APPLICATION OF REMOTELY SENSED DATA IN RUBBER CULTIVATION

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Programmes using satellites have established the combined use of sophisticated space and remote sensing technology for both measurement and monitoring of natural resources on the earth's surface. Satellite imagery provides better and economical data than the conventional methods as it facilitates synoptic viewing of large land areas. Thus satellite imagery can speed up survey of natural resources which could prove to be very beneficial in certain research and developmental actvities.

Remote sensing is the art and science of acquiring data about an object from a remote point without being in physical contact with the object of interest. The sensors employed in remote sensing, record the reflectance/emittance from the objects after they interact with the incident energy i.e. electromagnetic radiation (EMR), coming from the sun. The present day remote sensors operate from visible region to microwave region of the electromagnetic spectrum (EMS) (Fig.1).

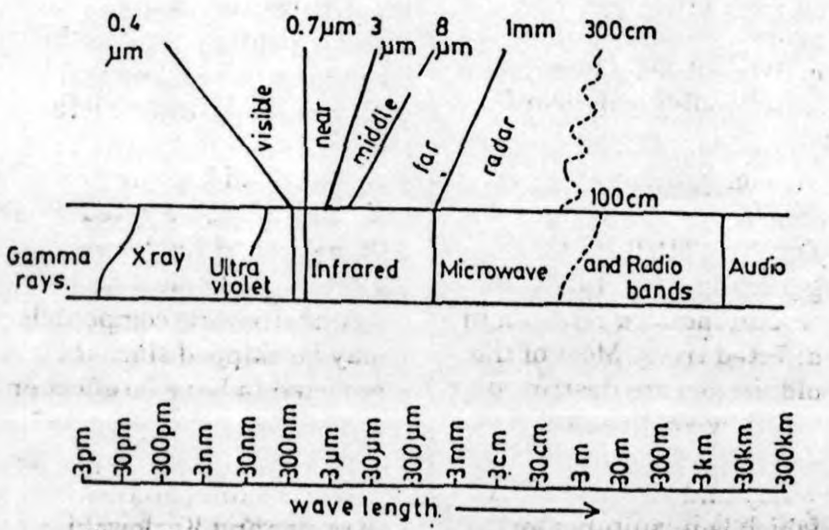

Fig 1 Electromagnetic spectrum

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There are two types of sensors which are presently in use viz., Image oriented sensors and Numerical oriented sensors. Image oriented systems are used by mounting them to aircrafts. Here the data of an object is recorded as an image i.e. photographs. Whereas the numerical oriented systems can be mounted to both aircrafts and satellites which record the data in digital format. Both types of sensors operate in visible, infrared and microwave regions of the EMS. The advantage of aerial photographs is that stereoscopic vision is possible while the satellite sensors do not provide for stereoscopic vision with the exception of the French satellite, SPOT. The great advantage with numerical data is that it gives scope for multiple enhancements for better image. Wheras image oriented data has less flexibility for being enhanced.

Typical for present time remote sensing research is the multiconcept approach which comprises:

- multispectral (or multiband) observation which is in different wave lengths to enable spectral signatures of objects.
- multistation observation which is from different stations at the same altitude (for stereoscopy) or at different altitudes.
- multipolarisd observation (for polarising properties) of objects.
- multidate (or multitemporal) observation which is of same area or object at different times or seasons.
- multienhancement or enhancemtnof imagery derived from digital processing or photographic recording. (Mulders, 1987)

POSSIBLE APPLICATIONS OF REMOTELY SENSED DATA RELATED TO RUBBER:

Rubber is a deciduous tree species introduced first to tropical India in early 20th century and this region is designated as the traditional region of rubber cultivation. Owing to increased demand for natural rubber, it paved its way to other non-traditional regions. There are however, continuous efforts to identify new potential areas which can be brought under rubber in both traditional and non-traditional regions. This paper is an effort to identify different aspects which could be looked into with the help of remotely sensed data. Following are some or the areas where remote sensing technology could prove useful.

