

**FOREIGN
CULTURE
BRANCH**

SX 79105 Q
RNX 7905:

FIELD TEST OF TWO TYPES
OF PLANTING GUN
Final Report
December 1979

Subject: RNX 7905, Field Test of
Two Types of Planting Gun -
Final Report

(1) Introduction

The performance of two types of planting gun were assessed on an operational planting project in the Vancouver Region in the spring of 1979.

(2) Purpose

The trial was designed to:

- a) Assess the mechanical performance of two types of modified planting gun.
- b) Compare the production and quality of gun planting with that of a dibble.
- c) Compare the ergonomic properties of the guns with those of a dibble.

(3) Personnel

Silviculture Branch: C. Clarke and P. Robson
Engineering Branch : K. Apt and R.W. Lane
Vancouver Region : G. Dixon
U.B.C. : R. St. Jean (Jack Walters was invited
but was unable to attend, due to other
commitments)
Planting Contractor: Steve Merrian

(4) Location

Planting Contract 92H12-47, Urquhart Creek, R.D. 2, Hope.

(5) Site:

The trial was carried out on an unburned northeasterly slope of variable topography, Fig. 1 and 2. Although the whole unit was rated as of moderate planting difficulty (see F.S. 703 attached), there was considerable difference between lower and upper slopes.

Most of the timing and planting quality assessment was done on the more moderate lower slope. The upper portion sampled, where 100 bullets were planted with the F.S. Pal gun, was rated as difficult due to a 70%+ slope, frequent bedrock, outcrops and stoney soil.



Fig. 1 Lower Slope of Planting Site



Fig. 2 Upper Slope

(6) Planting Stock

The trees planted were 1+0 Douglas fir, CBW 210, Seedlot 1226, characterized as tall and spindly.

