

## USING LINEAR PROGRAMMING MATHEMATICS IN PRODUCTION PLANNING APPLIED SEARCH

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### Abstract:

The aim of this research is to use operation research approaches in agricultural production planning to determine the optimal max of agricultural crops that maximize the productivity of one acre. Therefor 400 acres of laned called Moradia boycott 6 were selected after the building a linear programming model in light of agricultural constricts and Use the Simplex and graphite methods. It was found that allocation of the Land for the cultivation of the wheat Crop by 70% and Barley by 30% Lead to maximize the program.

### Introduction

Linear programming is one of the subjects of operating research as a branch of mathematics and this technology can be applied and it is multi -purpose on many life attempts, including agricultural production to help program it and determine the appropriate type that is suitable and the set of restrictions that can be objective determinants of agriculture, including the appropriate time for, agriculture and machines plows, settlement, seeds, workforce, and others

The study adopted the applied method of quantitative measurement, represented by (Linear Programing Model) on a sample of agricultural lands of a boycott, Al -Mouradia and the name (*Al -Rustamiya*<sup>(1)</sup>) in an attempt to determine the optimal productive mix that maximizes the profits of farmers from agricultural crops and contributes to increased agricultural yields. The productivity of one dunum is necessarily reflected in the development of the agricultural sector, which, despite its priority and absolute importance, did not receive the appropriate amount of research attention in comparison with other economic sectors, to achieve this purpose, the research structure was divided into (4) sections devoted to the first for the research methodology while .The second is to present a theoretical framework in the concept of linear programming and its use, and the third section was devoted to the applied side while the fourth section presented the most important conclusions and recommendations

## **1. Importance**

The importance of the research is acquired from the importance of food security in the lives of peoples and because programming and planning agricultural production and the use of scientific methods are among the most important elements of that planning. The research sought to achieve this end, achieving the following

1-1 Adaptation of academic knowledge of life requirements and their use in achieving a qualitative development at the level of comparison between agricultural crops and good decision-making.

1-2 supply The Iraqi library with a specialized research in employing quantitative methods in the agricultural production sector and filling the research gap of this sector with other economic sectors.

The central region, from which the research sample is chosen, contributes to 1-3

From the regional distribution of the production of grain yields and ensuring food security for citizens in the rate of 40%

## **2. Goals**

The research goal is within the framework of the optimal investment of available resources and maximizing the productivity of the land by studying opportunities and prospects for the success of the qualitative specialization in the production of grains using the linear programming entrance as one of the most important entrances to operations research in a way that encourages the adaptation and application of pure science and quantitative methods of developing the agricultural economy.

## **3. The search problem**

The research problem is embodied in the absence of scientific planning in choosing the cultivation of field crops, the tradition of societal heritage, experience and error in implementing its plans, and because the basis of scientific planning is the use of quantitative analysis tools, the essence of the problem is the failure to apply these tools in decision -making and simulation of historical heritage in cultivating grain crops.

## **4. Research hypothesis**

Resorting to the method of comparison between agricultural crops and the allocation of agricultural lands for a specific type of grain (wheat or barley) is that it increases productivity and greatly returns.

## **5. The means of all data**

The researchers relied on the completion of the research on a number of means, the most important of which are:

1. Personal interviews with workers in the cultivation of these crops
2. Some of the cultivation statistics of the cultivation of Al-Mouradia district
3. The annual statistical group of the Ministry of planning, the central statistical agency.

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This region witnessed the fiercest battles with British forces in the 1920\* 1

The first section: the research methodology

## 6. The quantitative means used by analysis

The researcher adopted the linear programming method in choosing the research composition and using the most important methods included in this method graphical method and Simplified method Simlex Method

The two methods were used together despite being an absolute alternative to each other to know the extent of the quantitative consequences and increase the reliability of quantitative analysis in addition to that they can together help other researchers to choose either of them according to the researcher's assimilation of the data of each method, which is an educational goal that can be added to the objectives of this research.

## 7. Research sample

Table (1) the areas planted with wheat and barley crops in the region (researched from El Mouradia district)

Years Area (dunams) Average yield (kg) notes

Wheat barley represents the net areas, that is, after deducting the drains and their taboos, the lands of the sat land and the areas planted with other crops, as well as the agricultural plans that reduced the areas due to insufficient water .

