Advances and Applications in Discrete Mathematics
© 2017 Pushpa Publishing House, Allahabad, India
http://www.pphmj.com
http://dx.doi.org/10.17654/DM018030367
Volume 18, Number 3, 2017, Pages 367-383 **ISSN: 0974-1658**

MODELING AND SIMULATION OF A FOOD PRODUCTION PROBLEM IN REGIONS OF CHAD

Abba Danna[1], Bakari Abbo[2], Youssouf Pare[3,4] and Blaise Some[3]

[1]Département de Sciences Economique
Faculté des Sciences Economique et de Gestion
Université de N'Djamena
Chad
e-mail: abba_danna@yahoo.fr

[2]Département de Mathématiques et Informatique
Faculté des Sciences Exactes et Appliqées
Université de N'Djamena
Chad
e-mail: bakariabbo@yahoo.fr

[3]Unité de Formation et de Recherche-Sciences Exactes et Appliquées
Université de Ouagadougou
Burkina Faso
e-mail: pareyoussouf@yahoo.fr
some@ouaga-univ.bf

[4]Université Ouaga I Pr Joseph Ki-Zerbo
Ouagadougou
Burkina Faso

Received: December 26, 2016; Accepted: March 2, 2017

2010 Mathematics Subject Classification: 90-XX, 90Bxx, 90Cxx, 49-XX, 65Kxx.

Keywords and phrases: operations research, economic function, variables, functional constraints, equations, inequations, food products, methods of simplex tables, modeling, digital simulation.

Abstract

In this paper, we discuss modeling and digital simulation of a problem of food production in regions of Chad.

In 2005, Chad, a traditionally agricultural and livestock breeding country became member of a select group of oil producing nations. As a matter of fact, over the last decade, the revenues of the oil helped the Chadian authorities to take significant measures to create jobs and to carry out many public works of interest (pavement of thousands of kilometers of roads, creation of countless health infrastructures, elementary, secondary, and higher education institutions, recruitment of thousands of people in the central and decentralized structures of the public administration, etc.) but the traditional sectors of the Chadian economy such as that of tax revenues have been completely or almost completely ignored.

However, with the plummeting price of oil barrel, budget problems were not long in coming to light. Moreover, there have been delays in payments of salaries of civil servants. The reality is that oil revenues alone are not enough.

An addition to these difficulties is the advent of the terrorist group “BOKO-HARAM”, and its misdeeds forced many producers to abandon production areas in the Lake Chad. In the face of substantial declines in income-generating activities, the Chadian government - in a recent policy to promote the development of agriculture - switched to the traditional sectors. Moreover, in addition to the distribution operations launched in previous times, again, dozens of tractors, animal-pulled carts and other accessory tools were provided to decentralized structures of the country. Adversely, arguments on the foreseeable depletion of oil generated resources were pouring in from everywhere and the return to agriculture was loudly proclaimed. Doubtlessly, a very close look into this U-turn to agricultural activities seems to primarily aim at the increase of income for farmers and its relieving beneficial effects on the sharply declining oil revenues.

It is under this new policy that a research team from the University of N'Djamena and the Virtual University of Chad (UVT) became interested in this study on modeling and digital simulation of activities of essential food production among others as well as the monitoring of populations. Also, investigations conducted in the central and eastern regions resulted in disturbing findings according to ECOSITE [6]. Hence the imperative for teachers and researchers to conduct studies and research in the agricultural sector in order to help policymakers anticipate possible deterioration of the economic situation of the country. This strategy may be used sustainably to improve the speed and quality of decision in the presence of the problems facing leaders in practical life while these are most often of a dynamic optimization. This operation requires the use of linear programming.

Very briefly explained, linear programming is an optimization method that, as it is called, deals with linear structural problems. But the nature of most issues including economic ones is probably not linear.

