A Study of Computing Techniques in Agricultural and Food Sector

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***Abstract*— Agriculture is an important sector of Indian economy. This sector accounts for 14% of nations GDP and 11% of its exports. Half of the population still relies on agriculture as its principal source of income. Agriculture serves as a source of raw material for large number of industries. This paper aims at exploring various computing techniques adopted in agricultural industry in general and with special reference to agricultural data analysis. Diverse innovative solutions have been proposed in the literature for agricultural yield prediction and data analysis world-wide. Sensor based detection of pests and diseases harming the agriculture have been adopted. Cloud based solutions as well as mobile based approaches are also being invented for agriculture computing. As per our study, computing techniques using Soft Computing, Data Mining, Image Processing and Embedded Systems are potential approaches for future applications in agriculture domain.**

Keywords – Agriculture, Soft Computing, Data Mining, Image Processing

I. INTRODUCTION

India accounts for only about 2.4% of the world's geographical area and 4% of its water resources, but has to support about 17% of world's human population and 15% of livestock. World population is expected to grow from 2.3 billon present to 9.1 billion by 2050 would require raising overall food production by 70%. Food production in developing countries should almost double. These above facts will make agriculture sector an important area for research. Researchers worldwide have applied innovative techniques to solve various problems in the field of agriculture.

II. REVIEW OF LITEREATURE

Authors have carried out an exhaustive study of computing techniques applied in agriculture and presented major concepts.

T.Hague, J.A.Marchant and N.D. Tillett [1] have studied Ground based sensing systems for autonomous agricultural vehicles. This paper examines ground based (as opposed to satellite based) sensing methods for vehicle position fixing. Sensors are considered in various categories, motion measurement (odometry, inertial), artificial landmarks (laser positioning, millimeter wave radar), and local feature detection (sonar, machine vision). Special emphasis is laid on the technologies which have proven successful beyond the field of agriculture, and to machine vision because of its topicality.

Rakesh Kaundal, Amar S Kapoor, Gajendra PS and Raghava [2] have discussed machine learning techniques in disease forecasting: a case study on rice blast prediction. Diverse modeling approaches viz. neural networks and multiple regressions have been followed for disease prediction in plant populations. However, these techniques are not well suited for predicting the value of unknown data points and consume longer training times. Hence there is need for exploiting new prediction software for better understanding of plant-pathogen-environment relationships. Further, there is no online tool available, which can help the plant researchers or farmers in timely application of control measures. The paper introduces a new prediction approach based on support vector machines for developing weather-based prediction models of plant diseases. Authors have selected six significant weather variables as predictor variables. Two series of models (cross-location and cross-year) were developed and validated using a five-fold cross validation procedure. For cross-year models, the conventional multiple regression approach achieved an average correlation coefficient (r) of 0.50, which increased to 0.60 and percent mean absolute error (%MAE) decreased from 65.42 to 52.24 when back-propagation neural network (BPNN) was used. With generalized regression neural network (GRNN), the r increased to 0.70 and %MAE also improved to 46.30, which further increased to r = 0.77 and %MAE = 36.66 when support vector machine (SVM) based method was used. Similarly, cross-location validation achieved r = 0.48, 0.56 and 0.66 using REG, BPNN and GRNN respectively, with their corresponding %MAE as 77.54, 66.11 and 58.26. The SVM-based method outperformed all the three approaches. Overall, this SVM-based prediction approach will open new vistas in the area of forecasting plant diseases of various crops. This case study demonstrated that SVM is better than existing machine learning techniques and conventional regression approaches in forecasting plant diseases.

Praduman Kumar and Surabai Mittal [3] studied Agricultural Productivity Trends in India on the sustainability issues. The sustainability issue of the crop productivity is of major conecrn. The post green revolution phase is characterised by high input use and decelerating total factor productivity growth (TFPG). The agricultural productivity growth attained during 1980's has not been sustained during the 1990s and has posed a challenge for researchers to shift the production function upward by improving the technology index. It is highly required to investigate issues related to the trends in the agricultural productivity, particularly with reference to individual crops grown in major states of india.

