

GIS Involved Automation of Agriculture Land, Punjab Province, Pakistan

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ABSTRACT

Agriculture for centuries is the mainstay of many countries especially in South Asia region. But with the passage of time, efficiency of soil decreases, resulting in the low production of crop or diminution of quality exceedingly. Spatial distribution and variation characteristics of soil fertility by application of geographical information systems (GIS) provide the better understanding about the soil through visualization. In developing countries like Pakistan population is increasing as stone rolling from a steep hill, the major task of recent era is to feed them. It is the hour of need to add latest technologies and techniques to estimate and enhance the power of yield. So, current scenario involves information technology to resolve our issues and better decision making on higher and farmer level. This paper represents the revolutionary step taken by the government of Punjab, Pakistan under the organization SFRI (Soil Fertility Research Institute) through a project named as "DDPLA" (Development of Digitized Profile of Land for Agriculture in the Punjab Province) which includes the soil surveying, sampling techniques and spatial database development for Punjab Province Pakistan. Efforts are made to computerized legacy system data to ensure durability and long lasting results of soil analysis to benefit particularly farmers and also educational institutes, government departments, Agriculture Organizations, researchers and any other personnel who is interested in agriculture. Chief tasks of the paper are spatially identification of focused area (Punjab Province, Pakistan) at tehsil level, collection of soil samples, their laboratory analysis, and analytical process on the resultant data and finally the storage of gathered data in well designed spatial database for Web Application. Three by three square kilometer grid is formed for the collection of soil samples all over the Punjab at tehsil level and at least four samples were collected from each grid for the interpretation of soil physical and chemical properties. Database development is the hub for all agriculture stakeholders, decision makers and scientists for improvement of agriculture yield. Without proper data stored in compatible database one cannot prepare a sustainable desktop or Web application. Hence special attention is given to spatial database which will lead to successful data fetching on web.

Key words Agriculture, Land, Automation, Centralized data, DDPLA, Sampling, Spatial database surveying, Web Visualization.

1 INTRODUCTION

Since early era, human beings are using land for two Major purposes. Food and water are primary resources which we need for our lives, and are our utmost concerns when we are building a sustainable community specially to fulfill the needs of people which inhabit the society. Agriculture is on of the historical ways used by humans for the provision of food. Agricultural improvement and increase in annual yield is an important concern. Irrespective of the food source

whether it is farming, fishing, or dairy, everything should be managed in a balanced way. Specific crops should be grown in the area where they can produce at its peak, and for crop's maximum output, the soil in which seed is sowed needs special care and balanced amount of nutrients so it can produce best crop. People have used farming, hunting and fishing in a sustainable way. Presently the problem of hunger is becoming larger as the population increases and with that food

input

increases.

To keep the food sources balanced with the population growth we should be extra careful, so that the same bounty enjoy in our lifetime will be available to our

Shelter: Shelter is imperative for human beings survival. Human as well as animals need a place where they can rest, but which can also protect them from the sun, severity of weather and storms[1]. But our concern here is agriculture land. Provision of the database is very crucial in decision making and policy making to the stakeholders. In this age of Information Technology the development of database through the application of modern techniques is need of time. First time in Pakistan history, Punjab agriculture department-brought together all obtainable resources in the development of authenticated and reliable database.

Through this project accessibility to Web-GIS application has arranged and an intelligent system to identify difference between actual and potential crop yield is produced and a mechanism to create an automatic recommendation for controllable factors was also developed. Agriculture plays the role of pillar in Pakistan's economy. Almost 21% of Pakistan's GDP[2] depends upon the production of various crops. Pakistan earns about 80% from the export of crops[2], for this it is essential to enhance the quality and annual yield of crops. That's why with time various steps are taken for the betterment of agriculture field. For this farmer must be familiar with his land which he cultivates and put his life into. He must be aware of the deficiencies in his land soil due to which his crop fails to produce maximum yield.

Manifestly the world is affluent with soil data due to the efforts of soil surveyor's past generations[3], and greater part of this data is mostly unused [3]. Legacy soil data often come in the form of soil maps, Topographic sheets, soil profile descriptions, soil survey reports or in obsolete "card catalogue".

offsprings. We must treat soil in such a way which should enhance its fertility and must not leave the soil barren or with salinity.

In this Modern Era of Technology we are still dependent on file based system (legacy system), especially developing countries like Pakistan. Legacy System has lot of draw backs like data loss, data redundancy, poor data management, Data Security, decentralized data and absence of sufficient data in need of time.

With recent advances in computer technology, the ability for storing, manipulating, analyzing, and presenting spatial data has been greatly enhanced. It is now possible to handle vast amounts of spatial data in digital form. Digital soil data are stored in the form of soil mapping units with attached attributes [4]. Main focus of this paper is agricultural land soil and its properties. Soil is a central natural resource of a country and socio-economic development of its people depends upon it. Thus, soil is getting more and more attention due to rapidly declining land area for agriculture, declining soil fertility, increasing soil degradation, defective land use policy and irrational and imbalanced use of fertilizers [5].

The major objective of the paper is as under:

- Data Acquisition and Development of Spatial Database for soil-climate suitability for Crops, vegetables and fruits.

