# The results of plantation soil preparation by a new assembly

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In Estonia a new aggregate DONAREN 190 is used to prepare the soil for plantations and natural regeneration. In the present paper the preliminary results of assembly's work are dealt - elements formed during scarification and their part, and soil compact in different surface elements are characterised, the rate of weeding and sodding of scarified surface is studied.

**Key words:** cultivation, soil preparation, soil hardness, weeding, sodding.

## Introduction

In Estonia the forest cultivation is known from old times. Sowed pine and spruce were cultivated in the first part of the 19th century. Naturally, in that period work capacity was low.

During the first independent period (1920-1939) about 3540 ha of forest plantations were established per year. Forest cultivation work considerably increased after the World War II because of overcuttings, being largest in 1948: 16024 ha. By 1950 large-scale post-war clearings and burned areas were attained to reforested and the cultivation work stabilized as 6000...7000 ha per year.

After re-establishing independence the capacity of cultivation work has decreased in Estonia. During the last years plantations are raised on the area of about 4000 ha yearly.

Forest cultivation is always accompanied by soil preparation to a different extent. The moss removal while sowing tree seeds, or digging holes for planting tree plants are included in soil preparation. Untill the beginning of the 1950s this work was done by hand. Soil preparation with machines started only in 1952. Since that time this difficult and work-consuming, but very needful work has been carried out by several machines. During 1970-1980 soil preparation for forest cultures by machines comprised about 70-80%. Nowadays these figures have essentially diminished.

For decades the stump-jump plough PKL-70 has been one of the most important assembles in plantation soil preparation. But in the present time instability of stands planted decades ago on the lands scarified by the above-mentioned unit comes up. This has forced to look for new more suitable machines, especially for preparing soil in overmoistured areas and on fertile clearings inclined to weeding and overgrowing with brushes.

Along with such machines as patch cultivators, scoop-hillockmakers, ploughs, etc. used for scarification in Estonia the new machine DONAREN 190 has been applied. It is a disc plough with active work parts installed to a forest tractor. There are two cogged discs with the diameter of 1500 mm started from a hydro engine. The space between the discs and at the same time between prepared furrows can be changed by a hydrosystem. By changing the pressure to vertical direction exerted on the discs it is possible to choose furrows' depth and width appropriate to the site type.

The disc plough with active work parts has been used by Joint-stock company AS METS&PUU. It is remarkable that one of the largest wood processing companies has started working at forest regeneration too. AS METS&PUU finances the research work on disc plough working results.

Soil preparation with DONAREN 190 was started in 1994. From June to November, 617 ha of the soil was prepared in different regions of the republic. In 1995 790 ha and in 1996 900 ha were scarified.

## Materials and methods

In the paper the conditions of forest regeneration on scarified clearings in some forest site types are examined. The research was conducted in the summer of 1995 on

23 clearings in *Oxalis-Rhodococcum*, *Myrtillus*, *Oxalis-Myrtillus*, *Oxalis*, *Hepatica*, *Aegopo-dium*, *Filipendula*, drained transitional bog and drained swamp site types with the total area of 82 ha. Clearings were situated in Alatskivi, Kaansoo, Kaarepere, Kaiavere, Laeva, Põlendmaa, Sõmerpalu, Tartu, Vana-veski and Vara forest districts.

2...3 trial strips with the length of 30...50 m and width 2 m were placed on the clearings with prepared soil with medium conditions. Trial strips were lying perpendicular with machine operations.

Measurements were made by surface elements: virgin surface, furrow, slope, furrow slice on trial strips. Surface element cross cut formed during one operation of the machine is shown in Fig. 1.

On trial strips the width of all surface elements was measured. On every surface element segment which was 2 m long (corresponding to the width of a trial strip) the coverage of herbal story and stage of surface sodding (missing - 0, week - 1, middle - 2, strong - 3), number and heights of tree species (both natural and artificial of origin) were determined.

