INTERVAL ESTIMATION OF AGRICULTURAL CROP PRODUCTIVITY FOR UNKNOWN PARAMETERS OF THE NORMAL DISTRIBUTION

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Abstract: *The article has a methodical character, and if the size of the sample in which the yield of agricultural crops is measured is small, the accuracy of the point statistical estimation decreases. After a maximum of 3-5 years of experience, the newly created variety is grown mainly with small-sized selections. In such cases, the importance of interval statistical evaluation is demonstrated.*

Keywords: *unknown parameter estimates, point estimates, statistical hypotheses, Pearson's distribution, Student's distribution, confidence interval and confidence probability.*

Introduction Section: In the field of agriculture, crops are planted in sufficiently large areas, and tillage and other operations are carried out for all the fields at the same time under the same conditions. As a result, the thickness, length, and number of open furrows of crops in the field are almost the same. Based on the central limit theorem of the theory of probability, when solving practical problems, we can consider the studied number as a normally distributed random variable when the sample size of arithmetic values of the sign is greater than 30. This confirmation is the conclusion of the central limit theorem of probability theory, which is used in the analysis of the results of scientific experiments on agricultural issues [2].

Theoretical part: Let the numerical symbol X of the main set under study have a normal distribution $(N(a, б))$ with mathematical deviation $M(X) = a$, mean square deviation $б = \sqrt{D(X)}$. Since the normal distribution is defined as a single value by two parameters, the first main task is to estimate the mathematical deviation and mean square deviation of the unknown parameters using a sample set. In this, known and unknown cases are studied separately.

б is known: The numerical symbol X of the studied population has a normal distribution with parameters $N(a, б)$, and let б be the mean squared deviation. Using the sample set $x_{1,} x_{2,} \ldots, x_n$, it is required to construct an interval statistical estimate of its unknown mathematical increase a with guarantee " γ ". In this case, the sample is the mean value $\bar{x}_T = \frac{1}{n}\sum x_i = \frac{1}{n}(x_1 + x_2 + \cdots + x_k)$, the random variable $\bar{x}_T$ is distributed with parameter $N(a, \frac{б}{\sqrt{n}})$ based on the central limit theorem of probability theory will have $\gamma = P\left\{\left|\overline{X} - a\right| \frac{\sigma}{\sqrt{n}} < Z\right\} = 2\Phi\left(Z_\gamma\right)$, where the value of the Laplace function $\Phi\left(Z_\gamma\right)$ is found from the table of the normal distribution law. As a result, an unknown mathematical expectation with a guarantee γ is constructed as an interval statistical estimate for a:

$$\gamma = (\overline{x_t} - \frac{\sigma Z_\gamma}{\sqrt{x}};\ \overline{x_t} + \frac{\sigma Z_\gamma}{\sqrt{x}}) \quad (1)$$

б is unknown: Let the number sign X of the main set be normally distributed and its mathematical expectation a and mean squared deviation б – be unknown. Let a certain mathematical expectation of a normal distribution be required to add a confidence interval with γ guarantee. For this, based on sample data, calculating its sample characteristics,

$$\bar{x}_T = \frac{1}{n}\sum_{j=1}^{k} x_j n_j, \quad S^2 = \frac{1}{(n-1)}\sum_{i=1}^{k}(x_i - \bar{x}_T)^2 n_i,$$

using these, we create a random number [4],[5],

$$T_n = \frac{\sqrt{n}}{S}(\bar{x}_T - a),$$

this quantity has a Styudent distribution with $k = n - 1$ degrees of freedom. Here $\bar{x}_T -$ is the sample mean, S- is the corrected sample mean square deviation, n- is the sample size,

$$P\left(\frac{\sqrt{n}}{S}|\bar{x}_T - a| < t_\gamma\right) = \gamma\ , \quad (2)$$

relation must be fulfilled, γ- probability given confidence. From this,

$$P\left(\bar{x}_T - t_\gamma \frac{S}{\sqrt{n}} \le a \le \bar{x}_T + t_\gamma \frac{S}{\sqrt{n}}\right) = \gamma, \quad (3)$$

As a result, when σ is unknown, a γ- guaranteed confidence interval for the unknown mathematical expectation a can be constructed by the following relation:

$$\bar{x}_T - t_\gamma \frac{S}{\sqrt{n}} \le a \le \bar{x}_T + t_\gamma \frac{S}{\sqrt{n}}; \quad (4)$$

where the value of $t_\gamma = t(n;\gamma)$ is obtained from the Styudent distribution table for the given n and γ.

Practical part: The average amount of cotton picked in the first harvest from each 50 bushels of cotton (in bolls)

2,4,5,3,2,4,5,3,1,6,4,5,4,0,4,5,2,4,5,3,4,0,1,8,2,4,7,5,1,3,6,4,3,4,6,4,3,6,5,3 ,4,7,4,5,2,6,4,5,3,4. Assuming that the random variable X is a normally distributed random variable with the following sample characteristics,

$$б_T = \sqrt{D_T} = \sqrt{3{,}27} \approx S_T = 1{,}81; \quad n = 50$$

let's make an interval statistical estimate with the unknown true yield a- and б-mean square deviation $\gamma = 0{,}95$ (with 95% confidence).

