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Development of Software "Cropsuit" for Evaluating Land Suitability for Different Crops

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ABSTRACT: A computer software (CropSuit) was developed for evaluating agricultural lands to assess their suitability for a particular crop. Soil site suitability criteria developed by NBSS&LUP for crop planning was taken as the basis for software development. The software takes the required inputs from the user for the given crop. Land evaluation involves matching of climatic and soil site characteristics with the requirements of crops and rating of these parameters as highly suitable (S1-with no or slight limitations), moderately suitable (S2-modarate limitations) and marginally suitable (S3-severe limitations) and unsuitable (N) classes. The results can be linked to Geographical Information System (GIS) to generate suitability maps of the study area. The program developed was tested across southern states and found to give valid results.

Key words: Software, land evaluation, land suitability assessment, GIS

INTRODUCTION

Crops and suitability analysis can be considered as a prerequisite to achieve optimum utilization of the available land resources for sustainable agricultural production. Land suitability analysis is the process to find out whether the given land resource is suitable for a specific crop or not. Land suitability analysis for sustainable crop production involves the interpretation of data relating to soils, vegetation, climate etc (FAO [2], 1976). Land evaluation using a scientific procedure is essential in assessing the potentials and constraints of a given land parcel for agricultural purposes (Rossiter [5], 1996). Various approaches of land evaluation have been developed, and each has a specific methodological procedure with strengths and weaknesses depending on the situation (Riquier *et al.* [4], 1970; FAO [2], 1976). The main objective of land evaluation is to appraise the potential of land for alternative kinds of land use by a systematic comparison of the requirements of the land use with the resources offered by the land (Dent and Young [1], 1981). In this study an attempt has been made to develop a software for assessing the suitability of crops for different areas for which land resource inventory information is available.

METHODOLOGY

Soil site suitability criteria developed for crop planning (Naidu *et al.* [3], 2006) was taken as the basis for software development. The land evaluation involves formulation of climatic and soil site criteria and matching these with requirements of crops and rating of these parameters as highly suitable (S1-with no or slight limitations), moderately suitable (S2-modarate limitations) and marginally suitable (S3-severe limitations) and unsuitable (N) classes. The crop requirements are matched with the land qualities of each mapping unit of study area to arrive at land suitability class. The table 1 summarizes the list of important land qualities considered and relevant land/soil characteristics.

Soil-Site suitability criteria for crops

Each crop requires specific soil-site conditions for its optimum growth. For rationalizing land use, soil-site suitability criteria for different crops need to be

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Table 1
Important land qualities and related characteristics

Land quality	*Land /Soil characteristics*
Temperature and light energy for plant growth	Temperature (Max. and Min.), sunshine hours and day length
Moisture availability in crop growing season	Rainfall, RH, frost, PET, Soil depth and texture
Root development and anchorage	Soil depth, texture in root zone, structure and hard pans
Oxygen availability to roots	Drainage, depth of ground water table, frequency and period of flooding, moisture retention capacity of soils.
Nutrient availability in root zone	Organic matter, CEC, base saturation, NPK status and pH.
Sensitivity to Soil toxicity	pH, salinity, sodicity, $CaCO_3$, Al and heavy metals.
Workability and management	Slope, surface stoniness/rockiness

determined and models developed for guiding the farming community to grow most suitable crop(s), depending on the suitability/capability of each mapped soil unit for a given area.

The adaptability of crops in one or the other area is the interaction between existing edaphic conditions and fitness of the genotype under these conditions. Although, huge data on crop production and agronomic management responses have been generated through experimentation by the SAU's and Crop Research Institutes, yet it has not been correlated with sufficient data base on the soil-site conditions in order to work out soil-site suitability models for optimizing land use in the country.

Crop Growth Requirements

Plant growth requires favourable temperature and moisture regimes and nutrient supply, linked to a sufficient rooting depth and a good energy regime for photosynthesis and biomass production. Crop productivity and profitability of agriculture are to a large extent also determined by field preparation and harvesting conditions, a workability-trafficability factor may also need to be considered for some land utilization types.

Crop growth requirements are specific and may therefore differ from crop to crop, and even from cultivar to cultivar. These crop requirements are not always directly measurable in the field and may need to be derived from other observations. These characteristics refer mainly to climate, soil-related parameters and landform data which are available in land/soil resource inventories prepared by National Bureau of Soil Survey and Land Use Planning/ All India Soil and Land Use Organizations for different regions.

Matching Crop Growth Requirements with Environmental Data

The matching operation consists in comparing climatic, soil and land form requirements with individual crop growing conditions for each agro-climatic zone. Results are expressed in terms of suitability classification.

