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THE ANALYSIS OF DYNAMICS OF FRUIT AND BERRY PRODUCTIVITY GROWN IN UZBEKISTAN

Achilov Mashrab Ulugbekovich
Independent Researcher, Tashkent State Agrarian University, Tashkent, Uzbekistan

Fayziev Atkham Asraevich
Candidate of Physico-Mathematical Sciences, Docent, Tashkent state agrarian university, Tashkent, Uzbekistan

ABSTRACT
In this article the productivity of the fruit and berry that grown in the republic during the 2003-2018s was analyzed mathematically, statistically as discreet \( \{ Y_t, t \in T \} \) dynamic range and its real productivity overviewed by statistical, with a 95% guarantee interval evaluations. Due to trend and the frequent part around the trend, seasonal effect and random part are the main constituents of dynamic line evaluated on statistical data for dynamic productivity of fruit and berry quantities. Statistical hypothesis were checked on studying dynamic ranges related with the parametric criterion by Pearson, Jack-Berra, Shapiro-Vilkakson. Conclusion has been come on the base of dynamic range of statistical analysis.

KEYWORDS: dynamic, trend, random, linear, parameter, the least quadratic, autocorrelation, coefficient, criterion, hypothesis, normal, dispersion, asymmetry, kurtosis, interval.

INTRODUCTION
President of Uzbekistan in his instructions and orders on rationalized reforms of fruit grown in the republic, in terms of quality, to be rich in health-related vitamins, and mentions its difference by its unique gusto in the world, to produce competitive fruit in the world market as well as to export the yield.

In the performance of these tasks a great deal of work is being done.

In the article average yield of fruit and berry that grown in the republic in the past 16 years (based on the data of the statistical government) have been studied as dynamic range and statistically analyzed its medium developing rate, random, seasonal and periodical peculiarities. Frictive average value, limited distinctions and other methods were used to identify the tendency of dynamic range.

The unknown parameters of the trends characterizing the main direction of the dynamic ranges are evaluated by statistical data using the least quadratic method and this model was adequate and checked by the help of statistical criterion.

MATERIALS AND METHODS
The average fruit and berry productivity in our republic which produced during 2003-2018s was analyzed (on the republican statistical government data) statistically as dynamic range.

The average annual productivity of fruit and berries is based on datum interval statistical estimates and the average productivity has been prognosticated for the coming year. Generally, the creation of an unstable dynamic with a fertility autocorrelation link was determined by a 95% guarantee with Darbin Watson criterion.

The difference of dynamic range from other statistical observations is to conduct check-outs at certain arranged (month, quarter, year) intervals. For instance, it is supposed to be the same discreet of dynamic range of annually produced wheat productivity length. The result of each observation of dynamic range is random quantity and they are trend, frequent part around the trend, seasonal effect and random parts and that is complex accidental process, and there have been a lot of scientific and text books which are devoted to study its genuine statistical principles: Anderson T. [1].
Kendal M., A. Stuart [2], Krendjer K., M. Khatanaka [3], Lux K.D. [4], Vaynu Y.Y [6].

It is known, that seasonal circulation of fruit cultivation in certain periods can be the basis for analyzing the discreet \( \{ Y_t, t \in T \} \) as a random dynamic series.

**RESULTS AND DISCUSSION**

In the article the fruit yield that grown during 2005-2018 \( \{ Y_t, t \in T \} \) (table 1, column 2,3) was statistically analyzed as dynamic series and the point of its actual productivity, statistical estimating of guaranteed interval and different process-related statistical hypotheses were verified.

It is known [1]-[3] that time series can be comprised by the followings:1) trend showing the main direction 2) frequent part around the trend 3) seasonal effect 4) random part.

