Crops cultivation parameters application in the land misuse assessment

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Abstract. The article discusses the problems of determining the agricultural crops parameters application for calculating the amount which paying compensation in the inappropriate agricultural land occupation case on the growing open ground tomatoes example. The study purpose is to determine the compensation amount in agricultural land misuse case using the open ground tomatoes example. At the same time, the following tasks were solved: - to determine the typical technology for growing open ground tomatoes in the Samara region; - on the basis of statistical data calculate the profitable part of growing open ground tomatoes; - identify the costs main sources and calculate the expenditure amount; - to determine the compensation amount in the case of growing open ground tomatoes with land alternative use in the Samara region.

1. Introduction

Agricultural production plays an important role in the economy of the Samara region. However, a number of regulation aspects related to the agrarian sphere peculiarities have not yet found legislative reflection either at the federal level or at the Samara region level. Among the priority problems is the formalization of the process determining the compensation amount in the agricultural land temporary occupation [1-9].

The economic damage from the land seizure by owners during their temporary occupation for non-agricultural needs is complex [10-15]. Losses of agricultural production include agricultural products wastage (profit decrease for the agricultural producer) [16-21].

The lost profit amount is defined as the difference between the planned revenue (income) from the sale of potential agricultural products and the cost of growing it [22-25].

2. Materials and methods

The study purpose is to determine the lost profit amount in agricultural land misuse case using the open ground tomatoes example. At the same time the following tasks were solved:

- To determine the typical technology for growing open ground tomatoes in the Samara region;
- On the basis of statistical data calculate the profitable part of growing open ground tomatoes;
- Identify the costs main sources and calculate the expenditure amount;
To determine the lost profit amount in the case of growing open ground tomatoes with land alternative use in the Samara region.

In the course of this work, it is necessary to determine the possible revenue from the cultivation of open ground tomatoes in the study area, located on the territory of the Volzhsky district in the Samara region, and the costs of growing them.

Income or revenue from product sales is calculated using the following formula:

\[ \text{Income} = \text{Gross Fee} \times \text{Price} \]

Where \( \text{Income} \) – income, rubles; \( \text{Gross Fee} \) – gross fee, ton; \( \text{Price} \) – price, rubles/ton.

In this case, the gross yield is defined as the product of the yield per the agricultural crop harvested area. In our case, when the area of the site is 1 ha, the gross harvest is equal to the yield.

3. Results

The best predecessors of tomato are legumes, cucumber, perennial herbs, onions, carrots. Poor predecessors for tomato are all plants of the Solanaceae family (potatoes, peppers, eggplant, physalis). Return to the previous place - no earlier than 3-4 years. The tomato area must be protected from cold winds.

The soil is prepared immediately after harvesting the previous crop. To destroy weeds, the field is treated with a LDG-5A disc cultivator to a depth of 6-8 cm. 15-20 days after peeling, autumn plowing is carried out to a depth of 27-30 cm with a general-purpose plow PLN-5-35.

In spring, the field is harrowed in two tracks with BZSS-1.0 toothed harrows. As the weeds grow and before planting the seedlings, cultivation is carried out to a depth of 10-12 cm with a KPS-4 cultivator.

The main application of mineral fertilizers is carried out with a ZAM Max 1500 mineral fertilizer spreader [26-31].

To obtain a high yield of tomatoes, it is necessary to grow healthy, seasoned seedlings. In the Samara region conditions the length of the growing season does not allow growing tomato by sowing seeds in open ground, so the seedling method has to be used. Seedlings are grown in heated film (spring) greenhouses.

Sowing seeds in a greenhouse is carried out 60 days before planting seedlings in open ground (usually, in the Samara region conditions seeds are sown at several times from 1 to 25 March). Seeding rate of tomato seeds is 8-10 g/m\(^2\). The feeding area of seedlings during sowing is from 3 x 3 to 4 x 4 cm [32-36].

The tomato root system is pivotal, but when grown by seedlings, a pick is carried out. After picking a tomato the root system is formed from lateral horizontal roots located in the arable layer (15-25 cm). The pick is carried out at the first real leaf (before the appearance of 3 real leaf). An hour before the pick, the seedlings are watered abundantly. Then a seedling with an earth clod is selected and the root is shortened by a third. Seedlings are buried in the soil by cotyledon leaves. When picking, the seedlings are seated on a large feeding area: 8 x 8 cm. The relative humidity should be 60-65%, strong ventilation is required.

