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The Global Challenges of Harvesting and how the CTL Method can Respond to Them

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The Global Challenges of Harvesting and how the CTL Method can Respond to Them

Abstract

The harvesting is examined globally and the factors that could increase the popularity of Cut to length method are listed. Also the benefits of CTL method and its suitability to different parts of the world are introduced. The CTL method harvesting techniques and machinery are introduced and at the end there are solutions that forest machine manufacturer Ponsse has developed.

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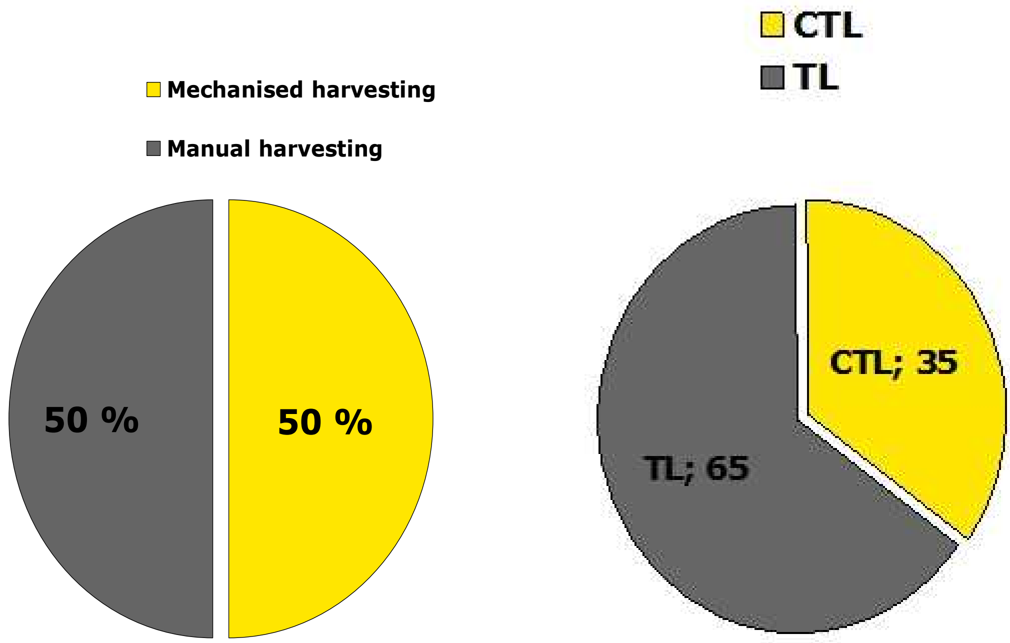
DESCRIPTIONS

CONTENT

1 NEED OF ADVANCED FOREST TECHNOLOGY

In the future the demand of advanced forest technology is going to grow because the population will grow. The standard of living will also increase in many parts of the world and how people will consume more different kind of processed wood such as different kinds of papers. The fact that the economy is growing globally influences building. Naturally the growth in building also increases the need of timber and need of advanced forest technology. Nowadays 50% of timber is harvested by mechanized methods and 50 % by manual method. The mechanized harvesting is divided in two groups: Cut to length method (35 %) and Tree length method/ Full tree method (65 %). Later in this document Cut to length method will be referred to as CTL, and Tree length/ Full tree method as TL. (Asikainen etc 2009, 3.)



GRAPH 1. How the harvesting is divided globally to mechanized harvesting and manual harvesting and how the mechanized harvesting is divided to TL method (Tree Length) and CTL method (Cut To Length). (Ponsse 2011)

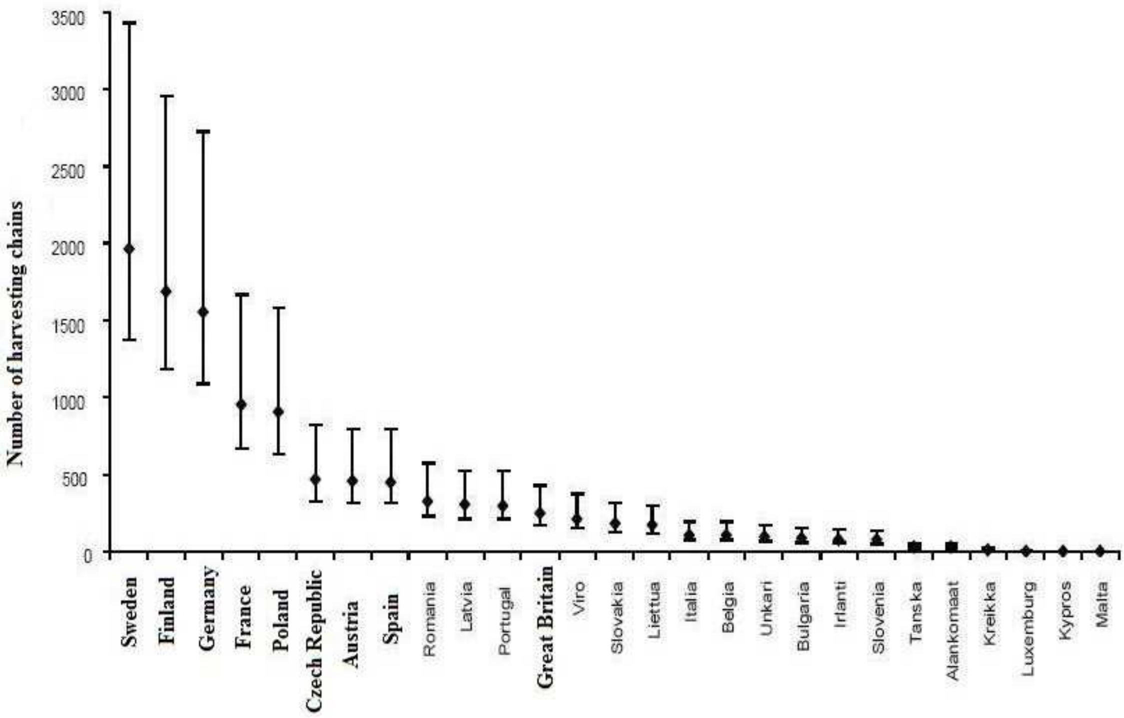
The mechanized harvesting is growing globally because the need of efficient harvesting methods. Also the fact that the bioenergy sector is going to grow because its green values increase the demand of advanced forest technology. Wood also has many possibilities that have not been discovered completely yet, such as biodiesel. (Asikainen etc 2009, 3)

In future it`s also very important that the harvesting method is nature friendly like CTL method is. This method suits many different conditions. It suits slopes that are up to 30% of incline. It suits in plantations, peat lands and almost every condition. (Uusitalo 2003, 20.)

