Crop- Soil Data Management System Of Cropping Decision System

Sikander Singh cheema, Dr Amardeep Singh

Abstract: There are various cropping system models and decision support tools for different purposes in different countries. These models and tools are providing help to the farmers to grow crops in those areas. As the need grows for analyses on crop production and management, cropping system models and decision support tools are increasingly structured to provide the capability for area-wide simulation and analysis at different ranges. A major challenge is the development of a data management system that can provide dynamic access to the farmers for producing the good crop s so that farmers can get more benefits from production point of view. There is an expanded requirement for soil data that can be utilized for uses of crop. The target of this paper is to present a methodology to develop a Crop and Soil Data Management system that is capable of automatic selection of crop depending on the given soil data, and can provide dynamic access to the crop-soil data by cropping system applications.

Index Terms: Management, Crop, Soil, Database, System, Procedures.

1 INTRODUCTION

Agriculture scientists are ending up progressively for changeability in crop generation with the creating availability of yield screens. Every now and again this variability can be related to contrasts in soil properties (e.g. Texture, percentage of (Salt, Clay, and Sand), organic matter, salinity levels, Electrical Conductivity, pH, N, P2O5, K2O and nutrient status) inside the field [14]. To create administration ways to deal with address this changeability, soil properties should check according to the crop suitability. Some soil properties have been connected specifically to a soil phantom reaction or deduced in light of remotely detected estimations of product shelters, including soil texture, nitrogen level, and organic matter content, and salinity status. Computer simulation models have recently become more common and acceptable for impact assessment studies and for supporting policy decisions on different temporal and spatial scales. Soil data are in high demand as inputs for running simple to complex models. That is why soil is very important factor to check the production of different crops. The procedures of soil development over scenes, along with administration prompted soil changes, have created soil varieties inside cropped fields that effect crop production [4]. Yield checking has shown to agriculturists that a significant part of the yield inconstancy inside fields is related with soil and scene properties [8]. Various soil properties impact the reasonableness of the soil as a medium for establishing. A portion of these vital properties incorporate soil water holding limit, texture structure, natural issue, pH, fertility, soil depth, the presence of prohibitive soil layers, and the amount and dispersion of crop residues [18]. These properties are mind boggling and shift spatially and transiently inside fields.

- *Assistant Professor, Department of Computer Science & Engineering, Punjabi University,Patiala,Punjab,India. Sikander@pbi.ac.in*
- *Professor & Head, Department of Computer Science & Engineering, Punjabi University, Patiala, Punjab, India, amardeep_dhiman@yahoo.com*

Objectives of this work are:

1. To limit the expenses of fertilizing for crops by selecting suitable soil for that crop from crop-soil database.
2. To maximize the expected return by crops for the particular soil.

Each crop needs particular types of soil nutrients [1]. Ideal treatment and liming esteems rely upon crop necessities and soil test outcome. This implies for an ideal yield, each product soil mix may have an alternate soil treatment cost. The soil investigation considered in this paper gives a complete database of soil properties (physical and chemical properties) for the different crops. Ranch supervisors need to manage numerous clashing targets when arranging which crop to develop. Baidu (1999) states that soil qualities are critical while deciding yield potential. Treatment and liming are generally used to adjust soils to the dietary necessities of the crops to be developed. Planting the crop that will the best fit the soil qualities is a fascinating contrasting option to limit the requirement for soil treatment, decreasing expenses and potential ecological harms. Furthermore, ranchers typically search for speculations that offer the best potential profit with the slightest conceivable dangers. As to goals to be viewed as, the crop determination issue might be hard to comprehend utilizing customary instruments. Therefore, this work will propose a database for crop and soil mapping, and further by developing a GUI based application one can use this for the selection of a crop based upon the soil properties.

