

Annex 1: Research Methodology—Overview of Research Methodology and Objectives

For students and researchers interested in the understanding and critiquing the research methodology that was followed to conduct the studies leading to this book, this Annex has been included as part of this book. This Annex is divided into four main sections: Section 1.1 first describes the basic reasons for choosing a multidisciplinary and mixed method research design. It then details the reasons for adopting a specific mixed method design for this study, including the research mixing rationale and purpose. Section 1.2 describes the broad research goal and objectives of this study. Section 1.3 provides an overview of the research rationale, which constitutes the reasons for selecting the broad and delimited objectives/scope of this study. Section 1.4 provides a list of the preliminary research questions that guided the literature review as well as the qualitative and quantitative investigations undertaken during the course of this study.

1.1 Mixed-Methods Research Approach

Although the call to make legal research an inter-disciplinary endeavor is by no means a new one,¹ the increasing interest² in finding solutions to essentially legal issues using a multi-disciplinary approach has received mixed reactions: Renowned scholars consider a multi-disciplinary approach to law and legal analysis as being

¹See Oliver Wendell Holmes, Jr., ‘The Path of the Law’ (1897) 10 Harvard Law Review 457, 469, where Judge Holmes of the US Supreme Court famously stated as far back as in 1897, that: “[f]or the rational study of the law the black-letter man may be the man of the present, but the man of the future is the man of statistics and the master of economics.”

²Julia Brannen, ‘Mixed Methods Research: A Discussion Paper’ (ESRC National Centre for Research Methods - NCRM Methods Review Papers - NCRM/005) 4 <<http://eprints.ncrm.ac.uk/89/1/MethodsReviewPaperNCRM-005.pdf>> accessed 21.10.13.

necessary and inevitable.³ Experts from other disciplines have also cautioned against designing policies based primarily on (economic) models that place artificial constraints on human or environmental behaviour (presumptions).⁴ Ironically, however, within the legal community, the scholars that have, in the past, examined the ‘demise of law as an autonomous discipline,’ have more recently expressed doubts as to the utility of such (multi-disciplinary) studies beyond the realm of academic research.⁵ Others have called for greater rigor in conducting such research in order to be certain of the quality of such work.⁶ Nonetheless, multi-disciplinary research is not only desirable, but also imperative to understanding and making recommendations on issues that affect more than just the legal rights and duties of individuals: issues that affect their ecology, livelihood, cultural and sociological traditions, and their everyday relationships.⁷ Accordingly, a multi-disciplinary approach is adopted for this study, an overview of which was provided in Chap. 1 above.

In the realm of social sciences research, multi-disciplinary studies are often studies that engage in exploratory research, i.e., research that engages, *inter alia*, in investigating or ‘exploring’ a topic that has received little or no empirical attention.⁸ Confirmatory studies often follow such studies and seek, *inter alia*, to statistically test the validity of theories or hypotheses emerging there from.⁹

³Richard A. Posner, ‘The Decline of Law as an Autonomous Discipline: 1962-1987’ (1987) 100 *Harvard Law Review* 761.

⁴Elinor Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (first published 1990, Cambridge University Press 2011) 6, where the author states: “What makes these [economic] models so dangerous – when they are used metaphorically as the foundation for policy – is that the constraints that are assumed to be fixed for the purpose of analysis are taken on faith as being fixed in empirical settings, unless external authorities change them.”

⁵Richard A. Posner, ‘Legal Scholarship Today’ (2002) 115 *Harvard Law Review* 1314.

⁶Gregory Mitchell, ‘Empirical Legal Scholarship as Scientific Dialogue’ (2004) 83 *North Carolina Law Review* 167.

⁷Agriculture is an area that affects all these aspects of rural life, especially in countries such as India where more than 50% of the population still depends on agriculture for their livelihood.

⁸Robert A. Stebbins, *Exploratory Research in the Social Sciences* (Thousand Oaks, Sage Publications 2001) 2–3, 30. The author also described other circumstances in which exploratory research is undertaken and distinguishes between different types of “exploration,” namely, (1) investigative exploration; (2) innovative exploration; (3) exploration for discovery; and (4) limited exploration. He then sets forth to define a new form of exploration, what he terms “social science exploration” that “combines the concept of exploration for discovery with certain new elements not mentioned in any of the [previously mentioned] four senses.” The exploration undertaken for the present study can be broadly categorized as ‘exploration for discovery’, wherein, the “research is not finished until everything of importance for describing and understanding the area under study has been discovered. In other words, exploration for discovery aims to be as broad as possible. . . .” However, it can also be described more specifically as “social science exploration,” which is, “a broad-ranging, purposive, systematic, pre-arranged undertaking designed to maximize the discovery of generalizations leading to description and understanding of an area of social or psychological life.” The manner in which formal and informal seed sectors promote (or do not promote) sustainable innovation in plant varieties is the area that is explored by the present study.

⁹Burke Johnson and Larry Christensen, *Educational Research: Quantitative, Qualitative and Mixed Approaches* (4th ed., Thousand Oaks, Sage Publications 2012) 17.

The subject matter of this book, namely, promoting sustainable innovation in plant varieties, was categorized as one that has received limited empirical and multi-disciplinary attention so far.¹⁰ In order to get a wide and comprehensive picture of the existing models, incentives structures, and trends in both agrobiodiversity conservation and seed related innovations, a structured and comprehensive, yet flexible methodology was considered necessary.¹¹ Accordingly, an exploratory approach was of primary significance at the starting point of the study. However, as several hypotheses and research questions arose during the course of the exploration, a parallel confirmatory approach was deemed necessary to complement the exploratory approach and to make practical recommendations grounded in current realities.¹²

¹⁰Several authors have undertaken intra-disciplinary studies in the topic of innovation in plant varieties and informal innovations in plant varieties, including from the perspective of a number of different countries. See for example, Robert Tripp, Niels Louwaars and Derek Eaton, 'Plant Variety Protection in developing countries: A report from the field' (2007) 32 *Food Policy* 354; Rajeswari Kanniah, 'Plant Variety Protection in Indonesia, Malaysia, the Philippines and Thailand' (2005) 8(3) *Journal of World Intellectual Property* 283; Timothy Swanson and Timo Göschl, 'Property Rights Issues Involving Plant Genetic Resources: Implications of Ownership for Economic Efficiency,' 35; Peter J. Goss, 'Guiding the Hand That Feeds: Toward Socially Optimal Appropriability in Agricultural Biotechnology Innovation' (1996) 84 *California Law Review* 1395; William Lesser and Martha Ann Mutschler, 'Balancing Investment Incentives and Social Benefits when Protecting Plant Varieties: Implementing Initial Variety Systems' (2004) 44 *Crop Science* 1113; and Keith Aoki, "'Free Seeds, Not Free Beer" Participatory Plant Breeding, Open Source Seeds, and Acknowledging User Innovation in Agriculture' (2009) 77 *Fordham Law Review* 2275. However, a multi-disciplinary study taking empirical facts (especially within India) into consideration while also taking extensive inputs from other and related disciplines, especially science, ecology, sociology and economics along with law, were not discovered in the literature review. cf. Sabine Demangue, *Intellectual Property Protection for Crop Genetic Resources: A Suitable System for India*, (Munich, UTZ Herbert Utz Verlag 2005) 18, who conducts a through analysis of the Indian Protection of Plant Varieties and Farmers Rights Act, 2001 from various perspectives, including economic, legal and scientific perspectives. The study, however, does not undertake empirical quantitative and confirmatory studies and does not focus on methods of promoting *sustainable* innovation in plant varieties. In the Indian context, see generally, Mrinalini Kochupillai, 'The Indian PPV&FR Act, 2001: Historical and Implementation Perspectives,' (2011) 16(2) *Journal of Intellectual Property Rights* 88; and Sudhir Kochhar, 'How effective is *sui generis* Plant Variety Protection in India: Some Initial Feedback' (2010) 15 (4) *Journal of Intellectual Property Rights* 273.

¹¹Anthony J. Onwegbuzie and Nancy L. Leech, 'On Becoming a Pragmatic Researcher: The Importance of Combining Quantitative and Qualitative Research Methodologies' (2005) 8 *International Journal of Social Research Methodology: Theory and Practice* 375.

¹²See generally, Anthony J. Onwegbuzie and Nancy L. Leech, 'On Becoming a Pragmatic Researcher: The Importance of Combining Quantitative and Qualitative Research Methodologies'. A combination of exploratory and confirmatory approaches is often used in conducting multi-disciplinary and interdisciplinary research. See for example, Marco Pautasso et al., 'Seed Exchange Networks for Agrobiodiversity Conservation: A Review' (2012) 33(1) *Agronomy for Sustainable Development* 151, 155. The authors used a diversity of methods combining both exploratory and confirmatory approaches to study the relevance of seed exchange networks in agrobiodiversity conservation. For the details of the empirical survey that was done as part of both the exploratory and the confirmatory part of this study, see Annex 6 below.

A primarily qualitative analysis is usually recommended for exploratory studies and a quantitative analysis is recommended for confirmatory studies.¹³ A systematic means of combining quantitative and qualitative investigations and analysis is offered by the mixed methods research approach.¹⁴ This research approach, although considered by many to be in its adolescence,¹⁵ also offers a great deal of flexibility with the ultimate aim of helping researchers find more comprehensive and ‘superior answers to [their] research question[s]. . .’¹⁶ In addition to helping enhance the significance and comprehensiveness of the analysis, the mixed methods approach also helps during the research implementation stage, to, *inter alia*, ascertain whether the instruments being used to gather information are indeed effective in providing the answers sought.¹⁷

The mixed methods approach (also called dialectical pragmatism) was accordingly adopted to conduct the qualitative and quantitative investigations deemed necessary for this study.¹⁸ Within the mixed-methods framework, however, in order to accommodate information gathered from sources that could not be accommodated within the most commonly enunciated mixed methods research designs, a modified combination of two known designs was adopted.¹⁹ The overall mixed method design used for the research undertaken for this book can thus be called a ‘partially mixed, concurrent and sequential, equal status design.’²⁰

¹³Burke Johnson and Larry Christensen, *Educational Research: Quantitative, Qualitative and Mixed Approaches*, 17.

¹⁴*Ibid.*, 34.

¹⁵Nancy L. Leech and Anthony J. Onwuegbuzie, ‘A Typology of Mixed Methods Research Designs’ (2009) 43 *Quality and Quantity* 265, 266.

¹⁶Kathleen M.T. Collins et al., ‘A Model Incorporating the Rationale and Purpose for Conducting Mixed-Methods Research in Special Education and Beyond’ (2006) 4(1) *Learning Disabilities: A Contemporary Journal* 67, 69.

¹⁷*Ibid.*

¹⁸Mixed research has been formally defined as “the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language in a single study or set of related studies. This type of research should be used when the contingencies suggest that it is likely to provide superior answers to a research question or set of research questions.” See Kathleen M.T. Collins et al., ‘A Model Incorporating the Rationale and Purpose for Conducting Mixed-Methods Research in Special Education and Beyond,’ 69.

¹⁹Mixed method research designs consist of three key dimensions – (i) the level of the mixing (partial or complete), (ii) time orientation (concurrent or sequential) and (iii) dominance (i.e. whether either the qualitative or quantitative element of the study is dominant or whether both elements have an equal status. This dominance or equality of status pertains to the importance given to the findings from each of the elements at the time of analysis and formulation of recommendations.) See Nancy L. Leech and Anthony J. Onwuegbuzie, ‘A Typology of Mixed Methods Research Designs,’ 267–268.

²⁰Nancy L. Leech and Anthony J. Onwuegbuzie, ‘A Typology of Mixed Methods Research Designs,’ 268–270, where the authors describe various designs for implementing a mixed methods research. Given the scope of the study and the necessity to accommodate traditional legal research methods, a strict abidance with one of the 8 suggested models was not possible. However, an attempt was made to stick as closely as possible to a combination of the P1 (partially mixed

1.1.1 *Partially Mixed, Concurrent and Sequential, Equal Status Design*

Partially Mixed: Although a mixed-methods approach was considered most appropriate for conducting the investigations necessary for this study, in order to accommodate traditional legal research methods, the research adopted a *partially* mixed method.²¹ This means that several of the findings from the qualitative segments of the research are not corroborated or confirmed by the quantitative segment and *vice versa*, and that several of the findings from each of the segments can be interpreted and studied independently. As is a suggested practice in partially mixed research, the “mixing” of the qualitative and quantitative findings was done primarily at the data interpretation stage.²² Nonetheless, some degree of mixing was also done at the research implementation²³ stage, in order to test instrument fidelity and for participant enrichment.²⁴

Concurrent and Sequential: In most mixed methods research designs, the qualitative and quantitative elements of the study are either conducted sequentially or concurrently.²⁵ Because the research objectives required the collection of information, data and opinions from diverse sources (e.g. the private sector, government sector, farmer level data, and findings from the historical research and literature review), the qualitative and quantitative elements of each segment of the study was conducted in part sequentially, and in part, simultaneously.²⁶ Several of the

concurrent equal status) and P3 (partially mixed sequential equal status) designs suggested by the authors.

