

Computational Experiences of Assignment Problems in Agricultural Sector

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ABSTRACT

Agricultural economics which strives for scientific planning in agriculture has become a significant area of specialization in Agriculture. Allocation of available resources to necessary activities in order to minimize the cost/time/wastage or to maximize the profit/effectiveness/quality has identified as one of the key area of decision making in agricultural sector; however, farm planners can offer effective techniques like Assignment Problem to address such a problem and produce optimal solutions. In the first phase of process, a real-time problem has to be converted into an Assignment Problem and in the second phase, the Assignment Problem will be solved for its optimum solution using *Hungarian's method*, widely used procedure to solve the Assignment Problem very effectively. But manual computations of these methods are quite lengthy and consume more time when the number of allocations exceeds three. However, quick and easy solutions became mandate for any cost reduction methodologies as the decision makers are not willing to pay more time at the initial stage of planning *per se*. Hence, there is a great need to provide not only a scientific and optimum solution but also quick and easy solutions that farm planners are attracted towards scientific decisions by which they can curtail unnecessary expenditure. In this paper, a simple step-wise procedure is developed using *Solver* tool in MS-Excel to solve an Assignment Problem by means of Linear Programming Technique. It is very flexible for the changes (if any) in the initial cost matrix and updates the optimum solution automatically with a single click instead of redesigning the entire procedure.

Key words: Assignment Problem, Agricultural aspects, *Hungarian's method*, LPP and Solver

INTRODUCTION

Generally, farm economists and farm management advisers are frequently dealing with problems relating to the optimal allocation of scarce means between competing purposes. The significance of such challenges in agriculture demands for the scientific programming methods to identify optimal allocation of resources. These allocation problems are successfully solved with the help of optimization technique namely Assignment

Problem (AP) which is a branch of Operations Research. The group comprises problems where we are given a matrix of effectiveness, showing what happens when we associate each of number of origins with each of the same number of destinations in such a way that each origin is to be associated with one and only one destination which provides the minimized/maximized cumulative effectiveness^[3].

Mathematically, the assignment problem is a special form of linear programming model similar to the transportation modeling which 'n' items are distributed among 'n' boxes, one item to a box, in such a way that the resulting return from the distribution is optimized. Trial and error works well enough for this problem, if we have 'n' origins and 'n' destinations then there will be $n!$ (n -factorial) such permutations which means $n!$ ways of assigning 'n' items to 'n' boxes. Suppose we had ten buildings for ten purposes, $10!$ (3628800) combinations of allocations are required to assign one building for one purpose and as 'n' gets large, we have too many trials to consider.

But among them, only one will give the optimum assignment with low cost or high profit. Generally, assignment problems of this kind will be solved using the transportation technique. Each facility can be regarded as a source with one item to be dispatched, and each purpose can be regarded as a destination with unit demand. Each facility may be allocated to only one purpose, and the performance of each facility in each purpose must be known.

The least cost or maximum profit shipment pattern can then be determined, corresponding to the optimal assignment of facilities to purposes^[1].

Further an alternative methodology the "Hungarian's method" is provided by Hungarian mathematician called D. Koenig, for the assignment problem, as developed by Kuhn. This method involves matrix reduction methodology in which subtraction and addition of appropriate values in the matrix yields an optimal solution to the assignment problem which involves a series of simple arithmetic operations on the $n \times n$ cost matrix. The matrix is modified in an iterative manner until at least one zero occurs in each row and in each column, such that 'n' of these zeros can be selected to give an optimal assignment^[2].

But it involves lengthy procedure and takes more time and efforts to achieve the optimal solution to minimize the cost. Sometimes

assignment must be done in order to maximize profits and with unequal facilities (origins) and alternatives (destinations). Such situations can also be dealt effectively using the same Hungarian's method with small modifications. Manual computations of Assignment Problems lead to fatigue if number of origins/destination is more than five. Hence, the situation demands automation of this procedure with simple steps to achieve the solution quickly and easily.

This paper is not only concerned with the special class of allocation problems in agriculture but also with the user-friendly computer oriented procedure to solve an Assignment Problem.

I. METHODOLOGY

2.1 Working Procedure of the Hungarian's Method

The following algorithm is useful to find an optimal assignment matrix to find an optimal assignment.

Step-1: Subtract the smallest entry in each row from all the entries of its row.

Step-2: Subtract the smallest entry in each column from all the entries of its column.

Step-3: Draw lines through appropriate rows and columns so that all the zero entries of the cost matrix are covered and the minimum number of such lines is used.

