Chapter 1
Introduction

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Sustainable and thus also economical farming requires precise adaptation to the natural and economic conditions. The irradiation of the sun, the natural water supply, the soil properties and the demand of the market just are not uniform at all.

Even within small regions or within a farm, the soil qualities or the slope of the fields can be different. Farmers have adapted their practices to this for centuries.

However, the differences existing within single fields also deserve attention. Within fields, there certainly are differences in the soil properties, in the slope, in the water supply and consequently in the development of crops in many cases. But as long as farming operations were done manually or by means of small implements, the farmers succeeded rather easily to adjust to these differences.

Yet this situation has changed fundamentally in many areas of the globe, where now machines with a working width of up to 40 m operate in fields that are much larger than those of the past. Under these conditions, the farmer has lost very much in immediate contact with the soil and the crop. The high capacity machinery treats large fields in a uniform way. This method cannot be regarded as being sustainable, since in most cases neither the soil nor the crop are uniform within a field. Permanent and precise adjusting to the varying, site-specific soil and crop conditions in the field can address the environmental needs much better and ensure high yields. This is the rationale for site-specific precision farming.

This rationale needs means to get to its objectives. Human visual observation and subsequent manual adjustment on-the-go hardly is possible when operating with high speeds and wide machinery. Sensors which record and computers that process the signals about the respective site-specific situations of the soils or crops within a field can and will overcome the challenges. When used in combination with actuators – which adjust the machinery correspondingly – they allow for automated

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and on-the-go corrected site-specific farming operations. The results of the sensing and processing can be stored in georeferenced, site-specific field maps. This is necessary whenever the sensing occurs prior to the respective field operation.

The main problem with this general concept is selecting suitable sensing principles and appropriate processing methods for its signals. A vast variety of concepts and alternatives has been developed, investigated and analysed in the past for many farming operations such as *e.g.* soil cultivation, sowing, fertilizing, crop protection, irrigation and harvesting. The results of this intensive, scientific work have been published in numerous journals and proceedings of conferences. For those interested in site-specific farming, the results present themselves in a very fragmented way.

This fragmented situation may be the inevitable initial fate of any new field that is developing in science and application. Nevertheless, this new field does need a compendium, which facilitates to obtain a fast overview. This book tries to be such a compendium about site-specific precision farming.

It is well known that the general attitude of the public towards modern farming techniques differs greatly. Only part of the public views modern farming techniques in an open-minded and affirmative manner. There is a substantial part of the public, which blames high-tech, modern farming for being a burden to the environment and the society. Especially mineral fertilizers, herbicides, fungicides and insecticides that are needed for high yields are regarded as contaminants for the environment.

Fortunately, applying agricultural chemicals within single fields in a site-specific way allows to reduce the amount needed while still maintaining or even improving the yields. The efficiency in the use of farm chemicals thus can be enhanced. In general, the same can hold for the efficiency in the input of energy, seeds and water.

In short, this book intends to show that precision farming can substantially help to get high yields per unit area as well as a protected environment.

It is not within the scope of this book to deal with technical details of precision farming. Due to the abundance of alternatives available, this would be impossible within one book. Instead of this, the book aims at explaining the rationales existing between agronomical sciences, sensing principles plus its physical, chemical and biological background as well as finally possibilities in agricultural engineering and farming management. Thus the book is based on an interdisciplinary approach within several fields of the agricultural sciences and adjacent disciplines.