

LOST HARVEST:

Quantifying the Effect of Plant Diseases on Major Crops in the Philippines

$$y = Y - Y[1 - P_1)(1 - P_2)...(1 - P_n)]^b$$

$$y = b_1x_1 + b_2x_2 + b_{1,2}x_1x_2$$

07

wardees

T

S

AVELINO D. RAYMUNDO, PhD

Professor of Plant Pathology
Crop Protection Cluster, College of Agriculture
University of the Philippines Los Baños
College, Laguna

LOST HARVEST:

***Quantifying the Effect of Plant Diseases
on Major Crops in the Philippines***

AVELINO D. RAYMUNDO, PhD
Professor of Plant Pathology
Crop Protection Cluster, College of Agriculture
University of the Philippines Los Baños
College, Laguna

Multinational Printers
Parañaque City

Copyright@2006 University of the Philippines Los Banos, College, Laguna 0431
& Bureau of Agricultural Research, Diliman, Quezon City

Raymundo, Avelino D.

Lost Harvest: **Quantifying the Effect of Plant Diseases on Major Crops in the Philippines.**

Includes bibliographical references and index

ISBN: 971-8778

1. Plant diseases
2. Crop losses
3. Crop protection

FOREWORD

Before this decade, few scientists researched on the ravaging effects of crop diseases to farmers' yield. Large volumes of harvest were routinely lost but these were rarely documented, much less quantified. There were probably two reasons behind this phenomenon. First, the methodologies for experimentation were difficult, thus, discouraging potential researchers from pursuing it. Second, the field received little attention and support from the scientific community. Yield loss estimation remained on the fringes of more popular scientific pursuits. In fact, when funds were scarce, it was one of the researches easily dispensed with.

But things have drastically changed since then. During the last ten years, the growing need to understand the spatial and temporal aspects of crop diseases inspired various researches on crop loss estimation. The field was also identified as a vital input in formulating more coherent and lasting management strategies. Although measurements of the intensity, frequency, and extent of crop losses were inadequate in many cases, the information generated were valuable. The results have provided an initial basis on how plant diseases were affecting major crops.

This book is a rich resource material which will benefit many readers. It will be a useful guide to researchers since it contains experimental methodologies specific to crops and diseases. The book encourages them to consider crop loss estimation in the context of current quantitative methodologies such as multivariate analysis, modeling, and computer simulation. Research administrators will find this a timely and vital reference in decision-making, especially in fund allocation. And in the academe, students at the graduate and undergraduate levels can use it as a reference for their courses in agriculture.

May you find this book equally valuable and may it encourage more research and publications that will promote stronger science for agricultural development!



LUIS REY I. VELASCO

Chancellor

University of the Philippines Los Baños

P R E F A C E

Scientific books on local subjects are rare in the Philippines. They never seem to get written despite the profusion of qualified prospective authors and of enough data. The subject of crop loss is no exception.

I wrote this book out of a sense of dejection arising from knowing that a considerable amount of data on losses are languishing in scientist's shelves and computer files and likely will remain there untouched until they become obsolete. Some of these data do get published, albeit in scattered journals, but a coherent view on the subject continues to be non-existent.

This book presents the results of available works on losses in many of the major crops of the Philippines. In order to understand the part that crop loss estimation plays in disease control or management, basic concepts are presented in Part I. The actual estimates of losses are contained in Part II, with appropriate citations, preceded by methodologies developed by various workers for specific crops and diseases. A general synthesis of these estimates and methodologies is provided in Part III, which contains, as well, recommendations for improving the generation of data appropriate for diverse purposes, including loss forecasting.

As mentioned in Part I, this book hopes to impress upon research administrators and crop protectionists that yield loss is critical in decision-making regarding priorities in research. Resource scarcity demands that funds be used only on research on the most economically important diseases and loss information should guide this decision. Likewise, the magnitude of loss due to a certain disease determines the necessity of a control measure and more importantly in the choice of strategy. For obvious reasons, the information found in this book is by no means complete both in terms of facts and methodologies. It should be possible, therefore, for researchers to plan further work to augment or improve on any deficiency. Along this line, recommendations for further research are given at the end of the book.

Dr. Ofelia K. Bautista, retired Professor of the former Department of Horticulture, University of the Philippines Los Banos (UPLB) and former Editor of the Institute of Scientific Information (ISI)-accredited journal, *The Philippine Agricultural Scientist*, and Dr. Rizaldo G. Bayot, Associate Professor of the National Crop Protection Center, Crop Protection Cluster, College of Agriculture, UPLB, reviewed the entire draft of the book. They have been instrumental in the evolution of the manner of material presentation. Dr. Narceo B. Bajet, retired Professor of the former Department of Plant Pathology, UPLB and currently with the University of Washington, USA edited the first 15 chapters of this book and provided valuable insights that improved the manuscript considerably. Rosmelia K. Raymundo, my daughter who is a freelance writer and editor, reworked many sentence structures in the manuscript enhancing their readability. Edwin N. Camaya provided superb English editing. I wish to acknowledge their invaluable help and vital contributions in shaping the book into its final form.

