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RESEARCH ARTICLE

Mathematical Approach for the Assessment of Suitability of Medicinal Plants for their Growth and Survival

Vijay Kumar*, Arti Saxena

Department of Mathematics, Manav Rachna International Institute of Research & Studies, Sector-43, Surajkund Road, Faridabad, Haryana, India

Key words: Intuitionistic fuzzy sets, Decision making

Abstract

There are many commonly available plants grown in the vicinity of rural areas namely as, *Emblica officinalis* (Amla), *Withania somnifera* (Aswagandha), *Aegle marmelos* (Bael/Bilva), *Bacopa monnieri* (Brahmi), *Piper longum* (pippali), *Eclipta alba* (vringraj), *Ocimum tenuiflorum* (Tulsi) and many others which have a certain medicinal values and used in the treatment of many ailments. But these plants cannot be grown anywhere and the growth of such plants mainly depends on many certain factors like atmosphere, quality of soil, quality of seed, *etc.* If we sow these plants in any place without knowing the possibility of its growth in certain areas or it may lose its actual medicinal properties. In our study we propose a mathematical approach that helps the individual to grow a suitable medicinal plant for their place. By using the procedure, one can also create the ambiance so that these plants can be grown with their proper medicinal benefits.

Introduction:

Since the inception of life, the cultivation of crops and grown of trees were the primary objectives of the society. Many diseases were cured by the use of fruits of the plants. The fruit of these plants has the capability to treat various ailments. Not only fruits of these plants but also various parts of these plants have been used for the purpose of treatment. For centuries, the benefits of these plants have been acknowledged by the scientific community, but the big irony is that these plants are not available anywhere over the globe and its properties vary from region to region. Due to which, selection of suitable places for the cultivation of these medicinal plants has been dependent on various factors. It is essential to have adequate knowledge of all those possible factors affecting growth and the survival of these medicinal plants, but as an individual, it is difficult to gather information about the cultivation of such medicinal plants. Lack of knowledge regarding the suitability of the type of medicinal plants, resulting in poor growth of these plants and sometimes have issues in their survival. It is a well-known fact that herbal products, which are the byproduct of these plants have no side effects or fewer side effects. India has been recognized as the wealthy repository of medicinal plants grown across various regions of the country, but the budding generation lacks in knowing the characteristics of such plants in use. It is the responsibility of the society to disseminate the knowledge of the characteristics owned by various medicinal plants over the centuries to the next generation, so that they may aware and use these plants as a medicine and endorse their benefits. The increasing demand of these plants to cure various ailments can only be fulfilled if these plants were grown in a suitable region with their medicinal values. We conducted systematic literature survey through PubMed, Web of Science and CNKI databases using the keywords "medicinal plants", "herbal products", "aromatic plants", "endangered plants" *etc.* and keyword combinations as "conservation", "sustainable use", "factors affecting growth" *etc.* Retrieved abstracts of relevant articles are described in this text.

Brahmi (2014), studied various factors affecting the cultivation of both medicinal and aromatic plants and found that lack of awareness in cultivation and locally non-availability are the main factors other than the remaining factors hinders the cultivation of such plants. Deeb (2013), conducted a survey of medicinal plants used by Lebanon's herbalists and discussed the applications of these plants to cure various ailments. Rafieian-Kopaei (2012) studied that there is a close relationship between medicinal plants and their needs for human beings to cure chronic diseases. Nalawade (2003) discussed the sustainable utilization of medicinal plant resources in the Taiwan region. The increased popularity of Green Tea, which is indeed a medicinal plant has many health benefits, have been discussed by Chacko (2010). Balunas & Kinghorn(2005)