This modeling and numerical simulation study focuses on a sample of fifty thousand (50,000) families randomly selected in regions of the central and eastern Chad. Furthermore, it is assumed that the farmers in the study areas produce four types of food products; namely sorghum, corn, sesame, and peanuts which constitute the basis of the people's diet without chemical inputs. The usual production target is of 400 tons of sesame, 2,200 tons of corn, 3,400 tons of sorghum and 310 tons of peanuts.

Furthermore, it is assumed that land as a production factor is abundant in the study area. Finally, the number of hours required to produce a ton of each foodstuff, the number of hours available by business as well as the benefits in euros obtained per ton are indicated in the following table:

Number of hours per ton and by type of commodity and industries. Vol. hrs/t

Activity sectors\ Vol. hrs/t	Number of hours\ ton of sesame	Number of hours\ ton of corn
Clearing	5 hrs	4 hrs
Cultivating	4 hrs	3 hrs
Sowing	3 hrs	4 hrs
Weeding	5 hrs	3 hrs
Harvesting	4 hrs	5 hrs
Contribution benefit in euros	260 euros	270 euros

Sources: Our development in 2016.

Producer organizations want to know whether by changing their current production program, they can achieve maximum benefit for the families involved in these activities.

In order to solve this problem, the methods and optimization techniques of our approach is as follows:

(1) Identification of variables or unknowns of the model

Note:

X_1, the number of tons of sesame expected;

X_2, the number of tons of corn expected;

X_3, the number of tons of sorghum expected;

X_4, the number of tons of peanuts to produce.

(2) Formulation of the system of functional constraints

$$\text{Max}(Z) = 260X_1 + 270X_2 + 280X_3 + 300X_4$$

subject to functional constraints:

$$\begin{cases} \text{Clearing:} & 5X_1 + 4X_2 + 3X_3 + 3X_4 \le 35000 & (1) \\ \text{Plowing:} & 4X_1 + 3X_2 + 4X_3 + 5X_4 \le 33000 & (2) \\ \text{Sowing:} & 3X_1 + 4X_2 + 5X_3 + 4X_4 \le 34000 & (3) \\ \text{Weeding:} & 5X_1 + 3X_2 + 4X_3 + 2X_4 \le 32000 & (4) \\ \text{Harvesting:} & 4X_1 + 5X_2 + 3X_3 + 3X_4 \le 36000 & (5) \end{cases}$$

(3) Development of the economic function *Z*

$$Z = \text{Max}(Z) = 260X_1 + 270X_2 + 280X_3 + 300X_4,$$

where Z is the total target income in euros that is to be achieved.

(4) The constraints of non-negativity or positivity

$$X_1 \ge 0,\ X_2 \ge 0,\ X_3 \ge 0,\ X_4 \ge 0.$$

Formulation of the linear programming model

$$\text{Max}(Z) = 260X_1 + 270X_2 + 280X_3 + 300X_4$$

subject to functional constraints:

$$\begin{cases} 5X_1 + 4X_2 + 3X_3 + 3X_4 \le 35000 & (1) \\ 4X_1 + 3X_2 + 4X_3 + 5X_4 \le 33000 & (2) \\ 3X_1 + 4X_2 + 5X_3 + 4X_4 \le 34000 & (3) \\ 5X_1 + 3X_2 + 4X_3 + 2X_4 \le 32000 & (4) \\ 4X_1 + 5X_2 + 3X_3 + 3X_4 \le 36000 & (5) \end{cases}$$

with

$$X_1 \ge 0,\ X_2 \ge 0,\ X_3 \ge 0 \text{ and } X_4 \ge 0.$$

To solve this linear program, we introduce five slack variables per constraint.

Let X_5, X_6, X_7, X_8 and X_9 be these variables.

