

Mechanized harvesting system for hardwoods

Maryse Bigot

Ingénieur Forestier, AFOCEL
France

Emmanuel Cuchet

Ingénieur en Agriculture, AFOCEL
France

Summary

In France, 13 million cubic meters of hardwoods are harvested every year, but it has become more and more difficult to find skilled chainsaw operators (number is decreasing), especially for harvesting small size trees or for working in areas affected by windstorms. Naturally, the idea of trying to use harvesters originally built for softwood to harvest broadleaved stands has appeared. The first experiments took place in the mid-nineties, in chestnut coppices. Now, several contractors are working according to the CTL system with conventional rubber-tire harvesters or with combo tracked excavator – harvesting head to cut and process hardwoods for pulpmills and sawmills. Depending on the size of the trees to be harvested and on the type of operation (clear cutting, thinning...), strategies are different. In 2002, AFOCEL made a survey, analysed different systems and made several time studies on different logging operations. The paper presents the results of these investigations and draws up the situation: about 350 000 m³ of hardwoods (pulpwood + saw logs) are harvested by the equivalent of 20 machines working full-time in broadleaved stands and another 20 machines working part-time in broadleaved and conifer stands. Most often, these are “normal” CTL harvesters, originally built for softwoods felling and bucking. The technical feasibility is then demonstrated for hardwoods until 0.300 m³. But if loggers all agree about the fact that mechanization brings advantages in terms of organisation and security, a lot of them, even after 2 years of experience, remain doubtful about the profitability of this activity. To be developed in the future, hardwoods mechanization must be thought “globally”: every player of the forest-wood chain has to make efforts (manufacturers, forest owners and managers, loggers, industry, schools).

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Introduction

In France, the classical system to harvest hardwoods is a two-stage system:

1. motor manual felling, delimiting and bucking at the stump,
2. extraction with forwarders or cable skidders, depending on the size of the logs, the slope...

According to this system, 13 million cubic meters of hardwoods are harvested every year: 8 millions for lumber and veneer, 5 millions for pulp and particle or fibreboards. There are four sources of pulpwood: coppices clear-cuts (chestnut, oak), poor value stand clear-cuts (mixed hardwoods species: beech, oak, birch, aspen...), thinnings in oak and beech high forests, and tops of large crop trees in final cuts.

In the last decade, the number of chainsaw operators has been considerably decreasing. Because of a lack of profitability, pulpwood and small size tree harvesting is becoming a real challenge. Naturally, the idea of trying to use harvesters originally purpose-built for softwood in broadleaved stands has appeared. Several initiatives have been undertaken since the early nineties but so far, hardwood mechanized harvesting was remaining at the experimental level.

Things have been changing since December 99, when two windstorms blew down in two days 140 million cubic meters (4 times the average annual harvest), including 60 million cubic meters of hardwoods. Because priority then has been given across the country to the recovery of largest and more valuable pieces of timber, both in conifer as in broadleaved stands, this event completely changed the situation concerning hardwood harvesting, especially pulpwood or small size trees, and lead to different strategies among contractors, wood suppliers and mills. In 2002, AFOCEL made an investigation to draw up the situation: how many cubic meters of hardwoods and what kinds of products are harvested by machines? What kind of machines can be used and in which conditions? What evolution can be expected for the near future?

Materials and methods

Survey

In mid 2002 we drew up a list of loggers using or intending to use harvesters in broadleaved stands. Basically this list was developed from the results of an exhaustive survey conducted by AFOCEL a few months before to characterize the French harvesting fleet. We have used and crossed different sources of information: regional lists, provided by the State offices, of loggers who applied for subsidies when investing in new machinery, phone books, books of professionals, but also verbal exchanges with loggers and foresters. We have mailed questionnaires but as the response rate was very low (< 10%), we had recourse to phone calls to get the basic information needed (type of machine, date of purchase, number of machine hours, type of products).

Interviews

In fall 2002, we visited 22 logging companies identified as harvesting hardwoods with machines or having the project to start such an activity: 8 contractors (working for wood-suppliers or sawmills), 10 suppliers (purchasing the wood stumpage, having the logging done by their own crews and machines, selling the products to sawmills and pulpmills) and 4 sawmills managing the logging (own crews + contractors) of the purchased standing timber. We interviewed harvester owners and harvester operators on several topics:

- The reasons that have driven them to decide to work in broadleaved stands with machines and the conditions in which they have developed, if so, this new activity
- The organisation and the performance of this activity
- Their feelings about the development of this activity in the future, both in their company and in forestry in general.