**Corresponding Author: drvijaykumarsudan@gmail.com*

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discussed in his research about the evolution of drug extracted from medicinal plants. Ross (2005) revealed that both traditional and modern medicines are the byproduct of various medicinal plants. Hamilton (2003, 2008) presented a case study to showcase the conservation and development of medicinal plants and their use in the present world. Schippmann (2005) discussed the impact of cultivation on the growth of medicinal plants and their conservation. Wagh & Jain (2013) studied various hazardous factors that show footprints on the status of medicinal plants in the Jhabua district of Madhya Pradesh, India. The conservation and sustainable use of medicinal plants have been studied by Larsen (2007) and Uprety (2012). The commonly grown medicinal plants in India are *Emblica officinalis* (Amla), *Withania somnifera* (Aswagandha), *Aegle marmelos* (Bael/Bilva), *Bacopa monnieri* (Brahmi), *Piper longum* (pippali), *Eclipta alba* (vringraj), *Ocimum tenuiflorum* (Tulsi). The objective of the study is to investigate the relationship between plants and suitable places, where such plants have been grown with their medicinal values-based on the generalized fuzzy set method of distances. In this contest, we established the decision making by using intuitionistic fuzzy set with hypothetical values. .

Methodology:

The application of fuzzy sets in dealing with the problem of decision making is increasing in almost every sphere of the universe as the decision helps to execute routine jobs that need exhaustive exercise and time taking (Atanassov, 1986; Szmidt, 2000; Kumar, 2012 & 2013). Fuzzy set theory and its generalizations have many applications in the selection of suitable alternative among the available one. Different decision-making models have been proposed by various researchers by establishing a relationship between factors and the corresponding alternatives by using various fuzzy techniques. A distance measure between two IFSs has been proposed by Burillo & Bustince (1986), and are the first one to propose the axiomatic definition of IF entropy. A new entropy method for IFSs has been proposed by Szmidt & Kacprzyk (2001) for dealing with real-life situations. Wang & Zhang (2009), Wang & Zhang (2008): Wan (2010) proposed hybrid methods flavored with IFS theory and information theory for multi-criteria decision-making(MCDM) problems to perform decision making when the available information is incomplete and imprecise. Yager (2004)adds more flavor to streamline the process of decision-making by proposing various MCDM techniques. Wei (2012) developed the elaborated concept as explained by Yager (2004) and Zhang (2014) and proposed some intuitionistic fuzzy operators, commonly known as aggregation operators to deal with the decision-making problems. In our work, we considered seven factors affecting the growth and survival of the medicinal plants are Atmospheric Humidity, Altitude, Rainfall, Soil, Light, Temperature and Seed. Seven medicinal plants such as *Emblica officinalis*, *Withania somnifera*, *Aegle marmelos*, *Peiper longum*, *Eclipta alba*, *Ocimum tenuiflorum* have been considered for the investigation of their growth and survival at five different places. Hypothetical data was processed by considering the finite set of medicinal plants, factors affecting the growth and the survival of plants and places to investigate the best suitable place for a particular plant. The aim of the study is to make suitable decision for each place $Pi(i=1,2.....,7)$ with the associated factors helps in the growth of plants $fi(j=1..., 6)$ to identify the best place for plant $k,(k=1,2....., 7)$ in individuals places considering all the factors. Individual fuzzy membership with respect to places, medicinal plants and the factors affecting the growth of plants are generated.

Distance Measure on IFS: for $X=\{x_1,x_2,..... X_n\}$, *let* $\mu_A(x)$, $\mu_B(x)$, $\nu_A(x)$, π_A *and* π_B be the membership function, non-membership function and hesitation index respectively of IFS *A,B*, then Intuitionistic normalized Euclidean distance between the two intuitionistic fuzzy sets *A,B* is:

$$E(A,B)=\left[\frac{1}{n}\sum_{i=1}^{n}\left[(\mu_A(x_i)-\mu_B(x_i))^2+(\nu_A(x_i)-\nu_B(x_i))^2+(\pi_A(x_i)-\pi_B(x_i))^2\right]\right]^{\frac{1}{2}}$$

with the condition that,

$$\mu_A(a_{ij})+\nu_A(a_{ij})+\pi_A(a_{ij})=1 \quad ; \quad \mu_B(b_{ij})+\nu_B(b_{ij})+\pi_B(b_{ij})=1$$

The lowest distance between two points gives the estimate of the alternative among the available ones.

