LINEAR PROGRAMMING : A BOON FOR FARMERS

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Abstract— **As we all know that condition of most farmers especially in India is horrible. The agriculture supports nearly 50 percent [2] of the employment but contributes only 15 percent to the Gross Domestic Product (GDP). Every day there is news coming on farmers suicides from different parts of the country. We should start thinking about farmers and their families and must try to find out different ways to help them. Nowadays, due to some policies taken by Indian Government, Indian farmers are massively coming together against these policies issued by government (against privatization) [4]Linear Programming can help them a lot to improve their condition .They will came to know which crop and in how much quantity they should plant their crop to earn maximum profit.**

Keywords— **Feasible region, feasible solution, optimal solution, optimal value**

I.   INTRODUCTION

Here are some of the examples where using LP is so much beneficial : Just think of a bakery which is in loss just because the workers and the owner of that bakery does not know that in how much quantity of food item they should produce and how much raw material is required[5] .A   small company which is not flourishing much because it does not know how many employees are required to achieve its targets. We just want best in less time and resources .Even when we move out of our house to reach our destination we all use google maps to get the shortest route to reach our destination.[1]A factory which is flourishing day by day because it knows how many workers and in which quantity of raw material is required to make a product. **[8]** Think of a transportation company who knows the best routes to transport products from different sources to different destinations   so that transportation cost is minimum.[2-5]. In all above examples what do you think how the factory owner and the transportation owner knows that how many workers[11] and how much quantity of raw material are required and what are the strategies used by transportation owner.They are using linear programming.

II.   PROPOSED ALGORITHM

A.   **Mathematical form of Linear Programming --**
Basically the use of linear programming is optimization of resources that is maximize our profit and minimize the cost (or time).From a small business to a big business ,from morning to evening in our daily life , everywhere we are using optimization. [2]LPP is the programming of allocation of limited resources subject to some constraints. Programming problems are optimization (maximization or minimization) problems. [8]Here we optimize Z (an objective function) that is subject to constraints .It also includes the variables that satisfy non negative constraints .So, an LPP has an objective function constraints (which may be equalities or inequalities) and non - negative condition[12] .General LPP can be written as:

Max/Min $z = c_1 x_1 + c_2 x_2 + \ldots + c_n x_n$

subject   to (s. t.)

$a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \;(\geq$ or $=$ or $\leq$ $)\; b_1$

$a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n \;(\geq$ or $=$ or $\leq$ $)\; b_2$

.
.
.

$a_{m1}x_1 + a_{m2}x_2 + \ldots + a_{mn}x_n \;(\geq$ or $=$ or $\leq$ $)\; b_m$

$x_j \geq 0$ **for all** $j= 1,2,3,\ldots,n$

$c_1,c_2,\ldots,c_n$ cost   coefficients
$b_1,b_2,\ldots,b_n$ decision variables
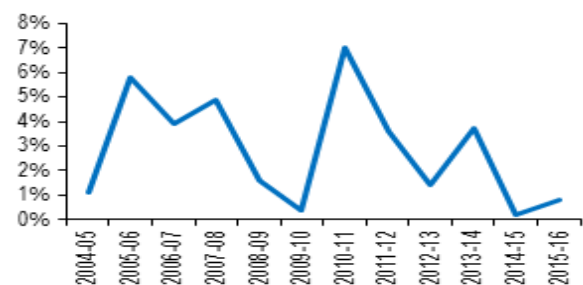$x_1,x_2,\ldots, x_n$ required coefficients

Fig. 1. Growth in agriculture sector (%)

B. Some Important terms --

- **Feasible Solution**: The value of (x , y) that satisfies all constraints and non-negativity condition is called feasible solution.[7]

- **Feasible Region** : Set of all feasible solutions i.e. All the values (x , y) that satisfies all constraints and non-negativity condition.

- **Optimal Solution** : A feasible solution that optimizes the objective function is an optimal solution.

- **Optimal Value**: The value of the objective function at the optimal solution.[9]

III. EXPERIMENT AND RESULT

A farmer has 150 hectares piece of land. He decided to grow wheat and rice on that 150 hectares of land. He wants to know how to plant each variety in the 150 hectares.
Here is the data:

Table-1 Wheat and Rice infomation

Crop	Cost per hectare	Days Labor take per hectare	Total profit per hectare
Wheat	300	20	800
Rice	100	50	1200

Farmer's budget=80000
Labor days(Man days)=1200
To find
(i) optimal value
(ii) optimal solution

Steps to solve this problem:

Step 1: Identifying decision variables

Let area for growing crop1 (Wheat) is X (in hectares)

And area for growing crop2 (Rice) is Y (in hectares)

where X and Y are the decision variables.

Step 2: This step involves finding (writing) objective function.

Given : profit for wheat = Rs. 800 per hectare

Profit for rice = Rs. 1200 per hectare

Objective function :

Max $Z = 800X + 1200Y$

Step 3: This step involves finding(or writing) the constraints:[4]

Given: Farmer's total budget : Rs. 80,000

Also Given: per hectare cost (for producing rice and wheat)

So, constraint 1 is given by:

$300 X + 100 Y \leq 80,000$

Given: Labour(Man) days =1200.

Now using above information, next constraint is :

$20X + 50Y \leq 1200$

Given: Total Area = 150 hectares

So the last constraint is:

$X + Y \leq 150$

Step 4: The non-negative condition[7]:

As X is area for growing crop1 (Wheat) and Y is area for growing crop2(Rice) .

Area can not be negative .So, both X and Y must be $\geq$ 0.

$X \geq 0, Y \geq 0$

So , these are the steps involved to solve this problem.