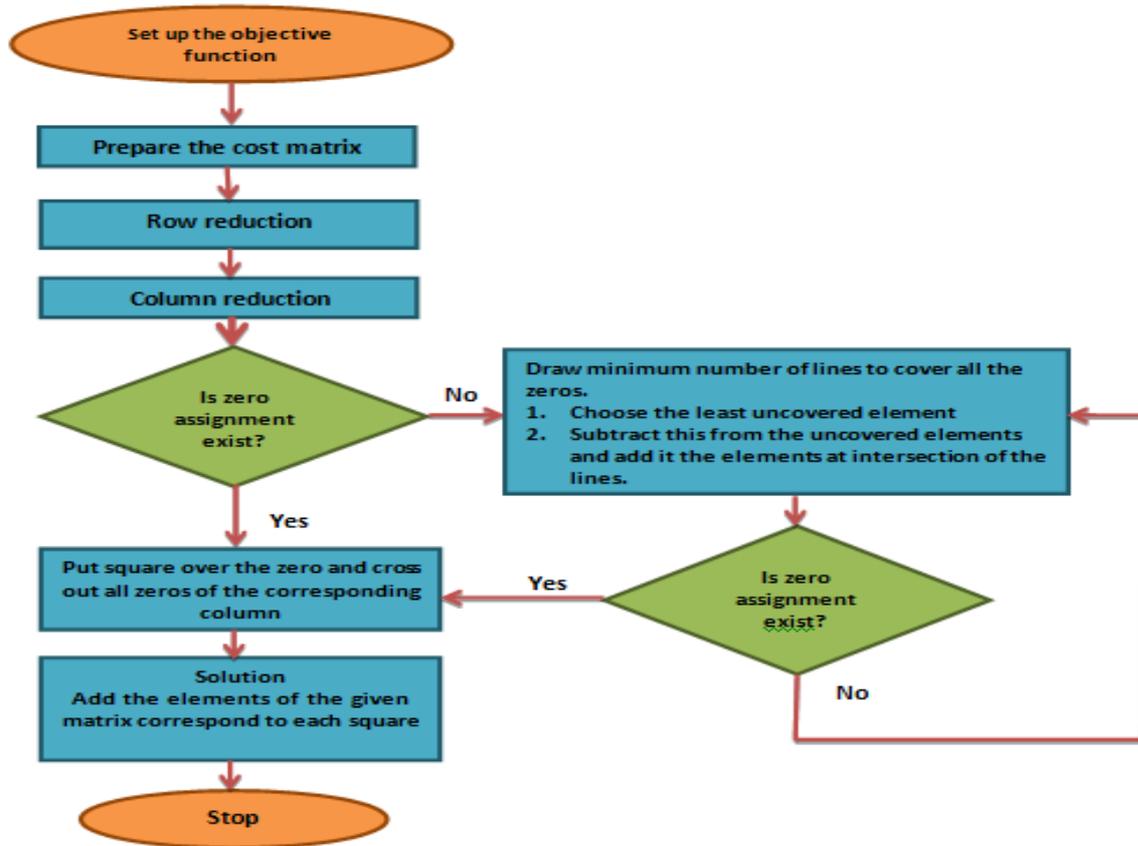
Step-4: Test for Optimality:

(i) If the minimum number of covering lines is n , an optimal assignment of zeros is possible and we arrived to an optimum solution.

(ii) If the minimum number of covering lines is less than n , an optimal assignment of zeros is not yet possible. In that case, proceed to Step 5.

Step-5: Determine the smallest entry not covered by any line. Subtract this entry from each uncovered row, and then add it to each covered column and then return to Step 3.

2.2 Flow chart for Hungarian Method of Optimal Assignment



2.3 Formulation of Assignment problem into Linear Programming Problem:

An Assignment Problem can be solved very easily by modifying as a linear programming problem. Let C_{ij} ($i, j = 1, 2, 3, 4, 5$) is the measure of effectiveness when i^{th} building is assigned to j^{th} purpose. It is also assumed that the overall measure of effectiveness is to be minimized (such as total expenditure to fulfill all purposes). As in the case of transportation problem here also we introduce decision variables X_{ij} with double subscripts so that X_{ij} indicates that the i^{th} building is assigned to j^{th} purpose. But i^{th} building can be assigned to only one purpose and j^{th} purpose can be served by only one building. Hence, the set of constraints will become

Then the Assignment Problem can be formulated as

$$\text{Minimize } Z = C_{11}X_{11} + C_{12}X_{12} + \dots + C_{nn}X_{nn}$$

Subject to

$$X_{i1} + X_{i2} + \dots + X_{in} = 1 \text{ for } i=1, 2, \dots, 5.$$

$$X_{1j} + X_{2j} + \dots + X_{nj} = 1 \text{ for } j=1, 2, \dots, 5.$$

$$X_{ij} = 0 \text{ or } 1.$$

The solution to AP by means of LPP using MS-Excel is explained clearly by Lavanya Kumari.P & Vijaya Kumar.K (2012)^[4]. In this paper several live problems related to Agricultural aspects have been considered and solved. A full-fledged step-wise procedure is provided for one problem and partially for other problems.

