THE CAZES & HEPPNER PLOW SCARIFIER

(TRIALS AND MODIFICATIONS)

SX 79501 Q

SILVICULTURE BRANCH

MINISTRY OF FORESTS

PROVINCE OF BRITISH COLUMBIA

Submitted: Gordon Dow 80/01/28

Approved:

D.W. Brewis
Co-ordinator, Site Preparation

R.C. Jones
Manager, Silviculture
SUMMARY

In view of difficulties encountered and restrictions imposed, both ecological and social on the use of prescribed fire, there is an increasing need for reliable mechanical techniques for the preparation of denuded forest lands for planted seedlings or natural regeneration.

One of the machines presently in use for site preparation is the Cazes and Heppner V Plow.

The purpose of this report is to describe observations made on the performance of this plow, to describe modifications that were made to the plow and comment on the effectiveness of these changes.

The original C & H Plow was intended to prepare a planting site in front of a mechanical tree planting machine but has since been used to prepare sites for hand planting. The Ministry of Forests purchased a C & H Plow and modified it to make it lighter and more maneuverable. The initial scarification done by the Ministry of Forests' plow proved unsatisfactory, and further modifications were found to be necessary.

The scarification of three sites was assessed. T.S.H.L. A00797 C.P. 9 Block D proved to be unsuitable for V plow scarification due to slope and excessive moisture while the other two blocks outside of Likely were drier and therefore more conducive to plowing.

The performance of the unmodified C & H Plow was poor not only because of site conditions but because of numerous breakdowns and poor handling qualities. The Ministry of Forests' plow had a high production rate but initially did a poor job of scarification. Modifications were made to this plow which improved the quality of scarification while keeping the high production rate. The quality of scarification can be further improved through modifications that were not feasible in the field.
The benefits gained from scarification with a properly designed V plow can easily justify the cost of plowing on appropriate sites. Therefore I recommend the design and testing of a modified V plow be initiated in the near future.
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1.0 INTRODUCTION

The purpose of this report is to describe observations made on the performance of the Cazes and Heppner V Plow, to describe modifications that were made to the plow and to comment on the effectiveness of these changes. I also wish to make recommendations concerning future changes that should be made to the plow to make it more effective.

The following factors have created a void in site preparation that needs to be filled if we are to get many of our logged sites back into production:

1) Logging is being carried out at higher and higher elevations where weather conditions often prohibit prescribed burning for many years in succession.

2) Many forest managers are becoming more reluctant to conduct prescribed burns in view of their escape potential and public pressure to reduce smoke pollution.

3) Costs are rising quickly on site preparation methods such as windrowing.

4) Costs are also rising on tree planting.

I believe that much of this scarification void can be filled through the skilled use of a properly designed V plow.

An area is plowed in order to meet four objectives:

1) To allow planters easier access through the slash.

2) To increase the number of trees that can be planted on an area.

3) To provide a better planting site for both ease and quality of planting.
4) To reduce the vegetative competition to the young trees.

A properly designed V plow can meet these objectives at a favorable cost on many sites.

The observations in this report were made between August 15 and October 15, 1979 on three sites in the Likely and Horsefly areas of the Cariboo Region.
The current model of the Cazes and Heppner Plow was developed from the Taylor Fire Plow by Cazes and Heppner Forest Services Ltd. of Abbotsford, British Columbia. The C & H Plow's purpose was to prepare a planting site in front of a mechanical tree planting machine. The mechanical tree planter saw limited use in 1977 in trials, but since that time the plow has been used on its own to prepare sites for hand planting. Despite the change in purpose of the plow, no adjustments or modification were made to the plow.

The original C & H Plow has a two part system. The prow and the outside arms are designed to break through slash and to deflect it to the outside of the prime mover. An inside plow breaks through the duff and scalps a one metre strip to mineral soil. (see photo 1 pg. 4) The outside arms and the front prow float independently of the inner plow but this movement can be restricted by adjusting two pins behind the prow.

