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Yellow Corn Production in Iraq: An Economic & Statistical Study, For the Period 2007-2023

Ali Shawket Ahmed Al-Obaidy*, Mahmood Ibraheem Waheed
National University for Science and Technology-Nasiriyah

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*Corresponding author:
Ali Shawket Ahmed Al-Obaidy
National University for Science and Technology-Nasiriyah

Abstract: Yellow corn is considered an important crop in the Iraqi agriculture, as it represents an industrial crop providing vegetable oil and fodder crop providing foodstuff for animals.

8 Iraqi governorates are commonly producing Yellow corn in Iraq. A relatively large number farmers were cropped Yellow corn for the season 2021/2022 and were examined by using specific questionnaire in order to estimate the factors affecting production in each governorate and on Iraq as a whole. However, a number of 596 forms were proved correct from a total number of 611 farmers, and the data were gathered and analyzed by using the statistical analysis; multiple linear regression, stepwise and the factor analyses which are provided by the SPSS package. The researcher used statistical methods: Multiple linear regression, Stepwise and Factor Analysis.

The results revealed that acquisition of arable land allocated for producing Yellow corn was the first factor influenced production decision, then the area cropped. The second factors were those concerning land preparation, such as types of cultivation and kinds of seeds.. However, factors concerning cropping service such as types of insecticides and method of harvesting product were at the third stage.

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انتاج الذرة الصفراء في العراق: دراسة اقتصادية وإحصائية للفترة 2007-2023

علي شوكت احمد العبيدي **محمود ابراهيم داود**
الجامعة الوطنية للعلوم والتكنلوجيا-الناصرية

المستخلص

تعتبر الذرة الصفراء من المحاصيل المهمة في الزراعة العراقية حيث أنها تمثل محصول صناعي يوفر الزيت النباتي ومحصول علفي يوفر الغذاء للحيوانات.

تنتج 8 محافظات عراقية الذرة الصفراء بشكل شائع في العراق. قام عدد كبير نسبيًا من المزارعين بزراعة الذرة الصفراء لموسم 2022/2021 وتم فحصهم باستخدام استبيان محدد لتقدير العوامل المؤثرة على إنتاج المحصول في كل محافظة، ثم على مستوى محافظات العراق ككل. وقد ثبت صحة عدد 596 استمارة من إجمالي عدد 611 مزارع. وتم جمع البيانات وتحليلها باستخدام التحليلات الإحصائية؛ الانحدار الخطي المتعدد، التدريجي وتحليل العوامل التي توفرها حزمة SPSS.

اظهرت النتائج ان امتلاك الارض التي تخصص لإنتاج الذرة الصفراء كان العامل الاول الذي يؤثر في القرار الانتاجي، يليه المساحة المزروعة. ثم في المرحلة الثانية تأتي العوامل المتعلقة بتحضير الارض، مثل نوع الحراثة وانواع البذور. اما العوامل المتعلقة بأنواع الحراثة، مثل انواع المبيدات الحشرية وطريقة حصاد المحصول فقد جاءت في المرحلة الثالثة.

الكلمات المفتاحية: الذرة الصفراء، المستلزمات الزراعية، الإنتاج، الإنتاجية.

Introduction

Yellow corn is one of the most important cereal crops in the world, comes after Wheat and Barley, as its global production exceeds rice, while its cultivated areas also rank third after them. The exact date of the introduction of yellow corn into Iraq is not known. In the 1930s, the Indian variety (Laltan) was introduced, then the synthetic variety (JI), which is of Pakistani origin, and then the American hybrid (Texas 43 group, Texas 30A) was introduced. After 1946, in cooperation with the International Food and Agriculture Organization (FAO), the cultivation of the crop spread widely in Iraq. In 1974, triple and quadruple hybrids were produced, then French hybrids were introduced, such as (LG11), which is an early spring hybrid. Other varieties were also introduced, such as the Pakistani (Lenilium), which is an autumn variety.

The research variables which are used are production, productivity, and cultivated areas of each governorate studied and on the level of the whole country of Iraq for the period 2007 -2023.

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I**mportance of Research:** The economic importance of yellow corn stems from its nutritional importance because it contains a high percentage of carbohydrates. The chemical composition of yellow corn are: Protein 10.6%, Oils 4.6%, Carbohydrates 81.0%, Fiber 2.2% and Minerals 1.6%.