2.4 Solver tool in MS-Excel and its Utilities About Solver

Solver is a part of a suite of commands sometimes called **what-if analysis** (what-if analysis tools). With *Solver*, one can find an optimal value for a formula in one cell called the *target cell* on a worksheet. *Solver* works with a group of cells that are related, either directly or indirectly, to the formula in the target cell. *Solver* adjusts the values in the *changing cells* specified, called the adjustable

cells to produce the result specified from the target cell formula. One can apply constraints to restrict the values *Solver* can use in the model, and the constraints can refer to other cells that affect the target cell formula. Use *Solver* to determine the *maximum or minimum* value of one cell by changing other cells, for example, one can change the amount of your projected advertising budget and see the effect on your projected profit amount^[6].

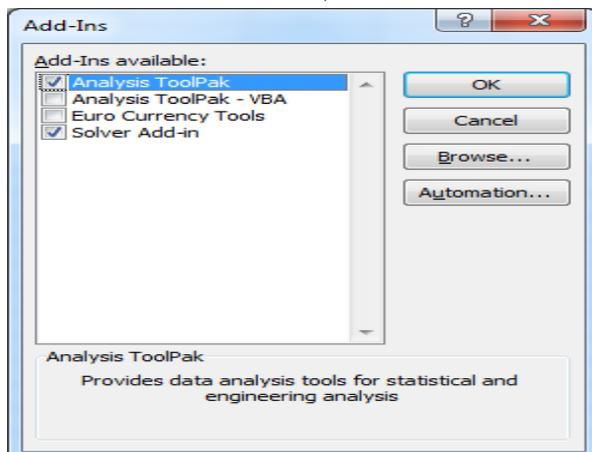
Supporting Terminology

- **What –if –analysis tools:** A process of changing the values in cells to see how those changes affect the outcome of formulas on the worksheet.
- **Formula:** A sequence of values, cell references, names, functions, or operators in a cell that together produce a new value. A formula always begins with an equal sign (=).
- **Constraints:** The limitations placed on a Solver problem. One can apply constraints to adjustable cells, the target cell, or other cells that are directly or indirectly related to the target cell.

2.5 How to Install Solver In Excel

Excel has a built-in statistical package for carrying out LPP. This feature is usually hidden and can be brought out to the menu by clicking the button sequencing.

Office button → excel options → add- ins → analysis tool pack and solver add-in(as shown in MS-Excel Screen below)→ ok.



Then, the solver can be included in the menu of ‘data’ automatically.

II. RESULTS AND DISCUSSION

Allocation problems related Agricultural aspects discussed in this section have been taken from^[5] directly for the sake of demonstration of developed procedure using *solver* tool in MS-Excel.

Problem-3.1:

A farmer intends to plant four different crops in each of four equal sized paddocks. The paddocks vary in soil fertility and the crops vary in their nutrient requirements, so that the costs of the fertilizers which must be applied depend on which crop is grown in which paddock. The associated cost matrix showing fertilizer costs for each crop in each paddock is given in table-3.1.

Crops	Paddocks			
	A	B	C	D
I	2000	3000	1000	1000
II	5000	8000	3000	2000
III	4000	9000	6000	1000
IV	8000	7000	8000	4000

Solution:

Since the paddocks are of equal size it may be assumed that the total revenue will be the same whatever assignment is adopted. The farmer’s objective in this decision problem is, therefore, to assign paddocks to crops in a manner which minimizes the total fertilizer cost. Mixed cropping of paddocks is not permitted, not may the same crop be grown in two paddocks.

3.1(a) Formulation of assignment problem into Linear Programming problem:

An Assignment Problem can be formulated as a Linear Programming Problem using variables with two subscripts as below.

Let C_{ij} ($i, j = 1, 2, 3, 4$) is the fertilizer cost when i^{th} crop is assigned to j^{th} paddock. It is also assumed that the overall cost of fertilizer is to be minimized (such as total fertilizer cost to cultivate four crops).

Let decision variables X_{ij} with double subscripts so that X_{ij} is the no. of crops assigned to j^{th} paddock.

But i^{th} crop can be assigned to only one paddock and j^{th} paddock can be allotted to only one crop. Hence, the Assignment Problem will be modified as LPP as below

$$\begin{aligned} \text{Minimize } Z = & C_{11}X_{11} + C_{12}X_{12} + C_{13}X_{13} + \\ & C_{14}X_{14} + C_{21}X_{21} + C_{22}X_{22} + C_{23}X_{23} + C_{24}X_{24} \\ & + C_{31}X_{31} + C_{32}X_{32} + C_{33}X_{33} + C_{34}X_{34} \\ & + C_{41}X_{41} + C_{42}X_{42} + C_{43}X_{43} + C_{44}X_{44} \end{aligned}$$