Time and productivity studies

In some cases we also carried out short time studies (3 to 10 hours) according the European harmonized protocol AIR3-CT94-2097 in order to get objective data on productivity of the process in different conditions, that we could confront to the annual, monthly or daily productivity that loggers had announced to us.

Results: a panorama of hardwood mechanized harvesting

Men

We have found 43 logging companies concerned, but more or less, by hardwood mechanized harvesting. Except a large pulpmill supplying company (100 people), all are small size companies (1 to 6 people). Among contractors, the main part of them was already loggers, carrying activities such as motor-manual harvesting, softwood fully mechanized harvesting or forwarding. A couple of them were also originally specialised in agricultural work. Concerning the suppliers, hardwood mechanized harvesting is mostly developed among those who were specialised in the hardwood trade than those who purchase and sell both softwoods and hardwoods.

The majority of these people have developed this activity by their own but we have also found a few examples of partnerships, of different types: supplier/contractor, mill (sawmill or pulpmill)/contractor, mill/supplier.

We have also found a dozen of professionals interested in developing an activity of hardwood mechanized harvesting but who have not taken any final decision yet: until then they have just experimented the technique on little patches or informed themselves on the subject (questioning machine sellers and operators).

Machines

Loggers use various types of machinery to cut and buck hardwoods. It seems that they have not found “the pearl” yet, but no machine is considered as totally inadequate either.

Concerning the harvesting heads, we can distinguish three categories.

- Conventional harvesting heads, built for softwoods, with no major mechanical modification, compose the more prevalent category. However, they require special adjustments, on rolls and knives pressure and speed in particular, to perform well in deciduous trees delimiting and bucking. These are, for example, KETO 100 and 150L, WOODY 50 and WOODY 60 (KONRAD), PATU 505, PONSSE H60, SILVATEC 445MD50, TIMBERJACK 742, 745, 746 and 762, SIFOR 350 and 500, WARATAH 762.
- Conventional harvesting heads with special mechanical modifications for a better adaptation to hardwood processing form a second category of machines. The special requirement is that they must perform well both in hardwoods and softwoods. Most often, they have been the fruit of a partnership between a machine dealer and a machine user, with sometimes the support of French government funds. Common modifications and adaptations concern the knives (number, position, profile) and their controlling mechanism. Sometimes a top saw is also mounted. KETO 150 HW, PONSSE H60W, SILVATEC 445MD50 and TIMBERJACK 762 are models of this category.
- Hardwood purpose-built harvesting heads are the third and last category. Until now, only two models have been specially designed for hardwood cutting and bucking: FORICOM H2564 and CHARLIER. They can also process softwoods.

All these heads are mounted either on wheeled carriers (60%) either on tracked carriers (40%). The latter are mainly excavators (different models from CASE, DAEWOO, KOMATSU, LIEBHERR...); there is just a few examples of forest carrier (TIMBCO 425). The rubber-tyre carriers are 4-wheeled (SIFOR 614 - TIMBERJACK 770 and 870 - VALMET 901), 6-wheeled (LOKOMO 990 - NOKKA, TIMBERJACK: 1070 et 1270 - VALMET 911) or 8-wheeled (PONSSE HS10, SILVATEC 856TH, 886TH and 896TH). We even found a specimen of a “4-wheeled walking” carrier (MENZI MUCK A71).

Generally, the 4-wheeled machines are preferred to the 6- or 8-wheeled ones because of their lower price but on the other hand, they are not so powerful and stable in steep terrain. Tracked excavators are also cheaper than conventional harvesters, and they can be easily resold if the harvesting activity is stopped. The problems are that it is harder to operate them in thinnings (because of the counterweight size and emplacement), they cannot be used to cross a road because of the tracks, and they have bad reputation among forest owners and managers.

Systems

At the end of 2002, we can consider that the equivalent of 40 machines are harvesting hardwoods in France but 20 of them are working full-time in broadleaved stands whereas the other 20 are working part-time in broadleaved - conifer stands.

Full-time or part-time working in broadleaved stands?