1. Soil surveys for identification of suitable soils
2. Identification and distribution of rubber and area under plantations
3. Identification of different rubber clones
4. Assessment of moisture status
5. Detection of damage caused by diseases, insect pests and other hazards
6. Agronomic conditions
7. Application of GIS module

1. Soil surveys for identification of suitable soils:

The importance of soil surveys in identifying areas suitable for specific crops has long been proved. While the traditional soil survey techniques are time consuming, remotely sensed data will help in conducting soil surveys in much less time with considerable accuracy. The non-traditional areas of India could be surveyed to identify potential soils, suitable for rubber.

There are certain methods of image analysis with reference to identification of soils as described by Bennema and Gelens (1969). These methods include aspect of element analysis, physiographic or physiognomic analysis and morphogenetic analysis. By the utilisation of apporpriate method of interpretation, the basic aspects, compound aspects and inferred aspects of soils can be derived, depending on the factors of soil formation. For example, in humid tropical or sub-tropical areas it is not possible to identify the soils directly as it will be covered by vegetation and by physiographic analysis only it can be interpreted. Whereas in arid and semiarid regions there could be direct exposure of surface soils and it is easy to identify the soils.

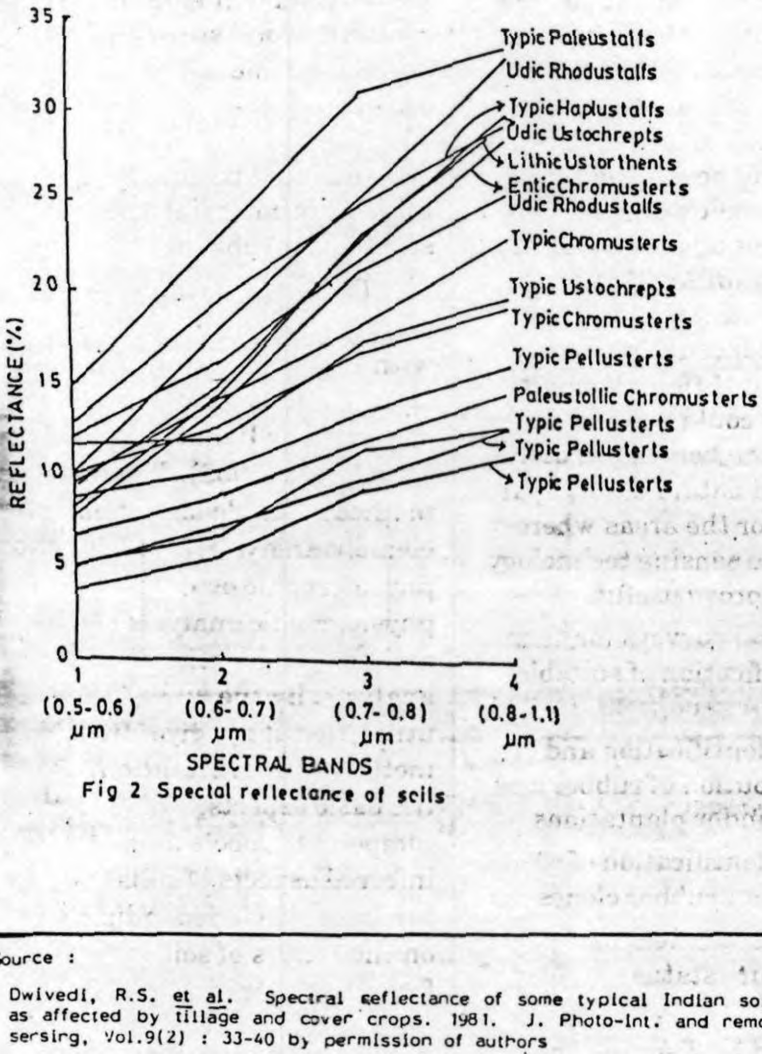

Fig 2 Spectol reflectance of scils

Source :

Dwivedi, R.S. et al. Spectral seflectance of some typical Indian soils as affected by tillage and cover crops. 1981. J. Photo-Int. and remote sersing, Vol.9(2) : 33-40 by permission of authors

Similarly, the inferred aspects like parent material, soil depth and erosion condition etc. can be detected only by physiographic analysis and morphogenetic analysis and element analysis may not be much helpful particularly in humid regions where rubber is normally grown.