Table-3.1(a): List of Formulae and corresponding cell addresses

Cell address	Formula to be typed	Cell address	Formula to be typed
G5	=Sum(B5:E5)	B10	=Sum(B5:B8)
G6	=Sum(B6:E6)	C10	=Sum(C5:C8)
G7	=Sum(B7:E7)	D10	=Sum(D5:D8)
G8	=Sum(B8:E8)	E10	=Sum(E5:E8)
B12	=SUMPRODUCT(B5:E8,B17:E20)		

Subject to

$$X_{11} + X_{12} + X_{13} + X_{14} = 1$$

$$X_{21} + X_{22} + X_{23} + X_{24} = 1$$

$$X_{31} + X_{32} + X_{33} + X_{34} = 1$$

$$X_{41} + X_{42} + X_{43} + X_{44} = 1$$

$$X_{11} + X_{21} + X_{31} + X_{41} = 1$$

$$X_{12} + X_{22} + X_{32} + X_{42} = 1$$

$$X_{13} + X_{23} + X_{33} + X_{43} = 1$$

$$X_{14} + X_{24} + X_{34} + X_{44} = 1$$

$$X_{ij} = 0 \text{ or } 1 \text{ for } i, j = 1, 2, 3, 4.$$

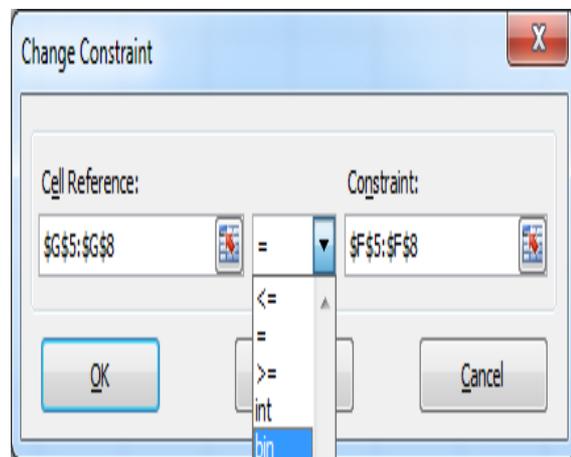
3.1(b) Steps to solve Assignment problem formulated as LPP using MS-Excel.

1. Enter the given cost matrix and required entries in excel sheet as shown in MS-Excel Screen-1.
2. Enter value '1' under column 'crops' and beside row 'paddocks' as shown in screen-Screen-1. Leave blanks in the cell range B5:E8.
3. Type the formulae as shown in table-1(a) in the respective cell addresses.
4. To express the constraints and objective function in solver tool,

GotoData → Solver then in resultant window, Select objective cell as \$B\$12 against 'set target' with min option (since our objective is to minimize the cost of fertilizer) and select the range of decision variables as "\$B\$5:\$E\$8" under 'By changing variable cells:'.

5. Enter constraints viz., \$B\$5:\$G\$8 = \$F\$5:\$F\$8, \$B\$10:\$E\$10 = \$B\$9:\$E\$9 and \$B\$5:\$E\$8 = Binary by using Add button under 'subject to the constraints' section with the help of '=' and 'binary(bin)' options available in the change constraint window as shown below.

6. Check [✓] 'Make unconstrained variables non-negative' option.
7. Select 'Simplex LP' under 'select a solving method' option. After completing all required selections and entries the solver parameters window looks like MS-Excel Screen-3.1.2(a).
8. Click on solve. The resultant window 'solver results' will be as shown in MS-Excel Screen-3.1.2(b). And optimum fertilizer cost will be obtained in the cell B12 automatically as shown in MS-Excel Screen-3.1.3.
9. Refer ^[5] for more detailed explanation.