2. MATERIAL AND METHODS

2.1 Database Description

Agricultural science provides information about soil components for each crop. So from this given information one can predict the suitable crop for a particular soil. Farmers can make the soil components suitable for crops by adding fertilizers also but parallel to that cost of production will also be increased, so farmers have to take care during selection of crops for the soil [2]. Electrical

Conductivity property of the soil is a major deciding factor in the production of a crop [21]. Planting Depth values is very important factor from production point of view [20]. Detailed values of the soil's chemical properties like Nitrogen, Phosphate, and Potash are taken from the paper written by David [10]. Texture is a main component of the soil and depending upon the type of texture one can do the division of the areas [3]. Selecting which crops to produce is one of the most important decisions faced by farmers. Farmers must know how to use risk management strategies to select the crops that best suit their needs. One of the most popular approaches to managing risk is to reduce risk exposure through diversification. For many agricultural producers this strategy leads to growing a number of crops that differ in their production and marketing characteristics. However, methods which lower risk generally reduce expected net returns [25]. Thus, it is important to account for the risk tradeoff when selecting the soil to grow the particular crop. In particular, growers often need to decide "how much diversification is enough" to capture most of the potential gains from expanding their enterprise mix. The effects of diversification, reflected in the relationship between absolute risk levels and the number of crops included in a portfolio as explained by Barry [5]. In other words, most possible risk reduction is achieved by including a few products in a portfolio. This means that adding another crop to an existing rotation or creating an entirely new portfolio may or may not be an effective risk management strategy. Various studies most often have used linear or nonlinear programming procedures to identify optimal crop portfolios for a particular case. Although risk programming approaches lead to theoretically optimal portfolios, there are practical limitations to the use of these methods by agricultural producers [15].

2.2 Crop-Soil management

So in this way when farmers will go to grow any crop then first they will check possibility of that particular crop in that soil by comparing the crop with the soil components. After checking the values of soil components one will put those values in the system and system will suggest the suitable crops in a particular order according to the given values with the help of software. In this way when a farmer will go for the best suitable crop for soil then that crop will need less input of fertility for the production and more yield will be. By using this method farmer will save money by selecting the suitable crop for the particular type of soil and different crops will be grown by farmers in different types of soil. So in this way crop diversification mechanism can be achieved. Development zones are typically partitioned in sections of land, every one turning into a creation unit. Consistently agriculturists need to choose what to plant in every section of land [24]. This requires the examination of trade-offs between speculations that must be made, expected benefits, and natural impacts of development. Economical agricultural soil utilizes the land accessible for cultivating as profitable as could be allowed while considering the ecological effect of the development procedure [6]. Under common conditions, soils present chemical limitations for crop improvement. Chemical soil tests are utilized to give data about acidity and supplement levels of each land section of land. Value of soil pH is very important to check the acidity of the soil. Soil pH is a measure of the acidity and alkalinity in soils [17]. Soil pH levels range from 0 to 14, with 7 being neutral, below 7 acidic and above 7 alkaline [9]. The optimal pH range for most plants is between 5.5 and 7.0. Soil pH is simply a measure of how acid or alkaline a substance is, and soil acidity or alkalinity is important because it influences how easily plants can take up nutrients from the soil [22]. As per the necessities of crops to be developed, it is regular to update soil chemical attributes, changing the amount of supplements and sharpness through preparing and liming, making beneficial agribusiness conceivable yet influencing the nature of soils, groundwater archives, and the general condition. Moreover, financial limitations may oblige agriculturists to utilize little amounts of mineral manures or not, making it important to utilize the supplements accessible in the soil as productively as would be prudent [16]. Consequently, deciding the crop that best fits the chemical attributes of every generation unit is a fascinating contrasting option to diminish the cost of soil treatment in the meantime as limiting the potential biological harms. Then again, agriculturists need to develop crops with the most ideal return and least monetary hazard under an arrangement of conceivable situations. So farmer has to select such a crop which suits best for that particular soil so that minimum fertilizers and other chemicals should use, in this way farmer will be able to get good income with less investment. The ideal utilization of soils is the premise of all types of maintainable land utilize, that is, farming area utilize that remaining parts gainful in the long haul. There are numerous advantages of an ideal utilization of soils, for example, a decline of rustic neediness, watershed assurance, and expanded biodiversity, more feasible agrarian generation, and expanded sustenance security. Subsequently, ideal soil utilize arranging is a vital issue with social, monetary, and natural ramifications [23]. As to soil attributes, the product development cost is considered to have a fixed and a variable cost part. Fixed expenses for a product are those that are not impacted by chemical attributes of the section of land, for instance, the cost of furrowing, bug spray application, collect picking, and reap pulling [13]. Then again, variable costs are those identified with the soil treatment that should be made to acquire the greatest yield of a given crop and shifts as indicated by the supplements and pH levels of the soil. A fixed cost is utilized to store fixed cost estimations for each product. Variable cost can be decreased by selecting the suitable soil. Soil treatment cost is straightforwardly identified with the measure of fertilizer and correctives that should be utilized. Along these lines, minimization of this cost suggests a diminishment of the measure of fertilizers and correctives to be cost of a given development technique is acquired by adding every one of the costs identified with the grounds designation of crops [7]. Homestead chiefs need connected, which thus lessens the natural effect of the development procedure. The aggregate venture to manage issues, for example, crop choices and their nourishing necessities, creation costs, chemical attributes of every section of land and the potential monetary situations. Considering these issues all the while makes the crop choice issue hard to break down with basic instruments. So crop-soil database will be an important tool for selection of appropriate crop. It will be beneficial for the farmers and agriculture scientists to predict the appropriate crop based

