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Fuzzy Based Approach For Farm Entrepreneur

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ABSTRACT

Nowadays technological advancements in the various fields have been a great support for making decisions especially in the field of agriculture, whether its crop production, irrigation management and pesticide control mechanism. Agriculture development is considered as under development because of a gap between agriculture knowledge management and decision support system. The main aim of this research is to reach farmers for their awareness, usages and perception based on GIS. The result is fuzzy system based GIS for farm entrepreneur which will give details of the crop quality, soil selection, area based crop production, localization of information, scientific availability of agriculture knowledge in the state of Punjab in India.

1. INTRODUCTION

Since ages, agriculture sector has been a very crucial for mankind and it is well known fact that three fourth of the entire population of India depends on agriculture. In past we have seen a sizeable increase in agriculture solely due to efforts of our farmer community and in the present scenario when agriculture has reached to the point of stagnation it is utmost important that farmers obtain necessary and latest information regarding crops for further development in the sector. Information technology has made its way to the villages via Broadband, Smart Phones etc and taking this in account a need of new web based portal has raised which will provide important and latest information about crops to help farmers in decision making. In the present competitive world to succeed in the agricultural business it is crucial to have latest updated information for decision making. Moreover farmers have to choose from different option for production due to latest research and development in the farm technology, quick and resourceful information with fast decision making is required to keep the farming business profitable. Creation of an information system is essential for the development and enhancement in the yield of agriculture. If a system can provide right information at right time, it will be helpful to enhance the agriculture field. Nowadays the most of the users (farmers) are literate, they can plan the strategies and make a decision for the current and next season with the help of information system. This paper presents the geographical information system, which mechanism and features of component GIS for farm Entrepreneur. This system has the ability of analysis, forecast, NPK values in soil, sowing and harvesting period of different crops in Punjab (India) and aid in irrigation water required in making decisions so for better agriculture yield this system is very useful in managing the agriculture farm information, providing service for the management of farm resources, moreover it can be very helpful in scientific analysis, yield decisions and assessment of farming.

1.1 Fuzzy Logic

A multiple value logic wherein truth values in the shape of real numbers can be anywhere between 0 and 1, considered to be fuzzy, as per Boolean logic, variable can have truth values 0 or 1 only, called crisp value. If truth value is anywhere between completely true to completely false then fuzzy logic can be used to handle this concept of partial truth. In fuzzy logic extremities of truth are 0 and 1 but there are also other states of truth which lies between these extreme points say .29. The working of this fuzzy logic seems somewhat closer as our brain works. In our brain we process data and form partial truths which are strengthen further after next level of data aggregation and when reach to a final limit cause some reaction/result as motor reaction. The computers with artificial intelligence and other such expert systems use similar type of processes.

1.1.1 Features of Fuzzy Logic

1. There is no requirement of precise and noise free inputs.
2. It can be programmed to fail safely if feedback sensor is destroyed or quits.
3. Despite input variations output control is a smooth control function.
4. The system performance can be improved easily as it processes user defined rules.

Architecture of Fuzzy Logic System:

- Fuzzification module: It transforms the system inputs of crisp numbers into fuzzy sets. It segregates the input signal into five steps –
- Knowledge base- It stores rules of If-Then provided by experts.

- Inference Engine- Human reasoning process is simulated by making fuzzy inference on IF- THEN rules and inputs.
- Defuzzification module-It transforms the fuzzy sets into crisp values.

Membership function: It helps to quantify linguistic term and represent a fuzzy set graphically. A membership function for a fuzzy set A on the universe of discourse X is defined as $\mu A: X \rightarrow [0,1]$.
Here, each element of X is mapped to a value between 0 and 1. It is called membership value or degree of membership. It quantifies the degree of membership of the element in X to the fuzzy set A.

