

Munich Studies on Innovation and Competition

Volume 5

Series Editors

Josef Drexl, Germany

Reto M. Hilty, Germany



More information about this series at <http://www.springer.com/series/13275>

Mrinalini Kochupillai

Promoting Sustainable Innovations in Plant Varieties

 Springer

Mrinalini Kochupillai
Max Planck Institute for Innovation and Competition
Munich, Germany

ISSN 2199-7462 ISSN 2199-7470 (electronic)
Munich Studies on Innovation and Competition
ISBN 978-3-662-52795-5 ISBN 978-3-662-52796-2 (eBook)
DOI 10.1007/978-3-662-52796-2

Library of Congress Control Number: 2016946352

© Springer-Verlag Berlin Heidelberg 2016

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer-Verlag GmbH Berlin Heidelberg

To the farmers of India and other developing countries who work tirelessly, in open fields, in all weather conditions, to feed 80 % of the world's population, every day.

Annadata Sukhi Bhava
(May the person who brings us food, be happy)

'Life is like a tree: Just like how a tree's roots are old and the branches are new, in the same way, life needs ancient wisdom and modern scientific knowledge, both together'.

Sri Sri Ravi Shankar

Acknowledgements

It is a rare fortune to have a Doktorvater who not only points a student in the right direction at the right time but also conveys complete confidence in the students' approach and abilities. I was one of the fortunate few who had such a Doktorvater. I would, therefore, first and foremost, like to thank Prof. Josef Drexl, my Doktorvater (supervisor) and the director of the Max Planck Institute (MPI) for Innovation and Competition, for his expert guidance and unwavering encouragement throughout the time that I spent researching and writing this book. It was the combination of his guidance, encouragement and support that gave me the insights, confidence and perseverance necessary to complete this work.

I would also like to thank Prof. Joseph Straus, professor emeritus and former director of the Max Planck Institute (MPI) for Intellectual Property and Competition Law. It was Prof. Straus who introduced me to the world of plant variety protection and provided me the initial guidance as I entered this intriguing field of study as an independent research scholar in 2008. I have, since then, also learned a great deal from his lectures and articles on the subject. In particular, his careful attention to the science underlying a discipline has encouraged me to also look closely at the science underlying the discipline of plant breeding, and I hope that this has enriched the study beyond what a purely legal analysis could have.

During the course of this research, several other experts also took time out of their busy schedules to help me understand the science, technologies, policies and/or laws underlying this complex discipline. I thank them in the order in which I had the good fortune of meeting and interacting with them: In the very initial stages of my research, Dr. Sabine Demangue, who had herself written a doctoral thesis titled 'Protection of Plant Genetic Resources: A Suitable System for India', provided a great deal of guidance and passed on some important literature that helped me kick off my research in this complex field. Ms. Diana Leguizamón, another doctoral candidate at MPI working on the topic of plant variety protection in the Latin America context, also provided a great deal of guidance during the initial stages of my research. Soon after, as I struggled with the basic science of

plant breeding, Prof. Shalaja Hittalmani (University of Agricultural Science, Bangalore), Dr. Aparna Das (Indo-American Seeds), Dr. Shashank Mauria (ICAR), Dr. Mahadevappa (advisor, Plant Authority of India), Ms. Sunita Sreedharan (advocate), Dr. Bala Ravi and Dr. M.S. Swaminathan (M.S. Swaminathan Research Foundation), Dr. Kannan Babu (Tamil Nadu Agricultural University), Dr. Pooram Gaur and Mr. B. Rao (ICRISAT), Dr. Bhowmik and Dr. Anita Babbar (Madhya Pradesh Agricultural University), Dr. Narayanan (Metahelix) and Dr. Vilas Tonapi (ICAR) helped me understand the basic concepts and complications that consume this field of study. Later, as my questions went beyond the basics, they also kindly agreed to give me more time, and their inputs have contributed significantly to my own understanding of the subject and therefore to the discussions that form part of this book.

