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AGRICULTURAL EXPERIMENT STATION

FORCED VS. DELAYED SYSTEMS OF CLEARING STUMP LAND

SUPPLEMENT TO BULLETIN 163

BY

M. J. THOMPSON

NORTHEAST DEMONSTRATION FARM AND EXPERIMENT STATION



UNIVERSITY FARM, ST. PAUL

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ERRATA

Bulletin 163, "Cost and Methods of Clearing Land"

TABLE III, Page 12

Cost of material Tract 1 is \$26.91 instead of \$24.00 as given.
Cost of material Tract 2 is \$13.09 instead of \$8.32 as given.

TABLE IV, PAGE 12

Cost of explosive per stump, Tract 1 is \$0.1257 instead of \$0.1121
Cost of explosive per stump, Tract 2 is 0.06 instead of 0.04
Total cost per stump, Tract 1 is 0.1547 instead of 0.1411
Total cost per stump, Tract 2 is 0.08 instead of 0.06

TABLE VII, PAGE 14

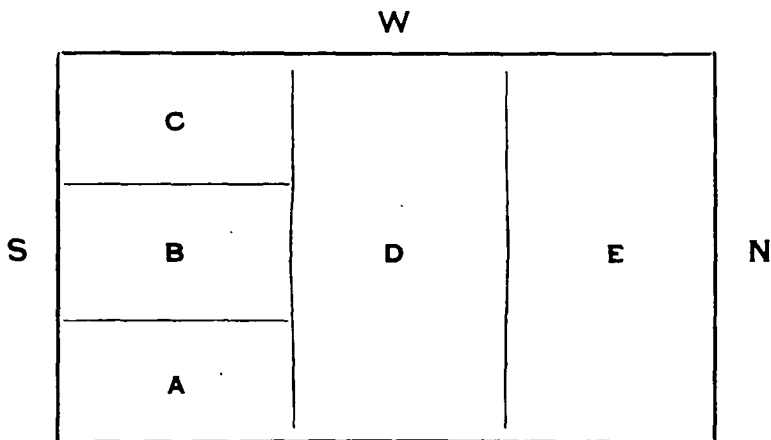
Cost of blasting per stump, Tract 2 (Table IV) is \$0.08 instead of \$0.06
Total cost of removal per stump, Tract 2 is 0.12 instead of 0.10
Final cost per stump, piled, Tract 1 is 0.1977 instead of 0.18
Final cost per stump, piled, Tract 2 is 0.22 instead of 0.09

FORCED VS. DELAYED SYSTEMS OF CLEARING STUMP LAND

By M. J. THOMPSON

INTRODUCTION

Bulletin 163 contains a general outline of the original project giving complete data for Tracts I and II and for Tract III to the stump stage. Tract III was sown in the spring of 1914 to clover and grass at the rate of about 2 pounds alsike clover, $\frac{1}{2}$ pound red clover, and $2\frac{1}{2}$ pounds mixed grasses, or a total of five pounds per acre. The land was prepared before and after seeding by stirring with one section of a spring-toothed harrow, drawn by one horse, and covering as much ground as possible between the stumps. It was lightly pastured during the season of 1914 and pastured through the seasons of 1915, 1916, 1917, and 1918. Removal of stumps was begun in 1918, and stumping and plowing was completed in 1919. This supplementary report covers the work of completing the clearing on Tract III and also miscellaneous data related to the general subject of land clearing and farm development. The diagram illustrates the plan of procedure and the methods employed on Tract III.



- Section A. $\frac{1}{2}$ acre. Cleared with 20 per cent dynamite.
Section B. $\frac{1}{2}$ acre. Cleared with 30 per cent dynamite.
Section C. $\frac{1}{2}$ acre. Cleared with 40 per cent dynamite.
Section D. $1\frac{1}{2}$ acres. Blasted lightly with 20 per cent dynamite and then cleared with stump-puller.
Section E. $1\frac{1}{2}$ acres. Cleared with stump-puller. The largest stumps then were split with dynamite.

In all sections, no stump was removed by either dynamite or machine until all had been pulled and piled that could be removed by direct horse power.

PROJECT STATEMENT

In June, 1918, two men and one team were employed in this field cleaning up the scattered wood and logs, saving everything of value for fuel and piling the rest. The stumps were piled over the cull wood piles. A census was taken of the stumps. Those which probably could be pulled were chalk marked to guide the teamster. This prevented the men wasting time on stumps too difficult to remove without the aid of dynamite or the stump-puller. After these stumps were pulled a second census was taken. This time not only the number but also the kind, condition, and diameter of the stumps at the ground was recorded. Blasting, pulling, piling, burning, and plowing were completed on Sections A, B, and C, in 1918. The forest fire of October 12, 1918, not only delayed the completion of the work but also modified the balance. The pulling only was done on Sections D and E in 1918 and the work was finished in 1919. There are 5.44 acres in the tract and originally there were about 314 stumps per acre.



Fig. 1. Tract III, July, 1918, After Four Years of Pasturage and Just Before Stumping Began
Note the thick stand of stumps.