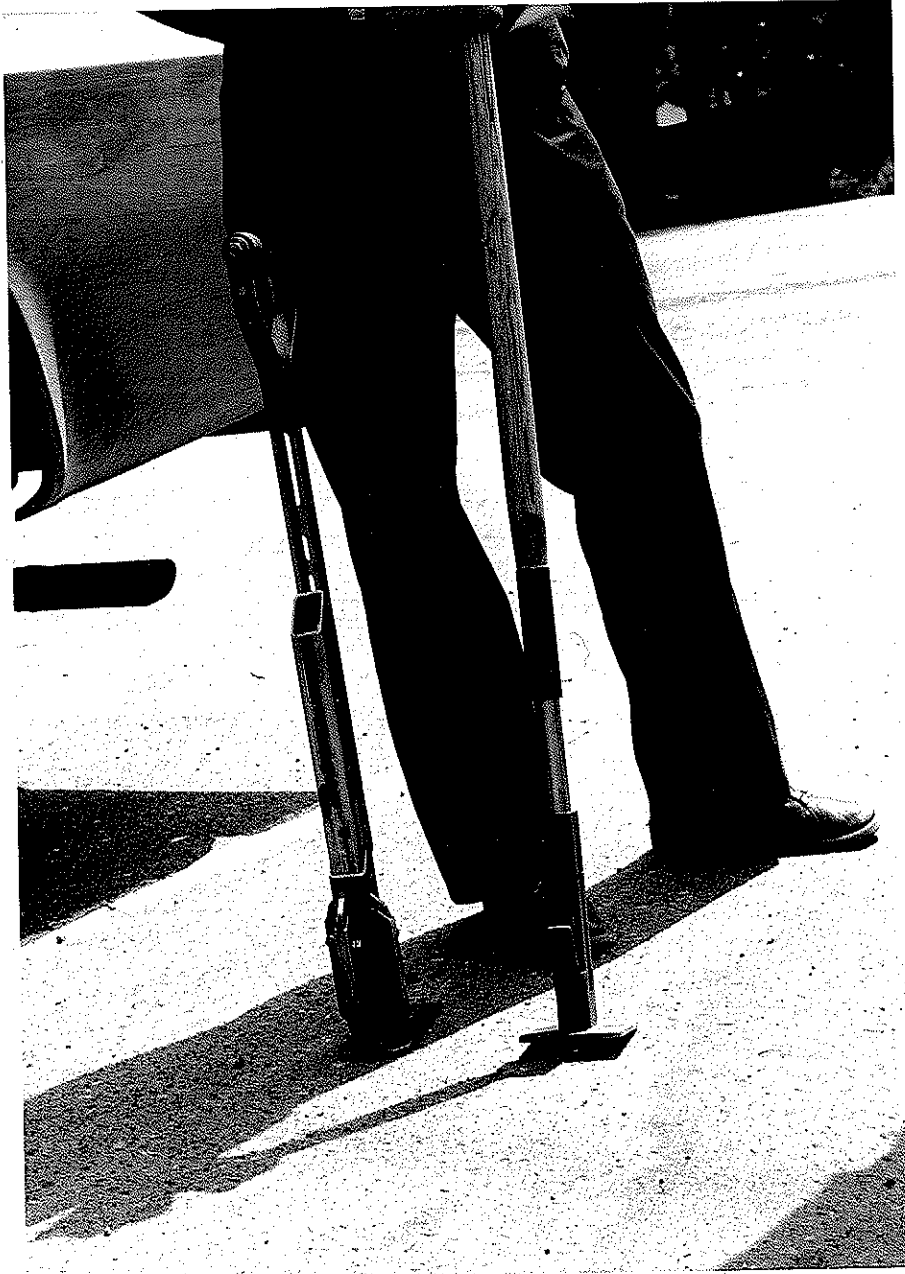


Fig. 3 UBC Gun (at left) and PAL-1 Gun

(7) Tools Tested

a) Modified Walters Gun (UBC Gun) (Fig. 3)

This is of all steel construction, has a D-type handle, and is intended for one handed planting. Loading is from the top of the square cross-section planting tube. The seedling is retained in the tube by spots of welding in two opposite corners. The bullet is pushed into the ground by four steel fingers which are open when the gun is held up and closed over the bullet on the down stroke. The configuration of the bottom plate is similar to that of a hoe and can be used for screefing.

The UBC gun weighs 6.3 kg. The cost of making the three prototypes was \$1500.

b) Forest Service Pal-1 Gun (Fig. 3)

This is of steel and wood construction and is intended for two-handed use. Loading takes place on the side of the square cross-section planting tube when the tool is lifted up. The bullet is retained in the tube by a spring flap, and injected into the ground by a partially open circumference sliding tube on the down stroke.

The tool weighs 2.4 kg. The cost of manufacturing six working prototypes was \$800.

c) PSB 211 Dibble with Screefer

This is the standard tool for planting plugs.

It weighs 2.2 kg and costs \$24.

(8) Method

Testing was on an operational basis in which a contract crew was equipped with six Forest Service Pal-1 guns, dibbles and the one UBC gun available.

Planters were checked individually and the time taken to plant 100 bullets recorded. Bullets destroyed or unacceptably planted were tallied.

It was unfortunate that the test took place at the end of the season when relatively few bullets were left to plant, thus precluding minor improvements and retesting the tools as the trial progressed.

(9) Results

Data from the field testing are summarized in Table 1 (following page).

TABLE I

Type of Tool	Time in Minutes to plant 100 trees	No. of Trees Satisfact. planted per hour	Mechanical Acceptability -Percentage (1) in each Class-			Cost Comparison based on 10¢ per dibble planted seedling	Planting Difficulty Rating
			Jammed In gun	Smashed by rock	Too Shallow		
UBC gun	24.00	200	6	(2) 8	5	81	8.00 Mod.
Sample #1	15.32	330	5	8	2	85	5.30 Mod.
Sample #2	21.98	250	2	4	3	91	7.00 Diffic.
Sample #3	22.25	240	2	8	2	88	7.30 Mod.
PSB 211 Dibble	34.27	175	-	-	-	100	10.00 (3) Mod.

(1) This percentage refers only to mechanical performance and is not the same as planting quality percent.

The four F.S. 704 plots known to have been established on the trial area indicate a planting quality percent of 96.2.

(2) Assuming an average loss of 14% through breakage, this amounts to an additional cost of \$2.40 per 100 planted trees, based on a production cost of 15¢ per CBW 210 grown seedling.

(10) Mechanical Performance

a) UBC Gun

The gun is sturdy, loads easily, slides well on both up and down strokes, compacts the soil satisfactorily, and for the most part inserts seedlings into the ground to an adequate depth.

At times, probably because of excessive free slide on the down stroke, the bullet breaks inside the planting tube. This leads to a loss of planting time when a planter (inexperienced with the gun) loads in a new bullet, forcing it on top of the broken one. This problem could be overcome by redesigning the push fingers to allow a shorter free slide.