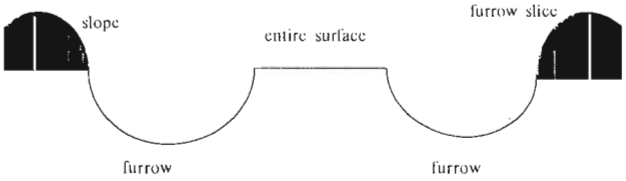


**Fig.1.** Surface elements formed during treatment of clearing by DONAREN 190.

On trial strips the resistance of upper 10 cm thick soil layer to pressure concentration was determined by a special equipment on all surface elements 15 times. The received index is conditionally called as soil hardness.

## Characterisation of treated surface

Considering natural regeneration and cultivation, the importance of treated surface from total area and the character of treating are essential. In accordance with the methods the treated surface was considered as a complex of the three elements: furrow, slope and furrow slice (top), which were added by unwrought surface. The average prepared widths in different site conditions are given in Table 1.

The width of virgin strips was stable 1.2 m, only in drained transitional bog it was 1.1 m and in *Oxalis-Myrtillus* site type - 1.3 m. The average width of furrows was 0.6 m, varying from 0.5 m in *Hepatica* and drained transitional bog site types to 0.8 m in *Oxalis* site type. The width of a slope, which was the most difficult element to determine, was 0.3...0.4 m.

**Table 1.** Dimensions of surface elements (m).

| Site type | Entire | Furrow | Slope | Furrow slice | Wall of branch-es |
|---|---|---|---|---|---|
| *Oxalis-Rhodococcum* | 1.2 | 0.6 | 0.3 | 1.3 | 1.6 |
| *Myrtillus* | 1.2 | 0.7 | 0.4 | 1.0 | 6.3 |
| *Oxalis-Myrtillus* | 1.3 | 0.7 | 0.4 | 1.6 | - |
| *Oxalis* | 1.2 | 0.8 | 0.4 | 1.5 | - |
| *Hepatica* | 1.2 | 0.5 | 0.4 | 0.6 | - |
| *Aegopodium* | 1.2 | 0.6 | 0.4 | 0.6 | 5.3 |
| *Filipendula* | 1.2 | 0.7 | 0.4 | 1.2 | - |
| Drained *Vaccinium uliginosum* | 1.2 | 0.6 | 0.4 | 0.6 | - |
| Drained transitional bog | 1.1 | 0.5 | 0.4 | 0.7 | 4.0 |
| Drained swamp | 1.2 | 0.7 | 0.3 | 1.4 | 4.0 |
| Average | 1.2 | 0.6 | 0.4 | 1.1 | |

The width of a furrow slice was the most varying by site types, ranging from 0.6 m in *Aegopodium*, *Vaccinium uliginosum* and *Hepatica* site types to 1.6 m in *Oxalis-Myrtillus* site type. The average width of a furrow slice was 1.1 m.

On some clearings, where a branch rake was used to clear slash, walls of branches with the width 1.6...6.3 m were found. These prevented the surface scarified from dividing uniformly on clearing.

The data given in Table 2 enable us to get a survey about the extent of soil preparation on treated clearings. It becomes evident that in different site conditions the part of unprepared soil is different. In *Filipendula* site type where the humus layer is thick and on peatlands the part of unprepared soil comprises a little more than 25%,

