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Interval Valued Neutrosophic Geometric Programming Technique for An Environmental Oriented Inventory Model with Benefits of Incineration

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Abstract

Right now, discover a economic request quantity for a herbal located stock model and blessings of burning at squander elimination strategy the use of neutrosophic geometric programming method. I absolutely have planned a model where the imperfect matters are changed. These blemished things may be considered in neutrosophic situation and the associated fees of placing a burning plant are considered as neutrosophic fluffy numbers. At that component we unravel with the resource of geometric programming approach. A numerical version is given to assist the trouble.

Catchphrases; *Economic request amount, Incineration prices, Neutrosophic trapezoidal fluffy amount, Geometric programming method.*

I. INTRODUCTION

As a rule, GP is a possible approach to apprehend a category of non-direct hassle in exam with other non-instantly strategies. The double hassle is much less complicated to attend to than the base hassle. GP technique changed into first furnished by way of Zener [4]. Later on, Duffin et al. [5] created GP technique for streamlining problems. Kotchenberger [6] became the number one Scientist who handled the inventory hassle through GP method.

In 1995, Smarandache [33–35] provided the term 'Neutrosophy' which indicates records on independent concept. NS is characterized through three free tiers; reality (participation) diploma, indeterminacy (wavering) diploma and misrepresentation (non-enrollment) degree. These days, NS is applied in severa fields of research paintings. Roy and Das [36] tackled multi intention creation arranging issue by using the usage of neutrosophic instantly programming technique. .

There are a few improvements on neutrosophic programming technique that have been performed on a few actual troubles. Jiang and Ye [76] characterised neutrosophic capacities and numbers for enhancement fashions . Ye [78] and Ye et al. [79] created neutrosophic amount without delay and non-direct programming strategies individually. In the two cases, creators made packages underneath NN situation. Regardless of the above advancements, there are a few holes inside the writing of Neutrosophic Optimization. The concept of the prevailing examination is to accumulate a method to decrease a non-instantly Neutrosophic Problem to a concerning GPP and in a while to apprehend it by the use of the right method counting on its diploma of problem.

Right now, gift some other technique of neutrosophic trapezoidal fluffy numbers with geometric programming strategy for locating the financial creation quantity with the blessings of burning.

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II. FUNDAMENTALS

This section present a few definitions and crucial mind recognized with Geometric Programming method, Neutrosophic fluffy numbers , Trapezoidal neutrosophic fluffy variety , Interval esteemed neutrosophic fluffy variety and its exactness paintings.

2.1Geometric programming problem:

Primal problem: Primal Geometric Programming(PGP) problem is

Minimize $g_0(t) = \sum_{k=1}^{T_0} C_{0k} \prod_{j=1}^{m} t_j^{\alpha_{0kj}}$

Subject to $\sum_{k=1}^{T_0} C_{rk} \prod_{j=1}^{m} t_j^{\alpha_{rkj}} \leq 1$, (r= 1,2,…..l) , j= (1,2,3…..m) $t_j>0$

Where $C_{0k} >0$ (k=1,2,…T_0) C_{rk} and α_{rk} are real numbers. It is constrained polynomial geometric problem. The number of term each polynomial constrained functions varies and it is denoted by T_r

for each r= 0,1,2….. Let T= $T_0+T_1+T_2+\ldots\ldots +T_l$ be the total number of terms in the primal program.

The Degree of difficulty is (DD) = T – (m+1)

Dual Problem:

Maximize $= \prod_{r=0}^{l}\prod_{k=1}^{T^r}(\frac{C_{rk}}{\delta_{rk}})^{\delta rk}(\sum_{s=1+T_{r+1}}^{T}(\delta_{rs})^{\delta rk}$

Subject to $\sum_{k=1}^{T_0} \delta_{0k} = 1$ (Normality condition)

$\sum_{r=0}^{l}\sum_{k=1}^{T_r} \alpha_{rkj}\delta_{rk} = 0$ (Orthogonality conditions)

$\delta_{rk} > 0$, (Positive constant)

2.2 Intutionisitic Fuzzy Number:

An Inutionistic Fuzzy subset $\overline{A}$ = { < x,$\mu_A(x)$, $v_A(x)$ > / x ϵX } of the real line R is called an intutionistic fuzzy number if the following conditions hold.