Quality of soil can be improved by putting special efforts in the enhancement of physical as well as chemical properties of soil. Several studies have discussed that soil properties vary across farm fields which causes spatial inconsistency in crop yields[6]. Precision farming management is aimed at controlling soil spatial variability by adding inputs in accordance with the site requirements of a specific soil and crop [6]. Major steps followed in project are described in Fig. 1.



Fig. 1. Project Flow Diagram

2 USE OF GIS IN AGRICULTURE

In agriculture production throughout the world GIS is playing a very helpful role by providing most suitable solutions for farmers to increase production of crops, reduce costs by applying fertilizers in a balanced ratio, and manage their land more effectively[7].

All sectors of the agriculture industry use ESRI's geographic information system (GIS) technology to share data, increase yields, predict outcomes, and improve business practices. By applying GIS technology to their operations, agricultural operations are able to manage resources and responsibilities more efficiently, devise data portals that disseminate vast amounts of agricultural data and interactive maps, and support farming communities. One Layer in a map of an agricultural area, might represent the boundaries of a piece of land whereas a second layer, soil types and third, the crop yield or a specific soil management[8].

In this era of Information and Computer Technology it is very important to bring agricultural management to new heights. In developed countries due to information technology solution of every problem is just one click away because of internet facility. For a long time, GIS is providing spatial solutions as well as suggestions for different agricultural problems by Remote sensing, statistical analysis on spatial data and by demarcation of sustainable agricultural area etc. With the help of Web-GIS every aspect of agricultural issue of any region is being solved with Maps, Graphs and user interactive functionalities at any time. So the farmer can complete his work more efficiently without wasting time and money. In Underdeveloped countries IT is an emerging platform through which relative information can be delivered to farmers, educational institutes, researchers and any other interested person.

In Pakistan Punjab Province contributes about 69%[2] in agriculture that's why always special importance is given for the enhancement of this field whether it's in tractor scheme, easy loan schemes for small area farmers or the availability of seed on reasonable prices and so on. From these efforts the most effective one is to automate agriculture data with the help of GIS facility on top of Internet period provide this information to general public.

3 DATA ACQUISITION TECHNIQUE

Data acquisition and preparation holds major share of any project, Hence most reliable and secured technique should be selected for data gathering. Different data acquisition techniques are used like Aerial Surveying, Terrestrial surveying, Satellite imagery, Topographic sheets, global positioning system(GPS). In this project as primary source terrestrial survey and topographic sheets are used to gather data.

3.1 Surveying

In 1896 soil surveys were first approved in the United States. Although L.J.M. Columella published broad writings on husbandry in the first century A.D. in the nineteenth century practical experience was the teacher of most farmers until the beginning of agricultural chemistry [9].

We used terrestrial survey for data Acquisition, although this method is labor intensive and expensive but its results are most reliable and precise. Soil survey includes characterizing soils of the area under study by classification of soil, describing soil profile, sampling of horizons, soil mapping and then interpreting soils for making recommendations about latent and suitability of soils for desired use of land (Soil Survey Staff, 1993). The information collected in a soil survey helps in the making of land-use plans, evaluates and predicts the effects of land use on the surroundings.

Global Positioning System (GPS) is a satellite navigation system which provides location along with time information of an object in every weather condition, irrespective to the location of object on or near the Earth where an unhindered line of sight to at least four GPS satellites is available. GPS was used to obtain geographical coordinates of observed field for collecting geographical location of soil samples. Lat/Long projection system used with WGS84 datum and accuracy of the GPS was usually 5m.

3.2 Sampling

Careful soil sampling is necessary for exact fertilizer recommendation. A sample must be the mirror of overall or average fertility of an area so analyses, recommendations and interpretations truly signify the nutrient or mineral condition of the soil. An exact evalua-

tion will result in supplementary fertilizer use, which can raise yields, trim down costs and potentially reduce ecological pollution.

Sampling is a procedure used for analyzing whole population. In quantitative studies we usually require a statistical representative sample. It is often not the case with qualitative analysis where we need a dependent sample with variations according to independent variables [10].

The main objectives of sample collection and research are to homogenize and acquire a representative soil sample to be used in physical, chemical and spatial analyses [11].

3.3 Sampling Techniques

Different techniques of Sampling are used like Simple Random Sampling, Cluster sampling, Systematic Sampling, Stratified Sampling, Grid sampling and many more.

We Choose the Combination of Grid Sampling And Stratified Sampling for our data as the area of interest & number of samples are pre defined, we plan the strategy to choose minimum 4 soil samples from a of the sub-sets are known, the results generate by it are more representative of the whole population, for many geographical enquiries it is very applicable and flexible. Correlations and comparisons can be easily made

To assess levels of temporal variation in population genetic structure and to infer historical changes in the levels of inbreeding and relative gene flow in America

4 SOIL SAMPLE COLLECTION FROM FIELD

Edelman soil auger (1.5m) was used to collect soil samples of surface and subsurface layers up to 6 inch deep. Location of each soil sample was recorded in GPS which were later digitized. Samples were sent to the laboratories for analysis of their chemical & physical properties and values of these analysis were recorded against each sample's East, North earlier saved

square grid of 3*3 kilometer, Stratified Sampling As there is heterogeneity in our data so we need to Reduce Standard error and control variation for the purpose of interpolation.

