|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table 1** | | | | | |
| Resources type | Required | | | | Available Resources |
|  |  |  |  |
| Land | 425 | 94 | 58 | 166 | 163134 |
| Seeds & Fertilizers | 1 | 1 | 1 | 1 | 100000 |
| Labour | 1 | 1 | 1 | 1 | 209802 |

Z max = 1144*X*1 + 841*X*2 + 1620*X*3 + 1891*X*4 (Profit) 425*X*1 + 94*X*2 + 58*X*3 + 166*X*4 163134 (Land) *X*1 + *X*2 + *X*3 + *X*4 100000 (Seeds & Fertilizers) *X*1 + *X*2 + *X*3 + *X*4 209802 (Labour) *X*1, *X*2, *X*3, *X*4 0

**Step 1:** Optimal Solution is: *X*\*= (0,0,2812.6,0) (*X*3 = 2812.6) and *Z*\* = 4556501.38

Resources actually used are: (163134, 2813, 2813)

**Step 2:** The decision maker feels that 163134 for land, 2813 for Seeds and Fertilizers, 2813 for Labour is enough to reach 4556501.38 Rupees. So, (163134 - 163134) = 0 units of land, (100000 – 2813) = 97187 units of Seeds & Fertilizers and (209802 – 2813) = 206989 units of Labour are idle resources. The decision maker, therefore, would like to try to find the solution of a new LPP with the resources changed from (163134, 100000, 209802) to (163134, 2813, 2813).

Z max = 1144*X*1 + 841*X*2 + 1620*X*3 + 1891*X*4 (Profit) 425*X*1 + 94*X*2 + 58*X*3 + 166*X*4 163134 (Land) *X*1 + *X*2 + *X*3 + *X*4 2813 (Seeds & Fertilizers)

*X*1 + *X*2 + *X*3 + *X*4 2813 (Labour) *X*1, *X*2, *X*3, *X*4 0 Optimal Solution is: *X*\*= (0,0,2813,0) (*X*3 = 2813) and *Z*\* = 4556501.38

**Step 3:** The decision maker may consider that traditional LP is not enough to

solve his problem because of the imprecise properties of the resources in nature.

After detailed analysis, he feels maximum tolerances for Land, Seeds & Fertilizers and Labour should be 5%

Now take Maximum tolerance as 5% of available resources.

*P*1 = 8516.7

*P*2 = 5000

*P*1 = 10490.1

|  |  |  |
| --- | --- | --- |
|  | *B*i | Tolerances (*P*i) |
| Land | 163134 | 8516.7 |
| Seeds & Fertilizers | 100000 | 5000 |
| Labour | 209802 | 10490.01 |

Z max = 1144*X*1 + 841*X*2 + 1620*X*3 + 1891*X*4 (Profit)

425*X*1 + 94*X*2 + 58*X*3 + 166*X*4 163134 + 8516.7 (Land)

*X*1 + *X*2 + *X*3 + *X*4 100000 + 5000 (Seeds & Fertilizers) *X*1 + *X*2 + *X*3 + *X*4 209802 + 10490.01 (Labour)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table 2** | | | | | |
|  | *Z*\*() | Land | Seeds & Fertilizers | Labour | *X*\*() |
| 0.0 | 4556501.38 | 163134 | 2813 | 2813 | (0, 0, 2813, 0) |
| 0.1 | 4580289.40 | 248198 | 2827.34 | 2827.34 | (0, 0, 2827.34, 0) |
| 0.2 | 4604077.43 | 249433 | 2842.02 | 2842.02 | (0, 0, 2842.02, 0) |
| 0.3 | 4627865.45 | 250668 | 2856.71 | 2856.71 | (0, 0, 2856.71, 0) |
| 0.4 | 4651653 | 251902 | 2871.39 | 2871.39 | (0, 0, 2871.39, 0) |
| 0.5 | 4675441.50 | 253137 | 2886.08 | 2886.08 | (0, 0, 2886.08, 0) |
| 0.6 | 4699229.52 | 254372 | 2900.76 | 2900.76 | (0, 0, 2900.76, 0) |
| 0.7 | 4723017.55 | 255607 | 2915.44 | 2915.44 | (0, 0, 2915.44, 0) |
| 0.8 | 4746805.57 | 256842 | 2930.13 | 2930.13 | (0, 0, 2930.13, 0) |
| 0.9 | 4770593.60 | 258076 | 2944.81 | 2944.81 | (0, 0, 2944.81, 0) |
| 1.0 | 4794381.62 | 259311 | 2959.49 | 2959.49 | (0, 0, 2959.49, 0) |