We met 8 machine-owners (mainly contractors) having their harvester cutting and processing hardwoods 80% to 100% of the time. Except one of them who is specialised in poplar, all have been working for at least one year in chestnut coppices, in private forest. As woodlots size is very often between 0.5 and 10ha, loggers have to amalgamate several of them. By this way, they manage to move their machine by road in average 1 or 2 times per month. The most common products are sawlogs of varying length (from 2m to 6m) and 2m or 4m length pulplogs. Top end diameter is nearly always 8cm. The proportion of pulpwood varies between 25% and 75% of the total volume. Some loggers are used to buck only 1 to 3 sorts of logs per site, others 5 to 7.

We also interviewed 8 loggers (mainly suppliers) who had invested in a harvester with the intention to use it both in conifer and broadleaved stands. So far, only 2 of them work significantly (at least 50% of the time) in hardwoods (beech, oak, aspen, birch...), in thinnings (100% pulpwood) or clear cuts (pulpwood proportion variable). The 6 other loggers, all working in the north-east part of France, where a lot of spruce, pine and fir stands were stormdamaged in December 99, preferred to give the priority to softwood recovering, instead doing thinnings in deciduous stands. So they have finally worked in broadleaved stands very scarcely.

With or without chainsaw operator?

Three systems have been developed, none of them prevailing on the others.

- Some loggers have a chainsaw operator (a salary or a contractor) working systematically in tandem with the machine. In most cases, he is in charge with felling the non-merchantable stems before the harvester, and the too large trees (generally, machines find their limits with trees having a diameter of 40-45cm). Sometimes, if necessary, he also re-cuts the stumps and check/correct the quality and the grading of logs that the machine has bucked. This generates an extra-cost but the aim is to improve the quality and the productivity of the machine work, while preventing also mechanical incidents.
- Other loggers have their machine working by itself the main part of the time and have recourse to a manual feller only in specific conditions (understorey too much developed for example), considering that a full-time manual worker would not be profitable.
- Other loggers have developed an original system: noting that the forwarder is able to extract the wood quicker than the harvester is able to process it, the forwarder operator works with a chainsaw ½ day to 1 day per week, to clean up the tricky zones or to put the finishing touches to the forest site.

Productivity and Costs

As seen above, systems used for hardwood mechanized harvesting are very different:

- Some loggers are specialised in very small size trees (DBH 8-15cm) whereas others harvest rather medium sized trees (DBH of 20-30cm),
- Some loggers are specialist in optimising tree value (they buck 5 to 7 different grade logs) whereas others harvest only pulpwood,
- Some machines are operated by an employee and work hardly 1500 hours per year whereas others are operated by the machine-owner himself for more than 1800 hours per year,
- Some machines work in tandem with a chainsaw operator, others not.
- Etc.

As a result, harvest productivity and costs are very variable. About costs, it seems that a 2 year experience is not long enough to evaluate them with accuracy but what is already sure is that they will be higher than in softwood harvesting due to lower utilisation rates, higher maintenance and repair costs, and lower productivities.

Concerning productivity, Figure 1 shows a few examples of productivity measured on different situations, but with operators more or less experienced (a few months to 2 years): this is the reason why we have preferred not to fit any model yet. These data are not conflicting with productivities announced by interviewed loggers: 6 to 8 apparent cubic meter per machine hour, 50 to 300 apparent cubic meter per day, 12 000 to 30 000 apparent cubic meter per year.

Discussion: positive and negative aspects for the development of hardwoods mechanization

About people motivation

Loggers come to hardwood mechanized harvesting by force of circumstances.

Interviewed on their motivation to start an activity of hardwood mechanized harvesting, loggers generally point out:

- The difficulties to find skilled manual workers to perform the job
- The intention to reduce the management cost (managing people take more time than managing a machine)
- The willing to improve work-planning and to be more reactive (tandem working with a forwarder is easier, machine production is less dependant on weather than manual crews...)

- The desire of diversification and modernisation.

Nevertheless, looking closer to the circumstances in which loggers have started this new activity, we have identified the factors that have really launched the method: these are the shortage of manual workers, work or wood, resulting in most cases from the December 99 windstorms.

Just after the windstorms, manual workers have widely deserted the too dangerous and non-profitable damaged stands (poor-value stands and chestnut coppices). This means a lack of work for loggers who were specialised in hardwood pulp logs and chestnut saw logs forwarding or trading but also a risk of interruption in the wood supply for the industry using these kinds of products. Even if in some cases, loggers managed to convince manual crews to work in windfall, harvest costs expanded then so considerably (sometimes twice) compared to usual conditions (higher wages and lower productivity) that a machine based system appeared finally to them as a more profitable and safer solution.