Grid sampling is a systematic technique used to reveal fertility patterns and assumes no logical reason for these patterns to vary within the field. In grid sampling, the field is divided into small areas or blocks. Uniform grids are susceptible to systematic errors and can result in both under and over sampling if soil regions vary in size. Cell sampling is a method in which samples are gathered randomly from the grid.

Grid sampling was first introduced, take 4.5-acre (\approx 1.8 ha) grid cell was frequently applied, but more recently the 2- to 3-acre grid representing 300- to 360-ft grid, respectively[11]

Stratified Sampling can be used with systematic or random sampling with point, line and area techniques, If the proportions

between sub-sets, Best fit for reducing Standard Error in data and control Variation and generates comparatively better results.

at 2001 stratified sampling was used by the soil seed bank of Pyne's ground plum[12].

in computer.

Areas such as those where manure is recently applied, saline and Highly Saline Areas, water logged Areas or lime has spilled are excluded as it hinders the true representation of soil properties.

Consider these before obtaining a soil sample: field area (Kilometers) per sample, sampling process, when to sample, sample depth, sampling tools and sample management.



Fig. 2. Crop Field

4.1 Analysis of Physical and Chemical Properties of Samples

After the collection samples were sent to the laboratories and analyzed for their physical and chemical properties, soil electric conductivity (dS/m), pH level, organic matter (%), texture (%), potassium (ppm) and phosphorus (ppm).

4.2 Electric Conductivity (EC)

An indirect capacity that correlates just fine with numerous soil chemical and physical properties is called Soil electrical conductivity [13]. EC measurements are expressed in DeciSiemens per meter (dS/m). Variation in electrical conductivity of soil depends on the amount of moisture contain by soil particles. Low conductivity Sand particle has, silts have medium conductivity, and clays have high conductivity. As a result, EC strongly correlates to size of soil particle and texture [14] It's an effective approach to map texture of soil because smaller soil particles like clay carry out more current than larger sand and silt particles. Measurements of soil EC have been used since the early 1900's [15].

EC is categorized into classes shown in Table 1.

4.3 Soil pH

The soil pH determines the basicity or acidity in soil. Soil pH directly effects the growth of plants, because it affects the availability of all plants nutrients by controlling the chemical forms of them [16]. pH controls many chemical processes so it is considered a master variable in soil. The response of soil pH change to the addition of organic matter depended on the type of plant materials and starting pH [17].

pH is categorized into classes shown in Table 2.

4.4 Soil Texture

In nutrient management soil texture (%) is playing vital role because it influences nutrient preservation. For instance, to store soil nutrients finer textured soils have greater ability [18].

Fig. 3. Sample taken by Soil auger

Soil texture is a term commonly used to allocate the proportionate supply of the different sizes of mineral particles in a soil. Organic matter does not include in it [19].

Soil texture is observed and classified as

Texture is categorized into classes shown in Table 3.

4.5 Organic Matter (OM)

OM (%) exerts several positive effects on soil physical and chemical properties, as well as the soil's capacity to provide regulatory Ecosystem services. Even low quantity of organic matter survives temperatures, pressures and disturbance involved with geologic processes. Once a plant begins to grow as parent material comes to rest, organic matter starts to put in [20].

OM is categorized into classes shown in Table 4.

4.6 Potassium (K)

For plant growth potassium (ppm) is necessary nutrient. Because huge amounts are absorbed from the root zone in the production of most agronomic crops, If K is not supplied in sufficient amounts or deficient, growth is diminutive and yields are condensed [21].

Potassium is categorized into classes shown in Table 5.

4.7 Phosphorus (ppm)

Phosphorus is a module of the complex nucleic acid formation of plants, which regulates protein fusion. Phosphorus is, therefore, significant in development of new tissue and cell division. Phosphorus is also linked with difficult energy transformations in the plant. Phosphorus deficiency stunted the growth of plants and often has an abnormal dark-green color affect to plant. [22].

Phosphorus is categorized into classes shown in Table 6.

After observing, all above physical and chemical properties of soil sample data is finally able to help recommend the fertilizers and suitable crop to increase the yield or production of land.

TABLE 1 PREPARED CLASSES OF ELECTRICAL CONDUCTIVITY

Classes	Remarks
≤ 4.0	Non-Saline
4.0 – 8.0	Slightly Saline
8.0 – 16	Moderately Saline
>16	Highly Saline

TABLE 2 PREPARED CLASSES OF pH

Classes	Remarks
7.1 – 7.5	Non-Calcareous Soil
7.5 – 8.0	Calcareous Soil
8.0 – 8.5	Slightly alkaline soil
>8.5	Alkali Soil

TABLE 3 PREPARED CLASSES OF TEXTURE

Classes	Remarks
0-20	Sandy
20-31	Sandy Loam
31-46	Loam
46-60	Clay Loam
>60	Clayey

TABLE 4 PREPARED CLASSES OF ORGANIC MATTER

Classes	Remarks
≤ 0.86	Poor
0.86 – 1.29	Satisfactory
>1.29	Adequate

TABLE 5 PREPARED CLASSES OF POTASSIUM

Classes	Remarks
≤ 40	Very Low
41 -80	Low
81 – 180	Satisfactory
>180	Adequate

TABLE 6 PREPARED CLASSES OF PHOSPHORUS

Classes	Remarks
≤ 7	Low
7 -14	Medium
14 – 21	Satisfactory
>21	Adequate

5 GRID DESIGNING OF WHOLE PUNJAB

For the better management, whole Punjab is divided into grids of 3*3 km by using spatial techniques and analysis, as it was our strategy that samples must be uniformly distributed and cover maximum area of interest, so to fulfill this need Punjab is partitioned into the square grids having distance of 3*3 kilometer as

shown in Fig. 4. and each grid has assigned unique code for their sole identity.

