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Web-Based Fertilizer Management System using Fuzzy Inference System

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Abstract: Application services using IT technology are being studied in various industrial fields but research and development in agricultural environment is insignificant. In addition, livestock wastes are produced using bio-energy and methane gas technologies in developed countries. In this study, we proposed a simulation to distribute the optimum fertilizer after soil analysis in order to prevent the death of crops due to overfeeding of the nutrient by excessively spraying the fertilizer with fermented livestock manure after spraying with chemical fertilizer.

Key words: Bio-energy, soil analysis, livestock manure, chemical fertilizer, insignificant, optimum

INTRODUCTION

Korea established a "Zero Waste Land Disposal Plan" in 2012 to ban marine dumping in manure and manure sludge in 2013 and to ban marine dumping in industrial wastewater and sewage sludge in 2014. The Ministry of Maritime Affairs and Fisheries in principle, prohibits marine dumping of waste-water and its treatment sludge from 2014 in order to prevent socio-economic disruption due to a total ban on marine dumping and to minimize environmental losses caused by marine dumping. Only those companies that have proved to be impossible and have set up a complementary device to allow some marine dumping within 31 December 2015. From January 2017, the company announced that it will expand and operate an electronic handover management system that manages all the processes from poultry manure to disposal in real time (Anonymous, 2017).

With combination of Information and Communication Technology (ICT) such as GPS, weight sensor and IP camera for livestock manure treatment, the livestock manure management system that prevents water pollution, soil and groundwater pollution and minimizes odor is piloted and will be phased in from 2017. The amount of animal manure generated in 2015 is 173 thousand tons. When livestock manure is used as fertilizer it has the advantage of saving fertilizer and pesticide value and organically farming.

The fertilizer is largely composed of three elements (NPK: Nitrogen, Phosphoric acid, Potassium) and it should contain trace elements which are very small but essential for plant growth. Nitrogen is a fertilizer used mainly for growing leaves and stems. Phosphorus is used to make flowers and fruits. Potassium fertilizer is used to make strong roots (Hebbar *et al*., 2004; Kolomaznik *et al*., 2008; Jonasson *et al*., 1996). In this study, we propose a simulation to distribute the optimum fertilizer after analyzing the soil in order to prevent the death of the crops due to overfeeding of the nutrient by excessively spraying the fermented liquid fertilizer after spraying the chemical fertilizer.

Experiment using fuzzy inference system: The NPK theory was made by a German Chemist Libhier in the 19th century. Nitrogen fertilizer gives crops good growth. However, the immune system is weak and vulnerable to insects. Therefore, pesticide use is frequent. This results in deterioration of soil strength and the use of higher amounts of chemical fertilizers (Sempere *et al*., 2002; Arias-Estevez *et al*., 2008).

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In advanced countries in the area of animal husbandry, animal wastes are produced using bioenergy and methane gas technology. Researches are being actively carried out to develop livestock manure as a resource technology rather than a waste. However, the production of bio-gas using livestock manure is still in the process of development of functional livestock and compost because of low economic efficiency with livestock manure recycling technology. In order to produce the best fruits, soil management needs to be carried out by taking comprehensive consideration of the orchard soil management method rather than the fragmentary knowledge (Surendra *et al*., 2014; Andersen *et al*., 2002; Ashraf *et al*., 2014). In this study in order to calculate the NPK fertilization, the NPK fertilization rate is determined according to the slope, weather condition. When the exact fertilization is difficult, the final fertilization calculation process using faith value using fuzzy rule and statistical based probability data is explained as Eq. 1.

Rule : IF A is tl Then C is B2
(Fu)
fact : A is tl'(Fr)
conclusion : C is t2'
(FC)
A :Soil absorption state
tl : Slope / weather conditions
C : Fertility reasoning result
Fu : Fuzzy number indicating the uncertaint y of the rule
Fr : Fuzzy number indicating the uncertaint y of the fact
FC : Fuzzy number indicating the uncertaint y of the conclusion
V1,V2,V1',V2': values

where, Fu is expressed as a Confidence Factor (CF) and Fr is expressed as a possible measure:

Post processing Rule
IF Soil = High and
Slope = High and (1)
Absorption = Med and then
NPK = CNF 70

Here, CNF 70 means that the confidence level of rule is 70%. If the confidence level is indicated by the conventional method without using the fuzzy rule it is always regarded as 100%. In this study, the optimal NPK spray amount reliability is estimated as Eq. 2 considering soil and slope absorption:

$$\beta_c = \beta_{comb}(\beta_c, \beta_{strong}) = \max((\beta_c, \beta_{strong}) \quad (2)$$

where, β_{strong} is the belief value for the conclusion reached already through the inference path and β_c is the belief value for another conclusion reached through the other inference path. The data generated in this way can be represented in IF-then format and fuzzy inference is a series of processes that derive new relationships or facts from given rules and use max-min inference.

