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AGROMETEOROLOGICAL FORECASTING BY METEOROLOGICAL FACTORS

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Abstract

The influence of the climate conditions in the crop production is of a special importance. For this reason taking and the importance of the wheat in world level, undertaken this study for the product estimations two weeks before the reaping (harvest).

In this study are considerate the diverse contemporary models. After certain analyses are choosing the model the result, more agree for the condition of our country. This model is base in the linear equation of regression, where include all the climate elements like average temperature, the effective and active temperature for the threshold 5ºC, 8ºC, 9ºC, 12ºC, Winter severe evaluated like sum of difference of diurnal minimum temperature with the minimum temperature <5ºC like the value of relative calnm of wheat, the rainfall, the amplitude and the evaporation.

After that, are chose the more signification periods for the wheat plant, which impute in this equation and is do the crop evaluation for some zones with the diverse climatic change of the Albanian region and with diverse productivity, according as crop. In this study, are evaluated the zones with diverse agro climate characteristics of Albania.

The highest value of forecasting error is 1.3 qu/ha (4.5%) to 2.2 qu/ha. These results show that this forecastimg model can be used for the condition of Albania.

Key words: *coefficient of correlation, multiplier regression, evaluation of productivity, equation, wheat.*

Introduction

Determination of the market price for agricultural production nowadays around the world is closely connected, with the expected quantity and quality of this production. With the new economical regulations in Albania, estimating the production have a special interest, not only for an economy or zone, but also for the entire country, since it is directly related with the foreign market. Thus a great attention must be dedicated to this problem because recently the market price of the wheat around the world is increasing.

Many sciences can be profitably applied to the agriculture; however, meteorology is most helpful of all, since the air and the water play the important role in every part of agricultural science. Of course, no single science can produce all the necessary practical knowledge and information required by agricultural management, therefore meteorology must be closely adjusted with agricultural science. .(Brochet PM et al, 1977).

Many factors affect the success and failure of the agricultural production, but among them the weather plays the most decisive role. The agricultural yield product depends directly and indirectly on the weather and climate. The knowledge on weather and climate conditions has considerably increased recently and is increasingly applied to help agricultural activities of all kind (Horie et al, 2003).

Considering that our country is mainly an agricultural one, we must intend to increase the plant areas in general and those planted with wheat in particular, and use the new accessible technology available as well as utilize our climate conditions to achieve a high production gain

Material and method

The statistical model is usually used to differentiate between empirical statistical models and physical-statistical models.(Luis S et al. 2010). In the empirical models, one or several variables are related to crop response, such as crop production (Horie et al, 2003). The independent variables are often the two agriculturally important meteorological elements like temperature and precipitation which are generally measured in every meteorological station, or derived agro meteorological indices (e.g. sum of temperature, photosintetically active radiation etc), and agro meteorological values determined by different equations (soil moisture calculated bay aid of water-balance equation etc.) The relationship is determined by means of regression techniques.(Varga-Hazsonits, 1983).

In our case we used the statistical method to estimate the wheat yield. The data used are: the bank of climate data obtained from Institute of Geosciences, Energy, Water and Environmental Institute for 1967-2005 period and the yield of wheat obtained from Statistical Office at Agricultural and Food Ministry.

In this study we considered some regions that are characterized by a diverse climate conditions. For the Western Lowland we selected the region of Lushnja and Shkodra, for the south east with a cold weather we selected the Korca region, Peshkopia and Gramsh regions in the North East, and Gjirokastra for the South of Albania.(Climate Atlas of Albania 1984).

The relationship between two factors, the yield product deviation and the deviation of climate elements, is carried out by the coefficient of correlation. This coefficient determines the amount, strength and direction of this relationship.

The correlative relationships can be of different kinds. Based on the form they fall in two groups, linear or curved. Also, based on the direction they can be positive or negative, while based on the number they can be simple or complex.(Zorba P 1998). In our case the relationship between the climate elements such as temperature with its threshold, the precipitation, the evaporation, and amplitude, is linear, while the relationship between the yield and the winter severity is curved.(AL.Merkoci et al. 2011).

Yield product has always fluctuated from year to year. The tendency include the impact of technology in wheat yields, introduction of new varieties, which best suit the environmental conditions and have a high productivity, the development of new cultural techniques, mechanization, phytosanitary, interventions more effective, etc. which is associated with a progressive and regular growth of production for a period of time(J. I. Chircov 1989).