The action of the gun involves ten moving parts which complicates the manufacturing and maintenance.

b) Forest Service Pal-1 Planting Gun (Fig. 4)

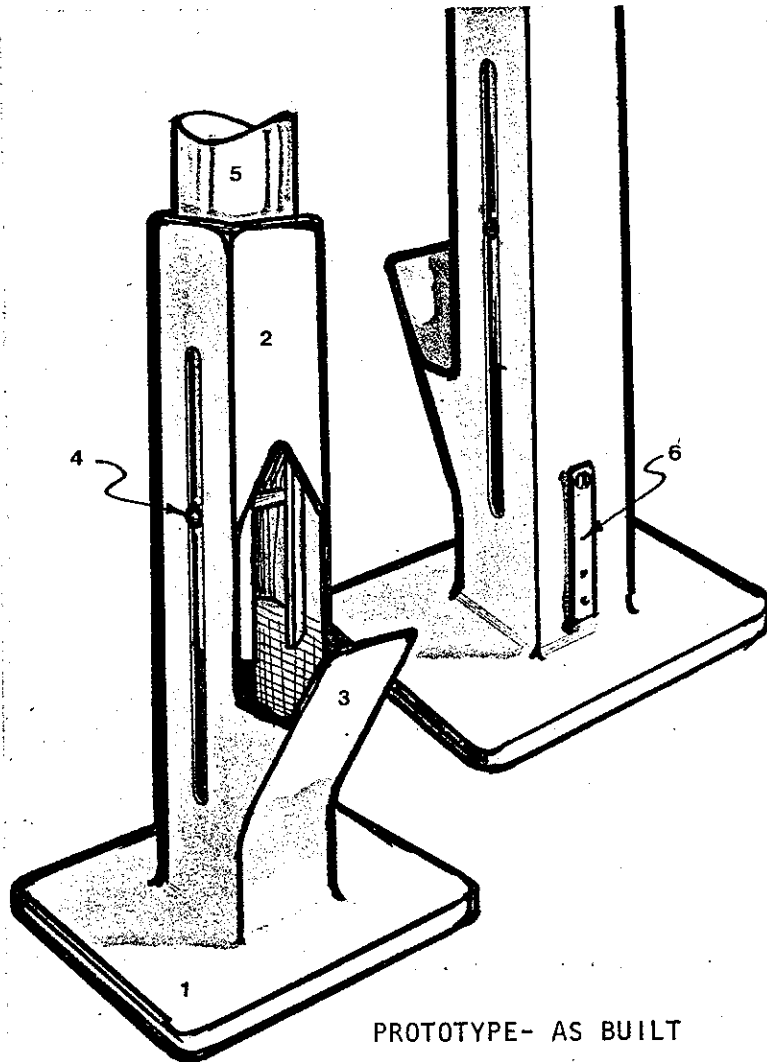
The gun consists of a sturdy steel planting head and a wooden handle. The mechanism slides freely and plants trees to an acceptable depth (98%) and compacts the soil well around the seedling.

The retention spring and guide pin showed weakening after some use.

The action of the gun is simple, facilitating fabrication and maintenance. The proposed modification shown in Figure 6 will reduce the number of moving parts from three to two and will eliminate the weakness mentioned above.

Containers have to be fully inserted in the planting tube before the down stroke is begun to avoid breakage.

Fig. 4
Pa1-1 Planting
Gun



1. BASE PLATE
2. BODY
3. LOADING SHUTE
4. GUIDE PIN
5. HAMMER
6. RETENTION SPRING

(c) PSB 211 Dibble

Has no moving parts, is as simple mechanically as possible, and thus has the advantages and disadvantages of a tool reduced to its most elementary form.

(11) Ergonomic Properties

These refer to the tool-man interaction in terms of comfort, fatigue, safety, etc., and are examined here with respect to the following work phases:

- | | |
|--------------------|--------------------------------|
| (a) Carry plants | (e) Penetrate ground |
| (b) Locate spots | (f) Insert container in ground |
| (c) Scarify ground | (g) Firm seedling in soil |
| (d) Carry tool | |

UBC Gun

The model tested had the advantage over the dibble in that the former doesn't require the planter to bend down in the act of planting.

Because the gun is loaded from the top there is no need to lift it in the act of loading. The weight of the test gun (6.3 kg) was a definite factor in promoting fatigue.

The planters at first liked the D-type handle, probably because it resembles the conventional dibble handle. However, after testing, they preferred the long straight handle that is intended for two-handed use.

Forest Service Pal-1 Gun

No bending is needed in the planting process. The planter can aim the gun accurately, a feature that is especially valuable in heavy slash where any visible spot can be planted provided there is a small opening. The planter is not exposed to the hazard of being snagged in the face by branches.