The interest in developing yellow corn cultivation is due to the fact that its grains are used at a rate of up to 40% of the composition of concentrated feeds for poultry in Iraq. It is also used as green fodder (silage) and in the extraction of starch and oils and many food industries. It is also used in bread making in some countries of the world. Therefore, the interest in growing this vital crop comes from interest in animal products and its importance in terms of high nutritional value.

Research Problem: The demand for yellow corn is derived from the demand for animal products. Despite the increasing demand for the crop and the development of hybridization and high-yielding varieties, production and productivity rates are still below their required levels. The planned area allocated for the crop for the year 2020 amounted to 742,000 Dm(*), while the actual cultivated areas amounted to only 394,000 Dm (53% of the total area planned), which is a major problem that must be studied in its various aspects.

The expansion of livestock projects expected in the coming years will widen the gap between the supply and demand of yellow corn, which makes it necessary to determine the most important factors that constitute obstacles to expanding and increasing production locally and not having to import it in the future.

Research Objectives: The research objectives are determined as follows:

1. Identifying the factors affecting yellow corn production at the level of the single governorate and at the level of the whole country of Iraq.
   (*) Dm is (Dunum), which is the unit of land measurement in Iraq (1 Dm = 2500 m^2
2. Demonstrating the impact of the factors through the use of available statistical and measurement methods.

Research Hypothesis: The research hypothesis will be as follows:

1. By listing the factors affecting yellow corn production and measuring the impact of each, we can determine the importance of each factor at the level of the single governorate producing the crop.

2. At the level of the country as a whole, characterize these factors, and then lay the appropriate scientific foundations to increase production to the required levels.

Development of Production, Productivity and Cultivated Areas: Data on production, productivity, and areas cultivated with yellow corn for the period 2007-2023 in Iraq indicate the development that occurred therein, as shown in table no. (1).

It is clear from Table (1) that:

1. The great fluctuation in the cultivated areas. They increased during the first period (2007-2014), then fluctuated returned to decline and reached their lowest levels in 2017. Using the annual growth equation converted to the natural double logarithmic form:

Lin Y = a + b X

Where Y is the dependent variable, X is time, and a, b are the constants of the equation (b represents the annual growth rate), the equation appeared as follows:

Lin Y = 166.04 Lin X

t = (3.949) F = 15.594 R^2 = 50.971

Which means that in each year of the studied time period, an area of 166,000 Dm was added in general, despite the fluctuation that occurred in the cultivated areas. It is a statistically significant value, as the calculated t value indicates. The explanatory power of the equation is large according to the value of F, and time explains 51% of the changes occurring in the cultivated area. If this area were added to the area actually cultivated in 2023, which is 394,000 Dm, then the total area would reach 530,000 Dm. However, is still less than the planned area for cultivation (742,000 Dm).

Table (1): Production, productivity, and cultivated areas of Yellow Corn in Iraq for the period 2007 -2023

years	Production (1000) tons	Productivity kg/acre*	Cultivated areas (1000) acres
2007	41	300	136
2008	53	431	123
2009	61	415	148
2010	77	315	245
2011	104	477	217
2012	172	563	286

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years	Production (1000) tons	Productivity kg/acre*	Cultivated areas (1000) acres
2013	297	657	452
2014	313	563	555
2015	171	503	339
2016	128	484	266
2017	101	462	201
2018	358	651	540
2019	410	633	674
2020	574	654	877
2021	368	534	679
2022	170	585	291
2023	232	588	394

(*) Acre = 4.05 Dm

Source: Republic of Iraq, Ministry of Planning, Central Bureau of Statistics, various issues.

2. The fluctuation in area is accompanied by fluctuation in production for the same period of time. The annual production growth equation showed the following equation:

Lin Y = 232.080 LinX

t = (4.400) F=19.360 R^2=56.345

Where Y is the volume of production and X is the time. It is clear from the equation that each year adds 232 thousand tons to production. The value is statistically significant according to the value of t. The explanatory power of the equation is large according to the value of F, and time explains 56% of the changes in production. It is clear that the value of the annual increase in production was not an indicator of the required development in the cultivation of the crop, which is parallel to the volume of demand for its various uses.