For successful cultivation of rubber all aspects of soils are to be looked into. i.e. slope, depth, chemical nature of soils, erosion conditions etc. which influence nutrition and anchorage etc.. Application of remote sensing techniques will enable us to identify and to quantify the suitable soils over large areas for rubber cultivation by using appropriate image interpretation method.

Literature is available on delination of different soils by analysing spectral reflectances. Dwivedi *et al* (1981) could separate different soil series using spectral reflectance values recorded using field radiometer corresponding to Landsat MSS. (Fig. 2). Similar report was given by Govardhan (1991) on delineation of soils based on field radiometer studies. Kashiram and Nageswara Rao (1993) reported separation of more number of physiographic units and corresponding soil associations by using IRS data than the conventional method of soil survey.

In NE states, particularly in Tripura, shifting cultivation is in practice which poses a potential threat of land degradation. NRSA (1991) had estimated the extent of jhummed areas in entire Tripura state using Landsat imagery. Such data can very well be used for extension of rubber in these areas for not only rehabilitating jhumias (who

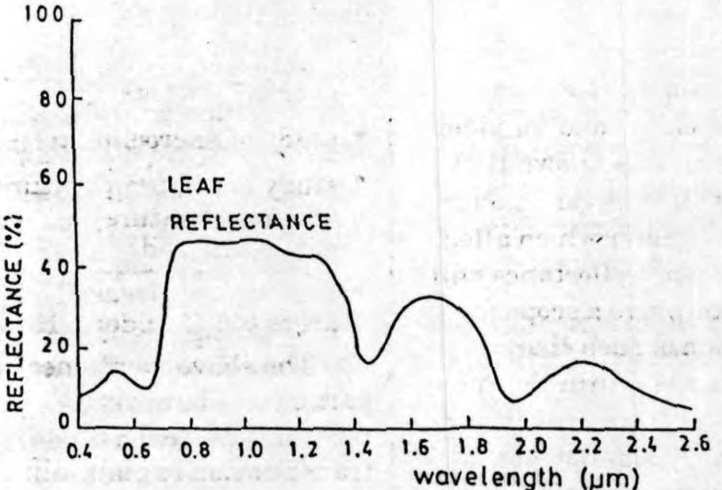

Fig 3a Reflectance spectrum of typical green leaf

Source : Mulders, M.A.. Remote sensing in Soil Science, 1987. page No.77 by permission of Elsevier Science Publishers BV, Amsterdam

practice shifting cultivation) but also for arresting further degradation of land.

It is evident that remote sensing could help us to identify areas where ruber could possibly be grown. This could be done on a very large scale in a comparatively shorter period of time and with much lesser effort.

2. Identification and distribution of rubber and area under plantations:

It is evident that under a given set of conditions, it is easy to distinguish different plant species with their specific reflectances. Fig.3a indicates the spectral signature of a typical leaf over a range of different wavelengths. This curve shows highest absorbance in red region and highest reflectance in near infrared region which is mainly due to chlorophyll content.

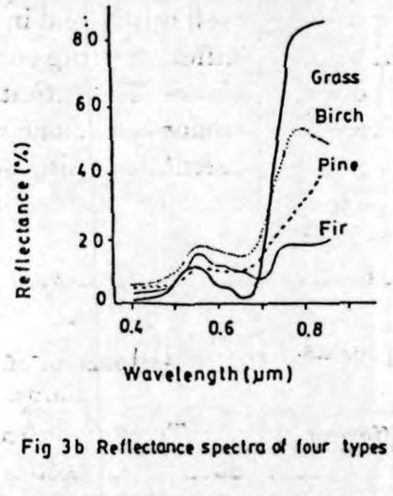

Fig 3b Reflectance spectra of four types of canopies

Source : Mulders, M.A.. Remote sensing in Soil Science, 1987 : page No.81 by permission of Elsevier Publishers BV, Amsterdam.

