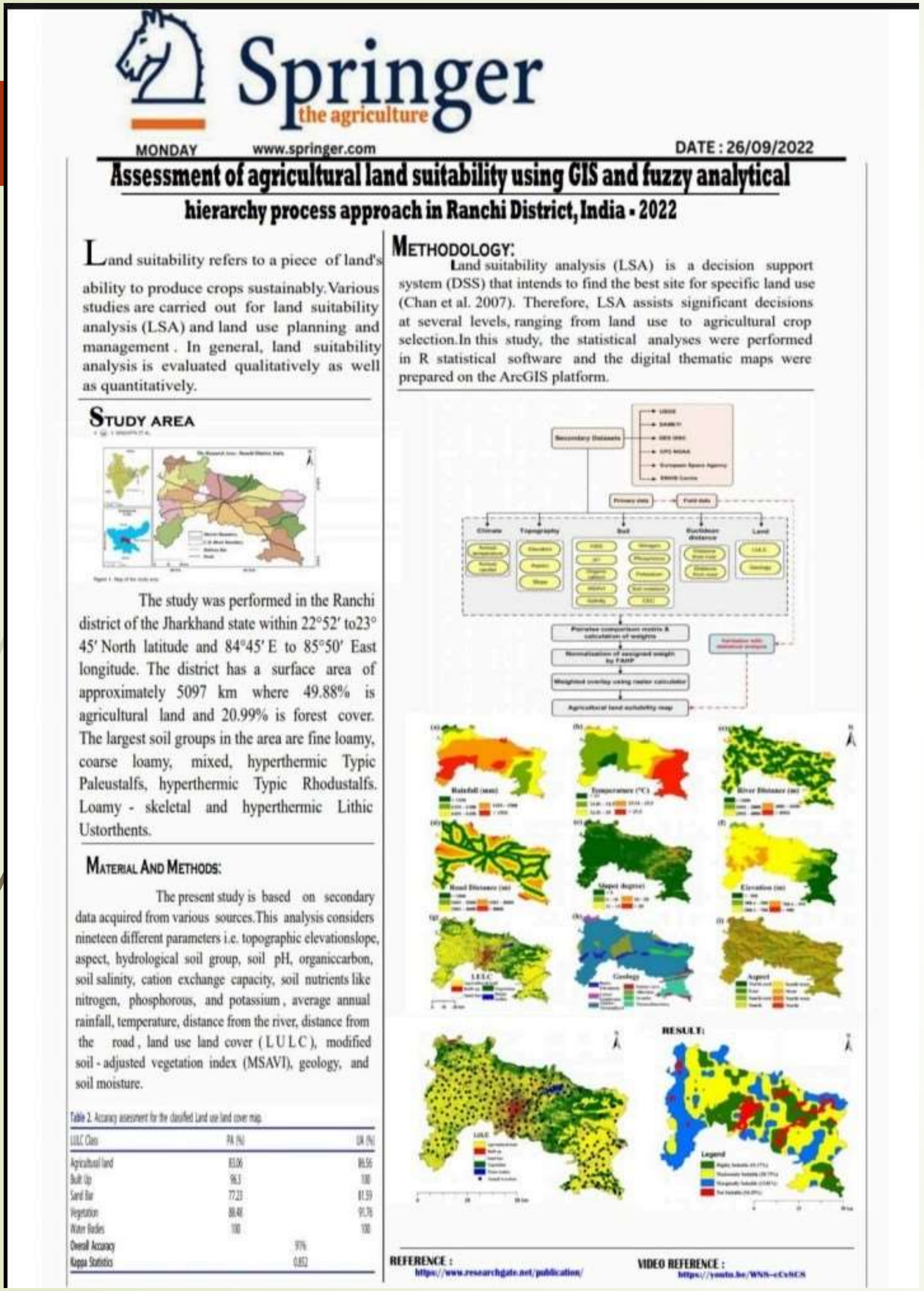


Springer
the agriculture

MONDAY www.springer.com DATE : 26/09/2022

# Assessment of agricultural land suitability using GIS and fuzzy analytical hierarchy process approach in Ranchi District, India - 2022

Land suitability refers to a piece of land's ability to produce crops sustainably. Various studies are carried out for land suitability analysis (LSA) and land use planning and management. In general, land suitability analysis is evaluated qualitatively as well as quantitatively.

## STUDY AREA

The study was performed in the Ranchi district of the Jharkhand state within 22°52′ to 23° 45′ North latitude and 84°45′ E to 85°50′ East longitude. The district has a surface area of approximately 5097 km where 49.88% is agricultural land and 20.99% is forest cover. The largest soil groups in the area are fine loamy, coarse loamy, mixed, hyperthermic Typic Paleustalfs, hyperthermic Typic Rhodustalfs. Loamy - skeletal and hyperthermic Lithic Ustorthents.

## MATERIAL AND METHODS:

The present study is based on secondary data acquired from various sources. This analysis considers nineteen different parameters i.e. topographic elevationslope, aspect, hydrological soil group, soil pH, organiccarbon, soil salinity, cation exchange capacity, soil nutrients like nitrogen, phosphorous, and potassium, average annual rainfall, temperature, distance from the river, distance from the road, land use land cover (LULC), modified soil - adjusted vegetation index (MSAVI), geology, and soil moisture.