3. There was also fluctuation in productivity during the period studied. The annual productivity growth equation showed the following formula:

Lin Y = 65.489 Lin X

t = (3.819) F=14.583 R^2=49.296

Where Y is the productivity and X is the time. It is clear that each year adds an amount of 65.5 kg/Dm to the productivity of the yellow corn, which is a statistically significant value according to the value of t. The explanatory

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power of the equation is great according to the value of F, and that time explains 49% of the change in productivity.

Methodology: For the purpose of achieving the research objectives, the factors affecting yellow corn production at the level of one producing governorate, and at the level of the whole country were identified. The research went beyond the statistical sampling method to include the entire statistical community. Thus, the researcher used a number of teams distributed among all the governorates included in the crop cultivation development program, with one team in each governorate consisting of a number of sector coordinators and technicians in addition to a technical staff at the program management headquarters. They collect and tabulate data provided by research teams. These teams organized their work in two stages. In the first stage, the names and locations of the farmers who grew the crop in the 2022/2023 season were determined. Then, in the second stage, direct contact took place with them and the required information and data were recorded through lists prepared by the researcher, which were distinguished by their clarity and the ease of reviewing their paragraphs due to the large volume of work and ensuring accuracy in completion.

The information collected shows the extent of the farmer's awareness of the importance of growing yellow corn and their desire to cultivate it. The field work that should be carried out by the farmer (total cultivated area allocated for growing yellow corn, the use of the plow and its type, the method of preparing land, the use of pesticides and seeds, the variety grown, the nature and type of irrigation, methods of harvesting, the amount of production achieved, then the methods of storage and quantities of waste from the crop). The impact of technical factors on production was emphasized. As for economic factors, their impact was implicitly reflected in the size of the farmer’s uses of each element of production. The number of people covered by the information reached 596, distributed among the governorates as follows: Baghdad 28, Babylon 137, Diyala 125, Diwaniyah 22, Salah al-Din 69, Kirkuk 124, Amara 16, then Wasit. 35 farmers.

It is worth noting that the agricultural authorities in Iraq have supported the Yellow corn crop by supporting prices, which prompted farmers to expand the agricultural area of the crop.

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Statistical Analysis Methods: The researcher used statistical methods that are compatible with the specific objectives of the research, including:

1. Multiple linear regression analysis: This method required effort in processing some data, deleting some, and merging data for some governorates, and then conducting a regression method to determine the effect of variables on crop productivity.
2. Stepwise method: Which is based on the idea of introducing the variable that has the highest degree of statistical significance in its relationship to the dependent variable. Then comes the second independent variable, and so on.
3. Factor Analysis: It was used with the aim of demonstrating the relative importance of each variable in explaining the total variation in yellow corn production, especially at the level of the country as a whole, as an additional step to support the results that were reached.

Results Discussion: From the table of results of the multiple linear regression, and since most of the data was of a descriptive nature, it was converted to the dummy variables method for the purposes of analysis. The researcher was forced to merge data for some governorates due to the small number of observations, taking into account the geographical homogeneity of the region. The statistical packages SPSS were used for analytical processes.

Baghdad

Y = 3.435 + 0.212 (Cultivated area) + 7.688 (Foggicide)

t = (9.787) (2.458)

R^2 = 80% F = 51.421

Where Y is always refers to the output.

The model shows that the independent variables that have a significant impact on yellow corn production in Baghdad Governorate are the cultivated area and the use of fumigants, as evidenced by the calculated t values. All other variables were excluded due to their low statistical significance. These two variables explain 80% of the changes in production according to the value of R^2, and the model is high significance according to the value of F.

The results indicate that increasing the area planted with yellow corn by one unit (1000 Dm) leads to an increase in production by 212 tons/Dm. Also, increasing the fogging pesticide by one unit (one liter) leads to an increase in production by 7,688 ton/Dm.

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Babylon: From the table of results, the following model appeared:

Y= 4.001 + 0.667 (Cultivated area) - 0.049 (Total area) - 3.798 (Seeds)+

t= (20.275) (-8.638) (-3.317)

8.798 (Middle school) + 2.488 (Primary school)

2.119((3.474)

F =194.76 R^2 = 85%

The independent variables entered the model are all statistically significant according to the calculated t values, explaining 85% of the changes in yellow corn production in Babylon. The calculated F value indicates the significant effect of the independent variables on production. The sign of the variables of the cultivated area and educational attainment (middle or primary school) was positive, which indicates their positive impact on production. Increasing one unit of the cultivated area (1000 Dm) adds an amount of about 667 tons to production. There is a big difference between this addition and its counterpart in Baghdad Governorate, which demonstrate the importance of choosing suitable land for growing the crop. The variables of total area and use of common seeds appeared negative, which are expected results for both variables.