When I started the empirical work that forms the central part of the research described in this book, several other experts also provided insights, suggestions, inputs and guidance, without which the extensive empirical research undertaken for this book would not have been possible. For the private sector surveys, I would like to thank Dr. Lakshmikumaran (advocate), Dr. Samathanam (advisor, Department of Science and Technology), Ms. Sunita Sreedharan and Dr. Bhim Dahiya (Kaveri Seeds) for their valuable inputs and detailed explanations and for sharing their insights. Without these inputs and insights, the study would have remained incomplete and could not have adequately covered the private sector's viewpoints. I would also like to thank Mr. Narendra Mittal, a large landowning farmer in Dehradun, who gave a great deal of his time to helping me pretest the farmer's survey. His inputs helped modify the farmer survey considerably and make it more understandable from a farmer's perspective. I would also like to thank Mr. Sandeep Pawar, Mr. Kishoreda and Dr. Ramkrishna Mule of the Sri Sri Institute of Agricultural Science and Technology Trust, for their time and invaluable inputs that helped me understand the science behind organic farming, once again from a grassroots and practical perspective. Mr. Pawar also introduced me to the work of Albert Howard, which proved to be of central importance for completing the analysis in Chaps. 3 and 4 of this work.

One person to whom I would like to extend special thanks is Dr. N. Jayasuryan (director, Microtest Innovations). It has been said that when one is focused on accomplishing a task that is close to one's heart, the Universe contributes by bringing one in contact with people who selflessly guide and help you out. Such people are indeed like godsent angels, and Dr. Jayasuryan was certainly one such angel. He not only took out a great deal of time from his packed daily schedule to personally explain the science of genetics and heredity to me but also put me in contact with several other people who then contributed significantly to the research by sharing their inputs, insights and further contacts. He also took great pains and personal interest in introducing me to government officials and university professors in Chhattisgarh and Madhya Pradesh, the regions where the farmer surveys for this study were administered. Without his support, the collection of data from villages would have been significantly more difficult, if not impossible.

The experts met as a result of Dr. Jayasuryan's efforts, who themselves proved invaluable for this study included Mr. Ramesh of the Indian Administrative Service, and his family, at Chhattisgarh who hosted me during part of my stay at Chhattisgarh and introduced me to several key officials working with the Ministry of Agriculture in Chhattisgarh and also to university professors who proved invaluable in getting in contact with regional agricultural extension officers (RAEOs) in the surveyed regions of Chhattisgarh. Without Mr. Ramesh's willing, enthusiastic and active help, it would have been next to impossible to contact so many key people and make arrangements for surveys within the tight deadlines I was working with. I am also grateful to his family for taking care of me as if I was one of their own family members during my time at Chhattisgarh, including particularly while I was unwell with severe stomach problems during the course of administering the first set of surveys in the pretest regions of Raipur. From within the Chhattisgarh region, I would also like to thank Mr. Mittal of the Agricultural University at Raipur and Mr. R.D. Kushwaha, head of agricultural extension at Deobhog, who were of great help in contacting RAEOs and organizing the making of announcements to farmers in the Deobhog region.

I would also like to convey my heartfelt thanks to Prof. A.K. Bhowmik of the Agricultural University in Jabalpur. Without his help, it would not have been possible to contact any of the RAEOs or to send announcements to farmers in the Narsinghpur and Gadarwara regions. In addition, I would like to convey my heartfelt and special thanks to the numerous RAEOs in Deobhog and Narsinghpur who went beyond the call of duty to help me organize and administer the surveys. I would, in particular, like to thank the following officials for their enthusiastic help: Mr. Sanjay Aggarwal, Ms. Somati Bairagi, Mr. Sampat Rai, Mrs. S. Rai, Mr. Durgesh Kaul, Mr. KS Verma, Mr. Arjun Singh, Mr. R.P. Bhavkole, Mr. R.-N. Patel, Mr. P.K. Thakur, Mr. D.K. Sharma, Mr. T.R. Patel, Mr. L.L. Srivastav and Mr. S.S. Kaurav. I would also like to convey my special thanks to RAEOs in the Raipur region who helped administer the pretest surveys among 90 farmers from various villages around Raipur, particularly, Mr. Kamlesh Kumar Sahu, Ms. Sunanda Meshram, Mr. Kirti Sahu, Mr. Surendra Kumar, Mrs. K. Basanti, Mr. H. Kasaar, Mr. K.C. Tandon, Mr. S.P. Dubey, Mr. M.L. Chandan, Ms. Anjita, Mr. Mukesh, Mrs. Anita Kujur, Ms. Manjulata, Ms. Veena Ghodeshwar, Mr. T.-L. Sahu, Mr. Khilendra Verma, Mr. Rajendra Kumar, Mr. A.K. Gauraha and Ms. Bhumeshawari Verma.