Table 2. Accuracy assessment for the classified Land use land cover map.

| LULC Class | PA (%) | | UA (%) |
|---|---|---|---|
| Agricultural land | 83.06 | | 86.56 |
| Built Up | 96.3 | | 100 |
| Sand Bar | 77.23 | | 81.59 |
| Vegetation | 88.48 | | 91.76 |
| Water Bodies | 100 | | 100 |
| Overall Accuracy | | 91% | |
| Kappa Statistics | | 0.852 | |

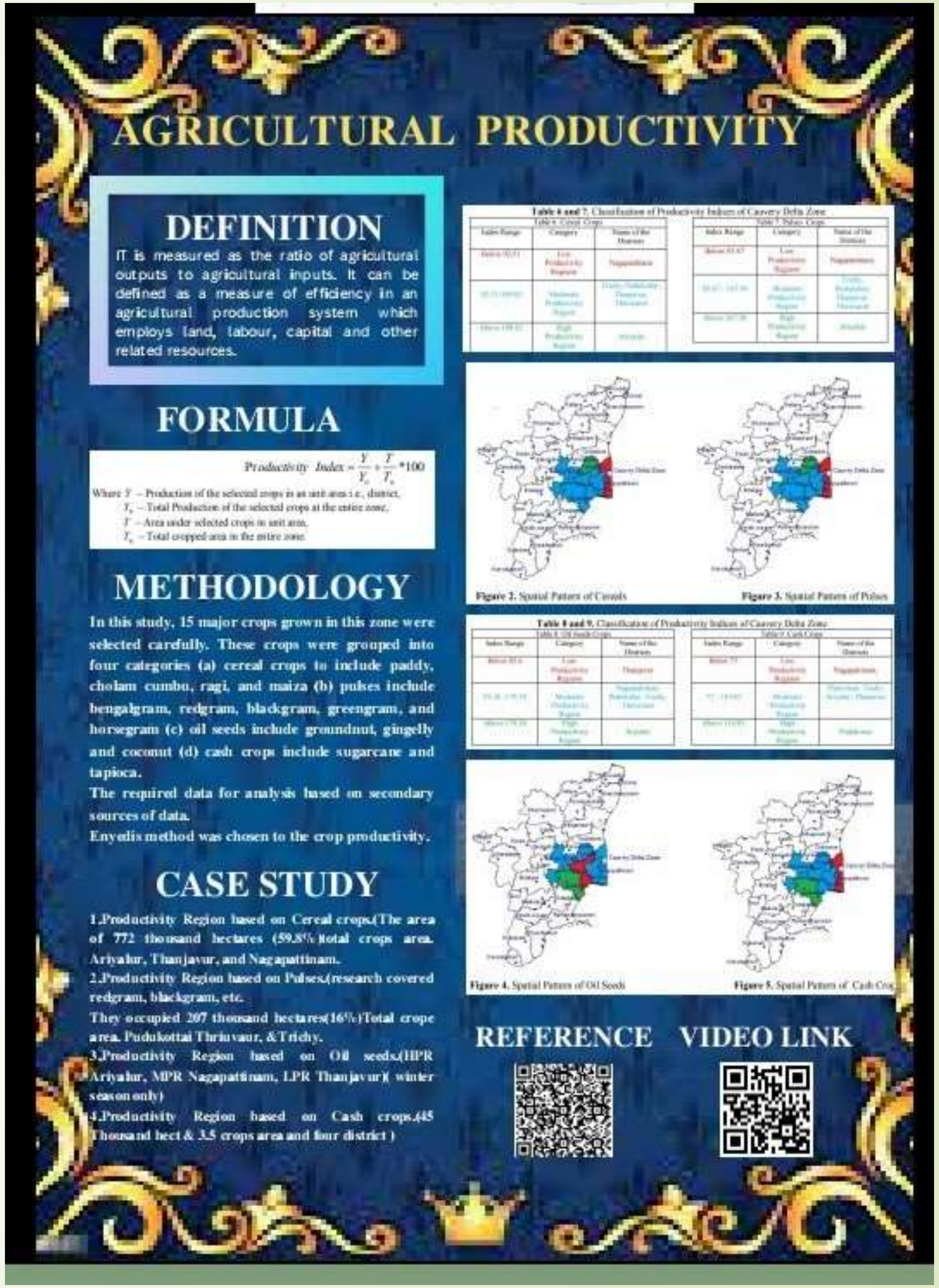
## METHODOLOGY:

Land suitability analysis (LSA) is a decision support system (DSS) that intends to find the best site for specific land use (Chan et al. 2007). Therefore, LSA assists significant decisions at several levels, ranging from land use to agricultural crop selection. In this study, the statistical analyses were performed in R statistical software and the digital thematic maps were prepared on the ArcGIS platform.

RESULT:

REFERENCE : https://www.researchgate.net/publication/

VIDEO REFERENCE : https://youtu.be/WNS-cCvSCS



# AGRICULTURAL PRODUCTIVITY

## DEFINITION

IT is measured as the ratio of agricultural outputs to agricultural inputs. It can be defined as a measure of efficiency in an agricultural production system which employs land, labour, capital and other related resources.

## FORMULA

$$Productivity\ Index = \frac{Y}{Y_e} \div \frac{T}{T_e} * 100$$

Where $Y$ – Production of the selected crops in an unit area i.e., district,
$Y_e$ – Total Production of the selected crops at the entire zone,
$T$ – Area under selected crops in unit area,
$T_e$ – Total cropped area in the entire zone.

## METHODOLOGY

In this study, 15 major crops grown in this zone were selected carefully. These crops were grouped into four categories (a) cereal crops to include paddy, cholam cumbu, ragi, and maiza (b) pulses include bengalgram, redgram, blackgram, greengram, and horsegram (c) oil seeds include groundnut, gingelly and coconut (d) cash crops include sugarcane and tapioca.

The required data for analysis based on secondary sources of data.

Enyedis method was chosen to the crop productivity.

## CASE STUDY

1.Productivity Region based on Cereal crops.(The area of 772 thousand hectares (59.8%)total crops area. Ariyalur, Thanjavur, and Nagapattinam.

2.Productivity Region based on Pulses.(research covered redgram, blackgram, etc.

They occupied 207 thousand hectares(16%)Total crope area. Pudukottai Thriuvaur, &Trichy.

3.Productivity Region based on Oil seeds.(HPR Ariyalur, MPR Nagapattinam, LPR Thanjavur)( winter season only)

4.Productivity Region based on Cash crops.(45 Thousand hect & 3.5 crops area and four district )

Table 6 and 7. Classification of Productivity Indices of Cauvery Delta Zone

Figure 2. Spatial Pattern of Cereals

Figure 3. Spatial Pattern of Pulses

Table 8 and 9. Classification of Productivity Indices of Cauvery Delta Zone

Figure 4. Spatial Pattern of Oil Seeds

Figure 5. Spatial Pattern of Cash Crop

REFERENCE

VIDEO LINK

# CROP DIVERSIFICATION

## DEFINITION:

Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value added crops with complementary marketing opportunities.

