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Analyzing crop yields of corn in Dedlow - Germany

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Abstract

In this study the researchers had been involved in a method of analyzing crop yields as a function of factors such as natural resources (rain and temperature) and also some specific inputs(organic material, chemical fertilizers, and some minerals) in Dedelow - Germany. The researcher used the method of ordinary least square regression and simultaneously analyzing systems of several equations which allows estimation procedures and thus to capture the often varying effects of certain factors on productivity in order achieve its main objectives to define the production function of producing corn in the study area

The results showed that the main agricultural applications (adding organic and chemical fertilizers) were the most significant, especially for the yield and number of ears dependent variables and less for the weight of one ear, while adding other micro minerals were less significant. Optimal values were calculated for some inputs.

الملخص

خلال هذا البحث تم تحليل إنتاجية محصول الذرة في ديدلو – ألمانيا باعتباره اقتران يعتمد على عدد من العوامل الطبيعية (مثل الأمطار والحرارة) وبعض المدخلات الأخرى (مثل السماد الطبيعي، السماد الكيماوي وبعض العناصر الصغيرة). استخدم الباحث اقتران الارتباط العادي الذي يسمح بحساب وتحليل العوامل المؤثرة على الإنتاجية من أجل تحقيق الهدف الرئيس للبحث لتعريف دالة إنتاج الذرة في منطقة الدراسة.

أظهرت النتائج أن المعاملات الزراعية الرئيسية (إضافة السماد الطبيعي والكيماوي) كانوا الأكثر معنوية لعاملي إنتاجية المحصول وعدد أكواز الذرة وأقل معنوية لوزن الكوز الواحد، بينما كانت إضافة المدخلات الأخرى والعناصر الصغيرة أقل معنوية. تم حساب بعض الكميات المثلى لبعض المدخلات في بيئة الدراسة.

Keywords: Production Function, Dependent Variable, Independent variable, Added inputs, Natural inputs.

1. Introduction

Increasing agricultural productivity has long been a part of national goals to combat hunger, meet subsistence needs, reduce dependence on imports for food and fiber, improve the balance of trade, increase national security and achieve sustainable growth. Griliches (1987) defined productivity as "...a ratio of some measure of output to some index of input use." Growth in agricultural output can be attained through expansion in farmed area, intensification of production and improvement in input use efficiency.

However, full consideration of the effect of agriculture on the local environment is important since short-run gains to agricultural productivity can have long-run implications on national output levels. In many countries, agricultural expansion has accelerated depletion of natural resource stocks, deteriorated environmental quality and encroached on sensitive ecosystem habitats. Examining the full effects of agricultural expansion policies on national welfare necessitates productivity analysis of broader scope.

Agronomic information on land quality, for example, is not routinely collected and reported with other information on land use. It is also interesting to note that natural habitats are often classified as "unimproved land" and assigned an economic value of zero (FAO, 1996). This is despite the fact that in their "unimproved" state, many lands provide a net positive flow of economic goods and services.

2. Objectives

The main objective of this research is to define the production function of producing corn in the study area and to analyze the relationships between the different outputs and inputs in the production process.

Other specific objectives are

- Analyzing the affect of adding the main agricultural applications (adding organic and chemical fertilizers)
- Analyzing the adding of other micro minerals.

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- Study the significance of natural climatic factors such as rainfalls and temperatures.
- Study the effects of rain and temperatures in the different months of the year in the study area.
- Calculate some optimal values for the quantity for some inputs such as organic fertilizers, chemical fertilizers, phosphorous, potassium, and magnesium.
- Examine if repeating some specific applications in the farming process may lead to igonrances of the climatic fators and leading to increase the importance of these applications.

3. Data and methodology

3.1. Data

The data for this study were available from a research project underwear at the Institute of Agriculture and Land use research Center (Zentrum fuer Agrarlandschafts und Landnutzungsforschung) in Dedlow in Germany and available by the Institute of Agricultural and Social Economics in Tropics and Subtropics in University of Hohenheim in Germany. The data was for the period 1983-2003 with no records for the year 1993, which means that the total was for 20 years.

