A STUDY FOR PERISHABLE INVENTORY CONTROL SYSTEM WITH THE HELP OF A MODEL BASED ON FUZZY DYNAMIC PROGRAMMING

Saloni Srivastava*

Dr. R.K. Shrivastava**

ABSTRACT

In this paper, we consider a model in which backlogging is not allowed, since the items in the inventory are perishable. To analyze perishable inventory system with crisp transformation function, we apply fuzzy dynamic programming technique. In this paper we consider both objective function and constraints are as fuzzy sets. By applying fuzzy dynamic programming, the existence of optimal solution for perishable inventory system approach is studied. In a fuzzy environment, to illustrate the optimal decision, numerical examples and sensitivity analysis are discussed.

*Department of Applied Science and Humanities, Sachdeva Institute of Technology, Farah, Mathura.

**Department of Mathematics, Agra College, Agra.

1. INTRODUCTION

It is found that the decision making problems such as inventory control systems and service facility systems, metaheuristic algorithm [6] and fuzzy dynamic programming have been used in a good amount. Bellman and Zadeh in 1870, considered the classical decision model and suggested several models for decision making in a fuzzy environment. The application of fuzzy set theory in mathematical programming was done by Bellman R.E. and L.A. Zadeh [2] and Zimmermann H.J. [9]. Development and applications in the field of fuzzy dynamic programming deal by Kacprzyk [4], Esogbul and Bellman [3] and Zimmerman [8, 10,11]. In fact the traditional economic criterion i.e. maximization of profit or minimization of cost models are useful in many real inventory problems. On the other hand there are many inventory problems for which the economic criterion model are not applicable including reservoir operation problems as well as some retail inventory problems. To incorporate the expert knowledge with fuzzy membership function only fuzzy criterion models are used, and therefore these models are closer to the spirit of modern decision-making thinking [7], than the existing inventory models. Let us consider a multistage decision making inventory control system in which reorder quantities $l_k(k = 1,2, \dots.)$ are the decision variables and $z_k(k = 1,2, \dots.)$ are the different states inventory level at the beginning of the period k of the system. At the beginning of each stage, a reorder of for l_k items is to be done and the decision maker should be able to evaluate the final state. Since items in the inventory are perishable, we assume that backlogging is not allowed. The following questions should be able to be answered by the decision maker, which states are the best?, which states are qualified and which states are too bad? Another important issue in perishable inventory control system is due to the nature of the stock. The objective of the problem is to minimize the stock almost zero at the end of the planning horizon. In this paper, our aim is to concentrate on inventory systems having perishable items and also to construct a fuzzy dynamic programming model for these types of inventory systems. We also focus on the optimal inventory control for this kind of inventory system is obtained as a natural extension of ordinary inventory control system. For different values of perishable parameter are obtained by optimal schedules, the final inventory with low or zero level.

2. DEPICTION OF THE MODEL (FUZZY)

For developing the model we have to consider the following notations and assumptions. Let $z_k \in Z \; for \; k = 1,2, \dots.., n + 1$ be the state variable representing the inventory level at the beginning of period k, where $Z = \{0, \tau, 2\tau, \dots \dots\}$. Considering an inventory model of n periods then the order quantity in each period k is assumed to be fuzzy variable $l_k \in V$, where $V = \{0, \delta, 2\delta, \ldots \ldots.\}$ is the set of values permitted for the decision. Most of the cases $\tau = \delta$, where τ and δ are the fundamental units of inventory. $z_{k+1} = z_k - Q_k + l_k - d_k$ is the crisp transformation function where d_k for $k = 1,2, \ldots.., n$ is the deterministic demand in period k and Q_k denotes the quantity of perished items in period k. $\widetilde{FC}_k(l_k) = \left\{\left(l_k, \lambda_{\tau_k}(l_k)\right)\right\}$ are fuzzy constraints on the decision variables representing the goal reordering quantity that should decrease as steadily as possible. $Q_k = \left[\frac{\alpha z_k}{\tau}\right]\tau$, i.e., the perished quantity Q_k is proportional to inventory on hand at each period k, where α is the perish ability parameter $0 \le \alpha \le 1$, τ is the fundamental unit of inventory (pocket). Let us consider $\tau = 5$ and $[z]$ denotes round off value of z. Let $\tilde{F}_k(z_{n+1}) = \{z_{n+1}, \lambda_{\tau_k}(z_{n+1})\}$ be the fuzzy goal, representing the decision that the inventory is very low at the end of the planning horizon. To solve the problem we propose the fuzzy dynamic programming technique of Bellman and Zadeh (1970). They explained that th basic type of fuzzy dynamic programming problem based on symmetric decision model is one in which the objective function as well as the constraints are fuzzy. The fuzzy objective function is characterized by its membership function and so are the constraints. To optimize the objective function subject to the constraints defined in the fuzzy environments, we use an optimal decision as a selection of activities that simultaneously satisfy the objective function and constraints. Here we assumed that the constraints are "non-interactive" and hence the logical "and" corresponds to the "intersection" (of fuzzy sets). The intersection of fuzzy constraints and objective function which is fully symmetric can be obtained under the "decision" in a fuzzy environment in this model.