## FORMULA:

Index of Crop Diversification = $1 - \sum$ /($\sum$ ) Where 'X' stands for the percentage of total cropped area under an individual crop.

## METHODOLOGY:

For calculating the index of crop diversification, Gibbs and Martin method is used.

## OBJECTIVE:

(1) to study the cropping pattern of Tamil Nadu State.
(2) to understand the techniques of crop diversification.
(3) to examine the crop diversification index for the districts of Tamil Nadu State.

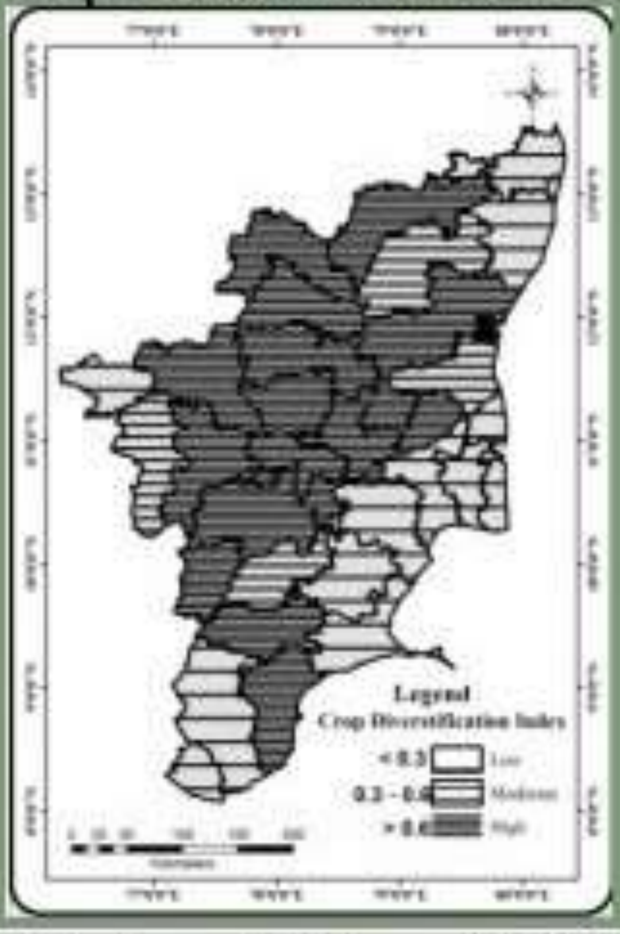
## STUDY AREA:

Tamil Nadu State is situated at the south-eastern extremity of the Indian Peninsula bounded on the north by Karnataka and Andhra Pradesh, on the east by the Bay of Bengal, on the south by the Indian Ocean and on the west by Kerala. It lies between 8° 5' and 13° 35' of northern latitude and 76° 15' and 80° 20' of eastern longitude with an area of 130,058 km².