Graphical Solution:

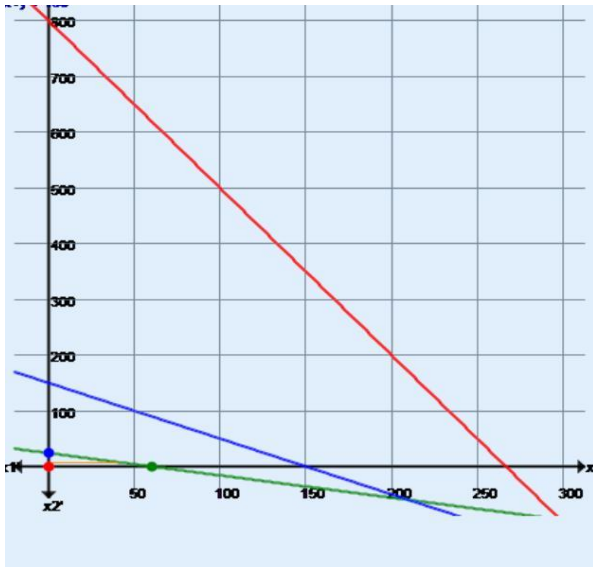After solving we get:

Table-2 Experiment Result

Extreme Point Coordinates (x_1, x_2)	Lines through Extreme Point	Objective function value $Z = 800x_1 + 1200x_2$
$O(0, 0)$	$4 \rightarrow x_1 \geq 0$ $5 \rightarrow x_2 \geq 0$	$800(0) + 1200(0) = 0$
$A(60, 0)$	$2 \rightarrow 20x_1 + 50x_2 \leq 1200$ $5 \rightarrow x_2 \geq 0$	$800(60) + 1200(0) = 48000$
$B(0, 24)$	$2 \rightarrow 20x_1 + 50x_2 \leq 1200$ $4 \rightarrow x_1 \geq 0$	$800(0) + 1200(24) = 28800$

The values of Z at extreme points O, A and B are :

At O (0, 0)   = 0
At A (60, 0)   = 48,000
At B (0, 24)   = 28,800

This is the graph

The maximum value of the objective function Z=48000 occurs at the extreme point (60, 0).Hence , the optimal solution to the given LP problem is:X1=60, X2=0 and max Z= 48000.Total area for growing wheat is 60 hectares and for rice is 0 hectare.

To solve this problem in R , we have install a package "lpSolve".[6]

This is the solution using R software.

```
> #Objective values of x and y
> opt$solution
[1] 60  0
>
> #Value of objective function at optimal point
> opt$objval
[1] 48000
```

Problem 2:

Let's look at a simple LP model for a small farm with the following details.[4]
Each year, four crops can be grown: jeera , wheat, mung , and cotton. Each has its own set of labour and mules specifications per hector.

Table-3 Information regarding crops

CROPS	Jeera	Wheat	Mung	cotton	RHS
Objective Function(pesos)	1372	1219	1523	4874	maximize
Land(ha)	0	0	0	1	≤5.0
Labor (months)	1.42	1.87	1.92	2.64	≤ 16.5
Mules (months)	1.45	1.27	1.16	1.45	≤ 10.0
Market Constraint (tons)	-	-	-	0.983	≤ 0.5

The amount of labour given by family workers over the course of the year could amount to a number of months.[2] The farm family owns a mule (draught animal services) that will provide draught control for 10 months of the year.
Let X_1=jeera, X_2=wheat, X_3= mung, and X_4=cotton be the inputs to the model.

$$\text{Max } Z = 1372 X_1 + 1219 X_2 + 1523 X_3 + 4874 X_4$$

Sub to Constraints:

$$1X_4 \le 5$$
$$1.42X_1 + 1.87X_2 + 1.92X_3 + 2.64X_4 \le 16.5$$
$$1.45X_1 + 1.27X_2 + 1.16X_3 + 1.45X_4 \le 10.0$$
$$0.983X_4 \le 0.5$$

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

X_1 = jeera =1.02/ha wheat=0 X_2= =mung= 7.14/ha X_3 0.50/ha X_4=cotton is the best answer.

Problem 3

Fertilizer Mix Problem

Super-Gro and Crop-Quick are two fertiliser brands that are accessible. [7]A minimum of 16 gramme of nitrogen and 24 gramme of phosphorus are needed in the field. Super-Gro costs Rs6 per bag, while Crop-Quick costs Rs3. Given the following information, how much of each brand should be purchased to reduce overall fertiliser costs?

Table - 4 Chemical contribution information

Chemical contribution		
Brand	Nitrogen (gram/bag)	Phosphate (gram/bag)
Super –gro	2	4
Crop- quick	4	3

The model's formulation
Consider the decision variables X_1 and X_2.
X_1 = Super-Gro bags
X_2 = Crop-Quick bags
The Role of the Objective:
Reduce to a bare minimum $6X_1 + 3X_2 = Z$
Constraints imposed:

$16 \leq 2X_1 + 4X_2$ (nitrogen constraint)
$24 \leq 4X_1 + 3X_2$ (phosphate constraint)

$X_1 >= 0, X_2 >= 0, X_3 >= 0, X_4 >= 0$
(Constraint of non-negativity)

The best option is to
$X_1 = 6 =$ Super-Gro bags (gram).

IV. CONCLUSION

In problem 1, The farmer should plant wheat in 60 hectares of land. He should not plant rice in that land. He will earn a profit of rupees 48000. So, the problem which was defined above is solved now. It sounds strange that the farmer should use only in 60 hectares of land out of 120 hectares of land but if he use rest of the land for planting rice then it will not be beneficial for him. Linear Programming gives best solution in limited resources. So, if Linear Programming is used in farming sector then the day is not so far when there will be no case of any suicides by any farmer and our country India will become " Sone ki Chidiya " again.

V. REFERENCE

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