The data coded and defined by researcher and presented in the Annex . Some variable have been squared to check their significance and effects on the models. The codes of the squared variable and their definitions are presented in the Annex.

3.2. Methodology

In this study the researcher had been involved in a method of analyzing crop yields as a function of factors such as natural resources (rain and temperature) and also some specific inputs(organic material, chemical fertilizers, and some minerals). The method of ordinary least square regression and simultaneously analyzing systems of several equations allows estimation procedures and thus to capture the often varying effects of certain factors on productivity.

The dependents variable were the YIELD, the EAR, and the GRAM.

Many trials were done to put these three dependent variables in three stages least square regression equations, but no significant results were obtained, which may need other different missed inputs or more investigation in the future.

After these trails the data had been checked in several models of ordinary least square (OLS) regression and different results have been achieved.

4. Results and Discussions

4.1. The YIELD regression analysis

Ordinary least square model used for the YIELD(dt/ha) of corn as depndent variable using the inputs data obtained from Dedlow station. All considered inputs were entered in the model as independent variables. These inputs were the different quantities of organic fertilizers in dt/ha, the quantities of chemical fertilizers in kg/ha, the quantities of phosphorus in soil in mg/100g soil, the quantities of potassium in soil in mg/100g soil, the quantities of magnesium in soil in mg/100g soil, the rainfall amounts in the different months, and average degree temperatures in the different months for the 20 years.

By running these data (the considered independent variables) in SPSS software for the YIELD as the dependent variable in an OLS, many inputs had been excluded by this regression.

About 42 considered independent variables had been excluded and 15 variables had been considered as independent variables for the YIELD dependent variable with different degree of significances.

The Model Summary and ANOVA results for this regression are presented in Table 1. The adjusted R square was 0.737 which is significant in this case. For the whole regression ANOVA is significant.

Table 1: The Model Summary and ANOVA results for the regression the YIELD as dependent variable

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.865	.747	.737	8.615

a Predictors: (Constant), SQMG, SRAIN7, SRAIN01, CHMESQ, FEBTEM, ORGSQ, SRAIN12, SQP, SQK, STEM4, ORGANIC, CHEMICAL, P, K, MG

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	80826.424	15	5388.428	72.606	.000
	Residual	27311.134	368	74.215		
	Total	108137.558	383			

a Predictors: (Constant), SQMG, SRAIN7, SRAIN01, CHMESQ, FEBTEM, ORGSQ, SRAIN12, SQP, SQK, STEM4, ORGANIC, CHEMICAL, P, K, MG
b Dependent Variable: YIELD

Source: Author

The results of ordinary least square for the YIELD as dependent variables are presented in Table 2. The constant coefficient was 27.739 and its significance was high. The independent variables were:

- **ORGANIC:** the quantity of organic fertilizers in dt/ha, it has positive coefficient value which means positive relationship, as more of quantity of organic fertilizers is added as more the yield will increase. The coefficient value of ORGANIC is 0.456 and this variable is highly significant.
- **ORGSQ:** the square of quantity of organic fertilizers; the coefficient value is -0.0026 and it is also highly significant.

Depending on the results of the previous two variables an optimal quantity can be calculated for the quantity of organic fertilizers which could be added for this kind of plantation.

By using the following equation

-b/2c = the optimal quantity of organic fertilizers

((Scharf et al., 2005) used this equation in the calculation of economic optimal N rate).

Where; b = coefficient value of ORGANIC, and c = coefficient value of ORGSQ

We got a value of 88 dt/ha as an optimal quantity of organic fertilizers.

Note: we will use the previous equation in determining the optimal quantity values for other independent variables in the rest of this research.

- **CHEMICAL:** the quantity of chemical fertilizers in kg/ha. Here also there is a positive relationship between the chemical quantities in kg/ha and the yield. The positive coefficient value was 0.149 and it is also highly significant.
- **CHMESQ:** the square of quantity of chemical fertilizers; the coefficient value is negative and it equals -0.0002. (P-value) of CHMESQ = .0128

The optimal calculated value for the quantity of chemical fertilizers is 372 kg/ha. for the YIELD which is the dependent variable.