## VIDEO LINK:

https://www.youtube.com/watch?v=B1PkkteMTiE

Index of Crop Diversification 2015-2016

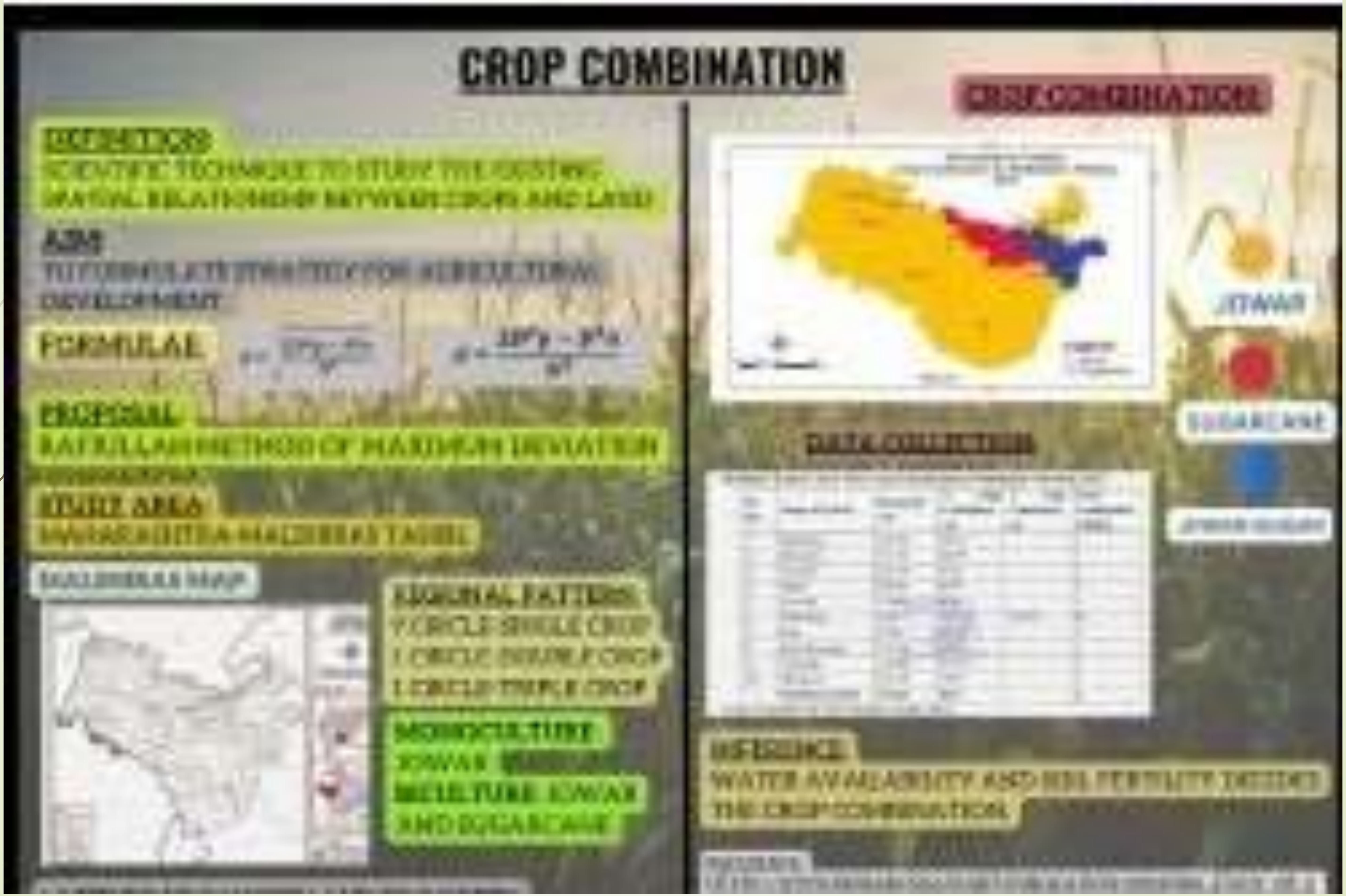


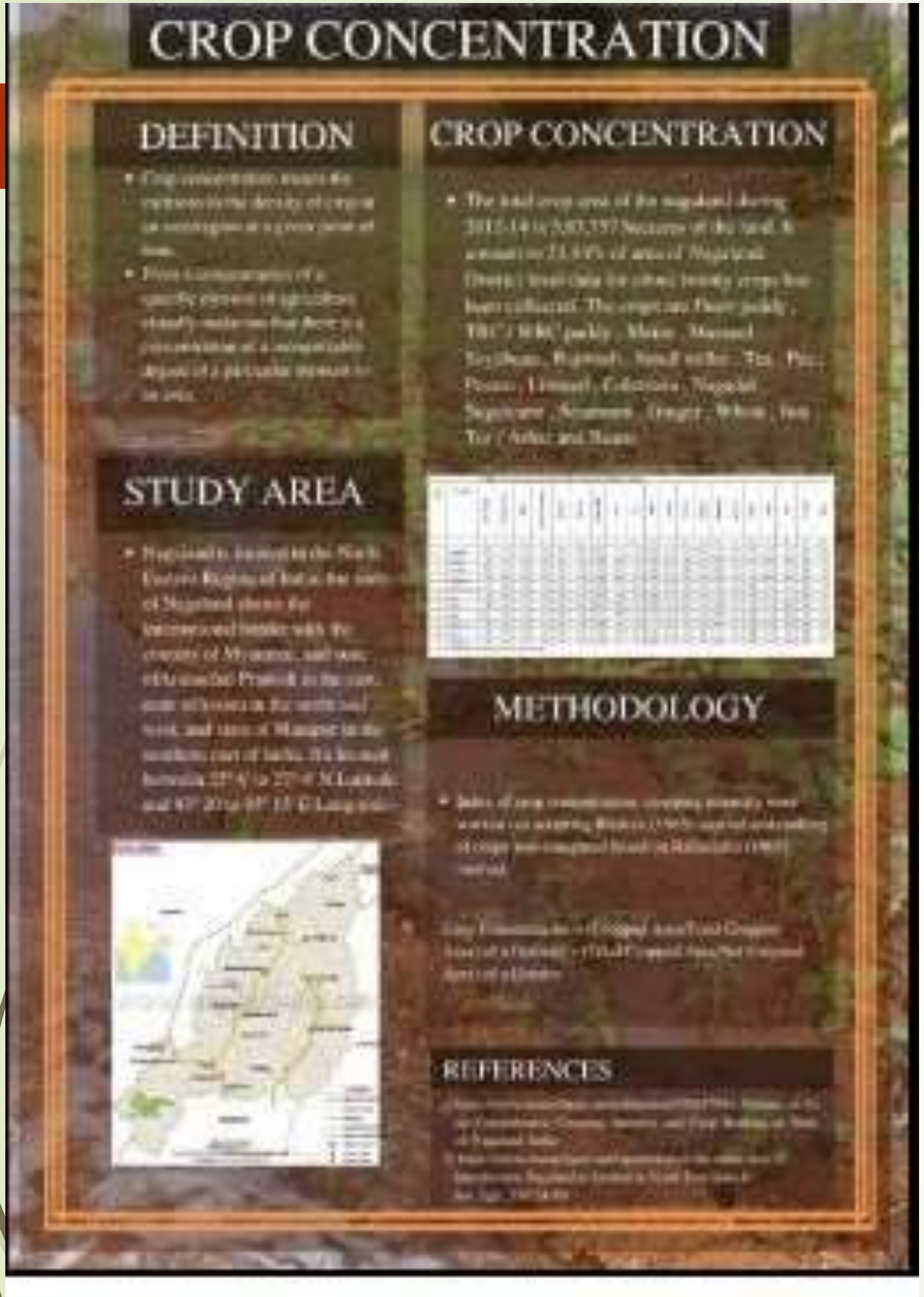

## RESULT:

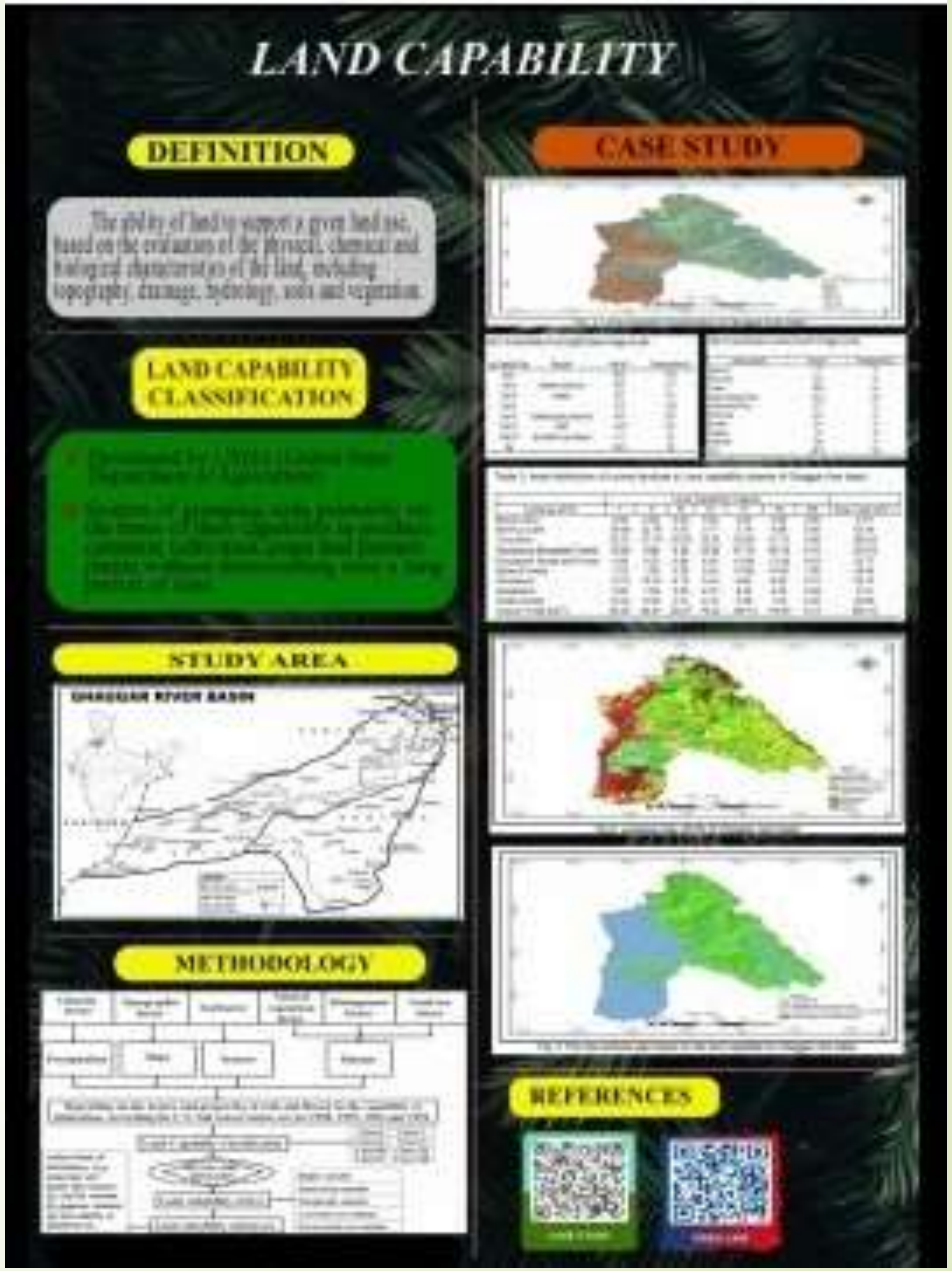
Crop diversification in India is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops. The overall index value of crop diversification of the study region was 0.84 in 2015-2016.

**REFERENCES:**
HTTPS://RRRS.REVISTE.UBBCLUJ.RO/ARHIVE/ARTPDF/V16N22020/RRRS16220203.

| No. | District | C.D. Index | No. | District | C.D. Index |
|---|---|---|---|---|---|
| 1 | Kancheepuram | 0.23 | 17 | Ariyalur | 0.68 |
| 2 | Thiruvallur | 0.24 | 18 | Pudukkottai | 0.23 |
| 3 | Cuddalore | 0.43 | 19 | Thanjavur | 0.18 |
| 4 | Villupuram | 0.62 | 20 | Thiruvarur | 0.07 |
| 5 | Vellore | 0.70 | 21 | Nagappattinam | 0.07 |
| 6 | Thiruvannamalai | 0.57 | 22 | Madurai | 0.52 |
| 7 | Salem | 0.79 | 23 | Theni | 0.75 |
| 8 | Namakkal | 0.65 | 24 | Dindugal | 0.64 |
| 9 | Dharmapuri | 0.80 | 25 | Ramanathapuram | 0.17 |
| 10 | Krishnagiri | 0.67 | 26 | Virudhunagar | 0.73 |
| 11 | Coimbatore | 0.41 | 27 | Sivagangai | 0.19 |
| 12 | Thiruppur | 0.66 | 28 | Thirunelveli | 0.21 |
| 13 | Erode | 0.73 | 29 | Tuticorin | 0.73 |
| 14 | Trichy | 0.66 | 30 | Nilgiris | 0.0 |
| 15 | Karur | 0.71 | 31 | Kanyakumari | 0.0 |
| 16 | Perambalur | 0.69 | | **Tamil Nadu** | **0.84** |


CROP COMBINATION


CROP CONCENTRATION
DEFINITION
CROP CONCENTRATION
STUDY AREA
METHODOLOGY
REFERENCES


LAND CAPABILITY
DEFINITION
The ability of land to support a given land use, based on the evaluation of the physical, chemical and biological characteristics of the land, including topography, drainage, hydrology, soils and vegetation.
CASE STUDY
LAND CAPABILITY CLASSIFICATION
STUDY AREA
GHAGGAR RIVER BASIN
METHODOLOGY
REFERENCES


CROP RANKING
INTRODUCTION :