M. Hadgu, Walter A. H. Rossing, Lammert Kooistra and Ariena H. C. [4] have presented spatial variation in biodiversity, soil degradation and productivity in agricultural landscapes in the highlands of Tigray, northern Ethiopia Kiros. There is a growing concern about food security and sustainability of agricultural production in developing countries. However, there are limited attempts to quantify agro-biodiversity losses and relate these losses to soil degradation and crop productivity, particularly in Tigray, Ethiopia. In this study, spatial variation in agro-biodiversity and soil degradation was assessed in 2000 and 2005 at 151 farms in relation to farm, productivity, wealth, social, developmental and topographic characteristics in Tigray, northern Ethiopia. A significant decrease in agro-biodiversity was documented between 2000 and 2005, mainly associated with inorganic fertilizer use, number of credit sources and proximity to towns and major roads. Agro- biodiversity was higher at farms with higher soil fertility and higher productivity (total caloric crop yield). Low soil organic matter, few crop selection criteria and steep slopes contributed to soil erosion. Sparsely and intensively cultivated land use types, as determined from satellite images, were associated with high and low agro-biodiversity classes, respectively, as determined during on-farm surveys in 2005. This study gives insight into the recent changes in and current status of agro-biodiversity and soil degradation at different spatial scales, which can help to improve food security through the maintenance of agro-biodiversity resources. Sparsely and intensively cultivated land use types, as determined from satellite images, were associated with high and low agro-biodiversity classes, respectively, as determined during on-farm surveys in 2005.

A. Lopez-Gomez, P. S. Fernandez, A. Palop, P. M. Periago, A. Martinez-Lopez, F. Marin-Iniesta, G. V. Barbosa-Canovas [5] presented emerging perspective of Food Safety Engineering. In general, food engineers are trained to solve engineering problems in the food industry. More specifically, the food engineer must specify the functional requirements, design, and testing of food products and finally, the evaluation of products to check for overall efficiency, cost, reliability and most importantly safety. Food safety must be considered foremost as the overall engineering problem encountered in the food supply chain and it must be solved from food safety engineering safe and secure. This multi-disciplinary approach will involve certain engineering components: (i) predictive microbiology as a tool to evaluate and improve food safety in traditional and new processing technologies, (ii) advanced food contaminants detection methods, (iii) advanced processing technologies, (iv) advanced systems for re-contamination control, (v) advanced systems for active and intelligent packaging. This article showed that the food safety engineering perspective is essential in order to produce high quality food products.

Xiaodong Zhang, Lijian Shi, Xinhua Jia, George Seielstad and Craig Helgason[6] have presented the Zone mapping application for precision-farming: a decision support tool for variable rate application. ZoneMAP is a web-based decision support tool for precision farming (http://zonemap.umac.org) has been developed to automatically determine the optimal number of farming management zones and delineate them using satellite imagery and field data provided by users. Application rates, such as of fertilizer, can be prescribed for each zone and downloaded in a variety of formats to ensure compatibility with GPS-enabled farming equipment. ZoneMAP is linked to Digital Northern Great Plains, a web-based application which hosts an archive of satellite imagery, as well as high resolution imagery from airborne sensors. Management zones created by ZoneMAP mapped natural variation of the soil organic matter and other nutrients relatively well and were consistent with zone maps created by traditional means. The results demonstrated that ZoneMAP can serve as an effective and easy-to-use tool for those who practice precision agriculture.

G.S.Bhalla and Gurmail Singh [7] from Centre for the Study of Regional Development Jawaharlal Nehru University, New Delhi have submitted a final report on Planning Commission Project Growth of Indian Agriculture: A District Level Study. This report discusses the introduction of the Borlaug seed-fertiliser technology during the mid-sixties brought about significant increase in the levels and growth of agricultural output in India, but the gains of new technology were not spread evenly over various states and regions of the country. Our three earlier studies provided a detailed analysis of the impact of this new-seed fertiliser technology on regional patterns of levels and growth of agricultural output at the state and district levels in India during the period 1962-65 to 1990-93. Introduction of economic reforms in India in 1991 which brought about fundamental changes in macro-economic and trade policies completely altered the entire agricultural policy framework which had prevailed during the planning period prior to 1990's. The promotion of new technology was undertaken through a package approach which consisted of supply of HYV seeds, research and extension, supply of fertiliser and other inputs at subsidised rates and provision of credit to enable farmers to undertake necessary production expenditures. The policy makers gave special emphasis to investment in agricultural R & D and extension services.

