Cultivation technology and efficiency of berry crops production in the conditions of the Central Chernozem Region

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Abstract. Different berry products are currently in high demand in the Russian market. Berry plantation establishment is a labor-intensive process that requires a comprehensive assessment of the suitability of the plot for intensive cultivation of berry crops, justification of planting patterns, and cultivation technologies, as well as calculation of labor, material and monetary costs. The government of the Russian Federation increased support of agricultural producers in the form of subsidies at the stage of establishing of plantation. Subsidies are also provided for expenditures connected with caring for berry-producing shrubs before coming into commercial fruiting. Calculations have been carried out according to the stages of cultivation (soil preparation; planting of a berry plantation; caring for young plantings; caring for fruit-bearing plantings), confirming the effectiveness of berry plantation establishment, production and sales potential of berry crops in the conditions of the Central Chernozem Region.

1. Introduction
The development of Russian horticultural industry is among the priorities of the state agrarian policy [1]. Sanctions imposed against the Russian Federation, as well as retaliatory measures taken by Russia, necessitated an accelerated development of horticultural industry. In recent years the government of the Russian Federation has paid increased attention to the domestic production of fruits and berries, subsidizing part of the costs of agricultural producers for orchard and berries plantations establishing and caring [1].

According to figures provided by experts of the Ministry of Agriculture of the Russian Federation, in order to fully provide the country’s population with fruits and berries in the coming years, it is necessary to set up to 250 thousand hectares of orchards, including 140 thousand hectares of apple orchards, 24 thousand hectares of pear orchards, 60 thousand hectares of stone fruit orchards, and 18 thousand hectares of berry plantations, subject to the availability of modern storage facilities in horticultural enterprises [2].

Raspberry and black currant are valuable berry crops, popular not only in Russia, but also in many countries of the world [3]. These berries regulate the activity of the gastrointestinal tract, improve appetite, increase immunity, and have bactericidal and anti-inflammatory properties. Berries are used
for hypertensive crisis and atherosclerosis, are indispensable for colds, and their juice is used for treatment and prevention of diabetes mellitus [4].

Medical standards of per capita berry consumption in Russia are 7 kg per year. However, so far the actual level of berry consumption is 70-76% of normal (4.8-5.3 kg), even taking into account imports.

As shown in Table 1, imports do not cover the existing deficit, which is estimated at 58 thousand tons with the deficit of 312 thousand tons [5]. Raspberry, blackberry and currants together account for 12-13% of the total import of berries, which is 6 times less than the import of strawberries. Among other things, this is explained by the complexity of transporting these berries over long distances.

| Berry species                  | 2016 | 2017 | 2018 | 2019 | 2020 |
|-------------------------------|------|------|------|------|------|
| Strawberry                    | 82   | 86   | 83   | 78   | 71   |
| Cranberry and bilberry        | 4    | 4    | 7    | 8    | 10   |
| Raspberry and blackberry      | 6    | 5    | 6    | 6    | 6    |
| Currants                      | 6    | 5    | 4    | 6    | 7    |
| Blueberry                     | -    | -    | -    | 1    | 2    |
| Other                         | 2    | 1    | 1    | 3    | 4    |
| Total                         | 100  | 100  | 100  | 100  | 100  |

In the Central Chernozem Region, 70-90% of berry production is concentrated in amateur horticultural plantations, but private subsidiary farms are unable to provide the population with these products. Full supply of berries can be obtained through the expansion of production plantings in horticultural enterprises using innovative low-cost technologies [6].

Modern berry crop cultivars are distinguished by high productivity, large fruit size, rich biochemical composition, disease resistance, and good winter hardiness [7]. In recent decades, new perpetual (everbearing) cultivars of raspberry have been created, which allow using nonconventional, less costly cultivation technology and obtaining environmentally friendly products outside the “raspberry season” (late summer – early autumn) thus extending the period of consumption of fresh raspberries by 1-1.5 months. Cultivation of perpetual varieties with early-winter mowing of aerial parts of plants and complete rejection of pesticides provides ecological, technological and economic attractiveness [8].

Russian horticulture has been developing rapidly over the past five years, which is largely due to government subsidies for garden creation and maintenance. While the area of fruit plantations has decreased to 100 thousand hectares by 2020 due to uprooting of old trees, there is a sharp increase in the area occupied by newly planted orchards (up to 80 thousand hectares) with the average laying of 15 thousand hectares in 2017-2020. In 2020, about 17 thousand hectares of new orchards began to bear fruit, providing the yield of 3.3 million tons from the total area. By 2024 the total area of fruiting perennial plantations is estimated to increase up to 140 thousand hectares yielding 5-6 million tons of fruits [9].

The increased rate of orchard creation is due to sanctions (that led to a sharp decrease in imports), organizational and managerial decisions of agricultural producers (that determine the areas of investment in order to improve the efficiency of the enterprise), and most importantly, significant state support of the industry in recent years from federal and regional authorities.

Along with agricultural organizations, peasant farm enterprises have also become engaged in planting orchards and berry fields in recent years in Russia. In order to receive subsidies, planting must be carried out on the area of at least 1 hectare. This condition is fulfilled in peasant farm enterprises.
2. Materials and Methods
The object of research was represented by agricultural producers of the Central Chernozem Region engaged in creation of berry fields and fruit production.