²¹Nancy L. Leech and Anthony J. Onwuegbuzie, ‘A Typology of Mixed Methods Research Designs,’ 267 where the authors define the basic difference between fully mixed and partially mixed research methods.

²²Nancy L. Leech and Anthony J. Onwuegbuzie, ‘A Typology of Mixed Methods Research Designs,’ 267. Also see, Janice M. Morse, ‘Approaches to Qualitative-quantitative Methodological Triangulation’ (1991) 40 *Nursing Research* 120–123.

²³See section II below for an explanation of the term ‘Research Implementation Stage.’

²⁴Instrument fidelity means “assessing the appropriateness and/or utility of existing instrument(s)” (such as a survey). Participant enrichment “represents the mixing of quantitative and qualitative techniques for the rationale of optimizing the sample. One way to optimize a sample is by increasing the number of participants.” Kathleen M.T. Collins et al., ‘A Model Incorporating the Rationale and Purpose for Conducting Mixed-Methods Research in Special Education and Beyond,’ 76–77. Also see Annex 6 below for details as to how the mixed methods research design was used to check instrument fidelity and to enrich participation.

²⁵Concurrent and sequential designs are features of the time orientation of a mixed methods research design, i.e. whether the mixing of qualitative and quantitative elements of the research is done simultaneously – at the same time, or concurrently – one after the other. Nancy L. Leech and Anthony J. Onwuegbuzie, ‘A Typology of Mixed Methods Research Designs,’ 267–268.

²⁶It is not uncommon for mixed method research designs to be flexible for the sake of pragmatism. In the mixed method design adopted for this research, the partly concurrent and partly sequential collection of qualitative followed by quantitative data and vice versa helped in designing the main survey questionnaire, which, in turn simultaneously asked both qualitative and quantitative

hypotheses that emerged during the qualitative investigations were tested later through quantitative data (sequential design).²⁷ However, the research design was also such that permitted collection of qualitative information/data and quantitative data concurrently.²⁸

Equal Status: The research findings are structured herein in the form of a legal research report with significant emphasis being placed on presenting a detailed and contextual review of relevant literature and the findings from the qualitative study conducted using the historical methodology. Nonetheless, the qualitative paradigm was dominant vis-à-vis the private sector survey, and the quantitative paradigm was given the dominant status for the farmer surveys. At the time of conducting the final analysis, however, both paradigms were given equal status (equal importance).²⁹

1.1.2 *Qualitative and Quantitative Research Designs*

Because mixed methods research designs comprise a qualitative as well as a quantitative paradigm/segment, it is common to select a dominant design for each of the segments. The dominant design for the qualitative segment of this research was the historical method coupled with conventional legal research using the tools of literature review and legal interpretation and critique (e.g. of statutory provisions and decided case law). The dominant design for the quantitative segment was the collection and statistical/econometric analysis of non-experimental data, including available data on plant variety application trends and survey data.

Qualitative Investigations using the Historical Method: The broad method adopted for conducting the qualitative part of the mixed research was a combination of historical method and a detailed multi-disciplinary literature review.

In the historical research method, the starting point is the identification of a research topic and the formulation of a research question. As the research progresses, several questions or sub-questions get added on to the scope of the historical research, in order to help develop or reach conclusions/recommendations there from. At the start of this study, within the context of its broad goal (i.e. promoting sustainable innovation in plant varieties), the specific topics for historical research included whether, and if so how, innovation in plant varieties

questions. Burke Johnson and Larry Christensen, *Educational Research: Quantitative, Qualitative and Mixed Approaches*, 434–436.

²⁷See for example Chap. 4 where the hypotheses that emerged from the scientific discussions in Chap. 3 were tested via an analysis of the Indian plant variety protection application data.

²⁸For example, through farmer surveys and concurrent multi-level interviews with regional agricultural extension officers.

²⁹It is not uncommon to give both the qualitative and the quantitative aspect of the research equal status in mixed method research designs. The equality of status is determined by the importance given to each aspect at the time of data interpretation and drawing of conclusions. Nancy L. Leech and Anthony J. Onwuegbuzie, 'A Typology of Mixed Methods Research Designs,' 268.

took place in the past and whether the adopted systems of innovation adopted in the past were sustainable. The historical research also looked into the evolution (from a scientific and legal perspective) of modern scientific methods of plant breeding and associated intellectual property protection regimes.³⁰

The starting point for the multi-disciplinary literature review was also based on the above identified research questions. As a second step, quantitative data collected from primary sources (particularly the plant variety protection data from India) further guided the research scope and the analysis.³¹

In order to get a better understanding of the broader context from which the identified question emerge, several questions, peripheral to the delimited scope of the empirical research, but associated with the broad research goal were identified. These questions were then answered using the commonly used methods of literature review as well as through the historical method.

Quantitative Investigations using Filing Trends and Survey Data: Preliminary answers, facts, information and insights that emerged from the literature review and the historical method adopted for qualitative research helped delimit the scope of the empirical research envisaged among farmers and the private sector seed companies. The empirical research, in turn, was also divided into qualitative and quantitative segments: The qualitative aspect of the empirical research included interviews with stakeholders in various parts of India and open ended questions contained within the structured surveys administered among members of the farming community and representatives of various seed companies. The quantitative aspect of the empirical research comprised plant variety application data from India and quantitative questions contained in the farmer surveys. As is common in mixed methods research designs, the findings from the qualitative research were used to better understand, complement and complete the findings from the quantitative data analysis and *vice versa*, throughout the 4 basic stages of the research, namely, during the research formulation stage, the research planning stage, the research implementation stage and the research analysis stage³² (each of these stages are described below in section 1.2 of this chapter).

For example, questions that emerged from the literature review and during the testing of the preliminary drafts of questionnaires as meriting more current or in-depth empirical investigation, helped structure the surveys and identify specific

³⁰Findings from the research undertaken vis-a-vis these topics are described and discussed in Chap. 3. A more detailed framework of research questions and sub-questions for the historical part of the qualitative research is provided under the head 'Research Questions' below.

³¹As collected from the journals of the Plant Variety Authority of India. See Chap. 4 for a detailed description.

³²This back and forth between qualitative and quantitative segments of the research gives to mixed method research designs, the name 'dialectical pragmatism.' Qualitative and quantitative methods are used in one or more of the following aspects of the research: (i) identified research objectives, (ii) data-sets or types of data used, (3) types of analysis undertaken, and (iv) types of inferences made. Nancy L. Leech and Anthony J. Onwuegbuzie, 'A Typology of Mixed Methods Research Designs,' 267.

qualitative (open ended) and quantitative³³ questions to be included therein.³⁴ Later, they also helped identify possible relationships within various data fields that could be tested statistically using appropriate software.³⁵

Further, in order to get a better understanding of the broader context from which the identified questions emerge, several multiple choice or open ended queries were included in the surveys that elicited information on ground realities that dictate farmer cultivation choices, seed purchase behavior, and breeders' research preferences. Such a broad understanding was considered necessary to ensure that the recommendations emerging from the this book be based on current and observed facts and trends.

The apparent intermingling of the quantitative and qualitative methods of research undertaken for this book, with the findings from one method guiding the content and scope of the investigations conducted using the other, is common in mixed method research designs. This is also done to converge and corroborate the findings from one research method with the help of the findings from the other method. This process helps build the scope of the research and understand the findings there from, in a pragmatic and multi-dimensional manner using whichever approach is most appropriate and practical in the circumstances.³⁶

1.1.3 Sampling Design

A 'sampling design' consists of two segments: 'sampling scheme' and 'sample size':

A sampling scheme represents 'the strategy used to select units'³⁷ and can, broadly speaking, fall into one of two categories: random (also called probabilistic)

³³Quantitative questions include multiple-choice questions or questions to which the respondents give limited answers on a predetermined scale (E.g. How often do you buy new seeds from the market/government for your preferred crop? (a) Every year (b) Once in 2 years, (c) Once in 3 years, or (d) Never). Quantitative questions can also elicit 'yes'/no' responses (E.g. do you cultivate pulses? Yes/No) or responses that have specific ranges or categories of answers, for example, age, gender, education, size of landholding etc.

³⁴Qualitative questions are usually open ended questions or questions that elicit more than a short answer within a predefined category. These can include questions seeking an opinion on an issue, a reason for choosing an answer or answer category (for example within a quantitative survey conducted in parallel), or an explanation of observed trends.

³⁵The 'back and forth' between qualitative and quantitative findings is a prominent feature of mixed method research (and hence the name dialectical pragmatism). It helps improve and expand the scope of the research as well as the findings there from beyond what would be possible via mono method research designs. Burke Johnson and Larry Christensen, *Educational Research: Quantitative, Qualitative and Mixed Approaches*, 432–434.

³⁶These processes are technically called Triangulation, Expansion, Development and Complementarity. See sub-heading "Mixing Purpose" below for definitions.

³⁷Units can be people, groups, settings, events etc. Kathleen M.T. Collins, Anthony J. Onwuegbuzie and Qun G. Jiao, 'A Mixed Methods Investigation of Mixed Methods Sampling Designs in Social Science and Health Science Research' (2007) 1 Journal of Mixed Methods Research 267, 271.

or non-random (also called non probabilistic).³⁸ Qualitative research,³⁹ which is often used to identify or construct a new theory, does not usually call for a random sampling scheme.⁴⁰ Quantitative studies, however, most of which are confirmatory in nature, require random sampling schemes.

The sample size represents the number of units selected for the study. In historical research, by definition, there is no sampling scheme and therefore no sample size, as the study is done primarily through the review of historical literature or documents and is supplemented with interviews or discussions with those familiar with the subject matter of the study. For other qualitative research methods, which aim to postulate a new theory based on the research findings, the maximum recommended sample size (variable according to chosen qualitative research methods) is between 15 and 30 respondents.⁴¹ Smaller sample sizes are acceptable if they are representative enough. In quantitative studies on the other hand, even the required minimum sample size is much larger. However, the recommended minimum sample size for quantitative (e.g. confirmatory) studies also depends on a number of factors: the population of interest, the objective of the study, the type of survey being administered, etc.

In a mixed method research, an appropriate sampling scheme and sample size must be identified for both the qualitative and quantitative paradigms of the study. The choice of sampling scheme (random or non-random) depends, once again on a number of factors: the population of interest, the objective of the study, the nature of the study (e.g. exploratory or confirmatory), etc.⁴²

Mixed method research is known to require a much smaller sample size than is considered ideal for purely quantitative research methods.⁴³ However, the sample size recommended for such studies is often larger than the size commonly used for

³⁸ibid., 271.

³⁹Note: There is no defined sampling scheme for historical research as it is usually conducted in a manner similar to literature review, with greater emphasis being placed on historical documents, including older literature (journals, books, documentaries), news reports, oral histories provided by people who are familiar with the times etc.

⁴⁰It has been said, for example, that “the criteria for sample size in qualitative research are not based on probability computations but represent expert opinion” See Kathleen M.T. Collins, Anthony J. Onwuegbuzie and Qun G. Jiao, ‘A Mixed Methods Investigation of Mixed Methods Sampling Designs in Social Science and Health Science Research,’ 271.

⁴¹Anthony J. Onwuegbuzie and Nancy L. Leech, ‘A Call for Qualitative Power Analysis’ (2007) 41 *Quality & Quantity* 105, 116.

⁴²Ibid., 110. Also see, Anthony J. Onwuegbuzie and Kathleen M.T. Collins, ‘A Typology of Mixed Methods Sampling Designs in Social Science Research’ (2007) 12(2) *The Qualitative Report* 281, 288, 290.

⁴³It has, for example, been said that if the goal of a mixed method research is exploration, a small sample size is acceptable. See Anthony J. Onwuegbuzie and Kathleen M.T. Collins, ‘A Typology of Mixed Methods Sampling Designs in Social Science Research,’ 288.

purely qualitative research methods. In practice, the requisite sample size for a mixed method research varies according to the scope and objective of the research. If the objective is primarily exploratory, a smaller sample size is considered adequate. However, if the research ventures into confirmation, it requires a larger sample size.⁴⁴

The sampling scheme and the sample size together constitute a sampling design, which dictates the type of generalizations that are justifiable from a study based on the chosen design.⁴⁵ Generalizations can be one of three broad types: (a) statistical generalizations (i.e. making generalizations from the data to the population from which the data was extracted), (b) analytical generalizations (i.e. applied to wider theory based on how the selected cases fit with general constructs), and (c) case to case transfers (i.e. making generalizations from one case to another similar case).⁴⁶ The ability to make statistical generalizations depends on the sampling scheme and sample size. Random sampling schemes and adequately large sample sizes are the pre-requisites for making statistical generalizations.