Case Study: a hypothetical case study has been framed to study the applications of the method:

Let $S=\{s_1, s_2, ... s_m\}$; $D=\{d_1, d_2, ... d_n\}$; $P=\{p_1, p_2, ...p_q\}$; be the finite sets of medicinal plants, factors affecting their growth and places respectively.

The fuzzy relations (FR), X and Y are defined as:

$$X=\{<(p,s),\mu_X(p,s),\nu_X(p,s)>|(p,s)\in P\times S\}$$

$$Y=\{<(s,d),\mu_Y(s,d),\nu_Y(s,d)>|(s,d)\in S\times D\}$$

where $\mu_x(p,s)$, and $\nu_x(p,s)$ indicate the degree to which the plant appears and does not appears in places respectively.

(i) $\mu_y(s,d)$, and $\nu_x(s,d)$ indicate the degree to which the plant confirm and does not the factor respectively . The estimation of the growth of the medicinal plant at some place using the information obtained has been given in table 1 of given case study. The methodology of the investigation is given in the following flow chart:

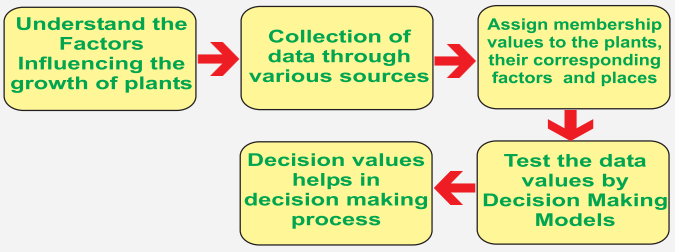

Figure-1: Flow Chart of Methodology

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Numerical Example:

Let $S=\{s_1, s_2, \ldots\ldots\ldots s_7\}$; $D=\{d_1, d_2, \ldots\ldots\ldots d_7\}$; $P=\{p_1, p_2, \ldots\ldots\ldots p_5\}$ be the finite sets of medicinal plants, factors affecting their growth and places respectively.

Suppose the IFR $X(P \rightarrow D)$ is given as:

Q	F_1		F_2		F_3		F_4		F_5		F_6		F_7	
	μ_x	ν_y	μ_x	ν_y	μ_x	ν_y	μ_x	ν_y	μ_x	ν_y	μ_x	ν_y	μ_x	ν_y
p1	0.8	0.2	0.1	0.5	0.7	0.1	0.6	0.2	0.4	0.3	0.6	0.3	0.7	0.2
p2	0.0	0.7	0.6	0.4	0.8	0.1	0.4	0.4	0.7	0.1	0.5	0.2	0.4	0.5
p3	0.7	0.1	0.4	0.3	0.6	0.2	0.3	0.4	0.2	0.6	0.8	0.1	0.5	0.5
p4	0.5	0.3	0.3	0.6	0.2	0.5	0.0	0.6	0.3	0.4	0.5	0.5	0.2	0.6
p5	0.6	0.2	0.2	0.4	0.1	0.6	0.1	0.6	0.6	0.2	0.4	0.6	0.1	0.4

Table-1: IF values for places and the presence of related factors

Suppose the IFR $X(P \rightarrow D)$ is given as:

R	Amla		Ashwagandha		Bael/Bilva		Brahmi		Pippali		Bhringraj		Tulsi	
	μ_y	ν_y	μ_y	ν_y	μ_y	ν_y	μ_y	ν_y	μ_y	ν_y	μ_y	ν_y	μ_y	ν_y
f_1	0.4	0.4	0.3	0.6	0.2	0.7	0.1	0.7	0.4	0.4	0.5	0.4	0.2	0.6
f_2	0.3	0.6	0.1	0.8	0.4	0.5	0.6	0.2	0.2	0.3	0.1	0.7	0.6	0.2
f_3	0.2	0.7	0.6	0.3	0.2	0.6	0.5	0.3	0.7	0.2	0.6	0.2	0.4	0.5
f_4	0.1	0.8	0.2	0.7	0.7	0.2	0.4	0.4	0.3	0.6	0.4	0.5	0.7	0.1
f_5	0.4	0.6	0.6	0.3	0.3	0.5	0.5	0.4	0.5	0.4	0.2	0.7	0.8	0.1
f_6	0.5	0.2	0.4	0.5	0.1	0.7	0.3	0.6	0.4	0.3	0.7	0.1	0.1	0.7
f_7	0.2	0.6	0.5	0.5	0.6	0.2	0.2	0.7	0.1	0.6	0.2	0.6	0.7	0.1

Table-2: IF values for factors present in Medicinal Plants

From the information is given in table (1) & (2), decision making for each place associated with the set of factors f_j, characterize for each variety of medicinal plants has been presented by using Intuitionistic normalized Euclidean distance measure. The lowest distance obtained points out correct decision making as given in Table-3 :

	Amla	Ashwa gandha	Bael/ Bilva	Brahmi	Pippali	Bhringraj	Tulsi
P_1	0.3257	0.1971	0.26	0.2942	0.1828	0.1571	0.2714
P_2	0.26	0.1428	0.2542	0.0999	0.1514	0.2256	0.1914
P_3	0.1914	0.2199	0.3257	0.2285	0.1428	0.0914	0.3828
P_4	0.0799	0.1285	0.2314	0.16	0.1542	0.1399	0.3442
P_5	0.1428	0.2028	0.2628	0.2157	0.1514	0.2428	0.2942

Table-3: Distances between places and related Medicinal Plant.

Results and Discussion:

From the Table-3, it is concluded that Bhringraj has been grown on the place P_1 and P_{13}, Amla has been grown in places P_4 and, Brahmi has been survived in place P_2.

The proposed method has been used to compute the growth and survival of medicinal plants at some places. Fuzzy evaluation matrices for different plants are established at different hypothetical places. Growth and the survival of plants at some places were calculated using fuzzy compositional rules. This decision-making tool provides support for the growth and survival of the plant at a particular place. Further, the method may be utilized to rank the places according to the type of plant cultivation. The proposed method finds to be cost-effective and eco-friendly as it reduces the laboratory evaluations.

References:

Atanassov, K,T. (1986): Intuitionistic fuzzy sets. *Fuzzy Sets Sys.*, 20(1): 87- 96.

Balunas, M.J. & Kinghorn, A.D. (2005): Drug discovery from medicinal plants. *Life Sci.*, 78(5): 431-441.

Brahmi, M. K. & Dutt, B. (2014): Factors Affecting Cultivation of Medicinal and Aromatic Plants in Rampur Block of District Shimla in Himachal Pradesh. *Indian Forest.*, 140(8): 786-788.

Burillo, P. & Bustince, H. (1986): Construction theorems for intuitionistic fuzzy sets, *Fuzzy Sets Sys.*, 84(3): 271-281.

Chacko, S.M., Thambi, P.T., Kuttan, R. & Nishigaki, I. (2010): Beneficial effects of green tea: a literature review. *Chin. Med.*, 5:Artilce# 13.

Deeb, T., Knio, K,, Shinwari, Z.K., Kreydiyyeh, S. & Baydoun, E. (2013): Survey of medicinal plants currently used by herbalists in Lebanon. *Pak. J. Bot.*, 45(2):543-555.

Hamilton, A.C. (2004): Medicinal plants, conservation and livelihoods. *Biodivers. Conserv.*, 13: 1477–1517.