The study used a systematic approach, including such methods as the monographic method, methods of comparison, program-targeted method, and dynamic analysis.

3. Results and discussion
Among berry crops in the Central Chernozem Region, garden strawberry is the most widespread, while raspberry and black currant are far below. These crops have long been grown in specialized horticultural farms in the region. Due to diversification of production, fruit-growing enterprises begin to produce honeysuckle, bilberry, gooseberry, etc., but raspberry and currants remain the main berry crops.

When creating berry plantation, most enterprises purchase planting material from various fruit nurseries. The economic life of berry fields is 15-16 years, after which the yield of berry crops decreases sharply and the shrubs need to be replaced. Fruiting of raspberry occurs in the second year after planting, black currant gives fruits in the third year with the yield increasing over the consecutive years and further declining. The yield of perpetual raspberry is higher (up to 10 t/ha) compared to the ordinary yield of up to 8 t/ha.

Pre-planting soil preparation requires deep plowing, anti-weed soil treatment, and application of organic fertilizers. Plantlets of both shrubs are demanding of fertilizers and watering, which should be at least 5 liters per 1 bush. Caring for young plantings consists in their pruning, treatment against pests and diseases (up to 5 times per vegetation season), watering, and application of organic and mineral fertilizers. Mainly drip irrigation is used with simultaneous application of micronutrient fertilizers. Growing raspberries requires the installation of a trellis, which significantly increases the cost of production.

Due to intensification of organic production in the region, some agricultural producers are engaged in the production of organic berry products. The technology of cultivation of perpetual raspberry and black currant differs in the use of fertilizers and protection agents. Humus is used as organic fertilizer, and biological preparations are used instead of chemical protection agents, which significantly increase the cost of production.

The authors have made calculations to determine the efficiency of production of raspberries and black currents in the conditions of the Central Chernozem Region.

Unlike fruit trees, berry bushes start bearing fruit much earlier. In the third year from berry plantation establishment, commodity producers can obtain products and regain their material investments, which are carried out in several stages:

- soil preparation and planting of berry field;
- caring for young berry plants;
- caring for fruit-bearing plantations.

The largest share in the costs of planting a berry field is occupied by purchase of plantlets, since most agricultural organizations and peasant farm enterprises do not have their own planting material. In the Central Chernozem Region it is possible to purchase raspberry plantlets at the price of 120-135 rubles and black currant for 30-35 rubles per 1 plantlet (in the calculations, the price of shrub plants is planned to be 125 rubles and 35 rubles, respectively).

After planting berry crops, caring for them includes keeping the row spacing clean, application of fertilizers, treatment against pests and diseases, watering, rodent control, and caring for the crown. The costs of raspberry and currant berry plantation establishment and caring for young plants during the year per 1 ha are shown in Table 2. In accounting the costs of berry plantation establishment and caring for plantings are recorded on an accrual basis as separate items. No products are produced during these years and the accounted costs will be further distributed in the form of depreciation expenses for the products obtained from fruiting plots in subsequent years.
The total costs of berry plantation establishment and caring for young plants amounted to 1,239.4 and 925.2 thousand rubles for raspberry and black currant, respectively. The berry field is planned to be used for 15 years and during this period the specified costs will be included in the production cost of products. Young berry fields and fruiting plantations are planned to be watered with simultaneous mineral fertilizer application and treatment of up to 5 times with various protection agents against diseases and pests, which takes up to 20% of all costs. Considerable costs are spent on harvesting (more than 50% for raspberries and 42% for currants). The total costs of planting and caring for young and fruiting plantations are presented in Table 3.

Table 2. Summarized data on the costs of berry plantation establishment and caring for young plants, thousand rubles per 1 ha.

| Cost items                              | Berry field creation | Caring for young plants | Total costs before fruiting |
|----------------------------------------|----------------------|-------------------------|----------------------------|
|                                        | raspberry            | black currant           | raspberry                  | black currant |
| Cost of plantlets                      | 510.2                | 140.0                   | 510.2                      | 140.0        |
| Cost of labor                         | 136.0                | 117.8                   | 169.5                      | 184.8        |
| Social security contributions          | 42.5                 | 36.8                    | 53.2                       | 58.9         |
| Fertilizers                            | 140.0                | 140.0                   | 140.0                      | 140.0        |
| Protection agents                     | 4.6                  | 4.6                     | 60.1                       | 51.9         |
| Maintenance of fixed assets:          |                      |                         |                            |              |
| - depreciation                         | 8.5                  | 10.4                    | 9.4                        | 13.8         |
| - repairs and maintenance              | 6.2                  | 8.1                     | 6.9                        | 10.8         |
| Petroleum products                    | 167.7                | 170.5                   | 169.8                      | 174.4        |
| Water                                  | 3.1                  | 6.1                     | 33.4                       | 66.5         |
| Electricity                            | 0.1                  | 0.1                     | 3.7                        | 6.9          |
| Other costs                            | 18.1                 | 17.2                    | 24.1                       | 33.1         |
| Total direct costs                    | 1,037.0              | 651.6                   | 1,180.3                    | 881.1        |
| Overhead costs                         | 51.9                 | 32.6                    | 59.1                       | 44.1         |
| Total costs                            | 1,088.9              | 684.2                   | 1,239.4                    | 925.2        |

