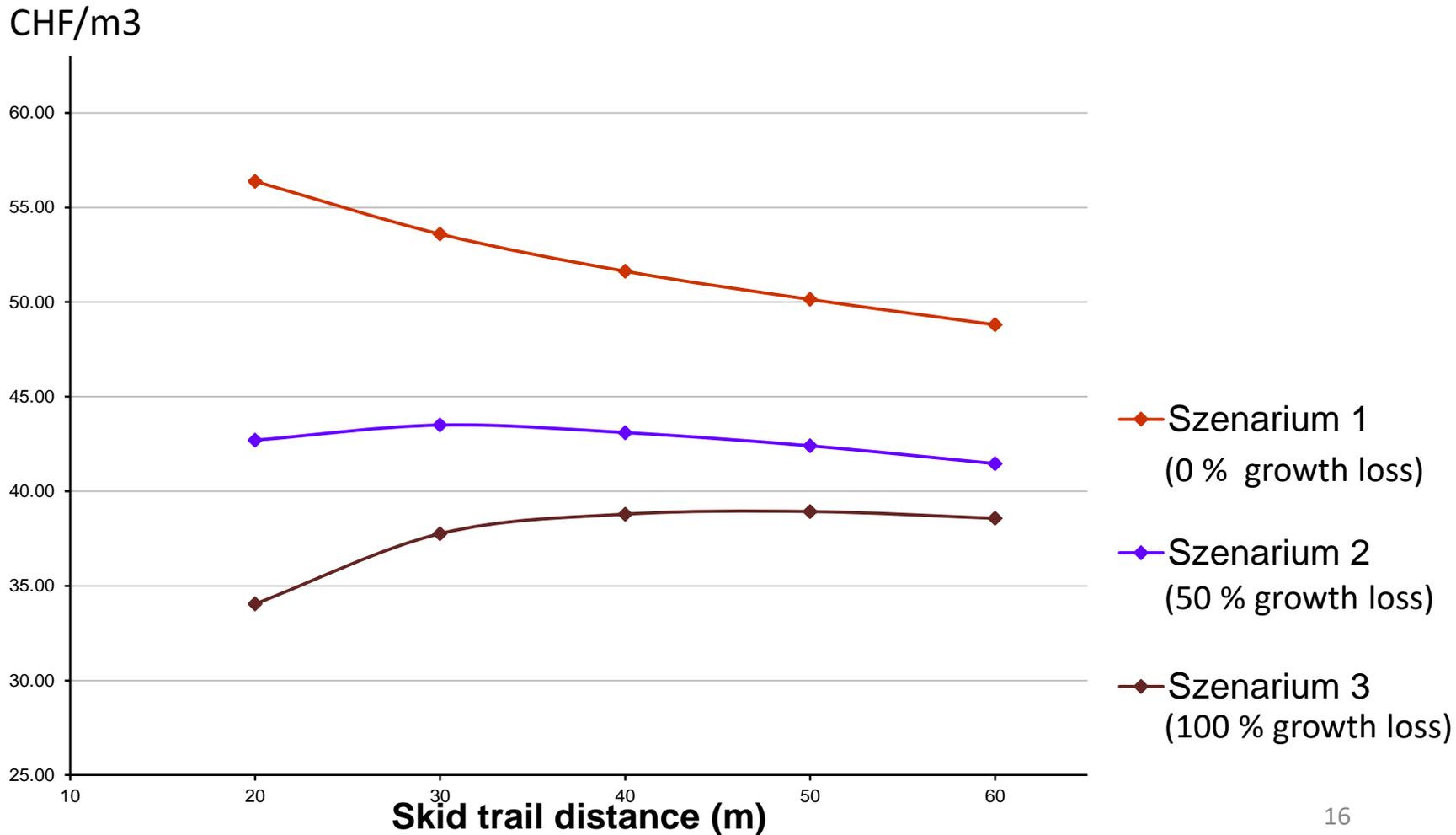


Integration of physical soil protection into the process of operational planning and implementation of timber harvesting and monitoring by public authorities