the proportion of area under various crops at point of time is know as cropping pattern under the cropping pattern sub section parameters deals with the ranking of crops
OBJECTIVE
to access the crops ranked of mysore from 2002-2007
to map the ranking of crops from 2002-2012 &2012-2017
Conclusion: over all crop ranking in all taluks of Mysore district has been obtained and as per secoundary data there are no changes in 1st crop ranking in the year 2017-2018 but 2nd ,3rd had changes

CHAPTER 16

# Remote Sensing Techniques in Agriculture

## INTRODUCTION

The word remote sensing was coined by Fischer in 1960 A.D.

Remote sensing is the acquisition and recording of information about an object without being in direct contact with that object. Remote sensing, in its broadest sense, is the collecting and interpreting of information of some property of an object or phenomenon without being in physical contact with it. One can experience it from everyday living. A photograph obtained by a camera is a record, which provides information about an object. A simple photograph can introduce us to some important remote sensing concepts. Different components within the photograph are different colours: for example in any photograph if the stone is red, the tree is green and the folder is blue. This information about colours is carried by means of electromagnetic radiation and the colours represent specific ranges of the electromagnetic spectrum. Spatial relationships between different components of a scene may also be determined from a photograph. However, in order to determine quantitative spatial information (for example, what is the area of the blue folder?), it is important that the scale of the photograph be known or an object of known length be included within the photograph. The metre rule held by the person allows the determination of distances and areas.