The matching exercise includes two steps, dealing in turn with a climatic and a soil-physiographic evaluation. Initially, the overhead climate of the soil units concerned is compared with that of the crop requirements. The specific soil and crop-linked growing season is calculated, using rainfall data, in particular consumptive use of water of the plant as obtained from the calculated PET, the crop coefficient and the soil moisture storage capacity.

The second step in the matching procedure refers to the comparison of the individual soil and land form properties of the soil units with specific crop requirements in terms of rooting depth, susceptibility to toxic elements, nutrient supply and trafficability/ workability. On the basis of the degree and number of constraints identified, a suitability classification may be established, into four classes viz., Highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and unsuitable lands (N). S1 class correspond to areas, which have a yield potential of above 80% of the maximum attainable harvest yield within the climatic area. The yield levels drop to 50% and 20% for classes S_2 and S_3 respectively.

DESCRIPTION OF SOFTWARE

The software was developed using Microsoft ACCESS. The software is user-friendly, menu driven and intuitive. The software architecture is described using flow chart Fig 1.1 and Fig 1.2. Suitability input options will enables based on the selected crop other parameters not relevant for the crop will disabled.

Data Management and program structure

Data management has been designed using MS ACCESS. Fig. 2 gives the entity-relation (ER) digagram and Fig. 3 gives the relationship between tables. It is user friendly menu driven software Fig 4