Deviations from this trend represent the effect of climatic factors, which give to the production a multi-year variability.(James W et al. 2004). Their action is positive (increasing productivity) when there are favorable climate condition or negative. The application of the model to forecast crop production passes in three phases:

The definition of trend yield of wheat product in time, which is the definition as yield productivity "theory" to normal climatic conditions, is the first step. The tendency is evaluated by linear regression equation:

$$R_t\left(i\right) = a \cdot i + b \qquad (1)$$

Where: R_t *(i)* is the theoretical yield of-year, *(i)* is the range of the year (often expressed in the last two digits of the year (e.g. 67 for year 1967). The deviation between actual yield and theoretical yield $E_{(i)} = R_{(i)} - R_{t(i)}$ is the deviation which belongs to the influence of meteorological factors.

The chosen correlations (second step) are proven with the Student's Test with P=0.05 for the 1967 – 2005 period. Note here that, after the correlation analyses, when two factors had the same correlation coefficient during the same period of time, we selected that correlation coefficient with the highest physiological impact on wheat for the period of time under consideration. For this data series the coefficient of correlation is accepted 0.35.

The model of yield product forecast will be based on the analysis of multiple regression.

$$E_{(p)} = m + n \cdot x_{(p)} + q \cdot y_{(p)} + r \cdot z_{(p)} + \ldots \qquad (2)$$

Where ($x_{(p)}$, $y_{(p)}$, $z_{(p)}$, ...) are the climatic parameters selected above, $E_{(p)}$ is deviation of wheat yield of year *p* from line trend. (WMO 1982).

Where *m, n, q, r, ...* etc. are coefficients calculated for the period up to 1992. Relationship of winter severity with production is chosen of parabolic form. Forecasted product for the year p will be as the sum of "theoretical" yield for that year and $E_{(p)}$.

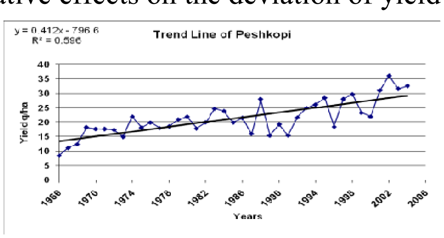
Results and discusions

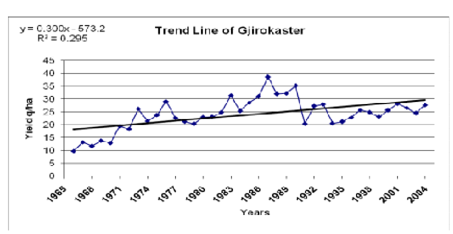
In building the statistical models of wheat forecasting, the first phase is to build the tendency line, which in other words is the theoretical efficiency for the normal climate conditions. For this reason there are data for the wheat crop for the periods 1967-2005. However, the equation of regression used the line of tendency from 1991 to the year that will calculate the forecast. There are a number of papers published that adjust this problem.

Figure 1 presents the tendency of wheat yield for the 1967-2005 time period. The x axis represents years (1967-2005).The y axis represents the efficiency of the plant of wheat.

To choose the agro climate indices and influence periods, are found the significant correlations between the values of agro meteorological elements for the vegetation period with the plant deviation. The forecasting month for wheat yield will be until May 30 in the cold regions, while for Lowland zone will be in May 15. Thus, the period of time under consideration will be from October 1st to May 30.

The factors considered in the correlation, are: the deviations of yield with the climate elements, the five day rainfall, the winter severity, as the difference of the diurnal minimal temperature with the minimal temperature <5°C, the value of transition from the condition of relative calmness of the wheat, the value of evaporation, the minimal temperature, the temperatures with diverse threshold according to the phenological phase, the amplitude, etc. Hereinafter in the tabl.1,2,3,4,5,6,7, we present the results of our calculations and comparisons considering the climate factors and the significant periods with positive or negative effects on the deviation of yield of wheat.





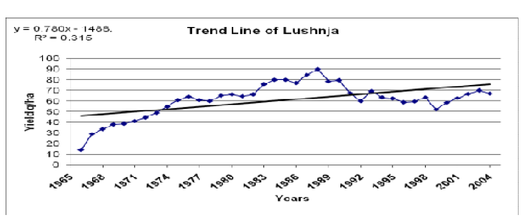


Figure 1. Trend Line of wheat production for periods 1967-2005

Table 1. Correlations between deviation of yield and rainfall

Regions	Periods	Coeff. R Number of days	Periods	Coeff. R Number of days	Periods	Coeff. R Number of days
Peshkopi	21.XII – 2.I	R=-0.33 30 days	21.I –15.II	R=-0.33 25 days	26.III –25.V	R=0.33 60 days
Shkodër	6.XI –31.XII	R=-0.64 55 days	1.II –15.III	R=-0.47 45 days		
Lushnje	5.XI –15.I	R=-0.67 70 days			21.III –15.IV	R=0.38 25 days
Gjirokastër	21.XI –10.II	R=-0.54 80 days				
Gramsh					6.III –25.IV	R=0.63 25 days
Korçë	10.II –20.III	R=-0.40 45 days	15.III		16.IV –15.V	R=0.37 30 days