2 POSSIBILITIES AND DEVELOPMENT OF MECHANIZED HARVESTING

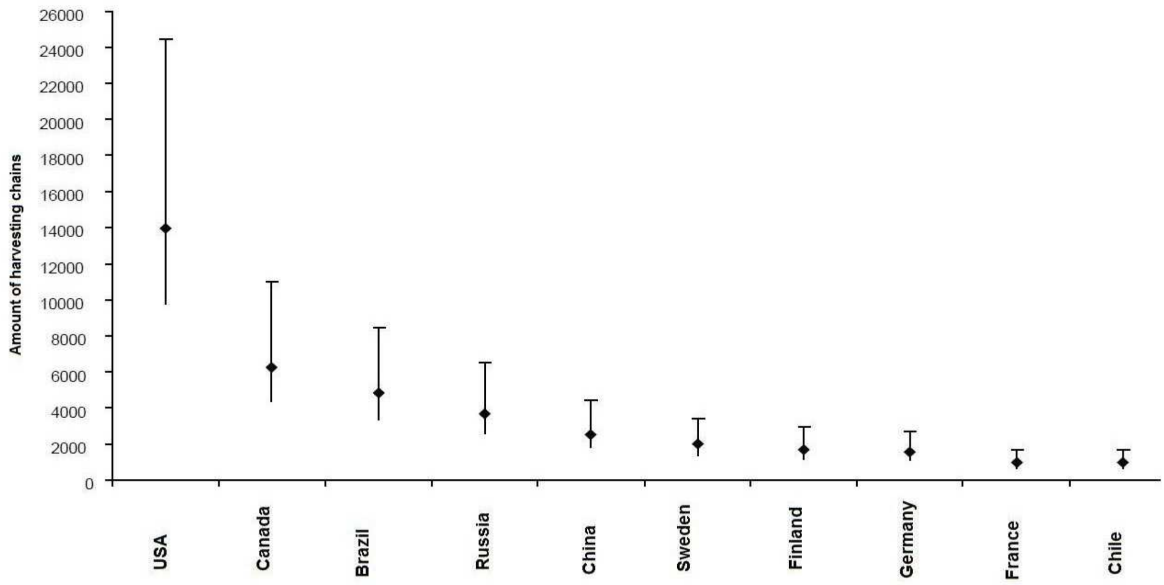
2.1 Theoretical number of harvesting chains

In graph number two the theoretical amount of harvesting chains (CTL) that could be possible in countries that are members of European Union is contoured. Harvesting chain consists of a harvester and a forwarder. In the calculation it is presumed that all the harvesting can be done by CTL method machines. The mountainousness has not been taken into account in calculations. The amount of harvesting per chain is divided in three options: 20 000, 35 000, 50 000 m^3. In Europe the chances to the biggest amount of harvesting chains are in Sweden, Finland, Germany, France and Poland (graph 2). (Asikainen etc 2009, 13.)



GRAPH 2. Theoretical number of harvesting chains in European Union. (Asikainen etc 2009)

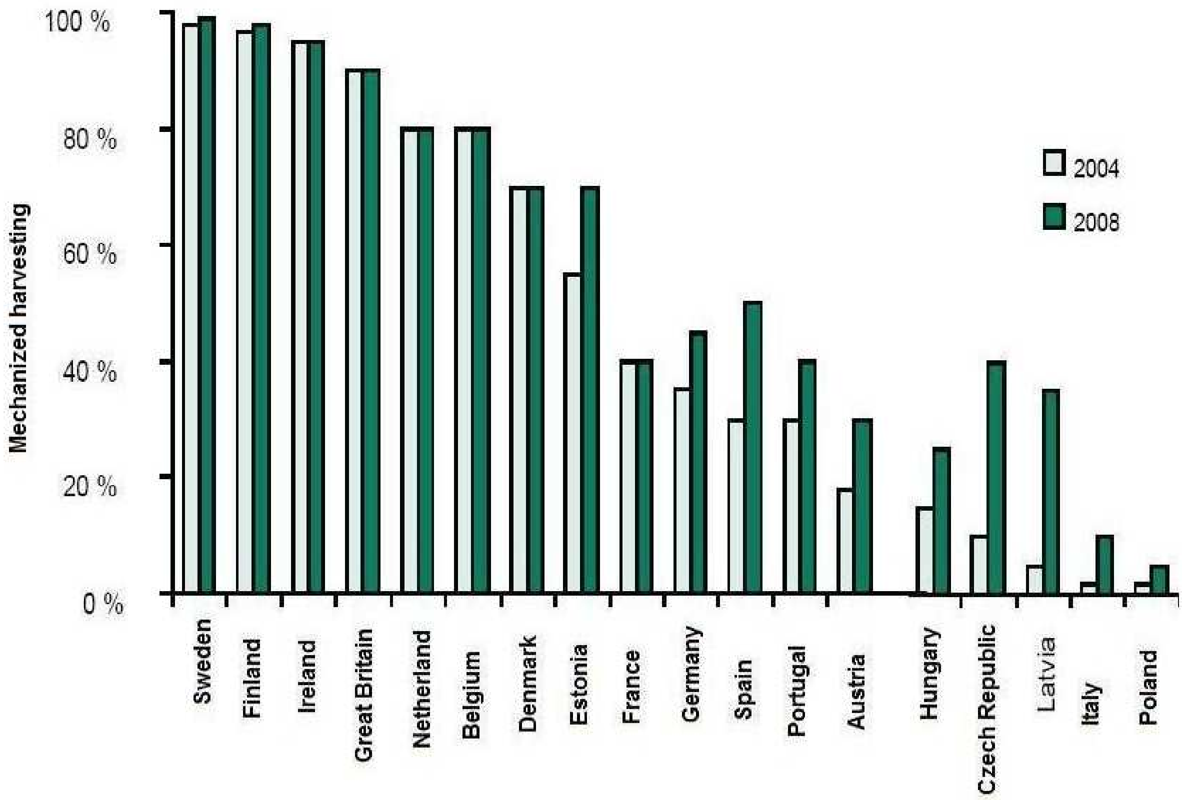
Graph number three shows the top ten countries which had the most harvested merchantable wood in 2005. If all the harvesting in the world could be mechanized the number of harvesting chains would be remarkable. The calculations presume that all the harvesting can be done by the CTL method machines and mountainousness haven`t been noticed. The need for harvesting chains is emphasized in North America where alone 14 000 - 35 000 harvesting chains are possible (graph 3). (Asikainen etc 2009, 14.)



GRAPH 3. Theoretical number of harvesting chains represented with different volume of harvesting per year. Volumes are 20 000, 35 000 and 50 000 m^3. (Asikainen etc 2009)

2.2 The development of mechanized harvesting in Europe

In the Baltic countries and also in Poland the environment is very beneficial for mechanized harvesting. Mechanized harvesting has grown in popularity quite fast in East Europe but the speed of advancement has varied much depending on the country. For example in Latvia and Estonia the harvester and forwarder- chain has become common quickly. In Lithuania and Poland mechanized harvesting hasn`t grow as fast as in Latvia and Estonia because the forest authority is afraid of growing unemployment and the fact that local harvesting entrepreneurs have poor level of investment in the machinery. Still the mechanized harvesting is growing in every part of Europe (graph 4). (Asikainen etc 2009, 15.)



GRAPH 4. The change in mechanized harvesting in Europe 2004- 2008. (Asikainen etc 2009)

2.3 The development of mechanized harvesting in Russia

The majority of the growth of forest machine industry took place in 2004- 2008, when Russia`s forest machine markets opened. The reasons to this progress have been increased harvesting amount of raw wood and the forceful decrease of Russia's own forest machine industry. Also favoring the CTL method instead of the TL method and Russia`s forest industry`s (especially sawmill) ownerships have moved partially to foreign people. (Asikainen etc 2009, 15.)

When the CTL method is deployed in new areas, first the forwarders are taken in use. For example in Russia`s Karelia the number of forwarders started to increase in the middle of the 90`s, but harvesters started to increase in the early years of 2000`s. Russian forest researchers have listed factors that advance the use of CTL method. These factors are improvement of leasing system, machine reliability, ergonomics and suitability for all kinds of logging. In contrast the factors that slow the use of CTL method are expensive import technology, low level of service, unemployment and infrastructure that supports TL method. (Asikainen etc 2009, 16.)

2.4 Utilizing and developing the diagnostics

The modern CTL forest machine can gather information example about productivity, measurement, fuel economy etc. This data is very handy when technical support is needed and also when new operators are educated to the job. (Asikainen etc 2009, 20.)

Forest machines diagnostics are nowadays highly developed and produce accurate information about the level of performance of the different components and devices. It also informs the operator if the level of performance is weakened. Information that is gathered by the method of diagnostics offers many opportunities to development, especially in utilizing the information. (Asikainen etc 2009, 20.)