Table (1) the ears planted with wheat and barley crops in the region yield.

Notes	Average (kg)		Avea (Acres)		Years
	barley	wheat	barley	Wheat	
It represents the net areas ,i.e. after deducting the drains and their taboos ,the infertile lands and the areas planted with other crops, as well as the agricultural plans that reduced the areas due to the lack of water	317	830	60	420	2013-2014
	360	720	70	401	2014-2015
	297	800	75	431	2015-2016
	310	680	55	395	2016-2017
	352	710	61	360	2017-2018
	360	730	70	340	2018-2019
	370	740	75	320	2019-2020
	338	745	66	381	Average

Source: Al-Kifl Agriculture Division, Agricultural Statistics Department: Unpublished data 2020

Note that both crops are winter field crops, and the following is an introduction to them

\* Wheat crop: It is one of the most important winter field crops and one of the most important types of food grains because it represents a major food item. The average area planted with this crop in the research area (Al-Rustania) for the period from (2013-2020) (381) acres with a standard deviation \*\* estimated (41.7), but the cultivated area witnessed a downward trend if it decreased from (420) acre in the 2013/2014 season to (320) acre in the 2019/2020 season

\*Barley crop: The average area planted with this crop during the mentioned period was (66.5) acre, with a standard deviation of (7.3) acre, but the cultivated area was also fluctuating.

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\*These areas represent approximately 30% of the total cultivated areas in the canton and are irrigated from the Euphrates River with a kilometer hole (651100), according to the Water Generator Division in the district

\*A statistical measure that measures the dispersion of values (cultivated areas) from their arithmetic mean

Table (2) presents the rivers that fall into the 6 district of Muradia (including the investigated area) from the Al-Kifl stream branching from the Euphrates River

Table (2) Collapsed District (6) Al-Muradia from the Al-Kifl Table

Meter3 second	length	Kilometer location	Rivers name	No
0,393	7	55,500	AL- hore river	1
0,511	4	52900	AL- najmia river	2
0,536	4	49990	AL- Ristimia river	3

Source: Water Generator Division in Al-Kifl District, Technical Section: Unpublished data 2018

## 8. Previous Studies

Although there are a good number of linear programming applications on multiple areas of life, the researcher did not find a specialized research that deals with the direction adopted by this research, as it was noted that most of the applications of linear programming related to maximization of profits (maximization the profit) or reducing costs (Minimiztion the Cost) has dealt with the production of goods in production factories, and this researches has not given much importance to its application in land planning and qualitative selection among agricultural crops .

### The second section: the theoretical framework for the research

#### The concept of linear program (1) -

Linear programming is a mathematical style to distribute a set of resources and limited capabilities or invest them to achieve the maximum benefit or result, and the linear programming method is the most common in the field of operations research and decisions related to the comparison between a set of possible alternatives with the aim of making the optimal decision (Bellman ,2003:27) and indicates Linearity to the relations between the variables of the seamable problem are written relationships in the sense that they respond harmoniously to the function of the model's goal, and accordingly, it is the most important assumptions on which the written programming model is (Better & Norton, 1986: 12-13) (Gross &Harris,2009:66)

1. The presence of a specific goal that the administration seeks to achieve such as production, increase profits or reduce costs
2. The stability of the prices of supplies and products, and that there is a written relationship between the variables
3. The resources used are limited and the idealism is to be achieved.
4. Expressing a goal function and restrictions with written arms or equations.
5. That there is more than one alternative to increase the margin of the decision-making maneuver by choosing the best

The above assumptions are the scientific conditions that must be met in the problem or are the technical requirements for the written programming problem that is available in the collection feature that means that the total value of any influence is only the result of collecting its molecular values (GAS's, 2004: 66) and is known as the written programming or written Its general form as follows: (Gross & Richard, 2009: 61)