For planting, the finished seedling should have: 7-9 leaves, single flowers on the first inflorescence, a height of 25-30 cm. The seedling yield is 100-125 pcs/m\(^2\). For 1 hectare of open ground, 330-360 m\(^2\) of protected soil is required; for sowing seedlings per 1 hectare of open ground, 300-400 g of seeds are needed [37].

Before sowing, the seeds are treated with Fitosporin-M. The drug consumption is 1.5 g/l of water. The consumption of the working fluid is 0.5 liters per 300 g of tomato seeds.

Seedlings are planted after the last spring frosts (usually the beginning of summer). Seedlings are planted by hand according to a 60 x 60 cm pattern (30 thousand plants/ha). After planting, irrigation must be carried out for the complete survival of the seedlings.
To maintain the soil in a loose state and to combat weeds, loosening is carried out: the first time soon after planting the seedlings, the second - after 2-3 weeks, then - with an interval of 10 days [38].

10-15 days after planting the seedlings, the Targa Super herbicide is used against annual cereal weeds. The drug application rate is 1-2 l/ha. The working solution consumption is 300 l/ha. Planting processing - sprayer OPM-2000.

To combat aphids, ticks, thrips, before the tomato bloom, spraying with insectoacaricide Aktellik is carried out (the drug consumption rate is 1 l/ha; the working fluid consumption is 500 l/ha).

During the growing season, to combat brown spot, late blight and alternaria, the fungicide Abiga-Peak is used in tomato plantings (the drug consumption rate is 3.75 l/ha; the flow rate of the working fluid is 500 l/ha).

To combat gnawing scoops, the Colorado potato beetle, tomato planting is treated with insecticide Decis Profi (the drug consumption rate is 0.03 kg/ha; the flow rate of the working fluid is 300 l/ha).

One of the methods for obtaining an earlier and higher tomatoes yield is irrigation during the entire growing season. It is recommended to maintain 65-85% soil moisture in the initial period of plant growth and development, 70-90% in the fruiting phase from the full field moisture capacity. Frequent watering contributes to the increased growth of tops and delays the fruits ripening. During the growing season, it is necessary to carry out 4-5 irrigations of 400-500 m$^3$/ha. During ripening, the need for water in tomatoes drops sharply. Moderate soil moisture during this period contributes to the amicable fruits ripening [39].

Pinching is equally important for obtaining early and high yields of tomatoes. Removing the lateral axillary shoots accelerates the fruits growth and ripening. When pinching, the lowest shoots are removed, and the upper ones (1-2 or more) are left. Side shoots should be removed in a timely manner, when they do not exceed 5 cm. The first pinching is carried out 10-12 days after planting the seedlings in the ground, the second - 10-15 days after the first.

The fruits are harvested in ripeness varying degrees, depending on the nature of their use. Harvesting is carried out 2-3 times a week. Fruits in full ripeness are harvested for processing or local sale. Harvesting green-ripe fruits is carried out in autumn during the frost period. These fruits are used for technical processing or ripening. The tomato fruits are harvested by hand and placed in a solid container (buckets, baskets) [40].

Attitude towards soil fertility. The tomato root system is powerful, highly branched, very demanding on the structure of the soil [41].

Nitrogen is necessary for the plants vegetative mass formation. With a nitrogen lack vegetative growth and fruiting weakens, the fruits become smaller. With an excess the vegetative mass grows, fruiting is delayed, plants lodging is observed, and their resistance to diseases decreases.

Phosphorus enhances the development of the tomato plants reproductive organs. The soil provision with these elements contributes to the root system development, fruits earlier flowering and ripening, an increase in yield, an increase in sugar content and dry matter in fruits, almost all of the absorbed phosphorus is spent on the fruits development.

Potassium is necessary in the phase of the first fruit inception beginning and until the ripening end. It affects the photosynthesis process, promotes the formation and movement of carbohydrates, the sugars accumulation in fruits, and increases the plants resistance to unfavorable environmental factors. The trace elements use in tomato cultivation provides an increase in yield, increased resistance to various environmental factors. The nutrient requirements of open ground tomatoes are shown in table 1.