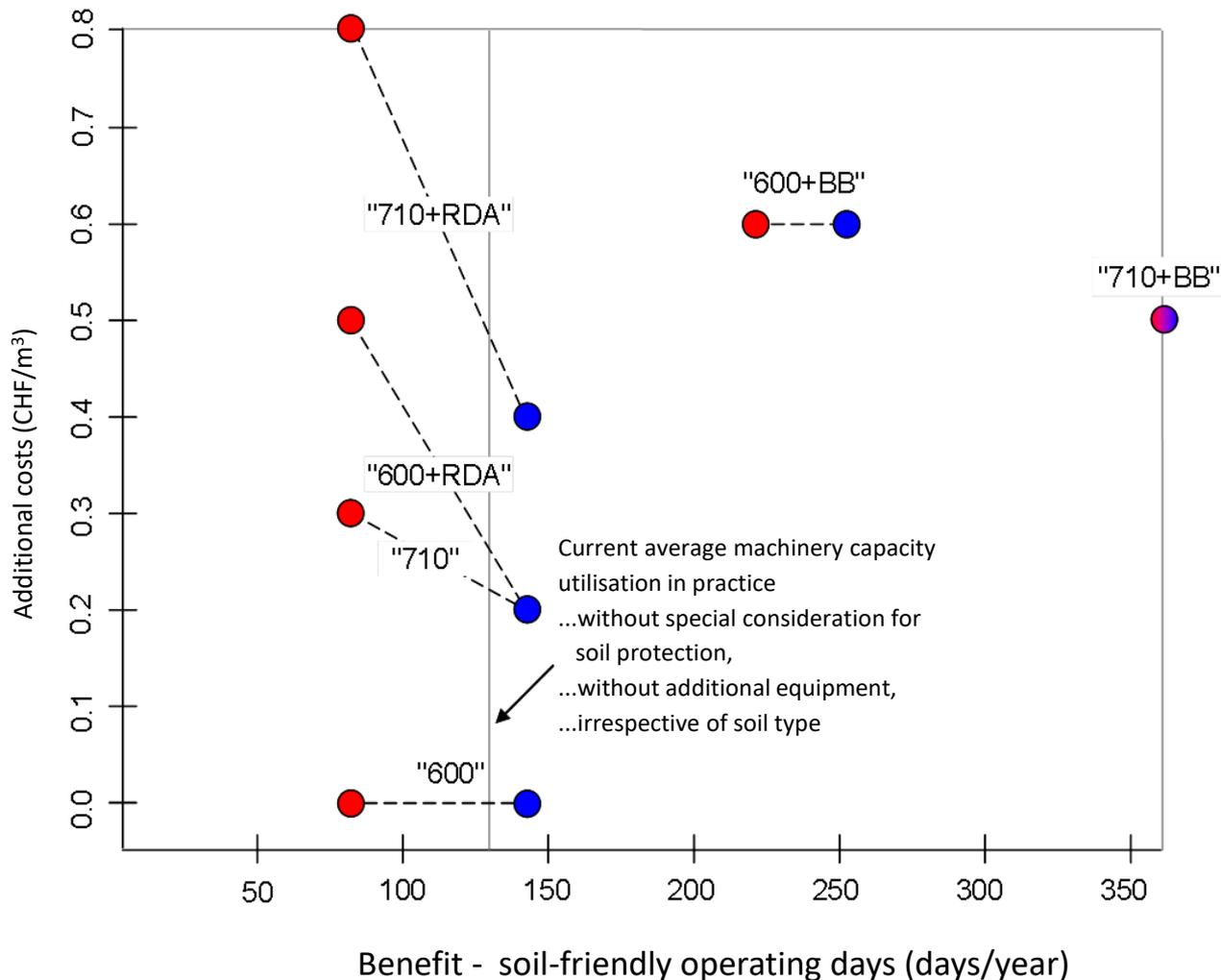
The production economic perspective

Harvest cost-free revenues in different scenarios of growth losses on skid trails (model calculations, example, Switzerland, Jäger 2012)