upon the database. Agricultural research and development (R&D) organization required a robust automated system for data collection, management, and analysis of crop seeds, for this database of crop-soil will be helpful [11]. It is important to estimate crop production for various policy decisions relating to storage, distribution, pricing, marketing, import-export, etc. One can apply various techniques to develop an application which can use the crop-soil database to give good results through graphical user interface. Food shortage has been among the most threatening problems to the world since the beginning of the new century [12]. A major premise of making right decisions is the ability to accurately assess crop growth and food supply, and a scientific decision-making process to provide appropriate strategies or counter measures based on them. This can be accomplished by using the decision support system (DSS) that provide accurate and detailed information about crop growth and food supply. Decision support system can be built by using the database like crop-soil database. The application of decision support system (DSS) in the fields of agriculture provides a new and efficient method for improving the management of regional food production mode and decision-making on the prediction of new crop. To develop a decision support system, it need detail description of database with embedded application. Author's future work will be to develop a decision support system by designing as application in any programming language with the crop-soil database. In the next section outline of all the proposed tables which will be use in the crop-soil schema are explained. These tables will contain detailed description of the tables with all the attributes. Star schema will be used by the authors to show description of the tables.

3. DATABASE ORGANIZATION

3.1 Database schema

A relationship of all the attributes which are used in the tables are shown in the below mentioned Fig. 1. There are total four tables which are used to keep record of crop and soil parameters.

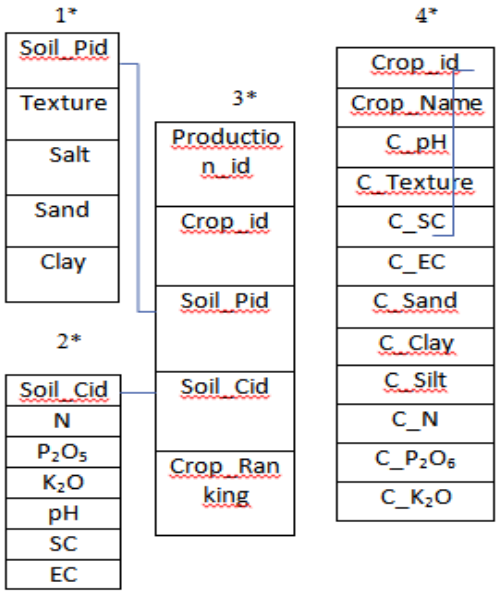

Fig. 1 *Star Schema of Crop-Soil database*

1* Soil_Physical Table
2* Soil_Chemical Table
3* Production Table
4* Crop_Type Table

As shown in the Fig. 1, star schema of the Crop-Soil database tbl_Crop_Production (Production) is the fact table and tbl_Soil_Che_type (Soil_Chemical), tbl_Soil_Phy_type (Soil_Physical), and tbl_Crop_Type (Crop_Type) are dimension tables.