Naming convention is made in such hierarchy division name, district name, tehsil name, row number and column number respectively.

Punjab has 8 Divisions, 34 districts and 114 tehsils, each division, district and tehsil was given distinguish code so each become identical.

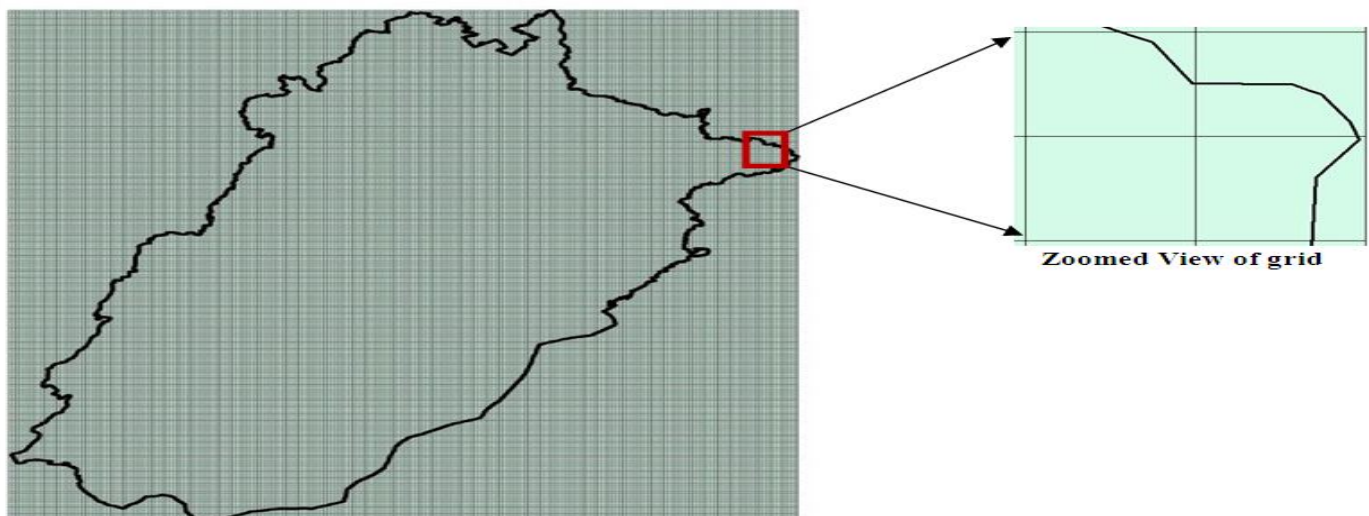


Fig. 4. Whole Punjab is divided into 3 by 3 Kilometers grids. So the distribution of samples taken can be uniformly distributed through- out complete area.

IJSER

6 DATABASE AND SPATIAL DATABASE

A *database* is a collection of data gathered about a particular subject or purpose. A *database management system* (DBMS) is a system that is used to store as well as retrieve information from a database. It manage data according to a particular subject, in such a way so that it becomes easy to track, verify, delete, add, update data, and information could be stored about the relationship of different subjects which makes it easy to bring scattered, unmanageable and large related data together.

In early 1960's database approach came into existence due to the restricted access of file processing system. As a result of database approach, the data is stored at one centralized location and is shared between multiple users, making *centralized data management* the main advantage of DBMS. Centralized nature of database system grants several advantages like reduced data redundancy (*The redundancy in the database cannot be completely eliminated as there are some performance and technical reasons to retain some amount of redundancy*), data sharing, enforcing data integrity, ease of application development, multiple user interfaces, backup and recovery, data security, data abstraction, program- data independence, and supports multiple views of the data [23].

The word "spatial database system" has become renowned during the last few years, somewhat through the series of conferences "Symposium on Large Spatial Databases (SSD)" held twice a year since 1989 represents that a database have sets of objects in real world instead of pictures of space [24].

6.1 Spatial database and GIS

Advances in computing technology in the late 1950s and 1960s were making forms of automated cartography possible which would in upcoming years lead to the development of GIS. The advancement of geographic information [25] [26] is indebted to spatial data analysis and GIS developments. Research in GIS has developed technical ability to work on spatially referenced data. Relationship between perception and geographic reality representation in digital form like points, lines and areas in 2D space has been stimulat-

ed. Spatial data analysis is related with that branch of data analysis where the geographical relationship of objects has important information.