Zhifang Yang and Gang Liu [8] have conducted research on publishing system of Fruit tree diseases and insect pests based on WebGIS. A web publishing system of fruit tree diseases and insect pests was developed based on WebGIS. It can publish most of the new information of fruit tree diseases and insect pests with the spatial and zone features in the orchard. It can also make appropriate prevention and cure decision in time. This system provides many analysis methods, including spatial query, statistical analysis, buffer analysis, overlay analysis, predication analysis, expert diagnosis and so on. The system was developed with Java, based on GIS platform ArcIMS. The system based on WebGIS are developed using GIS software (ArcIMS, ArcSDE, Arclnfo), experts knowledge models and the information of fruit tree diseases and insect pests in orchard. The GIS and biologic geographical statistics were applied to describe the distribution pattern of fruit tree diseases & insect pests and to carry out spatial overlay analysis and so on. The WebGIS technology is a promising mode to develop a control system for fruit tree diseases and insect pests. Newer ArcIMS technology has more actual functions and analysis methods.

Emerging trends in Indian Agriculture was studied by Ashok Gulati [9] mainly looking into what can we learn from these. The author discussed the key issues like will the next revolution in Indian Agriculture be triggered by corporate sector, can fast scaling up corporate sector in agribusiness lead the fragmenting smallholders, technology, market and increasing role of corporate sector in agriculture. The rise of corporate sector in Indian Agricultural system is discussed combining top & fragmenting bottom, spatial variation in agricultural growth and the things we can learn from it.

M. J. Florin, A. B. McBratney, B. M. Whelan and B. Minasny [10] discussed Precision Agric Inverse Meta-modeling to Estimate Soil, Available Water capacity at high spatial resolution across a farm. Geo-referenced information on crop production that is both spatially and temporally-dense would be useful for management in precision agriculture (PA). Agriculture yield monitors provide spatially but not temporally dense information. Crop growth simulation modeling can provide temporal density, but traditionally fail on the spatial issue. The research described was motivated by the challenge of satisfying both the spatial and temporal data needs of PA. The methods presented depart from current crop modeling within PA by introducing meta-modeling in combination with inverse modeling to estimate site-specific soil properties. The soil properties are used to predict spatially and temporally-dense crop yields. An inverse meta-model was derived from the agricultural production simulator (APSIM) using neural networks to estimate soil available water capacity (AWC) from available yield data. Maps of AWC with a resolution of 10 m were produced across a dry land grain farm in Australia. For certain years and fields, the estimates were useful for yield prediction with APSIM and multiple regression, whereas for others the results were disappointing. The estimates contain implicit information about climate interactions with soil, crop and landscape that needs to be identified. Improvement of the meta-model with more AWC scenarios, more years of yield data, inclusion of additional variables and accounting for uncertainty are discussed. Authors concluded that it is worthwhile to pursue this approach as an efficient way of extracting soil physical information that exists within crop yield maps to create spatially- and temporally-dense datasets.