Example case from South America about how to utilize the diagnostics information: In South America when a problem occurs with the harvester or forwarder that the operator can`t solve. The biggest problem usually is how to get the competent staff on the scene. The diagnostics of the machine can be beneficial in the situation. The computer of the forest machine can be connected through the data communication connection from the service. The source of the malfunction can be recognized by the remote access. And that is how the forest machine can either be repaired or the operator can be advised how to repair the forest machine. In theory forest machines could be operated from the office in plantation conditions. The remote diagnostics and repair of the forest machine can significantly improve the technical level of performance in challenging conditions. (Asikainen etc 2009, 20.)

The fuel economy and energy efficiency can be optimized with different kinds of software. The forest machines use only the necessary amount of power and energy. Technology is utilized for example in the situation when a tree is grabbed and fallen down. The control system of the harvester can recognize how big the handled tree is and can optimize the need of power that is needed in the harvester head. (Asikainen etc 2009, 21.)

3 CUT TO LENGTH METHOD

3.1 Main principles

In this chapter the main principles and machinery of the CTL method are introduced. Timber is logged with a modern harvester and forwarder. The harvesting chain can operate in both regeneration felling and thinning sites. (Uusitalo 2003, 57.)

The harvester is a machine that fells, delimbs, bucks and measures the tree in the logging site. Then the forwarder is used to transport the timber assortments from the logging site to the roadside and to unload timber assortments into separate piles. (Uusitalo 2003, 53.)

3.2 Machinery

3.2.1 Harvester

Nowadays nearly all the harvesters lend themselves to final and intermediate cuttings. The harvesters available on the market can be divided into four principal groups based on their size and engine power. The classification and related terminology (final felling machine, thinning machine, all-purpose machine) should not be narrowly interpreted. The majority of machines operate in all sorts of conditions but particularly ideal conditions exist for each size class. The smallest machines cannot cut the biggest trees on account of their grapple structure. If they are continuously used to harvest oversized trees, sooner or later the grapple components weaken and eventually break. (Uusitalo 2003, 67-68.)

TABLE 1. Typical performance values of harvesters. (Uusitalo 2003)

Machine type	Weight (t)	Engine (kW)	Lifting torque of crane (kNm)	Feed force of harvester head (kN)	Weight of harvester head (kg)
Small thinning harvesters	8-12	80	80-100	15	400-600
Thinning harvesters	15-18	140	140-180	20-25	800
All-purpose harvesters	20	150-200	200	22-27	1000
Final felling harvesters	20-24	200-240	210-270	24-30	1200

Thinning harvesters (small thinning machines) are best suited for sites due for the first commercial thinning, but also perform rather well in intermediate thinning and preparatory cutting operations. While thinning harvesters primarily operate in thinning sites they are also capable of harvesting in small-stemmed final felling sites, although their productivity is not comparable to that of heavy-duty machine models. On the other hand all-purpose harvesters are highly suitable for implementing thinning and final felling treatments alike. This factor is especially important when considering the utilization rate of machines. Worksites appropriate for machines specialized in harvesting stands of a certain size class have to be sought from a significantly broader region, which in itself is not economically profitable. Thinning or final felling harvesters are typically acquired by such entrepreneurs, who have significant contracting agreements in their own region, in which case they are always able to rotate the best suited machine for a particular job. (Uusitalo 2003, 68-69.)

PHOTO 1. A modern CTL method final felling harvester. (Ponsse)

Final felling harvesters are more efficient on final felling sites than all-purpose machines are, but due to their greater size are rather clumsy on thinning sites. Repeated use of a small sized harvester in final felling operations will weaken the mechanical durability of harvesting components (boom and harvester head), and thus should be avoided. (Uusitalo 2003, 69.)

Nowadays harvesters are mainly single-grip harvesters, in which all stages of harvesting work (felling, delimbing, bucking and measuring) are performed via a cutting head fitted to the end of the boom. Typically the boom reaches to 10 meters or a bit more, which permits thinning a forest at logging trail intervals of 20 meters. (Uusitalo 2003, 69-70.)

3.2.2 Forwarder

Modern forwarders are usually built on articulated chassis with three or four axles and large rubber tires and they are equipped with a hydrostatic-mechanical transmission. This transmission system allows the machine to react agilely to obstacles in the terrain. The log loader is controlled via boom levers. The seat can be rotated 360 degrees which enables working both forwards and backwards. (Uusitalo 2003, 81.)

Usually the forwarder`s rear tires are equipped with tracks over the tires; front tires may or may not have tracks. The rear of the forwarder consists of bunks that hold logs, and a log loader mounted behind the cab. The logs are loaded onto the forwarder using its log loader, and then carried to the roadside where they are unloaded. For sorting logs, forwarders can pick individual logs from the piles created by the harvester to produce loads of a single type. Once a homogenous load has been moved to the roadside, it can be unloaded into its own area with little additional effort. Different wood assortments can also be kept separate in the machine`s bunk if required. (MacDonald 1999, 57.)

Forwarders travel equally well forward or backward, and it`s easy because the operator`s seat is reversible and comfortable for travelling in either direction. Depending on the layout of the particular cut block the forwarder may travel backward from the roadside to the felling site so that the machine is not required to turn at either end of the cycle. (MacDonald, 57-58.)

Nearly all forwarders are fully employable in both final felling and thinning operations. Based on their size and power output, the forwarders on the market can be divided into four principal groups according to Table 2. (Uusitalo 2003, 81.)

TABLE 2. Typical performance values of forwarders. (Uusitalo 2003)

Machine type	**Wheels**	**Weight (t)**	**Maximum load (t)**	**Engine (kW)**	**Lifting torque of crane (kNm)**
Thinning forwarders	8	10-12	9	90	75
All-purpose forwarders	6 or 8	12-16	10-12	130	100
Final felling forwarders	8	15-20	13-17	150	130-150
Heavy final felling forwarders	8	20-22	18-19	200	140-160

Thinning forwarders are light-built, all-terrain vehicles particularly intended for thinning sites. These machines are characterized by 600-700 millimeter wide tires and both the front and back are fitted with bogie tracks. (Uusitalo 2003, 81.)

All-purpose forwarders are durable technological compromises capable of working productively in thinnings and final fellings alike. Greater productivity is achieved in final fellings with forwarders specially designed for that purpose, but in thinnings such machines cause considerably more damage to the soil and residual stand due to their bulkier structure compared to thinning and all-purpose forwarders. Productivity relative to the cost of the machine is also far from optimal if a final felling forwarder is primarily used in thinning operations. (Uusitalo 2003, 81-82.)

PHOTO 2. A modern CTL method final felling forwarder. (Ponsse)

Just as with harvesters, acquisition of forwarders is highly dependent on the composition and structure of forests regionally and the negotiated terms of the logging contract. If the contractor only has enough work for one forwarder in his/her region, he/she will most likely choose an all-purpose type of machine. Large forest machine contracting companies typically have better opportunities to buy a machine type designed for thinning or final felling operations in addition to an all-purpose forwarder. (Uusitalo 2003, 82-83.)

3.3 How the harvesting happens in CTL method

Tree felling commences by positioning the harvester head towards the tree. The harvester normally fells a tree in a single cut-through motion. When felling the biggest trunks, however, a countercut is first made on one side, then the grapple is turned towards the opposite side and the remaining stem sawed through. Before sawing through large trees, preliminary tension needs to be created by nudging the boom against the stem in the direction of the fall. Depending on the direction away from the machine towards which the tree is felled, preliminary tension is made by swinging, bending or extending the boom. Then the tree automatically starts to fall in the intended direction. The directed fall is completed by moving the boom and tilting the harvester head. The most efficient operators know how to utilize the kinetic energy generated from the fall and begin processing (delimbing, bucking and optimizing) it already as it falls. The boom is moved towards the eventual bucking and bunching location. The stem should not be processed at that instant when it crashes to the ground, because it could cause false length measurements or the harvester head may suffer damage. When processing the largest trees it is wisest to let go of the stem before it hits the ground to prevent the boom and also the machine and its operator from being forcefully jolted. (Uusitalo 2003, 70-71.)