* There exists mϵR such that $\mu_A(m)$ = 1 and $V_A(m) = 0$

* $\mu_A(x)$ is continuous function from R →[0,1] such that $0\leq,\mu_A(x) + v_A(x)\leq 1$ for all xϵX.

2.3 Trapezoidal Intutionistic Fuzzy number:

A trapezoidal intutionistic fuzzy number is denoted by $\overline{A}$ = (a_1,a_2,a_3,a_4) , (a_1', a_2, a_3,a_4') where

$a_1' \leq a_2 \leq a_3 \leq a_4'$ where the membership and non-membership function of $\overline{A}$ are in the following form

$$\mu_{\overline{A}}(x) = \begin{cases} 0 : x < a_1 or x > a_4 \\ \frac{(x-a_1)}{(a_2-a_1)} : a_1 \leq x \leq a_2 \\ 1 : a_2 \leq x \leq a_3 \\ \frac{(x-a_4)}{(a_3-a_4)} : a_3 \leq x \leq a_4 \end{cases}$$

and

$$V_{\overline{A}}(x) = \begin{cases} 1 : x < b_1 or x > b_4 \\ \frac{(x-b_2)}{(b_1-b_2)} : b_1 \leq x \leq b_2 \\ 0 : b_2 \leq x \leq b_3 \\ \frac{(x-b_3)}{(b_4-b_3)} : b_3 \leq x \leq b_4 \end{cases}$$

2.4 Neutrosophic set:

Leave X alone a universe set. A neutrosophic set An on X is characterized as A = {TA(x), IA(x), FA(x) : x ∈ X}, where TA(x), IA(x), FA(x) : X →−]0, 1[+ speaks to the level of enrollment, level of indeterministic, and level of non-participation individually of the component x ∈ X, with the end goal that −0 ≤ TA(x) + IA(x) + FA(x) ≤ 3+for all x ∈ X.

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2.5 Neutrosophic Number:

A neutrosophic set A characterized on the all inclusive arrangement of genuine numbers R is said to be neutrosophic number on the off chance that it has the accompanying properties.

i) A is normal if there exists $x_0 \in R$, such that $T_A(x_0) = I\ (I_A(x_0) = F_A(x_0) = 0)$

ii) A is convex set for the truth function $T_A(x)$, $T_A(\mu x_1 + (1-\mu)x_2) \geq \min(T_A(x_1),T_A(x_2))$ for all $x_1, x_2 \in R$, $\mu[0,1]$

iii) A is concave set for the indeterministic function and false function $I_A(x)$, $F_A(x)$

iv) $I_A(\mu x_1 + (1-\mu)x_2) \geq \max(T_A(x_1),T_A(x_2))$ for all $x_1, x_2 \in R$, $\mu[0,1]$ and

$T_A(\mu x_1 + (1-\mu)x_2) \geq \max(T_A(x_1),T_A(x_2))$ for all $x_1, x_2 \in R$, $\mu[0,1]$

2.6 Trapezoidal Neutrosophic fuzzy number:

A trapezoidal neutrosophic fuzzy number A (a,b,c,d,u_A, ~~v_A,w_A~~) in R with the following truth function, indeterministic function and falsity function which is given by the following

T

$$T_{\bar{A}}(x)=\begin{cases} 0: x<a_1 or x>a \\ \dfrac{(x-a)}{(b-a)}u_A : a\leq x\leq b \\ u_A : b\leq x\leq c \\ \dfrac{(d-x)}{(d-c)}u_A : c\leq x\leq d \\ 1, otherwise \end{cases}$$

$$I_{\bar{A}}(x)=\begin{cases} 0: x<a\ or x>a \\ \dfrac{(b-x)}{(b-a)}v_A : a\leq x\leq b \\ v_A : b\leq x\leq c \\ \dfrac{(d-x)}{(d-c)}v_A : c\leq x\leq d \\ 1, otherwise \end{cases}$$

$$F_{\bar{A}}(x)=\begin{cases} 0: x<a\ or x>a \\ \dfrac{(b-x)}{(b-a)}w_A : a\leq x\leq b \\ w_A : b\leq x\leq c \\ \dfrac{(d-x)w_A}{(d-c)} : c\leq x\leq d \\ 1, otherwise \end{cases}$$

3.1 Accuracy function of trapezoidal Intutionistic fuzzy number:

Now we use the accuracy function of Intutionistic fuzzy number.