After introducing the slack variables, the program becomes:

$$\text{Max}(Z) = 260X_1 + 270X_2 + 280X_3 + 300X_4 + 0X_5 + 0X_6 + 0X_7 + 0X_8 + 0X_9$$

S/C

$$\begin{cases} 5X_1 + 4X_2 + 3X_3 + 3X_4 + 0X_5 + 0X_6 + 0X_7 + 0X_8 + 0X_9 = 35000 & (1') \\ 4X_1 + 3X_2 + 4X_3 + 5X_4 + 0X_5 + 0X_6 + 0X_7 + 0X_8 + 0X_9 = 33000 & (2') \\ 3X_1 + 4X_2 + 5X_3 + 4X_4 + 0X_5 + 0X_6 + X_7 + 0X_8 + 0X_9 = 34000 & (3') \\ 5X_1 + 3X_2 + 4X_3 + 2X_4 + 0X_5 + 0X_6 + 0X_7 + 0X_8 + 0X_9 = 32000 & (4') \\ 4X_1 + 5X_2 + 3X_3 + 3X_4 + 0X_5 + 0X_6 + 0X_7 + 0X_8 + X_9 = 36000 & (5') \end{cases}$$

with

$$X_1 \geq 0,\ X_2 \geq 0,\ X_3 \geq 0,\ X_4 \geq 0,\ X_5 \geq 0,\ X_6 \geq 0,\ X_7 \geq 0,$$
$$X_8 \geq 0,\ X_9 \geq 0.$$

Resolution of this program is presented by the method of simplex tables:

Table 1

Econ. coeff. C_j	260	270	280	300	0	0	0	0	0
CP PB Q	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
0 X_5 35000	5	4	3	3	1	0	0	0	0
0 X_6 33000	4	3	4	5	0	1	0	0	0
0 X_7 34000	3	4	5	4	0	0	1	0	0
X_8 32000	5	3	4	2	0	0	0	1	0
0 X_9 36000	4	5	3	4	0	0	0	0	1
$Z_0 = 0$ €									
Z_j	0	0	0	0	0	0	0	0	0
$[C_j - Z_j]$	260	270	280	300	0	0	0	0	0

Observations. Is this table optimal? No! The elements of the line $(C_j - Z_j)$ are not all 0. Indeed, $(C_1 - Z_1) = 260 > 0$; $(C_2 - Z_2) = 270 > 0$; $(C_j - Z_j) = 280 > 0$; $(C_j - Z_j) = 300 > 0$. Therefore, we need to do iteration building Table 2. For that we must proceed in a similar way as that in the previous one.

Thus:

- **Researching the incoming variable**

$$Max(C_1 - Z_1) = \max(260;\ 270;\ 280;\ 300 > 0) = 300.$$

$X_4 \rightarrow X_4$ is the incoming variable (X_4, with its coefficient 300, is taken into Table 2).

- **Researching the outgoing variable**

To this end, we have to divide the elements of the quantity column by the corresponding elements in the column of the incoming variable:

$$Min(35.000/4 = 8.750;\ 33.000/5 = 6.600;\ 34.000/4 = 8.500;$$

$$32.000/2 = 16.000;\ 36.000/4 = 9.000) = 6.600\text{:}\ X_6 \Rightarrow X_6$$

is the outgoing variable (naturally X_6 comes out with its 0 coefficient) and the pivot is the element at the intersection of column variable and the incoming line of the outgoing variable, that is to say, 5. It is with this element called a *pivot* that we will proceed to get Table 2, through a series of steps to get the numbers: replacing the pivot with 1, and the other elements of the pivot column with zero (0).

We get:

(1) First operation on the fourth line (L2)

Obtain the number 1 in place of the pivot (5); to this end, we have to divide the pivot itself and therefore we divide all other elements of the pivot row by the pivot.