In the republic the fruit-berry yield \( \{ Y_n, n \in T \}, \) that produced in 2003-2018, based on geometrically in coordinate system, can be supposed to have linear combination \( y = a_0 + a_1 t \)
We make up this table on statistic data:

### Table 1

<table>
<thead>
<tr>
<th>№</th>
<th>Periods</th>
<th>$Y_\text{(t)}$ (centner/ha)</th>
<th>t</th>
<th>$t^2$</th>
<th>$yt$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2003</td>
<td>52,5</td>
<td>-7</td>
<td>49</td>
<td>-367,5</td>
</tr>
<tr>
<td>2</td>
<td>2004</td>
<td>58,2</td>
<td>-6</td>
<td>36</td>
<td>-349,2</td>
</tr>
<tr>
<td>3</td>
<td>2005</td>
<td>62,3</td>
<td>-5</td>
<td>25</td>
<td>-311,5</td>
</tr>
<tr>
<td>4</td>
<td>2006</td>
<td>73,8</td>
<td>-4</td>
<td>16</td>
<td>-295,2</td>
</tr>
<tr>
<td>5</td>
<td>2007</td>
<td>76,6</td>
<td>-3</td>
<td>9</td>
<td>-229,8</td>
</tr>
<tr>
<td>6</td>
<td>2008</td>
<td>82,5</td>
<td>-2</td>
<td>4</td>
<td>-165,0</td>
</tr>
<tr>
<td>7</td>
<td>2009</td>
<td>87,2</td>
<td>-1</td>
<td>1</td>
<td>-87,2</td>
</tr>
<tr>
<td>8</td>
<td>2010</td>
<td>92,6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>2011</td>
<td>97,3</td>
<td>1</td>
<td>1</td>
<td>97,3</td>
</tr>
<tr>
<td>10</td>
<td>2012</td>
<td>104,7</td>
<td>2</td>
<td>4</td>
<td>209,4</td>
</tr>
<tr>
<td>11</td>
<td>2013</td>
<td>112,3</td>
<td>3</td>
<td>9</td>
<td>336,9</td>
</tr>
<tr>
<td>12</td>
<td>2014</td>
<td>116,0</td>
<td>4</td>
<td>16</td>
<td>464,0</td>
</tr>
<tr>
<td>13</td>
<td>2015</td>
<td>128,1</td>
<td>5</td>
<td>25</td>
<td>640,5</td>
</tr>
<tr>
<td>14</td>
<td>2016</td>
<td>134,5</td>
<td>6</td>
<td>36</td>
<td>807,0</td>
</tr>
<tr>
<td>15</td>
<td>2017</td>
<td>118,3</td>
<td>7</td>
<td>49</td>
<td>828,1</td>
</tr>
<tr>
<td>16</td>
<td>2018</td>
<td>121,6</td>
<td>8</td>
<td>64</td>
<td>972,8</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1518,5</td>
<td>8</td>
<td>344</td>
<td>2550,6</td>
</tr>
</tbody>
</table>

In this linear model for the evaluation of unknown parameters by the least quadratic method, the following normal equations system is solved on experimental data

$$\begin{align*}
    b \sum_{i=1}^{n} x_i + a \sum_{i=1}^{n} x_i^2 &= \sum_{i=1}^{n} x_i y_i \\
    bn + a \sum_{i=1}^{n} x_i &= \sum_{i=1}^{n} y_i
\end{align*}$$

We will evaluate unknown parameters with calculations in tables in the linear combination

$$y = a_0 + a_1 t : 
\sum y_t = 1518,5, \sum yt = 2550,6, a_0 = \frac{1518,5}{16} = 94,91, a_1 = \frac{2550,6}{344} = 7,42$$

Consequently, the representational equation of the yield produced in 2003-2018s as the following $y(t) = 94,91 + 4,42 t$

With this model we can safely evaluate the productivity of the yield of the coming years.

Autocorrelation coefficient is important to study time series properties.

When we calculate RL autocorrelation coefficient with the given formula in [3], we see all $R_1, R_2, R_3, R_4, R_5$ value differentiated from zero.