TABLE I
PERCENTAGE DISTRIBUTION OF SPECIES OF TREES

Section	Cedar	Balsam	Birch	Pine	Tamarack	Spruce
A	7.0	75.6	10.1	7.3	....	....
B	2.8	70.5	7.0	7.0	12.3	....
C	2.8	68.4	10.3	12.7	4.4	....
D	2.5	63.1	15.3	6.0	7.4	3.1
E	4.2	64.0	8.3	10.2	3.5	1.0
Average	3.8	68.5	10.2	8.6	6.9	2.0

TABLE II
PERCENTAGE OF STUMPS PULLED DIRECT

Section	Cedar	Balsam	Birch	Pine	Tamarack	Spruce	Misc.	All stumps
A	82	83.0	36.0	33.0	....	....	....	75
B	100	89.0	33.0	....	96	....	....	80
C	66	78.0	9.0	15.0	55	....	33	60
D	66	65.0	38.0	34.0	83	66	100	61
E	50	54.5	42.5	20.4	35	80	100	53
Average	73	74.0	31.7	25.5	67.2	73	77	66

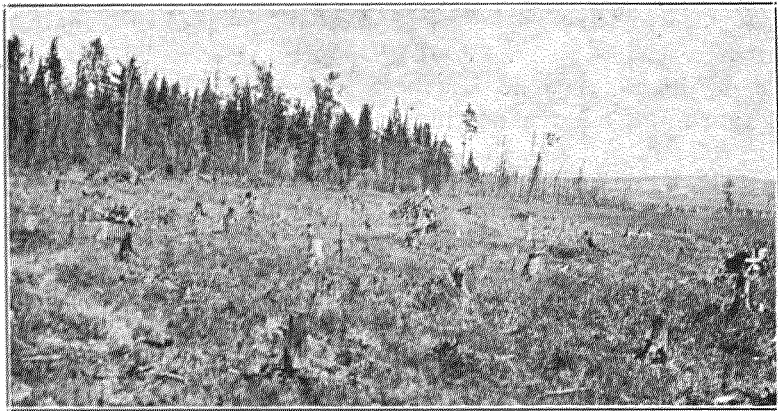


Fig. 2. Tract III After Two Thirds of the Stumps Had Been Pulled by a Man and Team

Not quite five years after brushing and logging, two thirds of the stumps were pulled directly by a man and team without any assistance whatever from dynamite, stump-puller, or block and tackle. By comparison with Table I it is evident that the number of stumps thus pulled increases directly as the percentage of balsam, spruce, and cedar becomes greater; and conversely, a smaller number are pulled where the number of pine and birch increases. These data can be studied to better advantage in connection with Tables IX, XV, and XVI, in bulletin 163.

TABLE III
AVERAGE DIAMETER OF STUMPS NOT PULLED

Section	Cedar	Balsam	Birch	Pine	Tamarack	Average
	Inches	Inches	Inches	Inches	Inches	Inches
A	13.5	10.0	15.0	14.5	....	....
B	....	10.5	14.5	15.0	11.0	....
C	16.5	9.0	12.0	17.1	13.3	....
D	11.7	8.6	12.0	17.1	....	....
E	14.3	9.5	16.2	15.8	13.3	....
Average	14.0	9.52	13.9	16.02	12.5	13.17

TABLE IV
AMOUNT AND VALUE OF DYNAMITE SAVED PER ACRE BY ALLOWING STUMPS TO DECAY AND
PULLING BY DIRECT HORSE POWER

Species	Number pulled per acre	Charge of dynamite saved per stump	Value of charge	Total saving per acre
Balsam	156	1 stick of 33-40 per cent	\$0.11	\$17.16
Cedar	8	1 stick of 33 per cent	0.108	0.86
Birch	11	2 sticks of 33 per cent	0.216	2.38
Pine	5	2 sticks of 33 per cent	0.216	1.08

These species represent 91 per cent of the total number of stumps. For the remaining species—tamarack, spruce, and balsam of gilead—we have no information as to the probable charge required to remove them. We have a positive saving of \$21.48 per acre on dynamite alone for these four species. The saving on the remaining stumps together with the value of caps and fuse will probably bring the total to more than \$25 per acre by a considerable margin. The balsam showed greater persistency and slower decay than is usually attributed to it. Manifestly, it is not in a class with popple or other rapidly decaying deciduous trees. Pine bears out its reputation for longevity and very slow decay.



Fig. 3. Tract III After Stumping and Before Plowing, 1919

Compare background of timber with Figures 1 and 2, and note effect of fire on vegetation.

In the following tables are presented the various units of expense that make up the total cost of clearing on the delayed clearing project, where dynamite was the only agency employed to assist the men and teams in the clearing operations. Three sec-

tions, each two-thirds acre in extent, constitute the area, and three grades of dynamite were used.

The difference in cost per stump can be partly explained by the differences in the cost of the dynamite used. But the greatest factor in affecting the price per stump is the kind of stump. For example, where 20 per cent strength was used and the cost was lowest, many of the stumps were balsam. In the other two cases there were more birch and pine (See Table I).

TABLE V
COST OF BLASTING STUMPS ON SECTIONS A, B, AND C

	Section A	Section B	Section C
Number of stumps blasted.....	63	52	70
Kind of dynamite used, per cent.....	20	30	40
Value of dynamite.....	\$6.45	\$7.56	\$11.50
Value of fuse.....	0.86	0.66	0.88
Value of caps.....	0.88	0.76	0.99
Total value of materials.....	\$8.19	\$8.98	\$13.37
Cost per stump, materials only.....	\$0.13	\$0.1726	\$0.19