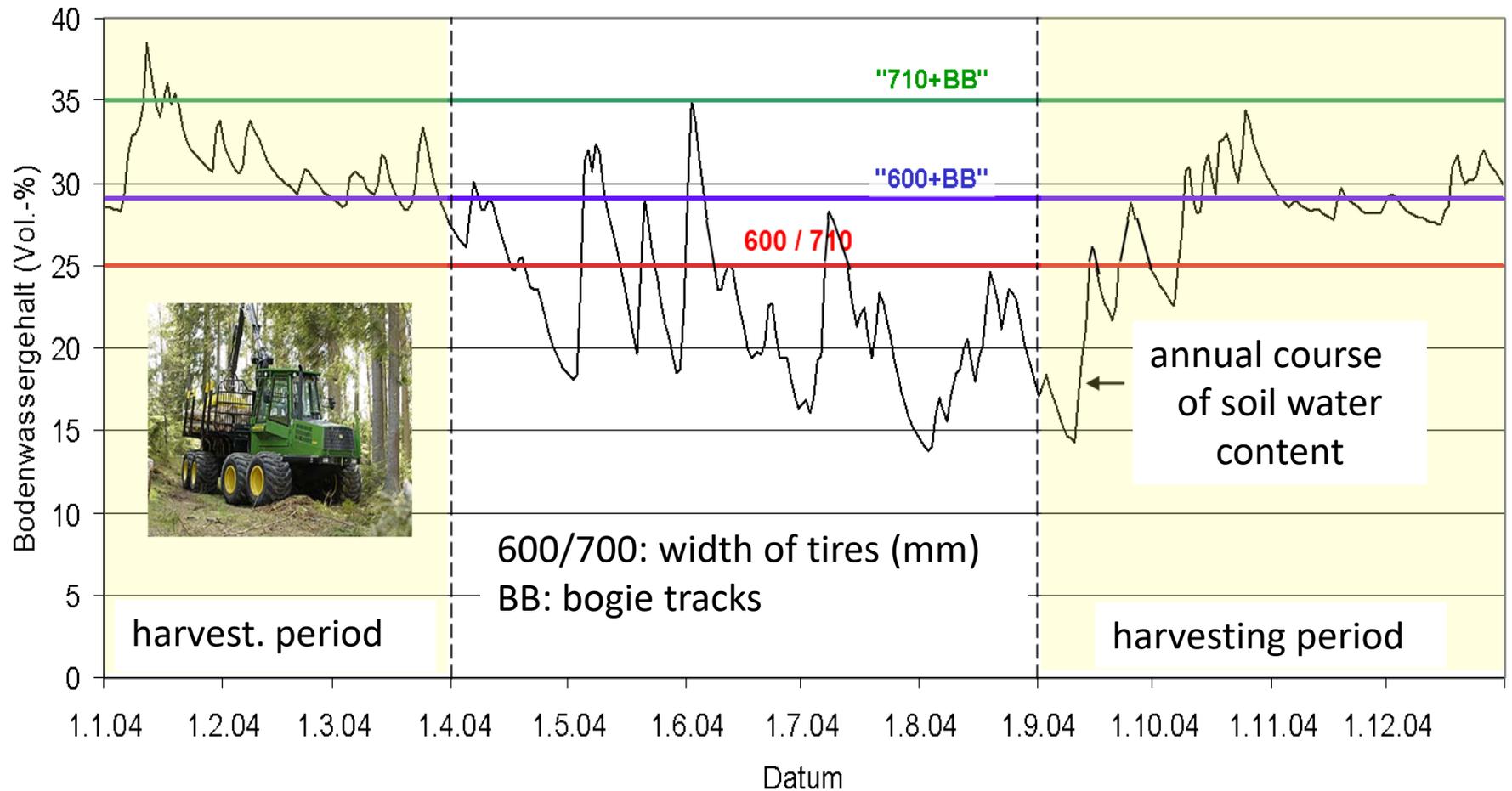
Cost-benefit relation

calculated for the John Deere 1110 D forwarder and for the year 2004, red = silty loam, blue = sandy loam, 600/710 = tyre width in mm; BB = bogie tracks; RDA = tyre pressure control system).



Modeling trafficability – marginal soil water content

e.g. Forwarder JD 1110 D on a sandy loam soil in 2004



Spjevak und Thees 2009

How to deal with a shorter harvesting period caused by poor terrain trafficability – principal approaches

Harvesting processes: especially **skidding and forwarding**

Harvesting time

enlarging – more months/period

- summer season ++

enlarging – more days/period

- technical equipment +++

enlarging – more hours/day

- shift working, night work

+

utilizing – more cubicmeter/hour

- productivity +++

Harvesting place

switching

- other soils and stands

Harvesting method

changing

- cable-based systems

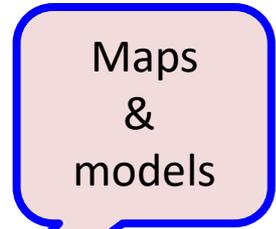
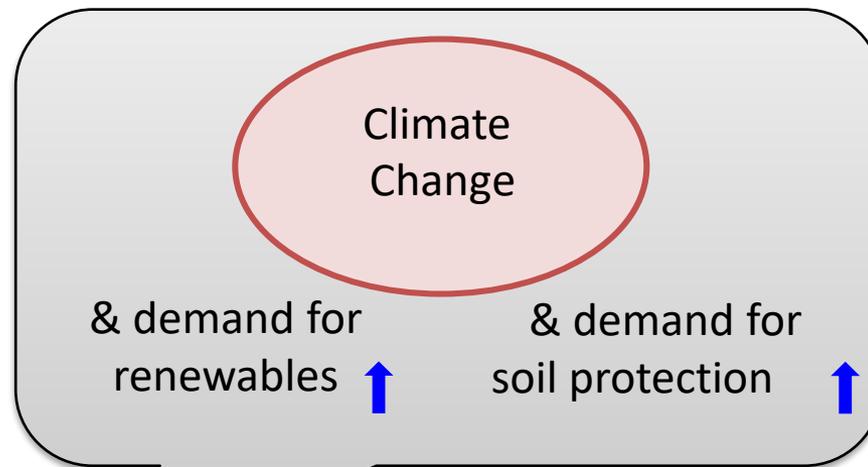
Reducing ground pressure

- wide-base tires
- reduced tire inflation pressure
- bogie tracks
- traction winch

> Modeling the marginal water content for operation planning and steering

+,++,+++: actual importance for CH

Summary & consequences



Physical soil protection in the forests will be more difficult & expensive:

- additional processes
- additional investments
-
- planning more sophisticated
- more monitoring & controlling