We get:

6600	4/5	3/5	4/5	1	0	1/5	0	0	0

(2) Second operation on the first line (L1): get a zero instead of 3

35000	5	4	3	3	1	0	0	0	0	
	6600	4/5	3/5	4/5	1	0	1/5	0	0	0

$$\begin{cases} -3x(6600) & + & 35000 & = & 15200 \\ -3x(4/5) & + & 5 & = & 13/5 \\ -3x(3/5) & + & 4 & = & 11/5 \\ -3x(4/5) & + & 3 & = & 3/5 \\ -3x(1) & + & 3 & = & 0 \\ -3x(0) & + & 0 & = & -3/5 \\ -3x(0) & + & 1 & = & 1 \\ -3x(0) & + & 0 & = & 0 \\ -3x(0) & + & 0 & = & 0 \\ -3x(0) & + & 0 & = & 0. \end{cases}$$

(3) Third operation on the third line (L3): get a zero instead of 4*

	6600	4/5	3/5	4/5	1	0	1/5	0	0	0
34000	3	4	5	4	0	0	1	0	0	

$$\begin{cases} -4x(6600) & + & 34000 & = & 7600 \\ -4x(4/5) & + & 3 & = & 1/5 \\ -4x(3/5) & + & 4 & = & 8/5 \\ -4x(4/5) & + & 5 & = & 9/5 \\ -4x(1) & + & 4 & = & 0 \\ -4x(0) & + & 0 & = & 0 \\ -4x(1/5) & + & 0 & = & -4/5 \\ -4x(0) & + & 1 & = & 1 \\ -4x(0) & + & 0 & = & 0 \\ -4x(0) & + & 0 & = & 0. \end{cases}$$

(4) Fourth operation on the fourth line (L4): get a zero instead of 2

	6600	4/5	3/5	4/5	1	0	1/5	0	0	0
32000	5	3	4	2	0	0	0	1	0	

$$\begin{cases} -2x(6600) & + & 32000 & = & 18800 \\ -2x(4/5) & + & 5 & = & 7/5 \\ -2x(3/5) & + & 3 & = & 9/5 \\ -2x(4/5) & + & 5 & = & 9/5 \\ -2x(1) & + & 4 & = & 0 \\ -2x(0) & + & 0 & = & 0 \\ -2x(1/5) & + & 0 & = & -4/5 \\ -2x(0) & + & 1 & = & 1 \\ -2x(0) & + & 1 & = & 1 \\ -2x(0) & + & 0 & = & 0. \end{cases}$$

(5) Fifth operation on the fifth line (L5): get a zero instead of 4

	6600	4/5	3/5	4/5	1	0	1/5	0	0	0
36000	4	5	3	4	0	0	0	0	1	

$$\begin{cases} -4x(6600) & + & 36000 & = & 9600 \\ -4x(4/5) & + & 4 & = & 1 \\ -4x(3/5) & + & 5 & = & 13/5 \\ -4x(4/5) & + & 3 & = & -1/5 \\ -4x(1) & + & 4 & = & 0 \\ -4x(0) & + & 0 & = & 0 \\ -4x(1/5) & + & 0 & = & -4/5 \\ -4x(0) & + & 0 & = & 0 \\ -4x(0) & + & 0 & = & 0 \\ -4x(0) & + & 1 & = & 0. \end{cases}$$

Table 2

Econ. coeff. C_j	260	270	280	300	0	0	0	0	0
CP PB Q	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
0 X_5 15200	13/5	11/5	3/5	0	1	-3/5	0	0	0
300 X_4 6600	4/5	3/5	4/5	1	0	1/5	0	0	0
←0 X_7 7600	-1/5	8/5	9/5	0	0	-4/5	1	0	0
X_8 18800	7/5	9/5	12/5	0	0	-2/5	0	1	0
0 X_9 9600	1	13/5	-1/5	0	0	-4/5	0	0	0
Z_1 = 1980000 €									
Z_j	240	180	240	300	0	60	0	0	0
$[C_j – Z_j]$	20	90	40	0	0	-60	0	0	0

Observations. Is this table optimal? No! The elements of the line $(C_j - Z_j)$ are not all 0. Indeed, $(C_1 - Z_1) = 20 > 0$; $(C_2 - Z_2) = 90 > 0$; $(C_3 - Z_3) = 40 > 0 \ldots$. Therefore, we have to do iteration in constructing Table 3. For that we must proceed in a similar way as that in the previous one.