Yanshui Jiang [11] authored the paper Geo-Referencing and Mosaicing Agricultural Field Images from A Close-Range Sensing Platform. Field images are becoming more frequently used for sensing the crucial properties of the crops in precision agriculture. Some of them contain distortions that need to be removed before further analysis. Data from images, such as the coordinates of the crops, also need specific algorithm to be extracted. For these purposes, two computer vision algorithms were developed for pre-processing the field images from two monocular vision systems. One algorithm was used for a tower remote sensing system data pre-processing for image distortion removal and the mosaic to generate geo-referenced images. The other was for the image data interpretation used for the vision system of a field robot. Satellite and aerial remote sensing systems are the two major platforms for collecting remote sensing images for agriculture. However, due to the critical drawbacks of these systems, such as low spatial and temporal resolution, a tower remote sensing system with a 360-degree rotatable camera on the top has been established in the experiment field to obtain the multi-spectra images for monitoring the status of the plants. In this research, the geo-reference and image mosaic algorithms were developed for data acquisition. While taking remote sensing images of the field, the camera will turn 360^{o} horizontally and 90^{o} vertically. This creates the difficulty of geo-reference because different images have different distortions. Therefore, traditional ways of geo-reference, such as using Ground Control Points (GCP), are no longer appropriate.

Jan T. Rosnes, Torstein Skåra and Dagbjørn Skipnes [12] have discussed Recent Advances in Minimal Heat Processing of Fish: Effects on Microbiological Activity and Safety. Thermal processing is one of the most common methods for achieving safe convenience fish products with an extended shelf life. Designing a thermal process for such products, typically in the range of 60-95 °C for 10 to 30 min, is challenging since the heat load required for inactivating target microorganisms may cause undesirable quality changes in the lipid and protein fraction. Concern about the safety of some fish products exists, particularly when considering the potential abuse caused by storage temperature. New methods that focus on minimal heating or rapid heating of fish products are therefore of vital importance. The main aim for new developments is to reduce the overall thermal load by reducing the temperature gradients in the product or by targeting specific potentially infected areas. In both cases, alternative technologies to conventional autoclaves, comb steamers or water baths were used for enhanced heat transfer, thereby providing more rapid heating and avoiding unnecessarily high heat loads on part of the product. Dielectric heating, Shaka technology and surface Pasteurisation are technologies that meet these approaches, and are now available for industrial applications. Minimal processing often relies on the use of multiple sub-lethal stresses or processes to achieve a similar level of microbial control such as that traditionally achieved by using a single lethal stress. Most minimally processed products require refrigerated storage and distribution to maintain food safety.

S.A.A. Almeida, L.R. Amorim, A. H. Heitor, M. C. B. S. M. Montenegro, J. Barbosa, L.C. Sá and M.G.F.Sales [13] have presented Rapid automated method for on-site determination of sulfadiazine in fish farming. A stainless steel veterinary syringe coated with a selective membrane of PVC is used as a potentiometric detector in a flow-injection-analysis. Sulfadiazine is an antibiotic of the sulfonamide group and is used as a veterinary drug in fish farming. Monitoring it in the tanks is fundamental to control the applied doses and avoid environmental spreading. Pursuing this goal, authors included a novel potentiometric design in a flow-injection assembly. The electrode body was a stainless steel needle veterinary syringe of 0.8-mm.

William W. Guo and Heru Xue [14] have invented an incorporative statistic and neural approach for the yield modeling and forecasting. It is a complementary approach to traditional time series analysis on modeling and forecasting by treating crop yield and associated factors as a non-temporal collection. Statistics are used for identifying the highly related factor(s) affecting the yield. The values are used for data cleaning and a supporting role in data expansion, if necessary, for neural network training and testing. Wheat yield and associated plantation area, rainfall and temperature in Queensland of Australia over 100 years are used to test this incorporative approach. The results show that well- trained multilayer perceptron models can simulate the wheat production through given plantation areas with a mean absolute error (MAE) of 2%, whereas the third- order polynomial correlation returns an MAE of 20%. In conclusion, a well-trained neural network is able to predict the wheat production with respect to a given plantation area with a high accuracy, compared with the statistical correlations. However, statistical analysis also plays an important role in identification of relevant factors, outlier detection and determination of general trend in data. This cannot be achieved by neural networks working like a black-box translator. The combination of these two approaches can lead to both meaningful qualitative and accurate quantitative data analysis and forecasting. It should be noticed that many other factors affecting crop yield have not been investigated in this study due to unavailability of these data. Further study should explore more relevant factors contributing to crop yield using this incorporative approach. This will not only assess the roles of individual factors in crop production but also further validate the usefulness of this approach as either a standalone application or a part of a comprehensive hybrid system in crop yield modeling and forecasting. The other area worth further investigation is to introduce multivariate regression to the process of Factor Selection in addition to the current single factor selection. This would combine those interrelated factors together for data analysis and forecasting. Although this incorporative approach is designed for crop yield modeling and forecasting, it can also be useful in data modeling and forecasting in other applications due to its generic nature.