Maximize or Minimize

$$x_0 = c_1 x_1 + c_2 x_2 + \dots c_3 x_3$$

Subject to:

$$a_{11} x_1 + a_{12} x_2 + a_{1n} \dots (\leq = \geq) b_1$$

$$a_{21}x_1 + a_{22}x_2 + a_{2N} (\leq = \geq) b_2$$

$$a_{m1} x_1 + a_{m2} x_2 + \dots + a_{mn} (\leq = \geq) b_m$$

As:

$$x_1, x_2, \dots, x_n > 0$$

$m_1 \rightarrow m_n =$  productivity, cost or profit

$C_1 \rightarrow c_n =$  Shop or produce that units number

$b_1 \rightarrow b_j =$  its desired programming limited resources quantity

It is noted from the last restriction that the sign of the variables ( $X_j$ ) is restricted on the condition that the negativity is not negative (non-negative).  $X_j$  takes real values ( $x_j + -x_j$ ) where the transformations ( $x_j + -$ ) and ( $x_j -$ ) take inappropriate values, and to put the linear sports model.

The following steps must be followed (Zeyuan, 2015: 72)

1. Defining the transformers (decision -making) whose values must be found and represented by house compulsory symbols
2. Determine all possible restrictions and relationships that link transformers and express them with linear arrangements or equations.
3. Determining the goal function (follow the goal) and representing it with a written follower in relation to the transformers and determining whether the goal of the issue is to maximize the target subor dinate or reduce it

The most important algorithms to solve linear sports programs: (2)

### 1. Simplex method

It was developed by the American mathematics scientist (Dantzig) and remained in application and use and for ease of dealing with it despite the increase in its acetic complications represented by the number of repetitive calculations. By composition (N, L) where N symbolizes the number of resolution and L to the number of bits needed for the characterization, although it is built with a "creative sporty sport that surpasses the theoretically style of the symposium, but the latter remained more used and reliable in the practical aspects due to its superior plain

Its steps are summarized by:- (Phillips & James, 1986: 33)(Dantzig,1998:102)

(1) The formulation of the problem is in the form of (intequalities) according to the restrictions placed and then converting these variations into equations by adding slack Variables represents the unavailable part of energy.

(2) Transfer equations to the linear programming schedule according to the following form constant Non-Basic Variable.

(2)

Basic Variables	Non-Basic Variables $x_1, x_2, \dots, x_n, s_1, s_2, \dots, s_n$	Constant
$s_1$		$b_1$
$s_2$	$a_{11} \ a_{12} \ a_{1n}$	$b_2$
.		.
.		.
.	$a_{21} \ a_{22} \ a_{2n}$	.
$s_n$		$b_n$

$a_{11}$  refers to the first variable of the first equation  $a_{21}$  to the first variable of the second equation and so on.

(3) To determine the pivotal column, the largest positive value is chosen in the goal function in the case of glorification (max) and the greatest negative value in the same function in the case of miniature)) with consideration in consideration not to change the signals of equations and replacement of that by hitting the final output in the last repetition b (1-) And then define the axial row and the axial element by dividing the constants to the elements of the axial column and the least resulting output is the axial row and its element is the pivotal element resulting from the intersection of the axial column with the axial row

(4) Removing the axial row and its variable, introducing the axial column variable instead of it and finding the values of the new interior of the interior by dividing the axial row elements in the step - repetition - the previous one on the axial element in it

(5) The establishment of other basic variables is extracted in the next stage and the following stages by hitting the pivotal element in each of the first stage with the corresponding variable of the new interior of the interior and then offering the result from the corresponding variable located with the same matrix from the previous stage (The same cell) and stop the solution when the target function signals and turns into the opposite state.

It started with the first repetition or zeros, and it is worth noting that the main solution is considered Unacceptable when the primary primary solution cannot be obtained and asylum is either to a method.

M (M\_technique) or the two -stage method.

## 2. Graphical Method

The solution in this method depends on the representation of the restrictions, and it is useful in solving the problems of linear programming that contains only two variables, whether the variables are restricted or not restricted by the sign, but they become more difficult if the number of variables increases to three or more White, 2013: 69

The steps of this method are summarized by the following (Mital and Mohan,2005:72)

1-Converting the varying into equations and determining the two points, each equation, assuming a zero value of one of the variables and compensation alternatively.

2-Representing the essential equations and determining the acceptable solutions area, then the accusative point values

Extreme Point) by vertical and horizontal projection on the X -and -Shadi or (X) and (Y) and compensation with the coordinates of extremism points in the goal function to determine the point that achieves the goal.