I cannot conclude the acknowledgements related to my empirical work without thanking the three hundred or so farmers who waited in line patiently to answer my long survey questionnaire. To be with all of you was a learning experience in itself—your patience and the complete absence of complaint can only be a source of inspiration for anyone who has had even one glimpse of the difficulties you face on a daily basis in your open fields and in your homes. Yet, it was heart-warming to see the love and belongingness with which so many of you invited me to your homes for a meal, snacks, tea or just a chat during the days that I spent with you. Without your patient and enthusiastic participation, this study would have been impossible.

I would also like to convey my special thanks to Ms. Mandakini Singh, Mr. Vikram Singh and Ms. Surabhi Singh for their help in locating and acquiring several important references, including several India-specific references that are not easy to locate and obtain copies of, in the most efficient and careful manner. I would also like to thank Ms. Sunita Bhalla, joint director of the Parliament Library at Delhi, for her help in locating the Seed Review Team Report and for organizing a copy of the report to be made and sent to me via Mr. Vikram Singh. Without this report, the historical research undertaken as part of this study would have been incomplete.

From within the International Max Planck Research School for Competition and Innovation (IMPRS-CI) programme, I would like to express my heartfelt gratitude to Dr. Andrea Wechsler, the first coordinator of the IMPRS-CI programme. Dr. Wechsler guided all IMPRS students in the initial months by providing feedback and suggestions on how to formulate a multidisciplinary thesis. She also organized several courses on mathematics and economics that helped all the law students of the IMPRS programme understand several of the basic concepts and approaches to multidisciplinary studies. I also would like to thank Dr. Sylvie Nerrison who took over the role that was initially played by Dr. Wechsler midway through my Ph.D. journey. I also convey my special thanks to several of my colleagues at the IMPRS-CI for their help, advice and support over the entire period during which I was working on this study. First, I thank Dr. Arul Scaria who provided several valuable and practical tips throughout my thesis journey—from pointing out possible roadblocks in the empirical research to sending me several references that contributed to my understanding of the mixed methods research approach, Arul was an invaluable and supportive ‘senior’ at the IMPRS programme. I would also like to thank Dr. Ashish Braradwaj and Dr. Tatjana Nobokin from the economics side of the IMPRS programme for the numerous hours they spent in explaining various complexities of the Stata software, the commands that could be used to conduct regressions and other tests within Stata and the meaning of various econometric terms. Without their patient help, the econometric investigations undertaken as part of this multidisciplinary study would have been significantly more time consuming and difficult. Additional support on the economics side was also given by my friend Dr. Gunjan Sharma who, despite working and living a busy life in the USA, always responded to SoS messages on Skype and gave several hours to me via Skype to discuss issues that perturbed me greatly.

In the 5 years, during which I have been consumed mentally and emotionally with the topic of this book, the support of my family has been most invaluable in guiding and sometimes pushing me through to the end. Although it has been my dream to study and learn from the poorest of the poor farmers in my country, personal circumstances made the time that I spent with them very challenging at an emotional, mental and also physical level. During this time, and during the entire period of 5 years that I was busy researching and writing this book, the patience, encouragement, love and support provided by my family ensured that I could complete this task that I felt so deeply about. The unwavering love, encouragement