- **P:** the phosphorous in soil in mg/100g soil. This variable increases the yield when farmers add additional quantities from it.

The coefficient value for P the independent variable to the YIELD the dependent variable is +1.463 and its (P-value) is 0.060.

- **SQP**: the square of phosphorous in soil, the coefficient value is -0.045 with low value of significance that reach about 0.10.

The optimal calculated value for the quantity of phosphorous in 100g soil is 16 mg as an input for the YIELD the output.

- **K:** the potassium in soil in mg/100g soil. The result of this factor was insignificant with (P-value) = 0.487. Its coefficient value equals – 0.371. This means that the relationship between the increasing of the quantity of potassium and the Yield is reversible with the consideration of the presence of the other studied variables.
- **SQK:** the square of potassium in soil. Also here the (P-value) for this factor was high = 0.594 and this mean it insignificant. The coefficient value was about + 0.007. This means that when this value increases the Yield will increase with the existence of other studied variables.

Even though the results of potassium in the soil and its square show insignificancy but they were factors that have considered by the model. Depending on this fact and also the fact that the agricultural production may depend on the nature and this could highly decreases the significance of some factors, we calculated an optimal value for the potassium in the soil. This was equal 27 mg/100g soil. It is also important to know that the average of the potassium in the soil for the studied period was 17.57 mg/100g soil with a standard deviation 6.09.

- **MG:** the magnesium in soil in mg/100g soil. Also the result here was insignificant, with negative sign for the coefficient value. The coefficient value = - 1.622 and the (P-value) = 0.479.
- **SQMG:** the square of Magnesium in soil. More significance factor even though it is insignificant, the (P-value) = 0.299 with coefficient factor value = + 0.182.

The optimal calculated value for the quantity of magnesium in 100g soil is 4.4 mg as an input for the YIELD the output. The average of the magnesium in the soil for the studied period was 5.45 mg/100g soil with a standard deviation 1.82.

The environmental factors that were significant in the model include:

- **SRAIN12:** the square of Rain in December. This factor was highly significant with a value of (P-value) = 0.002. The coefficient value for this factor = - 0.0012 which could mean as the rain in December increase there will an increase in the yield of this product in Dedlow.
- **SRAIN01:** the square of Rain in January. Also this factor was highly significant. The coefficient value of this factor = - 0.0094. Again the more rain in January could increase the yield Dedlow.
- **SRAIN7:** the square of Rain in July. This factor was highly significant. The coefficient value was positive for SRAIN7 and that could mean the Yield would decrease with more rain in July.
- **FEBTEM:** the temperatures in February c°. It is highly significant. The coefficient was minus with a value = 1.123. Low temperatures in February could increase the yield.
- **STEM4:** the square of temperatures in April. Its coefficient was positive with a value = 0.666. That means also low temperatures in April could increase the yield. Also this variable is highly significant.

Table 2: The independent variables, their averages, coefficients, (P-values), and optimal calculated quantities for the dependent variable YIELD (dt/ha).

