

The perspectives of the vine support systems developing – the introduction of the mobility

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ABSTRACT : The amount of the work in the vineyard, its yield greatly depends on what type of grape trellis is used in the vineyard. The horizontal grape trellis system of the vineyard - pergola - cultivation has a number of advantages. Such farming techniques increase yields by 2-3 times in comparison with the vertical shoot position system and provide the best quality of grapes. But this grape trellis has a significant disadvantages, the care of vines grown on horizontal trellis is very time-consuming. The authors have developed a new type of horizontal grape trellises - the mobile low industrial and high garden pergolas. As a result, we get a high yield typical for the low industrial pergola, which is 2- 3 times higher than the yield obtained on the vertical grape trellis, and its maintenance is just as convenient and simplified as that of the vertical grape trellis. For both - low industrial and high garden horizontal trellises - a significant reduction in labor intensity is achieved, and in addition - for high garden pergola - a significant reduction of traumatic care. The presented projects are an environmentally friendly solution to the problem of increasing grape yields and reducing labor intensity - not associated with environmental pollution with chemicals.

KEYWORDS: horizontal grape trellis system, vertical shoot positioning support system, mobile grape trellis, two plane vertical grape trellis, yields.

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I. INTRODUCTION

Viticulture is one of the distinctive areas of agriculture, the products obtained from it are used for various agricultural purposes, for example: table grapes, wine, raisins, canning and others [1,2].

Taking into account the market economic needs of the world, most of the grapes produced are used for the production of alcoholic beverages, mainly wine raw materials (wine materials).

Raw materials, that is, grapes, play a decisive role in the development of winemaking, therefore in viticulture, as well as in all fields of agriculture, one of the main tasks is to increase productivity and product quality, reduce its cost, which depends on many factors, including the quality performance of vine care, vine formation, vine training - green operations - pruning; spraying, mechanical and chemical tillage, fertilizer, irrigation, grape variety, etc.

In all these directions, scientific-research works are being carried out to increase the quality of the grape and yields.

The laboriousness (labor intensity) of working in the vineyard, its yield also greatly depends on what type of grape trellis is used in the vineyard [3,4].

Grape trellis is characterized by a number of positive characteristics:

1. Grape trellises allow us to properly form the frame of a vine in the first years and then maintain its shape;
2. Distribute the vine buds evenly over the flatness of the trellis, so that all the leaves get as much sunlight as possible;
3. Convenient construction of trellises makes it somewhat easier for the viticulturist to take care of the vines and harvest;

- At the expense of good lighting, raising the plane of leaves at a certain distance from the soil, good air circulation in the area where the planes leaves placed, decrease the probability of fungal diseases.

II. MATERIALS AND METHODS

Various grape trellises that exist today were taken as material. As methods - studying these trellises, their pros and cons; analysis, creation - invention of a new type of grape trellis.

There are many ways to cultivate a vineyard in the world, many types of grape trellis have been developed.

The most common and widely used grape trellis is the Vertical Shoot Position Trellis [1, 2] also known as VSP invented by the famous Austrian viticulturist Lenz Moser in the 1930s.

The advantages of VSP are the simplicity of the device and the use of inexpensive building materials for the cultivation of this type of vineyard. It is less time consuming and the most convenient and easily accessible for harvest grape and to carry out the green operation, tillage under vines.

The disadvantages are that the maximum area of the green mass and the maximum energy assimilation of the sun's rays cannot be obtained, as a result, the maximum yield cannot be obtained.

The horizontal grape trellis system or pergola has been used by mankind since ancient times [5, 6]).

This system of vineyard cultivation has a number of advantages. First of all, we get the maximum area of green mass, the energy is assimilated throughout the day and the vine gets the maximum energy of the sun. Grapes are protected from sunburn by leaves. Such farming techniques increase yields by 2-3 times and provide the best quality of grapes [6,7]).