**Table 2.** The relative distribution of surface elements by area (%).

| Site type | Entire | Furrow | Slope | Furrow slice | Wall of branch-es |
|---|---|---|---|---|---|
| *Oxalis-Rhodococcum* | 32.3 | 24.9 | 8.2 | 31.5 | 3.2 |
| *Myrtillus* | 30.5 | 26.4 | 8.8 | 27.5 | 6.8 |
| *Oxalis-Myrtillus* | 30.2 | 30.4 | 4.9 | 34.4 | - |
| *Oxalis* | 27.4 | 32.0 | 9.5 | 31.1 | - |
| *Hepatica* | 38.7 | 24.6 | 19.7 | 17.0 | - |
| *Aegopodium* | 35.5 | 22.7 | 13.7 | 15.9 | 12.2 |
| *Filipendula* | 26.3 | 32.6 | 14.5 | 26.6 | - |
| Drained *Vaccinium uliginosum* | 44.2 | 20.2 | 14.6 | 21.0 | - |
| Drained transitional bog | 27.2 | 19.6 | 16.1 | 20.1 | 17.0 |
| Drained swamp | 27.2 | 29.0 | 8.6 | 32.8 | 2.4 |
| Average | 31.9 | 26.3 | 11.9 | 25.8 | 4.1 |

but it is the same on *Oxalis* site type clearings (27%). In *Aegopodium*, *Hepatica* and drained *Vaccinium uliginosum* site type the part of virgin surface is found tobe 36...44% from clearings. The part of virgin surface depends on several conditions: the amount and character of scattered slash, number and height of stumps, relief, soil moisture, etc., but also it depends on proficiency and accuracy of an operator. On the basis of preliminary results it can be expected that 30% (the average of all types in the present case is 32%) of unprepared soil is silviculturally acceptable.

From reforestation and forest regeneration standpoint, furrows have likely a very important role. In studied site types the furrows formed 1/5...1/3 of the clearing area.

The part of the furrows was smallest in a drained transitional bog, *Vaccinium uliginosum* and *Aegopodium* site type, while biggest in *Oxalis-Myrtillus*, *Oxalis* and *Filipendula* site type. Furrows covered, on average, 26% of the area of treated clearings.

On average, 12% of the area of treated clearings cover slopes. The number was minimum (5%) in *Oxalis-Myrtillus* site type and maximum (20%) in *Hepatica* site type.

Besides furrows, from a reforestation standpoint, furrow slices have also a big importance. By site types the part of this surface element was largely varying - 16...34% of the area of treated (processed) clearings. The part of furrow slices in *Aegopodium*, *Hepatica* and drained transitional bog site type was smallest, and in *Oxalis-Myrtillus*, drained swamp and *Oxalis-Rhodococcum* site type biggest.

Soil hardness is an important factor which determines plant growth rate while growing in compact soil the roots of saplings have to break the resistance of the soil and to waste extra energy for that, after what an increase of above-ground part decreases. From the data given in Table 3 it can be seen that soil hardness in unprepared soil is more significant on clearings with mineral soil site types (10.5...24.2 kg $cm^{-2}$), where thick mould horizon are missing (*Oxalis-Rhodococcum*, *Oxalis-Myrtillus*, *Oxalis* and *Hepatica* site type). Soil hardness is expectedly intangible on peatlands (3.5...6.0 kg $cm^{-2}$), but also with thicker humus layer (*Filipendula* 7.8 kg $cm^{-2}$, *Myrtillus* 6.7 kg $cm^{-2}$, drained *Vaccinium uliginosum* 1.1 kg $cm^{-2}$) and on more humid sites (*Aegopodium* 9.6 kg $cm^{-2}$) relatively smaller numbers are obtained.

Analogous situation generally appeared in the soil prepared for furrows. But in some mineral soil site types, where the assembly during making furrows removed the bigger part of humus layer or thick mould horizon, the soil in furrows was essentially more compact than in unprepared soil. So soil hardness in unprepared soil and in soil prepared for furrows on *Myrtillus* clearings was 6.7 and 12.1 kg $cm^{-2}$, on drained *Vaccinium uliginosum* clearings 1.1 and 13.1 kg $cm^{-2}$, and on *Hepatica* clearings 12.3 and 19.3 kg $cm^{-2}$ respctively. Soil hardness on slopes was in all site types smaller than on furrows.

