Abstract - The Fuzzy Logic (FL) is a variant of soft computing which its versatile it widens its applications to all domain. This article focuses on its application in agriculture. The scope of this logic is not limited to few areas of agriculture. It is extended from the soil analysis to complete plant production, all the areas are comprised by the usage of FL. The short wider literature survey is carried out to understand the FL in agriculture.

Keywords - Fuzzy Logic (FL); Agriculture applications

1. Introduction

Disease Diagnose

In the contemporary age, research on sustainable agricultural production is a hot subject. Paddy farming is a major revenue form. The benefits of using the same mechanisms are indeed the efficient and accurate performance of those other mechanisms as opposed to something like the analysis by human of the similar problem. This proposed an internet-based software model to classify insects as well as potential magnitude of harm to something like the crop by evaluating different type of inputs including the signs of harm, the scale including its insect, the severity of destruction, etc. Until it becomes crucial, it is quite beneficial to recognize the paddy.

Such a specialized system offers the features to philtre the suspicious pests, though fluid functionality upgrades system consistency. The insect behaviour intensity is also gauged. Prospective reaping’s from vulnerabilities are not accumulated by growers. The deeply ingrained of danger are insects or pests. Harvesting ineptitude often decreases yield, provided that assessments have not been made either at required time. Fuzzy reasoning decreases the inaccuracy of growers' judgments, as growers remain alerted also by mechanism that the danger is important. Information technology is indeed a helpful tool during daily life in the modern world. Paddy growing is mainly distributed across villagers. In Sri Lanka, several Computing Centers including such “Nanasala” have computer access for rural citizens. EXRICE may be prominent amongst many computer centres at local levels because this will benefit growers greatly [1]. In overview EXRICE is indeed an internet machine solution that works with 2 AI approaches in sustainable agriculture (become hybrid system) is shown in Figure 1.

2. Crop Management

A knowledge-based decision-making aid framework for farming techniques as well as agriculture extension offers concept, strategies and outcomes. The targeted action and findings relating to DSS architecture, content knowledge, information processing and DSS assessment shall be provided through a multifaceted Decision Support System (DSS) facilitating the choice and maintenance of crop rotation [2]. The focuses particularly mostly on incorporation of expert information into fumigation interpretation technologies to nonlinear dynamics. The topic would end the introduction with the relevance and limitations including the DSS as well as this implementation choices or inclusion in other models is shown in Figure 2.
"limiting factor of knowledge-based engineering," since the DSS creator relies on specialists ready to express their views. As it is in this scenario is the correct" specialist would hardly be chosen because so few specialists are accessible throughout the covering crop field. However, the judgment issue of cover cropping may be assigned to probabilistic reasoning [3]. Unpredictable information obtained through crop specialists might be numerically provided by fluid deduction mechanisms. An illustration of an agro DSS on Computer level to be used through graphical interface or even in batch process seems to be the illustrated the DSS solution. There have been different options for enhancing the system at least by providing new goals of management, optional evaluation criteria or extra plant cover [4]. A change of variables in outside variable documents or perhaps a modifying of its incorporated fluid inference method is possible to incorporate user interface information. The DSS findings are perhaps, restricted to just the reliability including its specialist data generated. As a result, there are various generalisations throughout the nature of DSS, such as little incorporated deciding variables or very few predictor variables. Moreover, the systematic review was carried of DSS findings using DSS isn't really available at this stage. The DSS assessment has shown us that the DSS can yield consistent performance. In many other instances, the input parameters are quite sensitive [5]. In many other cases, the target variables (crowd efficiency) comply with results obtained. The quantitative assessment showed that "if instead" questions are answered with DSS, which would be a significant feature. Specialist recommendations for such a variety of case studies are well complied with. It refers in particular to the suggested parameters of judgement. The key critiques identified also by specialists might be omitted during the actual development and testing of DSS. This same DSS literally on the ground will also face a number of challenges [6]. The incorporation of DSS through multiple cropping generation, optimization models but more complicated ecological landscape models is often expected [7]. Consistent monitoring and technological assistance only appear to be feasible if business software producing companies will collaborate. With DSS growers can now make objective suggestions for installing and maintaining crop varieties. This can be achieved explicitly or implicitly, for example by the extension staff. Different climate and edaphic sites where expressed and different agricultural as well as crop varieties circumstances and cultivation goals in Europe. DSS is indeed capable of processing exact value and situational data for different perspectives (scenarios) and of rendering findings identical to the associated key attractions [8]. The selection of suggested protect plants and plant strategy as well as the varied solution variables values represent inconsistencies of professional expertise. Thus, the accuracy of DSS knowledge is indeed very similar to specialists [9].