After the felling the tree is transferred to the immediate work area where processing continues. The harvester head`s feed rollers propel the stem forward which results in the removal of branches as they strike the delimbing knives. When processing the largest trees, the operator can assist the successful completion of the delimbing and measuring process by swinging the boom in the same direction in which it proceeds. This maneuver ensures that the feed rollers do not slip as they move forwards. On final felling worksites it is recommended to leave logging waste in front of or alongside the harvester. Logging waste can then be easily moved with the grapple onto the logging track in order to prevent rut formation to soil. Collection of logging waste for use in energy production influences the technique used to harvest trees on many worksites. In order for logging waste to be easily collected, the harvester should not drive over logging waste piles. Felling and processing of stems on worksite should be concentrated in order for larger but fewer waste piles to accumulate for energywood harvesting. (Uusitalo 2003, 71-72.)

The bucking maneuver performed by harvesters is controlled by an automated measurement system, which suggests the optimal bucking point to the operator. A log is bucked from a stem by sawing through in a single motion from the topside downwards. Log bucking easily creates cracks in the underside of the remaining portion of the stem. It should either be partially supported against the ground or the boom should be moved downwards in the final stage of bucking so as to minimize cracking. Forest machine manufacturers have recently attempted to develop automated bending of the boom concurrent with the sawing motion. This innovation has been proven to reduce bucking-related cracks in the wood. (Uusitalo 2003, 72.)

3.4 Working techniques

3.4.1 Harvesting technology

In the unilateral technique the harvester progresses along the stand margin felling trees from a 10- 12 meters wide strip one strip at a time. This is the most commonly used mechanized harvesting technique in regeneration felling. The harvester removes trees standing in front and on one side of it within a suitable operating sector and then processes the felled stems on the opposite side of the logging trail. For example, when applying this technique, the harvester operator may proceed leftward or rightward. Tree felling is primarily oriented forward or sideward. (Uusitalo 2003, 72-73.)

In the bilateral harvesting technique, stems are processed on both sides of the logging trail. Many variations of these two techniques exist depending on harvester properties as well as individual habits and characteristics of machine operators. (Uusitalo 2003, 73.)

In thinning operations, the trees to be removed are generally selected by the harvester operator. Those trees blocking the logging trail are felled and processed first, after which thinning on the side is carried out. Thinning while stationed on the trail can be done in one of four ways (Uusitalo 2003, 73.)

1) The tree stem is cut from the stump but kept in an upright position and carried to the logging trail where it is then felled, delimbed and bucked.

2) Tree felling at the stump, carrying or pulling of the stem to trailside where it is then delimbed and bucked.

3) The tree is carried to the trail while it is falling after which it is delimbed and bucked on the trailside.

4) Tree felling, delimbing and bucking at the stump.

In modern-day thinning operations 20 meter trail spacing is commonly used. The harvester is able to clear the trail ahead while thinning forest on both sides of the trail in 10 meter wide strips. Logging trail spacing may vary between more or less than 20 meters as long as the average distance between trails amounts to at least 20 meters. (Uusitalo 2003, 73-74.)

When planning the logging trail network, the machine operator should maximize the amount of looped trails which enable driving around. This is how the total driving distance is minimized and troublesome intersections are avoided. In final felling operations, the logging trail is automatically located next to the harvester`s cutting strip whereupon the trail interval typically amounts to 10-15 meters. (Uusitalo 2003, 75.)

Thinning intensity is monitored during the cutting by counting the number of stems present in residual stand. As the thinning progresses, the harvester operator can examine the diameter distribution of removed trees with the help of the harvester`s built-in measuring device. The number of trees left in a stand can be determined by counting the number of stems within a semi-circle with a radius equivalent to the reach of the harvester`s boom. Slightly more trees can be left alongside the logging trail, for marginal trees are able to exploit the increased growing space provided by the trail (more nutrients and light). (Uusitalo 2003, 75-76.)

In mechanized wood harvesting, the following work stages can be distinguished (Uusitalo 2003, 76-77.)

1) Harvester driving
2) Positioning harvester head and felling
3) Stem delimbing and bucking
4) Supportive/ corrective measures and system disturbances
5) Undergrowth removal
6) Non-mechanical delays less than 15 minutes (phone calls etc.)

The time consumed to fell and process a single stem ranges from 20-60 seconds depending on stem size. In a typical stand designated for final felling, the approximate percent share of the total work time consumed according to task is as follows (Uusitalo 2003, 77.)

1) Positioning harvester head towards tree and felling (30%)
2) Delimbing and bucking (45%)
3) Driving (10%)
4) Delays and supportive/ corrective measures (15%)

The felled timber needs to be carefully sorted. Saw logs can be left partially scattered but preferably parallel to each other. Pulpwood should be bunched into suitable grapple piles. Within an individual stand, identical timber assortments from a specific tree species can be bucked which are destined for several different processing plants. In order to make sorting easier, harvester heads these days contain a color marking device by which streaks of various colors can be sprayed on the top ends of cut assortments. (Uusitalo 2003, 77.)

Logs are bunched into piles either along the trailside or within the cutting strip. The advantage of trailside bunching is that logging waste accumulates on the trail hence reducing the damage to soil. If a forwarder with a long boom is being used on the work site, logs are most commonly bunched within the cutting strip. Firstly trees standing on the margin(s) of the trail are felled directly away from it, and thereafter those on the trail are felled. Logs are bunched into piles in a row-like arrangement in order to facilitate forwarding. (Uusitalo 2003, 77.)

The harvester bunches logs in the process of delimbing and bucking them. The felled tree stem is first hoisted to an adequate working distance from the machine. Then delimbing commences and the harvester head is angled prior to crosscutting towards that spot whereupon the log is to be dropped. Wood assortments are collected into separate piles just as in manual bunching. Individual saw logs can be left unbunched. Pulpwood assortments should however always be arranged into suitable grapple piles. Bunching should be neatly done so as to ease forwarding work. (Uusitalo 2003, 78-79.)

When determining where to place assorted piles, the distance between the pile and logging trail is less important than the ease with which the forwarder can load it. Due to the work technique of harvesters (stationed on the trail and reaching out to process trees), the piles are in any case typically left within 5 meters of the logging trail. If a pile is situated right beside or behind a residual tree, it increases the time consumed during the loading phase as well as the risk of damage to the residual stand. A skilled harvester operator is able to consider the forwarding operation by evenly placing different wood assortments into dense piles of suitable size on both sides of the logging trail. (Uusitalo 2003, 79.)

The low productivity associated with thinnings is above all due to the small size of stems. In order to make thinning more efficient, multi-stem processing solutions have occasionally been suggested. Multi-stem processing refers to the processing of several stems at once during the harvesting work cycle. A standard harvester head can be fitted with multi-stem processing equipment. The harvester head saws through the stem but does not allow it to fall, rather clasps onto it while keeping it vertically aligned; maintaining an upright position, the harvester head then moves on to the next tree. After sawing through 2-5 stems, the grapple is turned horizontally and the stems are delimbed and bucked to length as one bundle. In stands consisting of small-diameter stems, output has been shown to increase by 15-30%. When stems are delimbed in bunches, the qualitative result is naturally imperfect, but slenderly branched stems harvested in initial commercial thinning treatments have nonetheless been found to be sufficiently delimbed and debarked for making pulp. (Uusitalo 2003, 86.)