Viacheslav I. Adamchuk, Raphael A. Viscarra Rossel, Kenneth A. Sudduth and Peter Schulze Lammers [15] have worked on Sensor fusion for precision agriculture with the rapid rise in demand for both agricultural crop quantity & quality. With the growing concern of pollution caused by modern farming practices, the efficiency and environmental safety of agricultural production systems have been questioned. While implementing best management practices around the world, it was observed that the most efficient quantities of agricultural inputs vary across the landscape due to various naturally occurring, as well as man-induced, differences in key productivity factors such as water and nutrient supply. Identifying and understanding these differences allow for varying crop management practices according to locally defined needs. Such spatially-variable management practices have become the central part of precision agriculture (PA) management strategies being adapted by many practitioners around the world. PA is an excellent example of a system approach where the use of the sensor fusion concept is essential. Among the different parameters that describe landscape variability, topography and soils are key factors that control variability in crop growing environments. Variations in crop vegetation growth typically respond to differences in these microenvironments together with the effects of management practice. Authors feel that ability to accurately recognize and account for any such differences can make production systems more efficient.

Sibel Ozilgen, Seyda Bucak and Mustafa Ozilgen [16] authored the article Improvement of the safety of the red pepper spice with FMEA and post processing EWMA quality control charts. Although there are numerous decades-old studies drawing attention to the presence of aflatoxins in spices and particularly in red pepper spice, the problem has not been eradicated. In the present study, information presented in the literature, about production method of red pepper spice, its contamination with aflatoxin and the uncertainty about the data are assessed to find out the points where improvement may be achieved. Failure Mode and Effect Analysis (FMEA) are performed to assess the risk. The highest total risk attributable to chemical plus physical plus biological causes is associated with the washing stage, which is followed by the receiving and the storage stages. The highest risk attributable to biological causes is associated with microbial growth and aflatoxin production due to insufficient control of drying conditions. The highest chemical risk is found for the presence of unintentional food additives, such as pesticides, herbicides, hormones, and heavy metals in fresh red pepper fruits. EWMA (exponentially weighted average) charts are employed to monitor aflatoxin production during storage. Authors successfully distinguished between the batches, which turned to be unsafe. Risk associated with unintentional additives may be reduced by using certified additives only.

Better drying control will definitely reduce the risk associated with the drying process. Codex Alimentarius plan has worldwide acceptance for assessing safety of the nuts. Red peppers are subject to fungal growth both during drying or subsequent storage processes. As red pepper is the second spice to salt in Turkey, and one of the most popular spices all around the world, an urgent need for improvement of the quality control procedures for the production and storage stages of these products has been addressed.

Zhuqing Ding, Ruoyu Zhang and Za Kan [17] have worked on Quality and safety inspection of food and agricultural products. LabVIEW IMAQ Vision is potentially useful for inspecting food and agricultural products since it combines the merits of both LabVIEW and IMAQ Vision, which have graphical programming environment and rich image processing functions such as defects detection, shape classification, fruit grading and quality evaluation, etc. The results of discussion showed that the utilization of IMAQ Vision module is restricted by the hardware environment and mixed programming with LabVIEW and MATLAB is the development trend of LabVIEW IMAQ Vision This paper comprehensively reviews the recent developments and applications in LabVIEW IMAQ Vision for food and agricultural inspection and also objectively presents current limitations and likely future development trends of it. However, it cannot be said that this method is very effective for measuring quality attributes. Authors concluded that LabVIEW IMAQ Vision is a powerful tool for the quality and safety inspection of food and agricultural products.