The plow is attached to the "C" frame by a sandwich plate with four pins through it. The correct mounting of the plow to the prime mover is imperative as any play or sloppiness in the plow will decrease maneuverability and lead to swift breakdown. The outside arms are attached to the sockets of the bulldozer's "C"-frame.

The C & H plow was used on a site preparation project on T.S.H.L. A00797 C.P. 9 Block D, east of Horsefly. The plow is approximately 2.8 metres long, 2.7 metres wide and weighs approximately 5,000 kilograms. This plow can be mounted on the "C" frame of any crawler tractor up to the size of the International TD-20 and the Cat D-7G.
Photo #1  C & H Scarification Plow.

Tractors with a horsepower rating equivalent to the TD-20 or the D-7G are the most suitable for use on most B.C. sites. The weight of the plow and the nature of most sites make any smaller prime movers impractical.

The Ministry of Forests purchased a C & H Plow and modified it by trimming it $\frac{1}{2}$ metre in length and 1,360 kilos in weight. The front roller was replaced with a skid plate. The rest of the plow is essentially the same. (See Photo #2, pg. 5). This plow was used at Likely on T.S.L. A07030 C.P. F and part of C.P. G. The plow was altered again for the remainder of C.P. G. (See section 5.3).
Photo #2 - C & H Plow foreground, Ministry of Forests' plow background.
3.0 METHODS

Each of the three sites studied were assessed for slash type and volume, stump type and size, slash depth and duff thickness. This was done by running 20 meter lineal strips at random bearings at 100 meter by 100 meter spacing. All slash over 7.6 cm diameter intersecting the 20 meter strip was measured, all slash between 2.5 and 7.6 cm was measured for the first 10 meters of the strip and all stumps within one meter of the strip were tallied. The slope, aspect and amount of mineral soil exposure were also recorded. (See Tables #1 and 2, pg. 8)

Time studies were made on the machines for each of the three sites. Non-productive operating time was recorded and the reason for it stated. The non-productive operating time was then stated as a percentage of total operating time. The area plowed during the timing was then measured and a hectare per hour (during operating time) performance figure derived. A figure for paid time was recorded from the pay slips and a hectare per hour (for paid time) was derived. (See Table #3, pg. 12).

Other information recorded in the time studies was soil type, slope, average length of strip, average width of strip and average distance between strips.

On the two Ministry of Forests blocks near Likely (C.P. F and C.P. G), plantable spots were assessed at three meter spacing along the outer edges of the plowed strip. These spots were classified as:

1. No screening required.

2. Minimal screening required.
3. Vigorous screening required.


One hundred and sixty of these spots were assessed for the area plowed by the Ministry of Forests' plow and one hundred and sixty on a similar area plowed by the modified version of the Ministry of Forests' plow. (See Appendix #2).

Costs were calculated on a total cost per hectare basis for all three areas and a total cost per tree basis on the two areas plowed by the Ministry of Forests' plow.
### Table #1 Site Description

<table>
<thead>
<tr>
<th>Area</th>
<th>Slope %</th>
<th>Aspect</th>
<th>Elev. in m</th>
<th>% Exposed Mineral Soil</th>
<th>Duff Depth cm</th>
<th>Slash Depth cm</th>
<th>Soil Moisture</th>
<th>Soil Type</th>
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<tbody>
<tr>
<td>T.S.H.L. A00797 C.P.9 Block D</td>
<td>15.6</td>
<td>35</td>
<td>0°</td>
<td>5.9</td>
<td>9.7</td>
<td>21</td>
<td>26.3</td>
<td>61</td>
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<tr>
<td>T.S.L. A07030 C.P. F Units B₁ &amp; B₂</td>
<td>9.2</td>
<td>23</td>
<td>180°</td>
<td>1340</td>
<td>3.3</td>
<td>13.9</td>
<td>25</td>
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<tr>
<td>T.S.L. A07030 C.P. G Unit A</td>
<td>13.6</td>
<td>30</td>
<td>50°</td>
<td>1370</td>
<td>1.0</td>
<td>10.6</td>
<td>21</td>
<td>22.4</td>
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### Table #2 Slash