The timber that has been harvested by the multi-stem processing method can be measured by scale that is in forwarder`s log loader. The weight can then be transformed from kilos into cubic meters by conversion formula.

3.4.2 Primary timber transport

Cut timber is transported from the forest to the roadside by a load-bearing vehicle, using a purpose-built forwarder. The work stages in forest transport can be delineated as follows (Uusitalo 2003, 80.)

1) Driving empty (without a load)

2) Loading

3) Driving between loading stops

4) Driving fully loaded

5) Unloading at landing

6) Non-mechanical delays less than 15 minutes

The majority of the working time in primary transport is consumed either by loading timber in the cutting area (approximately 40%) or unloading and stacking timber at the roadside (approximately 20%). Work productivity is most affected by cutting treatment, logging method, average extraction distance, volume of processed timber per 100 meters of logging trail, and size of wood bunk. The number of wood assortments significantly influences work productivity. As the number of wood assortments increases, the time elapsed while driving between loading stops, loading and unloading likewise increases. Forwarders (as well as harvesters) are equipped with intense xenon lights which enable working in dim or dark conditions. In the best case, the forwarder is paired with a harvester in the cutting area and primary transport is performed immediately after the harvester processes stems. Cut timber should be hauled from the forest promptly after felling especially during the winter, for the longer it remains in the forest after cutting, the greater the danger of it becoming blanketed with snow. In early summer fresh timber should not be left in the forest for more than a few days due to potential pest infiltration. (Uusitalo 2003, 80-81.)

3.5 Work safety

Forest work is still considered to be one of the most dangerous jobs, although increased mechanization of harvesting operations has reduced the number of accidents. In mechanized harvesting, the majority of accidents occur during machine maintenance. Work safety starts with worksite planning. A plan and map of the worksite must be made within which relevant risk factors are pinpointed (bluffs, power lines, road crossings). Particular caution must be taken when planning landing sites. If the cutting area abuts public routes, then it should be clearly marked with warning signs and flagging tape. (Uusitalo 2003, 96.)

Since logging work is mostly done alone, the employer must regularly communicate with the employee. The employee again is obligated to inform the employer if he/ she must perform dangerous machine maintenance or repair work. In felling and loading work, specified minimum safety distances need to be observed. (Uusitalo 2003, 96.)

First aid readiness at logging worksites must always be exquisite. For mechanized harvesting work, this means an adequate first aid kit, while for loggers a specialized, portable first aid kit complete with dressings and bandages is required. If break facilities are not an option, then workers should be provided with appropriate all weather gear. (Uusitalo 2003, 97-98.)

In CTL method forest machines the cab windows are constructed from shockproof polycarbonate glass. That makes a cab to very safe environment to work. Also the steps and other levels are roughed so the slip danger is minimized. There are also handles that can be hold on to when moving around the machine. (Uusitalo 2003, 135.)

3.6 Ergonomics

The cab space in modern-day forest machines is ergonomic, air-conditioned and soundproof. Some models also have active damping system that increases the stability of driving and significantly reduces sideways movements that affect the driver. The active damping system eliminates vibration caused by uneven terrain and keeps the cabin in a vertical position.

Separate safety standards exist for forwarders. Additionally, forest machine manufacturers have jointly agreed on certain fundamental solutions concerning forest machine ergonomics. The seat which is air suspended, must be adjustable to suit the physical proportions of the machine operator. Control devices should be fittingly within the reach of the operator. Those controls which are continuously used are situated within optimal reach of the operator, while less commonly used controls can be located further away. (Uusitalo 2003, 134.)

PHOTO 3. The level of ergonomics is very high in a modern CTL method forest machine. (Ponsse)

Work is usually performed in two or three shifts, the forest machine must be fitted with a lighting system that illuminates the immediate work area. The number and location of lamps varies according to machine make and model, but ordinarily 10-20 lamps are situated on the cab roof and 5-10 more on the boom of the crane. Nowadays the cab can be tilted or moved to give access to engine and transmission components. This makes maintenance and repair work easier. At least in wintery regions, a gasoline-powered heater has become a fixture in forest machines for it eases starting of the diesel engine during frigid temperatures. It also heats the cab and the hydraulic oil, so this allows the work to be started earlier when the hydraulic oil is warm. (Uusitalo 2003, 135.)

3.7 Why CTL method

The CTL method has the latest technology and the most environmentally friendly machines. CTL method causes far less damage to the soil and standing trees than TL methods. CTL machines don`t make damage to the soil because treetops and branches are set as a mat to minimize soil compaction and rubbing. Machines only drive on specific tracks and GPS system helps forwarder operator to plan the driving routes because the forwarder operator can see from the computer where the harvester has been. Also the unnecessary driving is then minimized. (Pulkki 2010.)

CTL method has softer impact on the environment and application to partial cutting. Minimal damage to residual trees is in CTL method under 5 %. The damage percentage in TL/FT method is over 20 %. Site impacts are minimal due to double bogie axle configurations and widely spaced machine trails of CTL machines. The ability to operate in riparian and reserve areas is also one of the good sides of CTL method. (Pulkki 2010.)

CTL applies well to small dispersed cuts, where minimal roads and landings are allowed. Pulpwood and saw log yield are also higher. Minimal residual and site impacts are possible even under wet conditions. (Pulkki 2010.)

High piles can be made and sorting is easy. Logs can be also loaded to trucks directly. Less equipment traffic is needed in roads which means that the transport costs of machinery are lower and the forest road stays in better condition. (Pulkki 2010.)

Half less roads are needed because the load size of final felling forwarder can be up to 30 m^3. Piles can be high and tight and “hot logging” is possible so less drying impact happens to timber in storage areas. Product sorting is easy and butt rot can be cut out from the stem and thus unmerchantable wood is not brought to the mill. Also less forest area is lost to roads and roadside debris piles (in CTL 1% of area covered, in FT 5% of area covered). Regeneration and silvicultural costs are smaller when using the CTL method. Also less site impact takes place, so sustained or improved yield is possible. (Pulkki 2010.)

The CTL method makes it possible to harvest peat lands even in summer. It makes thinning possible and merchantable wood is then available also from intermediate felling. Roadside storage is clean of logging waste (branches, treetops). Nutrients and seeds are left on site to increase the growth of next tree population. The scenery looks natural when the logging waste is in forest instead of roadside. And last but not least the fact that logs are carried, not dragged, so the damages of the timber are minimal and the environmental damage at landing site is also minimal. (Pulkki 2010.)

4 SUITABILITY OF CTL METHOD IN DIFFERENT PARTS OF THE WORLD

4.1 Flexibility of CTL method

CTL method suits challenging conditions. It suits slopes that are up to 30% of incline. It suits also in plantations, peat lands and it is proven to be the most efficient method to harvest wood. CTL is also nature friendly and it also makes thinning possible. One crucial factor that will direct the global development is land use and questions related to that, such as food producing, energy- and climate politics and the growth of population. The development will affect the political decisions about climate and energy. The next chapters describe what challenges there are in different parts of the world that need to be solved.

4.2 Suitability in Russia

In the growing market of Russia there is an expanding demand for cheap CTL machines. The method has already expanded to areas where there is western forest industry, which means the area in the west side of the Ural Mountains. The solutions that make logging possible in peat lands and in the season of bad roads are very important.

Thinning is not very common in a global scale, but as the forest management gets more common and the harvesting moves slowly from unmanaged forest to plantation and cultivation forest, forest management has to be as efficient as possible in near future. In Russia the quality of the log is set very high. In harvesting there is a lot of slashing waste, but the ability to pay for the bioenergy is poor because the transportation is expensive. Local bioenergy that comes from forest has great potential in regional and local levels. (Asikainen etc 2009, 31.)

