ForHeal Forestry Higher Education Advancement in Laos

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Timber harvesting as a timber production phase Mechanized logging

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Contents and goals

- After this section, you will be able to:
- Differentiate different classes of harvesters to know where to use them properly
- Learn the basics of harvester construction
- Describe the harvester head & crane
- Understand the Cut-to-length harvesting technologies
  - Preparation of the stand
  - Harvester technology of CTL harvesting – fully or partially integrated
- Advantages and disadvantages of harvester technology

Classification of harvesters

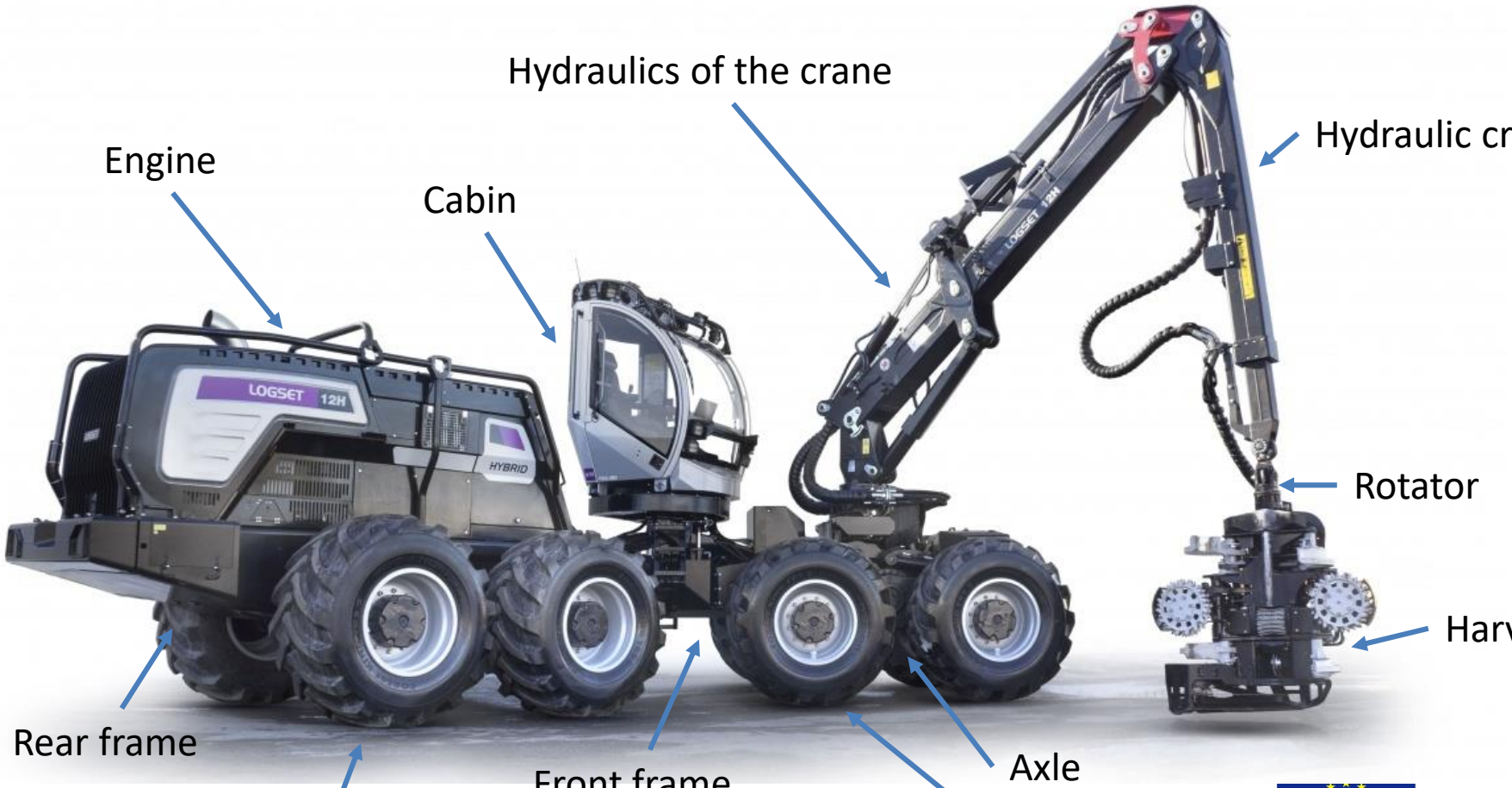
- Based on the size of processed stems
  - Small – younger coppices, forest cleaning operations
  - Medium – thinnings
  - Large – later thinnings, final cuts, salvage fellings
- Based on the type of chassis
  - Wheeled (most common)
  - Tracked
  - Walking
  - Combined

