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Analysis of the time-series yields of the winter wheat in the Ukraine

Nowadays special attention is paid to the estimation of the impact of agrometeorological conditions on the winter wheat yields formation, as it's one of the main grain in the Ukraine. This paper sums up the results of the investigation into the climatic changeability of the winter wheat yields and its yield dynamics according to the main soil-climatic zones. The time-series yields of 24 regions and at the Crimea from 1958 till 1998 were studied.

The time-series yield capacity was evaluated according to the following scheme:

- -yield trend determination, the evaluation of the correct trend choice, the checking of the following hypothesis that a random component is a stationary process;
- yield trend analysis, determination of the trend types ;
- a random component investigation.

In general crop capacity increment it's time fluctuation occurs, i.e. equally with average yield years there are high-yield and low-yield years. The change of grain yield in time due to nonmeteorological factors in the first approximation can be written in the form of straight line or a trend parabola .The law of the change in the yield meteorological component in time is closely connected with the changes in weather conditions of vegetation season during successive years and , as a rule, unknown the first approximation. Thus we have to consider the yield deviation from the trend as a random component . Trend fluctuation near the trend line determine the level of weather farourability conditions for some years.

For the estimation of the changes in the levels of winter wheat time-series yield capacity two characteristics were used: absolute Yt-increment and the growth rate of the trend yield capacity T.

Numerical values of the found average data over five-years period are shown in Table 1

Table 1. The dynamics of the main characteristics of the trend yield capacity of winter wheat (Yt/T)

Natural climatic zones	1956-1960	1961-1965	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995
Polesye	0,6/106	1,4/109	1,4/109	2,1/115	2,0/114	1,2/108	0,8/101	1,1/106
Wooded steppe	0,7/106	1,3/110	1,4/110	2,2/115	2,1/115	1,3/107	0,9/103	1,0/104
North and central steppe	0,8/109	1,3/111	1,5/112	2,2/112	2,1/112	1,3/105	0,8/103	0,9/103
South steppe	0,7/104	1,3/110	1,3/112	1,8/110	1,7/105	1,0/105	0,6/103	0,8/103
Average over the Ukraine	0,7/107	1,3/109	1,4/110	2,1/114	2,0/111	1,2/106	0,75/102	0,9/104

The table includes absolute increment of trend yield capacity (g/ha) determining the index and the value of trend increment in 5 years for each natural-climatic zones and relative characteristics of yield weight increment. A table 1 shows an increase in trend increment appears in all zones beginning of the period in question from 0.10 till 0.35 at Polesye and east regions of the wooded steppe zones and from 0.21 till 0.59 in all other zones till 1976-1980 approximately. Then the increment in all zones decreases by 0.08-0.15 q/ha , and in the south steppe especially at Lugansk by negative values. The weight increment decreased by 97-98 % at Polesye , the Stepp zone and in the north and central steppe zone of the Ukraine , in the south steppe zone by 101-102 %.Then an increase in trend increment appears in all zones by 0.28 – 0.42 q/ha from 1985 till1990.The lowest increment occurred in the Crimea –0.01-015 q/ha.

According to the classification of the yield trend in the Ukraine by A.N.Polevoy [2], the second type is typical of yield trend dynamics, i.e. the increase along with the rate decrease, the yield increase along with successive decrease in the rate increment is typical of a curve.

Peculiarities in the dynamic of winter wheat yield trend from 1960 till 1965 and from 1980 till 1985 are attributed to the influence of large-scale unfavorable weather conditions, on the production formation typical of these periods

Analysis of winter wheat yield trend over the Ukraine didn't result in more detailed trend characteristic. Thus the yield level is of primary importance. In some regions (at Zakarpatye, Kiev, Cherkassy, Kirovograd , Vinnitsa) the yield level is higher (average is 28-33 q/ha) than in the Crimea, at Zaporozhye, Lugansk, where the winter wheat mean yield is 20-24 q/ha. The increment trend is of the same character –it increases along with the rate decrease but the level is lower (0.8-0.22) q/ha . It's rather difficult to determine the reasons for winter wheat yield changeability as not only spring-summer conditions but autumn –winter weather as well have great impact on crop production.

At Polesye winter precipitation is very important as it creates a snow cover preserving winter crops from killing frosts. They play a decisive role in the wooded steppe and steppe zone in autumn-winter period and spring- summer growing period as well, as the thermal regime at the Ukraine is favorable for winter wheat growing period.