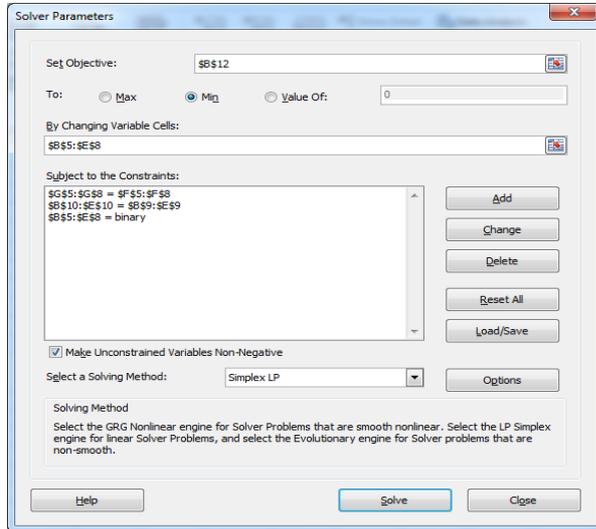


3.1(c) Screen shots of the solution for the problem 3.1

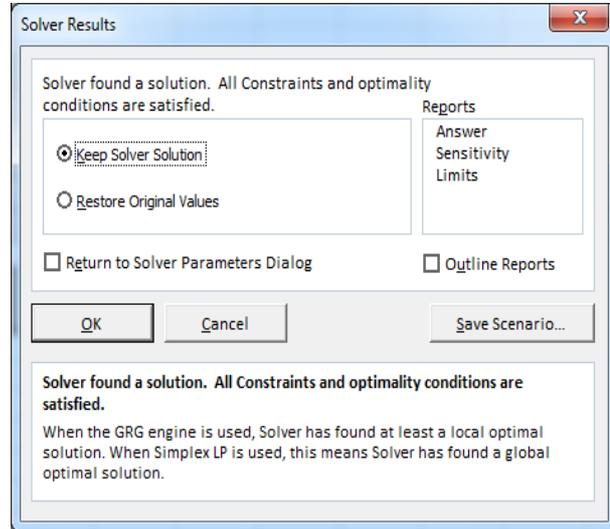
MS-Excel Screen -3.1.1

	A	B	C	D	E	F	G	
1	Example-1:Assignment Problem for Minimization							
2								
3	Crops	Paddock				Crops	Assigned	
4		A	B	C	D			
5	I	0	0	0	0	1	0	
6	II	0	0	0	0	1	0	
7	III	0	0	0	0	1	0	
8	IV	0	0	0	0	1	0	
9	Paddock	1	1	1	1			
10	Assigned	0	0	0	0			
11								
12	Total cost of fertilizers (Min)	0						
13								
14	Initial Matrix of Fertilizer cost in (Rs.)							
15		Paddock						
16	Crops	A	B	C	D			
17	I	2000	3000	1000	1000			
18	II	5000	8000	3000	2000			
19	III	4000	9000	6000	1000			
20	IV	8000	7000	8000	4000			
21								

MS-Excel Screen -3.1.2(a)



MS-Excel Screen -3.1.2(b)



MS-Excel Screen -3.1.3

	A	B	C	D	E	F	G	
1	Example-1:Assignment Problem for Minimization							
2								
3	Crops	Paddock				Crops	Assigned	
4		A	B	C	D			
5	I	1	0	0	0	1	1	
6	II	0	0	1	0	1	1	
7	III	0	0	0	1	1	1	
8	IV	0	1	0	0	1	1	
9	Paddock	1	1	1	1			
10	Assigned	1	1	1	1			
11								
12	Total cost of fertilizers (Min)	13000						
13								
14	Initial Matrix of Fertilizer cost in (Rs.)							
15		Paddock						
16	Crops	A	B	C	D			
17	I	2000	3000	1000	1000			
18	II	5000	8000	3000	2000			
19	III	4000	9000	6000	1000			
20	IV	8000	7000	8000	4000			
21								

Optimum solution for the problem-3.1:

Fertilizer cost

Allot paddock A to crop I-	Rs. 2000
Allot paddock B to crop IV-	Rs. 3000
Allot paddock C to crop II-	Rs. 1000
Allot paddock D to crop III-	Rs. 7000
Total -	Rs.13000

Problem-3.2:

A regional director of an agricultural advisory service is concerned to find the optimal assignment of his staff of five advisers to the five districts in his region. Each district has its

special agricultural problems and each adviser has particular strengths and weaknesses in his technical knowledge. The director is able to ascribe a mark out of a possible total of 20 to the degree of success he would expect each adviser to achieve if he were to be posted to each district. The marks awarded are shown in table-3.2. The objective is to assign advisers to districts to obtain the largest possible total mark.

Districts	Advisers				
	A	B	C	D	E
I	13	18	14	5	12
II	12	6	19	13	11
III	8	9	7	7	6
IV	2	11	8	3	5
V	10	15	7	2	11

Solution:

Since this assignment problem is one of maximization rather than minimization it has to be converted to a minimization problem prior to apply *Hungarian's* procedure to solve the problem manually by subtracting each element in the initial profit matrix from the largest element.

But the procedure remains same as mentioned in 3.1(b) except selection of *Max* instead of *Min* under the set objective function option of solver template as shown in 3.2.2(a).

Constraints for this problem will be (since there are 5 advisers and 5 districts)

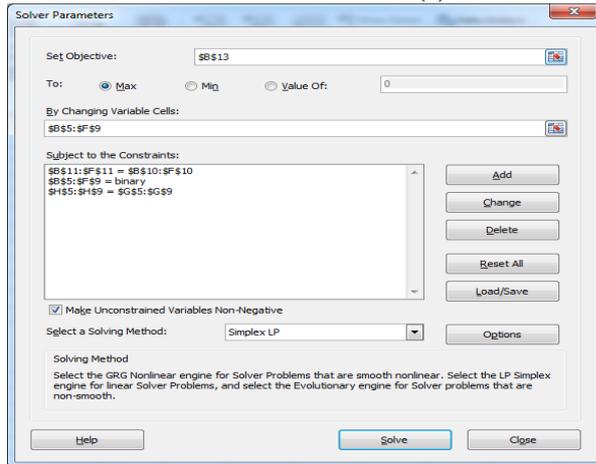
$\$H\$5:\$H\$9 = \$G\$5:\$G\9 , $\$B\$11:\$F\$11 = \$B\$10:\$F\10 and $\$B\$5:\$F\$9 = \text{Binary}$