Harvester class	Small	Medium	Large
Engine power (kW)	<70	70-140	>140
Weight (t)	4-8	9-13	13-15
Width (cm)	160-200	240-280	260-290
Boom reach (m)	6	8.5-10	10-11
Tree volume (m^3/stem)	<0.15	<0.35	>0.35
Max. cutting diameter (cm)	20-35	35-45	45-65
Performance (m^3/PSH_{15})	3-5	4-8	5-15

Harvester construction

- The most complex machines currently used in forestry
- Multi-operational
  - Fell
  - Limb
  - Buck
  - Bunch (pile)
- Consist of several functional parts:
  - Drive unit (engine + other parts that power the machine)
  - Chassis (bogie axles)
  - Cabin
  - Hydraulic manipulator (crane)
  - Utility device (harvester head)

Harvester construction



Forwarder construction

Unconventional harvester constructions



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Unconventional CTL machines

Harwarder

Forvester

What's the difference?

Harvester head & crane

- A hydraulic crane is a device that has to:
  - Lift and lower the harvester head
  - Maneuver the head into position
  - Carry the load
- A harvester head is a device that has to:
  - Cut the tree
  - Fell it
  - Limb it
  - Buck the stem into logs

Harvester crane

- The bearing capacity is the function of boom length (m) and nominal lifting power (kN)
- Base: box attached to the machine chassis
- Stabilizing supports: protective valve when the hoses are torn
- Pillar: welded closed construction; contains a planetary gear, which rotates the crane
- Main boom: a system of hydraulic extensions that form a compact unit

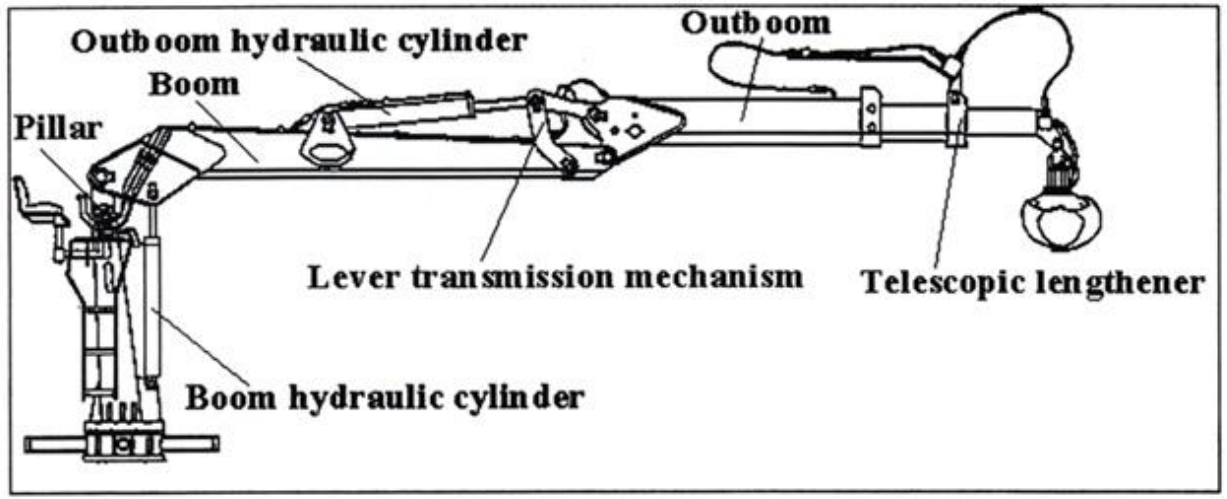

Figure 1. Forest machinery crane.