PSB 211 Dibble

From the ergonomic point of view, this is an inferior tool, requiring all three phases of planting (penetration, injection and firming) to be carried out separately with considerably more effort and discomfort than either of the guns. The extra work of bending down is tiring and hazardous in slash.

TABLE 2: Summary of Ergonomic Properties

Work Phases	UBC Gun	Pal-1 Gun	Dibble
Carry plants	No difference	No difference	No difference
Carry tool	Heaviest	Relatively light	Relatively light
Locate spot	No difference	No difference	No difference
Screef *	Acceptable	Acceptable	Good
Puncture ground	Standing up, one arm, fair aim.	Standing up, two arms, good aim.	Standing up, using foot, good aim.
Insert seedling	Standing up, load gun at hip height.	Standing up, load gun at hip height	Bending down, insert seedling into ground
Firm seedling	Compacts soil all around the plant as part of the motion of puncturing	Compacts soil all around the plant as part of the motion of puncturing	With dibble or foot, usually on only one side of the plant.

* Planters didn't use any of the tools for screefing, preferring to use the heel of the boot.

(12) Planter Preference

Planters preferred the F.S. Pal-1 Gun over the dibble or UBC Gun in soils with relatively little rock.

In rocky soils a higher percentage of bullets were crushed by the guns. Later, as the retaining spring weakened in the guns the planters switched to dibles. The test wasn't long enough to determine whether preference for the dibble was due to rocky soil or to fatigue of the retaining spring.

In addition to the improvements mentioned above, we will fit a square dibble to the tip of the Pal-1 handle to compensate for changing ground conditions. This will add about 300 g to its weight (Fig. 5).

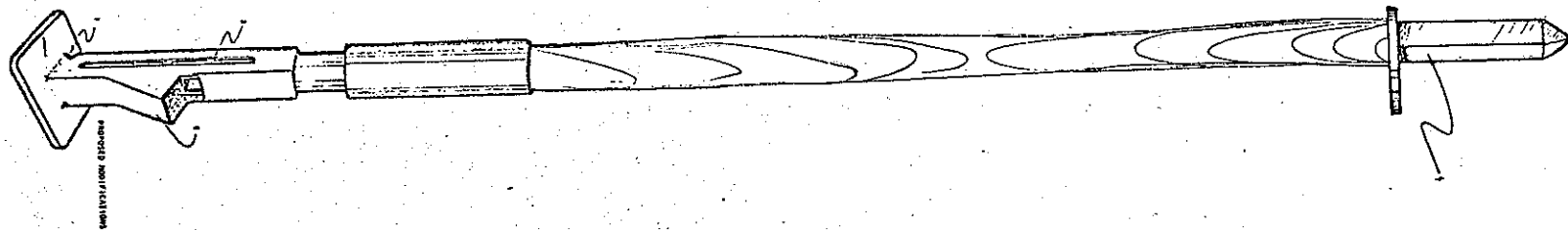
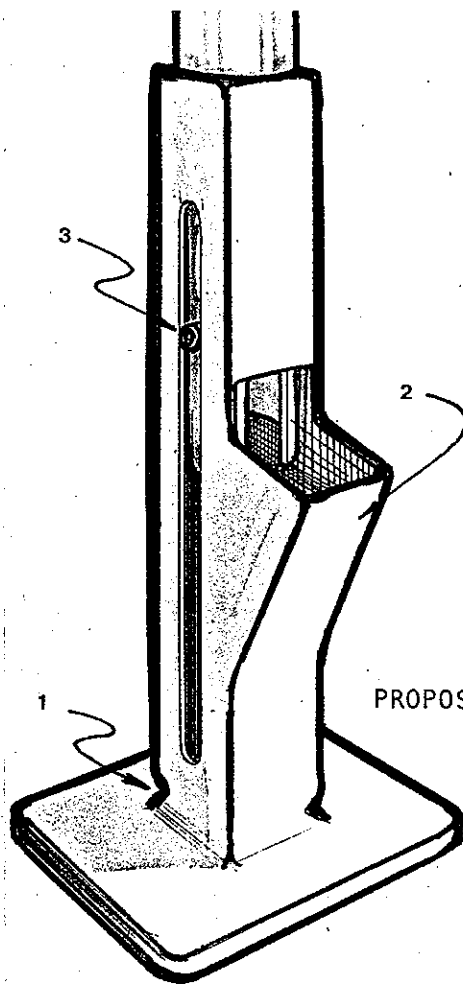


Fig. 5 Dibble & Gun combination for testing in 1980.

