Material and technical support of the enterprises of the agro-industrial complex of the Omsk region management and certification of the technical component of the production processes in crop production

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Abstract. The management of a modern enterprise of the agro-industrial complex should cover all aspects of the production of the main types of products produced. In this concept in modern economic conditions it is necessary to include not only economic indicators and ways of selling finished products, but also the use of modern technologies, production safety for the environment and people. Improvement of technologies for obtaining crop production is impossible without updating the equipment used for the mechanization and automation of production processes. For that reason, such a concept appeared in the legislation as certification of production technological processes, which pumps in the assessment of all technological process components, including the production means used, the quality of their technical condition and service. The article analyzes the current situation of the maintenance system, the structure and condition of the machine and tractor fleet of enterprises of the agro-industrial complex of the Omsk region. A method has been developed for processing information in terms of the agricultural enterprises revenue, and the share of work that the farm can transfer to a specialized technical service enterprise, taking into account its own profit, has been determined.

1. Introduction

Certification of technological processes and production is a documentary confirmation of the compliance of each component of the full functioning of the enterprise with the current standards. The procedure involves the finished products verification and technologies for its production, maintenance and rehabilitation work, test systems and technical control of the final result [1]. Since the beginning of 2017, many entrepreneurs and enterprises have heard of new certification - certification of technological processes. It is carried out in accordance with Article 215 of the Labor Code of the Russian Federation. As a rule, the state labor inspectorate comes to an unsuspecting enterprise, carries out an inspection, at the end of which a remark is issued stating that the technological processes in the organization do not comply with article 215 of the Labor Code of the Russian Federation, since they do not have a certificate. This note also indicates the date of the re-check. During this period it is necessary to eliminate all comments and pass the technological processes certification. If at the time of the re-verification the certification has not been passed, then a fine in the amount of 50,000 to 80,000 rubles will be issued for the legal entity.

In technological processes of agricultural production, the main means of performing technological operations are combines, tractors and agricultural machinery aggregated with them [2]. According to the Ministry of Agriculture and Food of the Omsk Region, the structure of the agricultural machinery park for 2018 is shown in Figure 1.
This technique is the main production means for the entire agro-industrial region complex and must meet the increasing requirements for production, as well as undergo appropriate certification of production processes, which implies not only a working condition, but also a corresponding maintenance level [3].

When considering the dynamics of the fleet structure over the past three years (2016 - 2018), it can be noted that the number of vehicles has changed slightly over the past year, mainly towards the reduction of existing machines (Fig. 2).

![Figure 1. The park structure of agricultural machinery in the enterprises of the agro-industrial complex of the Omsk region in 2018](image)

![Figure 2. Structure dynamics of the machine-tractor park of the Omsk region for 2016 – 2018](image)

![Figure 3. Renewal percentage of the main types of machinery in the Omsk region for 2016-2018,%](image)
Fig. 3 shows the renewal percentage of the main types of machinery in the Omsk region, which on average over three years amounted to 2.9%. Thus, there is an increase in the service machinery life before it is written off, and this trend is not supported by either an increase in the quality of the new machinery or an improvement in the technical service itself, while the deterioration of agricultural machinery at enterprises of the agro-industrial complex is growing every year (Fig. 4).

![Figure 4. Wear of agricultural machinery by enterprises of the Omsk region for 2018,%](image)

Based on the above data, it can be noted that the need for a radical vehicles fleet renewal for enterprises of the agro-industrial complex, which in modern economic conditions is practically impossible [4]. Taking into account the new requirements for certification of production processes, a number of agricultural enterprises will not actually be able to pass this test and receive certificates for compliance with the requirements of Article 215 of the Labor Code of the Russian Federation.

To maintain the equipment in working condition and meet new requirements, a new concept of technical service development is required, which is dictated not only by the change in the transport enterprises structure and the requirements of Article 215 of the Labor Code of the Russian Federation, but also by the crisis state of a significant part of the necessary material and technical base for machine-tractor park maintenance and repair. As a result, the enterprise of the agro-industrial complex is not able to carry out the whole range of operations of the planned maintenance and repair of equipment on its own [5].

2. Objects and methods

The methods of mathematical modeling and statistical processing of the results were used as the main research methods.

The profitability magnitude dependence of agricultural enterprises and the services needs formation in the field of technical service of agricultural equipment. Agricultural enterprises, having a certain amount of profitability in the form of revenue, can spend part of the technical service, including third-party organizations, which will affect the maintenance operations quality and volume, will directly affect the equipment reliability, and will allow to pass the legislation prescribed by the production processes at the enterprise [6, 7].