3.2(a) Screen shots of the solution for the problem 3.2

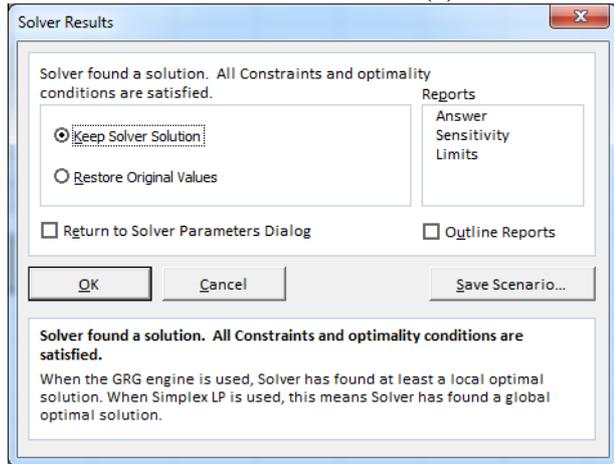
MS-Excel Screen –3.2.1

	A	B	C	D	E	F	G	H
1	Example-2: Assignment Problem for Maximization							
2								
3	Districts	Advisers					Districts	Assigned
4		A	B	C	D	E		
5	I	0	0	0	0	0	1	0
6	II	0	0	0	0	0	1	0
7	III	0	0	0	0	0	1	0
8	IV	0	0	0	0	0	1	0
9	V	0	0	0	0	0	1	0
10	Advisers	1	1	1	1	1		
11	Assigned	0	0	0	0	0		
12								
13	Maximum degree of success (Max)	0						
14								
15	Marks awarded to advisers out of 20							
16	Districts	Advisers						
17		A	B	C	D	E		
18	I	13	18	14	5	12		
19	II	12	6	19	13	11		
20	III	8	9	7	7	6		
21	IV	2	11	8	3	5		
22	V	10	15	7	2	11		

MS-Excel Screen -3.2.2(a)



MS-Excel Screen -3.2.2(b)



MS-Excel Screen -3.2.3

Example-2: Assignment Problem for Maximization							
Districts	A	B	C	D	E	Districts	Assigned
I	1	0	0	0	0	1	1
II	0	0	1	0	0	1	1
III	0	0	0	1	0	1	1
IV	0	1	0	0	0	1	1
V	0	0	0	0	1	1	1
Advisers	1	1	1	1	1		
Assigned	1	1	1	1	1		
Maximum degree of success	61						
Marks awarded to advisers out of 20							
Districts	A	B	C	D	E		
I	13	18	14	5	12		
II	12	6	19	13	11		
III	8	9	7	7	6		
IV	2	11	8	3	5		
V	10	15	7	2	11		

Optimal solution for the problem-3.2:

Marks awarded

Post adviser A to District I-	13
Post adviser B to District IV-	11
Post adviser C to District II -	19
Post adviser D to District III-	7
Post adviser E to District V-	11
Total -	61%

Problem-3.3:

It will be noted that the form of the problems illustrated so far has been somewhat limited, in that the number of facilities has been exactly equal to the number of uses, and it has been assumed that each facility could be allocated to every use. These restrictions can be relaxed by the use of certain computational devices. Consider the trivial case of a farmer who is concerned to allocate three land-using activities, I,II and III between three paddocks A, B, and C in a way which maximized the total gross margin. Assume that activity III

may not be undertaken in paddock C for some reason such as unsuitability of soil. The initial profit matrix for this problem may be set up as shown in table-3.3.

Solution:

The method of solution remains the same as that illustrated for the previous problem, but the penalty cost of Rs.0 is imposed to the activity III in paddock C ensures that this combination is excluded from the optimal assignment.