## 3. Algebraic Method

The problem is solved by using this method with a number of steps aimed at identifying the limits of the possible solution space

Then determine the point that can achieve preference over others according to the requirements of the goal function and the steps of this method as follows: \_ (Phillips, 1996: 81).

1. Converting the variations into equations that can be dealt with by force.

2. Determine all the basic solutions possible using the disassemble and the following relationship:

$$C_m^n = \frac{n!}{((n-m)! m!)}$$

$C = \text{Compleensation is equivalent}$

$\text{Factorial} = !$

$n = \text{Number of variables, } m = \text{number of equations}$

Converting the variations into equations that can be dealt with by force .-3

4-Determine all the basic solutions possible using the dismantling and the mentioned relationship.

\*This area is the location of the current study

Section Three: Practical (Applied) aspect

Building the model in the light of the boycott data 3-1

To represent the athletically research variables, the following symbols were given-:

$X_1$  The number of acre grown with barley crop

$X_2$  The number of acre grown with wheat crop

Since the goal of the research is to maximize the productivity of one, and because the productivity of one acre of the wheat crop is 750 kg/ acre and its productivity of the barley crop 340 kg / acre, within the usual conditions available, taking into consideration the rise in some lands from the water level, which causes many problems even assuming the use of Water pumps (fraud) and their need for a settlement cost and modification of large sums as well as the need to treat the bush (such as the tenderness and the (Al -Masm), which is a parasitic jungle that shares the crop its food and affects the productivity of one acre, and assuming the stimulation of lands using urea fertilizer and compound compost from nitrogen, potassium and phosphorus (used With a rate of 100 kg per acre) The goal function that maximizes the productivity of the acre can be formulated as follows :

$$750 x_2 + \text{Max } Z = 340 x_1$$

## 2. Form restrictions

### 1-Time

Barley cultivation begins in October of each year, while wheat transplantation begins in the middle of the aforementioned month and extends for a month or a little more for the wheat crop, and one acre needs wheat (approximately 4) hours while the barley acres (3) hours and the reason for this is to prepare the land to grow The wheat needs to be settled, modified, and more care compared to barley cultivation and because available from the total time to grow wheat is about one month (10/15-15/11) or 720 hours (30\*24), and available from the total time to grow barley is from 1/ 10 to 15/11, i.e. 45 days \*24 hours or (1080 hours), the period from 10/10 to 11/15 is shared between them, which means that it is possible to express time in the following form

### 1-2

$$3 x_1 + 4x_2 \leq 1080$$

Because the time for planting wheat starts from 10/10 and ends 11/15, while the hair transplant begins at 10/10 and not at 10/15 as is the case in wheat if the wheat can be handled with a single restriction, noting that the need of one acre is 4 hours as follows

### 1-3

$$4x_2 \leq 720$$

The time for seeds is very important for the crops, as starting with it before the customary date leads to the production of a large percentage of empty grains, while the delay in it leads to the incomplete maturity of the grains and the production of weak yields.

## 2. Under the space

The total area available for cultivation of the two crops in the region, the research (drawing) is with the limits of (2000) acre, but the gardening directorate has acquired (almost 1000) acre of which and planted it with evergreen (iodocaltos) trees, which leads to reducing the area available for cultivation to (1000) acre and if I did not exclude the clients, their taboos, and the land cultivated with other winter crops and the lands of the sabkha

### 1-4

$$X_1 + X_2 \leq 4003$$

### Registration of the negativity

The last restriction is the restriction of the negative and indicates that the production of the two crops must be positive in the circumstances and express it as follows

### 1-5

$$X_1, X_2 \geq 0$$

Thus, the linear programming model for research is written as follows

$$\text{Max}Z = 340X_1 + 750X_2$$

### 1-6

Subject To:

$$3X_1 + 4X_2 \leq 1080$$

$$4X_1 \leq 720$$

$$X_1 + X_2 \leq 400$$

$$X_1 + X_2 > 0$$

The first step is to convert the model's variances into equations by adding stagnant variables (Slack Variables), so the model takes the following form

$$\text{Max}Z = 340X_1 + 750X_2 - Z = 0$$

S. TO:

$$3X_1 + 4X_2 + S_1 = 1080$$

$$4X_1 + S_2 = 720$$

$$X_1 + X_2 + S_3 = 400$$

$$X_1, X_2, S_1, S_2, S_3 > 0$$

Using the simplified method to test the research hypothesis 3-2

After the variances have been converted into equations, the simplified method and the first steps of this method can now be used to prepare a table and transfer the variables to it as a prelude to "reaching the optimal solution by following the methodology of the method that was dealt with in detail" in the theoretical side of the research and as shown in the following table (3).