AFI(A) = [(a+ 2(b+c) +d) + (a' +2(b'+c')+d')] / 12

3.2 Score function of trapezoidal neutrosophic fuzzy number:

Let A= [T^L,T^U] , [I^L,I^U] , [F^L,F^U] be an interval neutrosophic number, then the score function of A can be defined by S(A) = $\dfrac{T^L+T^U}{2}+1-\dfrac{I^L+I^U}{2}+\dfrac{F^L+F^U}{2}$

III. MATHEMATICAL MODEL

5.1 Assumptions:

1. The interest is consistent.
2. No deficiencies are approved.
3. The matters to be reused, revised and burned are communicated as the extent of improper

matters.

4. The cost of repairing the matters which are sorted as reusable is insignificant.
5. Lead time is thought to be 0.
6. Planning skyline is big.

5.2 Notations:

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Q order length

C unit variable price

K fixed price of filing a request

P percentage of inadequate things in Q

q percent of inadequate matters those are reasonable for reuse

r percentage of inadequate things those are affordable for reuse

i percent of insufficient matters which are exposed to cremation (1-q-r)

s unit promoting value of factors of good satisfactory

v unit selling value of inadequate matters which can be arranged as reusable (v<s)

R unit cost of reusing

R1 unit selling cost of reused things (R1 >R)

I unit value of elimination via the techniques for cremation

I1 revenue earned according to unit

x screening price

d unit screening value

h retaining fee

d1 unit screening cost of the defective things.

E emission introduced approximately by way of cremation moderating expense

T cycle duration

IV. FRESH MODEL

Consider the scenario where a ton of length Q is conveyed straight away with a buying fee of c consistent with unit and a inquiring for value of K. It is widely wide-spread that every parcel were given consists of a known degree of defectives p, after 100% of screening unsuitable things is remoted from the remarkable things. To make advantage out of the damaged things, they may be make to revel in 2d screening i.E., the LCA gadget is applied to rank the faulty matters as reusable, re beneficial and the deposits to be burned depending on their extent which is communicated because the percentage of unsuitable matters. It is organized dependent on the diploma and nature of deformities found in every defective thing.

Let TR(Q) and TC(Q) be the all out profits and the all out cost consistent with cycle one after the other. TR(Q) is the combination offers volume of proper satisfactory, reusable matters, progressed things and the profits from the cremation of non-repairable devices.

TR(Q) = s Q(1-p) + vqpQ +R1 rpQ + I1 ipQ

TC(Q) is the combination of acquirement price according to cycle, screening cost in line with cycle, conserving price in step with cycle, screening fee of insufficient matters in keeping with cycle, remanufacturing cost in step with cycle, price on cremation according to cycle.

$$TC(Q) = K+cQ+dQ+d_1pQ+E+h^*\left[\frac{Q(1-p)T}{2}+\frac{pQ^2}{x}\right]+RrpQ + I\,ipQ$$

Total profit per cycle is the total revenue per cycle less the total cost per cycle, TP(Q)=TR(Q) – TC(Q) and it is given us

$$TP(Q) = s\,Q(1-p) + vqpQ + R_1\,rpQ + I_1\,ipQ - \{K+cQ+dQ+d_1pQ+E+h^*\left[\frac{Q(1-p)T}{2}+\frac{pQ^2}{x}\right]+RrpQ + I\,ipQ\}$$

The total profit per unit of time is given by diviging the total profit per cycle by cycle length,

TPY(Q) = TP(Q) / T and can be written as

TPU(Q)= D(s –vq-R_1r-I_1i+I i+d_1+$\frac{hQ}{x}$+Rr) + D(vq +R_1r+I_1i – I I –d_1-$\frac{hQ}{x}$-Rr-c-d-$\frac{K}{Q}$-$\frac{E}{Q}$)$\frac{1}{(1-p)}$-$\frac{hQ(1-p)}{2}$

TPU(Q) = $\frac{D}{1-p}[(s-c-d)-p(s-vq-R_1-I_1i+Ii+d_1+Rr]$ --- $\frac{hDQp}{x(1-p)}-\frac{hQ(1-p)}{2}-\frac{(K+E)D}{Q(1-p)}$

$$TPU(Q)=\frac{D}{1-p}G-\frac{hDQp}{x(1-p)}-\frac{hQ(1-p)}{2}-\frac{(K+E)D}{Q(1-p)}$$ where

$G=(s-c-d)-p(s-vq-R_1-I_1i+Ii+d_1+Rr]$ and the objective is to determine the optimal quantity. The necessary condition is $\frac{\partial TPU(Q)}{\partial Q}=0$

. Then Q = $\sqrt{\frac{2(K+E)Dx}{h[(1-p)^2x+2Dp]}}$

V. SOLUTION OF THE INVENTORY MODEL BY CRISP GEOMETRIC PROGRAMMING

We solve the proposed model by applying geometric programming and the degree of difficulty is 0.

