



## SOIL BASED REMOTE SENSING TECHNIQUES FOR FORECASTING POTENTIAL AREAS FOR MULBERRY CULTIVATION

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### ABSTRACT

*Remote sensing techniques can be effectively employed to sense various parameters recommended for mulberry tree. In this paper, we present detailed analysis of the soil required by mulberry tree. Using remote sensing techniques, thermal conductivity of soil can be estimated which may help us in identifying areas with the required soil type. Soil pH can be captured by the satellite. Using color image processing techniques, land areas satisfying the desired pH requirements can be identified. Thus, soil suitable for mulberry, both in terms of pH and thermal conductivity can hence be located. The paper proposes an advisory system to forecast potential areas for mulberry cultivation.*

**INDEX TERMS:** Mulberry, Remote sensing, soil, advisory.

### 1. INTRODUCTION

Mulberry trees have been known to mankind since a long time. However, what made them famous was their use in the sericulture industry. Mulberry leaves (*Bombyx mori*) serve as fodder for silkworms.

For maximum yield of silk, it is required that the silkworms should be healthy in their life period. Better the quality of mulberry leaves, healthier will be the silkworms. Mulberry is typically a tropical tree. However it can be cultivated in other regions as well by controlling factors affecting growth of mulberry tree.

Environmental Factors that affect the growth of mulberry leaves are:

#### 1) Light requirement:

Mulberry trees should be planted in an area that receives direct sunlight for at least 8 hours. Mulberry trees can grow in shady areas as well but the quality and quantity of the fruit is poor and even the tree's structure is weak

#### 2) Temperature requirement:

Being a tropical tree, it requires warm climate throughout the growth period. it has a very low temperature tolerance.

#### 3) Preferred soil type:

Well-drained loam or clayey loam.

Optimum soil pH: Mulberry requires slightly acidic soil with pH 5.0-6.8.

In this paper, we focus on predicting favorable regions based on soil type for cultivation of mulberry trees. When mulberry trees will be grown in such regions which totally satisfy the soil requirements, the yield of mulberry will increase. This will surely impact sericulture industry positively.

### 2. ANALYZING SOIL REQUIREMENTS

Soil as a medium for plant growth provides the environment for development and functioning of the plant's root system. Not only must the soil furnish the nutrients required for the metabolic processes of plant growth but it must also provide favorable air-water regimes for proper functioning of the plant. Various types of soil have different water holding capabilities which largely affects growth of plants. Vegetation cover largely depends upon the type of soil. Mantle of soil at the earth's surface is studied to understand soil formation and map patterns of soil variation. This mapping is done with the help of remote sensing. Remote sensing technologies offer accurate and timely information. Remote sensing allows mapping of large data which, otherwise, would have been physically impossible. Remote sensing produces maps which serve as quick method for estimating important characteristics required by the crop. Remote sensing thus helps in creative investigation of potential areas for plantation of mulberry.

Thermal diffusivity-

Soil temperature controls microbiology of the growing plants.

The manner in which heat flows through the soil is of considerable importance in plant cultural practices in general. Specifically, it affects plant root activity with respect to the uptake of nutrients, water, etc. Thermal diffusivity is basically related to thermal conductivity of soil. Thermal diffusivity is computed for different layers of soil. Using image processing techniques, heat currents in various layers of soil can be mapped to determine varying regions of thermal conductivity.

It is obvious that thermal conductivity of granular soil will depend upon intimacy of contact of the solid particles and the extent to which air is displaced by water in the pore spaces between the particles. Thermal conductivity



diminishes with decreasing particle size due to reduced surface contacts through which readily flow.

Thermal imagery is therefore a valuable asset for remote sensing because it conveys information not easily derived from other forms of imagery. The thermal behavior of different soils can permit derivation of information not present in other images.

Mulberry tree requires pH in the range of 5 to 6.8. We can obtain satellite images depicting various pH levels in a field.