2.1. EXPLANATION AND NOTATIONS [BELLMAN AND ZADEH] (1970)

In a space of alternatives Z, consider a fuzzy goal $\widetilde{FG}$ and fuzzy constraints $\widetilde{FC}$. Let $\widetilde{FG}$ and $\widetilde{FC}$ be combined to form a decision $\tilde{V}$ which is a fuzzy set given by $\tilde{V} = \widetilde{FG} \cap \widetilde{FC}$ and correspondingly $\lambda_{\tilde{V}} = \min\{\lambda_{\widetilde{FG}}, \lambda_{\widetilde{FC}}\}$. This definition can be extended to r goals $\widetilde{FG}_k, (k = 1.2.,,, r)$ and s constraints $\widetilde{FC}_i, (i = 1.2.,,, s)$ in a logical manner. On the other hand $\lambda_{\tilde{V}} = \min\left\{\lambda_{\widetilde{FG}_k}, \lambda_{\widetilde{FC}_i}\right\}, (k = 1,2, \ldots., r \text{ and } i = 1,2, \ldots.., s)$. The intersection of fuzzy seta is defined in the possibility sense by the min-operator. Traditional dynamic program was introduced by Bellman in 1957, which is actually contain the problem as a multistage decision process with n stages and the optimal policy has to be determined recursively. Let us consider the state variable z_k , the decision variable l_k , stage rewards $r_k(z_k, l_k)$, a reward function $R_k(l_n, \ldots\ldots, l_{n-k}, z_n)$ and transformation function $t_k(z_k, l_k)$.

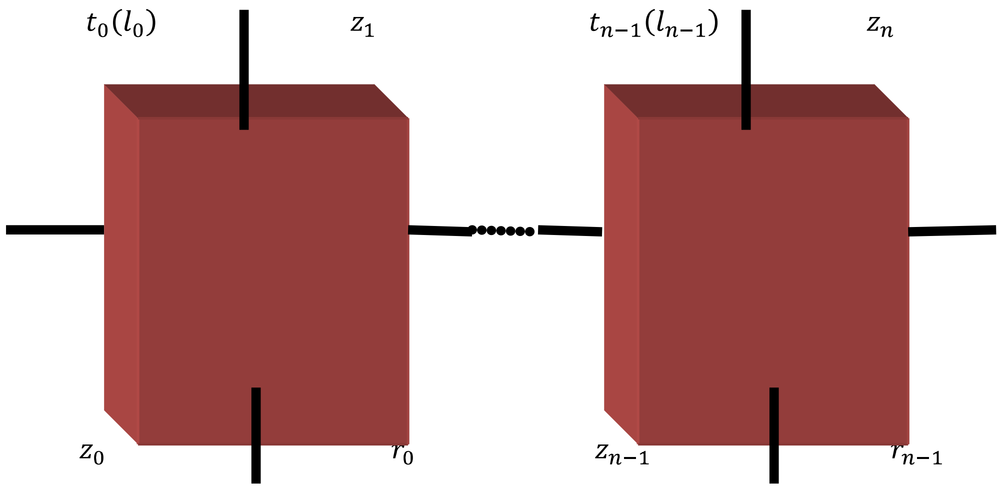
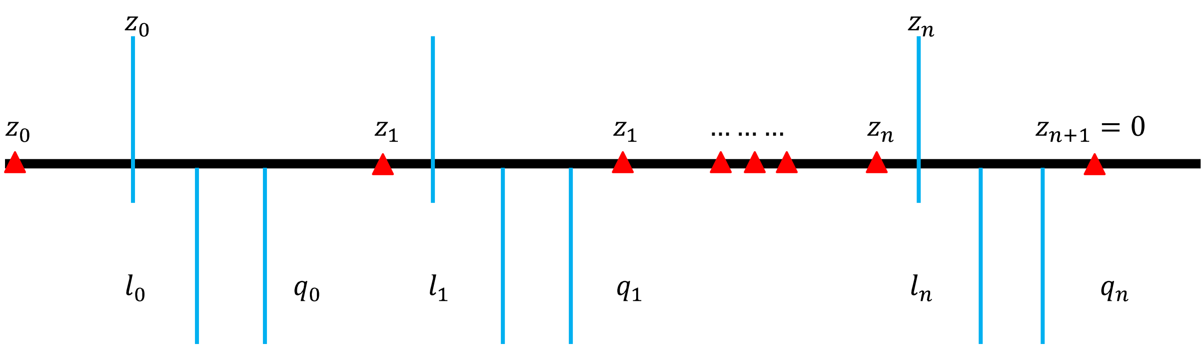