and patience of my husband, Enrico, who never for a second doubted that I would and should complete this work, was not only like a magic potion that kept my spirits and energy levels up but was unbelievable in its strength and consistency to me and to everyone else who had the opportunity to witness it—you, my dear husband, have worked harder for this work than I have and I am ever grateful to you for this. The support and time provided by my mother in helping my husband take care of my daughter who was born soon after I started my research for this book were also deeply touching and invaluable in ensuring that I could spend the long hours in my office without having to worry about my family. My mother spent hours and hours in the kitchen in my home cooking healthy and delicious meals for my entire family (and me) while I typed away in my office. That not a single word of complaint escaped her mouth even in times when I was in a bad mood due to stress does not cease to amaze me—you, my dear mom, have been a pillar of patience, forbearance and perseverance and you have inspired me my whole life. My uncle's invaluable and practical support, guidance and encouragement were also invaluable in completing this work—it is not often that you will find a scientist and a businessman, who is busy with work, meetings and assignments 24/7, taking several days off from his busy schedule to accompany his niece to faraway regions just to ensure her safety and to help in what ever way possible to complete the assignment as desired by the rather demanding niece. My father's lifelong insistence that our work should be our passion, and it must be aimed at benefitting the lives of the poorest of the poor in the world, was perhaps the underlying guiding force of this work. His enthusiasm and constant inquiry into the status of my work, and my sister's cheerful and loving presence, also gave me the emotional and mental strength needed to complete the work with total commitment and focus. I shout out an additional thanks to my sister, Malini, who introduced me to her contacts who work with farmer groups near Delhi—the discussions with these farmers provided several insights that complemented the farmer surveys done in the villages. I am also immensely grateful to my daughter, Meera, who grew from being a baby in my arms to a strong, talkative and confident 3-year-old during the time I wrote the first draft of this book; she showed patience and understanding beyond her years, especially during the last phase of my book writing, when for a period of almost 5 consecutive months, I was hardly ever home to see her or be with her. During these days also, my husband's and my mother's love and patience in playing the roles that a mother usually does ensured that she did not feel any dearth of loving care. I would also like to thank my yoga family in Munich, especially Ms. Julia Uhlmann, who spent several hours babysitting my daughter—you have been like a sister to me throughout this journey, and your unconditional love and support cannot be forgotten. My dear family, I have learned from you all more than I have learned from books and classrooms and discussions. I have learned the most valuable lessons of life, love, patience and understanding from you all over the last 5 years. And the only thing I can give you in return is my gratitude.

Lastly and most importantly, I would like to thank Sri Sri Ravi Shankar. It is you and your presence and the knowledge and the unconditional love that you have showered on me over countless years, and perhaps also countless lifetimes, that has

made me finally start looking at life from a perspective beyond personal comfort zones, personal gains and personal fame. You have taught me that every atom in this Universe has its purpose and makes an important contribution in its own way. You are an inspiration to millions on this planet, and despite your unbelievably packed schedule, you always give quality time to my questions and my concerns, thereby giving me the much-needed confidence and energy to continue with my work and dreams. I pray for your continuing guidance so that I may serve the people of this Earth, and I may serve my purpose on this Earth, in whatever manner and measure necessary, as selflessly as you do.

Contents

1	An Economic & Philosophical Introduction to ‘Sustainable Innovations’ in Plant Varieties	1
1.1	<i>Shiva</i> : A Symbol of ‘Sustainable Innovation’	1
1.2	<i>Shiva</i> to Schumpeter: Revisiting ‘Creative Destruction’	5
1.2.1	<i>Shiva</i> , Sombart & Schumpeter: Identifying the Differences	8
1.2.2	The Sustainability of ‘Creative Destruction’	9
1.3	‘Creative Destruction’ in the Agricultural Seeds Sector	11
1.4	The Organization of This Book	15
1.5	A Note on Methodology	17
2	The International Legal Framework for the Protection of Plant Varieties and Agrobiodiversity	19
2.1	The International Legal Framework for the Protection of Plant Varieties: The Background Leading to the Research Goal	19
2.1.1	The UPOV Texts	21
2.1.2	The CBD and the ITPGRFA	27
2.1.3	Sustainable Innovation: What and Why	36
2.1.4	Why In Situ Agrobiodiversity Conservation?	40
2.2	The Background Leading to the Delimited Research Objectives (Scope of the Study)	41
2.2.1	Why Intellectual Property Protection Regimes?	41
2.2.2	Why India?	42
2.2.3	The Informal Seed Sector: What and Why?	44
2.2.4	Why the Pulses Sector	45
3	Plant Breeding & Seed Improvement: Then & Now	49
3.1	Traditional (<i>In Situ</i>) Agriculture & Associated Socio-Cultural Practices: Historical and Scientific Perspectives	50
3.1.1	On-Farm Crop Improvement and In Situ Evolution of Agrobiodiversity	51