Table (3) Simplex Method

B.V	$X_1$	$X_2$	$S_1$	$S_2$	$S_3$	Constant	Ratio
$S_1$	3	4	1	0	0	1080	290
$S_2$	0	(4)	0	1	0	720	180
$S_3$	1	1	0	0	1	400	400
Z -	340	750	0	0	0		
$S_1$	3)(	0	1	-1	0	360	120
$X_2$	0	1	0	1/4	0	180	—
$S_3$	1	0	0	-1/4	1	220	220
Z -	340	0	0	-375/2	0	-175800	
$X_1$	1	0	1/3	-1/3	0	120	
$X_2$	0	1	0	1/4	0	180	
$S_3$	0	0	-1/3	1/12	1	100	
Z -	0	0	-226/2	-149	-74	-175800	

It is noted that the third iteration has brought us to the optimal solution, where all the values of the objective function have turned into negative values or zeros (the inverse of the case you started with respect to positive values) it was shown from using the method that the cultivation of (120) acres of barley and (180) A acre of wheat leads to maximizing the productivity of one acre , while the remaining 100 acre of the county’s lands can be allocated for the cultivation of other crops. By planting the two crops together, the results can be verified when substituting the target function after multiplying them by minus 1, as the method assumes

$$-Z = -175800$$

After multiplying by negative (1)

$$Z = 175800$$

By substituting the function:

$$Z = 340X_1 + 750X_2$$

$$Z = 340(120) + 750(180) = 175800 \text{ tons}$$

This result is identical to what the method found in the last iteration as a final value

### 3.3 of the objective functions the graphical Method

After converting the differences into equations, this method requires as mentioned above, determining the points of each equation for the purpose of representing them graphically on the drawing and rewriting the form of the form

$$Z = 340x_1 + 750x_2$$

$$\text{Equation (1)} \quad 3x_1 + 4x_2 = 1080$$

$$\text{Equation (2)} \quad 4x_2 = 720$$

$$\text{Equation (3)} \quad x_2 + x_1 = 400$$

From the equation (1)

$$\text{IF } X_1 = 0, x_2 = 1080/4 = 270$$

$$\text{If } x_2 = 0, X_1 = 1080/3 = 360$$

Thus, we have obtained two points of this equation (360,0) (0,270)

From the equation (2):

$$\text{IF } X_1 = 0, x_2 = 720/4 = 180$$

Thus, we will get from this equation one point for the lack of the other variable in it

This point is (0,180)

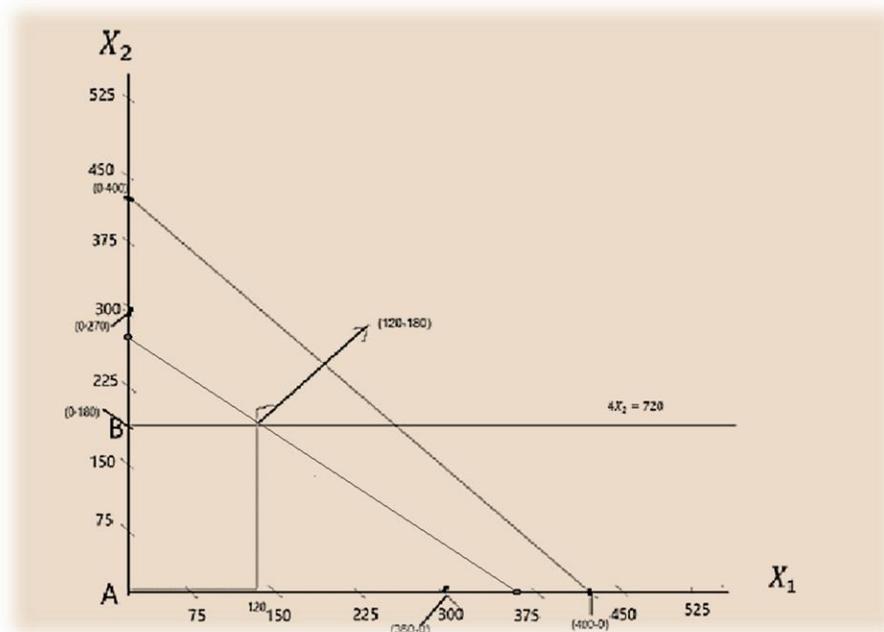
From the equation (3):

