Preface

This book emphasizes scientific computing and applications in agriculture. It is said in one of its chapters that Mathematics is the stairs given to man by God to reach the infinity. Currently, we are living in the information age and we can not climb the steps of this stairs without information technology and quantitative methods. The Mathematics part of the statement has generalized to scientific computing, even considering its more basic philosophical foundations.

The chapters cover a wide range of applications and techniques from different countries, groups and scientific institutions. Although some of them are still in an early stage and better suited for academic or research environment, others are almost ready to be used in real conditions of rural areas. The richness of this book is precisely its diversity, which is capable of stimulating convergence among different areas of knowledge and may result in unexpected advances, both in the area of computational methods and in agricultural research.

Chapter 1 has an introductory nature and aims at giving us an account about a successful agricultural research institution that owes an important part of its triumph to a strong investment in scientific computing. This chapter is a testimony from people who played important roles in the creation of the organization and in the adoption of scientific computing as a support for agricultural research.

Next, **Chapter 2** addresses particularly the study of the spatial motion of agricultural activities. The methodology based on statistical descriptive methods associated with concepts from elementary physics and from geographical processing allows the evaluation of the spatial concentration and the dynamics of agricultural products as well as visualizing the center of mass of crops productions. This methodology can be used in order to give an overall summary of the spatial changes along the years. The procedure also allows studying the agricultural development and is particularly relevant to countries where substantial changes in the rural space use are ongoing, as it occurs in Latin America.

Working in a similar domain, **Chapter 3** presents, in a didactic way, a method to assess changes in land cover using the approach of the transition matrix. The method allows the evaluation of gains and losses, swap, and net change in different types of land cover and also allows the identification of systematic transitions in a region between two points in time. The method is a powerful tool for evaluating trends in agriculture within the land use policies that seek to environmental sustainability.

Chapter 4 presents an approach to analyze, monitor, and discover knowledge from remote sensing images associated to climate data. The techniques are based on the Fractal Theory, data streams, and time series mining: the FDASE algorithm; a method that combines intrinsic dimension measurements with statistical analysis; and the CLIPSMiner algorithm applied to multiple continuous time series of climate data. The monitoring tool presented permits that, instead of spending hours analyzing graphs and charts, the specialists may count on methods that spot the regions and the periods where they should pay more attention during the decision making process.

Also handling digital images, **Chapter 5** provides the theoretical and practical basis to estimate crop areas using statistical objective sampling and remote sensing data. Formulas are presented and can be applied to other land covers that occupy large portions of surface, such as forest, water bodies and urban areas. The estimate of crop areas is of great potential, since it allows predictions provided with quantification of the error. The method can be performed at different scales, from the smallest, as municipalities, to the larger, such as countries.

Chapter 6 describes how to use the Geographic Information Systems - GIS to combine data of weather and soil in order to define areas of potential suitable for the cultivation of sugarcane. The system generates a map of the distribution of the risk of frost and, as a result, the crop management can be designed in a way that sugarcane achieves physiological maturity before the period of increased climate risk, decreasing the chances of low productivity. This application of GIS shows potential to become a powerful tool for management of rural environment and of public policy.

Chapter 7 assesses the capacity of the self-organizing map, an unsupervised artificial neural network, for aiding the process of territorial planning through methods of visualization and clustering applied to a multivariate set of geospatial and temporal data. Population growth and hence the demand for quality public services and projects for regional infrastructure, require from public managers greater flexibility in decision-making so that they are observing the requirements of fairness, efficiency and effectiveness. Therefore, territorial typology provided by this method offers an important feedback for the development of a collective solution to issues relating to rural development.

To define the best area for commercial cultivation of eucalyptus in a certain region, **Chapter 8** uses satellite imagery, mapping and geo-referenced data on climate, the soil and watersheds, beyond the topography, with the aim of establishing forest policies considering socioeconomic issues. Specifically, this study allows evaluating the aptitude of a specific region, according to the environmental requirements for each species of eucalyptus, the soil capacity of water storage and the risk of frost.

Chapter 9 addresses the complex task of planning cultivation and harvesting of sugar cane with focus on tactical and operational aspects which determine the best way to manage fields, maximizing profits. The proposed mixed integer programming model extends the classical Packing formulation, adding a network flow structure to represent the harvest scheduling. Experiments performed with real-world instances ensure a realistic presentation of the processes. The presented algorithms are promising to solve, in reasonable time, even larger problems as they appear in practice.