3.1.2	Traditional Agriculture and Associated Scientific and Socio-Cultural Practices	55
3.2	The Evolution of Formal (<i>Ex Situ</i>) Crop Improvement and Plant Breeding	57
3.2.1	Mendelian Genetics and the Creation of Hybrids	59
3.2.1.1	The Economics of Hybrid Seeds	62
3.2.2	Self-Pollinating Varieties and Male Sterile Lines	63
3.2.3	Terminator and Traitor Technologies	66
3.2.4	Genetically Modified (GM) Seeds: Bt and Roundup® Ready Technology	68
3.2.5	The Sustainability of ‘Modern’ Agriculture	72
3.2.5.1	The Impact of Modern Plant Breeding on Genetic Variability and Genetic Diversity	73
3.3	Chapter Conclusions	75
4	The Indian Protection of Plant Varieties & Farmers Rights Act 2001: A Critical Overview	79
4.1	Indian Agriculture and Associated Agricultural Policies: History and Current Status	81
4.1.1	History of Agriculture and Agricultural Policies in India	81
4.1.1.1	Agricultural R&D in Pre-independence India	82
4.1.1.2	Agricultural Policies and 5-Year Plans in Independent India: An Overview	84
4.1.1.3	Green Revolution and HYV Seeds in India	86
4.1.1.4	Seed Act, 1966 and the Seed Review Team Report, 1968	91
4.1.1.5	The 5 Year Plans of India and Recent Trends	94
4.1.2	Background of the Indian PPV&FR Act	97
4.1.2.1	Agriculture in India: The Formal Seed Sector	97
4.1.2.2	Agriculture in India: The Informal Seed Sector	100
4.2	The Indian PPV&FR Act: Objects and Purpose	102
4.3	PPV&FR Act in Practice: Understanding Key Provisions	105
4.3.1	The ‘Parental Lines’ Case	105
4.3.1.1	Background: The Indian Seed Industry & Its Parental Lines	105
4.3.1.2	Background: Protecting Extant Varieties	107
4.3.1.3	Registration of Extant Varieties	107
4.3.1.4	Facts and Decision in the ‘Parental Lines’ Case	109
4.3.1.4.1	Novel	111
4.3.1.4.2	Extant	113
4.3.2	The ‘HMT’ Controversy	113
4.3.2.1	Background	113

4.3.2.2	Facts and Analysis Under the PPV&FR Act . . .	114
4.3.2.2.1	Researcher's Rights	116
4.3.2.2.2	Essentially Derived Variety	117
4.3.2.2.3	Rights of a Farmer's Variety Registrant	118
4.3.2.2.4	Cancellation of Registration	121
4.4	Plant Variety Protection Application Trends in India (2007–2013)	123
4.4.1	Coding the Indian Plant Variety Application Data	123
4.4.1.1	Explanation of Data Fields	124
4.4.1.2	Variables Used for Data Analysis	126
4.4.2	Plant Variety Protection Application Data: Description and Analysis	127
4.4.2.1	Overview of Trends: Applications for Plant Variety Protection in India	129
4.4.2.1.1	Top 10 Most-Popular Species	130
4.4.2.1.2	Top 10 Applicants (Table 4.5)	132
4.4.2.2	Application Category by Applicant and Crops	133
4.4.2.2.1	Application Category by Applicant	133
4.4.2.2.2	Application Category by Crop	133
4.4.2.3	Applications by Crop Pollination and Applicant	134
4.4.2.4	Applications by Applicant Category and Crop . . .	135
4.4.2.5	Applications by Applicant Category and Crops	136
4.4.2.5.1	A Closer Look at Private Sector Applications	136
4.4.2.5.2	A Closer Look at Public Sector Applications	139
4.4.2.5.3	A Closer Look at Farmers Variety Applications	141
4.5	Chapter Conclusions and Overview of Findings	142
4.5.1	Adoption of Non-sustainable Agricultural Policies	142
4.5.2	Adoption of Divergent Goals in Enacted Laws and Policies	143
4.5.3	The Scheme of the Indian Act	143
4.5.4	Incentives for Breeders (Formal Seed Sector)	144
4.5.5	Incentives for Farmers (Informal Seed Sector)	145
4.5.6	Balancing the Incentive Structure	145
5	Data Coding, Interpretation and Analysis	149
5.1	Private Sector Surveys & Interviews: Findings & Analysis	150
5.1.1	Responses to Research Questions (For List of Questions, See Annex 6)	151