TABLE VI
LABOR REQUIREMENT, SECTIONS A, B, AND C

	Section A		Section B		Section C	
	Man hrs.	Horse hrs.	Man hrs.	Horse hrs.	Man hrs.	Horse hrs.
Preliminary piling	9.6	19.2	9.6	19.2	9.6	19.2
Blasting	5.0	....	4.4	....	6.0	....
Pulling small stumps.....	10.0	20.0	14.5	29.0	10.3	20.6
Pulling after blasting.....	22.0	44.0	32.5	65.0	34.0	68.0
Burning	1.0	....	1.0	....	1.0	....
Repiling	0.25	0.5	0.25	0.5	0.25	0.5
Totals	47.85	83.7	62.25	113.7	61.15	108.3

TABLE VII
TOTAL COST OF CLEARING SECTIONS A, B, AND C, TRACT III, WITH DYNAMITE

	Section A	Section B	Section C
Cost of dynamite, fuse and caps.....	\$8.20	\$8.98	\$13.37
Cost of man labor.....	9.60	12.45	12.18
Cost of horse labor.....	12.60	17.05	16.17
Total cost $\frac{1}{3}$ -acre units.....	\$30.40	\$38.48	\$41.72
Total cost 1 acre.....	45.60	57.72	62.58
Average cost per acre, all sections.....	.....	.....	\$55.30

In order to interpret these data they must be presented in conjunction with Table III, page 12, Minnesota Experiment Station bulletin 163. In 1913 and 1914 the work was done by day labor

at 20 cents per hour and horse labor at $7\frac{1}{2}$ cents per hour, this charge being based upon costs of maintenance.¹ Dynamite prices in 1914 were as follows: 33 per cent, 12 cents per pound; 40 per cent, 13 cents per pound; 60 per cent, 15 cents per pound. In 1918 the same grades cost respectively, 21.6 cents, 23 cents, and 28 cents per pound, or an average increase of 67 per cent. The labor cost was still 20 cents per hour. But, owing to the labor shortage, boys working by the month had replaced men working by the day. In order to get an effective comparison it will be necessary to charge the labor and material for the green clearing of 1914, and the ripe clearing of 1918. We have done this in the final column, using the 1914 price as a basis.

TABLE VIII

COMPARATIVE COST OF CLEARING TRACT I, "GREEN CLEARING," 1914, AND SECTIONS A, B, AND C, "RIPE CLEARING," 1918

Project	Green clearing, Tract I, 1914			Ripe clearing, Sec. A, B, C, Tract III, 1918			Cost of 1918 clearing reduced to 1914 cost basis
	Man hours	Horse hours	Cost	Man hours	Horse hours	Cost	
Blasting labor	30.8	....	\$6.16	7.70	....	\$1.54	\$1.54
Material .....	....	....	26.91	....	....	15.27	9.16
Piling refuse material.....	13.0	....	2.60	14.40	....	2.88	2.88
	....	....	....	....	28.8	4.32	2.16
Pulling small stumps.....	....	....	....	17.40	....	3.48	3.48
	....	....	....	....	34.8	5.22	2.61
Pulling and piling stumps	26.56	....	5.31	44.25	....	8.85	8.85
	....	53.12	3.98	....	88.5	13.28	6.63
Repiling	8.40	....	1.68	0.25	....	0.05	0.05
	....	16.40	1.23	....	0.5	0.11	0.06
Burning	3.60	....	0.72	1.50	....	0.30	0.30
Miscellaneous items.....	13.00	....	2.60	....	....	....	....
	....	6.00	0.45	....	....	....	....
Totals	95.36	75.52	\$51.64	85.50	152.6	\$55.30	\$37.72

Owing to the increased cost of labor and materials, the cost of clearing ripened stumps in 1918 was greater than the cost of clearing in 1914 by \$3.67, or 7.1 per cent. However, using the same units of cost in both cases, the 1914 base price, we have a saving of \$13.92, or 36.7 per cent. It is interesting to note where the variation comes. The number of hours of man labor is nearly the same. Horse labor is nearly doubled on the later clearing. However, it amounts to an additional cost of \$11.56 which is practically balanced by the saving of 11.65 on dynamite, using 1918 prices. Using the 1914 price as a basis, every additional dollar invested in horse labor saved three dollars in dynamite.

¹"At this station, as at many northern farms in process of development, horses work practically the entire year, thus materially reducing the cost per unit."—Minn. Agr. Exp. Sta. Bull. 163. 1916.

Sections D and E were reserved for clearing with stump-puller combined with dynamite. On one half of the field, which comprised 3.49 acres, the larger stumps were blasted before pulling, while on the other half the blasting was postponed until after pulling. The object in each case was to blast only those stumps that would be unwieldy to handle in piling. After the small stumps had been pulled, 466 were left in this field. The machine was in operation and the pulling done in August, 1918. The stumps were not piled until the following June. One man or boy drove the horse or team which were used interchangeably, and two or three men worked with the machine and the cable.

TABLE IX
COST OF LABOR AND MATERIAL IN CLEARING SECTIONS D AND E

Items	Man hours	Horse hours	Cost
Man labor	102.43	.....	\$22.13
Horse labor .....	.....	116.16	17.45
Material			
16.7 lbs. 20 per cent dynamite.....	.....	.....	3.28
35 blasting caps.....	.....	.....	0.62
60 ft. fuse.....	.....	.....	0.60
Total	102.43	116.16	\$44.08

The 1918-19 labor costs for this work varied. For the first three items in Table X the rate was 20 cents per hour, and in all other cases 25 cents per hour. Horse labor was 15 cents per hour throughout, still based on cost of maintenance. Twenty per cent dynamite cost 19 cents per pound, fuse cost \$1 per 100 feet, and blasting caps 1.7 cents each. In order to get a proper comparison for the stump-puller work of 1914 and 1918-19, it will again be necessary to charge the same units of price in both cases. The 1914 rate is used as a base. For costs as applied to the 1918 work, see final column.