While quantitative studies mostly aim to make statistical generalizations, qualitative ones usually make analytical or case to case generalizations. In mixed research, statistical generalizations are justified either if the sample sizes of both the qualitative and quantitative paradigms of the research are large and random, or if the sample size of only one of the paradigms is large, that paradigm constitutes the dominant paradigm.⁴⁷ Accordingly, random sampling is recommended in mixed research only if the researcher intends to make statistical generalizations based on the findings of the research.

Given the objectives of the current research (as described in greater details below), the ‘simple random’ sampling scheme⁴⁸ was considered appropriate for the collection of data for the private sector survey, and the ‘stratified random’ sampling scheme⁴⁹ was considered appropriate to collect data for the farmer surveys. The sample size for each of these surveys was not determined at the outset.

⁴⁴Anthony J. Onwuegbuzie and Nancy L. Leech, ‘A Call for Qualitative Power Analysis,’ 110.

⁴⁵See Kathleen M.T. Collins, Anthony J. Onwuegbuzie and Qun G. Jiao, ‘A Mixed Methods Investigation of Mixed Methods Sampling Designs in Social Science and Health Science Research,’ 273.

⁴⁶Ibid.

⁴⁷Ibid.

⁴⁸In this scheme, “every individual in the sampling frame (desired population) has an equal and independent chance of being chosen for the study.” See Kathleen M.T. Collins, Anthony J. Onwuegbuzie and Qun G. Jiao, ‘A Mixed Methods Investigation of Mixed Methods Sampling Designs in Social Science and Health Science Research,’ 272.

⁴⁹In this scheme, “the sampling frame is divided into subsections comprising groups that are relatively homogenous with respect to one or more characteristics and a random sample is selected from each stratum.” *ibid.*

However, later, discussions with mixed methods research experts revealed that a sample size of between 100 to 150 for each of the surveys would likely be adequate (provided the sample was representative of the population and collected randomly), as a great deal of significant qualitative data was being collected via open-ended questions within the largely quantitative surveys.⁵⁰ The supplementary qualitative data (i.e. qualitative data other than that gathered via the surveys) was collected via a ‘maximum variation’ sampling scheme.⁵¹

The study aimed to randomly gather large samples for both the private sector and farmer surveys. However, as the time and resource constraints of the study did not permit both a random sampling scheme as well as a large sample size for both the private sector and farmer surveys, the study does not pretend to be adequate for making statistical generalizations vis-à-vis the private sector. However, vis-à-vis findings emerging from the farmers sector, statistical generalizations are defensible in the light of the adequately large sample size that was collected via a stratified random sampling scheme, and because the quantitative paradigm was dominant for the farmers sector. The findings from each of the sectors nonetheless contribute significantly, and in equal measure, in reaching the conclusions and making the recommendations contained in the final chapter of this study. In the light of the low response rate to the surveys administered to the private sector, more in depth and larger studies are recommended to supplement the findings contained herein vis-à-vis the private sector.

1.1.4 Mixing Rationale and Purpose

Mixing rationale: Noted mixed method research scholars recommend the identification of specific rationale for adopting a mixed methods research approach. In addition to the scope and nature of the research undertaken, the rationale for undertaking mixed research can fall into one or more of the following 4 broad

⁵⁰Although no minimum sample size for the quantitative elements of a mixed method research was forthcoming from a review of the mixed methods research literature, discussions with experts in the field confirmed that this sample size would be adequate at least to make predictions and reach some basic conclusions and findings. It was further suggested that if this sample size was representative of the population where the survey was conducted, and was collected via a random sampling method, hypothesis testing could be conducted using one or more of several statistical tools. Discussion with Anthony J. Onwuegbuzie (Munich, 12 July 2012).

⁵¹In this sampling scheme, settings, groups or individuals are selected in order to maximize the range of perspectives investigated in the study. Anthony J. Onwuegbuzie and Kathleen M.T. Collins, ‘A Typology of Mixed Methods Sampling Designs in Social Science Research,’ 285.

categories: (i) instrument fidelity,⁵² (ii) significance enhancement⁵³, (iii) treatment integrity, and (iv) participant enrichment.⁵⁴

As explained above, the present research adopted a mixed methods research design in the light of the multi-disciplinary nature of the envisaged investigations and because a combination of exploratory and confirmatory investigations was deemed necessary to make practical recommendations. At the research implementation stage, this research design was also considered necessary to check instrument fidelity and for participant enrichment. This design was also deemed necessary to enhance the significance of the findings from the qualitative and quantitative elements of the research at the research analysis stage.⁵⁵

Mixing Purpose: Experts identify five general purposes of mixed-methods studies: (a) triangulation⁵⁶; (b) complementarity⁵⁷; (c) initiation⁵⁸; (d) development⁵⁹; and (e) expansion.⁶⁰ Triangulation, complementarity, development and expansion were the broad purposes for choosing the mixed-methods research design.

More specifically, ‘triangulation’ was a purpose because the study seeks to use two different approaches, namely quantitative (empirical research) and qualitative (theoretical literature reviews and historical method) to study the same phenomena,

⁵²As stated above, ‘instrument fidelity’ means “assessing the appropriateness and/or utility of existing instrument(s)” (such as a survey). Participant enrichment “represents the mixing of quantitative and qualitative techniques for the rationale of optimizing the sample. One way to optimize a sample is by increasing the number of participants.” See Kathleen M.T. Collins et al., ‘A Model Incorporating the Rationale and Purpose for Conducting Mixed-Methods Research in Special Education and Beyond,’ 76–77.

⁵³‘Significance enhancement’ facilitate “thickness and richness of data and augments interpretation of findings, and instrument fidelity assesses the fidelity of the intervention.” *ibid*.

⁵⁴‘Participant enrichment’ “represents the mixing of quantitative and qualitative techniques for the rationale of optimizing the sample. One way to optimize a sample is by increasing the number of participants.” *ibid*.

⁵⁵For a more detailed review of the manner in which this was done, see Annex 6 below.

⁵⁶Triangulation: “Seeking convergence and corroboration of findings from different methods that study the same phenomenon.” See Anthony J. Onwuegbuzie and Nancie L. Leech, ‘Linking Research Questions to Mixed Method Data Analysis Procedures’ (2006) 11(3) *The Qualitative Report* 474, 480.

⁵⁷Complementarity: “Seeking elaboration, illustration, enhancement, and clarification of the results from one method with results from the other method.” See Anthony J. Onwuegbuzie and Nancie L. Leech, ‘Linking Research Questions to Mixed Method Data Analysis Procedures,’ 480.

⁵⁸Initiation: “Discovering paradoxes and contradictions that lead to a re-framing of the research question/questions.” *Ibid*.

⁵⁹Development: “Using the results from one method to help inform the other method.” See A J Onwuegbuzie and Nancie Leech, ‘Linking Research Questions to Mixed Method Data Analysis Procedures.’ *Ibid*.

⁶⁰Expansion: “Seeking to expand the breadth and range of the investigation by using different methods for different inquiry components.” *Ibid.*, 480.

and would like to see if the findings from these approaches converge or lead to common conclusions.⁶¹ Furthermore, ‘complementarity’ was a purpose because it was anticipated that some of the findings, e.g. findings from the qualitative interviews, would help better understand trends emerging from quantitative data and vice versa.⁶² From the perspective of ensuring that the study has an adequately comprehensive scope, ‘development’ was a purpose because it was anticipated that results from one method (e.g. the quantitative data analysis of the plant variety application data) would help inform the other method (e.g. historical research and other qualitative investigations).⁶³ Finally, expansion was one of the most important purposes of choosing the mixed methods research design because, given the breath of the potential impact that IP protection regimes can have on socio-economic and cultural lives of small and marginal farmers, it was considered necessary to expand the breath and range of investigations (and therefore of relevant information collected) by using the most effective method of collecting information in relation to each topic that needed investigation.

1.2 Designing and Executing a Mixed-Method Research

Renowned scholars (Collins et al. 2006) recommend following 13 steps sequentially to conduct a mixed-methods research study.⁶⁴ These steps fall within 4 broad stages of any research: (i) Research formulation stage, (ii) research planning stage, (iii) research implementation stage, and (iv) research analysis stage. Most of these steps were used to organize (and now also to explain) a significant part of the

⁶¹For example, in this study, historical research revealed that seed improvement efforts have slowly but surely shifted away from farmers’ fields and into laboratories. Further qualitative literature reviews (traditional means of conducting legal research), including review of literature from disciplines other than law (primarily science and economics) further led to the preliminary conclusion that the formal seed sector (in India) is primarily interested in R&D in hybrid seeds or seeds which farmers cannot save and re-sow season after season. Quantitative analysis of plant variety application data led to the same finding. Hence, the findings from various approaches converged.

⁶²See, for example, Chap. 5 where the qualitative interviews with regional agricultural extension officers (RAEOs) helped understand the differences in seed replacement trends in the two surveyed districts.

⁶³For example, in this study, qualitative multi-disciplinary literature review led the researcher to a hypothesis, namely, that once a farmer has access to improved seeds, he/she will have little or no incentive to engage in *in situ* agrobiodiversity conservation. Yet, the literature review also suggested that in countries such as India, where the vast majority of farmers are small and marginal land holders, farmers don’t have the economic means necessary to buy improved seeds each season. These contradictory findings informed the quantitative aspect of the study; the researcher decided to focus, *inter alia*, on collecting farmer level data on seed replacement from farmers of two regions in India.

⁶⁴See generally, Kathleen M.T. Collins et al., ‘A Model Incorporating the Rationale and Purpose for Conducting Mixed-Methods Research in Special Education and Beyond.’

research structure, to conduct the necessary investigations, and to analyze the collected data within this study. However, some of the steps were modified to the extent necessary within the framework of a time bound legal research.⁶⁵

Collins et al. recommend the identification of the research *goal*, *objectives* and *rationale* as the first steps to designing a mixed methods research. These steps fall within the research formulation stage.⁶⁶ As per the definition given within the model recommended by Collins et al., in selecting a research *goal*, the overall, long-term aim of the research is identified.⁶⁷ The research *objective* then identifies the specific tasks that will be undertaken within a research with a view to accomplishing its goal. To this extent, the research objective helps delimit the scope of the research that is aimed at supporting or achieving the identified goal(s), taking into account the time and resource constraints of the study.

The current state of affairs that help determine the importance of the study (i.e. why the study was needed), including the reasons for choosing the specifics that give it its delimited scope, constitutes the *research rationale* or background.⁶⁸ An overview of the current (international legal) state of affairs within which the current study is couched, as well as an overview of the reasons why specific choices were made to delimit the scope and focus of the research are explained in brief in Chap. 2 above.

Collins et al. further recommend the identification of the research mixing rationale and research mixing purpose as indispensable steps, necessary to identify the research questions that guide a mixed methods research. These steps also fall within the research formulation stage and lead to the next stage, namely, the research planning stage. The research planning stage consists of two steps: the identification of a sampling scheme and of a mixed method research design. These two steps have already been explained in the previous section of this chapter. This section details the first two steps constituting the research planning stage. The research implementation stage is spread out in various chapters of this study: the findings from the qualitative research (historical method, multi-disciplinary literature review, and conventional legal interpretation) is contained in Chaps. 2, 3 and 4. The structure and findings from quantitative surveys, including the steps of collecting, coding and interpreting the data has been detailed in Chap. 5 and Annex 6. The final research analysis (where the qualitative and quantitative findings are ‘mixed’ to reach concrete conclusions and recommendation) has been undertaken in Chap. 7.

⁶⁵Such a departure from the strict sequence of steps is also permitted by the flexibilities inherent in the mixed-methods research approach. See generally, Kathleen M.T. Collins et al., ‘A Model Incorporating the Rationale and Purpose for Conducting Mixed-Methods Research in Special Education and Beyond.’

⁶⁶*ibid.*, 69-70.

⁶⁷*Ibid.*, 70.

⁶⁸*ibid.*

1.2.1 *The Research Goal*

The research goal describes the overall, long-term aim of the research undertaken. From a broad and general perspective, the goal of most mixed methods research efforts have been found to fall into one or more of the following categories⁶⁹:

- (i) prediction
- (ii) adding to the knowledge base,
- (iii) measuring change
- (iv) understanding complex phenomenon
- (v) testing new ideas
- (vi) generating new ideas
- (vii) inform constituencies, or
- (viii) examining the past

The primary goal of the legal research undertaken in this book, stated in the above general terms, was to add to the knowledge base, understand a complex phenomenon, generate new ideas and examine the past.