Harvester head

Logset TH 55 harvester head

- Felling mechanism
  - Cutting mechanism (saw)
  - Pushing mechanism
- Limbing mechanism
  - Limbing knives
- Feeding mechanism
  - Spiked (chain) rollers
- Measuring mechanism
  - Measuring wheel (length)
  - Potentiometer in the limbing knives (diameter)

Software used for wood procurement and machine control

- Harvesters (and forwarders) are complicated machines
- The engine control module has to provide fast and reliable communication between individual parts of the drive unit, various sensors, etc.
- Software has to provide communication between measuring devices in the harvester head and the control system
- The software has to be able to display the collected data in comprehensible format to the operator, technician and management
- At the beginning, every machine producer had their own data format
- Since the 1980 a unified communication standard was in development, since 1987 StanForD format was released
- Many producers adapted the format: Dasa, LogMax, Parker Hannifin, Komatsu Forest, Ponsse, Rottne, John Deere Forestry, etc.

Software used for wood procurement and machine control

Producer	Wood procurement system	Forest machine system – Harvester	Forest machine system – Forwarder
John Deere	Timber Center, Timber Navi, Timber Calc,…	TimberLink	TimberLink
Komatsu	MaxiA, MaxiB,…	MaxiExplorer	MaxiForwarder
Ponsse	OptiGIS Office, OptiEditor, OptiStem,…	Opti4G, OptiMap Harvester,…	OptiControl, OptiForwarder,…
Rottne	Using DASA	Rottne D5	
DASA (only SW)	Optimization Builder, Production Report, File Transfer, Assortment Builder, Operation Monitor,…	Dasa 4 Dasa 5	Dasa 4 Dasa 5
Motomit (only SW)		Motomit IT/PC	Motomit IT/PC

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Cut-to-length harvesting

- Assortments are made at the stump
- Historically, the system was used due to shortage of power
- Today, the system is preferred due to better handling of assortments
- Low environmental impacts
- High productivity (with the right machines)
- Main production stages:
  - Felling and processing
  - Bunching
  - Forwarding
- The logging system is not limited to using fully mechanized logging
  - Chain saw + horse skidding, mechanized skidding, other machines
  - Harvester + cable yarder (high productivity in inaccessible terrains)

Preparation of the stand

- Prepare a felling prescription
  - Forest stand identification – ID, map, terrain conditions
  - Prescribed cut, type of cut
  - Machinery to be used, forwarding distance, desired assortments
- Mark the trees to be felled – operators do not have the time and resources (or knowledge) to decide on which trees to fell
- Divide the stand with forwarding trails that go through the center of the operational area
  - Width of the trail should be up to 4 meters
  - As straight as possible
  - With as low an slope as possible (lateral and longitudinal)
  - Keep the area of trails under 20% of the total area of the stand