| Table 1. Mineral fertilizers approximate doses for vegetable crops in the forest-steppe of the Volga region, kg ai per 1 hectare. |
|---------------------------------|-----------------|-----------------|-----------------|
| Crop                           | N               | P$_2$O$_5$      | K$_2$O          |
| Tomato                         | 70-90           | 90-120          | 75-100          |
The fertilization system for tomatoes in the open field during irrigation consists of fertilizing two methods: main and top-dressing. The main fertilizer is applied in the spring for deep cultivation. N\textsubscript{30}P\textsubscript{65}K\textsubscript{60} is used for cultivation. Diammofoska was used as a fertilizer in an amount of 3.0 cwt/ha. The first top-dressing at the flowering beginning is N\textsubscript{15}P\textsubscript{25}K\textsubscript{25}, the second top-dressing (during the fruiting period) - N\textsubscript{20}P\textsubscript{25}K\textsubscript{25}. At the first top-dressing, 0.3 cwt/ha of grade B carbamide, 0.5 cwt/ha of double superphosphate, 0.4 cwt/ha of potassium chloride are applied. At the second top-dressing, 0.4 cwt/ha of carbamide, 0.5 cwt/ha of double superphosphate, 0.4 cwt/ha of potassium chloride are applied. The highest increase in dry weight of tomato plants occurs from July to early August, when the mass of leaves and stems grows strongly and fruits are intensively set. The combination of these methods ensures the tomatoes highest yield. The main fertilizer fully meets the need for nutrients in tomato plants during the period of nutrients maximum consumption by tomato plants. Top-dressing allows you to meet the needs of plants during the growing season in nutrients [42-55].

4. Discussion

Based on the data in table 2 the open ground tomatoes yield in the Volzhsky district of the Samara region varied in a wide range. The average yield for five years was 234.34 cwt/ha. Information on the open ground tomatoes yield in 2014-2018 are given taking into account the All-Russian Agricultural Census of 2016 final results (table 2).

| Open ground tomatoes | 2014 | 2015 | 2016 | 2017 | 2018 | Average for 5 years |
|----------------------|------|------|------|------|------|---------------------|
|                      |      |      |      |      |      |                     |

In the agricultural products price monitoring in the Samara region, posted on the website of the magazine "Agro-inform", there is no data on prices for open ground tomatoes. The same situation is on the site of special accounting in the AIC RF.

In calculating the profitability, we use information on the purchase of open ground tomatoes from the owners of peasant farms and private plots in the Kinel-Cherkassky district and the sale of products on the Otradnensky market. In accordance with the information received, the purchase prices were 45 rubles/kg in July 2020, 45 rubles/kg in August 2020, and 65 rubles/kg in September 2020. The average purchase price is 51.67 rubles/kg.

\[
\text{In} = 234.34 \text{ cwt/ha} \cdot 1 \text{ ha} \cdot 51.67 \text{ rubles/kg} \cdot 100 \text{ kg/cwt} = 753019.57 \text{ rubles} \tag{2}
\]

Where 234.34 cwt/ha is the average yield of open ground tomatoes in the Volzhsky district of the Samara region; 1 ha - land area; 51.67 rubles/kg - the average selling price of tomatoes in the summer of 2020; 100 kg/cwt - coefficient of conversion from kilograms to centners.

The income amount when growing open ground tomatoes in the Volzhsky district of the Samara region in 2020 amounted to 1210834.78 rubles.

In the Samara region, the greenhouse is heated within two months - March-April. When heating a greenhouse with natural gas, the costs will be:

\[
\text{In} = 234.34 \text{ cwt/ha} \cdot 1 \text{ ha} \cdot 51.67 \text{ rubles/kg} \cdot 100 \text{ kg/cwt} = 753019.57 \text{ rubles} \tag{3}
\]

\[
330 \text{ m}^2 \cdot 2 \text{ m} \cdot 196.116 \text{ rubles/m}^2 \cdot \text{2 month} = 258873.12 \text{ rubles} \tag{4}
\]

Where 330 m\textsuperscript{2} - the area of the heated greenhouse; 2 m - greenhouse height; 196.11 rubles/m\textsuperscript{2} - tariff for heating 1 m\textsuperscript{3} of heated greenhouse volume in the absence of a gasmeter; 2 months - the heating season duration.
By order of the Department of Price and Tariff Regulation of the Samara Region No. 235 dated 28 July 2020, from 1 August 2020 new retail prices for natural gas sold to the population were established and put into effect. Greenhouse heating for 1 m$^3$ of heated volume is 196.116 rubles/month in the absence of a gasmeter.

The annual costs of setting up a greenhouse mainly consist of purchasing plastic wrap, which is stretched over the greenhouse fixed frame. The frame serves for a long period (at least 8-10 years). It is made from sawn timber waste, so the cost of it can be ignored.

The greenhouse cover film area is about 500 m$^2$ (330 m$^2$ roof area and 170 m$^2$ wall area). The price of specialized film for greenhouses "Neva" is 157 rubles per 6 m$^2$. Based on this, the cost of the film will be 13083.33 rubles.