Remote sensing images are obtained at distances that fall within following three broad ranges.

1. Sensors carried by aircraft generally obtain images at heights of 500 m to 20 km. In general most aerial surveys are carried out at heights of less



than 5,000 m though some remote sensing experiments carried out at much higher altitudes (20 km) using special aircraft. Aircrafts are useful for regional coverage flexibility and high resolution are associated advantages.

2. Sensors carried by spacecraft and satellites operate at distances of 250-1,000 km. Spacecraft (Which are manned) generally operate at altitudes of around 250-300 km. Many remote sensing satellites (which are unmanned) operate approximately 1,000 km above the earth.

3. Satellite cover the same area and provide continuous coverage of a fixed area. The ground covered by satellite passes can be had referring its path and row. Very high-altitude satellites operate 36,000 km above the Earth. These are geostationary satellites which have the unique capability of appearing to remain over the same part of the Earth at all times.

The satellites provide a synoptic view of large parts of the Earth as an entity rather than in a piecemeal fashion. The satellite images allow global problems to be viewed in a global context.

Remote sensing is not a replacement for conventional field-based research. It is a technique to complement it. The term *Ground truth* is used and often applied to field investigations. Ground-collected verification data are the integral part of remote sensing. They provide an independent source of data and are important in the identification of features detected by remote sensing means. However, in many parts of the world ground-based research is minimal or researchers working far apart may not know of a common link between their researches.

Remote sensing also provides an overall view of the globe, however, its useful applications would be limited. Remotely sensed satellite images help us to view the various components like environment (vegetation, cloud, rocks, cities) simultaneously. The interaction of many complex human-induced and natural processes produces the world that we live on today and global images allow us to analyse the inter-relationship of these processes.

For example in a remotely sensed satellite image three colours are predominating: blue, green and red. Every colour that can be observed by the human eye is formed by a combination of these colours. For example, yellow is formed by an equal combination of red and green with no blue input. Red, green and blue represent only a very small part of the electromagnetic spectrum. If in a photograph, the colours observed on the latter image appear natural, vegetation has bright red signature on the former image. This is because it is a false colour image which has been produced from data obtained in a part of the electromagnetic spectrum which cannot be detected by the human visual system. Two different surfaces may appear similar to the human eye but if they are viewed at a different wavelength, outside the visual range, they can often be quite distinct.

Computer technologies help us to observe wavelengths outside normal visual range by using false colouration of these wavelengths. This ability to obtain information across a range of wavelengths, far greater than can be determined by the human eye, is another major advantage of remote sensing. The production of an image is virtually an instantaneous record of the conditions that exist in a particular location at a specific time. If our environment is static, this image would be a sufficient record of the events that occurred at that location.

The Earth is a dynamic system. The natural forces are continually operating on it. Increasing human interferences such as deforestation are responsible for accelerating these changes. Remote sensing systems provide images of the same location at periodic intervals. This helps us to record the images with changing environment for evaluation.

The versatility shown by remote sensing systems regarding the area imaged and the wavelengths sensed, which has been discussed above, is mirrored in the different repeat cycles (i.e. how often an area is imaged). The Landsat system images most of the globe every 16 days and thus changes on a 16-day cycle can be determined. Such a repeat cycles is ideal for studying vegetational changes but would be entirely inappropriate for meteorological investigations because the atmospheric system alters much more rapidly. Consequently, meteorological satellites have much shorter repeat cycles, some as short as 30 minutes. When these properties of remote sensing systems are combined (the variation in area imaged and the detail obtained, the different wavelengths that can be sensed and the repetitive coverage that is available) and applied simultaneously in an investigation, then remote sensing techniques can be an extremely powerful approach for many applications which could not be using wavelengths at which vegetation is particularly sensitive, vegetational indices can be produced for entire continents. A gradual decline in a vegetation index over a number of years could be an indication that famine conditions are developing and following this warning, remedial action can be formulated and a possible catastrophe averted.

## REMOTE SENSING: HISTORY AND DEVELOPMENT

A man has a natural desire to know. The motivation to know what is behind the next hill, across the sea, through the forest, under the ocean, beyond the



clouds or to observe the beautiful face of earth from space is a powerful goal to our restless quest for new horizons and fresh challenges. Man's greatest technological breakthroughs have resulted from his curiosity about a phenomenon he could not experience directly with his senses.