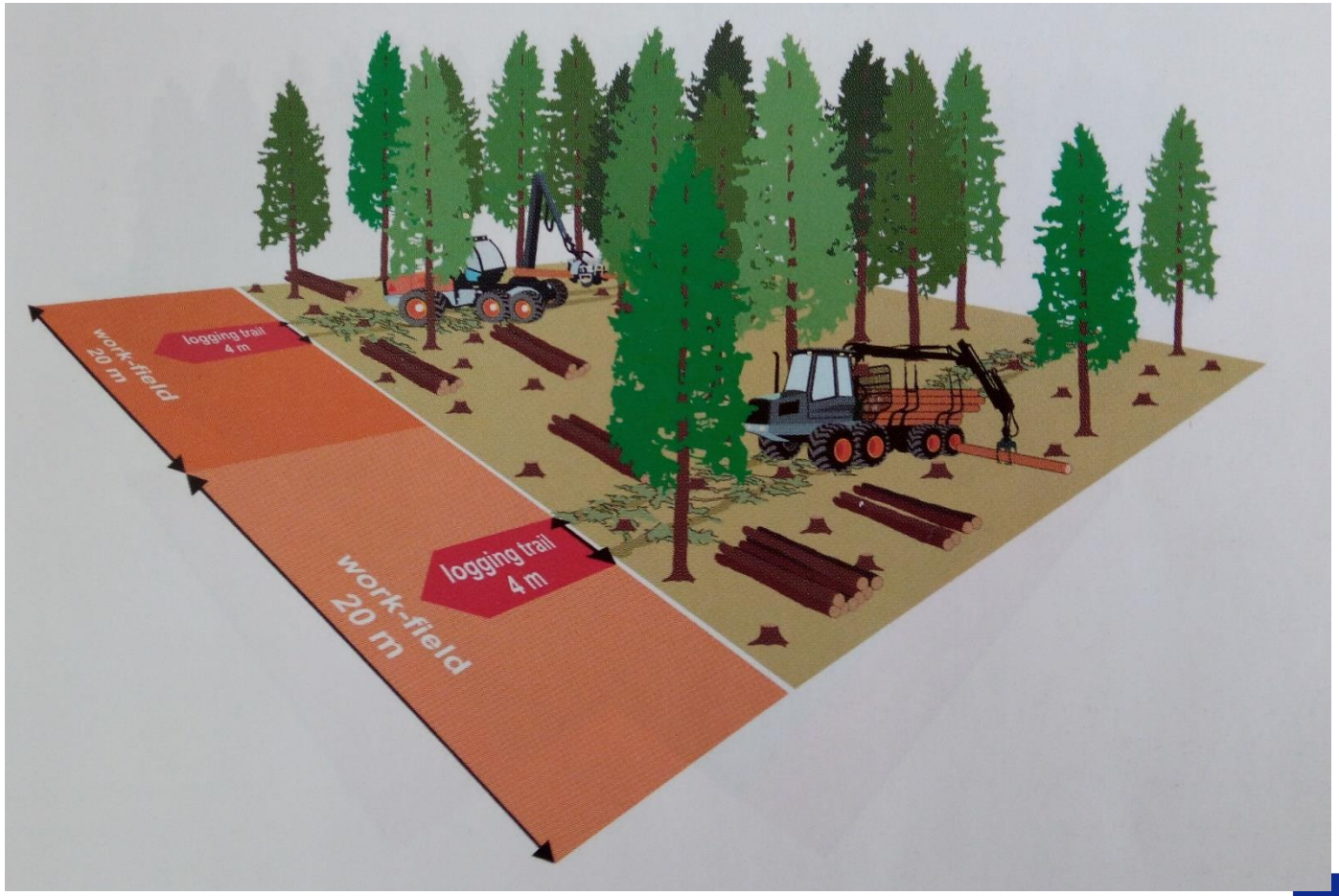
Harvester technology of CTL harvesting

- Harvester carries out individual operations in one fluid workflow
  - Approach the tree
  - Grip the stem
  - Fell the tree
  - Limb the stem
  - Cross-cut (cut-to-length) the stem into assortments
  - Bunch the logs at the side of the trail (perpendicularly, approx. 2-4m from the center)
- Forwarder's work is synchronized with the work of the harvester
  - Collects the bunched logs (assembles the load)
  - Forwards the load to the roadside
  - Stores the logs at the roadside by piling them up to 3m high