1.2 Concept of GIS

A Geographic Information System (GIS) is a computer-based application to map and analyze geographic data. This technology collaborate common database functions viz query and statistical analysis with the exceptional visualization and spatial analysis benefits offered by maps. Hence this ability of GIS differentiates itself from other information systems and makes it important for public and other organizations for handling situations, forecasting agricultural crop productivity and to plan new strategies. Many aspects of society can be revolutionized by GIS which is considered important among new technologies. Today we face major challenges in the shape of pollution, overpopulation, natural disasters, deforestation- all of these have vital geographic dimensions. Local problems such as finding the best soil, discovering the best option for disposal of hazardous material wastes can be addressed in a better way by analyzing spatial data using geographic information system. GIS can perform some old tasks such as geographic analysis and map making in totally different, better and faster ways as compared to typical methods.
In the past, before the advent of GIS a small number of people have skills to analyze and use geographic information system for problem solving and decision making. Today GIS has become a billion dollar industry which has given employment to millions of people world-wide.GIS is being taught as a subject in educational institutes in all over the world.

1.2.1GIS

GIS is "an organized compilation of database, application, hardware, software, and trained manpower competent of capturing, manipulating, organization, and analyzing the spatially reference database and production of output both in tabular and map form." Major tasks performed by the GIS are shown in Fig. 1

Fig 1.1 : Major tasks in GIS

1.2.2 GIS DATA TYPES

Geographical data are numerical representation of the real world in digital form. Geographic database is organized digital geographic data. The types of Geographical data are shown in Fig. 2

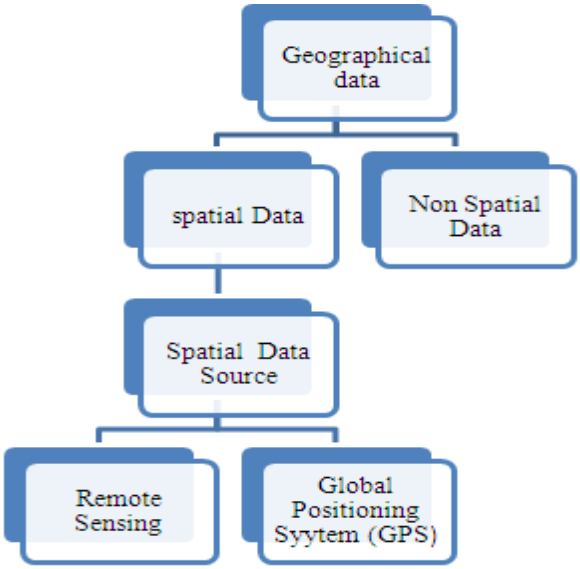


Fig. 1.2 : GIS Input data type

Remote Sensing data provides information regarding the earth surface features in the form of reflected electro-magnetic energy. Since the satellite has the capability to re-visit an area at defined intervals, thus temporal data can be used to identify any change which may occur during this re-visit interval. Further, satellite is available both in hard copy and digital form, hence digital based analysis provide consistent results in raster format.
Global positioning system is a network of navigational satellite which provides terrestrial position and tracking of moving object. The data is in vector format as it is in point form. The spatial data is stored as coordinate pair. Appropriate projection system for storing the geographic feature in 2D coordinate system is required. Specifying a common coordinate system for the database is required for the development of database in GIS.

2. LITERATURE SURVEY

Harsimranjit et.al. (2014) Discussed that Agriculture in India has a very significant history. Today, India ranked second worldwide in terms of farm output. Over the year agriculture has contributed towards India's GDP but is narrowly declining with the country's economic growth due lack of initiatives. Over the years there have been various advancements and experiments done in this field. One such is Fuzzy expert systems which are being used in agriculture for various activities i.e soil preparation, seed selection, pesticide management, water scheduling, weed management etc, with an objective to get better results and good yield out of crops. An fuzzy expert system is a collection of membership functions and rules that are used to reason about data. Unlike conventional expert systems, which are mainly symbolic reasoning engines, fuzzy expert systems are oriented toward numerical processing. In this paper we will be discussing role of fuzzy expert system and various experiments and research applied in field of agriculture.