In the early 1980s the relational database management systems (RDBMS) was introduced provided an exceptional solution to a burning problem, the need to split GIS software from database management, but the solution was only fractional. In the *hybrid* systems that flourished from 1980 to 1995 the attributes of features were stored in the RDBMS, but to store the locations and shapes of features, we need a separate, custom built database that was unable to make use of standard database-management software. The reason was very simple: by an RDBMS the shapes of features could not be defined in the simple tabular structure. [27].

Database used in this project is a spatial database to store the spatial data, in which point represents the city or towns of Punjab and polygon represents the boundaries of tehsils, districts and province as well as interpolated surfaces of soil and water sample parameters.

6.2 Conceptual Diagram

Conceptual modeling or semantic modeling is used to prepare and graphically represent the structure of information enclosed in a database. It outlines the particular entities in the system, together with their attributes, and the relationships between assorted entities. The function of a conceptual schema is to grant a higher-level order to a computing system. Computer systems in some organizations are so complex that they have need of this type of macro-management to keep them functioning accurately and proficiently Fig. 5.

7 DATA PROCESSING

A predefined Performa contains basic, location and analytical information, sent to all divisional labs. they fill the sheet with the analytical results after analyzing each soil sample, After that, received sheet is made compatible for software by removing extra fields and typing errors.

As shown in Fig. 6. (a) & Fig. 6. (b)

Major error observed during processing in received sheet is that samples are dislocated as they are often found beyond tehsil boundary as shown in Fig. 7 (a); hence it is crucial to verify the location of collected samples of respective tehsil. Mostly the values of latitude(N) and longitude(E) are filled without decimal, erroneously placed or interchanged by each other, as a result samples goes beyond the visible extent and could not be displayed.

To remove the discussed errors, samples were geographically verified by adding and displaying them in software. They were counterchecked with the boundary of respected tehsil as represented in Fig. 7 (b).

7.1 Sample Location Table

This table is designed to preserve the shape and location of each soil sample (Fig. 8); each sample has assigned unique ID (SL_ID) (Table 7) to make it distinguish.

Parameter values of samples taken from all tehsils, visualized on web are spatially associated with this

table. Hence the desired results against the query of user are displayed.

7.2 Sample Table

This table was designed to store all analysis results in such a way that user can retrieve exclusive parameter values against the queried soil sample. Each soil parameter has unique soil parameter ID (SP_ID) and as we discussed that each parameter is further categorized into classes (Table 1,2,3,4,5, and 6), which were approved by the department according to available data range. Each sub class has assigned unique soil parameter class ID (SPC_ID) (Table 8 (a) & Table 8 (b)).

On the basis of parameter classes, data is interpolated for those areas where samples were not taken so we have a general trend of soil parameter in that area, shown in Fig. 9. After interpolation each Soil parameter class has a surface and that surface is assigned a unique Surface ID (SWS_ID) (Table 8 (c))

