Economic efficiency of onion growing in the central part of Russia

O N Kukharev¹, V F Pivovarov², N P Laryushin¹, A V Soldatenko² and Yu A Vershinin²

¹Penza State Agrarian University, Botanicheskaya 30, Penza, 440014, Russia
²Federal Scientific Vegetable Center, 14, Selectionnaya str., VNIISSOK, Odintsovo district, 143072, Moscow region, Russian Federation

E-mail: kucharev@bk.ru

Abstract. Currently, Russia is one of the top five countries in terms of onion cultivation areas. It should be noted that Russia is also the largest importer of onions. Onion production in agricultural organizations and farms is increasing. High consumer demand and relatively low resource costs allow classifying this area of management as the most profitable and easy types of agribusiness. The paper shows the need to increase the economic efficiency of onion production in the central part of the Russian Federation. The necessary volume for import substitution is calculated. It is economically justified to use the technology of sowing onion seeds 90+50 cm in comparison with the traditional technology. The highest yield was obtained when seeding with an experimental machine at a seeding rate of 20 million units/ha.

1. Introduction
Currently, according to the recommended rational standards of food consumption that meet modern requirements of healthy nutrition, each person should consume 140 kg of vegetables per year, including onions at least 10 kg. This indicator is used for planning the volume of food production in the agro-industrial complex, as well as by citizens in the formation of individual diets [1].

The volume of onion consumption is due to the high value of this crop, its chemical composition, taste and medicinal qualities. Bulbs and green leaves of onions, depending on the variety and growing conditions, contain up to 4.5% protein, 4-8% or more carbohydrates, up to 0.60-1.14% mineral salts, a large amount of vitamins (A, B1, B3, C, PP), phytoncides and essential oils. [2] The chemical composition of onions depends on many factors, primarily the variety, environmental conditions and agricultural techniques [3].

Onions, especially sharp varieties, have long been used as a medicine for many diseases. Both in folk and modern scientific medicine, it serves as a means of treating beriberi, various inflammatory processes, infectious diseases; it has a positive effect on the secretory activity of the body. Various drugs are produced from onions, the action of which is based on sufficiently strong bactericidal and fungicidal properties [4].

2. Materials and methods
Economic efficiency calculation was conducted with the use of technological maps. The technological map is a plan of agrotechnical and organizational and economic measures, which consistently indicates the composition, volume of agricultural work on the cultivation of crops and their quality.
characteristics; the machines used; the number and qualification of workers servicing the units; production standards; agrotechnical and working terms of individual works; labor and money costs per 1 ha of sowing and unit of production.

3. Results

According to the Federal Statistics Service of the Russian Federation, the production of vegetables, including onions, reached 13685 thousand tons in 2018 [5]. As you can see from Fig. 1, recently, due to the policy of import substitution, vegetable production has been growing steadily in relation to 2014, an increase of 864 thousand tons or 6.7%. For each of the 146.9 million people in the Russian Federation, the volume of vegetable consumption in 2018 was 93.15 kg per year. Including onions (approximately) 8.3 kg/year, which is only 66.5% of the recommended rational norm of food consumption [1].

![Figure 1. Production of open ground vegetables in the Russian Federation.](image)

At the same time, the yield of vegetables in the Russian Federation is growing (figure 2), so over the past 5 years since 2014, it has increased by 61 t/ha or 26.4% and reached 292 t/ha in 2018 [5].

![Figure 2. Productivity of open ground vegetables in the Russian Federation.](image)

In the world, the production of onions is constantly increasing; its modern collections reach more than 87.0 million tons per year. The level of onion productivity in the main onion-growing countries of the world is more than 50 t/ha. In Russia, the average yield of onion is much lower, just over 20 t/ha. Therefore, an urgent task of modern vegetable growing in Russia and the Volga region is to increase...
the yield of this crop to 80-100 t/ha in compliance with the principles of resource conservation and environmental safety of production [6].

Agricultural producers can increase the production of vegetables in the next 3 ... 5 years by 6881 thousand tons, provided that the policy of import substitution is maintained and the state provides targeted support for the production of seeds of Russian selection, as well as equipment and technologies of Russian scientists. At the same time, the onion production technologies used must be economically justified. And the applied system of machines is rational according to the category of spent resources—the received production cost.

Thus, in the methods and schemes used today for sowing onion seeds, up to 60-70% of the field surface is under the row spacing and only about 30% is directly occupied by cultivated plants.

The main objective of sowing is the optimum plant density and uniform distribution of the area sown fields, i.e. creating conditions in which plants are evenly distributed four equal and mutually indispensable factor of life: light, heat, water and nutrition elements.

The role of the method and scheme of seeding is also in the fact that it determines not only the type of seeders, but also the design features, and the degree of application of the entire complex of machines for subsequent types of work (including harvesting), thereby determining the technical and economic indicators of the entire technological process as a whole. Especially important is the choice of the method and scheme of sowing when cultivating onions—sowing, because its quality and yield, all other things being equal, depend not only on the size of the area of plant nutrition, but also on its configuration, which in turn significantly affects the size of bulbs and the yield of sowing of a particular group [7,9].