In more legal terms, the goal of the research (as stated earlier) was to find the means of promoting *sustainable* innovation in plant varieties. Having identified this broad research goal, in order to make the scope of the research more manageable within the time and resource constrains of a doctoral thesis, the delimited focus of the research was on finding means of promoting sustainable innovations by (i) identifying factors, practices, laws and trends that interfere with or contribute to the accomplishment of this goal, (ii) with special emphasis on the role of the informal (farmers) sector with a parallel study of the current role being played by the formal (private) sector, (iii) within India as the main country where empirical research was to be conducted, and (iv) and an emphasis within India, on self-pollinating crops (particularly pulses).

The background and rationale that justify and explain the selection of the stated goal (and its delimited scope), is discussed in Chap. 2 above.

1.2.2 *The Research Objective*

The *research objective* identifies the specific tasks that will be undertaken within a research with a view to accomplishing its goal.

Following the identification of the broad research goal therefore, the research objective usually falls within one (or more) of the following broad categories:⁷⁰

⁶⁹See Kathleen M.T. Collins, Anthony J. Onwuegbuzie and Qun G. Jiao, 'A Mixed Methods Investigation of Mixed Methods Sampling Designs in Social Science and Health Science Research,' 270.

⁷⁰*ibid.*

- (i) exploration,
- (ii) description,
- (iii) explanation, and/or
- (iv) prediction,

From the perspective of this general framework, the objective of the research undertaken for this book, was to *explore, describe and explain* the factors that influence or affect sustainable innovation in plant varieties, including current practices and trends, legal rules and policies etc. that interfere, hinder with, or contribute to the accomplishment of this goal. The more specific objectives of the research included the following most relevant ones:

- (i) To *describe* the current and historical models of innovation in the formal and informal seed sectors (qualitative, exploratory, historical);
- (ii) To *explore* and *explain* the factors that affect innovation choices of the formal seed sector (literature review, historical, quantitative);
- (iii) To *explore* the strengths and weaknesses in the existing regimes designed to promote innovation in plant varieties, particularly from the perspective of their ability to promote sustainable innovation, (qualitative, exploratory, historical);
- (iv) To *explore* the current realities vis-à-vis agrobiodiversity conservation and *in situ* evolution of traditional seed varieties in rural areas (quantitative, exploratory, confirmatory);
- (v) To *explore* and *explain* cultivation choices of farmers (Quantitative, qualitative, exploratory);
- (vi) To *explore* factors that affect *in situ* evolution and conservation of agrobiodiversity (quantitative, exploratory, literature review, confirmatory)
- (vii) To *explore* factors that affect informal innovations (among farmers) (exploratory, quantitative, confirmatory); and
- (viii) To *explore* the challenges (if any) inherent in trying to simultaneously promote innovation in plant varieties and conservation of agrobiodiversity (exploratory).

1.2.3 Research Questions

As discussed above, at the start of the research, a primarily exploratory approach was deemed necessary to gain insights into the topic of the present study, namely, promoting sustainable innovation in plant varieties. As is common with topics that have not received significant multi-disciplinary and empirical attention (and which are approached from an exploratory perspective), the first phase of the study began without a research hypothesis. However, the broad scope and purpose of the research required the identification of several research questions and sub-questions that could guide and direct it (i) towards identifying specific research hypotheses, or (ii) towards identifying the problems or pitfalls that make this goal

difficult to achieve, and (iii) towards making useful recommendations to accomplish the goal. The following questions guided the literature review as well as the empirical research undertaken for the research in the preliminary stages:

The research goal presupposed the following:

- (i) That sustainable innovation is a normative goal worth pursuing
- (ii) That the current system (legal, scientific, political, economic etc.) is not such that promotes sustainable innovation.

This led to the formulation of the following preliminary questions that guided the initial literature review, the findings from which formed the research rationale/background (and are elaborated in Chap. 2):

- (i) How should this study define the term “sustainable innovation” and why?
- (ii) Why is this a normative goal worth pursuing/studying?
- (iii) What means (particularly which legal and policy instruments) are currently adopted (internationally) to promote any kind of innovation in plant varieties?
- (iv) Are these means also aimed at promoting sustainable innovation?
- (v) Are there specific international instruments that aim to promote *in situ* conservation of agrobiodiversity?

As a second step, and in the light of the research background contained in Chap. 3 above, the next set of questions that emerged related to the historical evolution of formal and informal plant breeding efforts, and the nature of present day formal innovations in plant varieties:

- (i) What types of innovations are seen in the plant breeding industry and in the farming community (nature and science of innovations relating to plant varieties, especially seeds)?
 - a. What, if any, are the current socio-cultural practices associated with agriculture and crop improvement at the village level?
 - b. What, if any, are the changes that the introduction of modern technology (vis-à-vis seeds) is bringing into these socio-cultural practices?
- (ii) How did they evolve (scientific and historical perspectives)?
- (iii) What is the nature of these innovations, i.e. do they or do they not comply with the ideal of ‘sustainable innovations’ as defined in this book? Why or why not?

The findings from the above questions (and several related sub-questions that emerged during the course of the qualitative multi-disciplinary literature review and historical investigations) are contained in Chap. 3 above.

On the basis of the findings from Chaps. 2 and 3, several hypotheses were formulated, with special reference to India:

- (i) The formal plant breeding sector of India will be most actively involved in R&D in relation to hybrids

- (ii) The formal plant breeding sector of India would show little or no interest in R&D, production and distribution of self-pollinating crops for which creation of hybrids is currently not possible or not cost-effective.

The more specific research goal, i.e. identifying means of (and hindrances in) promoting sustainable innovation in plant varieties via an analysis of pulses cultivation and innovation in India, emerged during the course of researching the above broad questions, particularly the trends in innovation seen in the formal and informal seed sectors of India: A study of the plant variety applications data in India revealed that the formal sector is focusing most of its research efforts into crops for which hybrids are important, for example, with regard to cotton, maize, sorghum etc. Even when filing for applications for self-pollinating crops, the filing data reveals that the applications are, to a large extent, for hybrids of self-pollinating crops such as rice. Other self-pollinating crops such as wheat and pulses are receiving little to no attention from the formal seed sector (particularly private sector seed companies). The application data from the informal sector reveal a different trend – all applications are for typical varieties of mostly self-pollinating crops such as wheat and rice. However, the gap vis-à-vis pulses improvement persisted also in the informal (farmers’) seed sector. The research question that emerged from these findings was:

- (i) Why is there sub-optimal innovation in pulses crops in both the formal and informal seed sectors of India? Are the reasons associated with this question helpful in identifying problems associated with promoting sustainable innovation in plant varieties? If so, how?

This research question required a parallel investigation into the following issues:

- (ii) What is the current Indian (legal) framework for the promotion of innovation in plant varieties?
- (iii) What is the current Indian (legal) framework for the promotion of agrobiodiversity conservation?
- (iv) How did the current Indian (legal) framework for the promotion of innovation and agrobiodiversity conservation evolve?
- (v) Are there any facts or circumstances that make the accomplishment of the goal (of promoting sustainable innovation in plant varieties, particularly pulses varieties) difficult (in India)?
 - a. If yes, what are some of these facts and circumstances?
 - b. How can these be identified?
 - c. Can the extent to which these facts interfere with or affect the accomplishment of the goal be examined? If yes, by what means?
- (vi) Is the current framework of intellectual property law, one of the key means of promoting innovation in any field, adequate to promote sustainable innovation in plant varieties, including in pulses varieties?
- (vii) Are current IP regulations in India adequate to incentivize farmer level innovations?

(viii) Are current IP regulations in India adequate to identify farmer level innovations?

Over the course of conducting the literature review and investigations based on the above questions, more refined and specific research questions emerged that guided the structure and content of the empirical surveys. An overview of these questions is provided in Annex 6 below.⁷¹

On the basis of the qualitative and quantitative research findings, a number of general theories and explanations emerged, which can be stated as follows:

The structure of IP laws (including that under UPOV 1978), as they currently exist, are such that hinder with the promotion of sustainable innovations in plant varieties, especially among the farmers' (informal) seed sector.

The minimum level of intellectual property protection for plant varieties as envisaged under TRIPs is neither necessary nor adequate to promote sustainable innovation in plant varieties in the public or the private seed sector (of India).

Existing IP regulations and associated (Indian) government policies, including those designed for the protection of plant varieties and farmers' rights do not address the key market failures vis-à-vis incentives for engaging in seeds related innovations and associated *in situ* conservation of agrobiodiversity.

A detailed explanation of the above theories and explanations is contained in Chap. 6 above. Recommendations emerging from the findings and discussions of the study are contained in the concluding chapter above, Chap. 7.

⁷¹In the literature dealing with research methods, it has been said that when the goal and purpose underlying a research question “is complex, it is necessary to have multiple questions and this frequently necessitates the use of mixed methods research.” See Isadore Newman, Carolyn S. Ridenour, Carole Newman, & George M.P. DeMarco, ‘A Typology of Research Purposes and its Relationship to Mixed Methods’ in A. Tashakkori and C. Teddlie (eds), *Handbook of Mixed Methods in Social and Behavioral Research* (Thousand Oaks, CA Sage 2003) 169.

Annex 2: Total Applications Filed by Species (2007–2014)

Species	Individual	NGO	Private	Public	Total
Black Gram	3		2	24	29
Black Pepper	1			4	5
Brinjal	1	2	207	17	227
Cabbage			8	1	9
Castor			9	6	15
Cauliflower			31	3	34
Chickpea	2			56	58
Coconut	1	1			2
Chrysanthemum				4	4
Diploid Cotton	1	2	22	37	62
Field Pea			1	35	36
Ginger	1	1		3	5
Green gram	2		3	42	47
Groundnut	2		1	30	33
Indian Mustard	3		17	50	70
Jute				27	27
Kidney Bean	2	5	1	11	19
Lentil				14	14
Linseed				5	5
Maize	4	7	231	111	353
Mango	4				4
Okra			62		62
Onion	1		9	1	11
Orchid		1			1
Pearl Millet			154	59	213
Pigeon pea	12	1	21	32	66
Potato	1	1	12	18	32
Rapeseed			1	10	11

(continued)

Species	Individual	NGO	Private	Public	Total
Rice	1306	195	205	202	1908
Rose			3		3
Safflower				8	8
Sesame	1	1		6	8
Small cardamom	1			3	4
Sorghum	1	2	85	98	186
Soybean			10	7	17
Sugarcane				54	54
Sunflower			78	9	87
Tetraploid Cotton			841	66	907
Tomato		1	137	12	150
Turmeric	1			6	7
Wheat	12	1	14	117	144
Grand Total	1363	221	2165	1188	4937

Annex 3: Crop Species Notified Under the PPV&FR Act, 2001⁷²

S. No	Crop Name (Common Name)	Botanical name
1.	Rice	<i>Oryza sativa</i> L.
2.	Bread wheat	<i>Triticum aestivum</i> L.
3.	Maize	<i>Zea mays</i> L.
4.	Sorghum	<i>Sorghum bicolor</i> (L.) Moench
5.	Pearl millet	<i>Pennisetum glaucum</i> (L.) R.Br.
6.	Chickpea	<i>Cicer arietinum</i> L.
7.	Mungbean	<i>Vigna radiata</i> (L.) Wilczek
8.	Urdbean	<i>Vigna mungo</i> (L.) Hepper
9.	Fieldpea	<i>Pisum sativum</i> L.
10.	kidney bean	<i>Phaseolus vulgaris</i> L.
11.	Lentil	<i>Lens culinaris</i> Medik
12.	Pigeon pea	<i>Cajanus cajan</i> (L.) Millsp.
13.	Indian mustard	<i>Brassica juncea</i> L. Czern & Coss
14.	Karan rai	<i>Brassica carinata</i> A Braun
15.	Rapeseed(toria)	<i>Brassica rapa</i> L.
16.	Gobhi sarson	<i>Brassica napus</i> L.
17.	Groundnut	<i>Arachis hypogaea</i> L.
18.	Soybean	<i>Glycine max</i> (L.) Merrill
19.	Sunflower	<i>Helianthus annuus</i> L.
20.	Safflower	<i>Carthamus tinctorius</i> L.
21.	Castor	<i>Ricinus communis</i> L.
22.	Sesame	<i>Sesamum indicum</i> L.
23.	Linseed	<i>Linum usitatissimum</i> L.
24.	Diploid cotton	<i>Gossypium arboreum</i> L.
25.	Diploid cotton	<i>Gossypium herbaceum</i> L.

(continued)

⁷²As of March 2016. Note: At the time the data analysis for Chap. 3 was conducted, only about 50 species had been notified under the Indian PPV & FR Act, 2001.