**Table 3.** Soil hardness on different surface elements (kg $cm^{-2}$)

| Site type | Entire | Furrow | Slope | Furrow slice |
|---|---|---|---|---|
| *Oxalis-Rhodococcum* | 24.2 | 23.9 | 11.8 | 6.7 |
| *Myrtillus* | 6.7 | 12.1 | 4.3 | 3.4 |
| *Oxalis-Myrtillus* | 16.0 | 15.1 | - | 4.4 |
| *Oxalis* | 10.5 | 13.7 | - | 5.1 |
| *Hepatica* | 12.3 | 19.3 | 13.8 | 6.0 |
| *Aegopodium* | 9.6 | 12.1 | 3.9 | 3.4 |
| *Filipendula* | 7.8 | 7.1 | - | 6.1 |
| Drained *Vaccinium uliginosum* | 1.1 | 13.1 | 7.9 | 0.8 |
| Drained transitional bog | 6.0 | 4.2 | 2.7 | 1.4 |
| Drained swamp | 3.5 | 3.0 | 2.1 | 2.5 |
| Average | 9.8 | 12.4 | 6.6 | 4.0 |

Soil hardness was relatively slight in furrow slices on all site type clearings (0.8...6.7 kg $cm^{-2}$). In future it is necessary to study at which hardness it is possible to start with plantations on furrow slices and how much time it will take furrow slices to get the needed compaction on one or an other site.

## Vegetation and surface sodding

Vegetation and surface sodding have an essential part in formation of environment for natural regeneration and cultivation. Data of these figures are given in Table 4.

Grass story with rather big coverage (51...90%) was developed on virgin surface in all site types. It concerned only 1...2 year old clearings. During soil preparation sod with vegetation was removed from the place of furrows, but weeding started after a year, especially on more fertile sites. Weeding was relatively insignificant in the furrows of *Vaccinium uliginosum* clearings - the cover-age of grass story was only 7%. Slopes and furrow slices were generally rather strongly reweeded after a year.

The weeding after soil preparation was quick in both automorphic fertile mineral soils (*Oxalis*, *Hepatica*) and fertile drained peatlands (drained transitional bog, drained swamp). So herbal vegetation (*Filipendula ulmaria* (meadowsweet), *Urtica dioica* (common nettle), *Cirsium*

**Table 4.** The coverage of grass story and sodding of surface on different surface elements.

| Site type | The coverage of grass story, % | | | | Sodding of surface | | | |
|---|---|---|---|---|---|---|---|---|
| | Entire | Furrow | Slope | Furrow slice | Entire | Furrow | Slope | Furrow slice |
| *Oxalis-Rhodococcum* | 51 | 27 | 33 | 37 | 1.1 | 0.1 | 0.4 | 0.7 |
| *Myrtillus* | 75 | 19 | 33 | 37 | 2.1 | 0.3 | 1.1 | 0.5 |
| *Oxalis-Myrtillus* | 82 | 32 | 71 | 59 | 2.4 | 0.6 | 1.7 | 1.4 |
| *Oxalis* | 86 | 13 | 56 | 79 | 2.9 | 0.1 | 1.4 | 2.0 |
| *Hepatica* | 85 | 35 | 71 | 51 | 2.9 | 0.6 | 2.3 | 0.7 |
| *Aegopodium* | 64 | 8 | 37 | 24 | 2.0 | 0.1 | 0.8 | 0.1 |
| *Filipendula* | 90 | 33 | 85 | 84 | 3.0 | 0.8 | 2.0 | 2.0 |
| Drained *Vaccinium uliginosum* | 72 | 7 | 28 | 7 | 2.0 | 0.2 | 0.8 | 0.0 |
| Drained transitional bog | 70 | 47 | 66 | 74 | 2.0 | 1.0 | 1.0 | 1.0 |
| Drained swamp | 74 | 30 | 63 | 66 | 2.3 | 0.5 | 2.0 | 2.0 |
| Average | 75 | 25 | 54 | 52 | 2.3 | 0.4 | 1.4 | 1.0 |

*sp.* (thistles), etc.) was even more vital on furrow slices in drained swamp than on an unprepared area.