Hamilton, A.C. (2008): Medicinal plants in conservation and development: case studies and lessons learned. In: Kala, CP, (ed.): **Medicinal Plants in Conservation and Development**. Pub. by: Plantlife International Publisher, Salisbury. P.- 143.

Kumar, V., Arora, H.D. & Pal, K. (2016): Intuitionistic trapezoidal fuzzy prioritized weighted average operators: an algorithm for the suitable treatment for lung cancer. *J. Appl. Prob. Statist.*, 11(1):91-104.

Kumar, V. & Vashist, D. (2013): Fuzzy procedure for the selection of car among various brands. *Int. J. Eng. Res. Tech.*, 6(3):337-342.

Kumar, V., Bharti, I. & Sharma, Y.K. (2012): Fuzzy diagnosis procedure of the types of glaucoma, *Int. J. Applied Info. Sys.*, 1(6):42-45.

Larsen, H.O. & Olsen, C.S. (2007): Unsustainable collection and unfair trade? uncovering and assessing assumptions regarding Central Himalayan medicinal plant conservation. *Biodivers. Conserv.*, 16(6):1679-1697.

Nalawade, S.M., Sagare, A.P., Lee, C.Y., Kao, C.L. & Tsay, H.S. (2003): Studies on tissue culture of Chinese medicinal plant resources in Taiwan and their sustainable utilization. *Bot. Bull. Acad. Sin.*, 44(2):79-98.

Rafieian-Kopaei, M. (2012): Medicinal plants and the human needs. *J. Herb Med. Pharm.*, 1(1):1-2.

Ross, I.A. (2005): **Medicinal plants of the world (volume 3): Chemical Constituents, Traditional and Modern Medicinal Uses**. Pub. by: Humana Press, New Jersey. P- 648.

Schippmann, U., Leaman, D.J., Cunningham, A.B. & Walter, S. (2005): Impact of cultivation and collection on the conservation of medicinal plants: global trends and issues. *Acta Horticul.*, 676(676):31-44

Szmidt, E. & Kacprzyk, J. (2000): Distances between intuitionistic fuzzy sets. *Fuzzy Sets Sys.*, 114(3):505-518.

Szmidt, E. & Kacprzyk, J. (2001). Entropy for intuitionistic fuzzy sets. *Fuzzy Sets Sys.*, 118(3):467-477.

Uprety, Y., Asselin, H., Dhakal, A. & Julien, N. (2012): Traditional use of medicinal plants in the boreal forest of Canada: review

and perspectives. *J. Ethnobiol. Ethnomed.*, 8:7.

Wagh, V.V. & Jain, A.K. (2013): Status of threatened medicinal plants of Jhabua district, Madhya Pradesh, India. *Ann. Plant Sci.*, 2(10):395-400.

Wan, S.P. & Dong, J.Y. (2010): Method of trapezoidal intuitionistic fuzzy number for multi-attribute group decision. *Con. Dec. (Kongzhi yu Juece)*, 25(5):773-776.

Wang, J.Q. & Zhang, Z.H. (2009): Multi-criteria decision-making method with incomplete certain information based on intuitionistic fuzzy number. *Con. Dec. (Kongzhi yu Juece)*, 24(2):226-230.

Wang, J.Q. & Zhang, Z.H. (2008): Programming method of multi-criteria decision-making based on intuitionistic fuzzy number with incomplete certain information, *Con. Dec. (Kongzhi yu Juece)*, 23, 11451-148.

Wei, G.W. (2012): Hesitant fuzzy prioritized operators and their application to multiple attribute decision making. Knowledge-Based Sys., 31:176-182.

Yager, R.R. (2004): Modeling prioritized multi-criteria decision making. IEEE Trans. *Syst. Man Cybern. B. Cybern.*, 34(6):2396-2404.

Zhang, Z. (2014): Intuitionistic trapezoidal fuzzy prioritized operators and their application to multiple attribute group decision making, *Brit. J. Math. Comput. Sci.*, 4(14), 1951-1998.