De Gruijter et al., [18] have worked on traditional differences in physical, chemical and biological soil attributes have been detected through soil sampling and laboratory analysis. The cost of sampling and analysis are such that it is difficult to obtain enough samples to accurately characterize the landscape variability. This economic consideration resulting in low sampling density has been recognized as a major limiting factor. Both proximal and remote sensing technologies have been implemented to provide high- resolution data relevant to the soil attributes of interest. Remote sensing involves the deployment of sensor systems using airborne or satellite platforms. Proximal sensing requires the operation of the sensor at close range or even in contact. Precision agriculture encompasses identifying, understanding and utilizing information that quantifies variations in soil and crop within agricultural fields. The information needed is generally spatially and or temporally intensive, which has led to the development of various sensing technologies that assess the soil or crop. These sensing systems are based on diverse measurement concepts, including electrical and electromagnetic, optical and radiometric, mechanistic, and electrochemical. Robustness of single-sensor measurements is often less than ideal because virtually all currently used sensor technologies can respond to more than one basic parameter of interest. For example, crop canopy reflectance sensors can be affected by multiple stressors such as water or nitrogen deficiencies, the reflectance of the underlying soil, and the size of the crop plants. A sensor fusion approach that integrates canopy reflectance sensing with other sensors measuring plant size and soil parameters has the potential to improve the measurement accuracy of agronomically important stresses in the crop. Accurate measurements are important to determine the best management treatment because the economic and/ or environmental risk associated with applying the wrong treatment to the crop can be large. Some examples of integrated soil and crop sensing systems that combine multiple sensors already exist, and others are in various stages of development. However, multisensor platforms are difficult to implement in an agricultural setting due to constraints such as cost and durability. Typically, low profit margins mean that agricultural producers are not willing to adopt technology with a high added cost.

Sea food related research is done by Saraya Tavornpanich, Mathilde Paul, Hildegunn Viljugrein, David Abrial, Daniel Jimenez and Edgar Brun [19]. They have developed Risk map and spatial determinants of pancreas disease in the marine phase of Norwegian Atlantic salmon farming sites. Outbreaks of pancreas disease (PD) greatly contribute to economic losses due to high mortality, control measures, interrupted production cycles, reduced feed conversion and flesh quality in the aquaculture industries in European salmon-producing countries. The overall objective of this study was to evaluate an effect of potential factors contributing to PD occurrence accounting for spatial congruity of neighboring infected sites, and then create quantitative risk maps for predicting PD occurrence. The study population included active Atlantic salmon farming sites located in the coastal area of 6 southern counties of Norway (where most of PD outbreaks have been reported so far) from 1 January 2009 to 31 December 2010. Using a Bayesian modeling approach, with and without spatial component, the final model included site latitude, site density, PD history, and local biomass density. Clearly, the PD infected sites were spatially clustered; however, the cluster was well explained by the covariates of the final model. Based on the final model a map was produced for presenting the predicted probability of the PD occurrence in the southern part of Norway. Subsequently, the predictive capacity of the final model was validated by comparing the predicted probabilities with the observed PD outbreaks in 2011. The proposed framework was found suitable for spatial studies of other infectious aquatic animal diseases.

George Nyamadzawo, Menas Wuta, Justice Nyamangara and Douglas Gumbo [20] have discussed the Opportunities for optimization of in-field water harvesting to cope with changing climate in semi-arid smallholder farming areas of Zimbabwe. Climate change has resulted in increased vulnerability of smallholder farmers in marginal areas of Zimbabwe, where there is limited capacity to adapt to changing climate. One approach that has been used to adapt to changing climate is in-field water harvesting for improved crop yields in the semiarid regions of Zimbabwe. This review analyses the history of soil and water conservation in Zimbabwe, efforts of improving water harvesting in the post-independence era, farmer driven innovations, water harvesting technologies from other regions, and future directions of water harvesting in semi arid marginal areas. From this review it was observed that the blanket recommendations that were made on the early conservation method were not suitable for marginal areas as they resulted in increased losses of the much needed water. In the late 1960 and 70s', soil and water conservation efforts was a victim of the political environment and this resulted in poor uptake. Most of the water harvesting innovations which were promoted in the 1990s' and some farmer driven innovations improved crop yields in marginal areas but were poorly taken up by farmers because they are labour intensive as the structures should be made annually. To address the challenges of labour shortages, the use of permanent in-field water harvesting technologies are an option. There is also need to identify ways for promoting water harvesting techniques that have been proven to work and to explore farmer-led knowledge sharing platforms for scaling up proven technologies. In-field water harvesting is one of the many climate change adaptation strategies that can be adopted by farmers in the semi- arid regions of Zimbabwe. In-field water harvesting can potentially enhance soil water storage, and this will enable crops to survive during mid-season droughts. Improved water harvesting may result in improved crop yields, food security and livelihood among households. Water harvesting should be integrated with other management strategies e.g., improving soil fertility management, tillage, timing of operations, pest management and choice of cropping system in order to increase the efficiency of use of the harvested water.