Fig.1. The basic fuzzy dynamic programming structure

The formulation of the problem is described as:

$$\max_{l_k} R_k(z_k, l_k) = \max_{l_k} \{r_k(z_k, l_k) * R_{k+1}(z_{k+1})\}$$

Such that $z_{k+1} = t_k(z_k, l_k) = z_k - Q_k + l_k - d_k\,; k = 1,2, \ldots \ldots, n-1$ and $Q_k = \left[\frac{\alpha z_k}{\tau}\right]\tau, 0 \leq \alpha \leq 1$



$\max_{l_k} R_k(z_k, l_k) = \max_{l_k} \{r_k(z_k, l_k) * R_{k+1}(t_k(z_k, l_k))\}$. It is to be noticed that all variables rewards and transformations are supposed to be crisp.

Theorem: ***The fuzzy dynamic programming problem***

$\boldsymbol{\max_{l_k} R_k(z_k, l_k) = \max_{l_k}\{r_k(z_k, l_k) * R_{k+1}(z_{k+1})\}}$***, where*** $\boldsymbol{z_{k+1} = t_k(z_k, l_k) = z_k - Q_k + l_k - d_k\,; k = 1, \ldots\ldots, n-1}$ & $0 \leq \alpha \leq 1$

Subject to the fuzzy constraints $\lambda_{\widetilde{FC}_k}(l_k)$ and $\lambda_{\widetilde{FG}_k}(z_n)$, has the optimal maximizing decision $\widetilde{D}^0 = \{l_k\}$; $k = 0, \ldots\ldots, n$ for a given z_0 .

Proof : Let $z_k \in Z$, $k = 0,1, \ldots\ldots, n$ be the crisp state variables where $Z = \{0, \tau, 2\tau, 3\tau, \ldots\ldots\ldots\}$ is the set of values permitted for the state variables and $l_k \in \widetilde{D}$, $k = 1, \ldots\ldots, n$ be the crisp decision variables where $\widetilde{D} = \{0, \alpha, 2\alpha, \ldots\ldots\}$ is the set of possible decisions. For each stage $t = 0,1, \ldots\ldots, n-1$, let the fuzzy constraints $\widetilde{FC}_t$ have the membership function $\lambda_{\widetilde{FC}_t}(l_k)$; $k = 1,2, \ldots\ldots, n$. Similarly the fuzzy goal $\widetilde{FG}_n$ be characterized by the membership function $\lambda_{\widetilde{FG}_n}(z_n)$. As we know that the logical operator "and is used a "intersection" in the statement of the theorem, the fuzzy decision set $\widetilde{D}$ is given by $\widetilde{D} = \bigcap_{t=0}^{n-1} \widetilde{FC}_k \cap \widetilde{FG}_k$. The membership function of the fuzzy set $\widetilde{D}$ by using the min-operator for the aggregation of the fuzzy constraints and the goal can be obtained as:

$$\lambda_{\widetilde{D}}(l_0, \ldots\ldots, l_{n-1}) = min\left\{\left(\lambda_{\widetilde{FC}_0}(l_0), \ldots\ldots, \lambda_{\widetilde{FC}_{n+1}}(l_{n-1}), \lambda_{\widetilde{FG}_n}(z_n)\right)\right\}$$