The actual saving, in spite of increased costs, is 22.1 per cent. Basing costs in both cases on the same unit of value, the 1914 price of labor and material, we find that the ripened, partly decayed stumps can be removed at a saving of 46 per cent over the cost of green clearing. The small amount of dynamite and accessories used is one cause of the lower cost, but the material saving in man and horse labor, ranging from 33 to 40 per cent, contributes to the same end. Part of the saving in labor is doubtless due to the fire which made the stumps much easier to handle. But it is also due to the fact that the stump-puller itself was carefully operated, and a better job was done than in 1914. To this table a charge should be added covering the rental of the machine. In

both cases it was loaned to the station without charge, hence no charge is entered in the account. Three dollars per acre would cover maximum rental costs. By pulling and piling stumps, horse power, is meant the smaller, more decayed stumps that were pulled by man and team with direct hitch.

TABLE X
COMPARATIVE COST OF CLEARING TRACT II, GREEN CLEARING, WITH STUMP-PULLER IN 1914
AND CLEARING SECTIONS D AND E, TRACT III, RIPE CLEARING, WITH STUMP-
PULLER IN 1918-19

Project	Tract II			Sec. D and E, Tract III			Cost of 1918 clearing reduced to 1914 cost basis
	Man hours	Horse hours	Cost	Man hours	Horse hours	Cost	
Preliminary piling	13.00	....	\$2.60	14.40	....	\$2.88	\$2.66
					2.88	4.32	2.16
Pulling and piling stumps (horse power)	....	....	....	20.00	....	4.00	4.00
					40.00	6.00	3.00
Pulling stumps	36.00		7.20	33.00		6.60	6.60
(machine)		24.0	1.80		16.00	2.40	1.20
Piling stumps after pulling	63.20		12.64	25.86		6.46	5.17
		112.2	8.41		25.86	3.90	1.95
Repiling stumps	3.00		0.60	2.00		0.50	0.50
		6.0	0.45		4.00	0.60	0.60
Miscellaneous items	31.00		6.20	2.50		0.53	0.53
		29.0	2.18		1.50	0.23	0.12
Blasting labor	19.35	....	3.87	4.67	....	1.16	1.16
Cost of materials.....	....	....	13.09	....	....	4.50	2.56
Totals	165.55	171.2	\$59.04	102.43	116.16	\$44.08	\$31.81

A comparison of the time per stump and per acre involved in pulling green stumps with a stump-puller and piling them, in 1914, and clearing ripe stumps with stump-puller and with horse power only and piling them, in 1918-19, throws some light on the distribution of labor in the operations. From the preceding tables we deduct the cost per stump, piled.

TABLE XI
COST PER STUMP OF PULLING GREEN STUMPS WITH STUMP-PULLER IN 1914, AND RIPE
STUMPS IN 1918 WITH STUMP-PULLER AND HORSE POWER, IN
TERMS OF TIME UNITS

	1914 Green stumps	1918-19 Ripe stumps	
		Horse power	Stump-puller
Total number stumps per acre.....	220	177	133
Total time per acre, man hours.....	36	20	33
Total time per acre, horse hours.....	24	40	16
Actual time per acre stump-puller was in operation, hours	12	20	9
Acres pulled daily.....	0.83	0.5	1.11
Average number of stumps pulled daily....	183	89	146
Time required per stump, machine work, minutes	3.27	....	4.03
Man labor, minutes.....	9.81	6.74	14.88
Horse labor, minutes.....	6.54	13.50	7.21

TABLE XII
COST PER STUMP PILED

	Costs
Tract I—Green clearing, stumps blasted, 1914.....	\$0.1977
Tract II—Green clearing, stumps machine-pulled, 1914.....	0.2200
Tract III—Sections A, B, C, ripe clearing, 1918-19, pulled by horse power and piled..	0.0355
Trace III—Blasted (dynamite \$0.173 and labor \$0.227)*.....	0.4000
Cost, per stump, piled, entire lot, 1919.....	0.1400
Tract III—Sections D and E, ripe clearing, 1918-19	
Horse power pulled, and piled.....	0.0565
Machine pulled, and piled*.....	0.1780
Cost per stump, piled, entire lot*.....	0.1088
Average cost per stump, piled, all stumps, all tracts, 1919.....	0.1244

* These items are high, as only a few large, tough stumps were left for blasting or machine pulling after the men and teams had pulled the smaller stumps direct.

A larger acreage was pulled with machine in 1918 because there were fewer stumps per acre left to pull. Fewer stumps were pulled per day and more time was spent on each stump in 1918, as the work was done by the regular farm crew, while in 1914 the work was done by more experienced men. While the cost of pulling was thereby increased, the work was done so much more carefully in 1918 that the cost of piling was considerably reduced. The average cost per stump, piled, in 1914, entire lot, was about 21 cents, while in 1918 the average cost was 12.5 cents. The average cost per stump was reduced by 40.4 per cent. It cost as much to blast and pile one stump as it did to pull and pile ten of the smaller, more decayed ones, for reasons: (1) Nearly half of this cost is the charge for explosive, and the actual labor charge is only 5 cents more than that for machine-pulled stumps. (2) A relatively small number of stumps was blasted and these were the largest, toughest, and least decayed of the lot. (3) Dynamite was used more sparingly than in 1914 when about three fourths of the stumps were blasted completely out of the ground, and the only labor involved was picking up and piling the pieces. In 1918, with a less skilled operator and smaller charges, not more than 8 per cent of the blasted stumps were completely removed from the ground.