Lewis Paton, Matthias C.M. Trofaes, Nigel Boatman, Mohamud Hussein, and Andy Hart [21] presented Logistic Regression on Markov Chains for Crop Rotation Modeling. The dynamical systems such as farmer's crop choices, the dynamics are driven by external non-stationary factors, such as rainfall, temperature and agricultural input and output prices. Such dynamics can be modeled by a non-stationary Markov chain, where the transition probabilities are multinomial logistic functions of such external factors. Authors extended the previous work to investigate the problem of estimating the parameters of the multinomial logistic model from data. This paper uses the model to analyze some scenarios for future crop growth and extended previous work to be able to model multiple crop choices and multiple repressors. The paper proposed a model for multinomial imprecise logistic regression, using sets of conjugate prior distributions, to get bounds on the posterior transition probabilities of growing wheat, barley or anything else, as functions of rainfall and the difference in profit between wheat and barley. Authors cared about robustness because, for certain rare crop types, very little data is available. By using sets of prior distributions, our approach allows us to make robust inferences even from near-vacuous prior information. For computational reasons, MAP estimation is used to approximate the actual posterior expectation. Other options, such as MCMC, are computationally far more complex. The application of this work to crop rotation modeling is still at an early stage. Farmers are faced with more than just three crop choices, and there are other variables that effect their choice.

Qiuxiao Chen, Chenghu Zhou, Jiancheng Luo and Dongping Ming [22] studied Fast segmentation of high-resolution satellite images using watershed transform combined with an efficient region merging. High-resolution satellite images like Quickbird images have been applied into many fields. However, researches on segmenting such kind of images are rather insufficient partly due to the complexity and large size of such images. In this study, a fast and accurate segmentation approach was proposed. First, a homogeneity gradient image was produced. Then, an efficient watershed transform was employed to gain the initial segments. Finally, an improved region merging approach was proposed to merge the initial segments by taking a strategy to minimize the overall heterogeneity increased within segments at each merging step, and the final segments were obtained. Compared with the segmentation approach of a commercial software eCognition, the proposed one was a bit faster and a bit more accurate when applied to the Quickbird images.

E.I.Papageorgiou, A.T.Markinos and T.A.Gemtos [23] have presented Soft computing technique of fuzzy cognitive maps to connect yield defining parameters with yield in cotton crop production in Central Greece as a basis for a decision support system for precision agriculture application. This work investigates the yield and yield variability prediction in cotton crop. Cotton crop management is a complex process with interacting parameters like soil, crop and weather factors. The soft computing technique of fuzzy cognitive maps (FCMs) was used for modeling and representing experts' knowledge. FCM, as a fusion of fuzzy logic and cognitive map theories, is capable of dealing with uncertain descriptions like human reasoning. It is a challenging approach for decision making especially in complex environments. The yield management in cotton production is a complex process with sufficient interacting parameters and FCMs are suitable for this kind of problem. The developed FCM model consists of nodes that represent the main factors affecting cotton production linked by directed edges that show the cause-effect relationships between factors and cotton yield. Furthermore, weather factors and conditions were taken into consideration in this approach by categorizing springs as dry-wet and warm-cool. The methodology was evaluated for approximately 360 cases measured over 2001, 2003 and 2006 in a cotton field. The results were compared with some benchmarking machine learning algorithms, which were tested for the same data set, with encouraging results. The main advantage of FCM is the simple structure and the easy handling of complex data. Summarizing the main contribution of the application work, Fuzzy Cognitive Maps, as an efficient methodology for capturing causal knowledge of domain experts, can be a useful tool for capturing the stakeholders' understanding of the system and their perceptions on the cotton yield requirements of the precision agriculture. Future work is directed towards the investigation on integrating data mining techniques with expert knowledge to develop advanced decision support systems in precision agriculture

