Chapter 7

Conclusion and Future Work

Profitability and sustainability of agriculture is a need of the day. Optimum irrigation is one of the key aspects to achieve these. Web based expert system for agriculture system; KrishiSENSE (www.krishisense.org) is developed to help the farmers to take decision on irrigation scheduling. The first section of the chapter summarizes the contribution and concluding remarks of the research. The next section highlights the possible future extension of the presented research work. The thesis ends with the summarizing the further scope of the work in the proposed expert system and possible directions of research from this point.

7.1 Conclusion

The proposed expert system is based on the water balance approach for irrigation scheduling. Optimum irrigation scheduling will not only save the precious water resources but also improve the productivity. The web service also provides important information of current temperature, relative humidity and wind velocity of the concern farm. It also provides other important information regarding soil and crop. These are type of soil, available water capacity of the soil (AWC) and expected dates of various stages of the concern crop. The weather data provided by the portal help the farmers take important decisions for crisis management as well for farm management. To increase the accessibility, android based mobile application with similar functionality is also developed.

An accuracy of the water balance method for irrigation scheduling depends upon the accurate estimation of evapotranspiration rate (ET₀). The Hargreaves equation is most simplified equation
Chapter 7

to estimate ET$_0$. Limitation of the Hargreaves equation is its inability to estimate accurate ET$_0$ under extreme weather conditions. Fuzzy based calibration of the Hargreaves equation constants $C_H$ and $E_H$ (equation 4.4) for different climate conditions is presented. This is generalised and non experimental calibration method. As this method needs only few temperature and wind data to characterize the location, it has a potential to use for the locations where only temperature and wind data available. The method is verified on eight locations of India with diverse climate conditions and geographic locations. The results are presented in the form of comparison of evapotranspiration evaluated using Panman-Monteith equation, original Hargreaves equation and modified Hargreaves equation. The result confirms better accuracy with modified Hargreaves equation compare to the original Hargreaves equation. The proposed calibration method provides a successful solution of ever persisted problem of inaccuracy of Hargreaves equation and development of the location specific calibration method. It also takes care of wide variation in the climate condition of the specific location during a year.

To improve the usability of the method, it is successfully converted as a computer application. Fuzzy based computer program - ECALTOOL, for the calibration of $C_H$ and $E_H$ of the Hargreaves equation is developed and validated. The tool has a very rich library of about 1100 locations of 190 countries. The users just required selecting the country, location and season to arrive at accurate values of $C_H$ and $E_H$. The performance of the tool has been verified by the results of published calibrated values for varied climatic conditions. Provision is also given to get the values of $C_H$ and $E_H$ for the location which is not available in the library of the tool. In the true sense the ECALTOOL is a universal tool for the calibration of the Hargreaves equation. Correctness and consistency of the tool is validated by comparing the estimation of ET$_0$ through the values of $C_H$ and $E_H$ suggested by the ECALTOOL with the published values of $C_H$ and $E_H$ based on experimental calibration. The result reveals considerable improvement in the accuracy.
of $ET_0$ estimation. The proposed calibration tool is available as executable file, so it does not require any licensed software platform to use it. The features like ease of operation, free to use and universal coverage will surely make the ECAL TOOL a very useful computer application to the agricultural fraternity.

An expert system development in the modeling framework provides certain advantages. The modular approach helps to achieve upward scalability of the system in terms of more crops and its variety. Knowledge integration is decoupled process from the system development. The knowledge can upgrade or refine at any stage. An expert system must provide the facility to add or modify the knowledge base easily. This feature is carefully considered in the KrishiSENSE. One can easily add, edit, delete the crop and crop knowledge base through the user friendly interface available under the admin login.

7.2 Future Scope

At present, KrishiSENSE is planned with eight important crops of the Gujarat state. These are cotton, groundnut, castor, wheat, maize, rice, mustard, and bajara. The most popular varieties of these crops are considered to develop the knowledge base. Still more crops with the different variety can be added to the knowledge base and the system can be made useful for more crops and various locations of India.

The soil and its water holding properties are an important aspect for any irrigation scheduling. In the proposed system, the soil information is available as library within the system. As of now the soil characteristic is provided for 30 locations of the Gujarat state. An approximation is made as the nearby area of the location has similar soil texture and water holding properties. This assumption may lead to some error in few cases. There is a scope to integrate more accurate and precise location specific information of soil characteristics using GIS or geophysics databases.
Apart from irrigation scheduling, another important aspect of agriculture is pesticide management. The concept of weather based disease forecasting is briefly presented in chapter 5. There are some common data requirement for weather based disease forecasting and irrigation scheduling. It is possible to develop and to integrate full scale disease forecasting system within the proposed expert system.