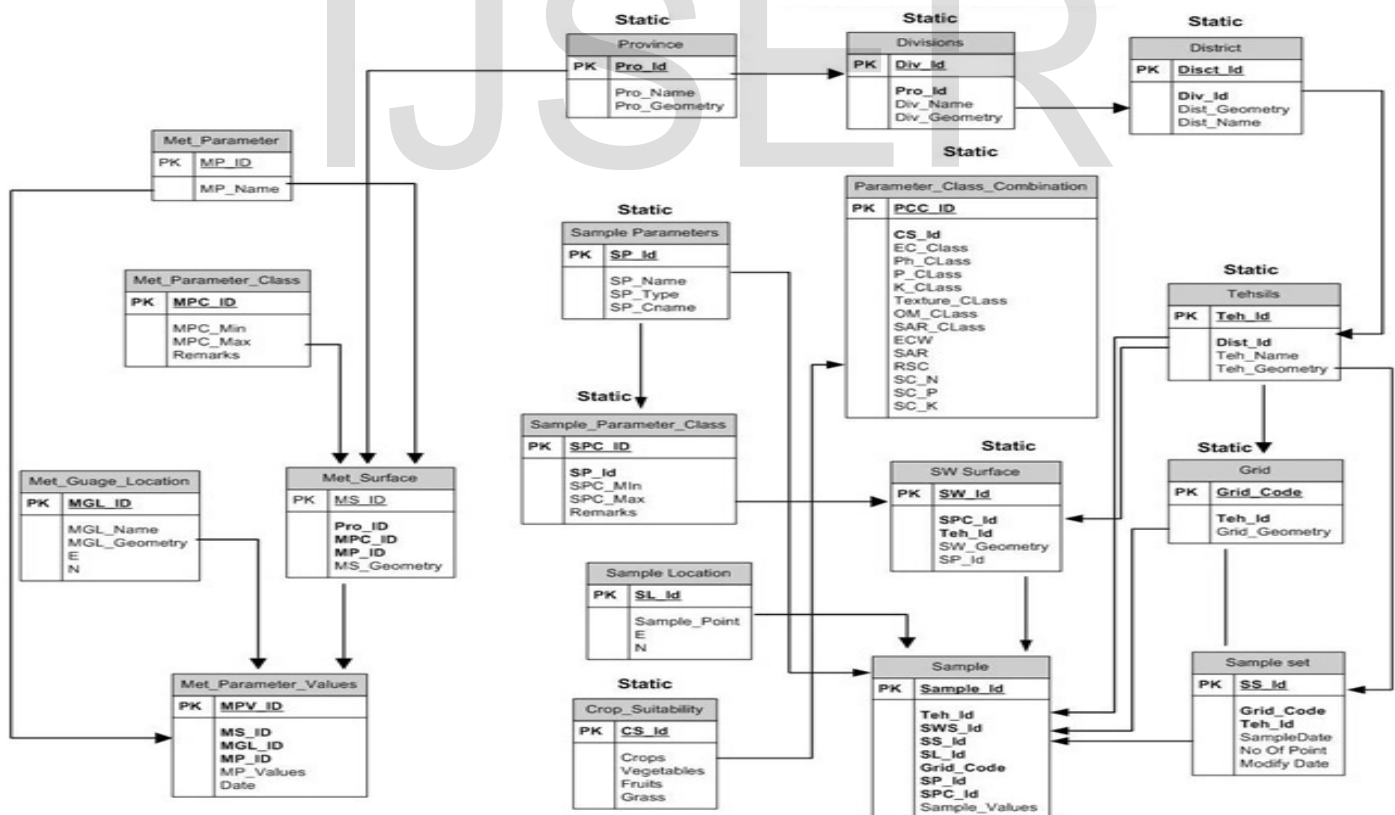


Fig. 5. Conceptual Schema of DBMS

DATA INFORMATION SHEET

District T. T. Singh

Tehsil T. T. Singh

Basic Information					GPS		Analytical Information							
Sr. No.	Grid No.	Sampling date	Village	Tehsil	Location Information		Analyses date	EC (dS/m)	pH	Saturation Percentage	Texture	O.M (%)	Av. P (mg/kg)	Av. K (mg/kg)
					N	E								
1	79	21/3/12	254 GB	T.T. Singh	72.66393	30.89182	20/6/12	3.93	8.3	34	Loam	1.09	13.70	300
2	79	21/3/12	254 GB	T.T. Singh	72.64259	30.88614	20/6/12	3.74	8.2	38	Loam	1.03	17.50	210
3	79	21/3/12	255 GB	T.T. Singh	72.65044	30.87854	20/6/12	3.25	8.1	36	Loam	0.88	14.50	180
4	79	21/3/12	255 GB	T.T. Singh	72.65915	30.88017	20/6/12	3.10	8.1	34	Loam	0.98	3.10	230
5	78	21/3/12	256 GB	T.T. Singh	72.63050	30.89287	20/6/12	2.93	8.0	38	loam	0.93	3.50	190

Fig. 6(a) Filled Performa received from divisional labs.

Basic Information					GPS		Analytical Information							
Sr. No.	Grid No.	Sampling date	Village	Tehsil	Location Information		Analyses date	EC (dS/m)	pH	Saturation Percentage	Texture	O.M (%)	Av. P (mg/kg)	Av. K (mg/kg)
					N	E								
1	79	21/3/12	254 GB	T.T. Singh	72.66393	30.89182	20/6/12	3.93	8.3	34	Loam	1.09	13.70	300
2	79	21/3/12	254 GB	T.T. Singh	72.64259	30.88614	20/6/12	3.74	8.2	38	Loam	1.03	17.50	210
3	79	21/3/12	255 GB	T.T. Singh	72.65044	30.87854	20/6/12	3.25	8.1	36	Loam	0.88	14.50	180
4	79	21/3/12	255 GB	T.T. Singh	72.65915	30.88017	20/6/12	3.10	8.1	34	Loam	0.98	3.10	230
5	78	21/3/12	256 GB	T.T. Singh	72.63050	30.89287	20/6/12	2.93	8.0	38	loam	0.93	3.50	190

Fig. 6(b) Performa after extra and unnecessary fields is removed.

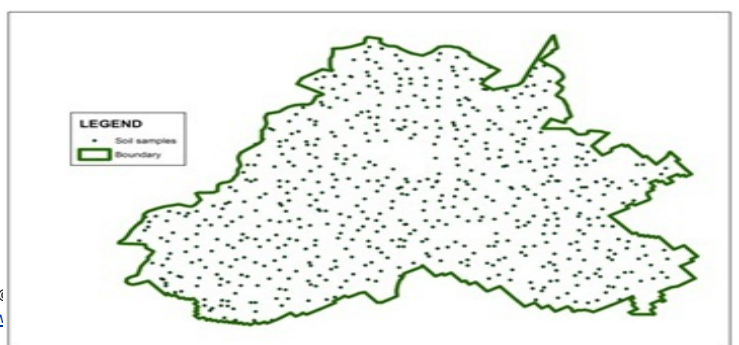
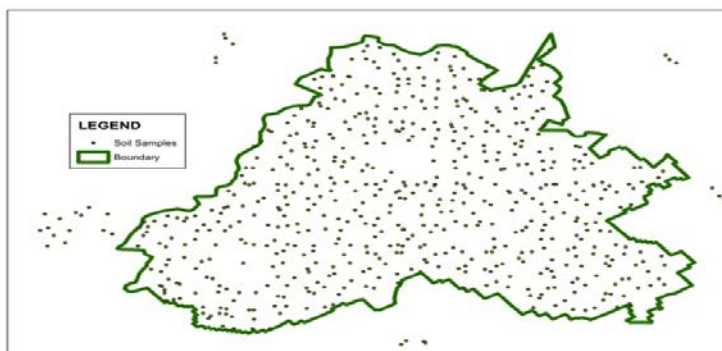