But the horizontal trellis system - the pergola - has a significant disadvantage, the care of vines grown on a horizontal trellis - is very time-consuming [8,9]). The vintner is forced to work with his head constantly pulled back and his arms raised high. Therefore, this method of vineyard cultivation is not often used in large areas, on an industrial scale (commercial grape growing). In such vineyards, the use of mechanization, the tractor is limited, cause the pergola in the vineyard cultivated on an industrial scale should be at human height.

It is more accepted as a decorative element of landscape design of private houses - the pergola gives a special beauty and coziness to the gardens and yards of private houses. In the yard of private houses, a pergola is usually placed above to save space - under the pergola (or alley) can be placed a table, chairs, or this space can be used for other useful purposes. When caring for a vine on such an alley, a ladder or its replacement device is used, which the viticulturist can not touch due to engaging in green hand operations while working, and there is a risk of its fall - trauma.

Recently, articles and inventions regarding mobile grape trellises began to appear in the literature[10,11]. The authors of these articles suggest solutions to various problems of viticulture through the mobile grape trellises they offer.

A. Palliotti (Palliotti A., 2012[10] proposed a Y-shaped trellis, the shoulders of which can be folded, set vertically and secured with a door hook (Fig. 1). During the growing season, the shoulders of the trellis are set in a Y-shaped position for better absorption of solar energy and increased productivity. Before harvesting, the trellis arms are folded, set vertically and secured with a door hook to mechanize harvesting. When installing the trellis vertically, the grower must approach each support poles separately, manually fold their shoulders, set them vertically, and fix with a door hook, which is very time consuming.

Installing the trellis shoulders in a Y-shaped position instead of a horizontal one will not allow the vine to absorb the maximum solar energy and get the maximum yield.



Fig. 1 A. Palliotti y-shaped vine training system

In viticulture also is used T-shaped pergola (trellis system) consisting of a vertical pole and shoulders mounted horizontally on it (T-shaped horizontal trellises).

We propose a T-shaped trellis system - a mobile trellis [12], the shoulders of which are movably attached to the poles by the hinges with the possibility of mounting them vertically and horizontally (Fig. 2). Only one-year-old branches take part in the bending, which are replaced with new ones every year (they have enough flexibility and elasticity to participate in bending-unfolding).

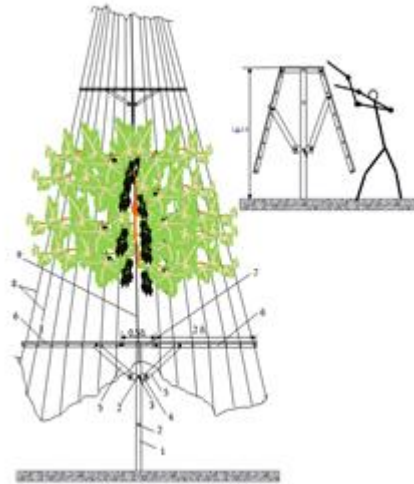


Fig. 2 T-shaped Horizontal Mobile Trellis

During the vegetation period - the development of green mass and fruit ripening - the shoulders are placed horizontally, and during the green operations - during pruning, spraying, harvesting - in a vertical position.

Figures 3, 4 show a technical drawing of the T-shape trellis system - a mobile trellis with folding shoulders (Fig. 3) and an axonometric view of two adjacent rows of this trellis (Fig. 4). Figs. 3, 4 show trellis with both folded and outstretched shoulders. As a result of the stretching of hawser 13 (stretching can be done with a winch), the shoulders 5 are raised and placed horizontally in the whole row. When releasing the hawser 13, the shoulders 5 gradually lower and stand upright. The fixation of the grape trellis in both positions is ensured both by fixing the parallelogram mechanism and by fixing the hawser.