5.1.1.1	Research Question 1: What Propels a Private Sector Seed Company to Enter a Market That Does Not Grant IP Protection to Plant Varieties?	151
5.1.1.2	Research Question 2: What Is the Current Research Focus of the Indian Seed Industry?	152
5.1.1.3	Research Question 3a: Pulses R&D, Production and Distribution Trends Among the Private Sector Seed Industry of India	155
5.1.1.4	Research Question 3b: Which Factors Influence (or Would Influence) the Private Sector's Interest (in the Present/Future) in Pursuing R&D in Pulses Seeds/Crops (Especially Those That Are Self-Pollinating and for Which No Male Sterile Lines Have So Far Been Identified)	156
5.1.2	Miscellaneous Comments	160
5.1.2.1	Importance of Farmers' Right to Save, Exchange and Resow Seeds	160
5.1.2.2	Farmers' Varieties in Public Domain	160
5.1.3	Section Conclusions	161
5.2	Farmer Surveys	163
5.2.1	Farmer Cultivation Choices/Preferences and Underlying Rationale	163
5.2.1.1	Research Question(s) Addressed	163
5.2.1.2	Testing Hypothesis A.1: Cultivation Trends and Cultivation of Pulses Versus Non-Pulses Crops in the Surveyed Districts	165
5.2.1.3	Testing Hypothesis A.2: Preferred Crops and Pulses Cultivation Trends in the Surveyed Districts	166
5.2.1.4	Testing Hypothesis A.3: Comparing Profit as a Cultivation Choice Rationale in the Surveyed Districts	167
5.2.1.4.1	Categorizing and Coding Reasons for Cultivation Choices/Preferences	168
5.2.1.4.2	Coding Rationale and Presumptions	169
5.2.1.4.3	Response Frequency Under Each CC Category	171
5.2.1.4.4	Test of Proportions (Prtest) on the Cultivation Choice Categories	172
5.2.1.4.5	Test of Proportions (Prtest) on Dominant Cultivation Choice Rationale Categories by District on Individual Seed Types	175

5.2.1.4.6	Test of Proportions (Prtest) on Cultivation Choice Categories by Cultivated Land Area	176
5.2.1.5	Section Conclusions & Analysis: Cultivation Choice Rationales—An Indication of Market Failure?	177
5.2.2	Farmer Seed Replacement and In Situ Conservation Practices	179
5.2.2.1	Research Question(s) Addressed	179
5.2.2.2	Hypotheses: Set 1	181
5.2.2.3	Understanding the Variables and Their Inter-Relationship	182
5.2.2.4	Testing Hypotheses: Set 1	184
5.2.2.4.1	Hypothesis B.1: Average Seed Replacement Trends in Pulses Versus Preferred Crops	184
5.2.2.4.2	Testing Hypothesis B.2 & B.3: Average Seed Replacement Values for Pulses and Preferred Crops in Each of the Surveyed Districts . . .	184
5.2.2.4.3	Testing Hypothesis B.4: Average Preferred Crop Seed Replacement Values in the Surveyed Districts . . .	185
5.2.2.4.4	Testing Hypothesis B.5: Average Pulses Crop Seed Replacement Rates in the Surveyed Districts	186
5.2.2.4.5	Sub-Section Conclusions (Combining Quantitative and Qualitative Findings)	187
5.2.2.5	Hypotheses: Set 2	189
5.2.2.5.1	Understanding the Variables and Their Inter-Relationship in the Data-Set . . .	192
5.2.2.5.2	Testing Hypothesis B.6	193
5.2.2.5.3	Testing Hypothesis B.7 and B.8 . . .	193
5.2.2.5.4	Testing Hypothesis B.9	194
5.2.2.5.5	Testing Hypothesis B.10	195
5.2.2.5.6	Testing Hypothesis B.11 and B.12 . . .	195
5.2.2.5.7	Testing Hypothesis B.13 and B.14 . . .	196
5.2.2.5.8	Sub-Section Conclusions	197
5.2.3	Factors Affecting Seed Replacement & Conservation: Linear and Probit Regressions	199
5.2.3.1	Research Question(s) Addressed	199
5.2.3.2	Hypotheses: Identifying Independent Variables That Might Affect the Dependent Variable 'Conservation'	200