Figure 4 illustrates the distribution of costs of labor and material in the green clearing operations of 1914 and the ripe clearing operations of 1918-19. The cost of explosive ranges from one half the total in Circle I to about one fourth in Circles II and III and only one twelfth in Circle IV. Man labor increases in reverse order. The use of the stump-puller contributes to this excess of man labor, especially in Circles II and IV. In Circle III it is increased because of the large number of stumps pulled by man and team direct.

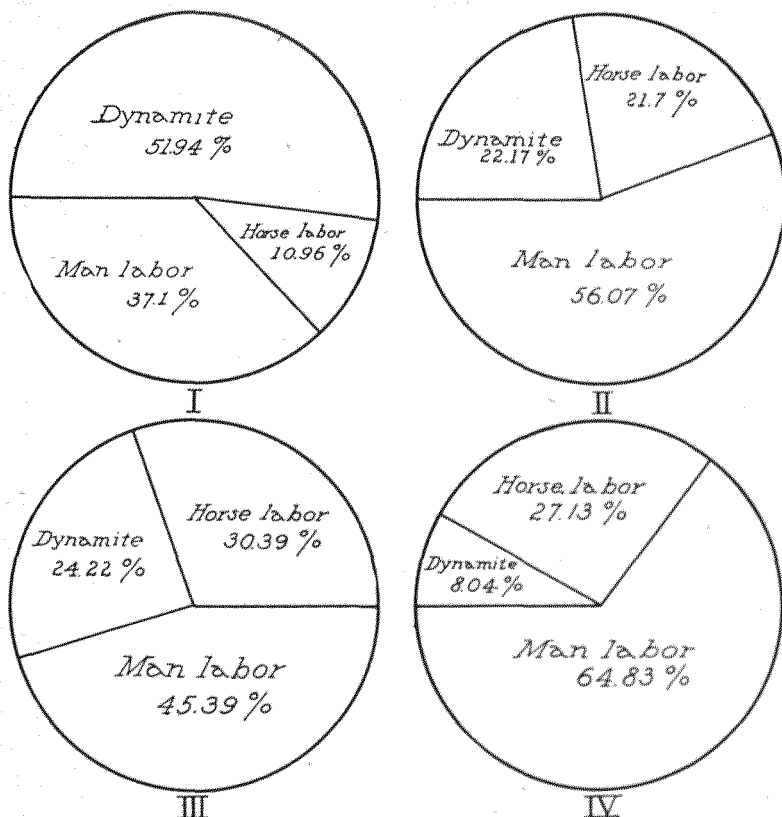


Fig. 4. Distribution of Labor in 1914 and 1918

- I. Clearing green stumps with dynamite, 1914.
- II. Clearing green stumps with horse power, 1914.
- III. Clearing ripe stumps with dynamite, 1918.
- IV. Clearing ripe stumps with horse power, 1918-19.

CROP PRODUCTION FOLLOWING GREEN AND DELAYED CLEARING

It has been demonstrated that the stumps were removed more cheaply where they were allowed to stand for several years after logging and brushing. But unless there was some return from the land in the mean time this was poor economy. Accurate data are available that justify the practice. In 1915, the first year of pasture, a thirty-day record only was kept (see 1915 report). For this period, about one fourth of the pasture season, the value of the butterfat produced by the milk cows and the gains by young stock was \$5.33 per acre. In 1916 four cows were pastured daily on these five acres for 137 days, with a butterfat return per acre of \$13.83. The returns per acre for 1917 and 1918, both dry seasons, were \$16.29 and \$12.67, respectively. In 1918 pasture was

available only part of the season and a running timber fire killed much of the grass in June. These figures would be materially increased if the value of the skim-milk which was fed on the farm were added. So it is quite evident that with good grade dairy cattle, and with proper seeding and management of the stump-land pasture, an annual return of \$15 per acre for butterfat, and skim-milk may safely be expected. Young stock on another stump-land pasture of poorer quality made an average daily gain of 1.4 pounds, for an average season of 124 days.

A part of this land was plowed in 1918 and sown to oats in 1919. The yield on this clover sod promised to at least equal if not exceed any other oat field on the farm. (See Figure 5.) Before it ripened, however, the crop was almost ruined by army worms.

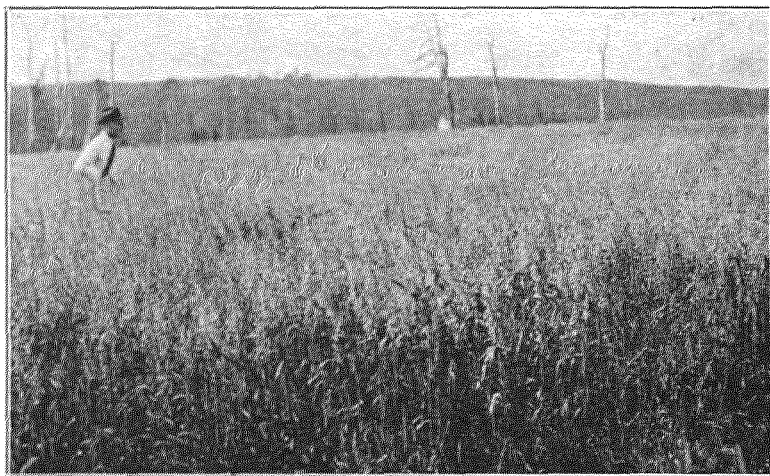


Fig. 5. Tract III, Crop of Oats, 1919

This was the first crop after stumping on the delayed clearing tract.