3. Fungicide decision making

A Fuzzy Control System (FCS) been established for decide when the Plasmopara viticola (PV), the elements that makes for downy mildew inside a vineyard is now being managed by a fungicide usage. The FCS has been developed as either a framework of specialists being used easily [10]. Internet is a proactive vineyard managing DSS. The FCS has been able to replicate the professional's rationale on the intention to study a fungus towards PV inside a vineyard that use the data supplied by DSS [11]. The DSS taken as response variable 1. grapevine phenology; 2. primary infection risk; 3. secondarily abundant sporangia; 4. secondarily infected risk; and 5. remaining fungicides safety given. The FCS output is called 'treatment,' or 'non-treatment' by any mixture of these inputs in IF THEN rules; fugitive interface, inference engine and defuzzification interface. In 18 biology wines in Italy, the FCD was tested by a five-strong committee of experts against the FCS by contrasting the scheduling of copper fungicides against PV [12]. The FCS was willing, with an accuracy level of 0.992, to repeat the experts' claim. The FCS suggested a treatment because the expert panel was 0.878, while the FCS prescribed no intervention because the advisory board was not 1. The FCS wasn't really approved. When the FCS is integrated into another DSS, novice winegrowers are helped to make proper decisions about low mildew control is shown in Figure 3 and Figure 4.

![Fig. 3: FCS Flow [3]](image_url)

In needed to aid the viticulturist take the decision the FCS produced throughout this study could've been integrated into another DSS. The FCS listed here will likely extend the knowledge of users in terms of disease control, in addition to helping non-expert wine-growers make "specialist" decisions [13]. Gent et al. proposed that farmers should study how the method arriving at its suggestions after just a process of expertise in order to avoid the system from making proper decisions [14]. This means that the repetition of the FCS will help farmers believe that the system makes the right judgments. A specialist framework can also allow users to make decision possible irrespective of the level of expert. This is significant also because understanding of infection hazard of a quickly and concisely differ amongst individuals [15] but because a threat farmer may be inclined to take additional treatments in comparison to a threat grower provided a similar prediction [16]. The FCS established throughout this work can support between types of decision maker by measuring the choice to either an appropriate riskiness [17].

Shading and Irrigation

This research deals with the design as well as operation of an automated fuzzy inference system and for shade as well as irrigation method. The built - in web model designed to [18] being implemented fluffy platform
The built-in web program gives data regarding different rain respect to access. Such data about rainfall were perceived to be input into and then using our established knowledge and understanding to maintain the shading and irrigation of the plant field for various rainfall events [19]. This use of illumination method in the cultivation area and of fugitive logic for regulating and sustaining the watering system is a new concept. Our built system can be implemented in the real-life scenario to ensure excellent results in the farming region in order to protect the plants from harmful effects of unnecessary plumage [20].

**Fig. 4: FCS Flow [10]**

The process of shade as well as watering of plants only with help of mathematical logic throughout developed framework as well as track this method [21]. The existing knowledge for evaluating the judgments is built here [22]. The precipitation frequency at various periods in rainfall is regarded with a contribution to fuzzy process, whereby the rainfall rate values are calculated utilizing the optimized internet method of [23] centred on android. A modern idea for the farming sector is the implementation of shadings and water management. In addition, it is indeed a revolutionary phenomenon to combine the furious concept of shade and watering [24]. Suggesting an automated device that decides to hold watering and shadowing together during various rain events [25]. As proper scheduling of crop shading and routine irrigation management help to maintain plants in a rational manner, keep hoping because if method can indeed be integrated life, this should yield excellent results also in agricultural sector, so that plants can indeed be protected from either the specific and disastrous impact of unexpected precipitation [26]. Table 1 shows the Fuzzy in Agriculture.