To calculate the costs of mechanized work (with the exception of irrigation), using the program for calculating technological maps in crop production, a technological map was drawn up for open ground tomatoes. The total costs amounted to 60269.59 rubles/ha. They include the cost of wages - 5347.02 rubles/ha; fuels and lubricants - 3565.89 rubles/ha; depreciation and maintenance - 1086.97 rubles/ha; seeds - 24000 rubles/ha; 3 cwt of diammonium phosphate - 7425 rubles/ha; 0.7 cwt of carbamide - 1316.0 rubles/ha; 1 cwt of double superphosphate - 2300 rubles/ha; 0.8 centners of potassium chloride - 1840 rubles/ha; plant protection products - 9725.84 rubles/ha; deductions to extra-budgetary funds - 1662.92 rubles/ha and general expenses - 1999.97 rubles/ha.

The best type of watering is sprinkling. Sprinkling is carried out by the sprinkler DD-70 VN-02 on the basis of the DT-75V or MTZ-80 tractor. The price of 1 m$^3$ of water for irrigation in 2019 amounted to 3.87 rubles (Spasskaya irrigation system). The consumption of diesel fuel according to the test data of the Povolzhsky machine test station is 28.9 kg/ha (at an irrigation rate of 600 m$^3$/ha). Irrigation costs will be:

\[
5 \text{ pcs} \cdot 400 \text{ m}^3 \cdot 3.87 \text{ rubles/m}^3 + 2000 \text{ m}^3 / 600 \text{ m}^3 \cdot 28.9 \text{ kg/ha} \cdot 48.5 \text{ rubles/kg} = 12412.17 \text{ rubles}
\]

Where 5 pcs is the number of waterings; 400 m$^3$ - irrigation rate per 1 ha; 3.87 rubles/m$^3$ - tariff for water for irrigation of agricultural crops; 2000 m$^3$ - irrigation rate for the entire growing season; 600 m$^3$ - irrigation rate during testing of the Povolzhsky machine test station; 28.9 kg/ha - consumption of diesel fuel per 1 ha during tests at the Povolzhsky machine test station; 48.5 rubles/kg - wholesale price for diesel fuel in 2020.

To carry out manual work during the growing season, a permanent staff is required. Work on arranging a greenhouse, sowing and growing seedlings, pinching, harvesting is practically not mechanized, but requires a significant amount of manual labor. The load of open ground tomato crops per one permanent worker is from 1.5 hectares, depending on the level of mechanization.

When employed from March to October, the wage fund will be:

\[
1 \text{ person} \cdot 29459 \text{ rubles/month} \cdot 8 \text{ months} \cdot (1 + 0.30) = 306373.6 \text{ rubles}
\]

Where 1 person - the number of permanent employees; 29459 rubles/month - average monthly wages of workers in the Samara region agriculture (table 3); 8 months - term of employment (March-October); 30% - deductions to extra-budgetary funds.

| Table 3. Average monthly accrued wages of organizations employees by type of economic activity, rubles. |
|-------------------------------------------------|----------------|----------------|
| Economic activity type                        | August 2020 | January-August 2020 |
| agriculture, forestry, hunting, fishing and fish farming | 29459 | 27140 |

The total costs of growing tomatoes in open ground in the Volzhsky district of the Samara region will be:

\[
60269.59 + 306373.6 + 12412.17 + 258873.12 + 13083.33 = 651011.81 \text{ rubles/year}
\]
Where 60269.59 rubles - costs for the technological map; 306373.6 rubles - wages fund for permanent employees; 12412.17 rubles - costs of irrigation; 258873.12 rubles - costs of heating the greenhouse; 13083.33 rubles - the cost of greenhouse equipment.

The lost profits amount in the alternative use of land applied for growing open ground tomatoes is 559822.97 rubles/ha annually and accordingly the lessor claiming this land must compensate this amount along with the costs of land reclamation actually incurred by the current year.

5. Conclusion

When conducting this study it was revealed that the possible amount of revenue from growing open ground tomatoes in the Volzhsky district of the Samara region amounted to 1210834.78 rubles. The cost of growing open ground tomatoes according to 2020 amounted to 651011.81 rubles. The possible profit from the operation of the site (growing open ground tomatoes) of 1 hectare in the Samara region conditions in 2020 amounted to 559822.97 rubles.

Thus, the cultivation of vegetables in open ground (including tomatoes) is currently the agricultural activity with the highest specific profitability per hectare. As a result, the lost profit from the inappropriate occupation of land plots under such activities will be maximum in comparison with field crops (15-40 thousand rubles / ha), with perennial grasses for seeds (up to 200 thousand rubles).

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