S. No	Crop Name (Common Name)	Botanical name
26	Tetraploid cotton	<i>Gossypium hirsutum</i> L.
27	Tetraploid cotton	<i>Gossypium barbadense</i> L.
28	Jute	<i>Corchorus olitorius</i> L.
29	Jute	<i>Corchorus capsularis</i> L.
30	Sugarcane	<i>Saccharum</i> L.
31	Black pepper	<i>Piper nigrum</i> L.
32	Small cardamom	<i>Elettaria cardamomom</i> Maton
33	Turmeric	<i>Curumma longa</i> L.
34	Ginger	<i>Zingiber officinale</i> Rosc.
35	Tomato	<i>Lycopersion lycopersicum</i> (L.) Karsten ex. Farw.
36	Brinjal	<i>Solanum melongena</i> L.
37	Okra	<i>Abelmoschus esculentus</i> (L.) Moench.
38	Cauliflower	<i>Brassica oleracea</i> L.var. <i>botrytis</i>
39	Cabbage	<i>Brassica oleracea</i> L. var <i>capitata</i>
40	Potato	<i>Solanum tuberosum</i> L.
41	Onion	<i>Allium cepa</i> L.
42	Garlic	<i>Allium sativum</i> L.
43	Rose	<i>Rosa</i> spp.(other than <i>R.damascena</i>)
44	Chrysanthemum	<i>Chrysanthemum</i> spp.
45	Mango	<i>Mangifera indica</i> L.
46	Duram wheat	<i>Triticum durum</i> Desf.
47	Dicoccum wheat	<i>Triticum dicoccum</i> L.
48	Other Triticum species	
49	Isabgol	<i>Plantago ovata</i> Forsk
50	Menthol mint	<i>Mentha arvensis</i> L.
51	Damask Rose	<i>Rosa damascena</i> Mill
52	Periwinkle	<i>Catharanthus roseus</i> L.
53	Brahmi	<i>Bacopa monnieri</i> L.Pennell
54	Coconut	<i>Cocos nucifera</i> L.
55	Orchids	<i>Vanda</i>
56	Orchids	<i>Dandrobium</i>
57	Orchids	<i>Cymbidium</i>
58	Pomegranate	<i>Punica granatum</i> L
59	Orchid	<i>Cattleya</i> Lindl.
60	Orchid	<i>Phalaenopsis</i> Blume
61	Eucalyptus	<i>Eucalyptus camaldulensis</i> Dehnh.
62	Eucalyptus	<i>Eucalyptus tereticornis</i> Sm.
63	Casurina	<i>Casuarina equisetifolia</i> L
64	Casurina	<i>Casuarina junghuhniana</i> Miq.
65	Bitter Gourd	<i>Momordica charantia</i> L.
66	Bottle Gourd	<i>Lagenaria siceraria</i> (Mol.) Standl.
67	Cucumber	<i>Cucumis sativus</i> L.
68	Pumpkin	<i>Cucurbita moschata</i> Duch. ex Poir.

(continued)

S. No	Crop Name (Common Name)	Botanical name
69	Barley	<i>Hordeum vulgare</i> L.
70	Coriander	<i>Coriandrum sativum</i> L.
71	Fenugreek	<i>Trigonella foenum graecum</i> L.
72	Almond	<i>Prunus dulcis</i> (Mill.) D.A. Webb
73	Apple	<i>Malus domestica</i> Borkh
74	Pear	<i>Pyrus communis</i> L.
75	Apricot	<i>Prunus armeniaca</i> L.
76	Cherry	<i>Prunus avium</i> L.
77	Walnut	<i>Juglans regia</i> L.
78	Grapes	<i>Vitis</i> spp.
79	Indian jujube (Ber)	<i>Ziziphus mauritiana</i> Lamk.
80	Tea	<i>Camellia sinensis</i>
81	Tea	<i>Camellia assamica</i>
82	Tea	<i>C.assamica</i> ssp <i>lasiocalyx</i> .
83	Acid Lime	<i>Citrus aurantifolia</i> Swingle
84	Mandarin	<i>Citrus reticulata</i> Blanco
85	Sweet Orange	<i>Citrus sinensis</i> (L.) Osbeck
86	Bougainvillea	<i>Bougainvillea Comm. Ex Juss.</i>
87	Banana	<i>Musa</i> spp.
88	Orchid	<i>Oncidium</i> Sw.
89	Canna	<i>Canna</i> L.
90	Gladiolus	<i>Gladiolus</i> L.
91	Muskmelon	<i>Cucumis melo</i> L.
92	Watermelon	<i>Citrullus Lanatus</i> (Thunb.) Mansf.
93	Jasmine	<i>Jasminum auriculatum</i> . L.
94	Tuberose	<i>Polianthes tuberosa</i> L.
95	Papaya	<i>Carica papaya</i> L.
96	China Aster	<i>Callistephus chinensis</i> (L.)Nees.
97	Peach	<i>Prunus persica</i> L Batsch.
98	Japanese Plum	<i>Prunus salicina</i> L.
99	Strawberry	<i>Fragaria x ananasan</i> Duch.
100	Chilli, Bell Pepper and Paprika	<i>Capsicum annuum</i> L.
101	Finger Millet	<i>Eleusine coracana</i> (L.) Gaertn.
102	Foxtail Millet	<i>Setaria italic</i> (L.) Beauv

Annex 4: Variables Used for Data Analysis— Survey Questions, Response Sets and Coding

**4.1 Table 1: Name and Description of the Variables Used
(Hypothesis A.1 – A.3, B.1 – B.12)**

Notation	Description/survey Question	Name of Variable	Code
District	Please name the Village, District and State that you live in.	Deobhog, Chhattisgarh	1
		Narsinghpur, Madhya Pradesh	2
Cult_Crops	Which crops do you routinely cultivate in your field?	Rice	1
		Sugarcane	2
		Mung (Green gram)	3
		Chickpeas	4
		Soybean	5
		Wheat	6
		Urad	7
		Masur	8
		Lathyrus	9
		Red Gram	10
		Peas	11
		Corn	12
		Others	13
CC_Cat	Dummy variable created by categorizing the cultivated crops as ‘Pulses’ or ‘Non-Pulses’	Non-Pulses	0
		Pulses	1
Pref_Crops	Of the routinely cultivated crops, which crop do you consider your main or preferred crop? (“Preferred Crop”)	Rice	1
		Sugarcane	2
		Mung (Green gram)	3
		Chickpeas	4
		Soybean	5
		Wheat	6

(continued)

Notation	Description/survey Question	Name of Variable	Code
		Urad	7
		Masur	8
		Lathyrus	9
		Red Gram	10
		Peas	11
		Corn	12
		Others	13
PC_Cat	Dummy variable created by categorizing the preferred crops as ‘Pulses’ or ‘Non-Pulses’	Non-Pulses	0
		Pulses	1
Area	Agricultural Land area over which you farm?	Marginal	1
		Small	2
		Semi-Medium	3
		Medium	4
		Large	5
Areabin	Dummy variable created by clubbing marginal and small landholdings into a new category “Small” and the semi-medium, medium and large landholdings into a new category “Large”	Small	1
		Large	2
SeedTyp	Dummy Variable created to identify seed type associated with the entries under SRR_ALL	Preferred Crop	0
		Pulses	1
PulsSRR	How often do you buy new pulses seeds from the market/government	Every year	1
		Once every 2 years	2
		Once every 3 years	3
		I never buy new seeds/I use my own saved seeds each season	4
PCSRR	How often do you buy new seeds for your preferred crop from the market/ government	Every year	1
		Once every 2 years	2
		Once every 3 years	3
		I never buy new seeds/I use my own saved seeds each season	4
SRR_ALL	Dummy Variable created by combining answers to PCSRR and PulsSRR	Every year	1
		Once every 2 years	2
		Once every 3 years	3
		I never buy new seeds/I use my own saved seeds each season	4

4.2 Table 2: First Level of Coding for Reasons for Cultivating Preferred/Pulses Crops

Answers in the original	Notation of new category	Description of New Category and coding of responses	Cited response	Code
This crop gives me the highest yield	CC_Profit (The cultivation choice is primarily profit driven)	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Profit was marked as ‘Yes’, else, as ‘No’.	Yes	1
This crop gives me the highest profit/income			No	0
I sell this crop in the market (for money)				
This is a cash crop				
The climate/soil in this region is suitable for cultivating this crop	CC_Envl (The cultivation choice is primarily driven by environmental conditions in the region)	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Envl was marked as ‘Yes’, else, as ‘No’.	Yes	1
This is a rain-fed region			No	0
There is lack of water in this region				
There is adequate (rain) water in this region				
We get minimum support price from government for this crop	CC_Conv_Sale (The cultivation choice is primarily driven by convenience of sale or guaranteed buyers for the crop in the region)	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Conv_Sale was marked as ‘Yes’, else, as ‘No’.	Yes	1
There is a guaranteed buyer (government/local buyer) for this crop				
It is easy to sell this crop within the (local/village) area			No	0
This crop grows on its own (no soil preparation etc. needed)	CC_Conv_Cult (The choice is primarily driven by convenience of cultivation, either due to its needing less labour or less care.)	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Conv_Cult was marked as ‘Yes’, else, as ‘No’.	Yes	1
This crop needs less care			No	0

(continued)

Answers in the original	Notation of new category	Description of New Category and coding of responses	Cited response	Code
This crop needs less time to grow	CC_Crop_Nature (The cultivation choice is primarily driven by the nature of the crop/seed)	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Crop_Nature was marked as ‘Yes’, else, as ‘No’.	Yes	1
This crop is less affected by climatic changes			No	0
This crop gives some yield even if the (climatic) conditions are bad				
This crop resists drought/flood/excess water/lack of water				
This crop is (naturally) resistant to pests and diseases				
Labor costs for this crop are low	CC_Input_Cheap (The choice is primarily driven by the fact that the inputs for this crop are cheap (er))	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Input_Cheap was marked as ‘Yes’, else, as ‘No’.	Yes	1
This crop requires less fertilizers and pesticides			No	0
This crop requires less water				
This is what we/I eat	CC_Eat (The choice is primarily driven by personal eating habits)	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Eat was marked as ‘Yes’, else, as ‘No’.	Yes	1
To make seed			No	0
This is our traditional crop	CC_Trad (The choice is primarily driven by traditional cultivation choices in the region)	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Trad was marked as ‘Yes’, else, as ‘No’.	Yes	1
We have grown this crop for generations			No	0
This crop is good for the soil/improves soil	CC_Conserver (This cultivation choice is primarily driven by convenience of sale or guaranteed buyers for the crop in the region)	If the answers in the survey matched with any of the mentioned “Answers in the original” in this row, the new category CC_Conserve was marked as ‘Yes’, else, as ‘No’.	Yes	1
This crop provides good nutrition			No	0
For crop rotation				
This crop is a protein source for the country				

Table 2a. If a farmer cited two reasons, namely convenience of sale and self-consumption as the reasons why he cultivates a preferred crop, the PMYN variable corresponding to that farmer was given the value 1 (indicating that the decision to cultivate this crop was guided primarily by a profit motive) because at least one of the reasons given by the farmer for choosing to cultivate this crop was a purely/largely profit oriented reason. Accordingly, a section of the coded data, could, for example, look like this:

Table 2a

Farmer Response in Original	Profit	Environment	Sale Convenience	Inputs Cheap	Nature of Crop	Self-Consumption	Traditionally grown crop	Profit Motive (Y/N)
Highest Yield, To Eat, Easy to sell	1	0	1	0	0	1	0	1
Traditional Crop	0	0	0	0	0	0	1	0
This crop resists diseases, no labour costs	0	0	0	1	1	0	0	1
This crop gives highest profit, it is convenient to sell	1	0	1	0	0	0	0	1
High yield, We eat this	1	0	0	0	0	1	0	1

4.3 Table 3: Variables Used for Probit and Linear Regressions

Notation	Description/survey Question	Name of Variable	Code
Seed Replacement Rate (SRR)	How often do you buy new seeds (Preferred Crop, Pulses) from the market/government	Every year (lowest conservation score)	1
		Once in 2 years (low conservation score)	2
		Once in 3 years (high conservation score)	3
		I never buy new seeds/I use my own saved seeds each season (Highest conservation score)	4
Conservation (ConsBin)	How often do you buy new seeds (Preferred Crop, Pulses) from the market/government	Every year (No Conservation)	0
		Once every 2 years (No Conservation)	0
		Once every 3 years (No Conservation)	0
		I never buy new seeds/I use my own saved seeds each season (Conservation)	1
SeedTyp	Dummy Variable created to identify seed type associated with the entries under Conservation (Cons)	Preferred Crop	0
		Pulses	1
District	Please name the Village, District and State that you live in.	Deobhog, Chhattisgarh	1
		Narsinghpur, Madhya Pradesh	2
Exchange Culture	1. Seeds of which crops do you exchange with other farmers? 2. Would you stop the practice of exchange if you develop a new variety of seed and get awarded for it?	Exchange preferred crop and pulses seeds and will not stop exchange	3
		Exchange either pulses or preferred crop (not both) and will not stop exchange / Exchange both but will stop exchange	2
		Exchange neither but will not stop exchange / Exchange either preferred crop or pulses (not both) but will stop exchange	1
		Exchange neither and will stop exchange	0
Seed Availability	Dummy Variable created by using information as to availability of new/improved seed for the corresponding answers for 'Preferred Crop' and 'Pulses Crop' in each of the districts surveyed	Improved/New Seed Available	1
		Improved/New Seed Not Available	0

(continued)

Notation	Description/survey Question	Name of Variable	Code
Profit Motive	What is the primary/main reason why you cultivate the preferred crop/ What is the primary/main reason why you cultivate the pulses crop?	Profit is the main reason	1
		Profit is not the main reason	0
Education	Education Level	No Education	0
		Primary	1
		Secondary	2
		Higher Secondary	3
		Graduate	4
		Post Graduate	5
Age	What is your age?	Whole numbers	NC ⁷³
Area	What is your agricultural land holding size?	Marginal	1
		Small	2
		Semi-Medium	3
		Medium	4
		Large	5

⁷³Not coded.