Sumitha Thankachan et.al. (2014) explained that technological importance have been a great support in the field of decision making in agriculture. The development of agriculture is least past few years due to lack of Agriculture knowledge and environmental changes. The main aim of this research is to reach farmers for their awareness, usage and perception in e-Agriculture. The study used statistical survey design technique to collect data from farmers for their awareness in e-Commerce. The results obtained indicated the level of awareness is less such that there is a need for e-agriculture for their support. e-Agriculture is a platform for supporting marketing of agricultural products

Avinash Kumar et.al.(2014) described that Geographical Information System (GIS) in irrigation water management. Precise assessment, analysis and management of irrigation water in spatial and temporal domain can be efficiently carried out by proper blending of GIS techniques. Estimation of irrigation water requirement from a farm level to regional scale is possible due to the management and spatial analysis capabilities of GIS. Conglomeration of GIS helps in precise management of water for irrigation and producing more crops per drop of water.

Saroj Acharya et.al.(2014) described review of the Geographic Information System (GIS) based tools for irrigation management has been carried out. A brief review of customization of ArcGIS as irrigation management tool is also presented. Need and potential of development of the GIS based irrigation management tools to visualize and analyze irrigation management data is discussed in detail. This technique can be employed to develop thematic maps of irrigation requirements to be used by decision-makers. The relevant review literature indicates that GIS is versatile tool

that can be used to provide an appropriate framework for manipulating, analyzing and visualizing spatial data and produce results in the form of map, table and graph to support planning and decision making process in irrigation management. Review of various studies revealed that GIS can be customized effectively to develop a tool capable of simulating irrigation water requirements spatially, useful in decision making process in irrigation management.

Upendra et. Al. (2014) explained in a developing country agriculture has traditionally dominated the Sri Lankan economy and there are various issues such as overproduction, under supply, pest and disease outbreaks which has affected the farming community. Controlling diseases and pests related to cultivation is one of the major issues that farmers has faced during their farming activities. The current process of detecting and controlling pests and diseases was very time consuming in terms of collecting, analyzing, processing pest and disease related data and notifying outbreaks to the relevant parties. This limits the timely and proactive actions that could have been taken to control those pests and diseases.

Vidita et. al. (2013) discussed that Integrated Pest Management (IPM) is a comprehensive approach that integrates a variety of practices to minimize the loss of farm productions due to pests and pathogens with optimum use of pesticides. Early detection of pest and its control is one of the aspects of IPM. Weather based forecasting is well accepted method for this. Various meteorological data like-temperature, humidity, leaf wetness duration (LWD) plays the vital roles in the growth of microorganism responsible for disease. Effective forecasting of such diseases on the basis of climate data can help the farmers to take timely actions to restrain the diseases. This can also rationalize the use of pesticides, which are one of the causes behind land pollution. Weather based forecasting system can be considered as a part of the Agricultural Decision Support System (ADSS) which is Knowledge Based System (KBS). This paper proposes fuzzy logic based structure for the plant disease forecasting system. It has been demonstrated that the proposed method can be implemented with minimum weather data liketemperature and humidity.

A. ED-Dahhak et. al (2013) explained that Plant cultivation in greenhouse is influenced by various factors, such as soil quality, water availability, and climatic conditions. Techniques have been developed either to adapt food crops to their environment or to adjust the environment to meet plant needs. In this paper, a fuzzy controller (FC) has been implemented for monitored drip irrigation duration to reduce water using as variables soil moisture degree and air temperature in greenhouse. Soil moisture degree can be detected by an electronic circuit based on a capacitive probe. The FC permits to irrigate at the right time, when the plant needs water and the soil water is insufficient. Sensors and actuators (pump and solenoid) are installed and connected to a PC via a data acquisition card NI PCI 6221. A graphical user interface was developed using LabVIEW to acquire data and monitor drip irrigation station.

K.Anji Reddy et. al. (2012) discussed that India has a strong agriculture base and agriculture being the field of high developmental priority, the creation of a suitable Computational Agriculture Information System has become essential as development of agricultural sector is a potential catalyst for socio-economic development. There is a need to locally develop information systems that are based on local needs and structures. In country like India, need to adopt and develop information systems based on its own needs and structures, using their own methods and practices in the areas like healthcare, agriculture, education etc. Some of the problems faced towards informatics development for agriculture in India are: Unavailability of appropriate Agriculture Information Systems to facilitate Agriculture Informatics suitable to the Indian requirements.