Thus:

• **Researching the incoming variable**

$$(C_j - Z_j) = Max(20;\ 90;\ 40) = 90:\ X_2$$

$\rightarrow X_2$ is the incoming variable (X_2 incomes with its coefficient 270 in Table 3).

• **Researching the outgoing variable**

To this end, we have to divide the elements of the quantity column by the corresponding elements in the column of the incoming variable:

$$Min\{15200/11/5 = 6909.09;\ 6600/3/5 = 11000;\ 7600/8/5 = 4750;$$

$$18800/9/5 = 10444.44;\ 9600/13/5\}.$$

X_9 is the outbound variable (naturally, X_9 comes with its coefficient 0) and the pivot is the element at the intersection of the variable column and row of the variable, so that is to say 13/5, and it is with this element called a *pivot* that we will start to get the numbers: 1 instead of the pin (13/5) and zero (0) instead of the other elements of the pivot column.

(6) First operation on the fifth line (L5)

Get the number 1 instead of the pin (13/5); for this purpose, we have to divide the pivot by itself and therefore, we have to divide all other elements of the line of the pivot by the pivot.

We get: (9600/13/5)

3,692.30	5/13	1	-	0	0	-	0	0	0	0
			1/13			4/13				

(7) Second operation on the first line (L1): get a zero instead of 13/5

	3,692.30	5/13	1	-1/13	0	0	-4/13	0	0	0
15200	13/5	11/5	3/5	0	1	-3/5	0	0	0	

$$\begin{cases} -13/5x(9600/13/5) & + & 15200 & = & 5600 \\ -13/5x(5/13) & + & 13/5 & = & 8/5 \\ -13/5x(1) & + & 11/5 & = & 0 \\ -13/5x(-1/13) & + & 3/5 & = & 4/5 \\ -13/5x(0) & + & 0 & = & 0 \\ -13/5x(0) & + & 1 & = & 1 \\ -13/5x(-4/13) & - & 3/5 & = & 1/5 \\ -13/5x(0) & + & 0 & = & 0 \\ -13/5x(0) & + & 0 & = & 0 \\ -13/5x(0) & + & 0 & = & 0. \end{cases}$$

(8) Third operation on the second line (L2): get a zero instead of 3/5

	3,692.30	5/13	1	-1/13	0	0	-4/13	0	0	0
6600	4/5	3/5	4/5	1	0	1/5	0	0	0	

$$\left\{\begin{array}{llll}
-3/5x(9600/13/5) & + & 6600 & = & 438462 \\
-3/5x(5/13) & + & 4/5 & = & 37/65 \\
-3/5x(1) & + & 3/5 & = & 0 \\
-13/5x(-1/13) & + & 4/5 & = & 11/13 \\
-13/5x(0) & + & 1 & = & 1 \\
-13/5x(0) & + & 0 & = & 0 \\
-13/5x(-4/13) & + & 1/5 & = & 5/13 \\
-13/5x(0) & + & 0 & = & 0 \\
-13/5x(0) & + & 0 & = & 0 \\
-13/5x(0) & + & 0 & = & 0.
\end{array}\right.$$

(9) Fourth operation on the third line (L3): get a zero instead of 8/5

3,692.30	5/13	1	-	0	0	-	0	0	0
			1/13			4/13			

7600	-1/5	8/5	9/5	0	0	-	1	0	0
			1/13			4/5			

$$\left\{\begin{array}{llll}
-8/5x(9600/13/5) & + & 7600 & = & 1692.31 \\
-8/5x(5/13) & - & 1/5 & = & -53/65 \\
-8/5x(1) & + & 8/5 & = & 0 \\
-8/5x(-1/13) & + & 9/5 & = & 1/5 \\
-8/5x(0) & + & 0 & = & 0 \\
-8/5x(0) & + & 0 & = & 0 \\
-8/5x(-4/13) & - & 4/5 & = & -4/13 \\
-8/5x(0) & + & 1 & = & 1 \\
-8/5x(0) & + & 0 & = & 0 \\
-8/5x(0) & + & 0 & = & 0.
\end{array}\right.$$