Table. 2. Correlations between deviation of yield and effective and active temperature for diverse threshold (5°C)

Regions	Efektive Temperature R and period		Duration in day	Aktive Temperature R and period		Duration in day
Gjirokastër	r =-0.54 r =-0.46	20.XI—26.XII 26.II-25.III	35 30	r =-0.63 r =-0.48	26.XI-31.XII 21.II-25.III	35 35
Gramsh	r =0.49 r =-0.41	10.XII-30.I 20.III-25.IV	50 35	r =-0.36 r =-0.46	21.XI-15.XII 26.III-20.IV	25 25
Lushnje	r =-0.37	26.II-15.III	25	r =-0.4	26.II-20.III	25
Peshkopi	r =0.4 r =-0.38 r =-0.47	15.XII-10.I 25.II-20.IV 25.III-20.IV	25 55 25	r =0.45 r =0.43 r =-0.47	21.XII-10.II 21.I-20.II 21.II-15.III	50 30 25
Sarandë	r =-0.46 r =-0.49	6-31.XII 16.II-25.III	25 40	r =-0.52 r =-0.55	11.XII-5.I 11.II-25.III	25 45
Shkodër	r =-0.35 r =-0.41	26.XI-31.XII 21.I-20.III	35 60	r =-0.35 r =-0.41	26.XI-31.XII 21.I-20.III	35 60

Table 3. Correlations between deviation of yield and effective and active temperature for diverse threshold (8°C)

Regions	Efektive Temperature R and period		Duration in day	Aktive Temperature R and period		Duration in day
Gjirokastër	-		-	r =-0.38	6.III-30.III	25
Gramsh	r =-0.43 r =0.34	1.III-25.IV 1-25.VI	55 25	r =-0.43 r =0.35	6.IV-30.I 1.VI-25.VI	25 25
Korçë	-		-	-		-
Lushnjë	-		-	-		-
Peshkopi	r =-0.51	26.III-20.IV	25	r =-0.47	26.III-20.IV	25
Sarandë	r =-0.42	1.III-25.III	25	r =-0.6	1-25.III	25
Shkodër	r =-0.4	6.V-25.VI	35	r =-0.42 r =-0.4	1-25.III 6.V-25.VI	25 50
Vlorë	-		-	-		-

Table 4. Correlations between deviation of yield and effective and active temperature for diverse threshold (12°C)

Regions	Efektive Temperature R and period		Duration in day	Aktive Temperature R and period		Duration in day
Gramsh	r =0.35	1-25.VI	25	r =0.34	1-25.VI	25
Gjirokastër	-		-	-		-
Korçe	-		-	-		-
Lushnje	r =-0.34	25.V-25.VI	30	r =-0.47	6-30.VI	25
Peshkopi	-		-	-		-
Shkodër	r =-0.33	26.V-20.VI	25	r =-0.33	26.V-20.VI	25

Table 5. Correlations between deviations of yield and amplitude

Regions	r and period	Duration in day	Regions	r and period	Duration in day
Lushnje	r =0.49 5.II-5.III	30	Lushnje	r =-0.38 26.V.-25.VI	25
Gramsh	r =-0.39 26.III-20.IV r =0.34 16.V-10.VI	25 25	Peshkopi	- -	-
Korçë	r =-0.38 21.IV-15.V	25	Shkodër	-	-
Gjirokaster	-	-			

Table 6. Correlations between deviations of yield and evaporation

Regions	r and period		Duration in day	Region	r and period		Duration in day
Peshkopi	r = -0.46	26.III-20.IV	25	Lushnje	r = -0.34	26.V-25.VI	30
Gjirokastër	r = -0.5	20.II-20.III	30	Shkodër	r = -0.45	1-25.III	25
Gramsh	r = -0.5 r = 0.35	1- 25.IV 1-25..VI	25 25	Korçë	r =-0.34	6.IV-5.V	30

