A TRIAL TO DEVELOP TECHNIQUES FOR USING TRACKED VEHICLES TO CREATE PLANTING SPOTS IN BRUSHY AREAS ON STEEP SLOPES

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T. Persson
FIELD TRIALS OF TRACKED VEHICLES FOR MECHANICAL
SITE PREPARATION ON STEEP SLOPES

Introduction

A large portion of the backlog NSR in Nelson Region is on steep terrain. Many are highly productive sites with a dense cover of woody and herbaceous plants. Some form of site preparation is necessary to reforest these sites. Previously we have made several attempts to use conventional mechanical site preparations on steep slopes but these were unsuccessful because of limitations of the equipment used.

A new attempt was made in 1981 with both a conventional crawler tractor, a John Deer 450, and an FMC flex-track forwarder. Both machines were equipped with six-way dozer blades. The position of these blades can be altered hydraulically into six positions. They can be raised and lowered, angled right or left and adjusted horizontally by dipping either right or left corner.

The 1981 program was possible because the Ministry and three Licensees, BC Timber (KFP and TFL 23) and Slocan Forest Products pooled funds budgeted for site preparation.
Without the efforts of Kootenay Tractor (Kootrac) in Nelson, this program may not have been possible. Kootrac built a six-way blade for an FMC at their own expense. They supplied a new FMC 220 forwarder, a crew of 2 men, a 4X4 truck and provided room and board for the crew, all for a flat rate of $91.00 per hour. Kootrac's efforts and contributions towards the success of the program is gratefully acknowledged.

**Techniques of Site Preparation**  Three techniques were developed with different effects and costs. These techniques are dip and dive, planting trails, and mounding. Unfortunately, we cannot show the difference in cost for each treatment, because time studies had not been budgeted for. A total of 305 ha were site prepared at an average cost of $202 per ha.

**Planting Trails**  These are basically skid trails constructed on contour. It is essential that the tractor has a six way blade because the cross section of the trail must be parallel to the slope. The driver must constantly adjust his blade so there is no cut and fill section nor a berm on the down hill side to act as barrier against surface runoff. The over burden, the logging slash and the L, F and H layers are side casted. Breaks in the trails are made at convenient spots, 20 - 30 m apart to further minimize erosion. Whether or not dry stream beds or water channels can be crossed, is a site specific decision. Care must be taken that any water is not diverted by track channels. Angle downhill just before the stream channel and uphill on the other side.
Dip and Dive  This technique is not new but we improved it. We use it on ground that is too steep to contour. The tractor works only in one direction. It travels straight downhill, screefs for a short distance, (2.5 - 6 m), and leaves an undisturbed patch between the screefs. The debris is left in the form of a berm at the lower end of the screef. The purpose of the berm is primarily to hold back the surface run-off so soil particles settle out and the water will seep into the ground rather than running on top of the surface.

The steeper the slope the greater the impact is of mechanical disturbance. On slopes over 40% the distance between the screefs in the line of travels is far more critical than the distance between the lines, because the surface runoff has higher velocity and therefore the filtering zone (area between screefs) should be enlarged.

Return trails should be pre-located. A conventional tractor spends 25% of its time on return trails and 75% dipping diving, an equal distance. The return trail should therefore not exceed double the length of the workstrip for efficient machine usage. A conventional crawler tractor has difficulty going through wet spots on a 20% adverse grade. Length of return trails and wet spots are not too critical for the FMC because of its high speed and superior traction.
Mounding  This technique was only used once, at Boulder Creek, east of Kootenay Lake. This site has not yet been logged. It is a good spruce site on level ground, but very high elevation (2000 m). During the silvicultural examination it was noted that low temperature must be a limiting factor because advance growth was only found on elevated spots, rotten wood, upturned roots, etc. All trees had high root systems (first level of branching above ground) which indicated they too had started on rotten wood. The silvicultural prescriptions for this stand calls for shelterwood cutting and pre-scarification.

The silvicultural objective is to obtain natural regeneration. Therefore, the purpose of the scarification was to imitate nature, create elevated seedbeds, hummocks or mounds to increase soil temperature.

These mounds should be at least 30 cm high, similar to an upturned tree stump. The screef can be very short, actually a gouge. Where the slope exceeds 10%, the gouge should be on the uphill side for water retention. Avoid driving over the mounds because it flattens them.

Machine Selection  It is essential that the machine has a six-way blade. The blade must contantly be adjusted so that screefs and berms are properly made. The blade is also used as an aid in steering. On steep slopes, it is important that the machine goes straight downhill, otherwise it can slide sideways and roll over. Rather than being totally dependent on steering brakes and clutches, the driver can angle the blade which helps push the front over. 

chin either the right or left corner of the blade.
Some crawler tractors are not designed to work on steep slopes. When they are sharply inclined, the transmission fluid is all at the front and the tractor loses its transmission and can "take off". The transmission fluid must be checked constantly and must never be allowed to run low. Over-filling is a good precaution. Check that the motor has a deep oil sump and that the oil pump will provide adequate lubrication to all parts of the motor when sharply inclined. Again, over-filling helps.

Examine tracks for wear. Worn grousers must be built up. Ice cleats improve traction on slash and windfalls.