Hence the membership function of the maximizing set $\widetilde{D}^0$ is given by:

$$\lambda_{\widetilde{D}^o}(l_0^o, \ldots\ldots, l_{n-1}^o) = \max_{l_0,\ldots,l_{n-1}} \max\left\{\min\left(\lambda_{\widetilde{FC}_0}(l_0), \ldots\ldots, \lambda_{\widetilde{FG}_n}(t_n z_{n-1}, l_{n-1})\right)\right\}$$

$$= \max_{l_0,\ldots,l_{n-1}}\left\{\max_{l_0,\ldots,l_{n-1}} \min\left(\lambda_{\widetilde{FC}_0}(l_0), \ldots\ldots, \lambda_{\widetilde{FC}_{n-2}}(l_{n-2})\right), \max_{l_0,\ldots,l_{n-1}} \min\left(\lambda_{\widetilde{FC}_{n-1}}(l_{n-1}), \lambda_{\widetilde{FG}_n}\left(t_n(z_{n-1}, l_{n-1})\right)\right)\right\}$$

Since, $\max_{l_{n-1}} \min\{C, f(l_{n-1})\} = \min\{C, \max_{l_{n-1}} f(l_{n-1})\}$, where C is a constant and f is an arbitrary function of l_{n-1} , the above membership can be also be written as:

$$\lambda_{\widetilde{D}^o}(l_0^o, \ldots\ldots, l_{n-1}^o) = \max_{l_0,\ldots,l_{n-1}} \min\left\{\lambda_{\widetilde{FC}_0}(l_0), \ldots\ldots, \lambda_{\widetilde{FC}_{n-2}}(l_{n-2}), \lambda_{\widetilde{FG}_{n-1}}(z_{n-1})\right\}s$$

$$\lambda_{\widetilde{FG}_{n-1}}(z_{n-1}) = \max_{l_{n-1}} \min\left\{\lambda_{\widetilde{FC}_{n-1}}(l_{n-1}), \lambda_{\widetilde{FG}_n}\left(t_n(z_{n-1}, l_{n-1})\right)\right\}$$

By the use of above recursive function, the optimal decision set $\widetilde{D}_0$ can be obtained.

3. SOLUTION PROCEDURE

The general solution procedure of solving inventory control problem by fuzzy dynamic program [5] approach is described

STEP 1: Using the forward calculation, we can calculate the lower z_k^l and upper z_k^u as:

$$z_k^{l'} = \max\left\{0, z_{k-1}^{l'} - \left[\frac{\alpha z_{k-1}^{l'}}{\tau}\right]\tau + l_{k-1}^l - d_{k-1}\right\}$$

$$z_k^{u'} = z_{k-1}^{u'} - \left[\frac{\alpha z_{k-1}^{u'}}{\tau}\right]\tau + l_{k-1}^u - d_{k-1}$$

STEP 2 : From backward calculation the bounds z_k^l and z_k^u are computed as:

$$z_{k-1}^{l''} = z_k^{l''} - \left[\frac{\alpha Z_k^{l''}}{\tau}\right]\tau + d_{k-1} - l_{k-1}^{u}$$

$$z_{k-1}^{u''} = z_k^{u''} - \left[\frac{\alpha Z_k^{u''}}{\tau}\right]\tau + d_{k-1} - l_{k-1}^{l}$$

STEP 3 : The final bounds are computed as follows:

$$Z_k^u = \min\{z_k^{u'}, z_k^{u''}\}$$

$$z_k^l = \max\{z_k^{l'}, z_k^{l''}\}$$

STEP 4 : From the above, compute

$$\lambda_{\tilde{D}}(z_k) = \max_{l_k}\{\min\{\lambda_{\widetilde{FC}}(l_k), \lambda_{\widetilde{FG}}(z_k, l_k)\}\}$$

$$\lambda_{\tilde{D}}(z_k) = \max_{l_k}\{\min\{\lambda_{\widetilde{FC}}(l_k), \lambda_{\widetilde{FG}}(z_k - Q_k + l_k - d_k)\}\}$$

STEP 5 : For the specific α , observing the table for $\lambda_{\tilde{D}}(z_1)$, we get the optimal pairs (z_k, l_k) with positive values. For each pair (z_k, l_k) select the corresponding pairs (z_i, l_i) from the table for $\lambda_{\tilde{D}}(z_2)$ and continuing this process, till $\lambda_D(z_{n-1})$ to get all possible optimal schedules.