Xuefen Mao et. al. (2011) improved the efficiency and effectiveness of agricultural infrastructure construction, a project management system integrated workflow and Geographical information system (GIS) with traditional information management system was necessary. To achieve this, agricultural infrastructure construction project business processes and specific functions were identified, and then the system architecture model based on the WFMC reference model, the database model based on spatial database engine (SDE) technology and the functional models were designed. Result shows that the business process of agricultural infrastructure construction project can be flexibly customized by integrating dynamic workflow management and statistical processes, and with the support of SDE and other GIS functions, the related map and other information of project can be seamlessly managed and displayed, also the spatial information can be online submitted, edited, and processed.

Ms. Neha Agarwal et. al. (2011) discussed that GIS was increasingly using geospatial data from the Web to produce geographic information. It is necessary to provide mechanisms to prepare data to help retrieval of semantically relevant data. Geospatial information (GI) constitutes to be the key factor in decision-making in a variety of domains, such as emergency management and agriculture. One way was to use semantic annotations to store the produced and relevant information. This paper illustrates study of semantic annotations of agricultural resources, using domain ontology's.

Sukristiyonubowo et al (2011) Study on management of inherent soil fertility of newly opened wetland rice for sustainable rice farming in Indonesia was conducted in Bulungan District, from 2009 to 2010. The aim was to know the soil fertility status and properly manage its fertility status to improve rice yield and sustain rice farming. Six treatments were imposed including T0: farmers practices, T1: farmer practices + compost + dolomite, T2: NPK recommended rate, N and K were split two times, T3: NPK recommended rate, N and K were split three times, T4: NPK recommended rate, N and K were split three times + compost + dolomite and T5: NPK recommended rate, N and K were split two times + compost + dolomite. The residual effect of dolomite and compost applied in 2009 was continually assessed in 2010.

Zhuang Weidong et. al. (2010) explained agriculture machinery guidance technology, which was one of precision agricultural important technologies. Based on GPS and GIS, it can raise working efficiency and improve the quality, reduce production costs, reduce driver working difficulty. This research's general goals realize the aided guidance function for agriculture machinery driving on road and straight line operation in the field by lightbar

3. PROBLEM DEFINITION

3.1 Aim of the system

The aim of the research of precision farming fuzzy expert system is to combine agriculture techniques, scientific research result, specialist's experience with computer technique, so that we can establish a comprehensive precision farming expert system which is of high intelligence. So, the knowledge of the expert and the ability of solving problem can be extended and inherited. As the guide of the farming production, it enhanced the level of the scientific management. The system adopt the system project guiding ideology, make the agriculture field expert's knowledge to be more systematic and formalization using the computer and artificial intelligence techniques, it is a comprehensiveness experts system which use the means of face to target to solve many problems. The system deal with the date separately, such as deal with the figure data and different property data, utilizing the mathematics logic and fuzzy reasoning means to carry on reasoning and analysis evaluation, make the system possess the ability of analysis, forecast and assistant decision.

Table1 3.1: Parameters used in the existing research

Sr. No	Parameter	Description
1	Sector Status in India	• Growth of socio-economic sector in India. • Nearly about 70% of population depend on agricultural sector. • Agriculture sector occupied almost 43% of India's geographical area.
2	Huge Investment made	• Huge investments in 11th Five year plan(2007-12) [5].
3	De-regulation in Agriculture sector	• Establishment of private markets/yards, direct purchase centers, consumer /farmers' markets for direct sale leads to good price to farmer. • To protect farmers from the exploitation of intermediaries and traders and also to ensure better prices and timely payment for their produce. • Significant technology growth in coming years.
4	Identified areas for Agriculture sector	• Needs monitoring on agricultural crop conditions, weather and climate and ecosystem.
5	Decision support needed	• For agricultural planning and policy making, plant production system, plant classification, land evaluation, control of green house