Annex 5: Explanation of Variables Used in the Hypotheses

Hypotheses A.1, A.2 and A.3

H_0 indicates the null hypothesis

H_a indicates the alternative hypothesis.

μ_D is the cultivation choice trends in Deobhog

μ_N is the cultivation choice trends in Narsinghpur

μ_{pc} is the average rate of cultivation of pulses crops in Deobhog.

μ_{pn} is the average rate of cultivation of pulses crops in Narsinghpur

μ_{PMYN} is the average number of farmers indicating profit as their primary motive for cultivating crops⁷⁴

Hypotheses B.1 to B.5

H_0 is the null hypothesis;

μ_{Pref} is the average seed replacement rate of preferred crops;

μ_{Puls} is the average seed replacement rate of pulses crops;

μ_{PrefC} is the average seed replacement rate for preferred crops in Chhattisgarh;

μ_{PrefM} is the average seed replacement rate for preferred crops in Madhya Pradesh;

μ_{PulsC} is the average seed replacement rate for preferred crops in Chhattisgarh;
and

μ_{PulsM} is the average seed replacement rate for the pulses crops in Madhya Pradesh

Hypotheses B.6 to B.14

H_0 is the null hypothesis;

H_a is the alternative hypothesis;

μ_{SrrS} is the average seed replacement rate among marginal, small and semi-small landholders (hereinafter, small landholders);

⁷⁴An explanation of how this category was created is detailed below.

μ_{SITL} is the average seed replacement rate among semi-medium, medium and large landowners (hereinafter large landholders);

μ_{SITSC} is the average seed replacement rate among small landholders in Deobhog, Chhattisgarh

μ_{SITLC} is the average seed replacement rate among large landholders in Deobhog, Chhattisgarh

μ_{SITSM} is the average seed replacement rate among small landholders in Narsinghpur, MP

μ_{SITLM} is the average seed replacement rate among large landholders in Narsinghpur, MP

μ_{PCS} is the average preferred crop seed replacement rate among small landholders

μ_{PCL} is the average preferred crop seed replacement rate among large landholders

μ_{PulsS} is the average pulses seed replacement rate among small landholders

μ_{PulsL} is the average pulses seed replacement rate among large landholders

μ_{PCSD} is the average preferred crop seed replacement rate among small landholders in Deobhog, Chhattisgarh

μ_{PCLD} is the average preferred crop seed replacement rate among large landholders in Deobhog, Chhattisgarh

μ_{PCSN} is the average preferred crop seed replacement rate among small landholders in Narsinghpur, MP

μ_{PCLN} is the average preferred crop seed replacement rate among large landholders in Narsinghpur, MP

μ_{PulsSD} is the average pulses seed replacement rate among small landholders in Deobhog, Chhattisgarh

μ_{PulsLD} is the average pulses seed replacement rate among large landholders in Deobhog, Chhattisgarh

μ_{PulsSN} is the average pulses seed replacement rate among small landholders in Narsinghpur, MP

μ_{PulsLN} is the average pulses seed replacement rate among large landholders in Narsinghpur, MP

Annex 6: Private Sector & Farmer Surveys: Scope, Structure, Methodology & Implementation

Following the broad overview of the research method given in Annex 1 above, this Annex provides details of the methods and steps employed to design and conduct the empirical research surveys and associated open-ended interviews relevant for this research. The chapter is divided into three parts: The first summarizes the questions (identified through the literature review and discussions in the previous chapters) meriting empirical investigation. Part 6.2 describes the rationale, methodology and design of the Private Sector Survey, including the method adopted to administer the same and the reason why certain segments of the private sector survey had to be excluded from the analysis detailed in Chap. 5 above. Part 6.3 describes the rationale, methodology and design of the Farmer Surveys, including the method adopted to administer the same. As in Part 6.2, Part 6.3 also describes the problems encountered in the process of administering the farmer surveys and the reasons for rejecting certain sections of the data collected during the process.

6.1 Identifying the Questions for Qualitative and Quantitative Empirical Investigations

The literature review and discussions in the previous chapters helped identify a number of issues and questions as meriting more in-depth empirical investigation; either due to the absence of comprehensive data/information or due to the lack of availability of up to date information on specific topics. An overview of these issues and questions is provided below as identified in each of the previous chapters.

6.1.1 Questions Guiding the Structure and Content of the Private Sector Survey/Interviews⁷⁵

Chapter 1 provided a philosophical and economic introduction to sustainable innovation. It noted that vis-à-vis plant variety innovations, perhaps more than in any other field of innovation, neither the ‘Creative Destruction’ nor the ‘destructive creation’ frameworks are sustainable. This is because unlike in most other fields of technology where the evolution or continuation of less desirable (or ‘old’) products, processes or ‘features’ is largely unnecessary, in the sphere of plant breeding and plant improvement, the continuation and *in situ* evolution of ‘old’ landraces is necessary for both short and long term sustainability of innovation and of agriculture itself.

The scientific, ecological and sociological basis of the observations in Chap. 1 were discussed Chap. 3 by taking a closer look at modern day plant variety innovations (i.e. the dynamics of creation and destruction) in the plant breeding (formal) sector, as well as traditional conservation and crop improvement practices in the farmers’ (informal) sector. The objective of the investigations in Chap. 3 was to determine whether the innovations that are predominant in the plant varieties sector are sustainable in the light of the meaning and scope of the term ‘sustainable innovation’ as discussed in Chap. 2. A review of relevant scientific and sociological literature revealed that indeed, most present day innovations in the plant breeding industry follow the pattern of Schumpeterian ‘Creative Destruction’ or of ‘destructive creation’ and are designed to preclude downstream farmer level *in situ* improvement of plant varieties. A great deal of scientific literature was also found to reveal that these innovations lead to environmental degradation and erosion of traditional agricultural practices that contribute to sustainability of agricultural innovations and of agriculture itself. The chapter led the study to question whether the formal plant breeding industry has any interest in working with self-pollinating varieties for which male sterile have not so far been identified or successfully employed. Empirical investigation was deemed necessary to determine the current research interests and focus of the formal plant breeding sector. Part of this investigation was conducted using plant variety application data from India in Chap. 4 above. The data revealed that although the private sector is engaged in R&D for both cross-pollinating and self-pollinating crops, its main focus is on crops for which hybrids are important. Even in self-pollinating crops, the private sector is more focused on producing hybrids and not on typical varieties. It was further found that private sector interest in pulses varieties is almost non-existent.

However, in order to determine whether (i) the private sector is engaged in R&D, production and/or distribution for self-pollinating crops even though these are not subject matter of currently filed plant variety protection applications, (ii) what factors contribute to private sector interest in R&D in any specific crop species,

⁷⁵See Part 6.2 below for the final structure of the private sector survey within which these questions were couched.

and (iii) what factors, if any, might incentivize private sector participation in self-pollinating plants, especially pulses varieties, the following questions were formulated for inclusion in empirical investigations either via interviews or via more comprehensive and widely distributed surveys:

- (i) *What propels the seed industry to enter an unprotected market:* What were the reasons that propelled seed companies to enter the markets of various developing countries, including countries that do not provide patent protection for plant varieties and/or plant breeders' rights⁷⁶?
- (ii) *What is the current research focus of the seed industry:* Is the formal plant breeding sector, especially in countries that do not recognize patent rights in plant varieties, focused mostly or exclusively on hybrids or are they also engaging in R&D for self-pollinating crops⁷⁷?
 - a. If yes, what drives their interest in R&D in self-pollinating crops?
 - b. If not, why not and what changes, if any, in laws and policies would encourage them to engage in R&D for self-pollinating crops?
- (iii) *What is the current portfolio of seed production/distribution companies?*
 - a. Are there seed companies that merely multiply and distribute seeds of self-pollinating crops (without engaging in R&D for improving seeds of such crops)?
 - b. What are the reasons why companies do or do not engage in such multiplication and distribution?
- (iv) *Classification of Respondent Companies:* Are companies of any specific size or structure more interested in R&D or production/distribution of self-pollinating crops?
- (v) *Interest and engagement with plant variety protection laws (plant breeders' rights):* Are seed companies filing plant variety protection applications in countries that do not offer patent protection for plant varieties?
 - a. If yes, why?
 - b. If not, why not?

The above questions were converted into a comprehensive survey, the more focused scope, design and structure of which is explained below in Part II of this Chapter.

⁷⁶This question has its basis not only in the discussion on the science of hybrids in Chap. 3, but also in the findings of Chap. 4 where it was found that the private seed sector entered the Indian market in the 1980s despite the absence of any IP protection in India at the time.

⁷⁷This question was partially answered in Chap. 4, which looked into the PVP filing trends in India and found that the private sector is mostly filing applications for hybrids and corresponding parental lines and not for self-pollinating crops. Even within the self-pollinating crops' category, the private sector is more interested in hybrids of rice and wheat and not in 'typical' varieties of these crops that can be saved and further improved by farmers.

6.1.2 Questions Guiding the Content and Structure of the Farmer Survey/Interviews⁷⁸

Chapter 2 discussed the international legal background from which the research goal for this book emerged. It discussed, in particular, the ongoing review of Article 27.3(b) of TRIPs in which there is a deadlock on a number of issues, particularly the issue of disclosure of origin of genetic material used in any invention for which a patent is sought. In this context, Chapter 2 identified a gap that mandated empirical investigation: Once farmers have access to the improved seeds that are created by using their traditional knowledge and genetic resources, do they still have an incentive to maintain these resources by continuing to use and improve them?

During the course of the literature review and investigations detailed in Chaps. 2–4, it was discovered that there exists some literature from the field of ecological economics which argues (in a theoretical paper) that unlike in other industries where incentivizing the production of certain products also incentivizes the continuing and expanding production of raw materials necessary to produce these products, in the plant breeding industry this does not happen, *inter alia* because farmer-producers of raw materials are also consumers of the improved seeds. They have greater incentive to adopt improved seeds and discard traditional seeds that embody agrobiodiversity. However, the literature review did not unearth any quantitative empirical research confirming this theory. There was also little indication in the literature as to current trends and preferences vis-à-vis innovation and cultivation among farmers. However, there was significant evidence of efforts by a number of non-governmental organizations (NGOs) aimed at promoting *in situ* conservation of local agrobiodiversity. At the same time, existing literature vis-à-vis agriculture in India suggests that small and marginal farmers cannot afford to buy new seeds from the market. This gave rise to the probability that in the Indian context, adoption of new varieties and conservation of agrobiodiversity are on-going in parallel, albeit undertaken by farmers of different land holding sizes. These contradictory assertions and theories in the literature, led to the following questions:

- (i) Are efforts by NGOs (to promote *in situ* agrobiodiversity conservation) indicative of a tendency among farmers to move away from traditional seeds and farming practices towards modern capital-intensive agriculture?
- (ii) If yes, does this mean that the economic incentives⁷⁹ for saving and re-sowing (traditional) seeds (cost saving) are not (any more) adequate incentive for farmers to engage in *in situ* conservation of agrobiodiversity?

⁷⁸See Part 6.3 below for the final structure of the farmer survey within which these questions were couched.

⁷⁹Given the costs associated with buying new seeds and the capital intensive supplements such as fertilizers and pesticides that need to be purchased with such seeds, it seemed intuitive for the researcher that farmers, especially those belonging to economically weaker sections of society would choose to retain their own traditional seeds.

