SESSION 3
Paper (a)

MECHANISATION OF FELLING AND DELIMBING IN NEW ZEALAND

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INTRODUCTION

Over the past two decades there has been a worldwide trend to reduce the level of manual inputs into tree harvesting, by using mechanical means for tree felling, delimbing, and processing. This push for mechanisation has been for a variety of reasons, such as:

1. Increased demand for wood fibre.
2. Scarcity of skilled labour.
3. Rapid rising cost of labour.
4. To improve the workers' environment with respect to safety and climatic conditions.

Mechanisation has had most success when handling small piece sizes (<.35 m^3), where motor-manual techniques are very expensive. But, mechanisation has not always been the answer, and many countries are re-evaluating at what level to mechanise. This paper discusses mechanisation within New Zealand: its past experience, present status, and future implications.

THE RESOURCE

Much of New Zealand's pulpwood supply has and will come from radiata pine thinnings and clearfell of unthrifty species (mainly ponderosa pine). Over the next few years an estimated 2.3 million m^3 of this smallwood (<.35 m^3) will be harvested annually (*Ref.1), and over 90% of this will be on flat or rolling country that is suitable for working mechanised systems.

In general, the cost per cubic metre of chainsaw felling and delimbing is about three times higher in small trees than in larger old crop radiata. The high cost of manually harvesting small trees, as well as the more hazardous and difficult working conditions indicate that mechanised felling and delimbing may have some potential over the use of chainsaws in this type of timber.

PAST EXPERIENCE

Mechanised Tree Felling

The first attempt at mechanisation was through the use of directional felling tree shears. The shear was a QM shear fitted on a Cat D6 tractor. It was a simple, reliable, single-action shear capable of directional control and some bunching ability. The shear could fell trees up to 66 cm, yield higher wood recovery through lower stumps, caused less breakage, and had greater safety and more flexibility, since it could work in wet and windy conditions. Clearfell production

rates were approximately 500 trees per day in old crop radiata, and 800-900 trees per day in ponderosa (*Ref.2).

With plans for increased harvesting of ponderosa and the projected needs for manpower, the next attempt at mechanisation was with feller-bunchers. The first machines introduced were tree-to-tree machines, where the tree was severed from the stump, carried, and deposited into a bunch. The first feller-buncher was a Bobcat 1075 front-end loader with a double-acting 38 cm shear and accumulator arm, giving the option of carrying more than one stem during felling and bunching. The next tree-to-tree machine was a Clark 450 FB front-end loader with a 50 cm accumulating shear. Observed production of both tree-to-tree machines ranged from 90-130 trees per hour in radiata thinnings and 100-160 trees per hour in clearfell (*Ref.3).

Limited area machines were introduced about the same time. They were based on excavator carriers, and were capable of felling and bunching a limited area of standing trees while remaining stationary. The two machines introduced were the Hitachi UH07 with a 50 cm accumulating shear, and the Drott 40LC with a 60 cm accumulating shear. Both machines had a production rate of approximately 110 tree per hour in clearfell ponderosa (*Ref.4).

Mechanised Delimbing

Conventional chainsaw delimbing in small trees has always been highly labour intensive and estimated to contribute 30% of the total log extraction cost of some operations (*Ref.5). With the high production levels attained with mechanical felling, more manpower was required for delimbing to maintain this production. In an attempt to reduce delimbing costs and maintain production levels achieved by mechanical felling, mechanised delimbing was introduced to New Zealand in several forms:

1) Single-Stem Delimbers

The first mechanical delimber-processor introduced was the Can-car processor. The Can Car was a stationery delimbing machine designed to work from a stockpile of trees on the landing. A knuckle-boom crane fed single stems onto the delimbing bed and into the processing shear. The stem was held stationery while five over-lapping,curved knives moved along the stem to delimb a 2.4 m length. The stem was fed through the processing shear and held in place for the next delimbing stroke. The machine was capable of handling trees up to 40 cm, cross-cutting to lengths of 2.4 or 4.8 metres, producing a high quality trim. Production was about 50 trees per hour, which meant that two Can Cars were required to service one feller-buncher (Ref.6). The high cost and low productivity of the single-stem delimber indicated the need for a low cost device that could handle more than one stem at a time.

2) Multi-Stem Delimbers

The cheapest and simplest multi-stem delimber attempted in New Zealand was the gate delimber. The gate delimber was a rectangular steel grid (4 m x 2 m) that was chained between two standing trees. During extraction, stems were delimbed by backing the skidder drag of trees, top first, through the gate. In the brief trial, the grapple on the skidder prevented the tree tops from spreading apart enough for proper delimbing. Delimbing quality was poor in ponderosa and the gate concept abandoned.

Another simple multi-stem delimber tried was a multiple-tooth jaw delimber. The machine consisted of a stationery lower jaw and an upper jaw that was lowered onto the stems. The skidder approached the delimber, dropped the load, drove past the delimber, then winched the stems into the jaws. The jaws were closed and the stems dragged through. Delimbing quality was surprisingly good, although a final trim was required on the landing.

The most common multi-stem delimber was the chain flail. The delimber had several rows of chain which flailed from a rotating drum. The flails were mounted in a variety of ways, and all had independent power sources from the carrier. One flail was mounted on the front end of a Clark 666 skidder, which gave the ability to raise and lower the flail onto the stems. Another was mounted on a trailer and towed behind a Treefarmer C-8, and a third was mounted on the rear of a Treefarmer C-6 skidder. The flails were capable of keeping up with the feller-buncher productivity of 110 trees per hour.