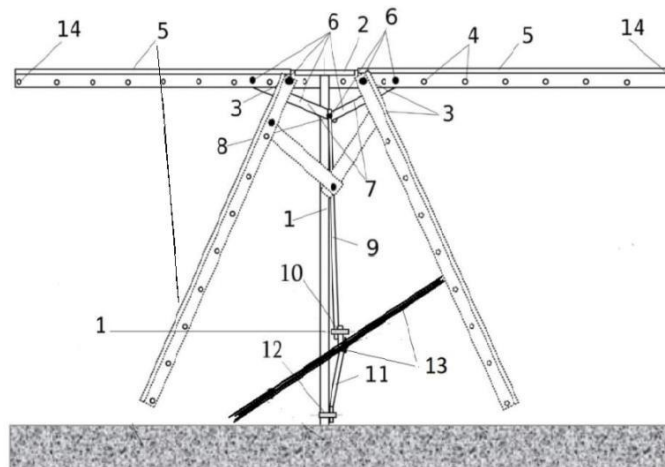


Fig. 3 Technical drawing of the T-shaped Mobile Pergola Trellis

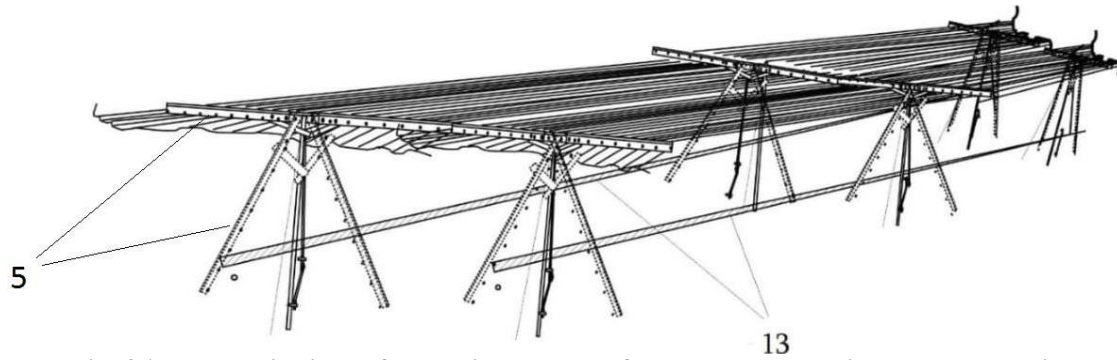


Fig. 4 Axonometric views of two adjacent rows of the T-shaped Mobile Pergola Trellis

Today (although less) also is used two plane vertical trellis (Figs. 5), which are two vertical rows located close to each other (60-100 cm) [13]. It is difficult to understand what the viticulturists are guided by when they install such trellis for grapes. When even the technical varieties of grapes grown on a single row vertical grape trellis – VSP (vertical shoot position system), if the summer does not turn out quite sunny, can not collect enough sugar. It is clear that the adjacent rows of these two plane trellis will overshadow each other and will not give us a large crop, while the sugar content of the grapes will not be high.



Fig. 5 Two-plane trellis

But if the upper part of such trellis will be articulated (movably connected) to the lower part and we will provide them with a mechanism to change the position of the upper part of the trellis, then it will be possible to place the rows horizontally or close to the horizontal during vegetation. We get a two-plane mobile trellis (Fig. 6 a, b, c, d, e)

For such two plane mobile trellis, we have developed a simple mechanism for mounting the rows vertically and horizontally, which will allow the owners of such trellis to easily upgrade it.

