Traction mobile device for rotary tillage

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Abstract. The organization of the territory of a forest nursery is the division of its territory into parts that have different economic purposes in order to make the most efficient use of the nursery area and ensure maximum mechanization of work. The establishment of a new nursery begins with the establishment of its outer boundaries. The most optimal shape of the nursery area is square or rectangular. The area of the nursery is divided by a network of main and secondary roads into branches, fields and quarters. The width of the main roads - main roads, circumferential and located perpendicular to the length of the side of the fields - should be 6-8 m, and the secondary ones, located along the long side of the fields, should be 3-6 m. The branch of the nursery is located taking into account the soil, relief and hydrological conditions. Plots with the best structure and granulometric composition of fertile soils, flat relief, protected from adverse effects of winds are allotted for the sowing department. The auxiliary area of the nursery is 25% of the useful area for large nurseries, 30% for medium nurseries, 40% - for small nurseries.

1. Introduction
For the most efficient use of machines and tools in large nurseries, the field length is recommended to be 300-500 m and more, and the width - 40-120 m, in medium and small nurseries, the field length is 50-200 m, width - 20-60 m.

The territory of the nursery is divided into parts with the help of a theodolite, after clearing it of shrubs, stumps, logging residues and planning the area.

The nursery is divided into fields and quarters with a network of roads. In small and medium-sized forest nurseries, the area of the quarter is equal to the area of crop rotation. To prevent soil washout and erosion on the slopes, the nursery fields are divided in such a way that the main soil cultivation is carried out across the slope. In areas damaged by wind erosion, crop rotation fields are located perpendicular to the prevailing direction of harmful winds or with a deviation from it by more than 30° [1].

In work [2], the authors proposed a new scheme for organizing a forest nursery with circular fields, shown in figure 1, as well as design solutions for mechanized tillage in them [3,4,5].
**Figure 1.** Scheme of the organization of a forest nursery with circular fields: 1 - sowing department; 2 - school department; 3 - forest belts; 4 - hedge; 5 - areas for digging planting material, composting and other economic purposes; 6 - roads and lanes with hydronates; 7 - technological sites; I-V - crop rotation fields.

According to the proposed scheme, the forest nursery consists of a sowing department, organized from round fields, equipped with traction devices I to V crop rotations, a school department, also organized from round fields, equipped with servo rotation devices. The sowing and school departments are separated by a forest belt and surrounded by hedges. The nursery is equipped with areas for digging in planting material, preparation of kospost, technological sites and a network of roads and strips with hydronates.

2. Materials and methods

With the aim of increasing the automation of technological processes for growing planting material in forest nurseries and partial replacement of machine-tractor traction with other types of drive, the author of [6] proposed methods for organizing circular forest nurseries.

Circular forest nursery with radius $R_{\text{max}}$ consists of a central square with a radius $R_c$, consistently increases in the diameter of ring-shaped crop areas with radius $R_{j}^{k}$, separated by tramlines of width $a$ and consisting of rows of plants with a radius $R_{f}^{k}$.

To organize a circular field of the nursery, it is necessary to set the radius of the central site, it will be determined with the parameters $a$, $b$ and $h$. Also determine the number of seeding lines with radii $R_{i,j}^{c,k}$ and the maximum radius of the nursery $R_{\text{max}}$. 

Formula for the maximum radius of the first ring-shaped crop area:

$$R_{1, \text{max}}^{k} = R_c + a + H$$  \hspace{1cm} (1)

Where, $a$ – the width of the technological track;  
$H$ – sowing field width.

The maximum radius of the second annular sown area is defined as:

$$R_{2, \text{max}}^{k} = R_{1}^{k} + a + H = R_c + 2(a + H)$$  \hspace{1cm} (2)
To grow planting material, it is also necessary to determine the radii of the seeding rows. Radius of the first and subsequent sowing rows $R_1^c$ a circular nursery is defined as:

$$R_1^c = R_c + a + b$$

Using the above formulas, it is possible to design a circular forest nursery of the required size with the required number of planted areas and the number of seeding rows.

The authors propose a new design solution [7] for performing mechanized technological operations during soil cultivation in forest nurseries when growing forestry crops.

The traction mobile device for circular tillage, figure 2, contains a central support with an arrow connected with the possibility of rotation relative to the support through a vertical shaft with a splined connection and a hinge, a working trolley, a chain drive sprocket for moving the working trolley connected by means of a bearing support to a vertical shaft. The vertical shaft is additionally equipped with a clutch capable of being connected to a sprocket and connected to a motor mounted on the boom by means of a vertical shaft drive, and configured to be disconnected from the vertical shaft drive. The central support is made in the form of a gearbox, the drive shaft, with the coupling of which is connected to the vertical shaft, and the driven shafts are connected to the drills.

![Diagram of a traction mobile device for circular tillage](image)

**Figure 2.** a) – diagram of a traction mobile device for circular tillage in side view; b) – diagram in a top view of the gearbox of a traction mobile device for circular tillage.

Traction mobile device for circular tillage works as follows. Before starting work, the traction mobile device is located in the center of the circular field to be processed. The operator closes the clutch 13, then opens the clutches 6 and 21. Turns on the engine 14. Torque is transmitted from the motor shaft 14 through the clutch 13 to the shaft 11. From the shaft 11 through the drive sprocket 9, chain drive 8 and the driven sprocket 7, the torque is transmitted to the vertical shaft 4. From the vertical shaft 4 through the splined connection 15 and the hinge 16, the torque is transmitted to the drive shaft 17 of the gearbox 18, where from the drive sprocket 22 through the chain transmission 23...
the torque is transmitted to the driven sprockets 24 and the driven shafts 25 and drills 27 associated with them. When assuming the working position by the gearbox 18, i.e. after burying the driven shafts 25 with drills 27 into the soil to the required value, the operator turns off the engine 14, opens the clutch 13 on the shaft 10, and closes the clutches 6 on the vertical shaft 4 and 21 on the drive shaft 17 of the gearbox 18. Thus, the sprocket of the chain drive of the drive for moving the working carriage 5 becomes stationary relative to the gearbox housing 18. The mobility of the device is achieved due to the possibility of installing the device anywhere in the treated area without preliminary preparation of the base for fixing the central support. The use of the proposed invention improves the efficiency of processing a circular field [7].

3. Conclusion

In Russia, there are more than 1,450 nurseries with an area of over 15,730 hectares, the bulk of which are concentrated in the Altai Territory, the Republic of Tatarstan, Tver, Perm, and Vladimir regions. By the method of placing the territory and the nature of the technological process, circular and linear are distinguished. Circular nurseries have an area in the form of a circle, along the edges of which natural plantations are preserved. The proposed technical solution was specially developed for circular forest nurseries in order to replace wheeled and tracked tractors with environmentally friendly technologies. This installation works by means of a traction drive from an electric motor, which favorably affects the soil cover and reduces emissions into the atmosphere, and also provides an increase in productivity, mobility and efficiency due to the possibility of its installation at any point of the treated surface [8].

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