Equally good results were not secured from the two tracts that were stumped green and immediately cropped. In 1915 one half the land was planted to corn, but owing to a very unfavorable season and late planting no crop was harvested. The rest of the land was sown to oats with clover and timothy. Less than one ton per acre of oat hay was harvested. In 1916 the corn was sown to oats, with a crop return of approximately 26 bushels per acre. The part of the land in meadow (1915 oat crop) yielded 1.4 tons of hay per acre. In 1917 oats produced 20 bushels per acre, market potatoes, 73 bushels, and hay, 2,175 pounds per acre. In 1918 all grain and root crops were produced on land where one clover crop had been grown and the sod turned under. The three tracts were henceforth on a relatively equal basis, so the comparison may be

discontinued. A more intensive study than was possible in this cropped area has been included in a new project.

A comparison of the two systems of clearing is all in favor of the delayed plan. The work was done at a saving of one third or more. During the years intervening between cutting off and stumping, an annual grass crop was assured. During this same period the forming clover sod was reinforcing the thin leaf mold of the virgin soil, roots and woody matter were decaying, and the land was settling, all of which contributed to simplify and cheapen the job of breaking, getting a seedbed, and growing a crop.

APPLICATION OF COST DATA

In closing the discussion of this project, several facts should be emphasized. It was necessary to use prices in expressing terms of cost, but these are fluctuating factors while the units of time and material are constant. For example, clearing with dynamite was more expensive in terms of money in 1918 than in 1914, but measured in hours of labor and pounds of material it was considerably cheaper. Principles rather than sums of money are involved. Units of time and material have a general application, while units of cost have a local application of time and place. The aim of this work was to determine whether the green or delayed system of clearing was the better and how much so in terms of human or animal energy and pounds of dynamite consumed.

REPRINTS FROM 1916 REPORT

"METHODS OF GRASS SEEDING ON CUT-OVER LAND"

"A test was made of three methods of soil tillage in sowing grass seed among the stumps. One acre was harrowed with one section of a spring-toothed harrow both before and after seeding; another was harrowed before seeding, and a third after seeding. The first plan was found most satisfactory, the second a little better than the third. Six pounds, three each of mixed grasses and of clovers, were sown per acre."

"BY-PRODUCTS OF LAND CLEARING"

"The land clearing work in progress deals only with development up to the stumping stage. One ten-acre tract was cleared by contract at \$38 per acre. The contractor took out the brush; felled and trimmed the timber; burned all brush, tops, branches, and windfalls; did everything up to the stumping stage except cut the cordwood. This was contracted at \$1.25 per cord. The data on lumber, fence posts, and cordwood are on record; the polewood is not yet sawed and the sawdust was used for bedding.

TABLE XIII
COST OF CLEARING AND RECEIPTS PER ACRE

Expenditures per acre—	
Clearing contract	\$38.00
Sawing lumber, 3,505 feet at \$5 per thousand.....	17.52
Splitting cordwood at \$1.25 per cord.....	1.87
	<hr/>
Total	\$57.39
Receipts per acre—	
3,505 feet of lumber at \$16.....	\$56.08
1½ cords wood at \$3.....	4.50
15 fence posts at 10 cents.....	1.50
Polewood for fuel.....	.....
Slab wood for fuel.....	.....
Sawdust for bedding.....	.....
	<hr/>
Total	\$62.08

"The lumber was sawed on the farm with a portable mill. The sales figures represent farm values. Generally speaking, where there is a market within a reasonable distance the cost of clearing up to the stumping stage should not only be covered by the receipts, but there usually should also be a small margin of profit. This, of course, refers to lands of the local soil type and vegetation."

REPRINTS FROM 1917 REPORT

"LAND-CLEARING PRACTICE"

"Considerable clearing was done at the station in 1917, combining the use of dynamite and the stump-puller. The plan followed was to pull the stump first and blast afterwards. Labor was scarce, so a boy was used with the team, and a man and a boy on the cable. In two and three-fourths days of nine hours each, or twenty-five hours, 2.8 acres were pulled, or one acre in nine hours. The stumps were entirely removed and were not allowed to drop back into the holes.

"It took no longer to blast the stumps after pulling than before and there was a saving in dynamite. Fully three fourths of the stumps were blasted with one-half stick (one-fourth pound) of 20 per cent dynamite. The stumps range in diameter from twelve to fifteen inches. It would seem that on high land with stumps having at least partly dead root systems, this plan is quite effective if properly carried out. With ordinary labor it is not difficult to pull twenty stumps an hour if relatively numerous, and many more can be removed as the crew gains experience. One man can easily blast fifty stumps a day, after pulling.

“COMPARATIVE EFFICIENCY OF 30 PER CENT AND 20 PER CENT DYNAMITE”

“The land clearing was done in August, 1917. The loose, rotted stumps were pulled first. A census of the remaining stumps was taken as to number, kind, condition, and size. They were then blasted. By incomplete removal we mean that some portion is



Fig. 6. Tract Burned Over October 12, 1918

The fire converted many small peat deposits into miniature lakes, with the bottom covered with stones. The water here is more than three feet deep.

left that will require some power to remove it. Thirty per cent dynamite is known as stumping powder and the lower grade is called farm powder. The following table summarizes the data:

	Tract I	Tract II
Area, acres	1.25	1.62
Number stumps	70	121
Percentage green	33.0	41.3
Percentage dead	67.0	58.6
Percentage pine	41.4	31.4
Percentage birch	28.7	31.4
Percentage balsam	25.7	28.1
Percentage cedar .....	....	3.3
Percentage popple .....	....	4.9
Percentage miscellaneous	4.2	0.9
Average diameter, inches	14.37	13.8
Stumps completely removed.....	10	15
Percentage strength dynamite.....	20	30
Number one-half pound sticks.....	98	112
Cost per pound, cents.....	17	19
Cost per stump, total, cents.....	11.9	8.79
Cost per stump, removed.....	13.91	10.03

"Altho the stumps blasted with 30 per cent dynamite were a trifle smaller, more of them were green. The cheapest work was done with the stronger powder."