(13) Conclusions

- a) Both guns tested proved to have potential for planting CBW 210's. Their production rate was considerably higher than that of the dibble.
- b) Of the two guns, the F.S. Pal-1 is the lighter, faster, and cheaper to make. The cost of on-line production of the Pal-1 is estimated as close to that of the Canadian Forestry Equipment K-1 type dibble.
- c) The guns are at a disadvantage on rocky soils because of the relatively high number of bullets broken and discarded.
- d) Mechanical problems encountered in the trial can be overcome at minimum effort and cost; see Fig. 6 for proposed modifications.



PROPOSED MODIFICATIONS

1. RETENTION DIMPLE TO REPLACE SPRING.
2. STRONGER, MORE SIMPLY FABRICATED LOADING SHUTE.
- SHUTE IS LOCATED 10 mm HIGHER ON BODY TO EASE BULLET ALIGNMENT.
3. STRONGER, LARGER GUIDE PIN.

Fig. 6

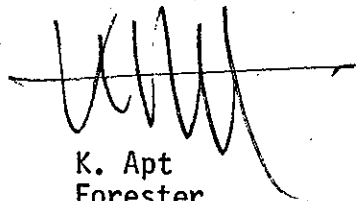
PROPOSED MODIFICATIONS

(14) Recommendations

- a) Provided that CBW 210's are available for planting next season, the F.S. Pal-1 gun be given a more extensive trial to evaluate its potential more fully.
- b) That no further funds be provided for developing or improving the UBC gun.

Note that neither the trial nor this report are intended to evaluate bullet planting as a whole, or to compare bullets with bareroot or plugs from an economic or biological point of view. The intent was only to evaluate their mechanical and ergonomic properties. However, it should be said that there is no need for a rigid container (e.g. CBW 210) if planting is by dibble. The extra cost of producing this type of planting stock can only be justified if (1) an injector tool is used, and (2) such a tool provides a sufficient increase in production to offset the inherent disadvantages of injector planting.

Experience has shown that contractors are usually reluctant to switch from a type of planting tool that is known to them to something new. If we decide to continue producing bulleted stock, we must be able to demonstrate the advantages of the gun to their satisfaction.



K. Apt
Forester
Resource Development Section
Engineering Branch



P. Robson
Forester
Silviculture Branch

British Columbia Forest Service
Reforestation Division
Planting Difficulty Rating

Planting Project No. 92 H 12-47 Forest District V R.D. 2
Block/Unit No. Urquhart Cr. Method of Site Preparation Nil-Unburned

SITE CHARACTERISTICS AND POINTS RATING			
1. Vegetation	Infrequent grass, herbs & low shrubs. <u>1</u> point	Frequent grass patches, herbs, low shrubs, infrequent naturals 3	Continuous grass or other vegetation, naturals planted trees. 6
2. Thickness of duff or litter	Less than 5 cm (2 inches) 1	5-20 cm (2-8 inches) <u>3</u>	Over 20 cm (8 inches) 6
3. Fine Debris	Scattered branches and tops. 1	Grouped branches and tops, less than 1 m (3 ft.) high, loose arrangement <u>3</u>	Filed branches and tops, more than 1 m high (3 ft.) or in a continuous mat. 6
4. Coarse debris	Scattered logs. 1	Frequent logs, some grouped and crossed, less than 1 m (3 ft.) high. <u>3</u>	Frequent logs, grouped and crossed, more than 1 m (3 ft.) high. 6
5. Stoniness	Infrequent stones or boulders. <u>1</u>	Frequent stones, boulders or coarse gravel. 3	Continuous stoney layer and/or frequent boulders, gravel. 6
6. Compaction	Loose <u>1</u>	Occasional compact areas, e.g. landings. 3	Definite hardpan or compact layer throughout. 6
7. Slope	10 - 35% 1	0 - 10% 25 - 65% <u>3</u> 35%	over 65% 6
8. Unplantable areas	Infrequent patches of surface water, bedrock, etc. <u>1</u>	Frequent patches of less than 0.2 ha (1/2 ac) 3	Frequent patches of more than 0.2 ha (1/2 ac) 6
Circle one point rating in each of the eight factors and total = <u>16</u> points =			
Planting Difficulty Rating			
Planting Difficulty Class:			
Less than 10 points		EASY	
10 - 20 points		MODERATE	
21 - 30 points		DIFFICULT	
31 plus points		SEVERE	
F.S. 703 <u>P. Robertson 79-05-15</u>			

TABLE 3: F.S. 703, Planting Difficulty Rating for the trial area.