Wasit

The following model is shown:

Y = - 16.567 + 0.841 (Cultivated area) - 0.020 (Total area) + 2.609

t = (14.855) (- 2.835) (2.297)

(Intermediate level)

F = 80.128 R^2= 94.9%

The equation shows that the cultivated area and educational attainment (primary school) variables had a statistically significant and positive effect, while the effect of total area was statistically significant but negative according to the calculated t values. It is a clear that farmers in Wasit themselves determine the land for growing the crop. These variables explain 94.9% of the changes occurring in the amount of yellow corn production, which is also confirmed by the calculated F value. Adding 1,000 Dm to the cultivated area will add 841 tons to production, which is a result much greater than what was concluded in the models of Babylon and Baghdad governorates, and reinforces what was mentioned about the importance of choosing the appropriate land for growing the crop, if a decision is made to expand horizontally in its cultivation.

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Salah al-Din

The following model is shown:

Y= 92.453 - 26.828 (Improved seeds)

) t= (-2.091

F = 4.371 R^2 = 6.1%

It appears that the only independent variable affecting yellow corn production whose negative impact has been proven is the use of improved seeds in a relatively high quantities. This result is certainly not consistent with economic and scientific logic, but it shows that farmers in Salah al-Din were either not accustomed to using improved seeds or that they had not obtained good results in previous years, which made them very hesitant to use them (The researchers believe through their research that this is main reason for this result).

Amara and Diwaniyah

The following model is shown:

Y= 6.438 + 0.411 (Cultivated area) – 8.642 (Tenure type - Lease) +15.713

t= (8.430) (-3.660) (3.978)

(Tenure type – Contract) + 0.013(Total area) – 7.569 (Improved seeds)

(-2.180)(3.630)

F = 29.970 R^2 = 97.2%

It is clear from the model that the factors affecting yellow corn production in Al-Amarah and Diwaniyah governorates are the cultivated area, type of tenure (rent and contract), total area, and improved seeds. They are statistically significant according to the calculated t-values. These variables explain 97.2% of the change in production, which is clearly high percentage. The equation is of great importance according to the value of F. The negative sign of the rental tenure variable indicates the adverse effect of the rental process on production, and the total area variable also had an adverse effect, as is the case in the previous governorates, as well as the improved seeds variable. As for the cultivated area, its impact was positive, and increasing this area by one unit leads to an increase in production by 411 thousand tons.

Kirkuk

The following model is shown:

Y= -14.612 + 2.449 (Cultivated area) - 0.039 (Total area) - 10.060 (Flip plough use)

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t= (6.905) (-5.579) (-2.079)

F = 56.391 R^2 = 87%

The model indicates that the cultivated area, the total area, and the use of the flip plow are the variables that have a statistically significant effect on production according to the calculated t values. They explain 87% of the changes in production according to the R^2 value. The equation has high statistical significance according to the F value.

The positive sign for the cultivated area variable indicates a positive effect, as increasing it by one unit leads to an increase in production by a value of 2449 thousand tons, which is a value that exceeds all the values of the previous governorates. The negative effect of the total area variable was evident, as is the case in other governorates. However, the negative effect of the variable of using the rotary plow, ensures that the governorate's farmers' general preference for using the digger plow over other types of plows.

Dayala

The following model is shown

Y= 66.362 - 0.108 (Total area) – 32.110 (Mechanical harvesting) – 85.153 (Tenancy type)

t= (9.472) (-3.331) (-3.223)

F = 34.920 R^2 = 51%

The equation shows that the independent variables with statistical influence are the total area, mechanical harvesting, and rental type, according to the calculated t values. These variables explain 51% of the changes in yellow maize production in Dayala according to the R^2 value. The F value also shows the high explanatory power of the model.