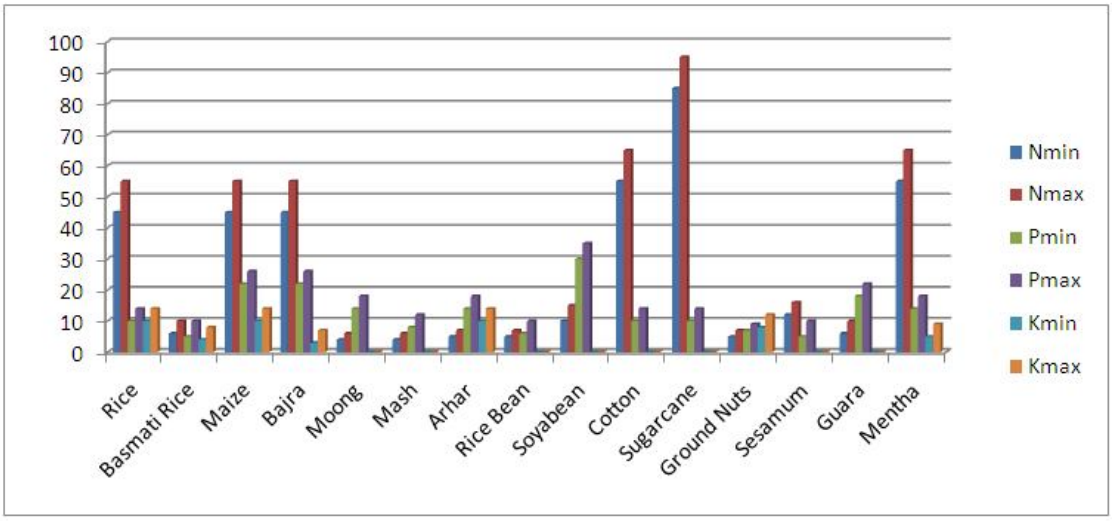
The above mentioned were the parameters of the previous research [5]. The parameter no. 4 and 5 has been achieved in this research as given below.

Table 3.2 : Parameters used as basic for the proposed research

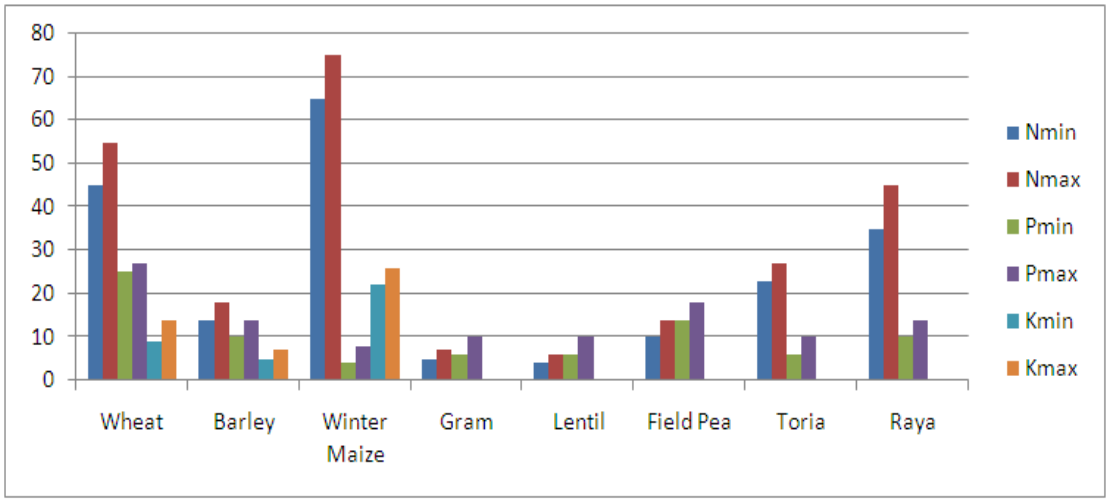
Sr. No.	Parameter	Description
1.	Demand For Good Quality Crops	• Growth in exports of agriculture produces to international market. • Enhanced food regulatory standards.
2.	Soil Based Crop Selection	• Technology is doing wonders to make comfortable and easy, similarly information technology can be used to develop a system which would help farmers to take decisions about their crops using NPK values.
3.	Area Based Crop and Soil	• Crops can be produced at a lower cost if weather data is used. • A good crop can be saved from being a bad crop due to bad weather.
4.	Availability of Scientific Knowledge of Agriculture	• Field specific, crop specific knowledge can be co-related with information technology for the betterment of agriculture. E.g. Sowing and Harvesting Period.
5.	Dissemination of Localized data	• Local information such as – Area under food and non food crops, production of fruits, vegetables etc can be made available to all so that marketability and profitability of agricultural produces be increased.