The variable	Average	Un-standardized **Coefficient B**	Std. Error	Standardized Coefficients Beta	T	**(P-value)**	Optimal Calculated Quantity
(constant)		**23.739**	6.299		3.769	**.000**	
Quantity of organic fertilizers: dt/ha ORGANIC	30.00	**+ 0.456**	.069	.901	6.654	**.000**	**88**
The square of quantity of organic fertilizers ORGSQ	2000.00	**- 0.0026**	.001	-.399	-3.487	**.001**	
Quantity of chemical fertilizers: kg/ha CHEMICAL	71.88	**+ 0.149**	.030	.628	4.982	**.000**	**372**
The square of quantity of chemical fertilizers CHMESQ	10156.25	**+ 0.0002**	.000	-.160	-1.526	**.128**	
Phosphorous in soil: mg/100g soil P	10.80	**+ 1.463**	.775	.333	1.886	**.060**	**16**
Square of Phosphorous in soil SQP	131.27	**- 0.045**	.027	-.254	-1.660	**.098**	
Potassium in soil: mg/100g soil K	17.57	**- 0.371**	.534	-.135	-.696	**.487**	**27**
Square of Potassium in soil SQK	345.74	**+ 0.00685**	.013	.095	.534	**.594**	
Magnesium in soil: mg/100g soil MG	5.45	**- 1.622**	2.288	-.176	-.709	**.479**	**4.4**
Square of Magnesium m in soil SQMG	32.97	**+ 0.182**	.175	.236	1.040	**.299**	
Square of Rain in December SRAIN12	2660.33	**- 0.0012**	.000	-.166	-3.175	**.002**	
Square of Rain in January SRAIN01	1022.67	**- 0.0094**	.001	-.462	-10.711	**.000**	
Square of Rain in July SRAIN7	11544.00	**+ 0.0007**	.000	.567	9.520	**.000**	
Temperatures in February c° FEBTEM	-0.13	**- 1.123**	.249	-.300	-4.506	**.000**	
Square of Temperatures in April STEM4	51.20	**+ 0.666**	.127	.467	5.233	**.000**	

Source**:** Author.

4.2. The EAR regression analysis

Ordinary least square model was also used for the **EAR (number of ears/m²)** of corn as dependent variable using the same previous inputs data which were obtained from Dedlow station. All different considered inputs variables which were entered in the YIELD regression model as independent variables also entered here for the EAR regression analysis.

By running these data (the considered independent variables) in SPSS software for the EAR as the dependent variable in an ordinary least square regression, the same inputs (42 considered independent variables) that had been excluded in the previous model (for YIELD) had been excluded here for the EAR regression analysis by the software, and 15 variables had been considered as independent variables for the EAR dependent variable with different degree of significances.

The Model Summary and ANOVA results for this regression are presented in Table 3. The adjusted R square was 0.640 which is significant in this case. Also the ANOVA for the whole regression is significant.

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By running these data (the considered independent variables) in SPSS software for the YIELD as the dependent variable in an OLS, many inputs had been excluded by this regression.

About 42 considered independent variables had been excluded and 15 variables had been considered as independent variables for the YIELD dependent variable with different degree of significances.

The Model Summary and ANOVA results for this regression are presented in Table 1. The adjusted R square was 0.737 which is significant in this case. For the whole regression ANOVA is significant.

Table 3: The Model Summary and ANOVA results for the regression the EAR as dependent variable

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2	.809	.655	.640	57.6277

a Predictors: (Constant), SQMG, SRAIN7, SRAIN01, CHMESQ, FEBTEM, ORGSQ, SRAIN12, SQP, SQK, STEM4, ORGANIC, CHEMICAL, P, K, MG

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
2	Regression	2315513.656	15	154367.577	46.483	.000
	Residual	1222110.177	368	3320.952		
	Total	3537623.833	383			

a Predictors: (Constant), SQMG, SRAIN7, SRAIN01, CHMESQ, FEBTEM, ORGSQ, SRAIN12, SQP, SQK, STEM4, ORGANIC, CHEMICAL, P, K, MG
b Dependent Variable: EAR

Source**:** Author.

The results of ordinary least square for the EAR as dependent variables are presented in Table 4. The constant coefficient was 431.976 and it significant was high. The independent variables were:

- **ORGANIC:** for the EAR dependent variable it has also a positive coefficient value which means positive relationship, as more of quantity of organic fertilizers is added as more the number of ears will increase. The coefficient value of ORGANIC is 1.760 and it is highly significant.
- **ORGSQ:** the coefficient value for EAR was -0.011 and it is significant.

By using the results of the previous two variables the optimal quantity was 80 dt/ha of organic fertilizers for the EAR dependent variable.

- **CHEMICAL:** there is a positive relationship between the chemical quantities as independent variable and the number of ears. The coefficient value was 0.785 and it was highly significant.
- **CHMESQ:** the coefficient value is negative and it equals -.0016. The Sig. value of CHMESQ = .188, which means that this variable is not significant for the EAR dependent varaible.