Table-3.3:Initial Profit Matrix (Rs.) per paddock

Activity	Paddock		
	A	B	C
I	1200	1500	1000
II	2000	1750	800
III	1400	1650	0

Constraints will be

$\$F\$5:\$F\$7 = \$E\$5:\$E\$7, \$B\$9:\$D\$9 = \$B\$8:\$D\8 and $\$B\$5:\$D\$7 = \text{Binary}$

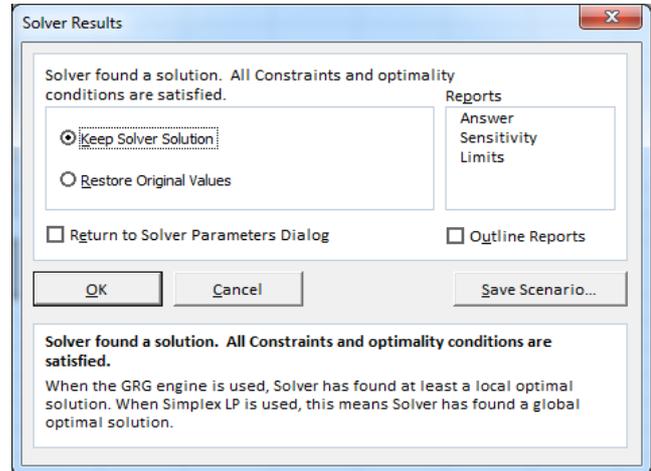
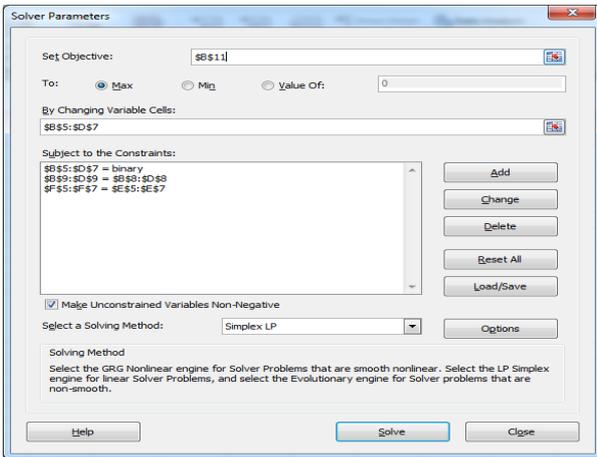
3.3(a) Screen shots of the solution for the problem 3.3

MS-Excel Screen –3.3.1

Example-3: Assignment Problem for maximization with unequal tasks						
Activity	Paddock			Activity	Assigned	
	A	B	C			
I	0	0	0	1	0	
II	0	0	0	1	0	
III	0	0	0	1	0	
Paddock	1	1	1			
Assigned	0	0	0			
Total gross margin (Max)	0					
Initial Profit Matrix(Rs.)						
Activity	Paddock					
	A	B	C			
I	1200	1500	1000			
II	2000	1750	800			
III	1400	1650	0			

MS-Excel Screen -3.3.2(a)

MS-Excel Screen -3.3.2(b)



MS-Excel Screen -3.3.3

Example-3: Assignment Problem for maximization with unequal tasks						
Activity	Paddock			Activity	Assigned	
	A	B	C			
I	0	0	1	1	1	
II	1	0	0	1	1	
III	0	1	0	1	1	
Paddock	1	1	1			
Assigned	1	1	1			
Total gross margin (Max)	4650					
Initial Profit Matrix(Rs.)						
Activity	Paddock					
	A	B	C			
I	1200	1500	1000			
II	2000	1750	800			
III	1400	1650	0			

Optimum Solution for the problem-3.3:

Profit (Rs.)

Assign Activity I to paddock C- Rs.1000
 Assign Activity II to paddock A -Rs.2000
 Assign Activity III to paddock B-Rs.1650
Total -Rs.4650

Problem-3.4:

A farmer might have a set of several buildings available which could be devoted to a number of different uses. Suppose there are four buildings available, A, B, C and D and five possible uses as follows:

1. Store implements
2. Store wheat
3. Store fodder
4. Keep cattle
5. Keep pigs

Use	Buildings			
	A	B	C	D
Store implements	50	0	30	0
Store Wheat	220	200	300	275
Store fodder	160	150	180	175
Keep cattle	0	450	0	300
Keep pigs	0	390	0	0

Only four of these five possible uses can be accommodated in the available buildings. One use must therefore be foregone, but the farmer insists that accommodation must be provided for cattle. In addition, not all buildings are suitable for every use. Buildings B and D have entrances too narrow to enable them to be used for the storage of implements, while A and C are too remote from a water supply to be used for stock.

Finally, building D cannot satisfactorily be adapted for pig keeping. All these conditions, together with the estimated financial gains from

the remaining feasible allocations of buildings to the various uses, are incorporate in the initial profit matrix shown in

Solution:

This matrix includes a dummy facility/building (E) to allow one use to be foregone, and infeasible allocations of facilities to uses are marked with a maximum penalty cost (say Rs.1000). Since farmer compels the accommodation for the cattle hence, the least cost Rs.0 is allocated in dummy Column that means ‘Cattle keeping’ should not to be assigned to dummy building and it must be assigned to either of possibilities B or D and these inputs can be viewed from table-3.4(b). Further not possible allocations are assigned zero costs (since the objective is maximization).