Table 3.3 : Range of nutrients for the different crops [Punjab Agriculture University, Ludhiana]

ID	Season	Crops	Nmin	Nmax	Pmin	Pmax	Kmin	Kmax
1	Kharif	Rice	45	55	10	14	10	14
2		Basmati Rice	6	10	5	10	4	8
3		Maize	45	55	22	26	10	14
4		Bajra	45	55	22	26	3	7
5		Moong	4	6	14	18	0	0
6		Mash	4	6	8	12	0	0
7		Arhar	5	7	14	18	10	14
8		Rice Bean	5	7	6	10	0	0
9		Soyabean	10	15	30	35	0	0
10		Cotton	55	65	10	14	0	0
11		Sugarcane	85	95	10	14	0	0
12		Ground Nuts	5	7	7	9	8	12
13		Sesamum	12	16	5	10	0	0
14		Guara	6	10	18	22	0	0
15		Mentha	55	65	14	18	5	9
16	Rabi	Wheat	45	55	25	27	9	14
17		Barley	14	18	10	14	5	7
18		Winter Maize	65	75	4	8	22	26
19		Gram	5	7	6	10	0	0
20		Lentil	4	6	6	10	0	0
21		Field Pea	10	14	14	18	0	0
22		Toria	23	27	6	10	0	0
23		Raya	35	45	10	14	0	0