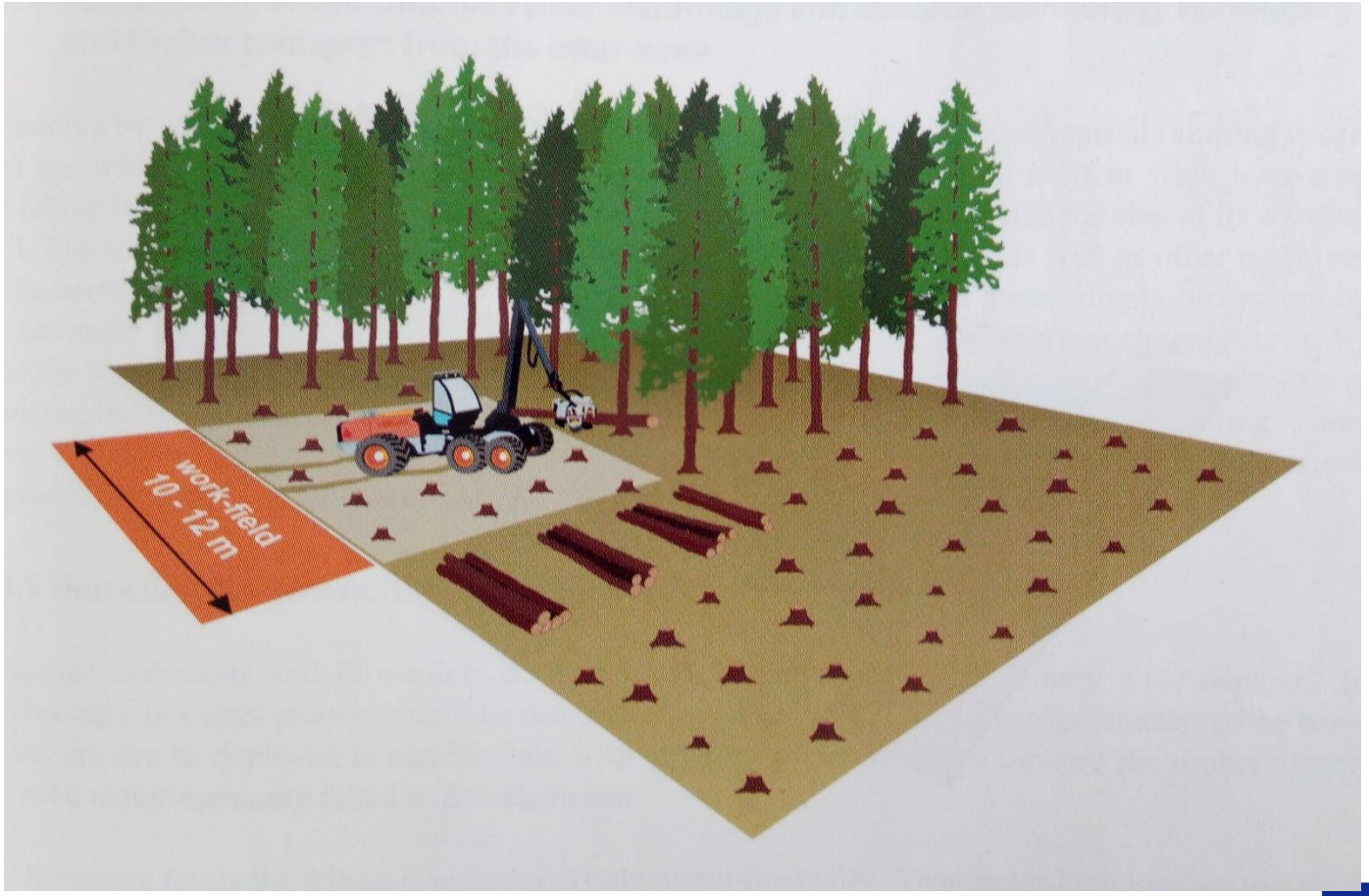
Complex harvester technology

- Width of the harvester's operational area is 20m
  - The harvester is working from the center of the area
- Forwarder collects logs bunched by the harvester on the sides of the trail it created
- As much as 20% of the stand surface is dedicated to the trails
- In clear-cuts, harvester does not create trails
  - Processes all trees in its vicinity (10-12m radius)
  - Bunches logs at the sides of the machine
  - Puts slash from limbing in front of the wheels to reduce the ground pressure