FIG. 7 (A) SAMPLES BEYOND THE TEHSIL BOUNDARY

Fig. 7 (b) Samples after geographic verification

TABLE 7 SAMPLE LOCATION

SL_ID (PK)	Shape	E	N
SL_231474	Point	71.91886	31.02813
SL_231475	Point	71.94030	31.03284
SL_231476	Point	71.97365	31.02921
SL_231477	Point	71.96315	31.03047
SL_231478	Point	71.00648	31.02713

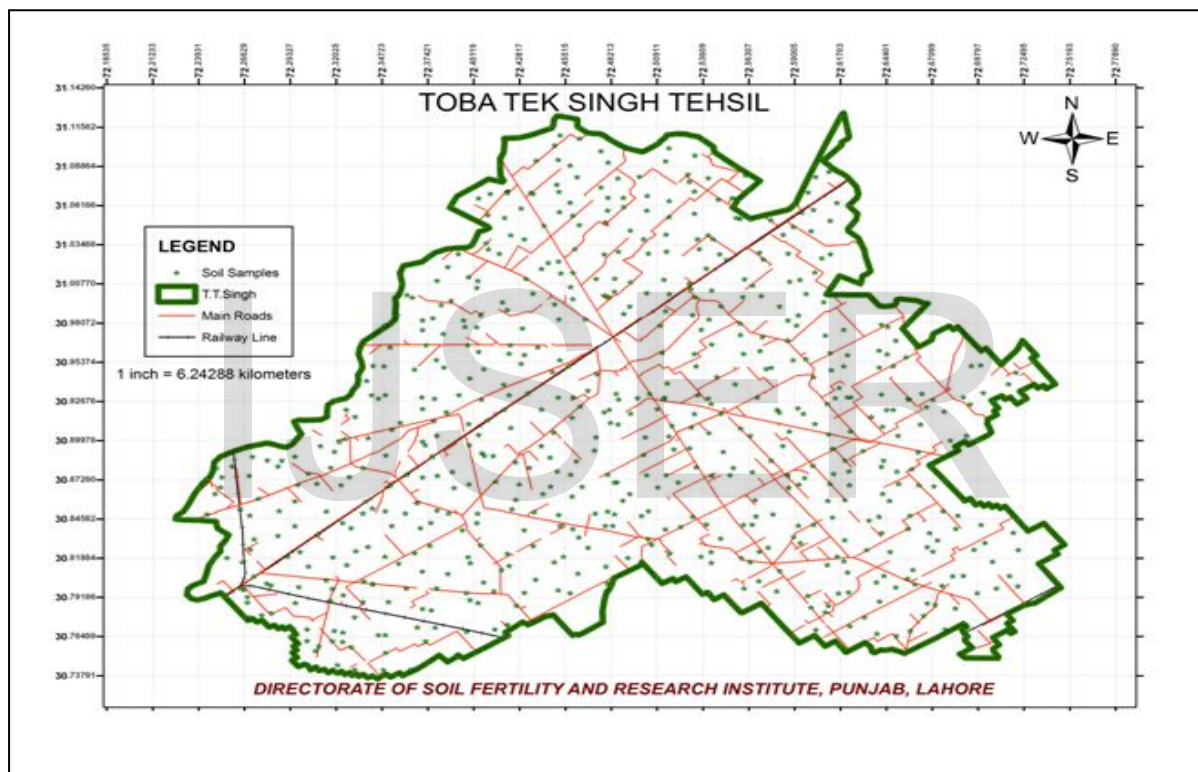


Fig. 8. Sample Location

TABLE 8 (a)

PK	Sample value	SP_ID	SPC_ID	SWS_ID	SL_ID	The_ID	Grid_Code
S_ID							

TABLE 8 (b)

SP_ID	SP_NAME
1	EC
2	PH
3	TEXTURE
4	O.M.
5	Av.P
6	Av.K

TABLE 8 (c)