5.2.3.3	Testing the Hypotheses: Linear Versus Probit Regressions Models	202
5.2.3.3.1	Linear Regression Results	202
5.2.3.3.2	Probit Regression Results	203
5.2.3.3.3	Interpreting the Regression Results	204
5.2.3.4	Sub-Section Conclusions and Analysis	206
5.2.4	Socio-Cultural Practices in the Surveyed Districts	208
5.2.4.1	Current Seed Exchange Practices	209
5.2.4.2	Opinion on Willingness to Share and to Stop the Practice of Sharing/Seed Exchange	210
5.2.4.2.1	Responses to Question 1: Rewards Versus Exclusive Rights	211
5.2.4.2.2	Response to Question 2: Willingness to Exchange/Share Improved Seeds	211
5.2.4.2.3	Response to Questions 3 and 4: Willingness to Share with the Government and the Private Sector	213
5.2.4.3	Sub-Section Conclusions and Analysis	214
5.2.5	Evidence of Farmer-Level Innovations and Village Level In Situ Agrobiodiversity Conservation	215
5.3	Chapter Conclusions (Summary of Key Findings)	217
6	Addressing Market Failures for Sustainable Innovations in Plant Varieties	219
6.1	Schumpeter and the ‘Value-Neutrality’ of Modern IP Regimes	219
6.2	Market Failure and IP Protection	223
6.2.1	‘Market Failure’ as a Justification for IPRs	224
6.2.2	‘Market Failure’ as a Justification for Limiting IP Rights	227
6.2.3	IP Law and ‘Missing Markets’	228
7	Conclusions & Recommendations: Leveling the Incentives Landscape to Promote Sustainable Innovations in Plant Varieties	231
7.1	The Need to Level the Landscape of Incentives: Overview of Research Findings	232
7.1.1	Incentives Skewed Heavily in Favor of Formal Plant Breeding	232
7.1.2	Addressing Government Policies That Act as ‘Perverse Incentives’	233
7.1.3	The Indian Law Is a Good Attempt at Balancing Divergent Interests	235
7.1.4	‘Creative Destruction’ Is Not the Observed Phenomenon vis-à-vis Innovations in the Agricultural Seeds Sector	236