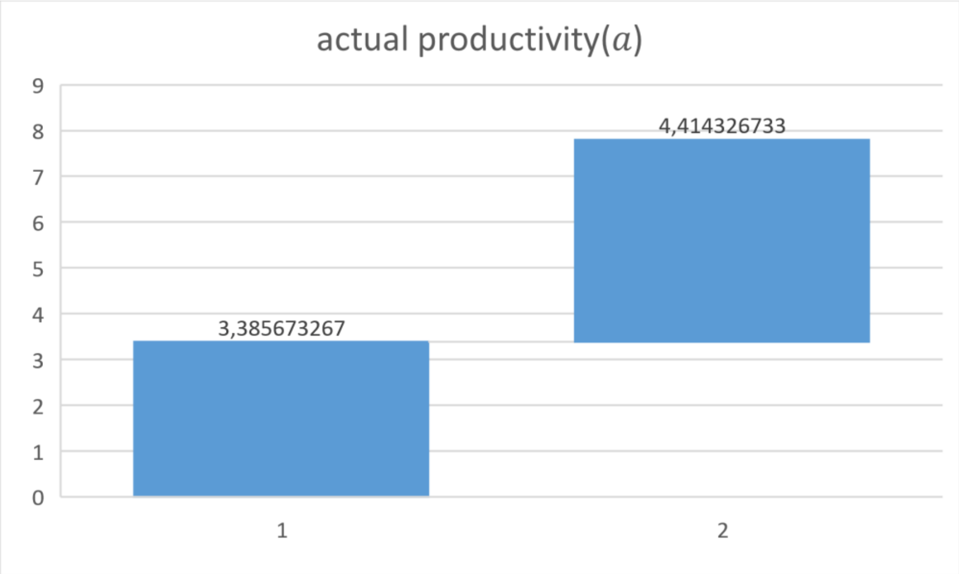
A random variable has a normal distribution when the arithmetic mean of a random variable that does not differ significantly from each other exceeds the observed values. We construct an interval statistical estimate with γ-guarantee for the unknown mathematical expectation of a normally distributed random variable based on the formula (4) above,

$$\bar{x}_T - t_\gamma \frac{S}{\sqrt{n}} \le a \le \bar{x}_T + t_\gamma \frac{S}{\sqrt{n}};$$

From the Styudent's distribution table $t_\gamma = t(n;\gamma) = t(50;\ 0{,}95)$=2,009 and from the above calculations $\bar{x}_T \approx 3{,}9gr,\ \ \sigma_T \approx 1{,}81,$ the unknown mathematical expectation of cotton picked on average from one grain of the observed cotton variety A confidence interval constructed with 95% confidence for

$$3{,}9 - 2{,}009\frac{1{,}81}{\sqrt{50}} \le a \le 3{,}9 + 2{,}009\frac{1{,}81}{\sqrt{50}};$$

$$3{,}386 \le a \le 4{,}414.$$



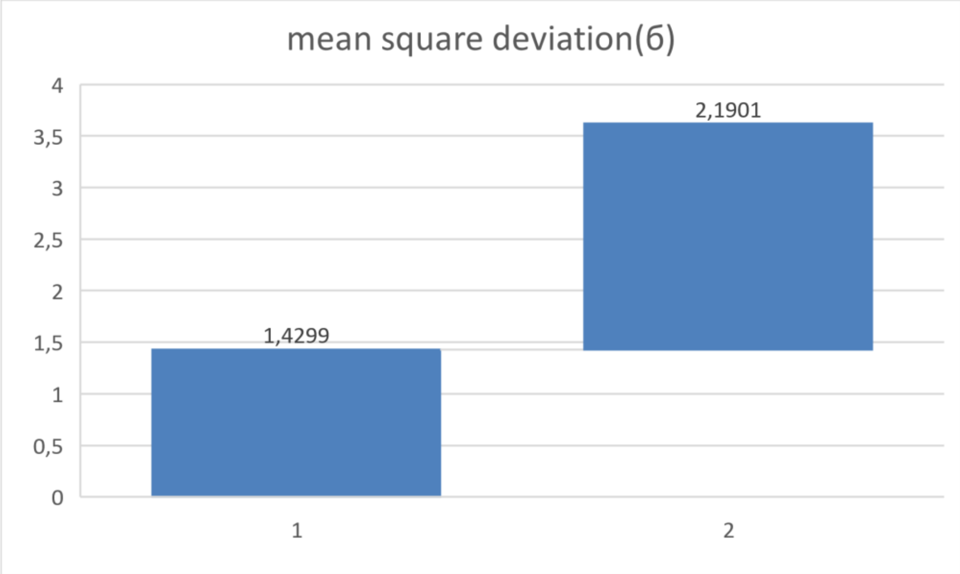
We construct an interval statistical estimate of the unknown mean square deviation σ– of a normally distributed random variable using the following relation,

$$S_T(1-q) \le \sigma \le S_T(1+q),$$

A confidence interval constructed with a 95% guarantee for σ- by finding the value of $q(n;\gamma) = q(50;\ 0{,}95)$=0,21 from the Pearson distribution table is as follows,

$$1{,}81(1-0{,}21) \le \sigma \le 1{,}81(1+0{,}21),$$

$$1{,}43 \le \sigma \le 2{,}19,$$



Conclusion: In order for the sample to be representative, the selection must be random and all elements of the population must have the same probability of falling into the sample. Otherwise, statistical studies may lead to incorrect conclusions. Using the above relationship (4), based on the results of the experiment, it is possible to construct an interval statistical estimate of the yield of agricultural crops with γ-guarantee.

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