<table>
<thead>
<tr>
<th>Area</th>
<th>Slash Vol. m³/ha</th>
<th>Stumps m³</th>
<th>2.5 - 7.6 cm dia.</th>
<th>7.6 cm + dia.</th>
<th>Total</th>
<th>No./ha</th>
<th>Avg. dia. cm</th>
<th>Avg. ht. cm</th>
<th>Vol./ha</th>
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</thead>
<tbody>
<tr>
<td>T.S.H.L. A00797 C.P.9 Block D</td>
<td>13.79</td>
<td>169.98</td>
<td>183.78</td>
<td>663</td>
<td>26.2</td>
<td>59.1</td>
<td>31.5</td>
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<td></td>
</tr>
<tr>
<td>T.S.L. A07030 C.P. F Units B₁ &amp; B₂</td>
<td>6.74</td>
<td>257.20</td>
<td>263.94</td>
<td>350</td>
<td>37.7</td>
<td>47.1</td>
<td>20.75</td>
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<tr>
<td>T.S.L. A07030 C.P. G Unit A</td>
<td>11.49</td>
<td>186.16</td>
<td>197.60</td>
<td>706.5</td>
<td>27.7</td>
<td>61.4</td>
<td>49.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.0 SITE DESCRIPTION

The Jacobson Brothers' T.S.H.L. A00797, C.P. 9, Block D, on which the original C & H Flow was used, is a high productivity, Interior Wet Belt Spruce, Balsam site. It was logged during 1977 by a high-lead logging system. This block is 113 hectares in size of which 38.5 hectares were treated with the plow. Access to the area is gained by crossing the Whiskey Bridges, 152 km east of Horsefly on the Black Creek Road. (See Appendix 3).

Photo #3 - T.S.H.L. A00797 C.P. 9 Blk.D

T.S.L. A07030 C.P.'s F and G are located 37 km from the Likely Ranger Station on the Rollie Lake Road. Both of these sites are medium productivity, Interior Wet Belt Spruce, Pine, Balsam sites. These sites were logged during 1973 by rubber tired skidder and were unsuccessfully burned in 1975. C.P. F is 35 ha in size of which 30 ha were treated and C.P. G is 96 ha of which 70 ha were treated. All three sites had vegetative
competition and duff layers which would have made planting without site preparation difficult.

Although the average slope on T.S.H.L. A00797, C.P. 9 was only 2% greater than on T.S.L. A07030 C.P. G, soil type and soil moisture helped make plowing along the contour almost impossible on the Horsefly site. Plowing against the contour opened the possibility of erosion during the spring run-off on this block. In retrospect, the combination of slope and wet ground made this site unsuitable for this type of mechanical site preparation. Plowing along the contour of the Likely sites was achieved with little difficulty except when the slope exceeded 24%.
5.0 PERFORMANCE

5.1 The Cazes and Heppner V Plow.

Although site conditions were the largest factors in the production rate on T.S.H.L. A00797, other factors contributed significantly to slow production to 0.325 ha/hour which is about 1/3 that recorded on the other sites. (See Table 3, pg. 12). These factors included the plow's condition on arrival to the site, the plow's design, the mounting of the plow to the C-frame, the inexperience of the operator, and the prime mover used.

Before coming to the Horsefly site, the C & H Plow had been working on a rugged "blowdown" area east of Quesnel. This left the plow worn in many places and it was loose and sloppy compared to a new plow. This condition led not only to increased breakdowns but to poorer handling qualities for the operator. Breakdowns such as cracked plates, broken shackles, broken hinges, missing pins, etc. caused the plow to be idle 40 hours of its available 141 hours. This compares with a figure of 8 of 140 hours for the Ministry of Forests' plow. As well, $1,137.00 was spent for parts and repairs on the C & H Plow. (See Appendix #1).