Many other people showed interest and offered encouragement in the writing of this book. Some were so kind as to provide materials that were difficult to find. The genuine elation of many of my students that such book will come into fruition has kept me motivated to no end. Mae Ditan, a Plant Pathology *cum laude* graduate who typed many of the tables, took time to engage me in many discussions about the book and I thank her for her sincere interest.

Four Ph. D. students of mine, Dr. Jocelyn P. Pedroso, Dr. Revelieta B. Alovera, Dr. Carlos S. dela Cruz, and Dr. Benny Corcolon either quantified or analyzed the economic implications of losses due to tungro in rice, Stenocarpella disease complex in corn, mosaic in abaca, and freckles in banana, respectively, the results of which were discussed extensively in the book. In their present positions in the academe, government, and the private sector, they continue to espouse the importance of crop loss estimation. I wish to acknowledge them for their significant contributions in the advancement of this field of study in the Philippines.

The Bureau of Agricultural Research promptly approved and provided funding for the publication of this book. BAR's support and that of the University of the Philippines Los Banos in several project extensions are gratefully acknowledged.

My wife, Dr. Asuncion K. Raymundo demonstrated, while being preoccupied as Professor and Director of the Institute of Biological Sciences, UPLB, an unusual flair for providing the necessary push in maintaining momentum in the writing of the manuscript. On many occasions when the impetus to write sputtered, she gently would remind, to my occasional deserved discomfiture, that there was a deadline to meet and a commitment to fulfill. This effectively kept the writing regimen going until the very end. The completion of this book owes much not only to her vigilance but to her unwavering support as well.

Avelino D. Raymundo

CONTENTS

Pages

FOREWORD i

PREFACE ii

UNIT I : PRINCIPLES AND METHODS OF ASSESSMENT OF CROP LOSSES DUE TO DISEASES

A.	Introduction	1
B.	The importance of plant diseases in Philippine agriculture	1
C.	Principles of crop loss assessment	2
D.	Measurement of plant disease	3
E.	Methodology of crop loss assessment	4
	1. Survey methods	
	2. Sampling methods	
	2a. Simple random sampling	
	2b. Stratified sampling	
	2c. Multi-stage sampling	
	3. Single tiller/plant methods	
	4. Paired-plot experiments	
	5. Field plots with varying disease severities	
	5a. Use of chemicals	
	5b. Use of variable amounts of inoculum	
	5c. Use of host resistance	
	5d. Inoculation of host at different times	
	5e. Manipulation of environmental conditions	
	6. Simulated-damage techniques	
	7. Computer simulation modeling	
F.	Basic models of disease-loss relationship	7
	1. Single point model	
	2. Multiple point model	
	3. Area-under-the-disease-progress-curve model	
	4. Response surface model	
G.	Effect of multiple diseases and pests	9
H.	Models for quantifying multiple pest effects	10
I.	References	11

UNIT II : ESTIMATES OF LOSSES DUE TO DISEASES IN MAJOR PHILIPPINE CROPS

CEREALS

Chapter 1	Corn downy mildew	15
Chapter 2	Corn banded leaf and sheath blight	25
Chapter 3	Corn Stenocarpella disease complex	37
Chapter 4	Corn bacterial stalk rot	45

Chapter 5	Rice tungro	51
Chapter 6	Rice blast	69
Chapter 7	Rice sheath blight	75
Chapter 8	Rice bacterial leaf blight	91
Chapter 9	Rice bacterial leaf streak	101
Chapter 10	Rice root nematode	105
Chapter 11	Sorghum tar spot	107
Chapter 12	Sorghum sheath blight	113

FRUITS

Chapter 13	Banana freckles	117
Chapter 14	Banana nematodes	123
Chapter 15	Mango anthracnose	127

FIBER CROPS

Chapter 16	Abaca bunchy-top and mosaic	131
Chapter 17	Cotton Fusarium wilt	141

PLANTATION CROPS

Chapter 18	Coconut cadang-cadang	147
Chapter 19	Sugarcane ratoon stunting disease	151
Chapter 20	Sugarcane leafscorch	161

LEGUME

Chapter 21	Peanut stripe	163
Chapter 22	Peanut leafspots	167

VEGETABLES

Chapter 23	Bacterial wilt	173
Chapter 24	Cabbage nematodes	175
Chapter 25	Tomato nematode	177
Chapter 26	Potato viruses PXV and PYV and lateblight	181
Chapter 27	Potato viruses PXV, PYV, PSV and PLRV	187
Chapter 28	Sweet potato feathery mottle virus	191
Chapter 29	Taro feathery mottle virus	195

OTHER CROPS

Chapter 30	Ginger leaf spot	197
Chapter 31	Mulberry rust	201
Chapter 32	Tobacco mosaic virus	205

UNIT III SYNTHESIS AND RECOMMENDATIONS..... 209

BIBLIOGRAPHY 217

SUBJECT INDEX 232