PHOTO 4. Ponsse forwarder working in Komsomolsk-Na-Amure, Russian Far East. (Ponsse)

4.3 Suitability in North America

North America is seen as a difficult market to CTL method. North America has long traditions with TL method. The change from TL to CTL does not happen just by investments. Developing the technology of accessory will be the key of success in North America. (Asikainen etc 2009, 32.)

CTL method is used specially in eastern parts of Canada. Scandinavian forest machine technology has been discovered to be a competitive choice for the cable system in gentle slopes up to 30 degrees. But the CTL method has not reached the popularity as the majority method. (Asikainen etc 2009, 32.)

The situation of the market in Canada has been weak because a lot of factories have been closed especially in eastern parts where CTL method is used. There are uncertainties that slow CTL method becoming the general method. CTL represents the competitive high technology but harvesting entrepreneurs are in trouble with profitableness so the change of the harvesting method is hard to execute because entrepreneurs find the CTL machines a little bit more expensive than TL machines. (Asikainen etc 2009, 32.)

The management of young forests that are planted will grow in the future in eastern parts of Canada. The use of bioenergy and forest management will grow in future. So it is very important to tell that CTL method offers a great chance to treat forests in a nature friendly way and in the same time get bioenergy from energy thinning. In many areas the labor force consists mainly of immigrants so the education and also language skills can cause problems. (Asikainen etc 2009, 32.)

PHOTO 5. Ponsse harvester in USA. (Ponsse)

4.4 Suitability in Europe

The need of advanced forest technology is significant in Central and Southern Europe because of the increasing amount of energy wood, harvesting of deciduous trees, harvesting in slopes and the need of thinning. Also the challenges that the season of bad roads cause to harvesting and harvesting in peat lands are important matters to notice. In Europe there is a great demand for environmentally friendly forest management and sustainable forest economics. That why the ecological matters and good quality of harvesting is emphasized. The majority of harvested wood is gathered by agriculture tractors and in slopes the cable systems are the most common method.

CTL method could be used in most of the logging sites but mechanized harvesting has increased slowly mainly because the old traditions are hard to change. (Asikainen etc 2009, 32.)

In Central and Southern Europe it`s typical that entrepreneurs own forest machines instead of forest industry. The amount of mechanized harvesting is going to increase because harvesting has to be more efficient because the costs of haulage, fuel and road tolls have risen. (Asikainen etc 2009, 33.)

The new European Union countries like Poland, Romania and Bulgaria have a lack of labor because the jobs have poor wages and the image of work is not tempting. But the image of the work could be improved with high technology CTL method machines. (Asikainen etc 2009, 33.)

PHOTO 6. Ponsse Buffalo forwarder in Scotland. (Ponsse)

4.5 Suitability in South America

The majority of mechanized harvesting is centered to plantations, so the forest machines should be developed to that kind of conditions. The markets have been promising because customers are mostly big international companies that mainly produce pulp and they buy many machines at the same time. (Asikainen etc 2009, 33.)

Forest technology that is needed in plantations is more basic where the level of information technology is not so important but machine reliability, user friendliness and technology that improve machines cooling in tropic conditions are factors that are very important. Harvesting chains are very effective and the machine utilization degree is high. A forwarder is a workable solution in plantation forests. Purpose built harvesters and excavator based harvesters are used in harvesting. (Asikainen etc 2009, 33.)

Labor is not usually educated and the understanding about information technology is poor. Machines need to be simple and maintenance should be easy to perform. In the conditions of South America the simple products are what is needed nowadays and then you have a foothold in the market. This makes it possible in the future to sell the next generation technology that is more advanced. (Asikainen etc 2009, 35.)

PHOTO 7. Ponsse Ergo in eucalyptus forest. (Ponsse)

4.6 Suitability in Asia

In Asia the problems that are related to soil are a challenge. But CTL method has an answer to that because slashing waste can be used as a mat which strengthens soil. So the rubbing which is directed to soil is minimal. Slashing waste that is left on the harvesting site works as nutrition so that`s a win-win situation in every way.

A competition is focused on the land use in Asia. For example in Indonesia to use of forestry is only given the lands that have the poorest growing conditions. Forest machine manufacturers see that going to Asia should be done with a forest industry company. That is how they can develop the standard of activities which are suitable for local conditions. (Asikainen etc 2009, 36.)

PHOTO 8. Ponsse Buffalo forwarders in Pingyin, Guangxi, China. (Ponsse)

4.7 Suitability in Africa

The forest technology sector sees Africa as an interesting opportunity and the CTL method suits the harvesting conditions of Africa well. But there are many problems in operational environment such as poor level of infrastructure, poverty, restlessness of society, health care problems and diseases like AIDS. Also for bioenergy there are a lot of opportunities that could be utilized from bush plants. (Asikainen etc 2009, 36.)

PHOTO 9. Ponsse Elephant forwarder in South Africa. (Ponsse)

5 BENEFITS AND CHALLENGES OF CTL METHOD WORLDWIDE

5.1 Benefits of CTL method

CTL method machines are very competitive in every market area, also in North America. CTL machines have benefits compared to TL method machines such as better quality in harvesting, eco- efficiencies and environmental friendliness. CTL method also suits thinnings and cultivated forests better. (Asikainen etc 2009, 36.)

CTL method machines are also much better when it comes to fuel economy because only two forest machines are needed in the harvesting chain instead of TL method`s four forest machines. CTL machines also have the latest engine technology so they consume less fuel per machine than TL machines. CTL machines are also much environmentally friendly and don`t pollute air so much as TL method machines because of more advanced engine technology. (Asikainen etc 2009, 36.)

In CTL method the stumps can be sprayed with a rot stopping liquid that prevents stumps from polluting the new tree generation. A purpose built CTL method harvester can be equipped with a system that sprays the rot stopping liquid directly to stump at the same time when the tree is felled. (Metla 1999, 14.)

CTL method has also cheaper costs when comes to harvesting, utilization of wood is better, quality and cleanness are better because the timber is carried in CTL method not dragged like in TL method. When the factors of nature are also considered to this, CTL method is more competitive than TL method. (Asikainen etc 2009, 36.)

5.2 Challenges of CTL method

Despite the fact that CTL method has many benefits there are also many challenges. The level of education is high which is needed from operators and some parts of the world the labor can even be illiterate. Training the operators how to use the machine is challenging but necessary. (Asikainen etc 2009, 37.)

Forest industry's problems have disturbed forest machine markets in North America. That`s the main reason why so little has been invested to new forest machinery. Also CTL machines are found to be more expensive than TL machines but that`s not the whole truth. Because in CTL method only two machines (harvester and forwarder) are needed, instead of TL method`s four machines (feller-buncher, skidder, slasher and loader). And when you only have two machines in a harvesting chain you only need two operators at a time instead of four as in TL method. That decreases labor and fuel costs significantly. When these facts are considered it`s obvious which method is better. (Asikainen etc 2009, 37.)

6 TREE LENGTH AND FULL TREE METHODS

6.1 Suitability of TL method

TL method is only competitive when clear cutting harvesting sites are large and located near a road. Large harvesting sites which are clear cut are not common in Europe. It is predicted that the amount of large harvesting sites that are clear cut will decrease in near future. Reasons to this are for example influences on the scenery and rules of certification that will be tightened.

6.2 Why TL method is the majority method

The main reasons why TL method is such a popular harvesting method is that the machine`s technique is simple and easy to fix and in many countries the forest industry has factories that support TL method. But the biggest reason is that the method has long traditions which are hard to change. (Asikainen etc 2009, 40.)

7 WOODBASED BIOENERGY OFFERS MANY OPPORTUNITIES

7.1 The wood based bioenergy has green values

The climate change is a great threat to nature and humankind. By replacing the fossil fuels by renewable energy such as wood based energy the climate change can be restrained. This is one of the most important means to restrict emissions. Other means are optimizing the production and use of energy, changing the consumption to ways that save energy and cause less emission. (Knuuttila 2003, 19-21.)