The optimal calculated value for the quantity of chemical fertilizers is 339 kg/ha. for the EAR.

- **P:** this variable has less significance value for the number of ear compared to its significance for the yield. Actually the (P-value) was = 0.118.

The coefficient value for P the independent variable to the EAR dependent variable is +8.125.

- **SQP**: the coefficient value is = -0.188 and it is not significant (P-value) = 0.304.

The optimal calculated value for the quantity of phosphorous in 100g soil is 21 mg as an input for the EAR the output, this 5 mg of phosphorous more compared to the optimal quantity for the YIELD.

- **K:** The result of this factor for EAR showed the same concerning the insignificancy and reversibility that resulted for YIELD. The value of (P-value) = 0.850 and the coefficient value = -0.676.
- **SQK:** the (P-value) for this factor was = 0.546 and that means it insignificant, and the coefficient value was about + .052.

The calculated optimal value for the potassium in the soil for EAR dependent variable equal 6.5 mg/100g soil which is less than the calculated optimal value for the YIELD (it was equal 27 mg/100g soil).

- **MG:** for EAR as dependent variable also the result was insignificant, with negative sign for the coefficient value. The coefficient value = -19.491and the significance was more for EAR than the YIELD ((P-value) for EAR dependent variable **=** 0.204 and it was for the YIELD = 0.479).

- **SQMG:** also it is more significant factor for the EAR, the (P-value) = 0 .176 with coefficient factor value = + 1.591.

The optimal calculated value for the quantity of magnesium in 100g soil is 6.6 mg as an input for the EAR the output. This is more than the optimal value of magnesium for the YIELD.

The environmental factors that were significant in the EAR model include the same previous variables for the YIELD, they were:

- **SRAIN12:** this factor was also highly significant with a value of (P-value) = 0.000. The coefficient value for this factor = - 0.0098 which may mean as the rain in December increase there will an increase in the number of ears/ m² of corn in Dedlow.
- **SRAIN01:** it is also highly significant with coefficient value = -0.0613.
- **SRAIN7:** it is highly significant. The coefficient value =+ 0. 0015 which may mean the number of ears/ m² of corn would be decreased with more rain in July in Dedelow.
- **FEBTEM:** the temperatures in February c°. It is highly significant. The coefficient was different in sign compared to the YIELD. The sign for the EAR was positive while it was for the YIELD. The value = 10.356, which means the higher the temperatures in February the more the number of ears/ m².
- **STEM4:** this coefficient was negative with a value = 0.598. That means also more temperatures in April could increase the number of ears/ m² (the opposite to the result of YIELD). This variable is less significant.

Table4: The independent variables, their averages, coefficients, (P-value), and optimal calculated quantities for the dependent variable EAR (ears/m²).

The variable	Average	Un-standardized **Coefficient B**	Std. Error	Standardized Coefficients Beta	t	(P-value**)**	Optimal Calculated Quantity
(constant)		**431.976**	42.137		10.252	**.000**	
Quantity of organic fertilizers: dt/ha ORGANIC	30.00	**1.760**	.458	.608	3.841	**.000**	**80**
The square of quantity of organic fertilizers ORGSQ	2000.00	**-.011**	.005	-.300	-2.238	**.026**	
Quantity of chemical fertilizers: kg/ha CHEMICAL	71.88	**.785**	.200	.578	3.916	**.000**	**339**
The square of quantity of chemical fertilizers CHMESQ	10156.25	**-.0016**	.001	-.161	-1.319	**.188**	
Phosphorous in soil: mg/100g soil P	10.80	**8.125**	5.187	.323	1.567	**.118**	**21**
Square of Phosphorous in soil SQP	131.27	**-.188**	.183	-.184	-1.029	**.304**	
Potassium in soil: mg/100g soil K	17.57	**-.676**	3.570	-.043	-.189	**.850**	**6.5**
Square of Potassium in soil SQK	345.74	**.052**	.086	.126	.604	**.546**	
Magnesium in soil: mg/100g soil MG	5.45	**-19.491**	15.305	-.369	-1.273	**.204**	**6.1**
Square of Magnesium m in soil SQMG	32.97	**1.591**	1.173	.360	1.357	**.176**	
Square of Rain in December SRAIN12	2660.33	**-.0098**	.003	-.230	-3.763	**.000**	
Square of Rain in January SRAIN01	1022.67	**-.0613**	.006	-.524	-10.396	**.000**	
Square of Rain in July SRAIN7	11544.00	**. 0015**	.000	.234	3.362	**.001**	
Temperatures in February c° FEBTEM	-0.13	**10.356**	1.667	.483	6.213	**.000**	
Square of Temperatures in April STEM4	51.20	**-.598**	.851	-.073	-.703	**.483**	