SP_ID	SPC_ID	MIN	MAX	SWS_ID
1	1	0	4	SW_36
1	2	4	8	SW_37
1	3	8	16	SW_38
1	4	16	INFINITY	SW_39

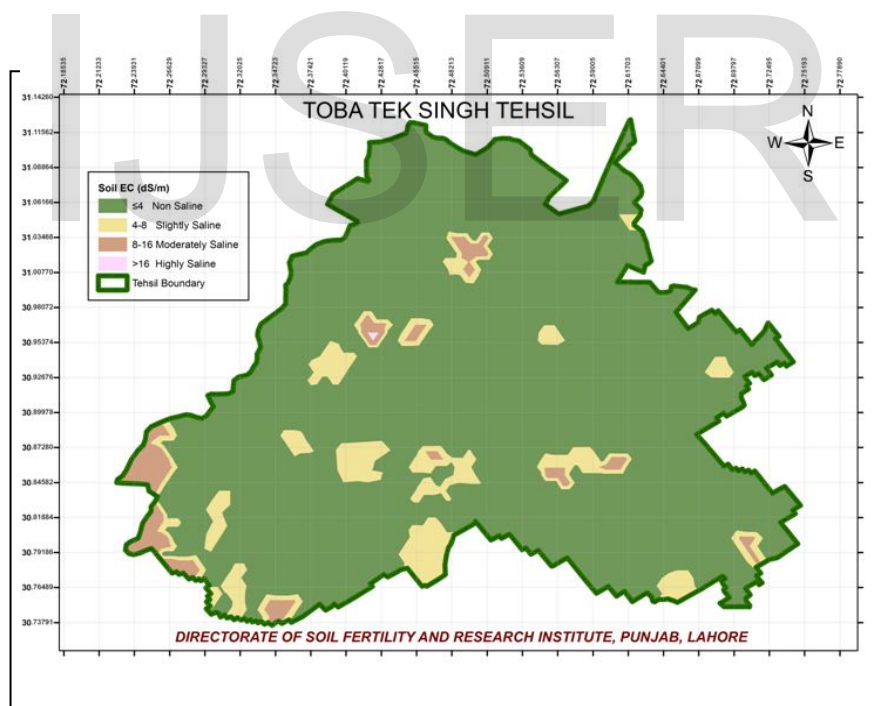


Fig. 9. Interpolated Map of Soil Parameter

8 WEB GIS

After the success of desktop GIS further attention is given to the development of GIS functionality on Worldwide Web, in the Internet and private intranets and is called Web GIS. Web GIS have the facility to make dispersed geographic information reachable to huge over the world users. Internet users are able to approach GIS applications from any place through any browser without buying accredited or expensive GIS

software. Web GIS made it achievable, to attach GIS functionality in a wide range of internet based applications in education as well as business and government sectors. Most of these applications are running on intranets within multinational organizations and government agencies (Hazard management, infrastructure facilities provision, prediction) as a means of distributing scattered, out of reach data in one place on low price and using geospatial data[28]

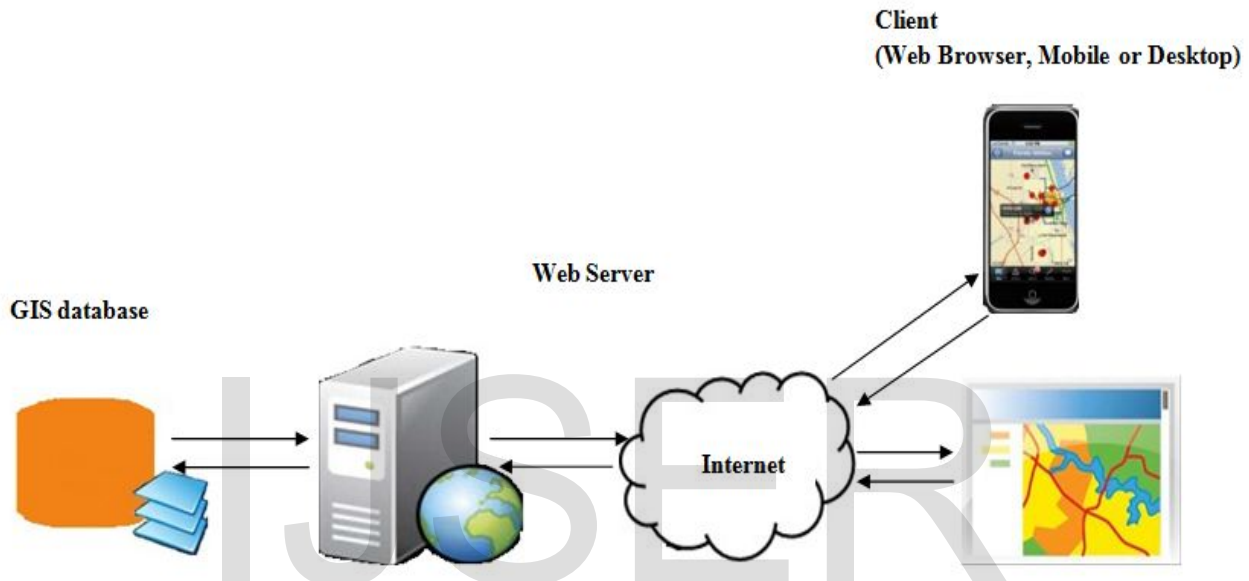


Fig. 10. Three tier structure of Web GIS

9 CONCLUSION

1. For the increase in yield of crops, file based data is transferred into computerized data with the help of Geographic Information System techniques.
2. Data about soil parameters are gathered with careful consideration and preplanned schemes by dividing Punjab Province into grids of 9 Sq.km.
3. Then analytical results incorporated with GIS facility of interpolation draw a picture of spatial variation in soil parameters throughout the

province. Sampling and analysis were made on tehsil levels to get maximum accuracy for soil chemical and physical properties.

4. Afterwards interpolated surfaces with their attributes like salinity in soil, presence of Nitrogen, Phosphorous and Potassium so on is stored in a spatial database to preserve the shape along with characteristics of the area.
5. Database is connected with the final representation phase which is Web-GIS application to fetch data which user queried through website functionalities.

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