(According to calculation of Table 2)

This statement is based on to suppose that dynamic series has autocorrelation link.

Although we check the yield equation of berry-fruit with Dubrin-Vatson criteria the following hypothesis $y(t) = 94,91 + 4,42 t$. is observed in linear association

$$d_{kuz} = \frac{\sum_{t=1}^{T-1} (y_{t+1} - y_t)^2}{\sum_{t=1}^{T} y_t^2}$$

We can see that all $d_{kuz}$ values, found out in [1]- [3] special table, it is seen that

$$d_{krit} = 1.08$$

critical value is small from $d_{kuz} < d_{krit}$

So, with a 95% guarantee, the hypotheses has been accepted as random autocorrelation of quantities has $y_t = \rho y_{t-1} + \varepsilon_t$, $\rho = \text{COV} (y_t, y_{t-1})$ combination.

The fruit yield that will be produced this economic year is connected with the previous year’s yield.
We have identified that the hypotheses about annual average fruit yield produced in the republic has normal distribution: \( H_0 : P(X < x) = \Phi_{a,\sigma}(x) \) has been checked by Jack-Berra, Shapiro-Vilkakson, Pirson parametric criterion that resulted in being presence of normal distribution with a 95% of guarantee.

Based on the fact that a statistical assessment of the annual yield of the fruit was made using the following formula

\[
\bar{Y}_{T+i} - t(T - 2; \alpha)\bar{\sigma}_y \leq a_0 + a_1(T + i) \leq \bar{Y}_{T+i} + t(T - 2; \alpha)\bar{\sigma}_y
\]

Based on the statistical analysis of the dynamics of annual fruit yields produced in our country we have the following information:

<table>
<thead>
<tr>
<th>№</th>
<th>Periods</th>
<th>( Y_{(t)} ) c/ha</th>
<th>( Y_t^2 )</th>
<th>( \Delta Y_t )</th>
<th>( \Delta Y_t^2 )</th>
<th>( \Delta^2 Y_t )</th>
<th>( \Delta^2 Y_t^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2003</td>
<td>52.5</td>
<td>2756.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2004</td>
<td>58.2</td>
<td>3387.24</td>
<td>5.7</td>
<td>32.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2005</td>
<td>62.3</td>
<td>3881.29</td>
<td>4.1</td>
<td>16.81</td>
<td>-1.6</td>
<td>2.56</td>
</tr>
<tr>
<td>4</td>
<td>2006</td>
<td>73.8</td>
<td>5446.44</td>
<td>11.5</td>
<td>132.25</td>
<td>7.4</td>
<td>54.76</td>
</tr>
<tr>
<td>5</td>
<td>2007</td>
<td>76.6</td>
<td>5867.56</td>
<td>2.8</td>
<td>7.84</td>
<td>-8.7</td>
<td>75.69</td>
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<tr>
<td>6</td>
<td>2008</td>
<td>82.5</td>
<td>6806.25</td>
<td>5.9</td>
<td>34.81</td>
<td>3.1</td>
<td>9.61</td>
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<tr>
<td>7</td>
<td>2009</td>
<td>87.2</td>
<td>7603.84</td>
<td>4.7</td>
<td>22.09</td>
<td>-1.2</td>
<td>1.44</td>
</tr>
<tr>
<td>8</td>
<td>2010</td>
<td>92.6</td>
<td>8574.76</td>
<td>5.4</td>
<td>29.16</td>
<td>0.7</td>
<td>0.49</td>
</tr>
<tr>
<td>9</td>
<td>2011</td>
<td>97.3</td>
<td>9467.29</td>
<td>4.7</td>
<td>22.09</td>
<td>-0.7</td>
<td>0.49</td>
</tr>
<tr>
<td>10</td>
<td>2012</td>
<td>104.7</td>
<td>10962.09</td>
<td>7.4</td>
<td>54.76</td>
<td>2.7</td>
<td>7.29</td>
</tr>
<tr>
<td>11</td>
<td>2013</td>
<td>112.3</td>
<td>12611.29</td>
<td>7.6</td>
<td>57.76</td>
<td>0.2</td>
<td>0.04</td>
</tr>
<tr>
<td>12</td>
<td>2014</td>
<td>116.0</td>
<td>13456.00</td>
<td>3.7</td>
<td>13.69</td>
<td>-3.9</td>
<td>15.21</td>
</tr>
<tr>
<td>13</td>
<td>2015</td>
<td>121.5</td>
<td>16409.61</td>
<td>12.1</td>
<td>146.41</td>
<td>8.4</td>
<td>70.56</td>
</tr>
<tr>
<td>14</td>
<td>2016</td>
<td>134.5</td>
<td>18090.25</td>
<td>6.4</td>
<td>40.96</td>
<td>-5.7</td>
<td>32.49</td>
</tr>
<tr>
<td>15</td>
<td>2017</td>
<td>118.3</td>
<td>13994.89</td>
<td>-16.2</td>
<td>262.44</td>
<td>-22.6</td>
<td>510.76</td>
</tr>
<tr>
<td>16</td>
<td>2018</td>
<td>121.6</td>
<td>14786.56</td>
<td>3.3</td>
<td>10.89</td>
<td>19.5</td>
<td>380.5</td>
</tr>
<tr>
<td>Total</td>
<td>1518.5</td>
<td>154102.1</td>
<td>69.1</td>
<td>884.45</td>
<td>-2.4</td>
<td>1161.9</td>
<td>21.1</td>
</tr>
</tbody>
</table>