Source**:** Author.

4.3. The GRAM regression analysis

Ordinary least square model was also used for the GRAM (gram/ear) or the average weight of every ear of corn as dependent variable using the same previous inputs data which were obtained from Dedlow station by dividing the productions of corn on the number their of ears for the 20 studied years. All different considered inputs variables which were entered in the previous regression models as independent variables also entered here for the GRAM regression analysis.

By running these data (the considered independent variables) in SPSS software for the GRAM as the dependent variable in an ordinary least square regression, the same inputs (42 considered independent variables) that had been excluded in the previous models had been excluded here for this regression analysis, and 15 variables had been considered as independent variables for the GRAM dependent variable with less degree of significances than the previous two models.

The Model Summary and ANOVA results for this regression are presented in Table 5. The adjusted R square was 0.534 which is significance in this case but as a low degree of significance compare to the YIELD and EAR. The ANOVA for the whole regression is highly significant.

Table 5: The Model Summary and ANOVA results for the regression the GRAM as dependent variable

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
3	.731	.534	.515	.2796

a Predictors: (Constant), SQMG, SRAIN7, SRAIN01, CHMESQ, FEBTEM, ORGSQ, SRAIN12, SQP, SQK, STEM4, ORGANIC, CHEMICAL, P, K, MG

ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
3	Regression	32.943	15	2.196	28.086	.000
	Residual	28.776	368	0.0782		
	Total	61.719	383			

a Predictors: (Constant), SQMG, SRAIN7, SRAIN01, CHMESQ, FEBTEM, ORGSQ, SRAIN12, SQP, SQK, STEM4, ORGANIC, CHEMICAL, P, K, MG
b Dependent Variable: GRAM

Source**:** Author.

The results of ordinary least square for the GRAM as dependent variables are presented in Table 6. The constant coefficient was 0.487 and it was significant.

Most of the included independent variables were low significant for GRAM model, the included variables by the model were:

- **ORGANIC:** the coefficient value of ORGANIC is + 0. 0037 and its (P-value) = 0.094. This variable is considering having more significance value compare to other variables of the GRAM model.
- **ORGSQ:** the coefficient value for GRAM was -.00002 and its (P-value) = 0**.**425.

The optimal quantity of organic fertilizers was = 98 dt/ha for the GRAM dependent variable.

- **CHEMICAL and CHMESQ:** both variables were insignificant. For CHEMICAL the coefficient value equals 0**.** 0004 and for CHMESQ it equals -0.0000005.

The optimal calculated value for the quantity of chemical fertilizers was 419 kg/ha. for the GRAM dependent variable.

- **P, SQP, K and SQK:** all of these variables were insignificant for the GRAM model. The coefficient values for all of them have negative signs.
- **MG and SQMG:** both variables were insignificant. For MG the coefficient value equals 0.0474 and for SQMG it equals -.0032.

The optimal calculated value for the quantity of magnesium in soil was 7.3 mg/100g soil for the GRAM dependent variable.