Complex harvester technology



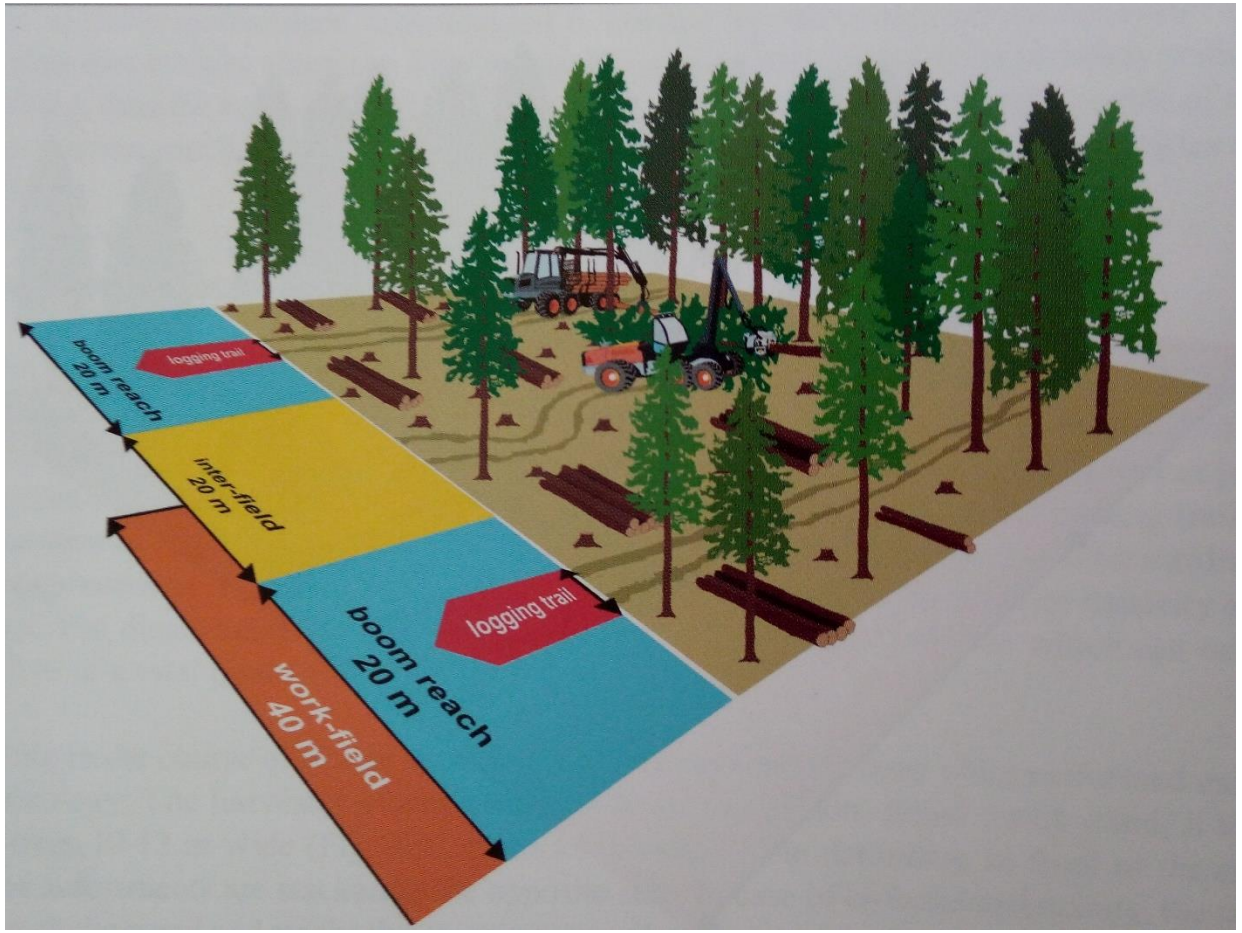
Complex harvester technology



Complex harvester technology with a hidden trail

- The width of the operational area is 40m
  - Besides designated trails, harvester moves on the boundary of two normal operational areas (hidden trail)
- Felled and processed trees on the hidden trails are bunched on the outer limit of the harvester's reach (as opposed to bunching them close to the machine)
- Bunched logs have to be within the reach of the forwarder
- Other option is that the harvester only fells the trees on the hidden trail and processes them from the designated trail later
- Forwarder travels only on the designated trails
- Only used with thinned stands
  - Greater residual stand damage in denser stands