By watching the data of surface sodding it can be seen that virgin surface was sodded on clearings from medium to strong. In the soils prepared for furrows the sodding was very weak after a year. The sodding of furrow slices was generally weak. The furrow slices were, at medium sodding, in *Oxalis*, *Filipendula* and drained swamp site type. Slopes were sodded from weak to medium.

Vegetation study allows us to conclude that after a year on average 1/3 of furrows and slopes and 2/3 of furrow slices will be covered by grass.

## Conclusions

Consequently using DONAREN 190 the conditions of plant growth on treated areas have radically changed on furrow slices and in furrows which covers 52% of the clearing area. On average, 1/3 of the clearing area has remained uncultivated. From a forest regeneration viewpoint slopes in nature form a category difficult to mark its boundaries which importance is on the average 12% of the clearing area. There is no clear relationship between the treated surface part and site type. Such extent of soil preparing on clearings is sufficient for providing initial density necessary for cultivations. *Aegopodium*, *Vaccinium uliginosum* and *Hepatica* site type clearings are obviously more difficult objects.

From a forest regeneration point of view the rate of weeding and sodding of prepared soil is essential. By research data it can be quickly understood, especially in more fertile districts with strong grass growth in both mineral and peat soils (probably during 1...2 years). When the assembly is used in preparing soil for the next-year cultivation from spring to autumn it is rational to work on strongly weeding areas in autumn. On such clearings spruce cultivation into furrows (where moisture condi-tions permit that) the spruce transplants during a couple of years after cultivation have better growth conditions than on unprepared surface. Closing of furrow slices and the use of them as a place of cultivation require further exploration.

# О РЕЗУЛЬТАТАХ ПОДГОТОВКИ ПОЧВЫ ДЛЯ КУЛЬТУР ПРИ ПОМОЩИ НОВОГО АГРЕГАТА

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*Резюме*

Объём лесокультивационных работ в Эстонии в последние годы сократился. Если раньше на государственных лесных землях в год закладыалось 6-7 тыс. га лесных культур, то в последние два года этот показатель составил не более 4 тыс. га. Однако вопрос подготовки почв для лесных культур

по прежнему остается актуальным. Хотя площадь территории Эстонии невелика, лесорастительные условия здесь очень разнообразные, а это обуславливает применение различных спрособов обработки почвы. В настоящее время также возникли проблемы, связанные с ведением хозяйства в лесах, заложенных на почве, подготовленной при помощи механизмов, применявшимися до сих пор (ПКЛ-70). Это вынуждает искать новые подходящие машины для подготовки почв под лесные культуры.

Сейчас наряду с применяемыми машинами появилась новая – DONAREN 190. Речь идёт о смонтированном на лесном тракторе дисковом плуге с активными рабочими органами. Этот механизм стало использовать АО "METS&PUU", которое занимается подготовкой почвы по заказам лесовладельцев. Примечательно, что одна из крупнейших лесообрабатывающих фирм Эстонии занялась и лесовозобновлением.

Одним рабочим ходом машины создаётся пахотная борозда, склон и пахотный пласт (см. рис.). Пахотная борозда и пласт составляют в среднем 52% от площади обработанных вырубок. В среднем 1/3 площади вырубок остаётся необработанной. Такой объём обработки поверхности земли на вырубках является достаточным для обеспечения первоначальной густоты лесных культур.

С точки зрения лесовозобновления существенной является скорость зарастания травами и задернения подготовленной почвы. По данным исследований, это может происходить довольно быстро, особенно на более плодородных участках с сильным ростом трав как на минеральных, так и на торфяных почвах (в течение 1-2 лет). На сильно зарастающих травами участках почву целесообразно подготавливать осенью.

Ключевые слова: лесокультивация, подготовка почвы, твёрдость почвы, зарастание травами, задернение.