Soil_Physical: tbl_Soil_Phy_type
(Soil physical properties)

Description	This table contains the details of the soil having physical properties
Primary Attribute	Soil_Pid
Attributes	Texture, Salt, Sand, and Clay

Soil_Chemical: tbl_Soil_Che_type
(Soil chemical properties)

Description	This table contains the detail of soil having chemical properties
Primary Attribute	Soil_Cid
Attributes	pH value, N (Nitrogen), P_2O_5 (Phosphate), K_2O (Potash), SC (Salinity Class), EC (Electrical Conductivity)

Crop_Type: tbl_Crop_Type

Description	This table contains detail of the crops with soil requirement
Primary Attribute	Crop_id
Attributes	Crop_Name, C_pH (Crop pH value), C_Texture (Crop Texture), C_EC (Crop Electrical Conductivity), C_SC (Crop Salintiy Class), C_Sand (Crop Sand), C_Clay (Crop Clay), C_Silt (Crop Silt), C_N (Crop Nitrogen), C_ P_2O_5 (Crop Phosphate), C_ K_2O (Crop Potash)

Production: tbl_Crop_Production

Description	This table contains the sequence in the descending order of suitable crops for the particular soil.
Primary Attribute	Production_id
Attributes	Production_id, Crop_id, Soil_Pid, Soil_Cid, Crop_Ranking.

In the above mentioned tables, there is complete detail of the parameters used in the crop-soil database. Soil_Physical table having name tbl_Soil_Phy_type used to store the values of the physical properties of the soil like Texture, Salinity Class, Electrical Conductivity, Salt, Sand, and Clay etc. this table will give the detailed information of the soil from physical parameter point of view.

Soil_Chemical table, with name tbl_Soil_Che_type is used to keep the record of all the chemical properties of the soil where a farmer is going to grow the crop. It includes the parameter like soil pH value, Nitrogen, Phosphate, Potash. Crop_Type table with name tbl_Crop_Type is used to store the complete detail of the crop and the required values of the soil suitable for that crop. This table includes the parameters like Crop_Name, Crop pH value, Crop Texture, Crop Electrical Conductivity, Crop Salinity Class [19], Crop Sand, Crop Clay, Crop Silt, Crop Nitrogen, Crop Phosphate, Crop Potash. Last table Production table named tbl_Crop_Production will predict the naming of the crops in the descending order which will give good production according to the given values of the soil parameters. Attributes of this table are Production_id, Crop_id, Soil_Pid, Soil_Cid, and Crop_Ranking. Crop ranking field will give the details of the suitable crops for the particular soil. During designing of the tables in the database every field will be mandatory because each and every field of the soil is very important from the crop prediction point of view.

3.2 Inputs and output

In this proposed work all the parameters of the soil (Chemical &Physical parameters) will be input for deciding the suitable crop. First a framer will test soil in the soil laboratory, after this he will get a report having the value of the soil parameters which are required for the good production of crop. In this way next step will be to feed these values in the software, where all the soil's parameter values will be compared with the suitable value of the soil (calculated values of the soil parameters according to the crops) and if the values are near to the calculated values then mark that parameter's value 1 otherwise depending upon calculated and given parameter's the values its value go far from one to give weightage according to the parameter's value. After calculating the values of all the parameters, do the summation and then compare with different crop's values, and depending upon the weighted value the largest weighted values crop will be on the top and according to this values all the crop's output will be in the descending order. So from that list a framer can decide for the crops which are on the top in the list.

$$S = \sum_{n \in k}^{k} \text{Individual Soil Parameter}'\text{s Weight value}$$

