ABSTRACT

Developments in Information and Communication Technology (ICT) have brought a huge impact on the social and economic development of the world. In India, most of the rural community depends on farming for their lives. Modern farming practice is necessary to satisfy the food grain requirements of the growing population. ICT plays a vital role in imparting sustainable knowledge to farmers by offering a wide range of solutions to some of the challenges with an objective of improving the crop productivity.

The Wireless Sensor Networks (WSNs) is one of the enabling technologies and is successfully used for efficient and profitable precision agriculture. A sensor network is a highly distributed, self-organised system consisting of a set of battery-operated small sensor nodes. It is used to monitor the various location-specific parameters related to soil, crop and climate. The sensor nodes are mostly deployed in open and harsh environments and should operate in an unmanned manner for an expected duration. These nodes rely on battery power for their functioning hence energy efficiency is of paramount interest in these resource constraint networks. It is identified that the grid topology based sensor network is well suited for agriculture applications (Yu et al. 2006; Keshtgari et al. 2012). The various field-specific parameters collected by the sensor networks are reported to a base station (sink) for further processing. The data stored in the sink are used for the mission of soil moisture forecasting and sugarcane yield classification problems.

Sugarcane is one of the profitable and indigenous crops cultivated in India. Being a long-term irrigated crop, it does not need a specific soil type but needs a high water requirement. Therefore, adequate soil moisture should be available throughout the growing period, as the cane growth is directly proportional to the water transpired. This makes the research work discussed in this thesis to give primary focus to soil moisture forecasting along with

sugarcane yield classification problem. The sugarcane yield classification is given importance because of its immense use in the daily life.

This thesis contemplates certain propositions: Firstly, a soil moisture forecasting model is presented, which is based on two-level ensemble classifiers. Ensemble learning is a machine learning paradigm, where multiple learners are trained to solve the same problem. The proposed ensemble model combines the benefits of Radial Basis Function (RBF), Multi Layer Perceptron (MLP) and Support Vector Machines (SVM). The main intention of the proposed model is to predict accurately the future readings of the soil moisture data since it has great influence on crop growth and cultivation. The proposed model is applied on two different data sets and achieves the highest prediction accuracy of 83.52% and 89.53% than other single level classifiers used.

Secondly, an Adaptive Neuro Fuzzy Inference System (ANFIS) model for sugarcane yield classification process is put forth. This makes using the historical data of sugarcane yield. As the number of parameters influencing the sugarcane yield is identified as twenty, and results in a tremendous increase in the number of fuzzy rules. Therefore, a multilevel ANFIS model has been constructed. Next, the ANFIS parameters are trained using evolutionary algorithms, namely, Genetic Algorithms (GA), Particle Swarm Optimization (PSO) and Imperialist Competitive Algorithm (ICA). The results obtained show that the ANFIS trained with ICA convergence faster than GA and PSO.

Subsequently, a decision support system based on human knowledge and experience, called fuzzy cognitive maps (FCM), is adopted for sugarcane yield classification problem. A cognitive map is a mental model of the external environment that is constructed according to exploratory behaviour, whereas the fuzzy cognitive maps represent cognitive models in the form of fuzzy directed graphs. FCMs are well suited to represent relatively unstructured knowledge and causalities expressed in imprecise forms. In the FCM, the historical data and the casual association of various yield influencing parameters are

established by domain experts. Training and learning of the model both on the basis of historical data and cognitive model with inter relationships of concepts captured as weights between links. The FCM has been trained using the Hebbian-based learning approach (FCM-DDNHL), evolutionary approach (FCM-GA) and the proposed hybrid learning approach (FCM-DDNHL-GA). Superior results are obtained with the proposed hybrid model in terms of classification accuracy and per class accuracy. FCM has the ability to learn with a smaller data set and serves as a guide in determining the right decision about the class of yield.

The outcome of the proposed models will support the agriculture farmers and farm officer by providing valuable information to attain higher yield.