**Table 1: Fuzzy in Agriculture**

| S. No | Description | Reference |
|-------|-------------|-----------|
| 1     | Crop characteristics valuation | 11 |
| 2     | Chestnut ink sickness spot identification | 12 |
| 3     | Enhanced technique for the Soyabean crop | 13 |
| 4     | Agri Management | 14 |
| 5     | Apple climatic risk identification | 15 |
| 6     | Cropping pattern management | 16 |
| 7     | Irrigation system for Capsicum | 17 |
| 8     | Tillage soil fragmentation analysis | 18 |
| 9     | Crop land analysis | 19 |
| 10    | Precision in agriculture | 20 |
| 11    | Integration for disease control | 21 |
| 12    | Identification of quality of grape | 22 |
| 13    | Predicting the maximum grain production zone | 23 |
| 14    | Water reusage | 24 |
| 15    | Estimating agricultural biogas efficacy | 25 |
| 16    | Crop classification | 26 |

4. Conclusion

This article focuses on trend in usage of FL in agriculture. The survey clearly reveals that the FL is predominately used to maximise the yield. In a way or other finally all the analyses lands over better production. Starting from soil analysis, move on to plant pattern managing, then to irrigation and shading system along with biogas efficacy by the agriculture. So, the wider spectrum of agriculture is completely accommodated by FL. This survey also reveals that, focusing on hybrid technique possess a scope in this area. The major identity is that in future research may focuses hybrid versatile combinations to achieve the maximum production.

**References**

[1]. Chathuranga, T.N. and Anthony, G., Disease diagnose of rice plants using fuzzy-expert hybrid system. Proceeding of the Eighth Annual Sessions. Sri Lanka Association for Artificial Intelligence, 14, 20, 2011.

[2]. Sodtke, R.M., A Multi-objective DSS for cover crop management processing fuzzy expert knowledge. EFITA/WCCA, pp.25-28, 2005.

[3]. Gonzalez-Dominguez, E., Caffi, T., Bodini, A., Galbusera, L. and Rossi, V., A fuzzy control system for decision-making about fungicide applications against grape downy mildew. European Journal of Plant Pathology, 144(4), pp.763-772, 2016.

[4]. Zadoks, J.C., EPIPRE, a computer-based decision support system for pest and disease control in wheat: Its development and implementation in Europe. Plant disease epidemiology, 2, pp.3-29, 1988.

[5]. Gent, D.H., De Wolf, E. and Pethybridge, S.J., Perceptions of risk, risk aversion, and barriers to adoption of decision support systems and integrated pest management: an introduction. Phytopathology, 101(6), pp.640-643, 2011.

[6]. Gent, D.H., Mahaffee, W.F., McRoberts, N. and Pfender, W.F., The use and role of predictive systems in disease management. Annual review of phytopathology, 51, pp.267-289, 2013.

[7]. McRoberts, N., Hall, C., Madden, L. V., & Hughes, G. Perceptions of disease risk: from social construction of subjective judgments to rational decision making. Phytopathology, 101, 654–665, (2011).

[8]. Bar-Shira, Z., Just, R.E. and Zilberman, D., Estimation of farmers’ risk attitude: an econometric approach. Agricultural Economics, 17(2-3), pp.211-222, 1997.

[9]. Trono, E.M., Guico, M.L., Labuguen, R., Navarro, A., Libatique, N.J. and Tanganon, G., Design and development of an integrated web-based system for tropical rainfall monitoring. Procedia Environmental Sciences, 20, pp.305-314, 2014.