Sustainable use of wood based energy is one of the most significant ways to decrease carbon dioxide emissions. Sustainability means that there is no overuse of forest resources and the carbon stock which is in the eco system of forest isn`t diminished. The use of forest resources can rather increase the carbon stock in the eco system of forest. Then the excessive carbon dioxide can be engaged in the eco system, standing trees and soil. (Knuuttila 2003, 21.)

By increasing the use of forestry products we can also increase the carbon stock that is engaged in the forestry products. This also decreases the amount of carbon dioxide in the atmosphere. Increasing the use of wood based energy is an important step towards sustainable development. The potential of increasing the use of wood based energy is great. The global share of wood based bioenergy can be multiplied in the near future and the use of wood based bioenergy is potentially increasing because its green values. (Knuuttila 2003, 21.)

7.2 The influences of wood based bioenergy

In addition to the climate effects the harvesting of energy wood has extensive societal effects. Those are divided into economical and other societal effects. (Knuuttila 2003, 21.)

7.2.1 Influences on the economy

The utilization of wood based energy has many economical influences; national, regional and company economics. In the national economic sense the most important thing is the increased use of areal natural resources if exported fossil fuels (coal, oil, gas) or exported electricity are replaced by wood based fuels. This is how the profit of the production chain remains within the borders of national economics. The utilization of wood based energy directly increases the areal and company economics in the areas where the production chains of energy wood work. (Knuuttila 2003, 21- 22.)

7.2.2 Influences on the society

The procurement of energy wood affects functionally and qualitatively the procurement of the merchantable wood, production of peat and how the forest management is practised. And it also supports the vitality of farms and countryside. (Knuuttila 2003, 22.)

7.2.3 Influences to forest management

The collection of the logging waste has many benefits that help forest management. The cultivation of forest is much more cost efficient. The costs of soil cultivating decrease, the quality of the work is improved and the use of smaller and cheaper plants is possible. All these factors are beneficial to the cost effectiveness and for the quality. The production of wood is also improved because the plants can grow a year earlier and more naturally born plants are grown. And it is more probable that a fully stocked plant stand is formed. When collecting the logging waste it`s important to notice that the nutrient content of the area is preserved. It`s recommended that about 30% of the logging waste is left in the regeneration area. (Knuuttila 2003, 22.)

7.3 Harvesting techniques of energy wood in CTL method

Wood based bioenergy can be harvested in the same time that thinning is made when CTL method is used. Energywood can be harvested with delimbing or not delimbing techniques. Also the logging waste and stumps can be used to bioenergy production. Primary transport of logging waste is made by a forwarder. The excavator pulls stumps up from the soil and then a forwarder is used for primary transport.

8 THE DEMANDS OF MARKET AREAS

Forest machine manufacturers who can manage CTL method, excavator based harvesting method and TL/FT method has the chance to adapt the technology that is needed in each situation. In future the harvesting methods and technologies are going to develop and mix. “New” methods are born from methods that have been used earlier. (Asikainen etc 2009, 41.)

8.1 Developing methods and technology

Forest industry is developing fast in many countries like in Brazil, Uruguay, Chile, South Africa, China, Indonesia, Australia and New Zealand. In future the technology that is developed to plantation harvesting is in a important role because the harvesting and wood processing is growing powerfully in countries which were listed earlier. The harvesting technology that is used in Europe is not the right solution to export the harvesting technology to plantation harvesting. But modifying the harvesting technology to the needs of developing market areas is the solution. For example the automation in agriculture- and forest machines is first taken in use in plantations and after that in Europe. The transfer of technology will also be challenging and the model of business activities and structure of work organization has to be solved. (Asikainen etc 2009, 41.)

8.2 Marketing and exporting

Traditionally the export of forest technology has taken place in contact with forest industry wood supply. Forest industry has invoked technology that has been noticed to be efficient. When the whole system starts to work, forest industry has moved the harvesting activity to entrepreneurs to improve profitableness. This kind of development is happening right now for example in Russia and South America. (Asikainen etc 2009, 42.)

Exporting the technology demands that competitive advance is achieved; good products, inclusive and competent service, education have to be in order. From the viewpoint of technology exporter the low volumes of business in the starting point are problematic because it`s usually unprofitable. (Asikainen etc 2009, 42.)

The transfer and export of technology demand a lot of information and experience from a target area. The most important things are thorough research of area`s market potential now and in future, knowing about culture, business relations and networks, the situation of the competition in the market and marketing and also knowledge of local conditions. The comprehensive service is one factor that is essential if the action in the area is going to be continuous or permanent. A possible model of business is an overall delivery that includes: machines, service deals, services and training. (Asikainen etc 2009, 42.)

8.3 Conclusions

The need of advanced forest technology is going to grow because the amounts of harvested wood are going to increase. It doesn`t matter where in the world the harvesting happens. CTL method is the most competitive method to harvest.

The factors that slows CTL method from becoming the majority method are: Forest industry`s infrastructure which supports TL method, traditions in harvesting and lack of competent labor. Also cheap manpower in developing countries tempts forest industry companies to use manual or motor manual methods instead of mechanized methods to harvesting.

9 SOLUTIONS BY PONSSE

9.1 Company background

Ponsse Plc specializes in the sales, production, maintenance and technology of CTL method forest machines. Its operations are guided by a genuine interest in its customers and their business operations. The company develops and manufactures innovative harvesting solutions that follow the principles of sustainable development and are based on customer needs. The company was established by forest machine entrepreneur Einari Vidgrén in 1970, and it has been a pioneer of timber harvesting solutions based on the CTL method ever since. (Ponsse 2011.)

The engine requirements are going to be stricter in near future when new Tier 4 standards become valid. Mercedes Benz engines that Ponsse uses in its machines meet new standards. The profitability of the customer`s business is a matter of honor for Ponsse. We want our products and services to help the customer reach maximum efficiency in his work. Ponsse invests substantially in product development. Almost 100 industry professionals focus every day on technological research and development. The product development centre is located at the Ponsse forest machine plant in Vieremä, allowing the developers to become aware of production-related quality factors through intensive cooperation with the plant's other departments. (Ponsse 2011.)

A few solutions that Ponsse has invented to the challenges of different type of harvesting are introduced in this chapter. More information and a complete product line brochure can be found at Ponsse`s website: www.ponsse.com

9.2 Product range

9.2.1 Harvesters

The Ponsse selection of harvesters covers all aspects of wood harvesting. The best wood harvesting productivity is achieved using versatile, efficient machinery. Ponsse harvesters are suitable for all kinds of harvesting, from the initial thinning to the heavy final felling. (Ponsse 2011.)

9.2.2 Forwarders

All Ponsse forwarder models have ample power for varying conditions and the most challenging terrain. Its extremely favourable ratio of net weight to load bearing capacity, the smallest turning radius in its size class and dimensions that spread the weight evenly over all of the wheels are hard to beat. Ponsse forwarders can also be used as skidders if they are equipped with a clam bunk. (Ponsse 2011.)

PHOTO 10. Ponsse Buffalo forwarder equipped with a clam bunk. (Ponsse)

9.2.3 Harvester heads

Durability and dependability are central to Ponsse harvester head design. The harvester heads must endure extreme stress and at the same time operate accurately and as gently as possible so as not to damage the trunk surface unnecessarily. Ponsse harvester heads were developed in collaboration with the users: decades of experience and continuous product development make Ponsse the market's quality leader in harvester heads. (Ponsse 2011.)