- (iii) What (if any) are the circumstances in which farmers choose to use traditional self-saved seeds?
- (iv) What are the reasons/circumstances in which farmers choose to use new/improved/hybrid seeds?
- (v) Whether farmer-owners of any specific agricultural landholding size are adopting improved seeds or are all farmers (irrespective of land holding size) doing so?⁸⁰
- (vi) As a corollary, are small and marginal land owners who are described in the literature as being the farmers who cannot afford new and improved seeds and associated inputs (such as chemical fertilizers and pesticides) then, consciously or un-consciously, undertaking *in situ* conservation of agrobiodiversity (and not buying new seeds at all)?⁸¹
- (vii) What, if any, is the impact of these choices on cultural practices of seed exchange?
- (viii) What, if any, is the impact of these choices on agrobiodiversity conservation and *in situ* evolution of diverse local landraces?

Chapter 2 provided an overview of existing international instruments aimed at promoting plant variety innovations on the one hand, and promoting agrobiodiversity conservation on the other. The chapter found that the emphasis of most ‘hard’ laws in the international arena is on formal plant variety innovations (plant breeding and biotechnology). Farmer level innovations that are, in essence, synonymous with *in situ* conservation and evolution of agrobiodiversity are mostly protected by ‘soft’ laws, the implementation of which are more difficult to monitor internationally. In fact, the central (desirable) characteristics of such informal innovations are what make them ineligible for protection under ‘hard’ (implementable) laws similar to intellectual property rights regimes.

In the national and international arenas therefore, farmer innovations are, at best, ‘compensated’ or ‘acknowledged’ (for example via a benefit-sharing mechanism) and the number of cases of benefit sharing resulting from such innovations are rather small or not well documented.⁸²

⁸⁰For example, questions on land holding size, seed replacement rate, use of traditional versus modern seeds for preferred crops versus pulses crops etc.

⁸¹The author was of the view, before conducting the farmer surveys, that the small and marginal land owners would be the ones preserving agrobiodiversity, while the medium and large land-owners would be found to prefer new improved seeds. In this way, it is likely that the ideals of preserving agrobiodiversity and incentivizing private sector innovations would likely be ongoing side-by-side, albeit to the economic detriment of the smaller land owners.

⁸²There are of course, a few exceptions. See for example, Christine Godt, ‘Regulatory Paradoxes — The Case of Agricultural Innovation.’ Nonetheless, most of the literature in relation to farmers’ innovation and conservation efforts relate to issues of access and benefit sharing. See also, Shannad Basheer, ‘New Age “Indian(a) Jones”?: Regulating Bioprospecting and Incentivizing Innovation’ SpicyIP Blog (November 3, 2005) <<http://spicyip.com/2005/11/new-age-indiana-jones-regulating.html>> accessed October 31, 2014.

Chapter 2 (overview of international legal regimes) also revealed that in order to comply with the UPOV 1991 standards for the protection of plant varieties, the EU has adopted a law whereby farmers cultivating a landarea less than that required to cultivate 92 tons of cereal are permitted to save seeds without having to compensate the plant variety right owner, while larger farm owners are not permitted to do so. This approach, it was discussed, appears reasonable and equitable, but would result in a meaningless standard in a country like India where the average landholding sizes are between 1 and 2 hectares. Furthermore, even to the extent that such a law (or a modified version of it) has the potential of helping the cause of *in situ* conservation and evolution of agrobiodiversity by focusing efforts in this direction on smaller (more manageable) farms, it was still considered necessary to address the previously identified issue, namely, whether farmers (even of small landholding sizes) have any incentive to actually save seeds and re-sow them (with the aim of improving or conserving them) in the light of the availability of 'improved' seeds that promise much higher yields and therefore greater economic prosperity?⁸³

Although a comprehensive international investigation into the above issue was considered important, an empirical study involving a large number of countries, both developed and developing, was not possible within the time and resource constraints of a doctoral thesis. Accordingly, one country, namely India, was chosen for conducting empirical research into the above questions, *inter alia*, because of the diversity of agricultural practices and landholding sizes that are available for study in India. Chapter 4 therefore studied the Indian agricultural sector and plant variety protection regime via the evolution of national agricultural policies, recent case law, a case study, and plant variety application trends. The chapter found that the 'Green Revolution' led to a major shift in the approach and strategy of the Indian government: Research moved away from farmers' fields and into labs and agricultural university grounds. The emphasis also shifted away from traditional organic means of increasing yield and productivity and became focused on increasing yields through the adoption of chemical supplements such as fertilizers and pesticides.

The study of a recent Indian caselaw and a case study further revealed that although the Indian PPV&FR Act makes a sincere attempt to actively encourage both informal farmer level innovations and agrobiodiversity conservation, several factors impede the farmers' ability to obtain compensation, in the form of royalties or awards, for their efforts. The chapter also identified the existence of several policies (particularly government efforts to increase seed replacement rates) that potentially decrease farmer incentive to engage in *in situ* conservation of agrobiodiversity, and increase their interest in pursuing modern agriculture using improved or hybrid seeds.

⁸³The data therefore can check whether there is a greater propensity to conserve among smaller landowners – the data shows that there is no statistically significant trend in favor of conservation among smaller land-owners as compared to larger land owners.

Chapter 4 also looked at plant variety application trends in India that helped answer some of the questions that emerged from Chap. 3 from the Indian context. However, the identified trends also suggested the existence of a paradox in laws and policies relating to plant varieties: laws that promote formal innovation appear to undermine or dilute the impact of laws and policies designed to promote agrobiodiversity conservation, and vice versa.⁸⁴

From the investigations and literature review presented in Chaps. 1–4 above, it was observed that the key questions that emerged (as meriting empirical research) were tending to overlap. The key questions that emerged were therefore further refined and divided into the following broad subject heads:

- (i) *What factors (direct and indirect) drive cultivation choices and cultivation preferences of farmers?*
 - a. Which crops do farmers favor cultivating the most?
 - b. What are the reasons why they give preference to these crops?
 - c. Do farmers of specific landholding sizes or education levels prefer to cultivate certain types of crops more than others?
- (ii) *In situ conservation versus seed replacement for the adoption of new varieties:*
 - a. Whether farmers continue to grow traditional varieties and save and improve such varieties?
 - b. Whether farmers continue to grow traditional varieties and save and improve such varieties once formally improved new/hybrid seeds of such traditional varieties are made available to them?
- (iii) *(Other) factors that affect conservation/ seed replacement trends*
 - a. Whether farmers of specific landholding sizes are more likely to save and re-sow traditional varieties and thereby (knowingly or unknowingly) engage in agrobiodiversity conservation?
 - b. Whether farmers that have a certain (minimum) level of education are more or less likely to save and re-sow traditional varieties and thereby (knowingly or unknowingly) engage in agrobiodiversity conservation?
 - c. Is there any difference in seed replacement rates and conservation trends for various types of crops?
- (iv) *Evidence of farmer level or village level conservation or in situ crop improvement/innovation:*
 - a. Do the farmers recognize their own seed as being different, unique, or better than the seeds of other farmers in the village?
 - b. Do the farmers recognize the seeds in their own village as being different, unique or better than the seeds of neighboring villages?

⁸⁴Also see discussion in Chap. 6.

- c. Are there popular seed sellers within villages that most farmer prefer to obtain their seeds from?
 - d. What is the most common source of seeds for farmers of various land holding sizes?
- (v) *Direct and indirect factors affecting farmer level innovations*
- a. Are farmers who save and re-sow seeds (rather than buying new seeds from the market each season) more likely to improve seeds and therefore obtain farmers' variety certificates under the Indian PPV&FR Act?
 - b. Are farmer innovations more (or less) likely in specific types of crops?
 - c. Are farmer-owners of specific landholding sizes more (or less) likely to innovate?
 - d. Are farmers who have a certain level of education more (or less) likely to innovate?
- (vi) *Impact of exclusive rights regimes on socio-cultural practices of seed exchange and seed saving:*
- a. Would grant of exclusive rights encourage farmers to stop seed saving practices?
 - b. Would grant of exclusive rights encourage farmers to stop seed exchange practices?
 - c. Would grant of exclusive rights make farmers stop giving their seeds to Universities and/or to corporations engaged in seed improvement efforts?

6.2 Private Sector Surveys: Scope, Methodology, Structure and Implementation

6.2.1 The Private Sector Survey: Scope and Methodology

6.2.1.1 Scope

The questions identified during the course of the literature review formed the basis and rationale for undertaking empirical research as part of this study. Although the identified questions gave a clear direction for the survey, they were nevertheless found to be rather broad in scope. A more manageable scope was necessary to conduct meaningful empirical investigations. In order to delimit the scope vis-à-vis subject matter, a specific issue (or set of issues) that could serve as a starting point and key means of collecting relevant information needed identification.

In the Indian context, an analysis of PVP filing trends revealed that the private sector R&D focus continues to be in relation to crops for which hybrids are important and hybridization is a possibility. Self-pollinating crops such as wheat and rice were also of some interest to the private sector, but primarily only so far as creating hybrids of such crops is possible. Although the apparent absence of self-

pollinating crops from formal sector R&D efforts was marked, conducting empirical research encompassing all self-pollinating crops was not practical. In order to choose a relevant sub-category of self-pollinating crops that would nonetheless help answer the identified questions, the plant variety application trends were considered more closely.

It was noticed that among all self-pollinating crops, a crop in which the private sector showed almost negligible interest, was the pulses crops category.⁸⁵ Further, the public sector research efforts in relation to pulses seeds were found to not have lead to any substantial increase in pulses crop yields. However, there were pockets of interest in pulses-related R&D visible within the Indian PVP application statistics. The literature reviewed in this connection suggested that some private companies multiply and distribute pulses seeds to their farmer customers in order to give them a diverse set of crop-seeds to choose from each season, and to encourage crop rotation. However, no study deals with the types of companies engaged in such multiplication and distribution, and whether they were also engaging in some R&D to improve these pulses seeds.

The more focused issue that emerged from the discussions in the previous chapters, therefore, was the sub-optimal innovation in self-pollinating crops, particularly pulses. A focus on sub-optimal innovation in pulses was also considered suitable within the broader objective of this book, namely, finding means of promoting sustainable innovation in plant varieties, because of the nature of pulses crops: They are known to naturally enhance soil fertility and therefore contribute to long term sustainability of agriculture. Within this focused scope, it was considered appropriate to further focus on issues other than those answered by science, namely legal, economic and sociological issues (if any), particularly those associated with intellectual property law and policy.

In order to further delimit the geographic scope of the investigations, India was chosen as the country where empirical research vis-à-vis the private sector would be conducted, for the following reasons:

- (i) India has a large and diverse seed industry that includes local (state level), national and multinational corporations engaged in plant/seed related R&D, production, distribution, or a combination of these activities.
- (ii) The private sector seed industry in India has an interesting history (see Chap. 4) – it commenced large scale seed related R&D, production and distribution activities well before India adopted an intellectual property rights regime for the protection of plant varieties.
- (iii) Both public and private sector seed corporations exist and operate simultaneously in India.
- (iv) More than a decade has elapsed since India adopted the PPV&FR Act and both the public and the private sector appear to be using the system with significant zeal.

⁸⁵See discussion under Sect. 4.4 of Chap. 4.

- (v) The Indian PPV&FR Act is considered a model law for promoting formal innovations in plant varieties while not compromising the interests of farmers, especially in developing countries. The parallel existence of the formal and the informal seed sector in India made it an ideal location for conducting the necessary empirical research.

6.2.1.2 Methodology

Having chosen India to conduct the empirical research associated with the private sector seed industry, it was necessary to design a methodology for conducting the research that was appropriate in the Indian context. Some of the peculiarities of the Indian situation that needed to be taken into account while choosing the methodology were as follows:

- (i) India is a diverse country where there are more than 20 official languages. The existence of a large number of locally owned and locally run seed companies made the issue of survey language very significant.
- (ii) A preliminary discussion with several experts led to the understanding that in general, response rates from private sector enterprises in India is extremely low.⁸⁶ A research design that relied primarily on a sufficiently high response rate was therefore not guaranteed to succeed.
- (iii) Seed companies are spread out through the length and breadth of the Indian sub-continent making personal interviews with them rather difficult, expensive and time consuming.
- (iv) There is no central agency (private or government run) that keeps track of all seed companies in India and there is no one reliable and comprehensive list of seed companies in India. Where lists do exist, they often contain outdated or inaccurate information.

On the basis of the above identified considerations and scope of the research, a mixed-methods approach was considered most suitable for conducting the private sector specific empirical research. As discussed in Annex 1, the mixed methods research design permits the researcher to conduct qualitative and quantitative investigations simultaneously or concurrently and provides a larger canvas from which to draw appropriate inferences.