Graph 3.1 : NPK values for different crops of Kharif



Graph 3.2 : NPK values for different crops of Rabi

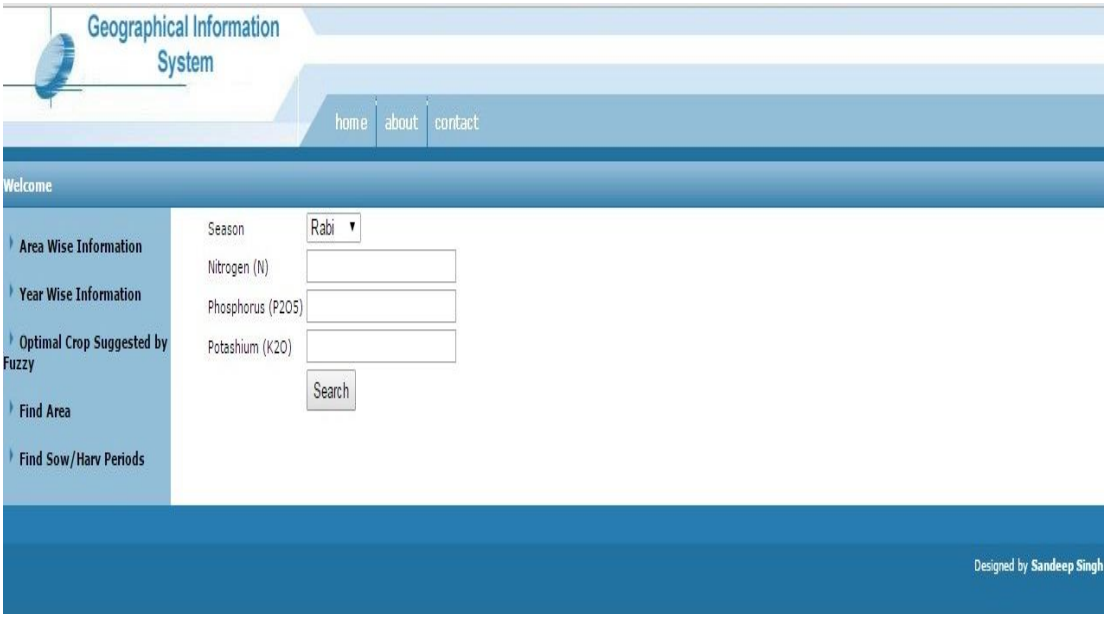


Figure 3.1: Inesrt the Values of NPK of soil

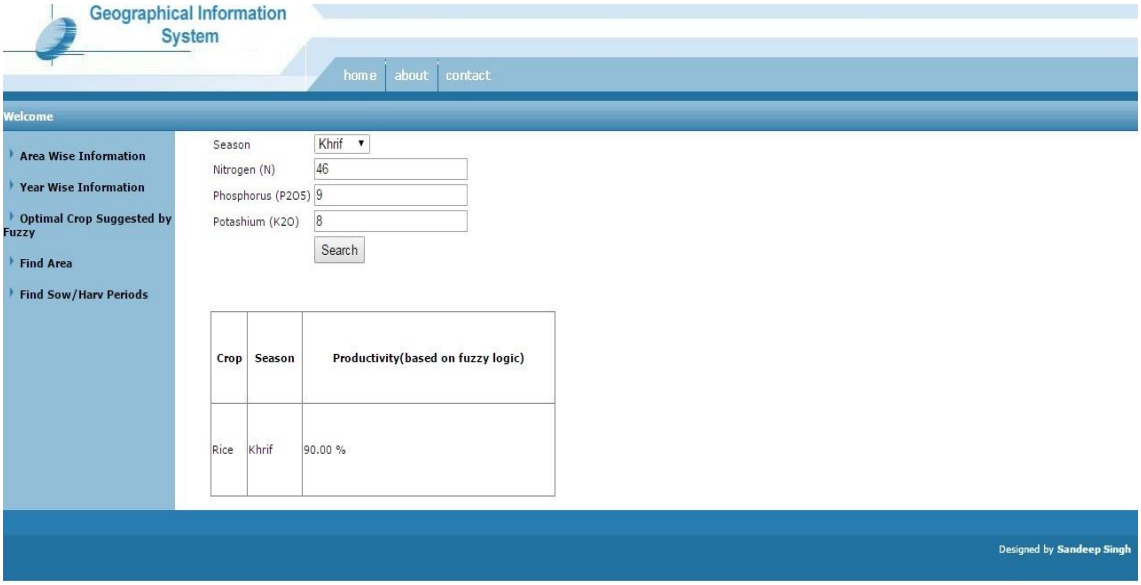


Figure 3.2: Showing the Result to the Farmer

4. RESULTS & DISCUSSIONS

In this research user can make decision according to the type of soil, can predict irrigation requirements and area wise information, crop yield, good quality crops, sowing and harvesting period. In this, fuzzy logic has been implemented on GIS for Farm Entrepreneur using various parameters Demand For Good Quality Crops, Soil Based Crop Selection, Area Based Crop and Soil, Availability of Scientific Knowledge of Agriculture, Dissemination of Localized data. Note that such system can better decide crop yield, type of soil, irrigation requirements etc. The fuzzification is simple, hence making more suitable for present day crop growth requirements through regulated supply of water and nutrients. The nutrients rang of various crops are different in regions based on the soil type and rainfall and irrigation requirements. This Geographical Information System for Farm Entrepreneur will aid the farmers in making decisions based on nutrient range, soil type and irrigation requirements. The NPK contents for various crops in Punjab have been taken from the Punjab Agriculture University, Ludhiana, Punjab. The Geographical Information System for Farm Entrepreneur will give decision for the high yield of the crop, soil improvement, sowing and harvesting period etc.

5. FUTURE SCOPE

The GIS has a very good scope for future research:

- The GIS can be made more handy and valuable if Punjabi language is incorporated in this system.
- For solution of more complex economic issues it can be further developed taking into account more economic models.
- Further improvement can be done through by incorporating real time market information specifically about price. It will be more beneficial in the case where market price is higher than the MSP.
- The GIS can be used to send emails, SMS etc to farmers and online farmers' forums can be created to encourage real time discussions among them foir fast solution of farm related problems.
- IVR facility can be provided in local language to make it more useful for farmers.

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