Now value of S is compared with the calculated value of soil parameters corresponding to the crops. Depending upon the compared values one will make a list of crops in descending order and according to this list a farmer will go to grow the suitable crop based on the soil's condition. In this way production of crop will be more when one will go with the best combination of soil and crop. So farmer can go for different crops and if an area has less ground water then in that area farmer can avoid paddy crop. So crop diversification is possible by applying this concept. The future profit of a given crop in a section of land is dubious and in addition the last yield and offering cost. This work presents an optimization framework based on crop soil database to aid decision making in difficult crop-selection problems. It is essential to stretch out the framework to consider crop diversification. It will give a timetable of crops to be planted in back to back periods. As was demonstrated it is vital for some agrarian models to exchange diverse crop writes in the same or nearby sections of land in back to back periods yet in addition to consider the employments of different assets. Issues to consider in revolution incorporate confinements about crops to be planted in progressive seasons and the utilization of cover crops between primary harvests. Plus, it is essential to consider nitrogen administration since bug harm can be diminished by staying away from abundance nitrogen levels.

4. INVESTIGATION AND FINDINGS

This crop-soil database will be very helpful to the Indian Punjab to predict the crops for the particular type of soil. As the crop diversification is the demand of time, so if farmers will go for a particular crop then it will affect the production of the crop as well as bad impact on the fertility of the soil. So it is the major necessity for the environment to rotate the one crop after the other to save the soil and farmer's economic condition. From the crop-soil database, it is very easy for the local farmer to predict the crop for his soil, in this way he can grow different types of the crops and will save the ground water and soil fertility. Database will contained the crops record, from this given record, a farmer after getting the report of his soil, can compare that report's parameters with the given crop-soil database and on the basis of that he can predict the crop for that season in that soil. In the output, a list of crops will be there in the descending order according to the production of the crop for a particular type of soil. This database will be helpful to break the paddy-wheat chain. Now a day paddy-wheat chain is very dangerous to ground water and for soil fertility. By using these strategies mentioned in this paper the procedure to select the crops according to the soil components will enhance soil utilization, lessen development costs, limit monetary dangers, expand the financial return, modify treatment use to a given spending plan, and limit the natural effect of the development procedure. Likewise, by utilizing these proposed procedures in this paper may enable farmers to wind up better educated about the distinctive other options to choose the proper crop.

5. CONCLUSION AND FUTURE WORK

Although considerable progress has been made towards designing the crop-soil database, this will be very helpful when one can design a GUI application to access the choice of the crop by feeding soil's parameters in that application. In this way it will be very easy for the farmers to predict crop with the help of the software. Other existing crop soil mapping techniques can also be used with the proposed one to check the effective implementation of this. As we discussed earlier, the diversity of the crops will increase by using required database. We intend to carry out this development as one of our future research directions. In addition, the interaction of different variables of soils corresponding to the crop can be analysed.

References

[1] Adesina, A.A., & Zinnah, M.M., "Technology characteristics, farmers' perceptions and adoption decisions: a Tobit model application in Sierra Leone.", Agricultural Economics, 9: 297–311, 1993