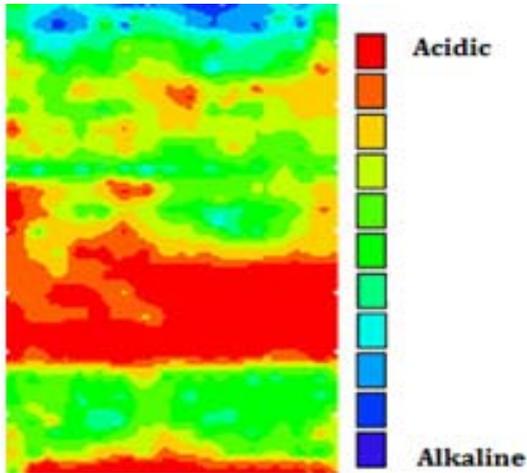


Figure 1: Satellite image showing spectral signature of pH levels across a terrain.

(Image Courtesy: Missouri.edu)

The term 'Spectral Signature' has been used to refer to the spectral response of a feature, as observed over a range of wavelengths (Parker and Wolf, 1965).

### 3. REMOTE SENSING

Remote sensing depends upon observed spectral differences in the energy reflected or emitted from features of interest. This principle is the basis of multispectral remote sensing, the science of observing features at varied wavelengths in an effort to derive information about these features and their distribution. Remote sensing allows determination of following properties of soil:

- 1) Soil Moisture
- 2) Soil temperature
- 3) Soil Texture

#### Soil moisture content:

The thermal properties of water contrast with those of many other landscape materials, so that the thermal image can be very sensitive to the presence of moisture. That itself is often a clue to the differences between different classes of soil.

The increase in thermal conductivity as a result of raising the density is small compared with the impact of adding water to the soil. The presence of water films at the points of contacts between the particles not only improves the

thermal contact between the particles but also replaces air in the soil pore space with water, which has about 20 times the thermal conductivity of air. Mulberry tree requires ample water supply. This means that thermal conductivity of soil is increased. Soil moisture maps can be collected through remote sensing. They can allow determination of moisture content in the soil.

#### Soil texture:

Roughness of soil can be remotely sensed. The roughness or texture is different for different types of soil. For example sandy soil is coarse and granular whereas clayey soil is fine and smooth. As mulberry requires loam to clayey loam soil, using image processing techniques, only these specific areas can be highlighted.

### 4. IMAGE PROCESSING FLOW DIAGRAM

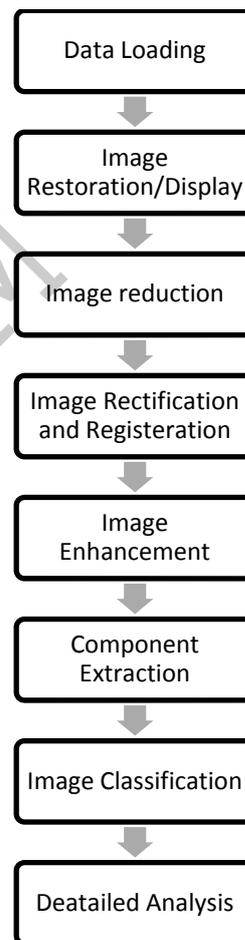


Figure 2: Flow Diagram

#### 1) Data Loading:

The data acquired from the satellites is loaded into the system that will further carry out image processing.

#### 2) Image Restoration and display:

Noise is eliminated from the image. We compute the suitable image degradation model to remove the effect of added noise. Specific filters may be used to remove certain types of noise. For example, Median filter successfully removes impulse or salt and pepper noise, Min-Max filter is used to remove Gaussian noise and so on.

#### 3) Image reduction:



A single image is composed of hundreds of thousands of pixels. However, not all pixels are important. Because of the presence of redundancies, we can successfully compress an image.

It is proposed to use spectral transformation as compared to spatial transformation. The benefit of using spectral transformation is suppression of topographic shading factor. Spectral transformation leads to multispectral images which are often highly correlated.