Figure 1 shows the simulation procedure of NPK fertilizer using fuzzy inference system in MATLAB tool. A total of 10 rules were used in this study and simulation was performed to calculate the optimum NPK application rate under the output conditions, taking into account soil and slope absorption. Three fuzzy rules are used in our work and the output condition is NPK fertilizer recommended yield. The input conditions as shown in Fig. 1 are 34% of soil with poor nutrition 76% of slope is somewhat higher and soil absorption is not good in 2 stages out of 10 stages. Optimum fertilizer recommended yield considering soil condition shows recommendation of NPK fertilizer application rate of 80% and reduction of

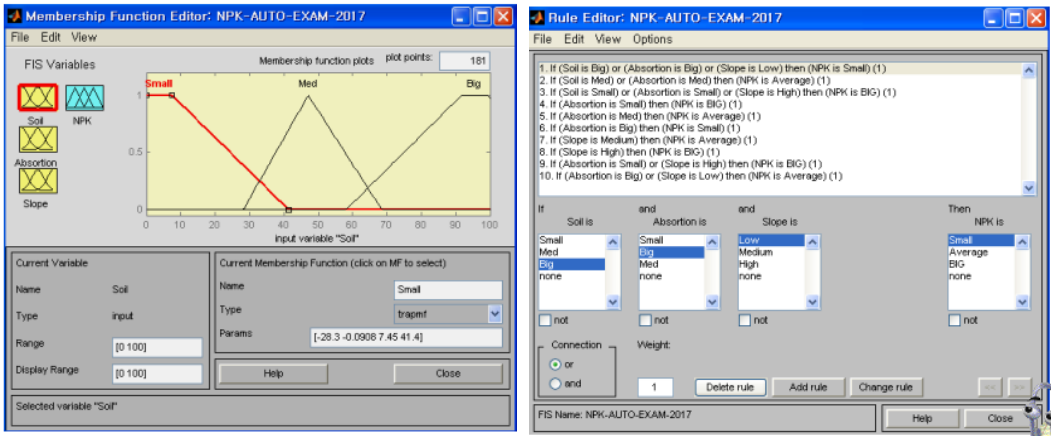

Fig. 1: NPK fertilizer recommendation simulation using MATLAB fuzzy reasoning system

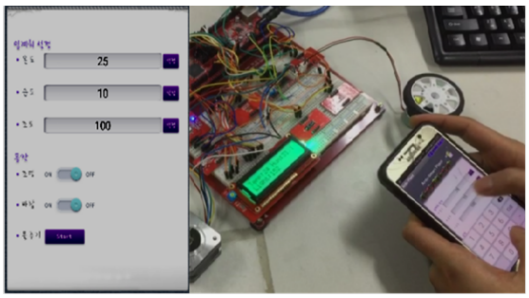

Fig. 2: Temperature and humidity sensor monitoring system

normalization condition from 50-30%. When the optimal manure application formula for crops is completed, software that accurately calculates the amount of liquid will be developed using ICT technology. The current problem with the application of manure that showed overproduction of the crops due to excessive nutrient supply because of the desire to harvest a lot of crops without considering the soil conditions precisely (Eulenstein *et al*., 2014; Habib *et al*., 2017).

Figure 2 illustrates a soil PHS sensor-based soil system analysis system. Crops can be harvested well under the same soil conditions and harvesting may not be very good. If the proper temperature, humidity and pH (pH) are not exactly matched to the crops, even if good fertilizers are supplied, the crops will be over produced grow rather than naturally grow because of wrong soil conditions (Fageria, 2001). The NPK fertilizer recommendation algorithm using Fuzzy Inference system is shown in Algorithm 1.