We used two types of crawlers. The John Deere 450 is a conventional crawler tractor with rigid suspension. The drive sprocket is in the rear and all track rollers are rigidly mounted. This tractor has a high centre of gravity, it is narrow and rolls over easily. When it goes over a berm the driver must proceed extremely slowly because it drops down violently on the other side. Another undesirable characteristic is that the driver usually pushes all windfalls to the side instead of driving over them. This is time-consuming, it can also damage existing regeneration.

Slope limitations for conventional crawlers are 20% when making trails and 45% when dipping and diving. On slopes steeper than 45%, the driver must keep the blade constantly in the ground for safety reasons. The result is a continuous trail which is not acceptable.
Slope limitations for a "flex-track" tractor are much broader. A FMC can easily contour on 30% slope and up to 40% providing there are no large stumps or windfalls. On our projects, an FMC has dipped and dived on 75% - 80% slope quite satisfactory. This difference in performance is mainly due to track design. The drive sprocket is in front, the track is tight on the top and slack on the bottom allowing the track to mould itself to uneven ground and obstacles. An FMC can walk over a windfall which a conventional crawler must push aside. Each trackroller has its own suspension and moves independently. Watching an FMC go over a windfall, one is reminded of a snake, each trackroller lifts when its turn comes, the rest of the track is on firm ground.

On our projects we found that flex-track crawlers such as FMCs have superior traction and are more stable than conventional tractors. There are other flex-track machines available which we have not used. Most are developed for use on snow or muskegs and are equipped with rubber tracks. Such tracks are not likely to last when subjected to the abrasion of rocks and slash.

**Intensity of Site Preparation**

The intensity of site preparation and distribution of plantable spots depends on the constraints for each area such as:
Steepness of slope. Can the tractor make trails on contour or must it dip and dive?

Are there surface rocks which can not be crossed because they do not provide sufficient traction?

Creeks and small streams. How wide reserves are needed?

Large, high stumps that the tractor must drive around. Directions must be changed gradually so there are likely to be untreated patches.

Where the tractor can make planting trails, the intensity of planting spots is high. There is no wasted time because the tractor can work both ways.

Where the tractor dips and dives it is difficult to create sufficient number of plantable spots to obtain optimum stocking per hectare.

There are several reasons. The first is that this treatment method is used on much steeper slopes. The undisturbed area between screefed patches must be increased to control erosion.

There are also machine limitations to consider. Once the tractor lifts its blade to create and crawl over a berm, it travels a distance equal to its own length before the dozer blade touches the ground again. A John Deere is 2.5 m long -- distance between screefs is 2.5 m. An FMC is 6 m long -- distance between screefs is 6 m.
As a result of these machine limitations, a John Deere can produce more dip and dive patches per hectare than an FMC. However, this argument is really academic because in practice, an FMC can trail the same site with higher efficiency and at lower cost.

On most of our dip and dive projects with an FMC we obtained approximately 150 screefed patches per hectare, 2.6 m wide and varying from 2.5 m to 6 m in length. One solution to increase the number of plantable spots is to decrease spacing between planted trees on the screef. Group planting.

Safety on Steep Slopes

1. Use only flex-track machines such as the FMC because it has superior traction and is more stable than conventional tractors. There are other flex-track machines available which we have not used. Most are developed for use on snow or muskegs and are equipped with rubber tracks. Such tracks are not likely to last when subjected to the abrasion of rocks and slash.
2. The canopy must be well protected with screens, and the driver must wear a seat belt. + Roll-over bar on machine.

3. Transmission must be fully filled or over filled.

4. Grousers with ice cleats must be in good condition, wear beyond 50% is not acceptable. Build them up.

5. The tractor must have a six-way blade. It is a steering aid and therefore an important safety aspect. Furthermore, the screening done with a six-way blade is far superior than a standard dozer blade.

6. Do not put the driver under any "production stress". Show him what you want to achieve, but he decides what is too steep or too dangerous.

7. Work straight downhill, otherwise the tractor can slide sideways.

8. Avoid rock outcrops (no traction).

9. The tractor needs a reasonably level "jumping off" and landing spot at top and bottom of the strip. In most cases there are trails that can be used, otherwise suitable trails need to be constructed.

10. The tractor must have a winch and a long winch line.
11. Fine textured soils are extremely slippery when wet. These areas should be treated during the dry season. It may increase moving costs but it reduces the working time spent per hectare if these soils are treated when dry.

12. Show the driver the kind of berms you want, heights can vary but they must be steep on the uphill side for water retention. Tractors with slow hydraulic systems should stop temporarily while the blade is lifted, otherwise the dirt in front of the blade is spread out instead of being left as a high berm.

T. Persson
Special Project Coordinator

TP:sh/msa
## APPENDIX I

### SITE PREPARATION DONE WITH AN FMC

<table>
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Site preparation with a John Deere 450 mounding at Boulder Creek

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APPENDIX II

Dip and Dive

Close up of same screef
Alder: Note size of stems.

Dip and dive through an alder patch.
FMC "takes off" from top road.

Landing on bottom road.
Dip and dive. A series of good screefs.