Fig.3b gives an idea as to how different plant species vary in their spectral reflectances. Similarly rubber can also be identified by its specific brick red tone on the image.

The extent of area under rubber is a data which is of great importance to both the planner as well as the person concerned with research and development. Although we have data on the total area under rubber, it is difficult to verify its accuracy periodically. The data on area under rubber helps the planner and policy maker to predict the yield in a particular year which in turn helps in deciding important matters like imports and support price etc.. It is also essential to have details of the extent of area under rubber in a given geographic area for monitoring different growth conditions. This estimation of area under rubber can be achieved using satellite data by digital analysis. Digital analysis enables us to analyse each pixel (picture element) so that higher accuracies can be obtained. Normally, the supervised classification will help in area estimation which uses independent information e.g. spectral reflectance to define training - data for establishing classification (Sabins, 1978). To enable supervised classification, it is necessary to do interactive processing with computer, visual interpretation and ground investigation. There was a report by Menon (1991) about the area under rubber in Trissur district of Kerala using supervised classification technique in digital analysis of IRS- LISS I data. For obtraining better image, there are other enhancement techniques as described by Sabins (1978).

3. Identification of different rubber clones:

Identification of different clones and their distribution can better be achieved by using satellite data. As such this information is needed for identifying the location specific clones and for yield statistics. It is known that any significant variation in any parameter which affect the spectral reflectance will definetely give a scope for detection of such change. For examle, Gururaja Rao *et. al.* (1988) showed that there were significant differences in epicuticular wax contents in leaf among some clones they studied viz., GI 1, RRII 308, RRII 105, RRIM 43 and Tjir 1 which led to significant variations in their spectral reflectances recorded by spectro radiometer. Similarly, other parameters with established significannt variations in certain morphological and physiological features may well be utilised in differentiating rubber clones. The extent of area under each clone can be calculated using supervised classification technique in digital analysis in combination with ground investigation.

4. Assessment of moisture status:

Thermal infrared band data pertains to thermal properties of the objects of interest in the environment. This thermal IR data can be used in the

- estimation of evaporation over large areas
- study of microclimate
- study of soil temperature and soil moisture conditions and
- detection of diseased crop areas etc. (Mulders, 1987).

The above mentioned parameters however, influence the leaf transpiration to maintain the leaf temperature at optimum level. These changes in temperature which are influenced by transpiration can be measured by sensors working in middle IR region of EMS. This information gives an idea about the soil moisture status as a whole for further monitoring to maintain optimum moisture conditions.

5. Detection of damage caused by diseases, insect pests and other hazards:

There will be differences between healthy plants and plants acted upon by damage agents like insects, diseases, fire, water deficit, floods and storms etc. with reference to their spectral reflectances. The manifestation of damage may be

- a morphological change like stunted growth, defoliation, loss of branches and wilted look etc.

- a physiological change like decrease in photosynthates, deterioration of chloroplasts etc.
- or both

A morphological change imparts a decrease in reflectance in especially IR region. Whereas the case of physiological change mainfests a shift in green peak towads yellow peak due to deteriotation of chloroplasts and finally a shift towards red region. These changes in spectral reflectance can be detected and quantified with digital image analysis. Reports are available pertaining to damage detection and quantification of the damage caused by different agents. Vogelmann and Rock (1989) used Landsat TM data for detection as well as quantification of damage caused by pear thrips in forests. They had made use of single band data and ratio-based transformations for detection and classification of the extent of damage. Similarly, such detection techniques can be extended to the case of rubber also for the estimation and to know the spread of damage because of outbreak of pests and diseases so that timely control measures can be adopted, using satellite data.