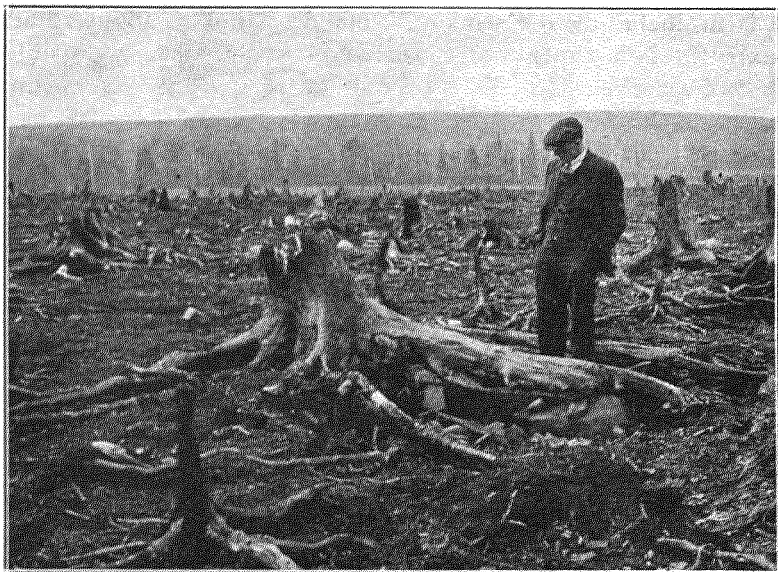


Fig. 7. Burned-Over Tract October 12, 1918

The fire both simplified and complicated land clearing. This large stump will pull easily but it will be difficult to blast it.

THE FOREST FIRE OF OCTOBER 12, 1918

The Northeast station was directly in the path of the great forest fire of October 12, 1918, and it escaped complete destruction by a very narrow margin. The first wave of fire came from the west-northwest about half past three in the afternoon. This passed directly behind and around the buildings on the poultry unit. By using the entire force of men available, aided by a providential shift in the wind to due west, these buildings were saved. The second and more extensive fire wave struck the farm about six o'clock in the evening from the same direction. Before seven the superintendent's residence and the auditorium were in flames. The balsam grove directly behind these buildings was the immediate cause of their destruction. Later in the evening the horse barn burned. With the air full of burning gases, the woods combustible as tinder, and a sixty-mile gale blowing, the fighters were powerless. The roads to Duluth were cut off and likewise the outlets to the north. Men, women, and children took refuge in plowed fields and in the creeks under the bridges,

protecting themselves against the smoke with blankets or garments salvaged in a quick get-away from their burning homes. The total loss in fuel, lumber, fences, equipment, and buildings at the station was approximately \$25,000. The fire overran the entire farm, including the remaining stand of timber, about 70 acres in extent. This timber must be harvested as soon as possible if it is to be conserved. The fire was so intense that it consumed almost all the small brush. It is now possible to see across a forty-acre tract where formerly it was impossible to see more than two rods, owing to the dense undergrowth. (See Fig. 10.) The pastures were most severely injured where the stumps were thickest and the vegetable mold deepest, close in and around each

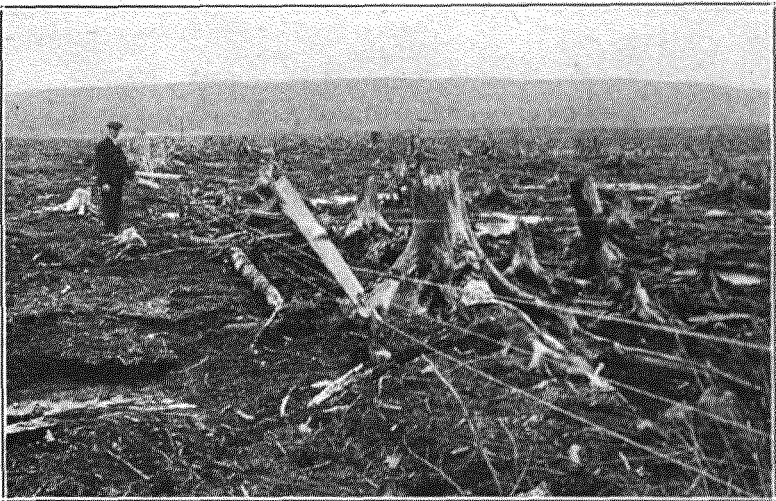


Fig. 8. Fence Destroyed by the Fire

The great fire severely damaged the fences. The sod and vegetable mold was most thoroly destroyed about the stumps where the fire penetrated to the clay subsoil and exposed the roots.