The negative sign for the total area variable indicates the negative effect of the variable in all governorates included in the study and indicates the unwillingness of farmers to allocate all the available areas to the yellow corn crop. While it turned out that mechanical harvesting had a negative impact on production, this is due to the fact that more than 85% of the number of farmers in the governorate were not accustomed to using mechanical harvesting, but rather were accustomed to traditional methods of field work. The type of tenure (rent) has negative impact on production, and this confirms what this variable showed in the governorates of Amara and Diwaniyah.

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Analysis at the Level of Iraq: The Step-Wise Analysis Method was used after merging the data of all governorates to determine the impact of each of the studied factors on the production of the yellow corn production across Iraq. After the analysis, the following model appeared:

Y=126.977 + 51.371 (Tenure, rent) - 76.986 (Mechanical harvest) +

t = (15.267) (-10.238)

0.332(Cultivated area) + 78.222 (Certified seeds) + 82,480 (Dump plow)

8,922) (8.241) (4.598))

+ 8,922 (Insecticides) + 23,133 (Improved seeds) + 23.688 (No use of pesticides)

(-2.127) (2.177) (-4.003)

F =142.880 R^2 = 66.5%

The variables with a significant impact are sequential in their importance at the level of Iraq, and that the equation has a high explanatory power according to the value of F, and that the apparent variables explain 66% of the change occurring in yellow corn production.

The variable (type of tenure - leasing) is considered the first, which indicates the importance of this method of land tenure, as it appears that the majority of farmers rent land from others who own it or who rented it from the local government or contracted for it. In fact, the issue of land ownership and placing it at the disposal of farmers is considered a major problem that often constitutes an obstacle to their production decisions, and also leads to economic and social problems for the agricultural community. Its effects are reflected in the amount of production achieved. Therefore, this variable is more important than the variable of the size of the areas cultivated with the crop, which came in third place in the sequence. The effect of the land tenure method appeared at the level of a single governorate, and it was negative in the governorates of Diyala, Amara, and Diwaniyah, while it was positive in the case of contracting. This result constitutes an important indicator for those concerned to review the procedures and decisions followed regarding the provision of land and adopt transparency and simplicity in a way that guarantees the rights of all parties in the production process, especially the farmer.

Then the mechanical harvesting variable came in second place with a negative sign. This is actually clear that this method is not desirable as it leads to decrease in the quantities produced. The farmers are accustomed to

using manual and traditional harvesting methods and the opportunities to discover the returns of mechanical harvesting are not available to them. This is the responsibility of the authorities concerned with agricultural extension in Iraq.

The cultivated area comes in third order and is a positive sign that reflects the importance of expanding areas allocated for yellow corn across Iraq.

Then the certified seeds are ranked fourth, with a positive sign showing the importance of using this type of seed over other types (hybrid, improved, and regular), due to the confidence that the farmer gained from planting it in previous years. While the use of improved seeds came in seventh place with a positive sign, although it gave negative results in the governorates of Salah al-Din, Amara, and Diwaniyah, it proved to be an important variable in the other governorates .

As for the use of the dump plow, it seems that only the farmers of Kirkuk Governorate use the digger plow to a large extent, while those of the other governorates use the digger and dump plows to plow their lands, and the triple plow is rarely used for reasons related to its high cost .

It is natural for the variable of not using pesticides to appear with a negative sign, confirming that the majority of farmers use fumigants to improve and increase production, while few of them use pesticides, which are ranked sixth, with a negative sign. This is due to the high costs of this type of pesticides and their lack of availability in many cases.

For the purpose of demonstrating the effect of each of these variables on the response variable, factor analysis was used and variables were arranged in descending order. The results are as shown in Table No. (2):

Table (2): Results of factor analysis:

The first component variable		
1	Type of tenure (renting from people)	0.777
2	Use of pesticides	0.565
3	Use of fogging pesticides	0.504
4	Using a plow (excavator)	0.472
5	Using regular seeds	0.443
6	Mechanical genie	0.425
7	Type of tenure (contract or lease from the state)	0.365
8	Use of certified seeds	0.366

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The first component variable		
9	Using a tipper plow	0.331
10	Not using pesticides	0.267
11	Use of improved seeds	0.200
12	Academic achievement (high school graduate)	-0.184
13	Cultivated area	0.015

From Table (2), the order of the factors affecting production of yellow corn was completely consistent with the results reached in the previous analysis, where it was found that the land tenure factor was first, then the negative effect of the pesticide factor, which was stronger than the positive effect of the factor fogging pesticides, one of the negative effects of the factor is not using pesticides.