| | | | | | | | |
| Important characteristics of the selected sample | Statistical evaluation of selected characteristics of fruit and berry |
| Average yield \( \bar{y}_T \) c/ha | 94.91 |
| Dispersion | 665.765 |
| Square siding of the selected \( \sigma_x \) | 25.802 |
| Variation coefficient \( v \) (%) | 25.96% |
| Asymmetric \( A \) | -0.143 |
| Excess \( E \) | -1.1698 |
| Mistake of average value \( \bar{x}_T \) of the selected \( m_x \) | \( m_x = \frac{\bar{x}}{\sqrt{n}} = 6.451 \) |
| Limit mistake \( m'_x \) | \( m'_x = t_m = 2.15 \times 6.451 = 13.87 \) |
| Mistake of average square siding \( m_\sigma \) | \( m_\sigma = \frac{\sigma}{\sqrt{2n}} \times 2.5802 = 4.56 \) |
| Statistical evaluation with intervals (95%) \( \bar{x}_T \pm t_m \) | \( \bar{y}_T \pm t_m = 94.91 \pm 13.87 \) (81.04; 108.78) u/ra |
| Statistical hypothesis \( H_0 : P(X < x) = \Phi_{a,\sigma}(x) \) | With a 95% guarantee \( H_0 \) hypothesis was accepted |
CONCLUSION
Statistical analyzing based on the time series of the fruit yield produced in 2004-2018s can be concluded as the followings:
The fruit yield that produced in 2003-2018s in the republic is a connected process with a number of random factors;
The part of trend that characterizes the main direction of fruit producing process has linear connection of \( y(t) = 94.91 + 4.42 t \), so, the fruit yield grown in the republic, in 2019, will be around \( 99.33 \pm 100 \) c/ha with 95% guaranteed.
In general, the average fruit yield based on the applied statistic criterion that above mentioned has \( y(t) \sim N(94.91; 25.802) \) parametric normal distribution, the yield will be about \( (81.04; 108.78) \) c/ha with a 95% guarantee in 2019;
The fruit yield has autocorrelation combination that means presently yield will be linked
\[
y_t = \rho y_{t-1} + \epsilon_t; \text{ in previously received yield;}
\]
In common, annual fruit yield produced in the republic makes up unstable dynamic series.
REFERENCES