According to an operator who had used both the C & H Plow and the shorter and lighter modified plow, the modified plow offered increased visibility and was easier to maneuver. The operator could not lift the longer plow nearly as high as the shorter plow because of the sloppiness in the C & H Plow. This was a factor in dealing with stumps, slash accumulations and in getting out of mud holes. Because of the different site conditions, it is difficult to assess the difference in the quality of scarifying between the C & H Plow and the modified version of the Ministry of
Table #3  Performance Table

<table>
<thead>
<tr>
<th>Location</th>
<th>Production ha/hr.</th>
<th>Forward* Operating Time (%)</th>
<th>Width of Strips m</th>
<th>Distance Between Strips m</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.S.H.L. A00797 C.P.9 Block D</td>
<td>.325 .28 .39</td>
<td>37.0 27.0 44.0</td>
<td>2.5</td>
<td>3.4</td>
</tr>
<tr>
<td>T.S.L. A07030 C.P. F Units B₁ &amp; B₂</td>
<td>.92 .83 1.02</td>
<td>63.6 58.0 69.0</td>
<td>2.6</td>
<td>3.4</td>
</tr>
<tr>
<td>T.S.L. A07030 C.P. G Unit A</td>
<td>1.08 .98 1.30</td>
<td>66.2 60.0 70.4</td>
<td>2.8</td>
<td>4.0</td>
</tr>
</tbody>
</table>

* This figure represents the time that the blade was moving forward and scarifying versus the total time that the bulldozer was running.
Forests' plow.

The correct mounting of the V plow is very important in helping to prevent wear and breakdowns of the plow. The side arms of the C & H Plow were mounted too far away from the "C" frame causing increased stress on the arm hinges and mounting pins. One of the hinges eventually broke. The sandwich plate which attached the plow to the front of the "C" frame fit sloppily on the Cat D-7G. This caused the holding pins to bend and caused damage to the D-7G's "C" frame.

As with most equipment, the skill and experience of the operator is a factor in the effectiveness of the equipment. The operator at the Horsefly site had never operated a V plow before and this probably had a small bearing on the productivity.

The prime mover could have had some bearing on production rates on the different sites. The International TD-20 used on the Likely sites seemed to perform better than the D-7G at Horsefly because of additional horsepower, two speed steering clutches and a better weight balance for the weight of the plow. These points are open to contention and different operators may feel quite the opposite.

All of these factors combined with site factors to push the cost for T.S.H.L. A00797 C.P. 9 to $308.41/ha, more than three times the cost of the Likely blocks. (See Appendix #1).
5.2 The Ministry of Forests' V plow.

The Ministry of Forests' V plow scarified all of T.S.L. A07030 C.P. F and part of T.S.L. A07030 C.P. G before modifications were made to it. With an International TD-20 as a prime mover and an experienced V plow operator, the average production on the area was .92 ha/hour. The operator was impressed by the increased maneuverability and visibility of this plow versus its longer and heavier predecessor.

The production rate of .92 ha/hour would be good if the plow was creating a favourable microsite for planting. Unfortunately a number of factors combined to make the plow's scarifying performance poor.

Because of (1) the Ministry of Forests' plow being more rigidly mounted to the "C" frame (to prevent wear and breakdown), (2) the shortness in length of this plow compared to the C & H Plow, (3) shorter hinges than the C & H Plow and (4) different placings of the adjustment pins, there was less contact of the outside of the plow arms with the ground. Therefore the spots where tree planting was desired, the outside edges of the plow, were receiving very little disturbance. To make matters worse, material scalped by the inner plow was being deposited on the outside of the dozer track forcing planters to remove two layers of duff instead of the original one layer (and the desired bare ground). See Photo #4, Pg. 15.

Planters tended to plant down the middle of the plowed swath where the inner plow had scalped and compacted the mineral soil instead of on the outsides of the plowed area. This caused problems with not only the placing of the trees in unfavorable locations, but also in reducing the number of trees planted on the area by nearly half.
Photo #4 - Scarification by unmodified
Ministry of Forests' plow.
This problem could not be alleviated by changing the pin positions. The operator found that by changing the adjustment pin position and allowing the front prow to float more freely, there quickly built up a pile of sticks and debris under the plow which caused the plow to be ineffective. Ripper pins which were welded to the inside of the plow arms before the project started did not last through the first day of plowing. To get around these problems, modifications were made to the Ministry of Forests' plow.