In a second phase, in regions less affected by windstorms, when local softwood recovering was completed, some loggers started to run out of work in conifer stands. They decided to transfer their harvester in broadleaved stands instead of moving to further areas.

In such contexts, the support of the principle client (financial support or pluri-annual contract) played also a key-role for contractors or suppliers.

Mentalities and fears are without any doubt a real obstacle

The widely expressed feelings among loggers who have not started yet an activity of hardwood mechanized harvesting are:

- the fear of non-profitability,
- the fear to have their logs refused by the mills,
- the fear of the mechanization non-acceptance from forest owners and managers,
- the uncertainty about the total and annual volume of wood-resources (in the local area) that could be harvested with machines,
- the questions about market evolution (prices, types of products...).

A lot of these questions are also recurrent among loggers having at least one year of experience in hardwoods mechanization. Three types of behaviour can be distinguished, none of them prevailing or typical of a given situation:

- Optimistic loggers, who want to keep on working in hardwoods with machines and intend replacing their machine by a new one after 5 years,
- Hesitating loggers, who still do not know what they will do in the near future (1 or even 2 years seem a too short period to know if the system

is profitable): “we will do whatever we can so that it works and we will do it until the machine is paid then we’ll see”.

- Pessimistic loggers, ready to stop the activity: “if in a couple of months it is still non profitable, I’ll stop the machine”.

About the method itself

Hardwood mechanized harvesting: not an easy job, but an interesting one

Machine availability and capacity is naturally a very important issue but technical matters are not the real obstacles to hardwood mechanized harvesting. Indeed all hardwood loggers agree: “globally, it works” (in certain conditions of course, but the job is technically feasible and meets the forest owners/managers requirements, when the products characteristics also comply wood users specifications), but is also true that breakdowns are very frequent, far more frequent than with softwood harvesting: “there is always something wrong with mechanics”. To limit the negative impacts of breakdowns on productivity and costs, loggers point out the solution “you must be able to carry out repairs by yourself and as quick as possible: that means being able to anticipate and identify problems, keeping a stock of spare parts in your truck or pick-up, etc.”. As this ability comes with time and experience, loggers who had already operated CTL-harvesters in conifer stands were better prepared than novices. The quality of after-sale services from machine sellers is of course also crucial.

In hardwood mechanized harvesting, operator skills are perhaps even more important than machine capacities. In conifer harvesting, characterised by rather homogenous trees, the bucking has been automated because log grading is principally based on dimensional criteria (diameter and length). For hardwood logs, grading takes into account qualitative criteria as well, that the machine is unable to identify. As a result, operators can use the automated bucking process only for pulp logs. The rest of the time they have to be very concentrated to choose the right quality class bucking alternative before every cross-cutting: that implies that operators have to know exactly all product specifications (quality and dimensions). This is perhaps the reason why the major part of the operators we have found driving harvesters in broadleaved stands were people with a former experience in hardwood logging (they used to work as a chainsaw or forwarder operator). Several operators have also told us that this made the job more interesting.

A method procuring real advantages

According to loggers for who hardwood mechanized harvesting is a daily work, this method has two major and undeniable advantages.

First, the whole organization of the logging is easier, especially the coordination with the extraction and transport stages. The just in time production is now possible, working on large scale operations far from the office is also possible (only 1 or 2 operators to lodge, and who are able to manage their job by themselves, instead of large crews that require a

supervisor), *etc.* Therefore, if time spent on management and time lost in bad coordination decrease, that means lower costs.

Concerning security and ergonomic point of view, no doubt mechanization is a significant progress. Hardwood harvesting could transform in a more attractive job to young people.

Conclusion

Since December 99 windstorms, hardwood mechanized harvesting is no longer at an experimental stage in France: at the end of 2002, 20 machines work full-time in broadleaved stands (mainly in chestnut coppices) and other 20 machines part-time in broadleaved and conifer stands. Hardwood mechanized harvesting accounts for 2-3% of the average total annual hardwoods harvest (350 000 m³ on 13 million m³).

In France, there is now a general acceptance among loggers (not yet among forest owners and managers) that mechanization is the only way for pulpwood and small size deciduous trees harvesting in the future to face the lack of manual workers, and the question of profitability is considered as the most important problem. This situation looks very much like the one at the end of the eighties, when French loggers started to use CTL harvesters to do the thinnings in conifer plantations; nevertheless, nowadays, less than 15 years later, 450 to 500 harvesters harvest about 8.5 millions m³ of softwood, that is to say 40% of the total annual softwood harvest.