- **SRAIN12:** it is highly significant with a value of (P-value) = 0.004. The coefficient value for this factor = 0.00003. It is different compared to the signs of both models. In the GRAM regression the more rain in December the less the weight of an ear of corn in Dedlow.
- **SRAIN01:** it is insignificant with coefficient value = 0.00003.
- **SRAIN7:** it is significant. The coefficient value =+ .000006, the more rain in July the less the weight of an ear of corn in Dedlow.
- **FEBTEM:** It is highly significant. The coefficient sign was different in sign compared to the EAR regression and the same sign of the YIELD regression. The sign was negative, with a value = 0.0676, which means the lower the temperatures in February the more the weight of an ear of corn in Dedlow.

STEM4: this coefficient was positive with a value = 0.018. That means also higher the temperatures in April would decrease the weight of an ears of corn in Dedlow. The variable was highly significant.

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Table 6: The independent variables, their averages, coefficients, P-values, and optimal calculated quantities for the dependent variable GRAM (gram/ear).

The variable	Average	Un-standardized **Coefficient B**	Std. Error	Standardized Coefficients Beta	t	(P-value)	Optimal Calculated Quantity
(constant)		**.487**	.204		2.381	**.018**	
Quantity of organic fertilizers: dt/ha ORGANIC	30.00	**. 0037**	.002	.309	1.680	**.094**	**98**
The square of quantity of organic fertilizers ORGSQ	2000.00	**-.00002**	.000	-.124	-.798	**.425**	
Quantity of chemical fertilizers: kg/ha CHEMICAL	71.88	**. 0004**	.001	.071	.415	**.678**	**415**
The square of quantity of chemical fertilizers CHMESQ	10156.25	**-.0000005**	.000	-.016	-.114	**.909**	
Phosphorous in soil: mg/100g soil P	10.80	**-.00066**	.025	-.006	-.026	**.979**	**--**
Square of Phosphorous in soil SQP	131.27	**-.0002**	.001	-.040	-.192	**.848**	
Potassium in soil: mg/100g soil K	17.57	**-.0005**	.017	-.007	-.026	**.979**	**--**
Square of Potassium in soil SQK	345.74	**-.00015**	.000	-.086	-.355	**.723**	
Magnesium in soil: mg/100g soil MG	5.45	**. 0474**	.074	.215	.639	**.523**	**7.3**
Square of Magnesium m in soil SQMG	32.97	**-.0032**	.006	-.176	-.571	**.569**	
Square of Rain in December SRAIN12	2660.33	**. 00003**	.000	.207	2.907	**.004**	
Square of Rain in January SRAIN01	1022.67	**. 00003**	.000	.052	.883	**.378**	
Square of Rain in July SRAIN7	11544.00	**. 000006**	.000	.203	2.502	**.013**	
Temperatures in February c° FEBTEM	-0.13	**-.067**	.008	-.752	-8.325	**.000**	
Square of Temperatures in April STEM4	51.20	**. 018**	.004	.537	4.425	**.000**	

Source: Author

5. Conclusion

The three considered dependent variables the YIELD, the EAR, and the GRAM are parallel, the same studied independent variables are reliable for the three of them with differences in coefficient and significance values.

The results for the YIEILD were the most significance for the three variables, then the EAR, and the last was the GRAM.

The results showed that the main agricultural applications (adding organic and chemical fertilizers) were the most significance specially for the YIELD and EAR dependent variables, while adding other micro minerals were less significance.

Most of the studied natural climatic factors such as rainfall and temperatures were not significance. Only there were slight effects of rain in December, January, and of temperatures of February and April.

Some optimal value were calculated for some inputs. The optimal value for the quantity of organic fertilizers was ranging from 80 dt/ha for the EAR to 88 dt/ha for the YIELD, while the optimal quantity of chemical fertilizers was ranging from 339 kg/ha for the EAR to 372 kg/ha for the YIELD.

Optimal values for phosphorous, potassium, and magnesium in soil were also calculated even though the degree theire significances were not high enough.

Finally we may conclude that studying natural climatic resoucse for many years with some specific repeated applications in the farming process may lead to igonrances of such climatic fators and to increase the importance of the applications which could affect the productivity.