[10]. Zinnat, S.B. and Abdullah, D.M., December. Design of a fuzzy logic based automated shading and irrigation system. In 2014 17th International Conference on Computer and Information Technology (ICCIT) (pp. 170-173), 2014. IEEE.

[11]. Pandey, A., Prasad, R., Singh, V.P., Jhu, S.K. and Shukla, K.K., Crop parameters estimation by fuzzy inference system using X-band scatterometer data. Advances in space research, 51(5), pp.905-911, 2013.

[12]. Dal Maso, E. and Montecchio, L., Large-scale fuzzy rule-based prediction for suitable chestnut ink disease sites: a case study in north-east Italy. Forest Pathology, 45(4), pp.311-323, 2015.
[13]. Prakash, C., Rathor, A.S. and Thakur, G.S.M., Fuzzy based Agriculture expert system for Soyabean. In International Conference on Computing Sciences WILKES100-ICCS2013, Jalandhar, Punjab, India, 2013.

[14]. Papageorgiou, E.I., Kokkinos, K. and Dikopoulou, Z., Fuzzy sets in agriculture. In Fuzzy Logic in Its 50th Year (pp. 211-233). Springer, Cham, 2016.

[15]. Kim, K.S. and Beresford, R.M., Use of a climatic rule and fuzzy sets to model geographic distribution of climatic risk for European canker (Neonectria galligena) of apple. Phytopathology, 102(2), pp.147-157, 2012.

[16]. Mirkarimi, S.H., Joolaie, R., Esraghi, F. and Abadi, F.S.B., Application of fuzzy goal programming in cropping pattern management of selected crops in Mazandaran province (case study Amol township). International Journal of Agriculture and Crop Sciences, 6(15), p.1062, 2013.

[17]. Ceballos, M.R., Gorricho, J.L., Palma Gamboa, O., Huerta, M.K., Rivas, D. and Erazo Rodas, M., Fuzzy system of irrigation applied to the growth of habanero pepper (capsicum chinense jacq.) under protected conditions in yucatan, mexico. International Journal of Distributed Sensor Networks, 11(6), p.123543, 2015.

[18]. Abbaspour-Gilandeh, Y. and Sedghi, R., Predicting soil fragmentation during tillage operation using fuzzy logic approach. Journal of Terramachinics, 57, pp.61-69, 2015.

[19]. da Silva, A.F., Barbosa, A.P., Zimbuck, C.R.L., Landim, P.M.B. and Soares, A., Estimation of croplands using indicator kriging and fuzzy classification. Computers and Electronics in Agriculture, 111, pp.1-11, 2015.

[20]. Markinos, A., Papageorgiou, E., Stylios, C. and Gemtos, T., Introducing Fuzzy Cognitive Maps for decision making in precision agriculture. Precision agriculture, 7, p.223, 2007.

[21]. Roseline, P., Tauro, C.J. and Ganesan, N., Design and development of fuzzy expert system for integrated disease management in finger millets. International Journal of Computer Applications, 56(1), 2012.

[22]. Tagarakis, A., Koundouras, S., Papageorgiou, E.I., Dikopoulou, Z., Fountas, S. and Gemtos, T.A., A fuzzy inference system to model grape quality in vineyards. Precision Agriculture, 15(5), pp.555-578, 2014.

[23]. Li, Q. and Yan, J., Assessing the health of agricultural land with energy analysis and fuzzy logic in the major grain-producing region. Catena, 99, pp.9-17, 2012.

[24]. Almeida, G., Vieira, J., Marques, A.S., Kiperstok, A. and Cardoso, A., Estimating the potential water reuse based on fuzzy reasoning. Journal of environmental management, 128, pp.883-892, 2013.

[25]. Djatkov, D., Effenberger, M. and Martinov, M., Method for assessing and improving the efficiency of agricultural biogas plants based on fuzzy logic and expert systems. Applied energy, 134, pp.163-175, 2014.

[26]. Murmu, S. and Biswas, S., Application of fuzzy logic and neural network in crop classification: A review. Aquatic Procedia, 4, pp.1203-1210, 2015.