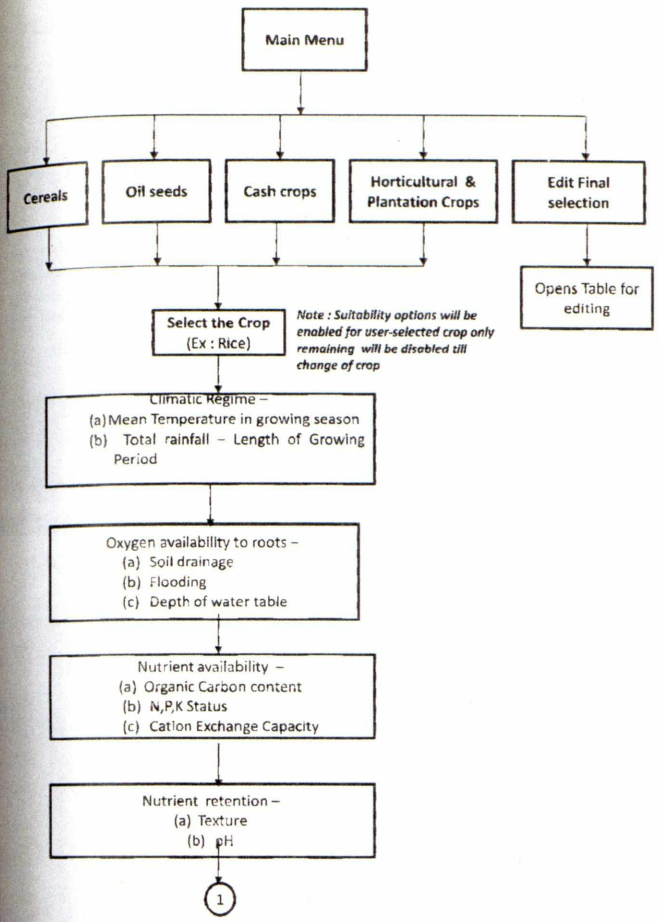

Figure 1.1: Program flow chart

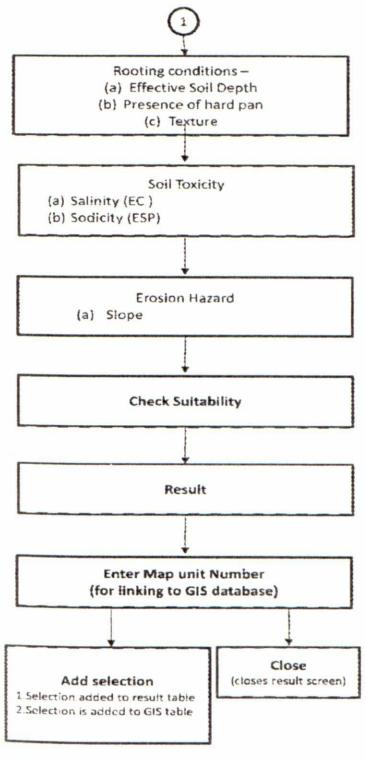

Figure 1.2: Program flow chart

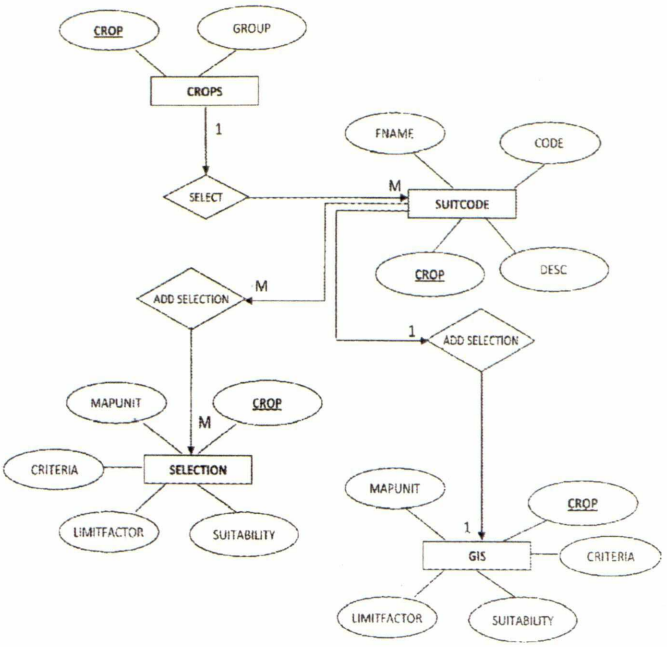

Figure 2: Entity-Relation (ER) diagram

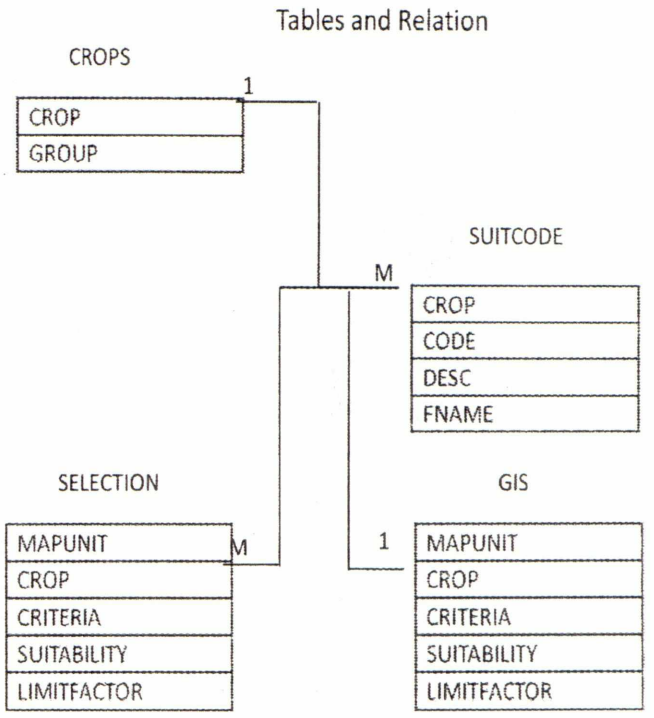

Figure 3: Data base tables and their relation

shows Main menu of suitability evaluation software. The user has to select one of the option.

For example if the user selects the option 'Cereals' then he will be presented with the next screen (Fig. 5).