[2] Adviento-Borbe, M.A.A., J.W. Doran, R.A. Drijber, & A. Dobermann, “Soil electrical conductivity and water content affect nitrous oxide and carbon dioxide emissions in intensively managed soils.”, Journal of Environmental Quality, 35:1999-2010, 2006.
[3] Arshad, M.A., G.M. Coen, “Chracterization of soil quality: Physical and chemical criteria.”, Amer.J. Alternative Agric, 7:25-31, 1992.
[4] Baidu-Forson, J., “Factors influencing adoption of land-enhancing technology in the Sahel: lessons from a case study in Niger.”, Agricultural Economics, 20: 231–239, 1999.
[5] Barry, P. J, “Capital Asset Pricing and Farm Real Estate.”, Amer. J. Agr. Econ., 62:549-53, 1980.
[6] [6]. Coelli, T.J., & Fleming, E., “Diversification economies and specializationefficiencies in a mixed food and coffee smallholder farming system in PapuaNew Guinea.”, Agricultural Economics,31: 229–239, 2004.
[7] [7]. Coelli, T.J., Rahman, S., & Thirtle, C., “Technical, allocative, cost and scaleefficiencies inBangladesh rice cultivation: a non-parametric approach.”, Journalof Agricultural Economics, 53: 607–626, 2002.
[8] [8]. Consuelo C. Romero, Gerrit Hoogenboom, Guillermo A. Baigorria, Jawoo Koo, Arjan J. Gijsman, & Stanley Wood.”Reanalysis of a global soil database for crop and environmental modeling.”, Environmental Modelling & Software, 35: 163- 170, 2012.
[9] [9]. Chapter Soil pH in the CropNutrition Mosaic from http://www.cropnutrition.com/efu-soil-ph
[10] [10]. David H. Hardy, M. Ray Tucker, & Catherine E. Stokes. “Crop Fertilization Based on North Carolina Soil Tests, Circular No. 1”, published by N.C. Department of Agriculture, and Consumer Services, Agronomic Division, Colleen Hudak-Wise, Director, Steve Troxler, Commissioner of Agriculture, Feb 2014.
[11] 11]. Department of Agriculture and Fisheries from https://www.daf.qld.gov.au/business-priorities/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting
[12] 12]. Home & Garden Information Center from http://www.clemson.edu/extension/hgic/plants/vegetables/crops/hgic1315.html.
[13] 13]. Islam, K.R., & R.R. Weil, “Soil quality indicator properties in mid-Atlantic soils asinfluenced by conservation mamagement.” J. Soil Water Conserv, 55: 69-78, 2000.
[14] 14]. Iqbal, J., Thompson, J.A., Jenkins, J.N., Owens, P.R. & Whisler, F.D. “Spatial variability analysis of soil physicalproperties of alluvial soils, Soil Sci. Soc.” American. J., 69:1338-1350, 2005.
[15] King, R. P., & D. W. Lybecker.”Flexible, Risk-oriented Marketing Strategies for Pinto Bean Producers.” West. J. Agr. Econ., 8: 124-33, 1983.
[16] Maas and Grattan. Crop salt tolerance data from http://www.fao.org/docrep/005/y4263e/y4263e0e.htm, 1999.
[17]]. Patriquin, D.E., H. Blaikie, M.J. Patriquin, & C. Yang., “On-farm measurements of pH, electrical conductivity, and nitrate in soil extracts for monitoring coupling and decoupling of nutrient cycles.” Biol. Agric. Hortic., 9:231-272, 1993.
[18] Planting Depth Effects on Corn Stand and Grain Yield from https://www.pioneer.com/home/site/us/agronomy/library/planting-depth-and-stand-yields.
[19] Richards, L.A. “Diagnosis and improvement of saline and alkali soils.”, Agricultural hand book 60. U.S. Dept. of Agriculture, Washington D.C., 160 p., 1954.
[20] S. Sanusan, A. Polthanee, A. Audebert, S. Seripong & J.C. Mouret .”Growth and Yield of Rice (Oryza sativa L.) as affected by Cultivars, Seeding Depth and Water Deficits at Vegetative Stage.”, Asian Journal of Plant Sciences, 9: 36-43 from https://scialert.net/fulltext/?doi=ajps.2010.36.43, 2010.
[21] Smith, J.L. & J.W. Doran.”Measurement and use of pH and electrical conductivity for soil quality analysis.” P. 169-185 In J.W. Doran and A.J. Jones (ed.) Methods for assessing soil quality. Soil Science Society of America Spec. Publ. 49. SSSA, Madison, WI., 1996.
[22] The old farmer’s almanac founded in 1792 from https://www.almanac.com/content/soil-ph-levels
[23] University of Vermont Extension Department of Plant and Soil Science from http://pss.uvm.edu/ppp/pubs/oh34.htm
[24] Von Lücken, C., & Brunelli, R. “Crops Selection for Optimal Soil Planning using Multiobjective Evolutionary Algorithms.”, In Proceedings of the Twentieth Innovative Applications of Artificial Intelligence Conference, 1751–1756. Menlo Park, CA: AAAI Press, 2008.
[25] Weimar, M., & A. Hallam, “Risk, Diversification, and Vegetables as an Alternative Crop for Midwestern Agriculture”. N. Cent. J. Agr. Econ, 10:75-89, 1988.