Together with the Ponsse Opti™ information system, Ponsse harvester heads create a system, which has been the basis of efficient, environmentally friendly, productive wood harvesting for years. A newcomer in the collaboration between the harvester and the Opti is the Ponsse GentleDrive™ – a gentle drive which minimizes surface damage when used for plywood birch or other delicate species' butt ends. (Ponsse 2011.)

The different models of Ponsse harvester heads in three size classes create a versatile, multi-purpose range of models for all wood harvesting sites. There is something for all major types of felling, from the heaviest trunks to small tree thinnings. (Ponsse 2011.)

The structure of all Ponsse harvester heads is as simple as possible and, considering their performance capacity, the heads are also light. Their ease of use, efficiency and reliability have thus been taken to the utmost extreme. The valve system and other central components are protected against harsh conditions, but are still easy to service and adjust as necessary. (Ponsse 2011.)

9.2.4 Cranes and loaders

As most of a forest machine´s time is used for crane work, its strength, speed and controllability are critical to the whole logging process. Ponsse answers these needs effectively in all size classes with powerful products, large hydraulic capacity and the advanced OptiControl system. (Ponsse 2011.)

Thanks to low structure and strong turning device based on a slewing drive, the Ponsse cranes have an extremely low centre of gravity, guaranteeing stability across the entire extent of their reach. Their tiltable vertical boom and quick extensions produce a swift linear movement from machine to tree, and the co-ordination of the optimally placed power arms makes handling even sizeable pieces easy. (Ponsse 2011.)

All components of the Ponsse cranes are manufactured using the latest manufacturing technology and are subject to continual quality assurance monitoring. The booms are machined only after all the welding has been done, ensuring the extremely high measurement precision of the components. This adds to the components' service life and facilitates their installation. Critical welding seams are finished using TIG welding. On top of all this, every fourth component manufactured is sent for special laboratory testing in which the manufacturing quality of critical points is inspected with ultrasound, penetrant solution, and other non-destructive materials testing methods. (Ponsse 2011.)

Unbeatable properties combined with high manufacturing quality and reliability have ensured the popularity of HN cranes throughout the world, year after year. (Ponsse 2011.)

Studies show that most forwarder run time is spent on loading operations. Therefore, loading efficiency cannot permit the slightest compromise involving the power, movement speed and controllability of the loaders. (Ponsse 2011.)

For this reason, Ponsse can provide its forwarders in their various size classes with strong loaders, large hydraulic capacity, and the advanced loader management system which will please even the most demanding operator. Combined with the stable, maneuverable Ponsse forwarders, Ponsse loaders form the perfect unit for transporting timber reliably and easily from stump to roadside. (Ponsse 2011.)

9.3 Solutions to different conditions

Ponsse has developed products that are specialized in challenging conditions of different type of harvesting.

9.3.1 Harvesting in plantation

The multipurpose Ponsse H7euca harvester head is optimized for debarking eucalyptus. The delimbing knives are designed especially for debarking, and they guarantee good debarking results during the first feed. Feed rollers optimized for debarking guarantee a good feeding mark, and the service life of the feed rollers can be extended by turning the rollers. The harvester head can be easily modified for harvesting softwood in regeneration felling and later harvesting. (Ponsse 2011.)

The excellent roller assembly geometry offers large trunk load-bearing capacity but also enables effective feed down to the smallest tree top. The short and durable structure and excellent delimbing capacity of the harvester head are features that guarantee high productivity even in difficult conditions. The Ponsse H7euca harvester head represents state-of-the-art technology in harvester heads, and effectiveness, reliability and easy control and service operations are characteristic. The PONSSE H7euca can be controlled by either with Opti4G or Opti2 control systems. (Ponsse 2011.)

PHOTO 11. Ponsse H7euca harvester head. (Ponsse)

9.3.2 Harvesting in slopes

Ponsse Ergo 8w is an ergonomic and extremely efficient harvester that offers particularly efficient features, especially for sloping sites and otherwise demanding terrain. Pulling force has been increased by 12% and the machine can be equipped with balanced bogies for achieving an excellent hill climbing capacity. As an eight-wheeler, the surface pressure of the Ponsse Ergo 8w is lower than that of a similar six-wheeler. (Ponsse 2011.)

The Ponsse Ergo 8w will continue to be the most effective harvester in its size class on the market. This is guaranteed by the machines efficient but economical Mercedes Benz engine, double-circuit hydraulics, and solid and service-friendly structure. (Ponsse 2011.)

PHOTO 12. Ponsse Ergo 8w suits well in harvesting conditions of slopes. (Ponsse)

9.3.3 Harvesting in peat lands

The environmentally friendly 10-wheeled forwarder concept meets the modern challenges of effectiveness and respecting the environment. The objective of the "Beating the challenge of peat land timber harvesting using conventional machines" project was to create a simple and reliable forest machine that leaps to a whole new level of environmental friendliness by introducing soft terrains with poor carrying capacity into the sphere of the forest economy. (Ponsse 2011.)

The purpose of the co-operation project between Ponsse Plc, Finland`s forest authority and Metla was to look for practical solutions that can be used to increase timber harvesting on peat soil when the soil is not frozen using machinery that is in general use. The development issues included:

1) equipping forest machines for soft soil,
2) adapting working with a machine to soils with poor carrying capacity,

3) developing on the design, and
4) improving the preconditions of wood harvesting companies.

(Ponsse 2011.)

PHOTO 13. Primary transport in peat lands can be done in summertime using Ponsse 10w. (Ponsse)

9.3.4 Harvesting bioenergy

The multi-stemming function of harvester heads is a solution for the productive harvesting of partially-delimbed or undelimbed pulpwood and energy wood. Ponsse has a broad selection of alternatives: all modern Ponsse harvester heads in the various size categories are suitable for multi-stemming either as such or equipped with minor accessories. The Ponsse EH25 energy wood harvester head is suitable for sites where no feeding or delimbing is required. (Ponsse 2011.)

With multi-stemming feature you can harvest both industrial and energy wood simultaneously, which increases the yield. All modern Ponsse harvester heads can be used for multi-stemming even without mechanical changes. When the aim is to harvest delimbed wood from the stand with multi-stemming, the handling and feeding of bundles can be improved with new feed roller solutions. The solution also works well in regular industrial wood felling. (Ponsse 2011.)

With Ponsse harvester heads, multi-stemming is performed with the control function of delimbing knives and feed rollers: the rollers hold the previous trunk in place while the knives grab a new one. After this the rollers open and close grabbing the new tree, and the new tree is cut. The operator can control all collecting features by the push of a button. Finally, the bundle is assembled as whole trees or it is delimbed by feeding the bundle through the harvester head, where necessary. (Ponsse 2011.)

The size of the harvester head is chosen according to the size of the trees to be handled. A strong harvester head, equipped with a large opening, is naturally able to hold larger trunks better. When the diameter of the trunk is small, a smaller and lighter harvester head can be used. The forwarder should preferably be equipped with a load scale for production data recording. (Ponsse 2011.)

The Ponsse LoadOptimizer load scale is a solution for weighing loads. It weighs, sorts, saves and manages load data automatically during the work. (Ponsse 2011.)

Ponsse LoadOptimizer load scale is a timber measuring method approved by the Finnish Act about wood measuring. Load data can also be printed or transferred to customer information systems using a USB memory stick. The load scale's display unit is fully dustproof and waterproof. The weight sensor is designed to endure extreme conditions and heavy use. In addition to Ponsse loaders, the Ponsse LoadOptimizer can be installed in the majority of other loaders. (Ponsse 2011.)

Ponsse LoadOptimizer load scale automatically measures trees harvested with the multi-stemming method when unloading, and weighing can be done by batches and timber grades. Timber grade selector switches to be installed in the control handles are available as optional equipment. (Ponsse 2011.)

PHOTO 14. Ponsse H6 harvester head is optimal solution for multi-stemming small trees. (Ponsse)

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