Table 3. Total costs of berry plantation establishment and caring for young and fruiting berry plants (per 1 ha), thousand rubles.

| Cost items                              | Raspberry planting | caring for young berry plantation | caring for fruiting berry plantation | Black currant planting | caring for young berry plantation | caring for fruiting berry plantation |
|----------------------------------------|--------------------|-----------------------------------|-------------------------------------|------------------------|-----------------------------------|-------------------------------------|
The costs of berry plantation establishment by years and caring for young and fruiting berry plants are distributed as shown in Table 4.

**Table 4. Distribution of costs by periods, thousand rubles/ha.**

|                | Periods                          | Soil preparation and planting | caring for young berry plantation – 1st year | caring for young berry plantation – 2nd year | caring for fruiting berry plantation |
|----------------|---------------------------------|-------------------------------|---------------------------------------------|---------------------------------------------|-------------------------------------|
| **Indicators** | **soil preparation and planting** | **caring for young berry plantation** | **caring for young berry plantation** | **caring for fruiting berry plantation** |
| Raspberry      | Soil preparation and planting   | 1,037.0                       | 150.5                                       | -                                           | 3,578.8                            |
|                | Caring for young berry plantation |                               |                                             |                                             |                                    |
|                | Caring for fruiting berry plantation |                           |                                             |                                             |                                    |
| Black currant  | Soil preparation and planting   | 651.6                         | 120.5                                       | 120.5                                       | 859.7                              |
|                | Caring for young berry plantation |                               |                                             |                                             |                                    |
|                | Caring for fruiting berry plantation |                           |                                             |                                             |                                    |

Higher costs for fruiting raspberry plantation are explained by manual picking of berries, while a berry harvesting machine is used for picking currants. The period of entry into the fruiting season is 1 year for raspberry and 2 years for currants.

The annual amount of costs for calculation is determined by the costs per year of fruiting and the amount of depreciation expenses, which amount to 88.6 thousand rubles for raspberry and 61.7 thousand rubles for currants per year.

The calculation of cost of products obtained with the account of the planned yield (50 c/ha for raspberry and 80 c/ha for black currant) and production costs with the account of depreciation expenses for berry field creation is presented in Table 5.
Table 5. Calculation of costs per 1 c of berries.

| Indicators | Raspberry | Black currant |
|------------|-----------|---------------|
| Product costs, thousand rubles/c | 750.9 | 921.4 |
| Production cost per 1 c, rubles | 150.2 | 138.2 |
| Total | 50 | 18,022 | 80 | 1,059.6 | 13,245 |

The estimated cost with the account of sales costs (20% of production costs) is 18,022 rubles per 1 centner of raspberries and 13,245 rubles per 1 centner of currant berries.

This estimated cost and planned selling price (25.0 thousand rubles/c for raspberries and 20.0 thousand rubles/c for currants) will give berry growers a positive financial result (Table 6).

Table 6. Estimated profitability of producing raspberries and currants.

| Indicators | Raspberry | Black currant |
|------------|-----------|---------------|
| Profit per 1 c, rubles | 6,978 | 6,755 |
| Profitability, % | 38.7 | 51.0 |

The costs of caring for a young orchard prior to fruiting consist of the costs of soil preparation, planting, and caring for the plantings. These costs form the amount that will be taken into account in product costing in the form of depreciation charges.

As evidenced by the data of calculations, the production and sales of berries provide profit after the beginning of fruiting. The increased interest in berry production is to a certain extent due to subsidies that agricultural producers can receive under various programs [10, 11].

For instance, the “Novice Farmer” program allows peasant farm enterprises receiving payments of up to 50.0 thousand rubles per hectare for berry fields creation, and about 20.0 thousand rubles per hectare for the use of berry fields before the start of full fruiting [12].

Applicants for subsidies must meet certain requirements:
- they must not have any tax liabilities;
- they must not be undergoing the process of reorganization;
- they must not be a foreign legal entity;
- they must have the claimed orchard areas available;
- they must have documented expenses for the previous year.

4. Conclusion
Cultivation of berry plant crops in the Central Chernozem Region can become profitable if new berry plantations are established using innovative energy-saving technologies and state support is provided to agricultural commodity producers [13, 14].

Providing subsidies will increase producers’ profitability and their engagement with increasing the area under raspberry and black currant in order to increase the production of high-quality and useful berry products.

The calculations carried out showed the feasibility of cultivation of seed-bearing fruits, stone fruit crops and berry plant crops.

An accelerated development of the whole horticultural industry (as well as its sub-industries) will exert an impact not just on the indicators of economic efficiency, but also on other types of efficiency
Sustainable development of rural areas is the most important objective of the state policy, the achievement of which will ensure food security, increase the competitiveness of the Russian economy and the well-being of Russian citizens.

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