5.3 The Modified Ministry of Forests' Plow.

The modifications to the Ministry of Forests' plow were mainly intended to change the focus of scarification from the inner plow to the area on the outside of the plow arms where it is most desirable to plant the trees. To accomplish this, the cutting edges from the inner plow were removed and cutting edges were attached to extend from the outside of the plow arms. (See Photo #5, pg.16). Because of this change, increased stresses on the plow hinges were anticipated. Therefore supports were welded on the inside of the plow arms against the "C" frame. (See Photo #6, pg.17). These supports could not be attached to the "C" frame because they would take away the floating ability of the front prow and side arms.

Photo #5 - Ministry of Forests' plow after modifications. Arrows indicate added scraping edges.
Wedges were welded between the side arms and the front prow to lessen the "toe-in" effect that the cutting edges had on the side arms. The toeing-in of the side arms put stress on the hinges and main connecting bolts from the side arms to the "C" frame. The hinges were showing signs of wear, therefore protection plates were welded over them.

Cutting edges were also welded onto the front prow. These prevented debris from building up under the plow. This enabled a change in the adjustment pin position which in turn allowed the cutters on the outside arms of the plow to be in contact with the ground longer and to therefore be more effective.

The total cost of the modifications was $800.00 for materials and welding and $346.00 for machine time while the TD-20 was either sitting idle or testing the plow.

After pushing the modified plow, the operator said that there was little
change in handling. Production went up to 1.08 ha/hour but I believe that it was mainly due to the wide distances between strips that were made after the adjustments. The most important difference was in the quality of the microsite that was created. The problem of a double duff layer was eliminated and in most cases the original duff layer was disturbed enough to allow easy planting. (See Appendix #2). Some material was falling back onto the dozer tracks but generally it was being pushed aside. The addition of the cutting edges increased the average strip width from 2.6 meters to 2.8 meters which brought tree spacing closer to the desired 3.0 meter spacing. (See Photo #7, below).

Photo #7 - Scarification by modified Ministry of Forests' plow.

The cost of scarifying the two Likely blocks (not including modification costs) was $8,327.00 which worked out to $83.27 per hectare. The cost per planted seedling of plowing the two blocks was 9.5¢. A 10 ha area on C.P. G that was not plowed had a bid price of 7.0¢ per tree higher than the plowed ground. Therefore for a cost of 2.5¢ per tree the following
benefits were gained:

1) The cost of planting was reduced.

2) The number of plantable spots was increased. Data indicates an increase from 750 to 864 plantable spots per hectare.

3) Trees will be more evenly distributed over the site due to the uniform pattern of site preparation.

4) Removal of competing vegetation is expected to result in improved growth of the planted seedlings.

5) Ease of access and planting greatly improved the moral of the tree planters. This is a very positive factor. We would anticipate improved planting quality although no specific data was obtained in this instance.
Further modifications should be made to the design of the V plow to improve the efficiency and quality of the plow's work.

Because the focus of scarification is on the outsides of the side arms, the inner plow should be removed altogether and replaced with supports so that strength is not reduced and so that most of the stress remains on the center of the "C" frame. This should make the plow lighter and there will be less effort spent on disturbing the ground unnecessarily.

The hinges connecting the side arms to the "C" frame should be beefed up because this is a potential breakdown area. The side arms should be mounted at either a different or additional position on the "C" frame. This should help to eliminate two other potential breakdown points which are the mounting pins which attach the hinges to the "C" frame.

The cutting edges on the side arms should extend further beyond the dozer tracks to reduce the compaction at the point where the tree will be planted. As well, the shape of the cutting edge should be curved to better dispose of debris without it falling back onto the scarified areas.