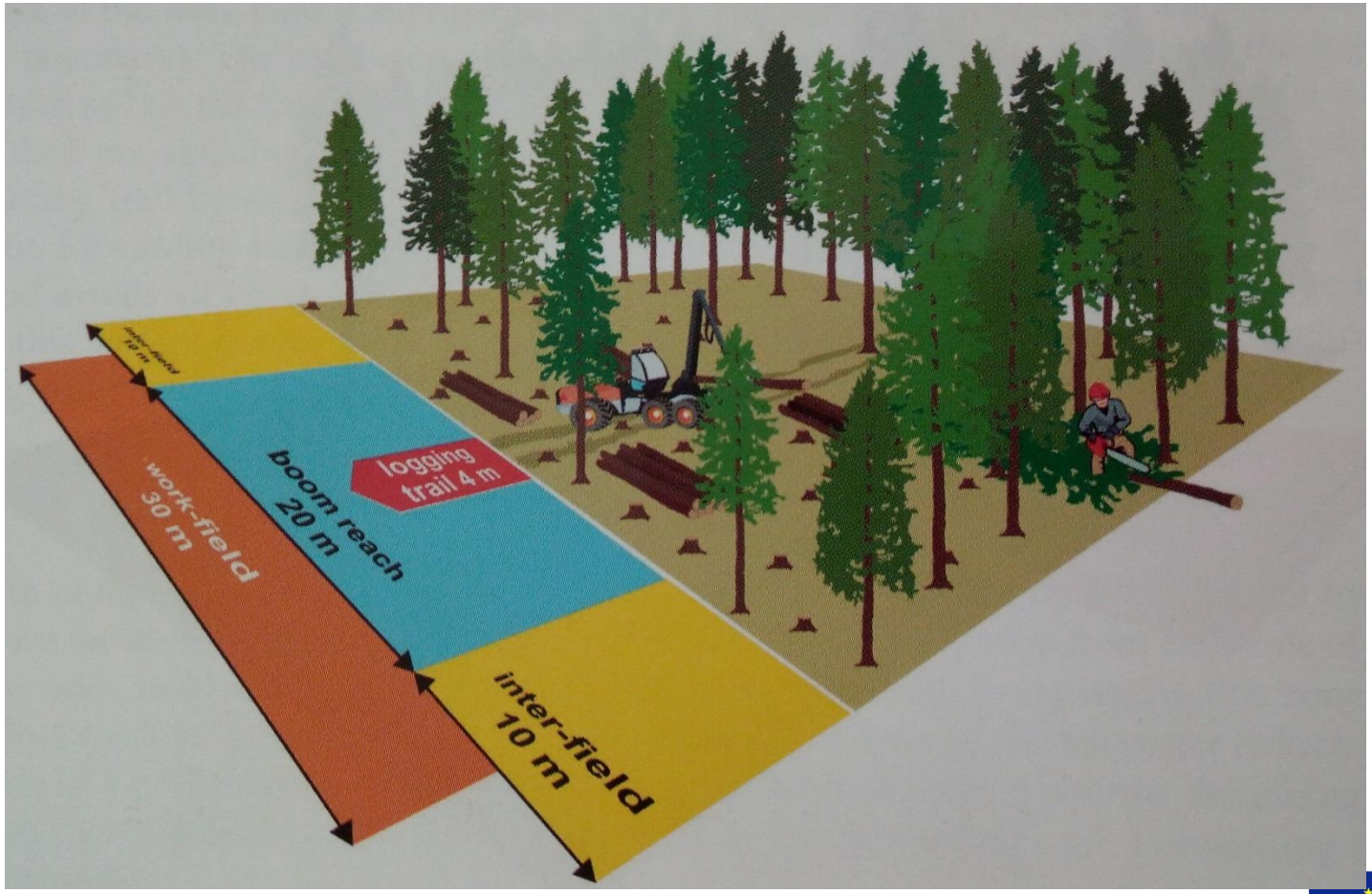
Complex harvester technology with a hidden trail



Complex harvester technology with chainsaw felling in the inter-zone

- Width of the operational area is 30m
- Harvester works on the trail
- Chainsaw feller works in the inter-zone, outside the reach of the harvester
  - Works are carried out separately (safety reasons)
  - Trees on the inter-zone are felled at the direction of the trail, so the harvester can reach the felled trees
- Forwarder works as usual

