15 Remote Sensing Estimation of Crop Biophysical Characteristics at Various Scales

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15.1 INTRODUCTION

Remote sensing has provided valuable insights into agronomic management over the past few
decades. The use of remote sensing for determining crop physiological and phenological status has
its roots in the pioneering work by William Allen, Harold Gausman, and Joseph Woolley [1–3], who
provided much of the basic theory relating morphological characteristics of crop plants to their optical
properties. These pioneering works have led to the understanding of how leaf reflectance changes
in response to leaf thickness, species, canopy shape, leaf age, nutrient status, and water status. Leaf
chlorophyll content and its absorption in the visible spectrum provide the basis for utilizing reflectance
as a tool either with broadband radiometers typical of current satellite systems or hyperspectral
sensors that measure reflectance at narrowbands. The basic understanding of leaf reflectance has
led to the development of various vegetation indices (VIs) that have been extended to crop canopies
and have been used to quantify various agronomic parameters (e.g., leaf area, crop cover, biomass,
crop type, nutrient status, and yield). These tools are still being developed as we learn more about
how to use the information contained in reflectances from a range of different sensors.

A summary of the progress in applying remote sensing to agriculture was recently published in a
collection of articles in *Photogrammetric Engineering and Remote Sensing* (volume 69) [4–8]. Other
recent reviews of the application of remote sensing methods to crops were developed by Hatfield
et al. [9,10]. These articles provide a summary of the multispectral and hyperspectral remote sensing
efforts in more detail and the reader is referred to these articles for a more thorough understanding.

This chapter contains a summary of experiences and advances made in the last 10 years in understand-
ing how remote sensing at a close range and at satellite level can be used to quantitatively assess
crop biophysical characteristics (BPCs). In what follows, the performance of VIs in estimating crop