4. NUMERICAL EXAMPLE

The general procedure explained in the above mentioned theorem is applied for the periodic review perishable inventory problem with number of periods n = 4. Assume the demand occurs in each $t = 1,2,3,4$ be $d_1 = 45$, $d_2 = 50$, $d_3 = 45$, $d_4 = 60$. At the beginning of each period, the inventory on hand is of perishable in nature. The number of items perished Q_k in each period k may be directly proportional to the inventory on hand in that period. Therefore, we consider $Q_k = \left[\frac{\alpha z_k}{\tau}\right]\tau$, where α is the perishable factor i.e. $\alpha \in [0,1]$ & τ is the fundamental unit of inventory. Here, we take $\tau = \delta = 5$ & $\alpha = 0$ for non-perishable inventory system, and $\alpha = 1$ case is a perfect perishable inventory system which is non-existence. We consider that it is necessary that the value of α lies between 0 & 1, i.e. $0 \le \alpha \le 1$.

Case 1: In our problem, if we assume that $\alpha = 0.25$, let the membership function of the fuzzy constraints $\widetilde{FC}_k$ on the decision variable l_k is given as:

$$\lambda_{\widetilde{FC}_k} = \begin{cases} 0 & if\ 0 \le l_k \le 50 - 10k \\ \frac{-3+0.5k+l_k}{20} & 50 - 10k < l_k \le 70 - 10k \\ \frac{5-0.5k+l_k}{20} & 70 - 10k < l_k \le 90 - 10k \\ 0 & 90 - 10k < l_k \end{cases}$$; where k = 1, 2, 3, 4

The membership function of fuzzy goal $\widetilde{FG}_k$ representing the decision to have a low stock at the end of the planning horizon $z_5 \cong 0$ is given by:

$$\lambda_{\widetilde{FC}_5}(z_5) = \begin{cases} \dfrac{1 - z_5}{20} & if\ 0 \le z_5 \le 20 \\ 0 & otherwise \end{cases}$$

Let z_0 be the initial stock or level at the beginning. The inventory level which is supposed to be zero and the permitted state values for the reorder quantities $l_k \in D$, be given by $d_j \in \{0, 5, 10, \ldots \ldots\}$ and that of the possible inventory levels $z_k \in Z$ be given by $\tau_i \in \{0, 5, 10, \ldots \ldots\}$. We are only concerned $\{d_k / \lambda_{\widetilde{FC}_k\,(l_k) > 0}\}$.............. the support of fuzzy constraint set $\widetilde{FC}_t$. In the following table, the bounded decision variables i.e. lower-bound l_k^l and upper-bound l_k^u are obtained. Here $0 \le z_5 \le 20$

k	l_k^l	l_k^u
1	55	85
2	45	75
3	35	65
4	25	55

For the different intermediate stages we find upper and lower bounds using the transformation function by the following three steps:

Step1: Calculation of the $z_k^{l'}$ and $z_k^{u'}$ for the state variable z_k are as follows

k	$z_k^{l'}$	$z_k^{u'}$
1	----	----
2	10	40
3	0	55
4	0	60
5	----	----

Table 1

Step 2 : Assuming $z_5^{l''} = 0$, $z_k^{u''} = 20$ and stating with z_5 , we get the upper and lower bounds as:

k	$z_k^{l''}$	$z_k^{u''}$
1	0	120
2	0	105
3	0	80
4	5	55
5	----	15

Table 2

D_4 / z_4	25	30	35	40	45	50	55	$\lambda_{\widetilde{FG}}(z_4)$
5	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	1/4	1/4
20	0	0	0	0	0	1/2	1/4	1/2
25	0	0	0	0	3/4	1/2	1/4	3/4
30	0	0	0	0	3/4	1/2	1/4	3/4
35	0	0	0	3/4	1/2	1/4	0	3/4
40	0	0	3/4	1/2	1/4	0	0	3/4
45	0	1/2	1/2	1/4	0	0	0	1/2
50	0	1/2	1/2	1/4	0	0	0	1/2
55	1/4	1/2	1/4	0	0	0	0	1/2