$$\text{If } x_1 = 0, \text{ then } x_2 = 400$$

$$\text{If } x_2 = 0, \text{ then } X_1 = 400$$

We will get the two points (400,0) (0,400)

By dropping these points on the drawing, it turns out that the area of acceptable or possible solutions is the dirty area that begins at the point of asset (A) and ends at the point of the terminal (D) and that (3) of the extreme points. It was obtained by compensation in the equations, because the unknown is the value of the C point at  $(x_2, x_1)$  Point C and by dropping two straight lines from this point on the two axes ( $x_2$  and  $x_1$  it becomes clear that it is a value and  $x_1$  will be (120) and the value of  $X_2$  is the point B i.e. (180) acre which is it The same results obtained using the simplified method and after compensating the values of the four points in the goal function we get the following results



By compensation in the goal function, we get the following:

$$Z = 340x_1 + 750x_2$$

$$Z_A = 340(0) + 750(0) = 0$$

$$ZB = 430 (0) + 750 (180) = 135000$$

$$ZC = 340 (120) + 750 (180) = 175000$$

$$ZD = 340 (360) + 750 (0) = 122400$$

It is inferred from the results that point (C) is the one that achieves the goal function by obtaining the highest productivity and in the amount of (175800) tons, which is the same amount that the simplified method showed.

## **Section Fourth**

### **Conclusions and Recommendations:**

#### **1- conclusion**

1-The wheat crop is the best in terms of productivity, as the productivity of the acre reaches 750 kg. This leads to maximize the productivity of the earth.

2-Allocating 30% of the province's area, i.e., limits (405) acre to plant the barley crop, too, is to glorify the productivity because it follows wheat in terms of productivity and importance, as indicated by linear programming applications for that ( $120/400 = 0.30$ )

3-In the light of the existing determinants or restrictions, the diversification of production is the best of specialization in producing one type of crop. The research hypothesis has also assumed that the diversification is consistent with the principle of reducing the risk and saying not all eggs in one basket)(

4-It is concluded, which is what the peasants have confirmed, that there is a decrease in the yield of one dunum of the two crops over time due to the frequent use of the earth and the legalization of the use of chemical fertilizers and the scarcity of watering water.

#### **2-recommendations**

1-Allocating half the area of the province to planting the wheat crop and 30% for the barley and using the remaining, which is (20%) in planting other winter crops, which are many.

2-Circulating the results of this study on other agricultural provinces to benefit from them in maximizing the productivity of the land and achieving sufficiency in the community's need for grains.

3-It is necessary for the directorates and people of agriculture to provide more data for those looking for cultivated areas, water sources, and the extent of the adequacy of machines and machines used in agriculture to benefit from them in broader future studies.

### **References**

1. Bellman, Richard, 2003, Linear programming and Network flows, Wiley, 2003
2. Beter B., and Norton, D., 1986, Mathematical programming for Economic Analysis, Macmillan publishing Co., New York
3. Gross, Saul, 2004, Linear programming, Method and Applications, ed5, university pres prentice – Hall, New York.
4. Gross, D., and Richard C., 2009, Fundamentals of
5. Zeyuan, Allen, 2015, Dynamic programming Queuing Theory, Wiley, New York. Kent publishing Company, Boston USA
6. White, D.J, 2013, Dynamic programming Holden Day, San Francisco,
7. Phillips, Don, 1996, Operation Research; Principle and practice, John-Wiley, sons USA