3. Research results

We have developed a method of processing information on the indicator of the agricultural enterprises revenue of the Omsk region. On the basis of the data obtained, a summary table was compiled of the farms revenue value in the Omsk Region per 100 hectares in ascending order, rub / 100 ha. In drawing up the methodology, the farms were impersonal, each farm was given a number, in order of increasing revenue rub / 100ga (Table 1).
Table 1. Agricultural enterprises revenue in rubles / 100 ha

| Farm number | Revenue, thousand rubles | Farm number | Revenue, thousand rubles | Farm number | Revenue, thousand rubles |
|-------------|--------------------------|-------------|--------------------------|-------------|--------------------------|
| 1           | 60.27                    | 17          | 759.77                   | 33          | 1079.62                  |
| 2           | 68.88                    | 18          | 782.56                   | 34          | 1109.88                  |
| 3           | 201.51                   | 19          | 789.21                   | 35          | 1124.56                  |
| 4           | 243.26                   | 20          | 792.24                   | 36          | 1145.49                  |
| 5           | 356.16                   | 21          | 812.57                   | 37          | 1146.19                  |
| 6           | 388.84                   | 22          | 814.01                   | 38          | 1169.03                  |
| 7           | 397.41                   | 23          | 846.42                   | 39          | 1171.82                  |
| 8           | 450.30                   | 24          | 857.39                   | 40          | 1304.71                  |
| 9           | 467.62                   | 25          | 875.42                   | 41          | 1356.63                  |
| 10          | 491.41                   | 26          | 893.07                   | 42          | 1462.83                  |
| 11          | 524.60                   | 27          | 898.88                   | 43          | 1586.02                  |
| 12          | 567.06                   | 28          | 975.89                   | 44          | 1656.96                  |
| 13          | 575.82                   | 29          | 1033.72                  | 45          | 1767.68                  |
| 14          | 647.17                   | 30          | 1044.00                  | 46          | 1780.84                  |
| 15          | 667.36                   | 31          | 1071.67                  | 47          | 1918.58                  |
| 16          | 722.07                   | 32          | 1077.87                  | 48          | 2071.18                  |

When processing the obtained data, a sample was taken from 49 farms, that is, the information is repeated \( n = 49 \), and the information is divided into \( N \) equal intervals, with an interval width \( n = 400 \). The number of intervals is determined from the expression:

\[
N = \sqrt{n} \pm 1
\]

Further we accept

\[
N = \sqrt{49} \pm 1 = 7
\]

When developing the methodology, the interval size was adopted equal to 400 rubles per 100 hectares. Upon further processing, the presented data compiled a statistical series of revenues of the farms under consideration (Table 2).

Table 2 Statistical revenue range of agricultural enterprises

| Revenue per 100 ha, rub / ha | The average value in the interval, \( ni \) | Test frequency, \( mi \) | Experienced probability, \( pi \) | Accumulated experimental probability, \( \Sigma i \) |
|------------------------------|------------------------------------------|-------------------------|-------------------------------|------------------------------------------|
| 0-400                        | 200                                      | 7                       | 0.143                         | 0.143                                    |
| 400-800                      | 600                                      | 13                      | 0.265                         | 0.408                                    |
| 800-1200                     | 1000                                     | 19                      | 0.388                         | 0.210                                    |
| 1200-1600                    | 1400                                     | 4                       | 0.082                         | 0.292                                    |
| 1600-2000                    | 1800                                     | 4                       | 0.082                         | 0.373                                    |
| 2000-2400                    | 2200                                     | 1                       | 0.020                         | 0.394                                    |
| 2400-2800                    | 2600                                     | 1                       | 0.020                         | 0.414                                    |

The experimental frequency shows how many agricultural enterprises in terms of revenue fall into one or another interval.

Experimental probability was defined as the experimental frequency ratio to the average value in the interval:

\[
p_i = \frac{m_i}{n_i},
\]

where \( m_i \) is the experimental frequency in the \( i \)th interval of the statistical series.
ni is the average value in the interval.

Next, determine the average value of the company's revenue per 100 hectares according to the formula:

\[
\bar{x} = \frac{\sum_{i=1}^{N} x_{ci} p_i}{N},
\]

where \(N\) is the number of intervals in the statistical series,
\(x_{ci}\) - the value of the middle of the \(i\)th interval,
\(p_i\) is the experimental probability of the \(i\)th interval.

Having carried out the necessary calculations for the considered farms, the following results were obtained:

\[
\begin{align*}
\bar{x} &= 200 \cdot 0.141 + 600 \cdot 0.265 + 1000 \cdot 0.388 + 1400 \cdot 0.082 + 1800 \cdot 0.082 + \\
&+ 2200 \cdot 0.02 + 2600 \cdot 0.02 = 934.694 \text{rub/100ha}
\end{align*}
\]

The dispersion characteristic of the revenue per 100 hectares was determined by the standard deviation:

\[
\sigma = \sqrt{\sum_{i=1}^{n} (x_{ci} - \bar{x})^2 p_i}
\]

After calculating the indicator obtained the following result:

\[
\sigma = \sqrt{(200 - 934.694)^2 \cdot 0.143 + (600 - 934.694)^2 \cdot 0.265 + (1000 - 934.694)^2 \cdot 0.388 + \\
+ (144 - 934.694)^2 \cdot 0.082 + (1800 - 934.694)^2 \cdot 0.82 + (2200 - 934.694)^2 \cdot 0.02 + \\
+ (2600 - 934.694)^2 \cdot 0.02} = 525.88 \text{rub/100ha.}
\]

After carrying out the necessary calculations, the results were checked for outliers. Check for drop-down points carried out according to the rule \(\bar{x} \pm 3\sigma\). If the extreme points of the information do not exceed the limits \(\bar{x} \pm 3\sigma\), then all information points are considered valid [8].