Use	Buildings				
	A	B	C	D	E
Store implements	50	0	30	0	1000
Store Wheat	220	200	300	275	1000
Store fodder	160	150	180	175	1000
Keep cattle	0	450	0	300	0
Keep pigs	0	390	0	0	1000

Constraints for this problem will be (since there are 5 buildings and 5 uses)

$$x_{15} + x_{16} = x_{17} + x_{18},$$

$$x_{25} + x_{26} = x_{27} + x_{28} \text{ and}$$

$$x_{35} + x_{36} = \text{Binary}$$

Again, the same method of solution explained in 3.1(b) may be employed except selection of *Max* instead of *Min* under the set objective function option of solver template as shown in 3.4.2(a) and optimum being reached.

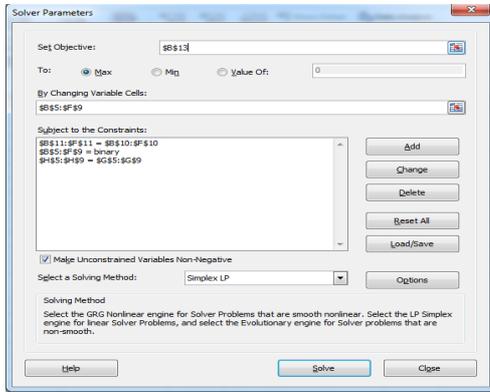
3.4(a) Screen shots of the solution for the problem 3.4

MS-Excel Screen –3.4.1

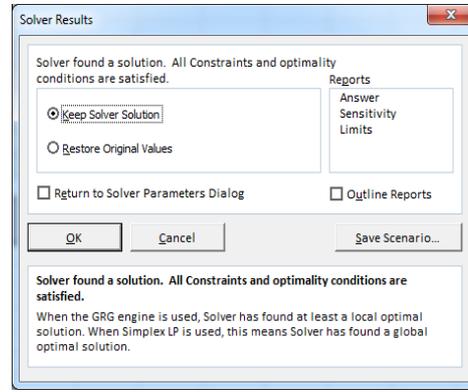
Example-4:Unbalanced Assignment Problem for Maximization							
Use	Buildings					Use	Assigned
	A	B	C	D	Dummy		
Store implements	0	0	0	0	0	1	0
Store Wheat	0	0	0	0	0	1	0
Store fodder	0	0	0	0	0	1	0
Keep cattle	0	0	0	0	0	1	0
Keep pigs	0	0	0	0	0	1	0
Buildings	1	1	1	1	1		
Assigned	0	0	0	0	0		
Total (Max)Profit	0						

Profit Matrix of assigning Building to various uses (Rs.)					
Use	Buildings				
	A	B	C	D	Dummy
Store implements	50	0	30	0	1000
Store Wheat	220	200	300	275	1000
Store fodder	160	150	180	175	1000
Keep cattle	0	450	0	300	0
Keep pigs	0	390	0	0	1000

MS-Excel Screen -3.4.2(a)



MS-Excel Screen -3.4.2(b)



MS-Excel Screen –3.4.3

Example-4:Unbalanced Assignment Problem for Maximization							
Use	Buildings					Use	Assigned
	A	B	C	D	Dummy		
Store implements	0	0	0	0	1	1	1
Store Wheat	0	0	1	0	0	1	1
Store fodder	1	0	0	0	0	1	1
Keep cattle	0	0	0	1	0	1	1
Keep pigs	0	1	0	0	0	1	1
Buildings	1	1	1	1	1		
Assigned	1	1	1	1	1		
Total (Max)Profit	1150						

Profit Matrix of assigning Building to various uses (Rs.)					
Use	Buildings				
	A	B	C	D	Dummy
Store implements	50	0	30	0	1000
Store Wheat	220	200	300	275	1000
Store fodder	160	150	180	175	1000
Keep cattle	0	450	0	300	0
Keep pigs	0	390	0	0	1000

Optimum Solution for the problem-3.4:

Optimal Assignment of Buildings to different Uses

- Assign building A to Purpose III (fodder storage) Rs. 160
- Assign building B to Purpose V (Pig keeping) Rs. 390

- Assign building C to purpose II (wheat storage) Rs. 300
- Assign building D to purpose IV (cattle rearing) Rs. 300
- Total Rs.1150**

CONCLUSION

The problems described in this paper are sufficient to demonstrate the scope of assignment techniques and their applicability for decision making in agriculture. Clearly, the number of real planning decisions which can be formulated in a way which makes them amendable to solution by this method is rather limited. On the other hand, the assignment technique has the important advantage that the computations involved are reasonably straightforward and user-friendly procedure developed in this paper made its applicability very easier. This would enable the sensitivity of solutions to changes in the assumptions to be investigated relatively easily. Similarly, the value of the technique is enhanced by the fact that it could be used by advisers in the field, or even by farmers themselves. Moderate working knowledge in MS-Excel is enough to deal with any type of allocation challenges in agriculture successfully.

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