(10) Fifth operation on the fourth line (L4): get a zero instead of 9/5

	3,692.30	5/13	1	-1/13	0	0	-4/13	0	0	0
18800	7/5	9/5	12/5	0	0	-2/5	0	1	0	

$$\begin{cases} -9/5x(9600/13/5) & + & 18800 & = & 1215385 \\ -9/5x(5/13) & + & 7/5 & = & 46/65 \\ -9/5x(1) & + & 9/5 & = & 0 \\ -9/5x(-1/13) & + & 12/5 & = & 33/13 \\ -9/5x(0) & + & 0 & = & 0 \\ -9/5x(0) & + & 0 & = & 0 \\ -9/5x(-4/13) & - & 2/5 & = & 2/13 \\ -9/5x(0) & + & 0 & = & 0 \\ -9/5x(0) & + & 0 & = & 0 \\ -9/5x(0) & + & 0 & = & 0. \end{cases}$$

Table 3

Econ. coeff. C_j	260	270	280	300	0	0	0	0	0
CP PB Q	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
0 X_5 5600	8/5	0	4/5	0	1	1/5	0	0	0
300 X_4 4.384,62	37/65	0	11/13	1	0	5/13	0	0	0
←0 X_7 1.692,31	-53/65	0	1/5	0	0	-4/13	1	0	0
X_8 12.153,85	46/65	0	33/13	0	0	2/13	0	0	0
270 X_2 9.600/13/5	5/13	1	-1/13	0	0	-4/13	0	0	0
Z_3 = 1319078,08 €									
Z_j	274,62	270	-210	300	0		0	0	0
$[C_j - Z_j]$	-14,62	0	0	0	0	-32,31	0	0	0

Observations. Is this table optimal? No! The elements of the line $(C_j - Z_j)$ are not all 0. Indeed, $(C_3 - Z_3) = 70 > 0.$ Therefore, we need to do iteration in constructing Table 4. For that we must proceed in a similar way as that in the previous one.

Thus:

- **Researching the entering variable**

$Max(C_j - Z_j) = Max(70) = 70$: $X_3 \rightarrow X_3$ is the incoming variable (X_3 incomes with its coefficient in Table 2).

- **Researching the outgoing variable**

To this end, we have to divide the elements of the quantity column by the corresponding elements in the column of the incoming variable:

$$Min\{5600/4/5 = 7000;\ 4384.62/11/13 = 5181.82;\ 1692.31/1/5 = 8461.55;$$
$$12153.85/33/13 = 4787.88\}$$

which implies that X_9 outbounds the variable (naturally, X_9 exists with its coefficient 0) and the pivot pin is the element at the intersection of the incoming variable column and line outbound variable, that is to say, 13/5, and it is with this element, called a *pivot* that we will start to get the numbers: use 1 instead of the pivot (33/5), and (0) instead of the other elements of the pivot column.

(11) First operation on the fourth line (L4): get the figure 1 instead of the pivot (33/13)

To this end, we have to divide the pivot by itself and therefore, we must divide all other elements of the line of the pivot by the pivot.