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Annex: The name of the variables, their definitions, their averages and their standard deviations

Name of the Variable	The variable	Average	Standard Deviation
Yield	Yield: dt/ha	72.67	16.80
Ear	Number of ears: ears/m²	419.85	96.11
EarSQ	Square of number of ears	185490.10	78173.92
Gram	Weight of one ear per gram	3.33	1.56
GramSQ	Square of Weight of one ear	726.68	168.03
Organic	Quantity of organic fertilizers: dt/ha	30.00	33.21
Orgsq	The square of quantity of organic fertilizers	2000.00	2626.40
Chemical	Quantity of chemical fertilizers: kg/ha	71.88	70.73
Chmesq	The square of quantity of chemical fertilizers	10156.25	13435.92
P	Phosphorous in soil: mg/100g soil	10.80	3.82
SQp	Square of Phosphorous in soil	131.27	94.15
K	Potassium in soil: mg/100g soil	17.57	6.09
Sqk	Square of Potassium in soil	345.74	234.07
Mg	Magnesium in soil: mg/100g soil	5.45	1.82
SQMg	Square of Magnesium m in soil	32.97	21.75
Rain9	Rain in September l/ m²	48.83	17.41
Srain9	Square of Rain in September	2687.17	1940.53
RAIN10	Rain in October l/ m²	23.00	9.90
Srain10	Square of Rain in October	626.67	507.69
RAIN11	Rain in November l/ m²	44.33	11.80
Srain11	Square of Rain in November	2104.33	1139.50
RAIN12	Rain in December l/ m²	46.33	22.69
Srain12	Square of Rain in December	2660.33	2251.58
RAIN01	Rain in January l/ m²	26.67	17.67
Srain01	Square of Rain in January	1022.67	821.32
RAIN2	Rain in February l/ m²	26.00	19.86
Srain2	Square of Rain in February	1069.33	1607.09
RAIN3	Rain in March l/ m²	31.83	13.56
Srain3	Square of Rain in March	1196.83	757.98
RAIN4	Rain in April l/ m²	35.67	23.19
Srain4	Square of Rain in April	1808.67	1800.59
RAIN5	Rain in May l/ m²	35.50	20.63
Srain5	Square of Rain in May	1684.83	1668.50
RAIN6	Rain in June l/ m²	53.00	24.62
Srain6	Square of Rain in June	3413.33	2686.95
RAIN7	Rain in July l/ m²	89.00	60.27
Srain7	Square of Rain in July	11544.00	14616.10
RAINT	Total Rain in Year without August l/ m²	460.17	101.26
SrainT	Square of Total Rain in Year without August l/ m²	221979.80	96203.60
Septem	Temperatures in September c°	13.07	1.21
Stem9	Square of Temperatures in September	172.19	31.20
Okttem	Temperatures in October c°	9.73	0.80
Stem10	Square of Temperatures n in October	95.37	16.00
Novtem	Temperatures in November c°	4.51	2.54
Stem11	Square of Temperatures in November	26.79	26.98

Name of the Variable	The variable	Average	Standard Deviation
Deztemp	Temperatures in December c°	1.10	2.55
Stem12	Square of Temperatures in December	7.67	6.05
Jantemp	Temperatures in January c°	-1.48	4.78
Stem01	Square of Temperatures of Rain in January	25.03	18.32
Febtem	Temperatures in February c°	-0.13	4.48
Stem2	Square of Temperatures in February	20.06	16.34
Martem	Temperatures in March c°	2.38	3.04
Stem3	Square of Temperatures in March	14.89	17.43
Aprtem	Temperatures in April c°	7.10	0.89
Stem4	Square of Temperatures in April	51.20	11.79
Maytem	Temperatures in May c°	12.28	1.53
Stem5	Square of Temperatures in May	153.21	35.70
Juntem	Temperatures in June c°	14.92	0.59
Stem6	Square of Temperatures in June	222.86	17.10
Jultem	Temperatures in July c°	16.72	0.80
Stem7	Square of Temperatures in July	280.09	26.52

Source : Zentrum fuer Agrarlandschafts und Landnutzungsforschung, Dedlow, Germany and Author

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