With the help of step 3 and above two tables, we have the following upper and lower bounds are:

k	z_k^l	z_k^u
1	0	0
2	10	40
3	0	55
4	5	55
5	----	15

Table 3

Within the lower and upper bounds, the optimal l_k and z_k are as follows:

Stage1 : $\lambda_{\widetilde{D}}(z_4) = \max_{l_4}\{\min\{\lambda_{\widetilde{FG}}(l_4), \lambda_{\widetilde{FG}}(z_4, l_4)\}\}$

$$\lambda_{\widetilde{D}}(z_4) = \max_{l_4}\{\min\{\lambda_{\widetilde{FG}}(l_4), \lambda_{\widetilde{FG}}(z_4 - Q_4 + l_4 - d_4)\}\}$$

***Stage 2* :**

l_3 \ z_3	35	40	45	50	55	60	65	$\lambda_{\widetilde{FG}}(z_3)$
0	0	0	¾	¾	½	¼	0	¾
5	0	0	¾	½	¼	0	0	¾
10	0	0	¾	½	¼	0	0	¾
15	0	½	½	¼	0	0	0	½
20	¼	½	¼	0	0	0	0	½
25	¼	¼	0	0	0	0	0	¼
30	¼	¼	0	0	0	0	0	¼
35	¼	0	0	0	0	0	0	¼
40	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0

***Stage 3* :** $\lambda_{\tilde{D}}(z_2) = \max_{l_2}\{ min\,\{\lambda_{\widetilde{FC}}(l_2)\,, \lambda_{\widetilde{FG}}(z_2 - Q_2 + l_2 - d_2)\}\}$

l_2 \ z_2	45	50	55	60	65	70	75	$\lambda_{\tilde{D}}(z_4)$
10	0	½	½	¼	0	0	0	½
15	¼	½	¼	0	0	0	0	½
20	¼	¼	0	0	0	0	0	¼
25	¼	0	0	0	0	0	0	¼
30	¼	0	0	0	0	0	0	¼
35	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0

Stage 4 : $\lambda_{\tilde{D}}(z_1) = \max_{l_1}\{ min \{\lambda_{\widetilde{FC}}(l_1), \lambda_{\widetilde{FG}}(z_1 - Q_1 + l_1 - d_1)\}\}$

z_1 \ l_1	55	60	65	70	75	80	85	$\lambda_{\widetilde{FG}}(z_1)$
0	**1/4**	**1/4**	**0**	**0**	**0**	**0**	**0**	**1/4**

Case 2 : If the perishable factor $\alpha = 0.5$, then we have

k	z_k^l	z_k^u
1	0	0
2	10	40
3	0	45
4	5	20
5	----	15

By the above way

Stage 1 :

z_4 \ l_4	25	30	35	40	45	50	55	$\lambda_{\widetilde{FG}}(z_4)$
5	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	¼	¼
15	0	0	0	0	0	0	1	1
20	0	0	0	0	0	½	¼	½

Stage 2 :

D_3 \ z_3	35	40	45	50	55	60	65	$\lambda_{\widetilde{FG}}(z_3)$
0	**0**	**0**	**1**	¾	½	¼	**0**	**1**
5	**0**	**0**	**1**	¾	½	¼	**0**	**1**
10	**0**	½	¾	½	¼	**0**	**0**	¾
15	**0**	½	¾	½	¼	**0**	**0**	¾
20	**0**	½	½	¼	**0**	**0**	**0**	½
25	**0**	½	½	¼	**0**	**0**	**0**	½
30	¼	½	¼	**0**	**0**	**0**	**0**	½
35	¼	½	¼	**0**	**0**	**0**	**0**	½
40	¼	¼	**0**	**0**	**0**	**0**	**0**	¼
45	¼	¼	**0**	**0**	**0**	**0**	**0**	¼

Stage 3 :

D_2 \ z_2	45	50	55	60	65	70	75	$\lambda_{\widetilde{FG}}(z_2)$
10	¼	½	½	¼	**0**	**0**	**0**	½
15	¼	½	½	¼	**0**	**0**	**0**	½
20	¼	½	¼	**0**	**0**	**0**	**0**	½
25	¼	½	¼	**0**	**0**	**0**	**0**	½
30	¼	¼	**0**	**0**	**0**	**0**	**0**	¼
35	¼	¼	**0**	**0**	**0**	**0**	**0**	¼
40	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Stage 4 **:**

l_1 \ z_1	55	60	65	70	75	80	85	$\lambda_{\widetilde{FG}}(z_2)$
0	¼	¼	0	0	0	0	0	¼

Case 3 **:** Let the perishable factor be $\alpha = 0.75$, then we get

k	z_k^l	z_k^u
1	0	0
2	10	40
3	0	35
4	5	30
5	----	15

By the above way:

Stage 1 **:**

D_4 \ z_4	25	30	35	40	45	50	55	$\lambda_{\widetilde{FG}}(z_4)$
5	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	¼	¼
20	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	¼	¼
30	0	0	0	0	0	0	¼	¼

Stage 2 **:**

l_3 \ z_3	35	40	45	50	55	60	65	$\lambda_{\widetilde{FG}}(z_3)$
0	0	0	¾	¾	½	¼	0	¾
5	0	0	¾	¾	½	¼	0	¾
10	0	½	¾	¾	½	¼	0	¾
15	0	½	¾	½	¼	0	0	¾
20	¼	½	¾	½	¼	0	0	¾
25	¼	½	¾	½	¼	0	0	¾
30	¼	½	¾	½	¼	0	0	¾
35	¼	½	½	¼	0	0	0	½

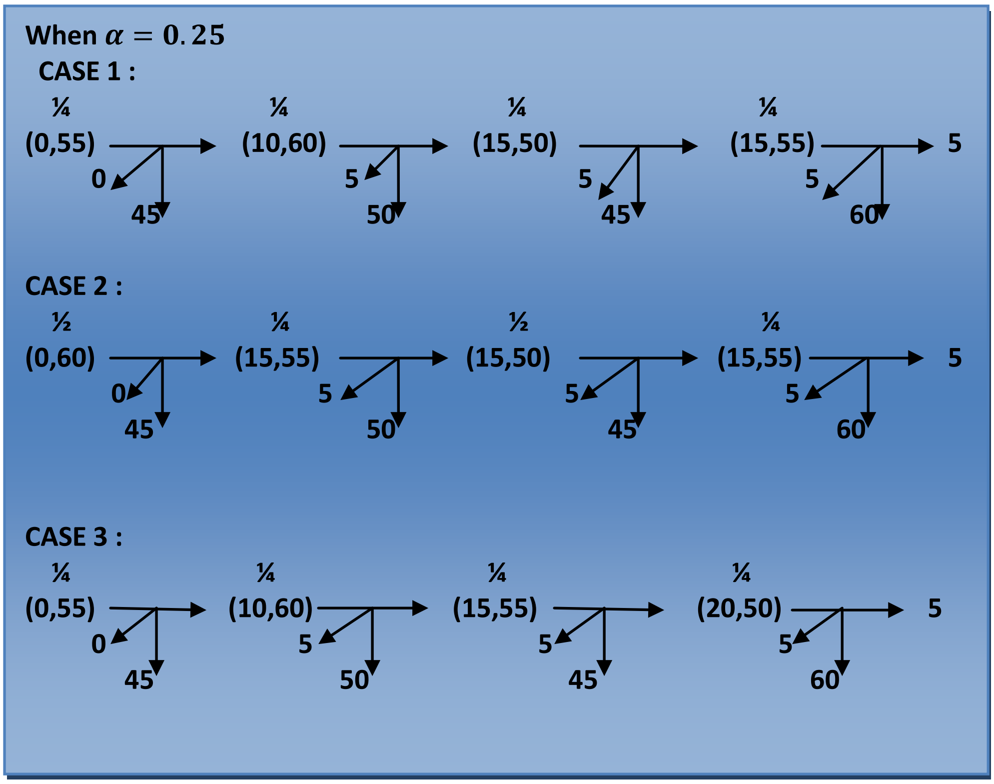
Stage 3 **:**

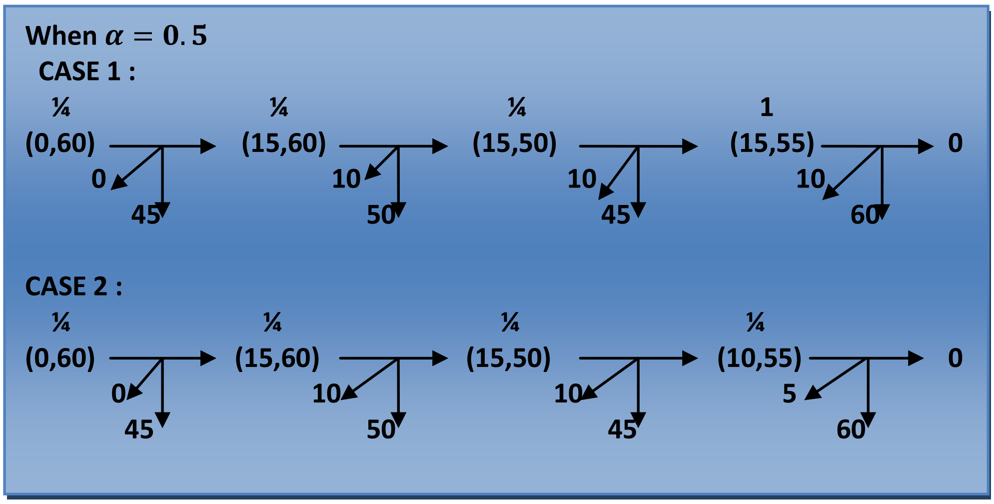
l_2 \ z_2	45	50	55	60	65	70	75	$\lambda_{\widetilde{D}}(z_2)$
10	**0**	½	¼	½	¼	**0**	**0**	½
15	¼	½	¼	¼	**0**	**0**	**0**	½
20	¼	½	¼	¼	**0**	**0**	**0**	½
25	¼	½	¼	¼	**0**	**0**	**0**	½
30	¼	½	¼	¼	**0**	**0**	**0**	½
35	¼	½	¼	**0**	**0**	**0**	**0**	½
40	¼	½	¼	**0**	**0**	**0**	**0**	½

Stage 4 **:**

l_1 \ z_1	55	60	65	70	75	80	85	$\lambda_{\widetilde{FG}}(z_1)$
0	¼	¼	**0**	**0**	**0**	**0**	**0**	¼

Optimal Schedule **:** For various values of perishable parameter α , using the above concepts , an optimal schedule are formed as :





It is to be noted that, we could get the optimum schedule for each for various values of perishable parameter in other way the cases with inventory level low or zero gives the optimal inventory.

5. PERCEPTIVE ANALYSIS

A range of perishable rates α have been compared by the optimal schedules. We have shown that the final inventory position become zero for $\alpha \geq 0.5$. This indicates that as $\boldsymbol{\alpha}$ increases, the optimal schedule become more accurate and crisp.

6. RESULT