As the index of the sequence of random deviations of winter wheat yield capacity from trend we considered the following statistic parameters: expected value, root-mean square deviation alternative, mediana, mode, asymmetry exponent, excess, total coefficient and climatic component coefficient. Table 2 shows obtained values of statistic characteristics of a random component of the time-series yields.

As apparent from Table2 expected value amounts to 93,3-98,4% from the trend all over the Ukraine. Mediana's estimation shows that yield decrease caused by the unfavorable weather conditions occurs over the Ukraine less frequently that increase resulting in the favorable combination of environmental factors , with the exception of the Crimea and Lugansk where yield decrease due to unfavorable conditions occurs more often than increase. The value of the mediana random component for all regions amounts to 99,8-103,4 and for the Crimea and Lugansk –94,7-97,8 respectively.

We estimated the changeability of winter wheat yield by the method of V. M. Pasov [1].As apparent from table 2 its maximum occurs in the north of the Ukraine and it decreases to the south-east, varies between 30-35% in the north and west and between 23-26% in the central, south and south-east regions.

Thus, we can consider west regions of the Ukraine as the regions with unstained yields (according to the classification by V.M. Pasov) and other regions as the zones of temperately-sustained yields.

REFERENS

1. Pasov V.M. Yield changeability and estimation of expected grain crop production .-L.: Gidrometeoizdat , 1986-152 p.
2. Polevoy A.N. Applied modelling and forecasting of grain crop production.-L.Gidrometeoizdat , 1988 –318 p.

Table 2. Main statistic characteristics of a random component of winter wheat time-series yields. (% from the trend)

Region	Criterion X^2	Expected value V	Mediana Me	Mode Mo	coefficient of alternative Cv	Asymmetry exponent Cs	Excess component Cc	Root-mean square
Chernigov	2,23	99,9	104,1	111,4	31,3	-0,25	2,86	7,2
Ljvov	2,7	98,1	104,1	111,4	29,9	0,40	2,40	6,9
Rovno	7,41	98,3	104,0	111,4	29,3	-0,13	2,38	7,7
Zhitomir	2,70	96,3	104,9	111,4	28,3	0,47	3,30	5,8
Volyn	1,29	98,4	104,8	111,4	28,9	0,11	2,32	7,4
Ternopol	4,10	99,1	103,8	111,0	33,2	-0,10	2,50	9,1
Khmelnitsk	12,1	98,4	103,4	111,3	26,2	-2,80	2,50	7,4
Iv.-Phrankovsk	7,4	99,1	104,0	111,2	31,2	0,10	2,21	9,1
Chernovtsy	7,4	98,6	103,9	111,3	32,7	0,50	2,41	7,5
Zakarpatye	6,9	99,1	102,8	111,4	35,5	0,60	2,70	10,0
Kiev	7,3	98,4	102,6	110,5	27,2	0,00	2,71	8,0
Kharkov	4,6	98,3	102,0	110,3	29,5	0,30	2,70	8,0
Poltava	1,8	98,2	103,1	109,6	29,6	0,10	2,62	9,8
Vinnitsa	6,0	98,2	103,6	109,6	29,4	0,00	2,31	8,7
Cherkassk	5,5	98,2	103,6	109,5	28,2	-0,10	2,23	9,3
Summy	5,1	98,1	103,8	109,5	28,9	-0,10	2,60	7,5
Dnepropetpovsk	8,8	98,0	101,4	107,4	38,1	3,91	2,60	7,9
Lugansk	2,7	98,0	98,3	99,6	28,7	-1,20	2,60	6,6
Donetsk	6,5	97,4	100,1	100,0	26,7	0,5	2,70	7,2
Kirovograd	6,5	97,3	101,4	101,4	28,0	2,4	2,40	7,7
Zaporogie	3,6	96,8	99,9	100,3	26,2	0,36	2,34	7,1
Kherson	7,0	96,7	100,4	100,8	27,0	0,16	1,94	7,1
Nikolaev	6,0	96,4	101,3	104,2	27,5	0,24	2,62	3,2
Odessa	3,18	95,5	100,8	102,1	23,6	-2,01	2,23	6,9

The estimation of the character of a random component distribution by exponents of asymmetry and excess and by the criterion χ^2as well showed that there are no sufficient reasons for rejecting the hypothesis about normal distribution.

The analysis of the time-series yields and the estimation of the general rules of its changeability enables the search for possible ways of winter wheat yield increase and forecast.