We get: (9600/13/5)

4,787.88	46/165	0	1	0	2/33	0	0	0

(12) Second operation on the first row line (L1): get a zero instead of 4/5

5,600	8/5	0	4/5	0	1	1/5	0	0	0	
	4,787.88	46/165	0	1	0	0	2/33	0	0	0

(13) Third operation on the second line (L2): get a zero instead of 11/13

4,384.62	37/65	0	11/13	1	0	5/13	0	0	0	
	4,787.88	46/165	0	1	0	0	2/33	0	0	0

(14) Fourth operation on the third line (L3): get a zero instead of 1/5

1,692.31	-53/65	0	1/5	0	0	-4/13	1	0	0
4,787.88	46/165	0	1	0	0	2/23	0	0	0

(15) Fifth operation on the fifth line (L5): get a zero instead of -1/13

9,600/13/5	5/13	1	-1/13	0	0	-4/13	0	0	0
4,787.88	46/165	0	1	0	0	2/23	0	0	0

Table 4

Econ. coeff. C_j	260	270	280	300	0	0	0	0	0
CP PB Q	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
0 X_5 1.769,70	1136/825	0	0	0	1	5/33	0	0	0
300 X_4 333,37	11/33	0	0	1	0	1/3	0	0	0
0 X_7 734,73	-0,54	0	0	0	0	0,32	1	0	0
280 X_3 4.787,88	46/165	0	1	0	0	2/33	0	0	0
270 X_2 4.060,61	0,41	1	0	0	0	-40	0	0	0
Z_4 = 1441713,76 €									
Z_j	288,76	270	280	300	0	8,97	280	0	0
$[C_j - Z_j]$	-28,76	0	0	0	0	-8,97	-280	0	0

Observations. We notice that all the elements of the line $(C_j - Z_j)$ are either negative or nil. The optimal solution is reached and it is as follows:

Comments. Given the digital data shown in the original table, a brief reading of Table 4 giving the optimal solution theoretically allows to make the following observations:

(1) $X_2 = 4{,}060.61$ tons of corn instead of the 2200 tons expected;

$X_3 = 4{,}787.88$ tons of sorghum instead of the 3400 tons planned for and

$X_4 = 333{,}37$ tons of peanuts instead of the 310 tons expected.

These results show that the quantities usually produced are by far exceeded. However, the commodities whose production was not under forecast by the program such as $X_5 = 1.769,70$ tons and $X_7 = 734,73$ tons offer information on interesting and feasible options for making choices in future times. But for now, they are of no interest to producers as they correspond to downtime in farming.

(2) Alternatively, $X_1 = 0$ tons of sesame indicates that the production of this foodstuff does not present any interest to producers. In this case, the root causes of low result should be explored.

(3) $Z_4 = 1{,}441{,}713.76e$ indicating the overall benefit shows the condition according to which producers who invest in these agricultural activities will not regret it.

(4) Finally, further research may investigate into various directions such as: (a) extending the field of study to other production activities; and (b) increasing the sample size.

Finally, the debate remains open to researchers who would like to take an interest in the field of agriculture activities that, despite major efforts already made, the field remains pristine. Furthermore, this study is not at all immune from deficiencies and inaccuracies. Any observations to improve its scientific quality is welcome.

References

[1] Bruno Simeone, Préférenze e Décisioni, anno accademico 1994-95, Scuola di specializzazione in Riciercaoperativa e Decisionali strategy, Università di Roma “La Sapienza”, Italy, pp. 136.

[2] Bruno Simeone, Metodi di Matematiciottimizzazione, annaacademico 1994-95, Dipartimento di Statistica, probabilità, statisticheapplicate, Università “La Sapienza”, Italy, pp. 194.

[3] G. Baillargeon, Linear Programming, Support to Economic and Technical Decision, SMG Publishing, Trois-Rivières, 1996, pp. 372.

[4] G. Baillargeon, Modeling and Optimization, 2nd ed, SMG Publishing, Trois-Rivières, 1997, pp. 188.

[5] Ministry of Agriculture of the Republic of Chad: Chad PNISR the validated version 2014, National Investment Plan of the Rural Sector of the Chad-PNSIR2014-2020, pp. 101.

[6] Ministry of Agriculture of the Republic of Chad: Five Year Development Plan of Agriculture in Chad, Document Principal, 2013, pp. 58.

[7] Priority Country Resilience PRP Chad, 2015, pp. 113.