Spectral correlation arises due to following factors:

i) Material spectral correlation:

It is caused by low reflectance of vegetation across the visible spectrum, yielding similar signature in all bands.

ii) Topography:

Topographic shading is the same in all solar reflectance bands and can, in certain situations be a dominant factor. It leads to band-band correlation in the solar reflective region. The effect is different for different thermal regions.

iii) Sensor band overlap:

This type of spectral correlation is basically related to the design of the sensors. Though it can be minimized by improving the design of the sensor, it can practically be never eliminated.

Spectral redundancy can be removed by principal component transform (PCT).

#### 4) Image rectification and Registration:

Image rectification is basically used to correct the distortions in the remotely acquired image. Image registration is used to map different sets of data into a single co-ordinate system. It thus allows uniform assessment of an image.

#### 5) Image Enhancement:

Image enhancement is subjective. We can use several enhancement techniques such as

i) Contrast stretching : It is a piece-wise linear transformation technique where the image contrast is adjusted on the basis of some threshold.

ii) Image enhancement using spatial filtering such as linear and convolutional filtering, High boost filters, statistical filters, gradient filters and so on.

#### 6) Feature Extraction:

It involves information extraction from the image, spectral and spatial pattern recognition.

Referring to the above pH scale, it can be inferred that

Using image morphology and segmentation, suitable information is extracted for detailed analysis.

#### 7) Image classification:

It includes data calibration, interpretation of target properties, training and verification. We can use Maximum likelihood classification, supervised or unsupervised classification, hard and soft classification or artificial neural network classification.

#### 8) Detailed Analysis:

Detailed analysis of the information extracted by the acquired images to forecast the potential areas for cultivation of mulberry can be carried out. We may also predict the amount of mulberry (in terms of vegetation cover) to have a broader insight for mulberry cultivation.

#### Estimation of Vegetation

Using the property of reflectivity, we can also predict the production of mulberry over a given piece of land.

Several vegetation indices are available for computing this value.

Ratio of a near- infrared band (NIR) to a red band can indicate vegetation.

Ratio Vegetation Index (RVI) =  $\rho_{NIR} / \rho_{red}$

Modulation ratio for NIR and red bands is called the Normalized Difference Vegetation Index (NDVI).

$$NDVI = \frac{\rho_{NIR} - \rho_{red}}{\rho_{NIR} + \rho_{red}}$$

Transformation of RVI leads to NDVI. It is used extensively to monitor vegetation cover on continental scale. However, in arid and semi-arid regions where biomass is low, it is a poor indicator of vegetation cover.

The Soil Adjusted Vegetation Index (SAVI) is a superior vegetation index for lower cover environments.

$$SAVI = \frac{\rho_{NIR} - \rho_{red}}{\rho_{NIR} + \rho_{red} + L} (1 + L)$$

Where L is a constant that is empirically determined to minimize vegetation Index sensitivity to soil background reflection variation.

(Huete and Jackson)

Using the above vegetation indices, the yield of mulberry trees over a layer of soil can be estimated.

#### 5. ADVANTAGES

The world of practical remote sensing has changed dramatically in recent decades. Aspects of remote sensing that formerly seem to require highly specialized knowledge to a much broader spectrum of users as data became less expensive and more widely available, and as manufacturers designed software for use by the non specialist. In agriculture, tools and data used include imagery data (AVHRR, Landsat TM, SPOT), vegetation indices, crop models, Geo- informatics system software, image processing, agro-meteorological data models, GIS software, Digital image processing, weather station data, climate data, etc.



## 6. CONCLUSIONS AND FUTURE SCOPE

The proposed advisory system predicts potential areas for mulberry plantation. As soil requirements by a mulberry tree are successfully met, the overall mulberry production will increase. We can also expect increase in the quality of mulberry leaves. Sericulture industry will benefit with the availability of mulberry in good quantity as well as quality. Further, the proposed solution can be extended to other varieties of crops. Crops which have stringent requirements of parameters or low tolerances can definitely benefit from this technique.

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