Max G(w) = $\prod_{r=1}^{n}(\frac{GD}{(1-p)w_{1r}})^{w1r}(\frac{hDQp}{x(1-p)w_{2r}})^{w2r}(\frac{hQ(1-p)}{2w_{3r}})^{w3r}((\frac{K+E)D}{Q(1-p)w4r})^{w4r}$

Subject to the conditions,

$$w_{1r} + w_{2r} + w_{3r} + w_{4r} = 1$$

$$w_{1r} + w_{2r} + w_{4r} = 0$$

$$w_{2r} + w_{3r} - w_{4r} = 0$$

and $w_{2r} + w_{3r} = 0$

solving these equations we get, w_{1r} = 1 , w_{2r} = -1 , w_{3r} = 1 and w_{4r} = 0

By applying Duffin's and Peterson's theorem , (from the primal and dual relations)

$$\frac{(K+E)D}{Q(1-p)} = w_{1r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r}) \text{ ---- (1)}$$

$$\frac{hDQp}{x(1-p)}+\frac{hQ(1-p)}{2} = w_{2r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r}) \text{ ------------(2)}$$

$$\frac{GD}{1-p} = w_{3r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r}) \text{ --------------(3)}$$

By dividing the equations (1) and (2) , we get, $\frac{(K+E)D}{Q(1-p)}=hQ[\frac{Dp}{x(1-p)}+\frac{1-p}{2}]$

Hence , $Q^2 = \frac{2x(K+E)D}{h[2Dp+x(1-p)^2]}$

$$Q_1 = \sqrt{\frac{2x(K+E)D}{h[2Dp+x(1-p)^2]}}$$

VI. SOLUTION OF INVENTORY MODEL BY INTUTIONISTIC FUZZY GEOMETRIC PROGRAMMING

Let A^I = (a,b,c,d) and (a',b',c',d') be the trapezoidal Intutionistic fuzzy number and the objective function is $TPU(Q_1)=\frac{D^I}{1-p}G-\frac{h^ID^IQp}{x(1-p)}-\frac{h^IQ(1-p)}{2}-\frac{(K^I+E^I)D^I}{Q(1-p)}$

by applying geometric programming and the degree of difficulty is 0.

Max G(w) = $\prod_{r=1}^{n}(\frac{GD^I}{(1-p)w_{1r}})^{w1r}(\frac{h^ID^IQp}{x(1-p)w_{2r}})^{w2r}(\frac{h^IQ(1-p)}{2w_{3r}})^{w3r}((\frac{K^I+E}{Q(1-p}$

Subject to the conditions,

$$w_{1r} + w_{2r} + w_{3r} + w_{4r} = 1$$

$$w_{1r} + w_{2r} + w_{4r} = 0$$

$$w_{2r} + w_{3r} - w_{4r} = 0$$

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and $w_{2r} + w_{3r} = 0$

solving these equations we get, $w_{1r} = 1$, $w_{2r} = -1$, $w_{3r} = 1$ and $w_{4r} = 0$

By applying Duffin's and Peterson's theorem ,(from the primal and dual relations)

$$\frac{(K^I + E^I)D^I}{Q(1-p)} = w_{1r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r}) \text{ -----(4)}$$

$$\frac{h^I D^I Qp}{x(1-p)} + \frac{h^I Q(1-p)}{2} = w_{2r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r})$$
------------(5)

$$\frac{GD}{1-p} = w_{3r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r}) \text{ -----------------(6)}$$

By dividing the equations (4) and (5) , we get, $\frac{(K^I + E^I)D^I}{Q(1-p)} = h^I Q[\frac{D^I p}{x(1-p)} + \frac{1-p}{2}]$