In our methodology, the accuracy limits of the information were:
- lower bound: 934.694 - 3 \cdot 525.88 = -642.9
- upper bound: 934.694 + 3 \cdot 525.88 = 2512.33

The lowest enterprise profitability per 100 hectares is \(x_{min} = 60.27\) thousand rubles, and the highest revenue of the enterprise per 100 hectares is \(x_{max} = 2608.12\) thousand rubles, therefore both information points are valid and should be taken into account in further calculations.

The coefficient of variation (relative dimensionless quantity characterizing the dispersion of indicators) was determined by the formula:

\[
v = \frac{\sigma}{\bar{x}}
\]

Since the variation coefficient in the calculations was in the range of 0.3 ... 0.5, the distribution law was chosen, which better coincides with the distribution of experimental information. In our case, this is the normal distribution law.

A distinctive feature of the differential function is the symmetric dispersion of the partial values of the indicators relative to the average value [9]. To determine the differential function in terms of the centered normalized function, the equation was used:
where \( A \) is the length of the \( i \)th interval, 
\( x_{ci} \) is the midpoint of the \( i \)th interval.

In addition, used the equation:

\[
f_a(-x) = f_a(+x)
\]

(7)

To determine the integral function \( F(x) \) through \( F_0(x) \) the equation used:

\[
F(x) = F_0\left(\frac{x-x_i}{\sigma}\right)
\]

(8)

where \( x_i \) is the value of the end of the \( i \)th interval.

The equation was also used:

\[
F(-x) = 1 - F_0(+x)
\]

(9)

The value of the differential and integral functions calculated according to the normal distribution law are given in Table 3.

Based on the obtained values \( f(x) \) and \( F(x) \) the graphs of the differential and integral distribution functions of the analyzed farms proceeds were constructed (Fig. 5).

Table 3. The value of the differential and integral functions calculated by the normal law

| Revenue per 100 ha., rub / ha | The average value in the interval, \( n_i \) | \( f(x) \)          |
|-----------------------------|------------------------|------------------|
| 0-400                       | 200                    | 0.1141           |
| 400-800                     | 600                    | 0.251            |
| 800-1200                    | 1000                   | 0.304            |
| 1200-1600                   | 1400                   | 0.205            |
| 1600-2000                   | 1800                   | 0.007            |
| 2000-2400                   | 2200                   | 0.002            |
| 2400-2800                   | 2600                   | 0                |

![Graph of the enterprises profitability distribution by revenue](image-url)
On the basis of the data obtained, it is possible to determine the maintenance work proportion that the farm can transfer to a specialized enterprise using the formula:

$$\varphi = 1 - \frac{z}{B}$$

(10)

where $\varphi$ - the proportion of maintenance work;
$z$ - is the cost of TO-2 and TO-3, when performing maintenance at specialized technical service enterprises;
$B$ - revenue of the agricultural enterprise.

If the value, then the company can afford to use the services of specialized enterprises for carrying out complex maintenance of the second maintenance and the third maintenance for the entire fleet of vehicles, which will not only significantly improve the reliability of equipment and machine performance, but also to certify production processes in the enterprise in accordance with federal law. The corresponding system of technical service, using the services of specialized enterprises of technical service, can be formed only in the conditions of production of sufficiently large farms.

Taking into account the fact that at present the equipment of the material and technical base (MTB) of farms is low, mainly MTB is represented by equipment and equipment of the Soviet period, which is not suitable for maintenance and repair of modern equipment [10]. This regulation becomes another obstacle to updating an outdated fleet of machine-tractor units, apart from their high cost and the production processes of such enterprises of the agro-industrial complex cannot be certified according to article 215 of the Labor Code of the Russian Federation. The development strategy of the technical service of the machine-tractor park should be aimed at the development of the dealer system, which will assume not only warranty, but also post-warranty service of the machines.

4. Conclusion

Based on the research, we can draw the following conclusions:

1. At present, according to the requirements of Article 215 of the Labor Code of the Russian Federation, all farms of the agro-industrial complex must undergo certification of production processes, which implies that each component of the enterprise’s full operation complies with the applicable standards, including the operability and reliability of the equipment used, and its quality service;

2. The machine and tractor fleet of the Omsk region is mainly represented by outdated equipment operating beyond the standard period of use, the average percentage of equipment renewal is 2.9%, therefore the wear of the fleet of machine and tractor units is increasing and the number of efficient machines decreases every year;

3. In the current conditions of the formation of technical service at the enterprises of the agro-industrial complex, the dealer system of technical maintenance can be formed only with a certain amount of profitability of the economy in the conditions of fairly large enterprises;

4. A method was developed for processing information on the indicator of the revenue of agricultural enterprises in the Omsk Region;

5. Using equation (10), it is possible to determine the proportion of maintenance and repair work that a farm can transfer to a specialized enterprise, taking into account its own profit.

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