Table 7. Correlations between deviations of yield and winter severity

Regions	Equation and . Koefficient of determination R²	Correlation coefficient r and period	Duration in day
Gjirokastër	$y = -0.0001x^2 + 0.0896x - 12.262$ $R^2 = 0.2177$	r=0.47 15.XII-30.I	25
Gramsh	$y = -0.0004x^2 + 0.1177x - 7.2622$ $R^2 = 0.1952$	r = 0.44 10.I-25.II	45
Korçë	$y = -0.0001x^2 + 0.1092x - 2.1396$ $R^2 = 0.1729$	r = 0.42 15.I-28.II	45
Lushnje	$y = -0.0004x^2 + 0.0746x + 2.7648$ $R^2 = 0.0981$	r = 0.31 15.I-25.II	40
Peshkopi	$y = -9E - 0.5x^2 + 0.0409x - 1.9914$ $R^2 = 0.3735$	r = 0.61 15.XII-30.I	45
Sarandë	$y = -0.0028x^2 + 0.1633x - 1.2237$ $R^2 = 0.0799$	r = 0.29 1.I-15.II	45
Shkodër	$y = -0.0006x^2 + 0.1328x - 5.7798$ $R^2 = 0.1262$	r = 0.36 20.I-20.II	30

The results from these tables are used in the multiple equations of regression. The equation of forecasting of the wheat yield for the North, Center and South regions under study are as follows:

Peshkopi
$$\Delta Y = 44.72576 - 0.03297x_1 + 0.0055096x_2 - 0.00963x_3 + 0.258532x_4$$
$$+0.000841x_5 - 0.05468x_6 + 0.010283x_7 - 0.02246x_8 + 3.36E-06x_8^2$$

Tendency $\left(y = 0.9844x - 70.613\right)$

Lushnje
$$\Delta Y = -0.99386 - 0.01321x_1 + 0.006389x_2 - 0.00658x_3 + 0.715872x_4$$
$$-0.00875x_5 + 0.0000131x_5^2$$

Tendency $\left(y = 0.264x - 495.97\right)$

Gjirokaster
$$\Delta Y = 8.818169 - 0.00522x_1 - 0.06079x_2 - 0.01272x_3 - 1.19302x_4$$
$$+0.016742x_5 - 1.8E-05x_5^2$$

Tendency $\left(y = 0.9339x - 50.28\right)$

Where x_1, x_2, ... x_n are the indipendent variable (meteorological factors) and the tendency is the trend line for the period1992-2005. Considering $Y = \Delta Y + y$ for the years 2002, 2003, 2004 and substituting these values, we will get the expected forecast values of wheat crop.

Results for the years 2002, 2003, 2004 are shown that he error varies from 07 to 1.5 in the absolute value and 2.2 to 4.5%. Figure 2 denotes the actual difference between the forecasting yield for year 2004, for the Lushnja.

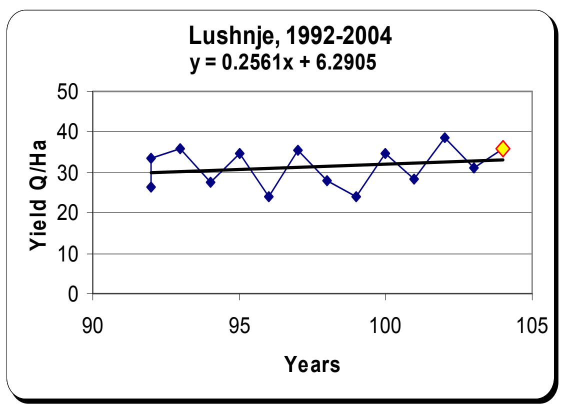


Fig.2. The graphic presentation between the forecast yields with the respective tactic for 2004 for Lushnja

Conclusions

From evaluation of yield of wheat, we conclude that from the agrometeorological viewpoint of production, responsible are: the rainfall for the periods December-April, Severerity of winter, and the air temperature in the more sensible phase of the wheat crop against this element. The rainfall between February 11 and March 25 has a negative effect. Any rainfall before this period and based on the soil humidity it is necessary to keep a working infiltration system. For the rainfall during 11 April-10 May period, time when the requirement for water is high, the above results indicate decrease of this element. So it is necessary for an artificial irrigation during this period.

The wheat plant has necessity for a sum of lower temperature for the periods December-April. This is valid in the cold regions, while in the West Lowland the sum of this temperature is smaller. For the cold regions this sum is about 360 to 400°C, when in other regions is about 190ºC.

According to analyses and the results obtained we conclude that the application of this model, of forecasting the wheat crop, for Albania is correct and can be applied if all the agrometeorological elements are used correctly.

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