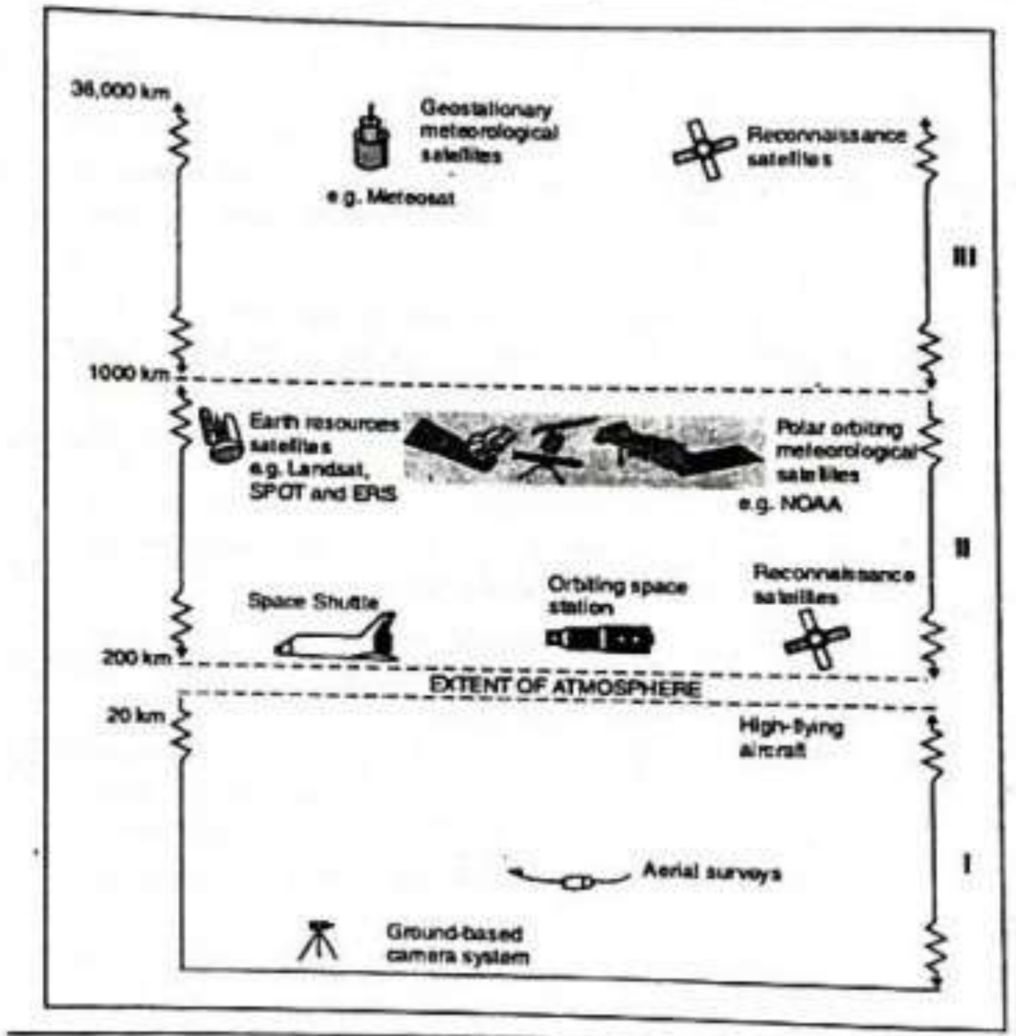



Fig. 16.1: Operational dates for different remote sensing plateforms. A marked change occurred about 1960 when spaceborne plateform became operational.

Remote sensing became possible with the invention of the camera in the nineteenth century. Astronomy was one of the first fields of science to exploit this technique and to this day much of astronomy is inextricably linked with remote sensing. A substantial amount of the progress in remote sensing has been as a result of its obvious military applications. It was only during the First World War that free-flying aircraft were used in a remote sensing role. The static nature of that conflict meant that photographs taken from aircraft were an invaluable source of information regarding the movement of troops and supplies. Remote sensing such as sensor technology are a result of government-sponsored military research programmes. Later on the improvements are exploited initially by the military and then filter down for civilian use. The use of remote sensing for environmental assessment really became established after the Second World war. These wars had not only proved the value of aerial photography in land reconnaissance and mapping but had also driven technological advances in airborne camera design, film characteristics and photogrammetrical analysis. In peacetime these technological advances were devoted to civilian mapping and terrain assessment applications.

Most countries have a national archive of aerial photographs, often held by their national mapping organization. The majority of them are black and white, though in recent years colour has become more common. From about 1960, remote sensing underwent a major development when it was extended to space. Space rocket and satellite technology advanced greatly during the 1960s mainly because of the 'Space Race' between the USA and the former USSR and India. This new phase of remote sensing may be considered under four headings, though the sections are not mutually exclusive.

The development of different kinds of satellites has added much potential in remote sensing studies. Before the 1960s remote sensing was confined to airborne platforms but since then many remote sensing system have operated from space. Early manned space flights showed the potential of images acquired from orbit and such images are still obtained today during Space Shuttle mission. These were specially used in Military Reconnaissance, Manned Space Flight, for collection of Meteorological data, knowing about Earth Resources, etc.

## DEFINITION OF REMOTE SENSING

Remote sensing is the science and art of obtaining useful information (Spectral, Spatial, and Temporal) about an object; area or phenomenon through the analysis of data acquired by a device is not in contact with the object, area or phenomenon under investigation.

Remote sensing in it's broader sense it refers to the activities of recording, observing, perceiving object or events at far away (Remote) places.

Remote sensing actually deals with inventory, monitoring and assessment of natural resources through the analysis of data obtained by observation are synoptic, provide repetitive coverage of large areas and the data is quantifiable



## CONCEPT OF REMOTE SENSING

The concept of remote sensing involves six stages

- Source of electromagnetic energy (EME), sun or transmitter is the source of the energy.
- Transmission of the energy from the source to the surface of earth ( as well as absorption and scattering by the atmosphere )
- Interaction of energy with the objects on the surface of earth. Due to interaction the processes like reflection, absorption, transmission and emission take place.
- Transmission of energy to the remote sensing sensor.
- Generation of data in pictorial and/or digital form.
- Analysis, interpretation and use of data.

## PRINCIPLES OF REMOTE SENSING

- The underline principle in which the whole remote sensing techniques is developed, is that " All objects on the surface of the earth have their own characteristic spectral signature"
- The responses of materials on the earth surface to incidence radiation are the energy emitted by all objects is a function of their temperature and structure. Hence, all objects have their own reflectivity depending on their own temperature and emissivity. Hence, by utilization of different reflectivity and emissivity of objects we can identify and classify them.

## TYPES OF REMOTE SENSING

1. Passive remote sensing
2. Active remote sensing

Passive remote sensing makes use of seasons that detect the reflected or emitted electromagnetic radiation natural sources.

Active remote sensing makes the use of seasons that detect reflected responses from object that are irradiated from artificially generated energy sources , such as Radar.

## In Respect of Wave Length Regions

Remote sensing is classified up to three types in respect to the wavelength region.