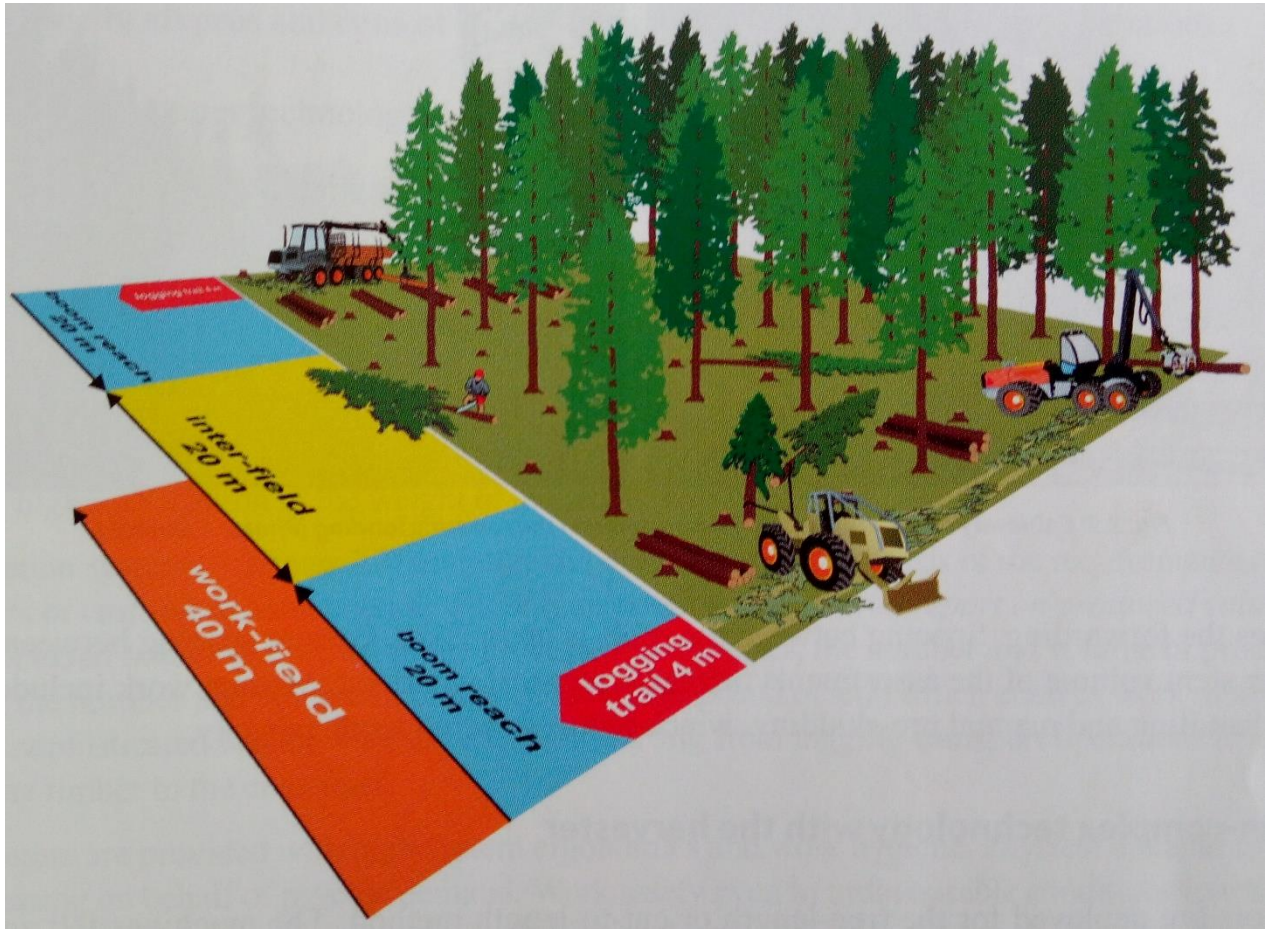
Complex harvester technology with chainsaw felling in the inter-zone



Combination of a Complex harvester technology with skidders

- Width of the operational area is 40m
- Harvester works on the trail
- Chainsaw feller works in the 20m wide inter-zone, outside the reach of the harvester
  - Skidder winches the trees to the trail
  - Harvester harvests trees as usual on the trail (10m to each side) and functions as a processor for the trees from the inter-zone
- Forwarder forwards all logs from the forest stand
- Great organizational demands
- Higher costs
- Greater potential damage to the residual stand (whole trees being winched)
- Smaller share of trails on the stand surface (more productive area)

Combination of a Complex harvester technology with skidders



Non-complex technology with forwarders

- Width of the operational area 20m
- In earlier thinnings, felling is carried out by a chainsaw feller
- Felled trees are left within the reach of the forwarder’s crane
- If trees are outside the reach, they have to be carried or winched to be in bounds

Non-complex technology with harvesters

- Harvester carries out the felling and processing
- Based on the terrain or slope, harvesters can be:
  - Wheeled
  - Tracked
  - Other
- Technology other than a forwarder takes the timber out of the stand
- Based on the terrain, it can be:
  - A skidder
  - A cable yarder

Advantages of harvester technology

- Lower personal costs than conventional technologies
  - Direct
  - Indirect
- Better assortment composition than conventional technologies
  - Driven by the sophisticated wood procurement systems
- Better ergonomics of the work environment
  - Better safety
  - Lower physical strain
- Lower environmental impacts
  - Lower residual stand damage

Disadvantages of harvester technology

- Demanding on work preparation and organization
  - High purchase costs mean that the machines cannot stay in the garage (broken-bown)
- Expensive and demanding training of the operators
  - The training itself is rather costly
  - It takes a long time for the operators to reach full productivity (the learning curve problem)
- Soil compaction
  - Heavy machinery compacts the stand soil to considerable levels
  - Not as much as skidders
- Harvesting costs are higher than conventional technologies reach

End of section 3

THANK YOU FOR YOUR ATTENTION