stump. Frequently the sod was so completely burned about and beneath the stumps as to produce the effect of elevating the stumps in mid-air. This simplifies clearing with the smaller stumps but makes it more difficult with the larger ones, since dynamite can not be used to advantage. In April, 1919, grass seed was sown throughout the timbered and stump area of the farm. A splendid stand was secured from a sowing of 2.5 to 5 pounds per acre, alsike and timothy mixed. (See Fig. 12.) Where the fire was most severe and the ash deepest, better stands were secured, as the seed, coming into direct contact with the moist clay underneath, did not suffer for moisture and the ash afforded excellent covering. The fire has, however, given rise to a number of new problems. What

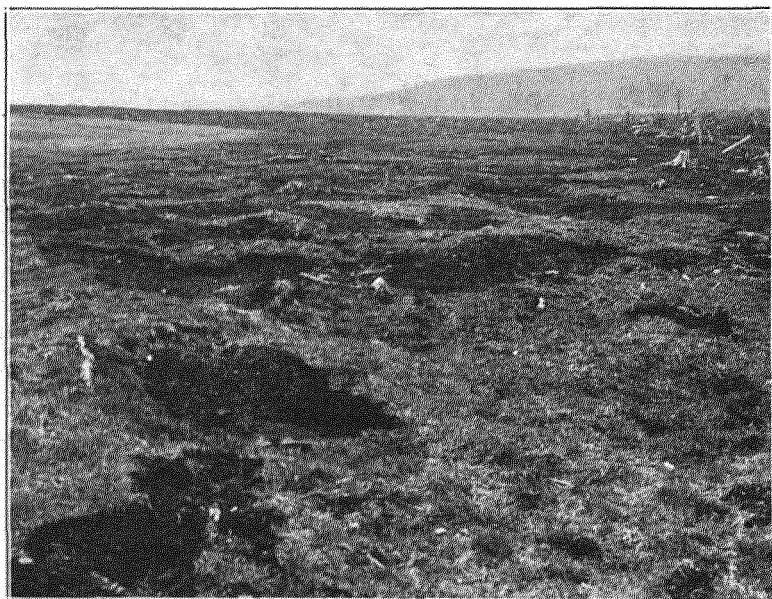


Fig. 9. Patchy Condition Typical of Meadows and Pastures Following the Fire, April, 1919



Fig. 10. Timothy and Clover, July 23, 1919

Compare this with Figures 8 and 9 and note how completely has been the recovery from the burned condition in four months. About five pounds of timothy and clover seed were sown in April. The burned patches are healing over and the stock can not keep down the rank growth.



Fig. 11. Station Forest Before the Fire

Compare this with Figures 3 and 10, its appearance after the fire.

will be the cost of the same operations as before the fire or on unburned lands? What is or will be the effect of the fire upon the productive power of the soil? Is the soil as a whole permanently injured or improved? How shall these lands be handled, (1) to eliminate the fire menace and (2) to realize a speedy and ample return. Projects are under way to study each of these problems and the findings will be reported in the 1920 and following annual reports.

SUMMARY

1. Two thirds of the stumps were pulled by horse power direct, without dynamite or machine.

2. The stumps not thus pulled averaged 13.17 inches in base diameter.

3. The value of dynamite and accessories thus displaced averaged about \$25 per acre.

4. The cost of clearing ripe stumps per acre, using dynamite, was \$55.31 in 1918, as compared to \$51.64, the cost of clearing an acre of green stumps in 1914, using dynamite, or an increase of 7.1 per cent due to increased costs of labor and material.

5. Put on the same base cost of labor and material (1914 prices), the 1918 cost of clearing ripe stumps was \$37.72 or 36.7 per cent less than the 1914 cost of green blasting.

6. The cost of clearing an acre of ripe stumps in 1918, using the stump-puller, was \$44.08, a saving of \$14.96 or 33.9 per cent on the cost of removing an acre of green stumps by machine power in 1914. This saving was effected because the most expensive item, dynamite, was very sparingly used and there was a saving of more than one third in labor.

7. Put on the basis of 1914 costs of labor and material, the 1918 cost of clearing an acre of ripe stumps with a stump-puller was \$31.81, a saving of 46 per cent on 1914 costs of removing an acre of green stumps with machine.

8. The stump-puller was loaned for all this work, so no rental charge was made. Three dollars per acre additional would cover this charge.

9. Stump-puller clearing cost more than dynamite clearing in 1914, but in clearing ripe stumps in 1917 it was lower than all other prices for either year. This was due to the practical elimination of the high-priced factor, dynamite, and a reduction of labor costs of more than one third.



Fig. 12. Growth of Grass Among the Trees, July, 1919

Three pounds of grass seed per acre, scattered in the ashes among the trees in April, 1919, produced this wonderful growth where, before October 12, 1918, the sun never penetrated the dense foliage.

10. The average cost of removing and piling a stump was reduced about 40 per cent for ripe stumps. It cost as much to blast, pull, and pile one large decayed stump as to pull and pile ten small ones by horse power. It cost as much to pull one stump, machine power, and pile it as to pull and pile three by horse power.

11. Approximately fifteen dollars per acre per year in dairy products was taken off this stump pasture.

12. In 1915 clearing operations, receipts exceeded costs of clearing up to the stump stage with a surplus credit of pole and slab wood, and sawdust for bedding.

13. In land clearing work in 1917, 30 per cent dynamite proved more effective than 20 per cent.

14. The delayed system of clearing on Tract III was superior to green clearing on Tract I in three respects:

- A. There was a saving of one third or more in cost per acre.
- B. There was a certain annual pasture crop harvested by the cattle while the crops from Tracts I and II were low in volume and high in cost of production.
- C. The quality of the land was improved by the decaying vegetation and thickening sod, the land was more easily plowed, and a better and cheaper seedbed was produced.