Zhang Chi, Chen Tianen, and Chen Liping [24], did some study on Strawberry Planting in ChangPing District of Beijing. The misuse of pesticide and fertilizer take a great pollution to the agricultural environment, which seriously affects the quality and safety of agricultural products. The government put forward a series of policies of subsidy to lead the farmers to proper pesticide application and scientific farming. But the effect does not turn out as it wished to be because of the backward implementation methods and Stat methods. This research provides a Precision Management method for effectively managing subsidies for agriculture. Based on Non- contact IC card, the authors developed a Precision Management System for agricultural related subsidy management. This system was applied in one center and eleven experiment stores in ChangPing district in Beijing. It solved problems like poor instruction for planting, delay in providing subsidies and in-accurate information during the strawberry growing season. Through this system, farmers can get the subsidies and instruction at the moment they buy agricultural materials, government can obtain the accurate data, and then adjust the policies in time to get the desired effect.

Andreas Michaels, Amos Albert, Matthias Baumann, Ulrich Weiss, Peter Biber, Arnd Kielhorn and Dieter Trautz [25] proposed an Approach towards robotic mechanical weed regulation in organic farming, particularly for carrot cultivation. For that purpose the autonomous agriculture robot 'BoniRob' is utilized which is the result of a predecessor project and which allows an 'App'-concept with changing sensor/actuators arrangements to cope with different use cases. The perception and navigation system is based on semantic localization. It enables adaptation to different environmental conditions encountered in typical tasks. The paper illustrates how this system is going to be employed for the task of mechanical weed control. Additionally, the system architecture is described including means to increase robustness and preventing undesirable system conditions. In order to ensure a robust task fulfillment in weed control, a new approach is proposed which combines an efficient collaboration of the autonomous robot with human interaction via immersion technologies. The weed manipulator is designed to operate in real world environment satisfying the requirements of speed and accuracy. A parallel-kinematic structure enhanced by computer vision was proposed to cope with the requirements.

An effort to model the agriculture yield forecast is made by Chandrahas[26], an ex-Principal Scientist from Indian Agricultural Research Institute, New Delhi. The model uses Biometrical Characters. No satisfactory model which has universal validity exists till date. Various organizations in India and abroad are engaged in crop forecasting studies. In India yield forecasting is mainly based on judgement and final crop production estimates. The authors used statistical methodology for crop forecasting using measurements of biometrical characters.

Guillermo A. Baigorria, James W Jones and James J.O Brien [27] presented work on coming up with predictive model using a regional climate model. This model uses twenty ensemble members of 18 year periods provided by the Florida State University/Centre for Ocean Atmospheric Prediction Studies that were outputs from a regional spectral model coupled to the National Centre for Atmospheric Research Community Land Model. Authors claim that prediction accuracy obtained with their model was much better than earlier models.

III. CONCLUSION

This paper reviewed the work of researchers and the techniques applied in various areas of agriculture such as autonomous agricultural vehicles, land degradation, disease forecasting, biodiversity, food safety engineering, estimating soil features, available water capacity, machine vision of plants, food processing, crop yield modeling, quality and safety inspection of food and agricultural products, optimization of in-field water harvesting, decision support system for precision agriculture application. Many research challenges exist in the agriculture domain, especially in the IT front. Our study reveals that there is a scope for further research for soft computing techniques in agricultural and food domain. We would like to explore ways of applying these techniques in Indian agricultural context.

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