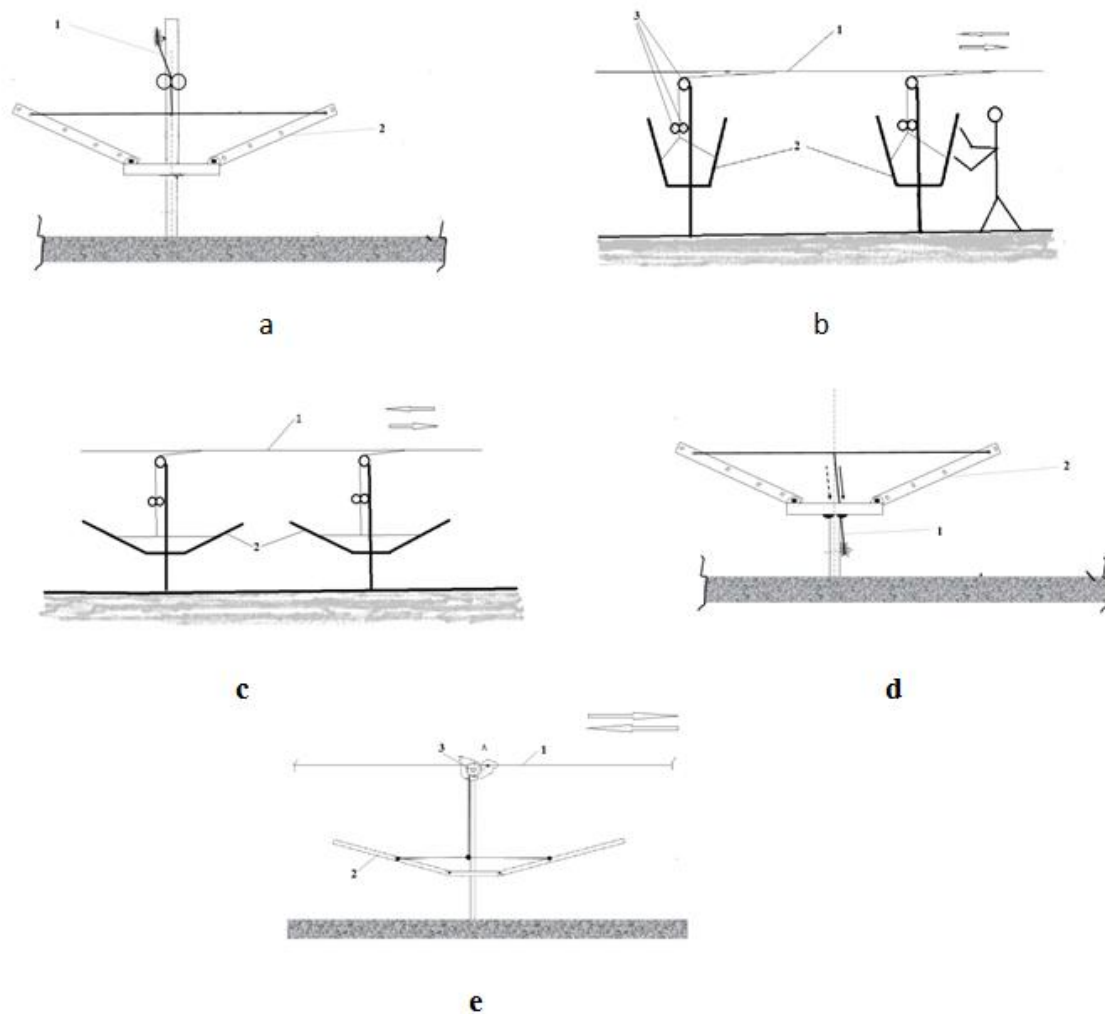


Fig. 6 Two-plane Mobile Trellis

a, b, c, e - two-plane mobile trellis with main hawser placed above the trellis, d - two-plane mobile trellis with main hawser placed below the trellis. e - two-plane mobile trellis with one roller, 1 – main hawser, 2 - shoulders, 3 - rollers

As a result of the stretching of the main hawser 1 (Fig.6, b), the shoulders 2 are raised and stand vertically (upright) or closed to vertically in the whole row. When releasing the main hawser 1 (Fig.6, c), the shoulders 2 gradually lower and placed horizontally or closed to horizontally. The main hawser can be placed above (Fig 6 a, b,c, e) or below the trellis (Fig 6 d). At the points where the direction of the hawser changes, rollers are installed.

This trellis shoulders mounting mechanism can also be installed on the mobile T-shaped grape trellis (Figs 2, 3, 4).