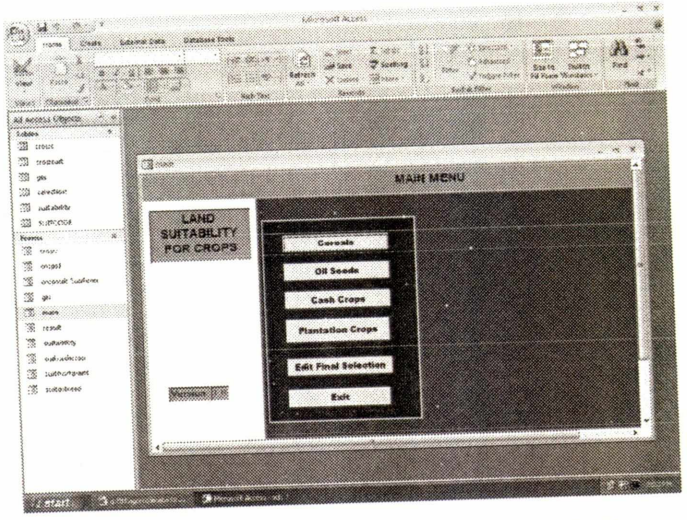

Figure 4: Main menu of the Land suitability evaluation software

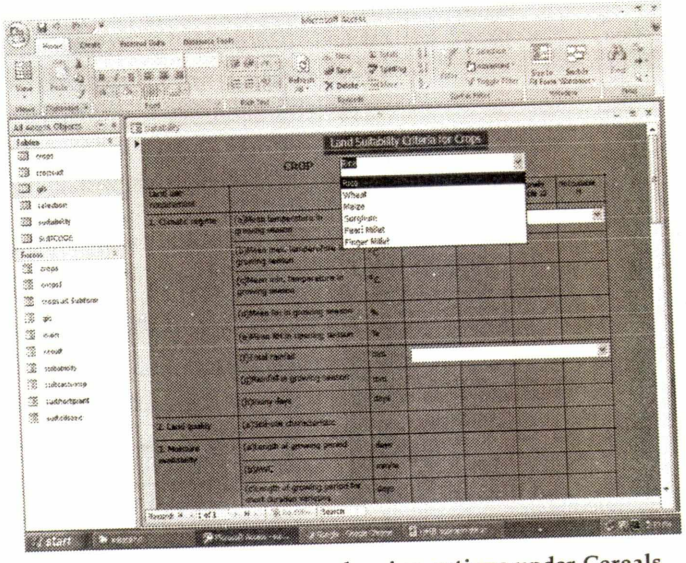

Figure 5: Computer screen showing options under Cereals

In the above screen the user has to select the crop for suitability evaluation then only the options required for that crop will be activated for example after selecting 'Rice' crop the criteria options for Rice crop will be displayed (Fig. 6).

After selecting the required options for the crop the software will show the suitability for each parameter and also the overall suitability (Fig. 7).

If the user is satisfied with the results and he want to add the results to a table which can be linked to GIS, then he has to select the option 'Add selection'. The result will be added to the table named 'GIS' which can be linked to map using standard procedures in GIS to join/relate attribute data to the map.

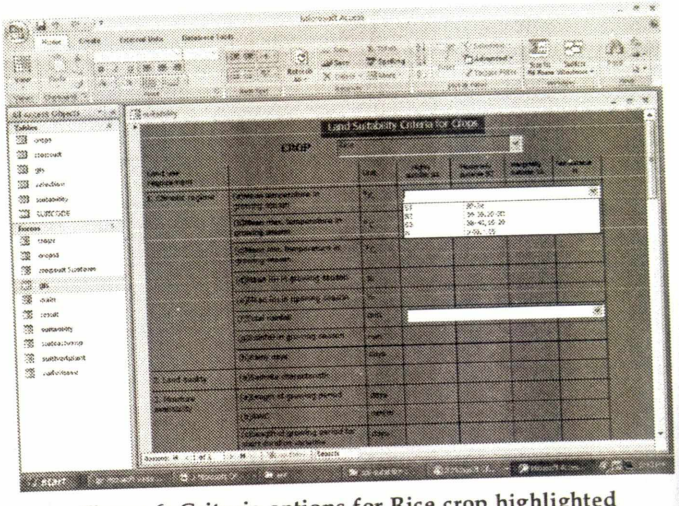

Figure 6: Criteria options for Rice crop highlighted

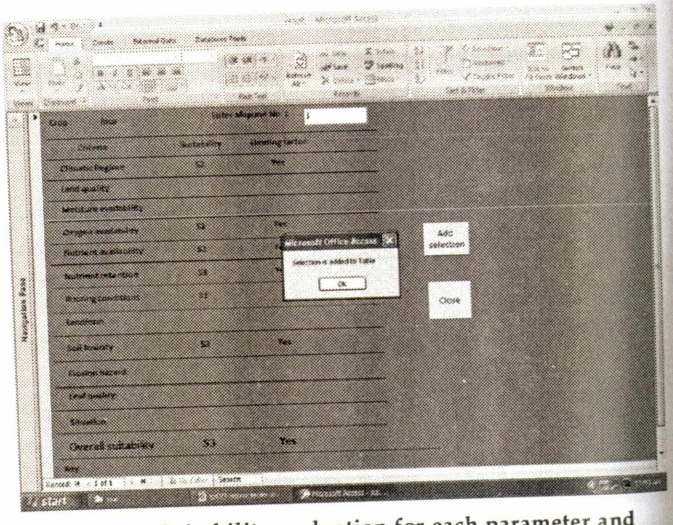

Figure 7: Suitability evaluation for each parameter and overall suitability

SUMMARY AND CONCLUSION

The present **"CropSuit"** software covers five cereal crops namely rice, wheat, maize, sorghum and finger millets, two oil seed crops (groundnut, sorghum), two cash crops (cotton, jute) and two plantation crops (coconut, areca nut) were studied. The software developed for different crops was tested for different districts and watersheds of Southern India and found to give satisfactory results. Efforts are on to extend software to include other crops and subclasses to reflect the kind (s) of limitations that need different management measures within class (S1,S2 or S3) will be included in future versions.

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