Algorithm 1; MATLAB fuzzy inference based NPK fertilizer recommendation algorithm:

```
#include <DHT11.h>
#define SensorP in A0
//pH meter  Ana log output to Rdunino Anlog Input  0
static float pHValue, voltage
DHT11 Pin 1 (Vss)-> Arduino + 5V
DHT11 Pin 2 (Signal)-> Arduino + 5V Pin 2
DHT11 Pin 2 (Signal)-> Arduino + 5V via Resistor  4.7K
DHT11 Pin 3 -> A / C
DHT11 Pin 4 (GND)-> Arduino Ground
int  pin = 2; // Connected Arduino digital pin number
DHT11 dht11(pin);
Void setup()
{
      Serial . begin(9600)
{
Void loop()
{
      Int err;
      float temp, hum I
      if ((err  = dht11 . read(hum i , temp )) == 0)
      {
          Serial .print ("temperature:")
          Serial .print (temp)
          Serial .print ("humidity:")
          Serial .print (humi)
          Serial .print In( )
      }
      else
          Serial .print("Error No : ")
      Delay(DHT11_RETRY_DELAY)
      //Display on screen
      this . IbI Temper1 .Text = one.Temper1.ToString() + " °C"
          this . IbI Temper2 .Text = one.Temper2.ToString() + " °C"

          this . IbI Humid1 .Text = one.Humid1.ToString()+ " %"
          if (millis() – samlingTime>samplinginterval)
                                    pHArray[pHArry Index++] =
analogRead(SensorPin);
          if (pHArra Index== ArrayLenth)pHArray Index = 0;
          voltage = avergearray(pHArray, ArrayLenth)*5.0 / 1024
          pHValue = 3.5*voltage + 0ffset
                                    samplingTiming = millis( )
          if (millis( ) – printTime > print Interval)
              //Every 800 milliseconds, print a numerical convert the state
of the LED indicator
          Serial .print("Voltage:" )
      Serial . print(voltage, 2)
      Serial . print(" pH value: ")
```

CONCLUSION

In this study, accurately estimate the manure output, we automatically calculate the manure excretion when entering the number of pigs. Simulation was performed to automatically calculate the fertilization rate of 3 elements of NPK fertilizer/100 m^2. However, actual fertilization is different due to differences in soil condition, cultivation type and fertilizer characteristics. The problem with the amount of manure and manure application is that the desire to harvest a lot of crops without considering the soil conditions precisely is excessive and the crops are overproduced in an overfeeding condition. If the fertilizer formula for optimal fertilizer application is completed, we can calculate optimal fertilizer application rate using MATLAB fuzzy inference based on proposed algorithm.

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REFERENCES

Andersen, A., B. Hoffmann, W. Muller and A. Griffiths, 2002. Using ants as bioindicators in land management: Simplifying assessment of ant community responses. J. Applied Ecol., 39: 8-17.

Arias-Estevez, M., E. Lopez-Periago, E. Martinez-Carballo, J. Simal-Gandara, J.C. Mejuto and L. Garcia-Rio, 2008. The mobility and degradation of pesticides in soils and the pollution of groundwater resources. Agric. Ecosyst. Environ., 123: 247-260.

Ashraf, A., M. Akram and M. Sarwar, 2014. Fuzzy decision support system for fertilizer. Neural Comput. Appl., 25: 1495-1505.

Eulenstein, F., M. Tauschke, M. Lana, A.K. Sheudshen and R. Dannowski *et al.*, 2014. Nutrient Balances in Agriculture: A Basis for the Efficiency Survey of Agricultural Groundwater Conservation Measures. In: Novel Measurement and Assessment Tools for Monitoring and Management of Land and Water Resources in Agricultural Landscapes of Central Asia, Lischeid, G., L. Mueller and A. Saparov (Eds.). Springer, Berlin, Germany, ISBN:978-3-319-01016-8, pp: 263-273.

Fageria, V.D., 2001. Nutrient interactions in crop plants. J. Plant Nutr., 24: 1269-1290.

Habib, S., M. Akram and A. Ashraf, 2017. Fuzzy climate decision support systems for tomatoes in high tunnels. Intl. J. Fuzzy Syst., 19: 751 775.

Hebbar, S.S., B.K. Ramachandrappa, H.V. Nanjappa and M. Prabhakar, 2004. Studies on NPK drip fertigation in field grown tomato *Lycopersicon esculentum* Mill. Eur. J. Agron., 21: 117-127.

Jonasson, S., A. Michelsen, I.K. Schmidt, E.V. Nielsen and T.V. Callaghan, 1996. Microbial biomass C, N and P in two arctic soils and responses to addition of NPK fertilizer and sugar: Implications for plant nutrient uptake. Oecologia, 106: 507-515.

Kolomaznik, K., M. Adamek, I. Andel and M. Uhlirova, 2008. Leather waste-potential threat to human health and a new technology of its treatment. J. Hazard. Mater., 160: 514-520.

Sempere, J., R. Nomen, R. Serra and J. Soravilla, 2002. The NPK method: An innovative approach for kinetic analysis of data from thermal analysis and calorimetry. Thermochim. Acta, 388: 407-414.

Surendra, K.C., D. Takara, A.G. Hashimoto and S.K. Khanal, 2014. Biogas as a sustainable energy source for developing countries: Opportunities and challenges. Renew. Sustain. Energy Rev., 31: 846-859.