It would probably be dangerous to think that the lack of manual workers will be a driving force strong enough to launch and sustain the development of mechanization in hardwoods. For softwoods, the real driving force was the development of dynamic silviculture schemes, planning regular thinnings in plantations to produce quickly high value timber. As this kind of silviculture does not exist (yet) for broadleaved stands, another driving force must be found. The wood industry (pulp, board, lumber, veneer...) must be aware that his supplying strategy will have a strong influence on the future of hardwood mechanization. But hardwood mechanization must also be thought "globally" to be developed: every player of the forest-wood chain has to make efforts:

- Manufacturers, to improve machinery,
- Forest owners and managers, to fit silviculture methods to mechanization,
- Loggers, to improve the efficiency and the quality of the whole chain (harvesting + extraction + transport),
- Industry, to develop log specifications without extra-quality,
- Schools, to train operators with adequate skills.

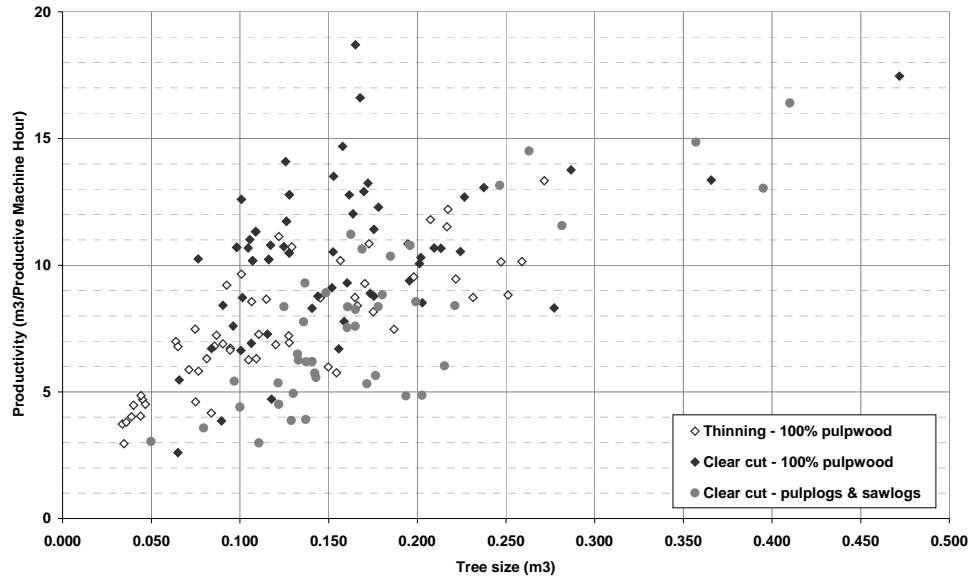


Figure 1. A few examples of harvester productivity measured in different hardwoods logging operations, with operators more or less experienced (1 point = 1 hour observation; 3 to 10 points per logging site).

References

Bailly A., Bartet X. 1999. Mechanized harvesting of broadleaved coppices. Proceedings of the joint FAO/ECE/ILO Committee on forest technology, management and training, in Pessac (France): Forest operations for tomorrow. 11 pages.

Bigot M., Peuch D., Hoellinger G., Pouthier H. 2002. Bûcheronnage mécanisé des peuplements feuillus: Mise au point d'une machine en Limousin. AFOCEL. Fiche-Information-Forêt n°648. 6 pages.

Bigot M. 2001. Using machines to harvest hardwoods in France. Proceedings of the 24th COFE annual meeting, in Snowshoe (USA-WV): Appalachian Hardwoods - managing change. 3 pages.

Sionneau J., Cuchet E. 2001. Mechanization of thinnings in hardwood: the French experience. Proceedings of the IUFRO meeting in Québec (Canada): Thinnings - a valuable forest management tool. 4 pages.

Full name	Maryse Bigot	Emmanuel Cuchet
Address	AFOCEL	AFOCEL
City	Domaine de l'Etançon	Route de Bonnencontre
State/Province	77 370 Nangis	21170 Charrey sur Saône
Country	France	France
Phone-number		
– work	+33 (0)1 60 67 02 34	+33 (0)3 80 36 36 20
– mobile		
E-mail-address	Maryse.bigot@afocel.fr	Emmanuel.cuchet@afocel.fr