We have also developed a T-shaped Balanced Mobile Trellis (Figure. 7), the upper part of which rotates around an axis located in its center[14]. The symmetry of the weights of the trellis shoulders (more or less balanced of the torques) about the stake (pillar) - the axis is placed on it - does not require large loads from the service personnel when placing this trellis in a horizontal or vertical position.

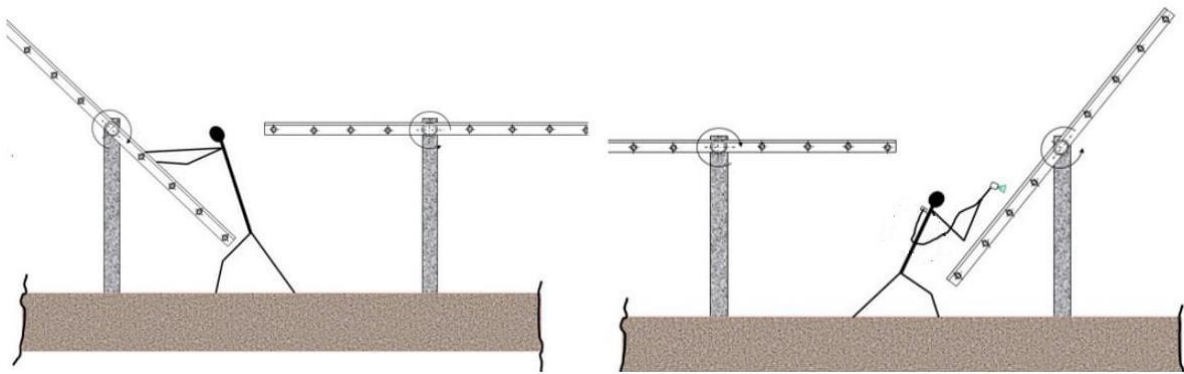


Fig. 7 Balanced T-shaped Mobile Trellis

For landscaping of private houses - to reduce the high time consuming and traumatic care of the yards and gardens high pergolas, we propose to attach the ramps to the pergola poles, on which can be placed a wheeled stand with railings made of light material with the possibility of its removal from the ramps (Fig. 8).

To move the stand on the guides – ramps the vinedresser may push the wires or rods of the upper part of the pergola, or the stand may be equipped with an electric motor and a remote control.

The ramps are installed with the possibility of removal, transfer, and installation along the entire length of the pergola.

A ladder can be secured to the stand or to the ramp to climb on the stand.