Hence , $Q^2 = \frac{2x(K^I + E^I)D^I}{h^I[2D^I p + x(1-p)^2]}$

$$Q_2 = \sqrt{\frac{2x(K^I + E^I)D^I}{h^I[2D^I p + x(1-p)^2]}}$$

VII. SOLUTION OF INVENTORY MODEL BY NEUTROSOPHIC FUZZY GEOMETRIC PROGRAMMING

$$TPU(Q) = \frac{D}{1-p}G - \frac{hDQp}{x(1-p)} - \frac{hQ(1-p)}{2} - \frac{(K+E)D}{Q(1-p)}$$ where

$$G = (s-c-d) - p(s - vq - R_1 - I_1 i + Ii + d_1 + Rr]$$

In Neutrosophic Fuzzy Model,

Let A^N = (a,b,c,d : a',b',c',d' : a'',b'',c'',d'') be a trapezoidal neutrosophic fuzzy number.

$$TPU(Q*) = \frac{D^N}{1-p}G - \frac{h^N D^N Qp}{x(1-p)} - \frac{h^N Q(1-p)}{2} - \frac{(K^N + E^N)D^N}{Q(1-p)}$$

By applying geometric programming technique with degree of difficulty is 0.

Max $G^*(w)$ =

$$\prod_{r=1}^{n} \left(\frac{GD^N}{(1-p)w_{1r}}\right)^{w1r} \left(\frac{h^N D^N Qp}{x(1-p)w_{2r}}\right)^{w2r} \left(\frac{h^N Q(1-p)}{2w_{3r}}\right)^{w3r} \left(\left(\frac{K^N + E}{Q(1-}\right.\right.$$

Subject to the conditions,

$$w_{1r} + w_{2r} + w_{3r} + w_{4r} = 1$$

$$w_{1r} + w_{2r} + w_{4r} = 0$$

$$w_{2r} + w_{3r} - w_{4r} = 0$$

and $w_{2r} + w_{3r} = 0$

solving these equations we get, $w_{1r} = 1$, $w_{2r} = -1$, $w_{3r} = 1$ and $w_{4r} = 0$

By applying Duffin's and Peterson's theorem , (from the primal and dual relations)

$$\frac{(K^N + E^N)D^N}{Q(1-p)} = w_{1r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r}) \text{ -- (7)}$$

$$\frac{h^N D^N Qp}{x(1-p)} + \frac{h^N Q(1-p)}{2} = w_{2r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r})$$
) ------------(8)

$$\frac{GD^N}{1-p} = w_{3r}\, g(w_{1r}, w_{2r}, w_{3r}, w_{4r}) \text{ --------------(9)}$$

By dividing the equations (7) and (8) , we get, $\frac{(K^N + E^N)D^N}{Q(1-p)} = h^N Q[\frac{D^N p}{x(1-p)} + \frac{1-p}{2}]$

Hence , $Q^2 = \frac{2x(K^N + E^N)D^N}{h^N[2D^N p + x(1-p)^2]}$

$$Q_3 = \sqrt{\frac{2x(K^N + E^N)D^N}{h^N[2D^N p + x(1-p)^2]}}$$

VIII. NUMERICAL EXAMPLE

Let us consider the inventory situation where a stock is replenished instantly with Q units of which not all are of the desired quality. The parameters

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needed for analyzing the above inventory situation are given below:

D= 50000 units/year , c = \$25/ unit , K = \$100/cycle, s = \$50 /unit , v = \$40/unit, h = \$5/unit/year,

R = \$5/unit, E = \$500/cycle , R_1 = \$ 15/unit , I = \$2/unit , I_1 = \$5/unit, x = 1/unit/minute, d = \$ 0.5/unit,

d_1 = \$0.5/unit, p= 0.05, q = 0.05 , r = 0.3, I = 0.2.

Assuming that the inventory operation operates on an 8 hours/day, for 365 days a year, then the annual screening rate, x = 1 X 60 X 8 X 365 = 175200 units/yr

Crisp model: The Optimal Order Quantity Q = 3590 units.

Crisp Geometric Programming Method:

The Optimal Order Quantity **Q_1 = 3590.102 units**.