7.2	Leveling the Incentives Landscape: Adopting Measure Both ‘Internal’ and ‘External’ to IP Laws and Policies	238
7.2.1	Establishing Checks and Balances Within the IP Regime for the Protection of Plant Varieties	240
7.2.1.1	Tweaking the Indian Plant Variety Protection Law	240
7.2.1.1.1	Modifying the Researcher’s Rights Exemption	240
7.2.1.1.2	Expanding the Circumstances in Which Farmers Can Claim Compensation for Improving a Variety	241
7.2.1.2	Amending UPOV While Retaining the Flexibilities Under Article 27.3(b) of TRIPs	242
7.2.2	Complementing Internal Checks Through External Means	242
7.2.2.1	Imposing Pigouvian Taxes for Soil Pollution and Agrobiodiversity Erosion	243
7.2.2.2	Support Work of Non-Governmental Organizations (NGOs)	244
7.2.2.3	Supporting Private Sector Efforts That Encourage Agrobiodiversity Conservation	245
7.2.2.4	Crop Insurance	245
7.2.2.5	Promoting Formal R&D into Landraces and Means of Increasing Yield of Landraces Using Sustainable Eco-Friendly Methods	245
7.3	The Way Forward	246
7.3.1	Implementing ‘Soft Law’ Contained in International Agreements	246
7.3.2	‘Fundamental Extension in Morality’ as a Means of Promoting Sustainable Innovations in Plant Varieties	247
Annex 1: Research Methodology—Overview of Research Methodology and Objectives		249
1.1	Mixed-Methods Research Approach	249
1.1.1	Partially Mixed, Concurrent and Sequential, Equal Status Design	253
1.1.2	Qualitative and Quantitative Research Designs	254
1.1.3	Sampling Design	256
1.1.4	Mixing Rationale and Purpose	259
1.2	Designing and Executing a Mixed-Method Research	261
1.2.1	The Research Goal	263
1.2.2	The Research Objective	263
1.2.3	Research Questions	264
Annex 2: Total Applications Filed by Species (2007–2014)		269

Annex 3: Crop Species Notified Under the PPV&FR Act, 2001	271
Annex 4: Variables Used for Data Analysis—Survey Questions, Response Sets and Coding	275
4.1 Table 1: Name and Description of the Variables Used (Hypothesis A.1 – A.3, B.1 – B.12)	275
4.2 Table 2: First Level of Coding for Reasons for Cultivating Preferred/Pulses Crops	277
4.3 Table 3: Variables Used for Probit and Linear Regressions	280
Annex 5: Explanation of Variables Used in the Hypotheses	283
Annex 6: Private Sector & Farmer Surveys: Scope, Structure, Methodology & Implementation	285
6.1 Identifying the Questions for Qualitative and Quantitative Empirical Investigations	285
6.1.1 Questions Guiding the Structure and Content of the Private Sector Survey/Interviews	286
6.1.2 Questions Guiding the Content and Structure of the Farmer Survey/Interviews	288
6.2 Private Sector Surveys: Scope, Methodology, Structure and Implementation	292
6.2.1 The Private Sector Survey: Scope and Methodology	292
6.2.1.1 Scope	292
6.2.1.2 Methodology	294
6.2.2 The Private Sector Survey: Structure and Content	295
6.2.2.1 Profile of Companies	296
6.2.2.2 Seed R&D Portfolio and Pulses Seeds R&D Portfolio	296
6.2.2.3 Seed Production and Pulses Seeds Production Portfolio	296
6.2.2.4 Seed Distribution Portfolio	297
6.2.2.5 Intellectual Property Protection Portfolio	297
6.2.2.6 General Opinions About Intellectual Property	297
6.2.2.7 Miscellaneous Opinions and Permissions	297
6.2.2.8 Pre-test	297
6.2.3 Creating a Master List of Seed Companies in India & Implementing the Survey	298
6.2.4 Supplementary Interviews	300
6.3 Farmer Surveys: Methodology, Structure & Implementation	300
6.3.1 The Farmer Survey: Scope and Methodology	300
6.3.1.1 Scope	300
6.3.1.2 Methodology	301

6.3.2	The Farmer (Informal Sector) Survey: Structure and Content	302
6.3.2.1	Direct and Indirect Factors Affecting Cultivation and Innovation	302
6.3.2.2	Pulses Crops v. Preferred Crops	304
6.3.2.3	The Key Questions Included in the Survey and Their Underlying Rationale	305
6.3.3	Identifying Pre-Test and Test Locations	309
6.3.3.1	Expert Views	310
6.3.3.2	Pre-tests	311
6.3.3.3	Final Test Locations	313
6.3.4	Sampling	313
6.3.4.1	Collected Sample Size	315
6.3.4.2	Collecting Qualitative Data Among Farmers	315
6.3.5	Coding and Arrangement of Data for Analysis	316
	Annex 7: Farmer Survey: Chhattisgarh & Madhya Pradesh (Translated from Hindi by the Author)	317
	Bibliography	325