The area around the adjustment pin should be enclosed to prevent the accumulation of debris which restricts the floating ability of the front prow and side arms.
7.0 CONCLUSIONS

1) A major portion of Blk. D, C.P. 9 T.S.H.L. A00797 was unsuitable for treatment with the machines which were used due to a combination of wet silty soil, an average slope of 15.6% and heavy slash;

2) the plow must be mounted very rigidly with as little play as possible to lessen breakdown and increase maneuverability;

3) of the two prime movers tested the International TD-20 seemed to be the best with the Cat D-7C a close second;

4) the unmodified C & H Plow focuses too much of its attention on treating the centre of the plowed strip while the desired spot for placing the trees is on the outside of the plowed strip;

5) the Ministry of Forests' plow with the added scraping edges did a better job of preparing the site for planting than did the C & H and the unmodified plow, but that additional modifications to it are still needed;

6) the benefits gained from scarification easily justified the costs incurred on T.S.L. A07030 C.P. F and C.P. G.

7) a properly designed V plow can more effectively prepare a site for planting at less cost than can windrowing if fire hazard reduction is not of prime concern.
8.0 RECOMMENDATIONS

I recommend that:

1) before any project is started the plow be in good condition with any worn parts replaced;

2) care and proper supervision be used to insure that the plow is properly mounted;

3) only prime movers having the capacity of the International TD-20 or a Cat D-7G be considered for plowing most B.C. sites;

4) any future design of a V plow focus its attention on scarifying the outside of the scarified strips instead of the center of the strips;

5) a newly designed V plow be constructed and tested as soon as possible and if successful be manufactured so that the backlog of areas needing scarification can be reduced;

6) if a prescribed burn is not possible or desirable and if fire hazard reduction is not of prime concern, the V plow be considered for planting site preparation.
APPENDIX I

Cost Summary - C & H Plow T.S.H.L. A00797 C.P. 9

Move D7G from Likely to J.B. Camp $286.00
Move D7G from C.P. 9 to Likely 312.00
Cat time 159 hrs. @ $56.00/hr. 8,904.00
Swamper for Cat $520.75 + 27% 661.35
Move plow from Quesnel to J.B. Camp 360.00
Move plow from C.P. to Williams Lake 198.00

Total Operating Costs $10,721.35

Repairs to Plow
Parts $380.96
Welding 756.00

Total repairs $1,136.96

Total Costs $11,858.31

Area treated - 95 acres or 38.45 ha

$124.82 / acre or $308.41 / ha

Cost Summary - Ministry of Forests' plow
T.S.L. A07030 C.P.'s F & G

134 hours straight @ 57.75/hour $7,738.50
Hauling cat 195.75
Supply material and mount plow 392.50

Total Cost $8,326.75

Area treated - 247 acres or 100 ha

$33.71 / acre or $83.27 / ha

Modifications to plow

Labour 28 hrs. @ $24/hr $672.00
Material Steel plate 128.27
12 hrs. standby for TD-20 @ $28.77/hr. 346.44

Total Cost of Modifications $1,146.71
APPENDIX II

Performance Comparison of Unmodified and Modified Ministry of Forests' Flow In Terms of Plantable Spots.

<table>
<thead>
<tr>
<th></th>
<th>NS</th>
<th></th>
<th>Min</th>
<th></th>
<th>Vig</th>
<th></th>
<th>N/P</th>
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<tr>
<td></td>
<td>#</td>
<td>%</td>
<td>#</td>
<td>%</td>
<td>#</td>
<td>%</td>
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<td>46.9</td>
<td>27</td>
<td>16.9</td>
<td>7</td>
<td>4.3</td>
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</tbody>
</table>

NS - No screening required  
Min - Minimal screening required  
Vig - Vigorous screening required  
N/P - Not Plantable

These samples were taken on similar sites on T.S.L. A07030 C.P. G.
APPENDIX III

MAPS
Area treated by Ministry of Forests' plow on T.S.L. A07030, C.P. G and C.P. F - shown in green.