Intutionistic Fuzzy Geometric Programming Method:

D= 50000 $\bar{D}$= (49600 , 49800 50200 , 50400)

D^I = (49600 , 49800 50200 , 50400)((49400 , 49800 50200 , 50600)

By using Accuracy function of fuzzy number $\bar{D}$, D^I = 50000

h = 5 , $\bar{h}$ = (4.8, 4.9, 5.1, 5.2) h^I = (4.8, 4.9, 5.1, 5.2) (4.5, 4.9, 5.1, 5.5)

By using Accuracy function of fuzzy number $\bar{h}$, h^I = 5

K=100 , $\bar{k}$ = (98,99,101,102)(95,99,101,105) and k^I = 100

E = 500 , $\bar{E}$ = (400,450,550,600)(350,450,550,650) and E^I = 500

The Optimal Order Quantity Q_2 = 3590.102 units

Neutrosophic Fuzzy Geometric Programming Method:

D= 50000 $\bar{D}$= (49600 , 49800 50200 , 50400)

D^N = (49600,49800,50200,50400))(49300,49600,50300,50600) (49400,49800,50200,50600)

(T^L , T^U) = (49700,50300) ,(I^L,I^U) = (49450,50450) , (F^L , F^U) = (49600,50400)

By using Score function of fuzzy number $\bar{D}$, S($\bar{D}$) = 50051

h = 5 , $\bar{h}$ = (4.8, 4.9, 5.1, 5.2) h^N = (4.8, 4.9, 5.1, 5.2) (4.8, 4.9, 4.9, 5.1)(4.5, 4.9, 5.1, 5.5)

(T^L , T^U) = (4.85,5.15) ,(I^L,I^U) = (5,5.85) , (F^L , F^U) = (4.7,5.3) and S($\bar{h}$) = 5.575

K=100 , $\bar{k}$ = (98,99,101,102)(95,99,101,105)(96,98,104,106)

(T^L , T^U) = (98.5,101.5) ,(I^L,I^U) = (97,105) , (F^L , F^U) = (97,103) and S($\bar{k}$) = 100

E = 500 , $\bar{E}$ = (400,450,550,600)350,450,500,700)(350,450,550,650)

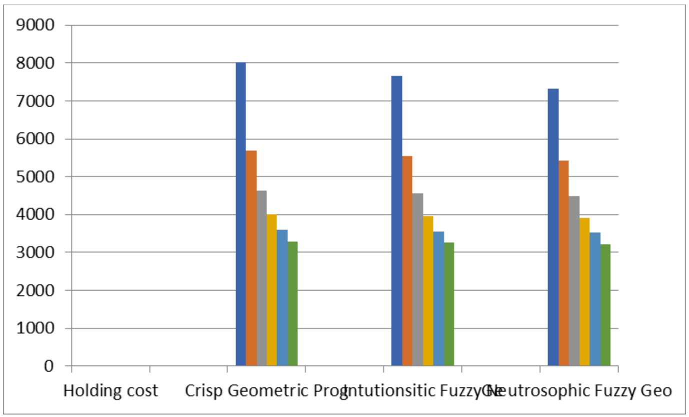
(T^L , T^U) = (425,575) ,(I^L,I^U) = (400,600) , (F^L , F^U) = (400,600) and S($\bar{E}$) = 501

Then Optimal Order Quantity Q_3 = 3594.8 units.

IX. SENSITIVITY ANALYSIS

In this paper , an optimal solution is obtained by using score function of trapezoidal neutrosophic fuzzy number and comparing graphically with the crisp geometric, Intutionistic geometric method as holding cost changes and hence the neutrosophic set gives the better solution.

Holding cost	Crisp Geometric Prog	Intutionsitic FuzzyGe	Neutrosopl
1	8027.711	7654.12	7328.26
2	5676.448	5539.647	5412.282
3	4634.801	4559.434	4487.627
4	4013.855	3964.604	3917.122
5	3590.102	3554.73	3520.384
6	3277.299	3250.325	3224.0



X. CONCLUSION

In this paper, we discover an economic order quantity for an environmental orientated inventory version and blessings of incineration at waste disposal method the usage of neutrosophic geometric programming approach. Incineration is the most critical way of the usage of the strength about content material of the waste.

The goal of this paper is how neutrosophic geometric programming approach can be utilized to resolve a non-linear programming problem and the concept lets in to outline the degree of reality, indeterminacy and falsity functions.

From the numerical example, we have compared the advanced values of crisp geometric, Intutionisitic and neutrosophic fuzzy geometric strategies and the exceptional benefits of the neutrosophic fuzzy geometric method is greater useful method to the actual existence problems.

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