*X*1, *X*2, *X*3, *X*4 0,

**Step 4:** Now, Using Werner’s approach

*Z*0 = 4556501.38

*Z*1 = 4794381.62

(Z1 – *Z*0) = 237880.24

Membership function of fuzzy objective

0

Membership function of fuzzy constraints

1

2

3

Now, Min

1144*X*1 + 841*X*2 + 1620*X*3 + 1891*X*4 4794381.62 – 237880.24

425*X*1 + 94*X*2 + 58*X*3 + 166*X*4 163134 + 8516.7 (Land)

*X*1 + *X*2 + *X*3 + *X*4 100000 + 5000 (Seeds & Fertilizers)

*X*1 + *X*2 + *X*3 + *X*4 209802 + 10490.01 (Labour)

*X*1, *X*2, *X*3, *X*4 0,

= 0.5; *X*\* = (0,0,2886.08,0); Z\* = 4675441.5

Resources actually used (167392.64, 2886.08, 2886.08)

We can find the fuzzy solution to the problem directly by solving the point-fix equation:

= 0.5 and *Z*\*() = 4794381.62 – 237880.24. So, *Z*\*(0.5) = 4703527.935

*F*(*cTx*) = . So, *F* (*4675441.5*) = = 0.5

**Step 5:** Let us assume that after recalling Table 2, determining b0 is considered.

**Step 6:** Presenting Table 2, ask the decision maker to determine p0.

**Step 7:** Let us assume *b*0 = 4675441.5 at = 0.5.

Hence,4675441.5 – 4556501.38 = 118940.12. So *p*0 must be between 0 and 118940.12.

Let *p*0 = 100000.

Membership function of fuzzy objective

0

Min

1144*X*1 + 841*X*2 + 1620*X*3 + 1891*X*4 4675441.5 – 100000

425*X*1 + 94*X*2 + 58*X*3 + 166*X*4 163134 + 8516.7 (Land)

*X*1 + *X*2 + *X*3 + *X*4 100000 + 5000 (Seeds & Fertilizers)

*X*1 + *X*2 + *X*3 + *X*4 209802 + 10490.01 (Labour)

*X*1, *X*2, *X*3, *X*4 0

= 0.35; *X*\* = (0,0,2864.35,0); Z\* = 4640247

Resources actually used (166132.3, 28644.35, 2864.35)

We can find the fuzzy solution to the problem directly by solving the point-fix equation:

= 0.35 and *Z*\*() =4675441.5– 105000. So, *Z*\*(0.35) = 4640247

*F*(*cTx*) = . So, *F* (4640247) = = 0.35

**Step 8:** Let us assume that the solution is satisfied.

**Step 9:** Take a simulation by choosing a set of *p*0s. Let us take six possible values of

*p*0 ∈ [0, 118940.12]; (0,25000, 50000, 75000, 100000, 118940.12).

**Step 10:** After referring to Table 3 (next), the decision maker may choose a satisfying solution and then terminate the solution procedure.

**Step 11:** The comparison of the solutions of Werners and Zimmermann

|  |  |  |
| --- | --- | --- |
| Parameters | Werners | Zimmermann |
|  | 0.5 | 0.35 |
| *Z*\* | 4675441.5 | 4640247 |
| *X*\* | (0, 0, 2886.08, 0) | (0, 0, 2864.35 0) |
| Resources used | (167392.64, 2886.08, 2886.08) | (166132.30, 2864.35, 2864.35) |

**Table 3** The optimal solution of a symmetric FLP for a given set of *p*0s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *P*0 |  | | | Resources actually used | | |
|  |  | *Z*\*\* | *x*\*\* | Land | Seeds & Fertilizers | Labour |
| 0 | 0.5 | 4675441.50 | (0, 0, 2886.08, 0) | 167392.64 | 2886.08 | 2886.08 |
| 25000 | 0.45 | 4664125.80 | (0, 0, 2879.09, 0) | 166987.22 | 2879.09 | 2879.09 |
| 50000 | 0.41 | 4654778.40 | (0, 0, 2873.32, 0) | 166652.56 | 2873.32 | 2873.32 |
| 75000 | 0.38 | 4646905.20 | (0, 0, 2868.46) | 166370.68 | 2868.46 | 2868.46 |
| 100000 | 0.35 | 4640247 | (0, 0, 2864.35, 0) | 166138.68 | 2864.35 | 2864.35 |
| 118940.12 | 0.33 | 4635792 | (0, 0, 2861.60, 0) | 165972.80 | 2861.60 | 2861.60 |

0   
   
 1



Zimmerman

Werners

0.66  
  
  
   
 0.5  
   
 0.34  
  
 0.27

0  
 4556501.38 4598527.935 4644695.45 4667827.935 4703527.935 4794381.62