In agricultural economics, one of the greatest drawbacks of mathematical programming models to evaluate agricultural processes is to calibrate the model in a base year. That is because it is difficult, if not impossible, to introduce in the models all the variables affecting farmer's decisions to obtain reliable results. **Chapter 10** presents a way to get the calibration of these models even using limited information. By using the dual form of the original model, this methodology allows to reproduce the situation existing in a baseline situation of the unit modeled (e.g. farm or region). This method, called the Positive Mathematical Programming, is currently being used in a great number of analyses of new agricultural policies in Europe.

Chapter 11 provides a brief explanation of some aspects involved with the development of models and mathematical-modeling simulations, to show their benefits to the decision-making process in the environmental impact assessment of agriculture. It shows that there are many types of mathematical methods to deal with decision making in this field of applications. The main models and simulators mentioned on the literature, as well as their uses, are outlined. The chapter also presents emerging trends in implementation of mathematical-modeling on agricultural research.

A linear approach is applied in **Chapter 12** to optimize crop rotation scheduling under some ecological restrictions. The work includes detailed description of three optimization problems that are solved in order to put together the ecological criteria with technical constraints specific of crops. To achieve its objectives, the authors use the technique of column generation to allow the construction of rotation plans in an iterative scheme. The results indicate that the methodology is appropriate and an incorporate new features as they become necessary or can discard those with less importance to a region or farming system specific.

Chapter 13 discusses the important process of leaching of pesticides and their risk of groundwater contaminating. It presents the basic concepts of simulation models and shows the mathematical development to prepare the model to assess the risk of water contamination by pesticides. The chapter shows the efficiency of the Pesticide Leaching Models (PLM) in use in the European Community to define policies controlling the use of pesticides, and their possible use by the authorities responsible for managing the risk of groundwater contamination.

Chapter 14 presents a simulation model structured into five modules, in which the use of multi-agent approach has the main role. It is a remarkable example of the combination of several techniques for the simulation of agricultural areas subject to flooding that offers the possibility to evaluate different strategies to be adopted according to the severity of the occurrence of floods.

Another use of models is demonstrated in **Chapter 15** that presents a fairly didactic approach of modeling technique to evaluate the spatial distribution of species. An application is made on data from Babaçu (Orbignya spp.), a palm tree native from Amazon region. Modeling techniques using neural networks and elements of descriptive statistics, together with the concept of maximum entropy, are used to evaluate the degree of loss of biodiversity. The use of the concept of ecological niche is very important in this context because it may allow assessment of the effects experienced by some species due to changes underway in the region.

The knowledge of precipitation conditions is so valuable information for agricultural management purposes that justify the continuous development and improvement of methods for forecasting. **Chapter 16** presents the development of an Artificial Neural Network (ANN) model for seasonal precipitation forecast based on climate indices, focusing on the practical aspects of selecting the best predictors, defining ANN architecture, data handling and ANN training and validation. Climate predictions can lead decisions towards a strategic view, aiming at minimizing unwanted impacts and taking advantage of favorable conditions. This approach can be successfully used to provide site-specific precipitation forecasts, valuable for the agriculture-related decisions.

Although the reuse of water, especially rainwater, has historically had a wide use in various regions of the world, there is still resistance to the reuse of wastewater, especially those used for agricultural irrigation. This important topic is approached in **Chapter 17** that aims at demonstrating the economic feasibility of reuse of water resources in agriculture, which can be one more element in environmental protection and aid to regions with water scarcity. The use of descriptive methods, based on the Lp metric and multicriteria approach is called compromise programming This methodology proves to be quite useful to define the reuse of wastewater or not, describing reuse as an option to be promoted and evaluated.

Facing another challenge, the focus of **Chapter 18** is in technological solutions to guarantee a reliable bovine traceability, what is very important for both producers and consumers of beef cattle. It is presented a decision support system dedicated to animal geolocation and to the analysis of sanitary problems. The system architecture is designed in three layers: acquisition, data management and spatial decision support. It has potential use to governmental institutions and farmers in case of a recall, saving time and costs apart from collaborating to achieve the food security.

Finally, aiming at contributing to the construction of a life cycle inventory database for agricultural production systems, **Chapter 19** proposes an integrated view for a data-construction methodology for agri-environmental assessment.

We would feel rewarded if this volume would help in improving the bridge between the academic people and agriculture practitioners community in benefit of the improvement of the food production in the world.