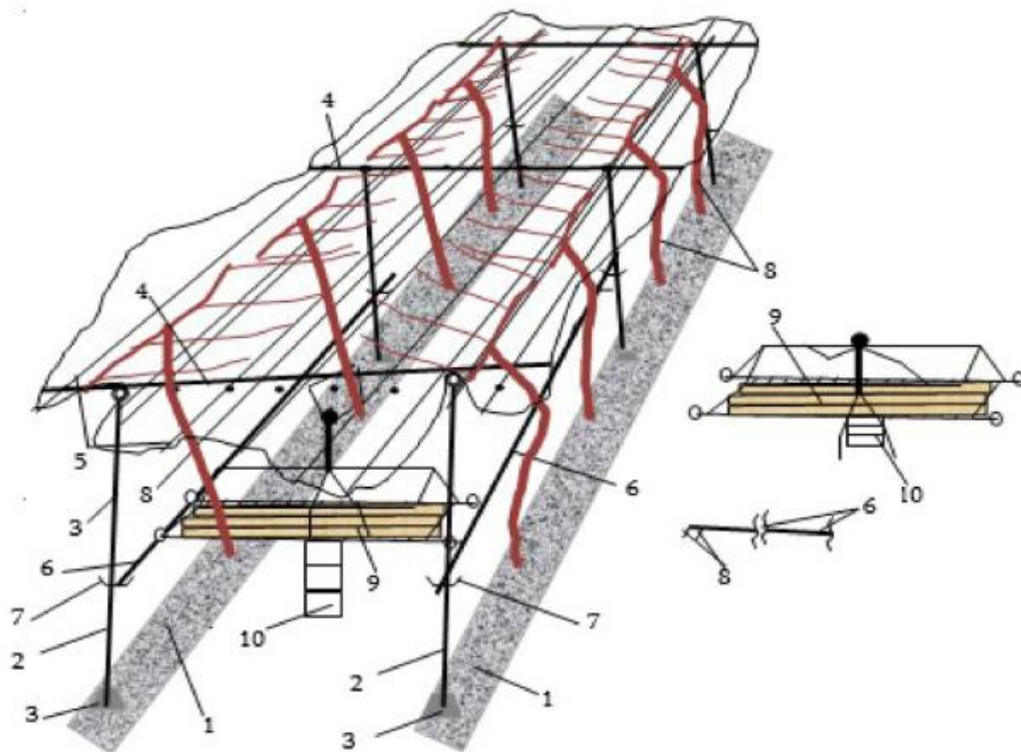


Fig. 8 Pergola with stand and ramps

2. Poles 4. Crossbars 5. Wires 6. Ramps 8. Vines 9. Wheeled stand with railings 10. Ladder

Hereinafter in this article, the pergola, which is installed at the height of a person's height and is used for growing grapes on an industrial scale, will be called a low industrial pergola. A pergola for landscaping a private house, which is set high in order to use the space under the pergola for various useful purposes - let's call a high garden pergola.

III. RESULTS

The proposed types of grape trellis – mobile low industrial pergola trellises - allow us to combine the advantages of horizontal and vertical trellises - to obtain a high yield characteristic of the pergola, which is 2-3 times higher than of the vertical trellis, and its maintenance is as convenient and simple as for the vertical trellis. Vertical installation of the trellis allows the use of mechanization, the tractor.

Raising the plane of leaves at a certain distance from the soil decrease the probability of fungal diseases. Reducing labor time reduces the cost of grapes.

We have submitted an application for the proposed grape trellis project to Sakpatenti, the State Patent Office of Georgia. It is recognized as an invention P 2021 7225 B and published in the Official Bulletin of Industrial Property of SAKPATENTI, THE NATIONAL CENTER OF INTELLECTUAL PROPERTY OF GEORGIA (Kharibegashvili et al. 2020) [12].

For the high garden pergola, the use of the stands with rollers, handrails, and ramps will also reduce the labor intensity of the viticulturist due to the disappearance of the need to constantly move the ladder and injuries associated with the risk of falling from the ladder.

IV. DISCUSSION

The disadvantage of the presented low industrial mobile grape trellises is its cost, it will be 3-4 times more expensive than vertical grape trellises, and not much more expensive than a T-shaped trellis (immobile). But if we take into account that its yield is 2-3 times higher than the vertical grape trellis, in 2-3 years it will compensate the costs incurred on it, and then we will get a net profit.

A mobile high garden pergola will not be much more expensive than a usual one, but this is justified by a decrease in trauma and laboriousness of caring for it. Individual owners of such high garden pergolas are free to order the stands and ramps in a small private workshops.

V. CONCLUSIONS

Today the world is characterized by a sharp, rapid increase in population and urbanization, a reduction in areas suitable for agricultural land.

If we also take into account that the area suitable for viticulture is limited by agro-climatic conditions, it becomes especially important to develop viticulture in an intensive type – to increase the grape yield in the same area of the vineyard – i.e. without increasing the area of the vineyard. The presented project - low industrial pergola meets this requirement.

Reducing labor intensity and trauma will allow lovers of a high garden pergola to use it more boldly, properly shape the vine, give it a beautiful look, get a good harvest. The comfort of caring for it will give them more pleasure, which will contribute to the spread of a high garden pergola.

The modern level of development of technologies and technics freely allows to introduce and spread the proposed projects of grape trellises – The Mobile Pergola Trellises.

The introduction of mobility opens up new possibilities for the vines support systems and provides new environmentally friendly solutions (not associated with environmental pollution by chemicals) to the many challenges facing viticulture.

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