Then the positive effect of the factor of using a digger plow, which was stronger than the positive effect of the factor of using a tipper plow. Then the negative impact of the factor of using regular seeds is greater than the positive effects of the factors of using certified seeds and improved seeds. There is the negative impact of the mechanical harvest factor, and the academic achievement factor (intermediate), which is due to the fact that the majority of farmers have indicated their educational attainment in either (reading and writing, primary, or middle school certificate).

Finally comes the positive effect of the factor of cultivated area, even though the researcher's expectations were that this factor was ahead of the other factors, but it seems that they were all stronger than it, despite its importance that appeared in all the equations that were reached at the level of one governorate, as well as at the level of Iraq.

Conclusions: The statistical analysis conducted by the researcher on the factors affecting yellow corn production showed the following:

1. The statistical analysis revealed the effect of the primary and secondary educational level on crop cultivation in Babil Governorate and intermediate education in Wasit Governorate only. The educational level variables did not show any effect on crop cultivation at the level of Iraq, while the effect of intermediate education was only ranked twelfth in the result of the factor analysis. The reason, in the opinion of the researcher, is that the majority of farmers are proficient in reading and writing, but at varying educational levels. However, most of them do not have a field culture that qualifies them to deal with scientific developments and modern agricultural methods, which

is mainly due to the weak role of agricultural extension institutions in the various governorates of Iraq.

2. The issue of land ownership and its allocation for crop cultivation is one of the important and influential topics in the productive decision of farmers, as the results showed in the governorates of Amara, Diwaniyah, and Diyala, and this variable came first in the analysis at the level of Iraq as a whole or in the factor analysis.
3. The use of pesticides and mechanical harvesting are important factors that have a major role in increasing and improving crop productivity, but most farmers did not take them. Perhaps this is due to reasons related to the high cost of all types as they are imported from abroad. Fogging pesticides have only shown their importance in Baghdad Governorate, but its effect was opposite in the analysis at the level of Iraq. Thus, the effect of the mechanical harvesting was negative in Diyala Governorate and at the level of Iraq. In the opinion of researcher, this is due to the high hourly wages of mechanical harvest, which are not commensurate with production returns, and farmers are accustomed to traditional methods of harvesting, especially for relatively small areas.
4. The results of the analysis at the level of Iraq showed that all farmers use certified seeds, then improved seeds, which is an indicator that considered good and its sustainability should be maintained.
5. Most of the Iraqi farmers use digger plows and tip plows. It seems that they are not accustomed to using the triple plow, and do not take into account important issues in plowing, such as using the plow from time to time. Cross or rotary plowing, which does not appear to be important in affecting production, has been completely excluded. The reason is that the small size of cultivated areas does not encourage farmers to use intensive mechanization in agriculture.
6. Among the factors that did not show an impact on production were the use of various types of pest control, the effect of soil quality, irrigation method, the quantities of marketed and stored production, as well as the quantities of lost crops and types of fertilizers. They are all important factors from the researcher' point of view, but they did not have a significant effect because they do not cause a major problem for farmers, as is the case with the factors that appeared in the production functions that were estimated.

Recommendations:

1. The researcher recommends paying attention first to the educational level of farmers, as it is the basic tool in raising the farmer's awareness and understanding of the importance of yellow corn cultivation and its role in developing the national economy and achieving self-sufficiency in animal production. Therefore, exceptional importance must be given to agricultural extension programs to force farmers to adopt modern scientific methods in growing crops.
2. The problem of land ownership requires a comprehensive review of all ownership procedures, leasing instructions, and contracts with the state and with individuals in a way that makes this matter clearer and removes from the farmer the restrictions that prevent him from expanding crop cultivation.
3. It also requires that all relevant agricultural institutions to work to provide basic agricultural requirements, such as plowing, harvesting and pest control tools, air-conditioned warehouses, etc., at a cost commensurate with production returns.
4. Perhaps among the general recommendations in this field is the importance of continuing to support intensive scientific research projects and adopting the recommendations that researchers come up with, whether in the aspects related to providing high-yielding hybrid seeds or in the economic aspects related to prices, costs and production. In addition to carrying out field experiments under the supervision of scientists specialized in the fields of plant breeding, the results of which are always put into practice.

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