The economically justified scheme for sowing onion seeds for onion production is 90+50 cm in the middle lane, where 90 cm is the lane occupied by the onion and 50 cm is the row spacing. The advantage of the proposed technology is that the seeds are distributed more evenly over the area when sown according to the scheme of 90+50 cm with a ground-spraying ploughshare. Seedlings appear more amicably, the growth of plant mass and the formation of crop is much higher than on tape and multi-line crops. The effectiveness of strip seeding is also shown in increasing the anti-erosion stability of crops. In the presence of a uniform density of vegetation, of the precipitation falling on the surface of plants, absorbs its kinetic energy and does not destroy the structural units of the surface soil and decreases the amount of moisture evaporating from the surface of the field.

Creating optimal conditions for the growth and development of onions ensures maximum realization of the genetic potential of the crop and is the basis for obtaining stable high yields of environmentally friendly products. In this situation, agrotechnological techniques that contribute to the most effective use of soil moisture and nutrients are particularly important in vegetable growing [6].

This method of seeding significantly improves the quality performance of harvesting machines, as its separating organs are not fed a layer of ground from the row spacing and line space. The uniform distribution of seeds over the area leads to the fact that during the growth of the crop, it independently loosens the soil inside the strip, destroying large soil structures and providing optimal conditions for the work of harvesting machines [7,8].

Production studies were conducted by A.V. Polikanov [9] in comparison with the SO-4.2 seeder (20+50 stripe seeding scheme) in accordance with OST 70.5.1-82 in the fields of the FSUE "Uchkhоз Penza SAA" of the Mokshansky district of the Penza region. Onion seeds of the Bessonovsky local variety were sown with a seeding rate of 15 million units/ha. The tests were carried out in the established time frame for sowing onion seeds in the central part of Russia, under real conditions, with soil moisture in the layer of 0-5 cm 14.4% and soil hardness of 0.16 MPa. The terrain of the field is flat, the slope is up to 30, the contour of the field is close to the correct rectangular shape, the area is 0.5 ha, the length of the rut is 250 m.

The uniformity of onion seed distribution over the seeding area was measured on a 90 cm wide strip sown with six ploughshares (the overlap of two adjacent ploughshares is 10 mm). Taking into account the highest productivity of the unit, the speed can be assumed to be equal to 5.4-7.5 km/h, which corresponds to four to six gears of the MTZ-80 tractor.
According to the results of production tests, the deviation from the actual seeding rate for the SO-4.2 seeder was 3.1%, for the experimental one - 3.7% (which approximately corresponds to the agrotechnical requirements for vegetable seeders). The proportion of seeds located in a layer of 2-3 cm in the SO-4.2 seeder is 81.8%, in the seeder with experimental ploughshares - 84.6%. The coefficient of variation, which characterizes the uniformity of the distribution of onion seeds over the seeding area, was 56% in the experimental seeder. The actual width of the sown strip varies at 85.1-86.1 with a coefficient of variation of 2.3% [9].

The results of production tests show that the technology used with an experimental seeder allows getting an increase in yield of 1.8-6.3 t/ha compared to the widely used SO-4.2 seeder. The highest yield was obtained when seeding with an experimental machine at a seeding rate of 20 million units/ha. However, the quality indicators of onion sowing significantly deteriorate in comparison with the seeding rate of 15 million units/ha. The yield of the sowing fraction of the first and third groups – the most valuable as seed material – in the first case is 64%, in the second – 74.4%. In addition, in the first case, the yield of the seed fraction with a diameter of less than 10 mm is 35.5%, in the second - 25%. Mechanized harvesting of this fraction is particularly difficult due to the fact that the bulbs of this size are received by the passage to the separating bodies of harvesting machines. Further increase in the seeding rate leads to a decrease in yield due to thickening of crops. The optimal seeding rate, which provides a yield of up to 13 t/ha and good quality indicators, can be considered 15-18 million units/ha [2].

4. Summary
A comparative analysis of costs, capital investments, and performance indicators for existing and projected onion cultivation technology allows making the following conclusions. The projected technology, with almost unchanged direct costs – 56,872 rubles per 1 ha of cultivated area (the existing technology – 57003 rubles), makes it possible to increase the output of gross output in value terms from 9,000 to 11160 rubles, that is, by 24%. As a result, the cost of 1 centner of production will be reduced by 1,940 rubles or 19.4 %. This allows using the projected technology to increase the profit volume from 1,590 to 3,770 rubles or by 2.4 times and increase the level of profitability by 29.4 %. Visual indicators that characterize the effectiveness of the introduction of new technology are the capital return and labor productivity. With little additional investment in the project, the level of capital return will increase by 29 % with an increase in labor productivity by 1.7 times. These indicators are achieved largely due to the integrated use of machines and reducing the cost of live labor. The recommended design method of mechanization with little additional investment can significantly improve the efficiency of onion cultivation.

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