Rising levels of carbon dioxide and other greenhouse gases are of great concern to scientists and policy makers because they trap infrared radiation that is emitted by the earth’s surface. Potential consequences of elevated carbon dioxide concentrations include a warming of the earth’s surface, melting of polar icecaps and a rising sea level, and an alteration of plant and physiological function and ecosystem. Perennial trees, occupying about 30% of the earth’s land surface, and accounting for about 80-90% of all plant carbon, may act as a valuable sink of carbon dioxide.

Gross primary production (GPP) represents the gross uptake of carbon dioxide by vegetation that is used for photosynthesis and is another widely used variable for monitoring vegetation productivity. A number of satellite-based GPP estimation models showed the potential of remotely sensed (RS) data in GPP modeling. However, most of the currently available GPP estimation models such as vegetation photosynthesis model (VPM), C-fix and MODIS GPP algorithm need meteorological inputs in addition to RS data.

Recently developed remote sensing data based GPP prediction model which does not depend on meteorological data efficiently calculated the GPP in different forest ecosystems. The remotely sensed GPP model uses only four remote sensing variables—two radiation budget variables (Albedo$_{NIR}$ and LST) and two ecosystem variables global vegetation moisture index (GVMI) and enhanced vegetation index (EVI). In
the present study, the remote sensing data based GPP prediction model as well as the VPM model was modified and improved in such a way to suit the model for arid and semiarid vegetation carbon sequestration studies by the introduction of a new vegetation index called total ratio vegetation index (TRVI).

A new generation of advanced optical sensors - VEGETATION (VGT) sensor on board the SPOT-4 satellite and the moderate resolution imaging spectroradiometer (MODIS) mounted on terra and aqua platforms acquires daily images of the globe, and offers potential for improved characterization of vegetation. The vegetation indices such as enhanced vegetation index (EVI), land surface water index (LSWI), global vegetation moisture index (GVMI) and total ratio vegetation index (TRVI) calculated from spectral reflectance value are used as input parameters for the calculation of GPP.

In present study, analysis of satellite images are combined with meteorological data and estimated the seasonal dynamics of carbon sequestration in the tropical cashew plantation area of Cuddalore and Perambalur district of Tamilnadu, India, using modified vegetation photosynthetic model (MVPM) and explored the capability of SVM, RBFNN and AANN to classify the pattern of carbon sequestration in the cashew plantation. The input data to the MVPM model are the enhanced vegetation index (EVI), the land surface water index (LSWI), total ratio vegetation index (TRVI), air temperature (T), and PAR (photo synthetically active radiation).

The VGT-S10 data was acquired and MODIS (8 day composite images) over the period of January 2006 to December 2009 for the study area and calculated EVI, LSWI and TRVI from the standard VGT-S10 data and calculated the GPP. The calculated GPP from VGT data using MVPM model predicts high GPP in the late wet season, as compared to dry season. The predicted MODIS GPP increases from January to March and decreases from April to June due to decrease in soil moisture and increased air
temperature. When GPP predicted by MVPM using VGT and MODIS are compared with MVPM GPP predicted using MODIS data was in best agreement ($R^2 = 0.92$) with MODIS GPP (MOD-17A2) and hence the predicted MVPM GPP using MODIS data was taken for carbon sequestration pattern classification using support vector machine (SVM), radial basis function neural networks (RBFNN), and autoassociative neural networks (AANN).

The 11 attributes (light use efficiency ($\varepsilon$), leaf phenology ($P_{scalar}$), land surface water index (LSWI), enhanced vegetation index (EVI), air temperature ($T$), minimum temperature ($T_{min}$), maximum temperature ($T_{max}$), optimum temperature ($T_{opt}$), total ratio vegetation vegetation index (TRVI), global primary production (GPP) and scale factor ($a$)) derived from remote sensing image and climate data were used to train the model. The comparison of SVM, RBFNN and AANN as obtained by taking the average performance values showed that the SVM recorded the highest accuracy of 98.6% as compared to RBFNN (95.2%) and AANN (96.38%). This implies that SVM outperforms RBFNN and AANN in identifying carbon sequestration pattern of cashew plantation using satellite imagery derived vegetation indices.

Another study is conducted to establish the temporal dynamics of carbon sequestration pattern of casuarina plantation in Cuddalore and Perambalur District of Tamilnadu, India, using an improved remote sensing model (IRS) which does not depend on meteorological data and use only on four remote sensing variables-two radiation budget variables ($Albedo_{NIR}$ and LST) and three ecosystem variables-EVI, GVMI and TRVI. The results from simulations of the IRS model using eight-day composite MODIS data have shown that the IRS model predicts reasonably well the gross primary production of an casuarina plantation. The IRS model overestimated GPP as compared to MODIS GPP. The IRS predicted GPP data is taken for carbon sequestration pat-
tern classification using support vector machine (SVM), radial basis function neural networks (RBFNN), and autoassociative neural networks (AANN).

The six attributes such as global vegetation moisture index (GVMI), land surface temperature (LST), enhanced vegetation index (EVI), Albedo value, total ratio vegetation index (TRVI) derived from remote sensing image and calculated global primary production (GPP) were used in the model. The comparison of performance of SVM, RBFNN and AANN showed that the AANN outperforms the RBFNN (77.34%) and SVM (93%) by recording the highest accuracy of (98.63%).

From the results of the study it is concluded that

1. The modified vegetation photosynthesis model and improved remote sensing model effectively predict the seasonal dynamics of carbon sequestration in cashew and casuarina plantation respectively.

2. All the three pattern classification models efficiently classify the carbon sequestration pattern in both cashew and casuarina plantation.

3. Among the three pattern classification techniques, SVM classifies the carbon sequestration pattern more efficiently as compared to the other two techniques in cashew plantation.

4. AANN is identified as best classifying technique when compared to SVM and RBFNN for casuarina plantation.

6.1 Major Contributions of the Work

The most important contribution of the research reported in this thesis is that it presents the method for carbon sequestration studies for broad leaf vegetation (cashew) and needle leaf vegetation (casuarina). The major contributions of the thesis are:
• A modified vegetation photosynthesis model was developed and evaluated for the carbon sequestration studies of broad leaves vegetation (cashew) of arid and semiarid areas by adding total ratio vegetation index (TRVI) as an additional parameter.

• The existing remote sensed data model (IRS) was improved in such a way to suit it for arid and semiarid needle leaf vegetation (casuarina) carbon sequestration studies by the inclusion of TRVI.

• The efficiency of the SVM, RBFNN and AANN was evaluated in classifying the carbon sequestration pattern of cashew and casuarina plantation.

6.2 Suggestions for Future Work

The MVPM model and IRS model GPP values are compared with MODIS GPP (MOD-17A2) data due to nonavailability of Flux tower site in the study area. Therefore the validation of models should be done by conducting this research in areas where flux tower is available.

Additional attributes may be included in both MVPM and IRS model in order to predict the carbon sequestration pattern more precisely.