We consider only those problems which are perishable inventory control decision problems, further which are solved by using fuzzy dynamic programming. Perceptive analysis done by determining the appositively of different schedules $\alpha = 0.25\,, 0.5\ and\ 0.75$. This also extended to solve inventory control problems with partial and full backlogging.

7. REFERENCES

[1] Bellman, R., 1957, Dynamic programming Princeton.

[2] Bellman, R., and Zadeh, L.A., 1970, Decision makin in a guzzy environment management science 17, B 141-164.

[3] Esogbue, A. O., and Bellman, R. E., 1984, Fuzzy dynamic programming and its extensions, In Zimmermann et al 147-167.

[4] Kacpizyk, J, 1983, Multi stage decision-making under fuzziness, vertag TUV Rheinland, Koln, Germany.

[5] Kacpizyk, J and Esogbue, A.O., 1996, Main development and applications, Fuzzy dynamic programming, Fuzzy sets and systems, 81, 31-45.

[6] K. Thangavel, M.Karnan, P.jaganathan, Pethalakshmi, R.Siva Kumar And Geetha Ramani, "Ant Colony Algorithms In Diverse Combinational Optimization Problems – A Survey", International Journal on Automatic Control System and Engineering, vol.6, no. 1, pp 7-26, 2005.

[7] Turban, E, 1998, decision support and expert systems, second edition, Macmillan, Newyork.

[8] Zimmermann, H.J., 1983, Fuzzy mathematical programming Computational operation Research, 10, 291-298.

[9] Zimmermann, H.J., 1985, Applications of Fuzzy set theory to mathematical program, Information Science, 36, 29-58.

[10] Zimmermann, H.J., 1991, Fuzzy set theory and its applications, second edition, Kluwer Academic publishers, Netherlands.

[11] Zimmermann, H.J., 2000, An application-oriented view of modeling uncertainty, European journal of Operation Research, 122, 190-198.