1. Visible and effective IR remote sensing
2. Thermal IR remote sensing
3. Microwave remote sensing

## SCOPE

Remotely sensed photographs and images are non-selective with respect to information content, i.e. the data interpreted from an individual record may be applicable to diverse fields. The information is useful to investigators in following diverse disciplines:

1. **Civil engineers** planning large construction projects such as highways, airports, railways or dams can obtain data on landforms, rock materials, soils, type of vegetation and drainage condition in the project area. Remote sensing is invaluable to map makers in their efforts to identify ground features and to position them accurately.
2. **Environmentalist.** Violations of natural law often show up in photographs e.g. illegal mining in remote areas, pollution of water by illegal dumping of chemicals and effluents from industry, air pollution due to the release of the smoke and poisonous gases through chimanies of industries. The analysis of disasters like floods, fires and hurricanes can be assisted by the study of remote sensing data and the information so obtained can be used in making emergency decisions and in combating the situation. Fast development in industrialization throughout the world is causing the serious problem of environmental pollution. Monitoring of this can be effectively tackled by employing remote sensing techniques. Thus, remote sensing has multi-disciplinary applications. Now, remotely sensed data can be processed and interpreted automatically through fast digital computers and thus large volume of information can be dealt with rapidly.
3. **Foresters and agriculturists** can determine the kind of trees and plants, which grow in an area, can assess their health and estimate their yield.
4. **Geographers** can analyse landuse patterns over large area and can study the effect of climate, topography, plant life, animal life and human activity in a particular area.



5. **Geology.** Geologists use remote sensing to find deposits of minerals and petroleum.
6. **Hydrologists.** Using remote sensing techniques, hydrologists can locate useful aquifers and can estimate the volume of surface and sub-surface flow in watershed.
7. **Military operations.** Infra-red sensing is very useful in military activities as infra-red images can be passively made at night.
8. **Oceanographers** can map the movements of ocean currents, marine organisms and water pollutants.
9. **Soil scientists** can prepare inventory of the important characteristics of soil by intelligently relating them to geological and geomorphological features and the type of vegetation found on images obtained by remote sensing.
10. **Wild life managers** can use aerial photographs for locating habitats of various kinds of animals.

## ROLE OF REMOTE SENSING

It has been established that ecological research and planning are among the few alternatives for the survival of man's economic and cultural society that are increasingly stressed by the number of men and power of his technology. Ecology as a scientific discipline has an opportunity indeed a mandate to bridge the gap between academia, technology and the very real and extensive environmental problems confronting modern and future society.

Remote sensing can be used in four ways: inventory and mapping of resources: quantitating the environmental; describing the flow of matter and energy in ecosystem and evaluating change and alternative solution for management of ecosystems. Solutions of many resource problem depend on adequate assessment of physical and biological characteristics integrated over a range of areas from a few square metres to thousands of kilometres and it can be well done by remote sensing. Most resource problem requires quantitative data in addition to definitions of what the problem is and where it is. In some cases even estimates of magnitude apply to large areas are sufficient for meaningful planning. In more sophisticated treatment, remote sensing particularly with the narrow bandpass instruments, can generate accurate numbers. The recent development of laser and air borne profilometer for studies of microtopography is capable of portraying changes in ground elevation in order of a few centimetres from space.

To appreciate function as opposed to structure in ecosystem requires the study of processes, interaction and transfer rates between different organisms as well as between organisms and their environment. Frequently, measures of metabolic activity are desired. Detection by air borne sensors of metabolic products or physical changes caused by active biological processes are important clues for inferences and conclusions about the direction and quantify of matter and energy flow in ecosystems. Alteration of natural ecosystems is, of course, manifest in all resource problems. Without change, that is without depletion, erosion, pollution, accruai, epidemic, the problem is seldom recognised. This perhaps, is the easiest type of information to procure by repetitive aerial surveillance, and it has been exploited with photography in the visual wavelengths and for this the satellite based photography in the visual wavelengths and for this the satellite based photography is of greatest use.

## ADVANTAGES OF REMOTE SENSING

Satellite remote sensing technology is useful to gather information beyond simple visual technique with respect to extent of coverage, permanent of record, spectral and spatial resolution, speed and consistency of interpretation of data, cost effective and reliable information etc.

1. **Extent of Coverage:** By using satellite technology information from a large area can be covered with short time with much accuracy as compared to traditional methods, for example, one LANDSAT-scene covers about 185 Km × 185 Km area and takes less than 30 Secs to record one scene from a height ranging from 550- 1600Km .
2. **Permance of Record:** Aerial and satellite data are the permanent and reliable record of ground features present at the time of sensing by photographic camera or multispectral scanner (MSS ).
3. **Spectral ad Spatial Resolution:** Greater fineness of the image and the details of the objects can be obtained by using spatial resolution of any sensor. For example, spatial resolution of LANDSAT MSS is 80m and of IRS LISSS-II is 36m.

   By using spectral resolution we can distinguish the different objects.
4. We may be able to see number of terrain features like forested and denudated hills, slopping of mountains, floods, sand dunes, crops and forested area, problematic area etc. in one scene.
5. **Speed and Consistency of Interpretation:** With the use of digital image processing system we can analyse the data consistently and speedily.



6. **Cost Effiective and Reliable:** Remote sensing offers cost effective and reliable monitoring systems. At times when the conventional field survey were not done honestly due to various difficulties, remote sensing offers help to cross check , verify and have more realistic and accurate data.

## DISADVANTAGES OF REMOTE SENSING

In addition to advantages accrued from remote sensing there are some misconception about remote sensing. It is unfamiliar to most users of geographic information and scientific personnel even though much of data have been generated with this technology. The misconceptions are ,

- Satellite based remote sensing does not have sufficient resolution.
- Remotely sensed data, particularly satellite data are not sufficiently accurate for practical application.
- Satellite data are too expensive.
- Remote sensing other than aerial photography is only experimental.
- Remotely sensed data are too complicated to use.
- Remotely sensed data are not readily available

## ADVANTAGES OF REMOTE SENSING AND CONVENTIONAL METHODS

- The remote sensing techniques provide the synoptic view of large area which is not possible by traditional ground survey methods.
- The data are recorded on the permanent basis.
- The data are unbiased record of the objects or phenomena.
- The data are amenable to multi-disciplinary use i.e. the same data can be used for agriculture, forestry, soil science, hydrology, geology etc.
- The process of data acquisition and analysis is faster than in conventional methods.
- Satellite data are received periodically varying from 14days to 28 days depending on the satellite. This capability of satellite helps in updating the information and monitoring the changes at short intervals.
- Remote sensing technique have the unique capability of recording data in visible as well as invisible parts of the spectrum (UV, IR, Microwave etc.)