6. Agronomic conditions:

Early reserch work on relationship between spectral reflectance and agronomic conditions had led to the development of transformations or vegetation indices where ratio-based transformation data are related to the vegetation parameteres. Common ratio vegetation indices include green/red index, NIR/VIS index and Normalised Difference Vegetation Index (NDVI = NIR- VIS/NIR + VIS). With the above indices, it is possible to assess agronomic conditions which inturn affect the reflectance properties. Much of the work was done on field crops in which spectral reflectance values were used in assessing crop conditions. Walburg *et. al* (1982) were able to distinguish four levels of N fertilisation in corn. The reflectance differences were related to leaf chlorophyll, leaf total N concentration, LAI and soil percentage cover. Similarly, Hinzman *et. al.* (1986) conducted experiments with winter wheat with three levels of N fertilization. They were able to delineate two extreme levels of N fertilization with spectral reflectance at four

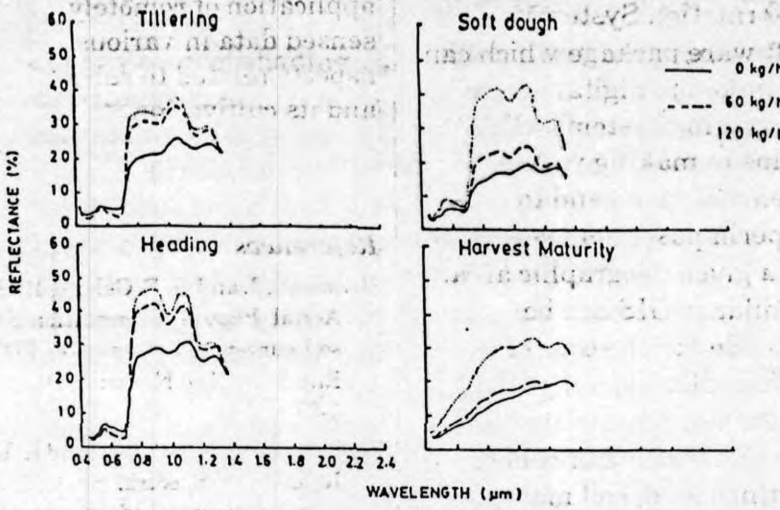

Fig 4 Spectral reflectance of winter Wheat at four stages of development with three levels of N fertilization

Source : Hinzman, L.D. et al. Effects of nitrogen fertilization or growth and reflectance characteristics of winter wheat. 1986. Remote sensing of environment. 19 : 47-61 by permission of the Director, Laboratory for applications of Remote sensing, Purdue University.

different stages of growth namely tillering, heading, soft dough and harvest maturity (Fig. 4). They concluded that near IR reflectance, IR/Red ratio and greenness index performed best for discriminating treatment levels. Perhaps such indices can be developed in case of rubber also to assess the agronomic conditions at varied growth stages which will help in monitoring the optimum growth conditions. This is possible with satellite imagery aided by digital analysis, visual interpretation and ground truth survey.

7. Application of GIS module:

GIS (Geographical Information System) is a soft ware package which can be linked to digital image processing systems. GIS helps in making various thematic maps and to superimpose them vertically on a given geographic area. Similarly, GIS can be extended to the case of rubber also whereby the thematic maps related to the distribution of rubber, fertility map, soil map, agronomic conditions and yield etc. can be generated and can be superimposed vertically to get a comprehensive picture of rubber in one given geogrphic area like one subdivision or a district or at a state level.

Besides the above mentioned major applications, remotely sensed data can be interpreted for patterns of wintering, clonal variations in wintering by using multispectral and multitemporal data. A lot of work is going on with reference to above ground biomass estimations and crop yield modelling by using satellite data. Such works can be taken up in rubber too which can help us in predicting yield under a given set of agronomic conditions. It can be positively concluded that there is a lot of potential for application of remotely sensed data in various aspects related to rubber and its cultivation.

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