The chain flails had problems achieving complete delimbing and required one man on the landing to do a final trim. Also, chain life was limited, in some cases only 40 hours, and out-fitting with new chains was time consuming and expensive. The flails also caused damage to the wood by embedding dirt and stones into the stem. To overcome the problem of damage to the wood, to extend chain life, and improve delimbing quality, a stationery flail was developed. It held stems above the ground using a platform, and the flail was lowered onto the stems. The sled-mounted platform was backed under the stems, held by a grapple skidder. The flail was lowered onto the stems and the skidder pulled them through. This system reduced the damage to the stems and improved delimbing quality, although a final trim was still required.

3) Harvesters

In the 1960s the Beloit Harvester was devloped in North America to delimb standing trees prior to felling. This concept was first introduced to New Zealand as the prototype Bolstad delimber. A delimbing carriage travelled vertically on a 7.5 metre high tower, which was mounted on the back of a Allis Chalmers HC6 tractor The tractor backed up to the tree and the delimbing carriage was pulled up the tree using the tractor's winch rope. As it repositioned for the next tree, the delimbing carriage returned by natural fall. The Bolstad delimber was able to partially delimb(65%) 90 trees/hour (Ref.6

The prospects of delimbing standing trees led to the development of the Waratah felling-delimbing head. The delimbing head with felling shear was mounted onto the boom of a Hitachi UH04 excavator. The boom was positioned at the base of the tree and moved the delimbing head from a height of 1 to 7 metres. The head was then lowered to fell and bunch the tree. A later model was mounted on a UH05 excavator and initially incorporated a topping shear to eliminate the need for manual topping - this was later abandoned. The Waratah system was the first attempt at a fully mechanised radiata thinning operation and could delimb, fell, and bunch 60 trees per hour (*Ref.7).

CURRENT OPERATIONS

Mechanised Felling

Currently there are four felling machines in operation in New Zealand. One is a QM directional-felling shear mounted on a Cat 995 tracked loader. The shear is working in clearfell ponderosa and

is felling 120 trees per hour. Also in clearfell ponderosa, is the Clark 450 FB feller-buncher, felling and bunching around 90 trees per hour for extraction by forwarder.

There are also two Hitachi feller-bunchers operating. A Hitachi UH07 is felling and bunching 100 trees per hour in contorta pine for extraction by two Cat 518 grapple skidders. The other, a Hitachi UH09, is working on rolling terrain (up to 26°) in Corsican pine. The machine is felling and bunching about 100 trees per hour for cable skidder extraction.

Mechanised Delimbing

Currently there are no single or multi-stem delimbers in production situations in New Zealand. However, recently the Sifer 644 single-stem delimber-processor was introduced. Trials in radiata thinnings and ponderosa clearfell indicate the potential to delimb 90 trees per hour to a reasonably high standard. Production is expected to increase with improved operator experience, but the machine is not yet in a production situation.

Harvesters

The Waratah delimber-feller-bunchers are currently sitting idle. The machines were performing well in radiata thinnings but external factors brought about a closure of the operations. The machines have potential for radiata thinnings or clearfell ponderosa.

LESSONS LEARNT

Fully mechanised systems have had limited success in New Zealand due to a combination of flaws within the systems and external constraints. Some of the problems were:-

1. Inadequate analysis and planning of work methods prior to machines being introduced. The need for good management to balance the machines within the overall system.

2. Low system availablity, reducing production and raising costs. Operations must be managed so that maintenance problems with one unit will not shut down the entire system.

3. Difficulties in meeting log preparation standards, which may need to be modified if low cost delimbing is to be achieved.

4. High cost of machinery versus labour. There is a need to work extended machine hours to offset high ownership costs.

5. Lack of well trained operators, supervisors, and repair servicing staff.

Mechanised delimbing was the main flaw in the fully mechanised systems. Single-stem delimbers are costly to own and operate and have yet to be proven highly productive. Multi-stem delimbers are less costly and more productive but do not achieve the delimbing standard set by most mills.

Mechanical felling has been cost competitive to manual felling in small stem sizes (*Ref.7). Some additional advantages of mechanical felling are:

1. Increased pulpwood volume recovery through lower stumps and reduced breakage.

2. Increased productivity and improved working conditions for manual trimming.

3. Increased productivity of extraction machines through bunching.

4. Reduced repair and maintenance on extraction machines due to low stumps.

5. Improved site conditions for subsequent tree planting.

6. Increased system flexibility through the ability to work in poor weather conditions and at night.

7. Improved safety for workers.

FUTURE IMPLICATIONS

1. Mechanical felling has a definite place in New Zealand's future, initially for clearfell of unthrifty species and secondly in thinnings on easy terrain.

2. Single-stem delimbers must be highly productive and maintain high availability in order to be cost effective.

3. There is a need to develop a low-cost multi-stem delimber attachment. Partial delimbing (80%) should be accepted in order to maintain high production. Any delimbing machine must be able to handle the large branches and stem malformation associated with radiata.

4. Harvesters such as the Waratah delimber-feller-buncher can be cost effective if operators are well trained, systems well balanced, and if machines provide high availability.

5. Mechanisation will be limited to small trees on flat or rolling terrain, except where mechanical delimbing may be done at the roadside.

6. Mechanised systems will require better system management, effective repair and maintenance strategies, and good operator training.

7. The relative cost (and availability) of labour to machine cost must be monitored to dictate the swing to and away from mechanisation.

In the past some innovative loggers made the step toward mechanisation. Many went out on a limb which was subsequently cut off. Mechanisation is not the answer to all smallwood harvesting problems, but it does have distinct advantages over motor-manual systems. Overseas developments should be closely monitored to determine their potential on the New Zealand scene. In order for mechanisation to succeed, there must be close co-operation between forest management, logging supervisors, contractors, and mill management.

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