Given the possibility of a low response rate, the private sector specific investigations were designed to give greater emphasis to qualitative investigations. The quantitative aspect of the private sector study was designed to be subject to an adequately high response rate to the survey questions. If the same was not

⁸⁶Interview with G. J. Samathanam, Advisor, Department of Science and Technology, Government of India (New Delhi 12 February 2012). He stated that even when surveys are sent by government departments, it is difficult to elicit responses from a large number of companies, especially when the time limit within which the answers are required is relatively short (within 3–6 months) and if the number of questions is large (more than 20).

forthcoming, a reliance on the previously discussed plant variety application trends was envisaged as the means of supplementing the information from the qualitative investigations and interviews.

The next step was the identification of a dominant qualitative method for conducting the necessary private sector specific investigations. The grounded theory method was adopted for this purpose for the following reasons:

- (i) A grounded theory approach is best suited for research investigating a specific phenomenon. The scope of the empirical research undertaken for this book was limited to investigating the reasons for sub-optimal private sector innovation in pulses. This constituted the phenomenon that could be comprehensively studied by the grounded theory method.
- (ii) The number of responses necessary for conducting a grounded theory research is relatively small and flexible – the literature identifies the optimal number of responses to range between 15 and 30.
- (iii) The grounded theory approach permits collection of responses in a variety of ways – through personal interviews, via surveys, via phone interviews etc.
- (iv) The ‘randomness’ requirement that is indispensable for conducting quantitative research is not a strict requirement for qualitative research approaches including the grounded theory approach.

While the qualitative (grounded theory research) aspect of the mixed research sought to understand the broad spectrum of reasons for the low interest in pulses related innovation, a quantitative aspect was envisaged for the survey to help confirm or reject predominant arguments and justifications associated with current intellectual property protection regimes.

In order to save time and costs, one part of the qualitative investigations was conducted concurrently with the quantitative elements of the research, i.e. via the private sector survey. Accordingly, a comprehensive survey questionnaire containing both open ended and multiple choice questions was formulated. This survey was emailed or posted to a master list of Indian seed companies. Alongside, a more diverse set of stakeholder-specific interview questions was put together to conduct personal interviews in order to gather a broader set of responses from various perspectives. The manner in which questions were chosen for inclusion in the interviews and the survey has been described in sub-part 6.2.2 below. The manner in which the master list of seed companies and of various stakeholders was created, and the survey/interviews implemented among them, has been described in sub-part 6.2.3.

6.2.2 The Private Sector Survey: Structure and Content

In accordance with the decided research methodology, the private sector survey was designed to include both open ended and multiple-choice questions, and was divided into 9 broad sections, namely:

- (i) Profile of Companies
- (ii) Seed R&D Portfolio (if any)
- (iii) Pulses seeds R&D Portfolio (if any)
- (iv) Seed Production Portfolio (if any)
- (v) Pulses seeds production portfolio (if any)
- (vi) Seed Distribution portfolio
- (vii) Intellectual Property Protection Portfolio (if any)
- (viii) General Opinion about Intellectual property (particularly PVP and patents)
- (ix) Miscellaneous opinions and permissions

6.2.2.1 Profile of Companies⁸⁷

In order to undertake an analysis of research portfolios and focal points on the basis of firm size, location, etc. a number of general questions aimed at profiling the responding corporations were included in the first section of the survey.⁸⁸ This section contained a diverse set of questions to determine things like company name, size, number of employees, year of incorporation etc. These questions were considered necessary for the purpose of categorizing the respondent companies in an adequate and comprehensive manner once all responses were received.

6.2.2.2 Seed R&D Portfolio and Pulses Seeds R&D Portfolio

This section contained questions to determine whether the companies had an R&D department at all and if yes, what the size of the department is, which crops the department was primarily conducting research in and for what reasons. The ‘pulses seeds R&D portfolio’ section asked similar questions, but was pulses specific. It also asked (if applicable) for reasons why the company was or was not undertaking pulses-related R&D and what changes in circumstances would induce them to change their decision.

6.2.2.3 Seed Production and Pulses Seeds Production Portfolio

This section contained questions to determine whether the companies had a seed production facility and if yes, the seeds of which crops were being produced. The

⁸⁷The word ‘company’ was used in the survey to include partnership firms, sole proprietorships and any other type of entity involved in R&D, production and/or distribution of seeds. Seed distributors were included in the survey mailing list primarily to obtain an idea of whether seed distributors were distributing seeds of pulses varieties, the source of seeds (public/private) and the reasons for the choice.

⁸⁸Although the minimum required number of responses was not forthcoming, an analysis of the responses received has been included in Chap. 5 above, as they reveal the existence of an interesting diversity of thoughts and approaches in the Indian seed industry.

reasons why the company focused on production of these crops (and not others) was also asked. The 'pulses seeds distribution portfolio' section asked similar questions, but was pulses specific. It also asked (if applicable) for reasons why the company was or was not undertaking pulses-related production and what changes in circumstances would induce them to change their decision.

6.2.2.4 Seed Distribution Portfolio

This section contained questions to determine whether the companies was distributing seeds and if yes, the seeds of which crops. The reasons why the company focused on distribution of seeds for these crops (and not others) was also asked. The section included specific questions to determine whether the company was distributing pulses seeds including why the company was or was not undertaking pulses seeds distribution and what changes in circumstances would induce them to change their decision.

6.2.2.5 Intellectual Property Protection Portfolio

This section elicited responses to determine whether the company had or was in the process of filing any PVP applications or patent applications in India or anywhere else in the world.

6.2.2.6 General Opinions About Intellectual Property

This section of the survey was primarily multiple-choice questions seeking to determine opinions of the companies regarding various forms of intellectual property protection vis-à-vis seeds and their relative importance in the company's current business model. These questions formed part of the quantitative aspect of the study.

6.2.2.7 Miscellaneous Opinions and Permissions

This section sought the companies' general opinion on intellectual property protection for seeds, pulses seed-related R&D and whether they would prefer to have the company's identity kept confidential during the time of data analysis and publication.

6.2.2.8 Pre-test

The first draft of the questionnaire was put through a general pre-test by eliciting opinions from an economist, a lawyer, and a seed industry representative.

Following the pre-test, several modifications were made to the survey. Due to time constraints, a more extensive pre-test could not be undertaken for the private sector survey.

6.2.3 Creating a Master List of Seed Companies in India & Implementing the Survey

Although the recommended sample size for a grounded theory research is between 15 and 30,⁸⁹ in order to collect as broad and diverse a set of opinions and inputs as possible, as well as to ensure that the sample collection method fulfilled the ideal of randomness, it was considered appropriate to administer the survey to all identifiable seed companies of India.⁹⁰

For this purpose, a master list of seed companies functioning in India was compiled using lists from two different sources: the private sector (the Seed Association of India)⁹¹ and public sector (Seed Net India)⁹². The two lists were then combined, the repetitions were removed, and the resulting names were arranged alphabetically (on the basis of the name of the company) in an excel sheet. Thereafter, the mailing address and phone numbers were written alongside each company name in the excel sheet (if the same were given in any one or more of the documents). Where the address/phone number was not given in any of the sheets, an Internet search was done to determine if any address or phone number could be obtained online.

Red, Yellow and Green Lists: Companies for which no phone number could be obtained from any source, were placed in a separate excel sheet titled 'Red List'. Where at least a postal address was available for these companies, hard copies of the survey were posted.

⁸⁹Unlike most quantitative methods that test existing hypothesis or theories, the grounded theory approach seeks to inductively develop new theories from an empirically collected data set. The sample size or the number of people interviewed as part of the grounded theory research is therefore relatively small given the comprehensive nature of the questionnaire that is usually designed for such studies. However, the theory that emerges can then be examined or confirmed by subsequent researchers using larger data sets. See Anthony J. Onwuegbuzie and Kathleen MT Collins, 'A Typology of Mixed Methods Sampling Designs in Social Science Research,' 289 (where the authors, citing other experts in the field, recommend a sample size of 15–20 or 20–30 for a grounded theory research).

⁹⁰Although, as discussed above, a low response rate was anticipated (*inter alia* due to the length and scope of the questionnaire, and due to its distribution only in the English language), another aim in making this effort was that in case a large enough number of responses was nonetheless forthcoming, a more elaborate confirmatory (quantitative) study could be conducted in parallel with the qualitative study.

⁹¹See <<http://nsai.co.in/>> accessed October 31, 2014.

⁹²See <http://seednet.gov.in/Material/Seed_Companies_Pvt_FS_CS.pdf> accessed October 31, 2014.

The companies for which a phone number was found/available, were telephoned to determine whether (a) the given/found telephone number was correct, and if yes, (ii) whether the company would be interested in taking part in the survey. If the response was a yes, (iii) the company's official address (where the survey could be posted), email ID, fax number, and the name and designation of the person to whom the survey could be sent was taken during the phone conversation. The companies that gave an email ID were asked if they would prefer to get the survey by post (hard copy) or by email (soft copy). The companies that were reachable by this method were placed in a new excel sheet named 'Green List', within which separate spreadsheets were made for 'Green List with emails' and 'Green List without Emails'. Hard copies of the survey were couriered with a cover letter explaining the purpose and relevance of the survey to all companies in the Green List without Emails.

A surveymonkey account was opened to send an online survey to all companies within the 'Green list with Emails' (187 companies). 6 emails bounced and 2 recipients opted out of the survey.

The companies for which a phone number was found but were not reachable (either because the phones were not being received or because the phone numbers were incorrect), were placed in a new excel sheet titled 'Yellow List'. Several of the companies listed in the Yellow List were well known companies with official websites. Addresses of these companies were confirmed from their website and were placed in a new excel sheet named 'Confirmed List'. Hard copies of the survey were posted to all companies within the yellow list (including the 'Confirmed list' companies). Later, the companies that have so far filed applications under the PPV&FR Act were also placed within this 'Confirmed List' (even if these were companies that were already in one of the other lists).

Posting of hard copies: Hard copies were sent by DTDC courier service which provides reliable and affordable all India coverage. Their website also provides tracking facilities to determine whether the courier actually reached the addressee.

All companies that had 2 or more listed/found addresses were sent hard copies of the survey with a cover letter at each of the addresses. 30 and 60 days following the posting of all hard copies, the tracking numbers were checked to determine whether the packages were 'delivered' or 'undeliverable' (and hence 'Returned to Shipper'). Following the final check, 191 out of the total 276 letters that were couriered were delivered with confirmation in the form of signatures or the company seal. Soft copies of the delivery status page from the courier service's website were saved for recording purposes.

The 'undeliverable' addresses were placed in a new 'excluded from survey' excel sheet list.

Responses: The deadline of April 15, 2012 was initially given to all companies. Later, the deadline was extended to May 10, 2012 and then again to June 20, 2012 and finally till August 30, 2012. Responses were received only from 12 companies at the end of the second deadline. A check was then done to determine whether the responses were representative for the types of seed companies that are known or expected to exist in India. Although the 12 firms that responded were quite representative of the types of seed companies in India, no responses were initially received from small companies that engage primarily in seed distribution. Special

efforts were therefore made to contact such companies using personal and formal contacts. At the end of the third and final deadline, a total of 15 usable responses were received.

The 15 completed surveys were studied to extract information relevant for the qualitative grounded theory research. Although the 15 responses would have been adequate to conduct a qualitative analysis using the grounded theory method, the same could not be conducted as an examination of the completed surveys revealed that respondents had either chosen not to respond to the open ended questions, or had answered them very briefly. The quantitative part of the private sector survey was not undertaken as the response rate was not adequate for this purpose.

6.2.4 Supplementary Interviews

In addition to the survey questionnaire, a number of supplementary interview questionnaires were designed to be administered among important stakeholders, including representatives of the private sector, the public sector State Agricultural Universities (SAUs), non-governmental organizations, law firms and the ICAR institutes. Initially, letters were sent requesting an appointment for an interview during a period of 2 months during which the researcher was in India for field studies. These letters were followed up with emails, and where possible, phone calls. The researcher personally interviewed all those who expressed their willingness to give time. Inputs from each of the stakeholders, as relevant to supplement the information acquired via the surveys (private sector and farmer surveys) have been reproduced in Chap. 5.

6.3 Farmer Surveys: Methodology, Structure & Implementation

6.3.1 The Farmer Survey: Scope and Methodology

6.3.1.1 Scope

As with the private sector, the questions identified during the literature review formed the basis for undertaking empirical research at the farmers/informal seed sector level. The specificity of the questions also gave a certain degree of clarity as to the subject matter and rationale for undertaking the empirical investigations. It was particularly clear, for example, that the literature review had revealed little structured and comprehensive information vis-à-vis present day trends in cultivation and innovation in the informal sector.⁹³ An analysis of plant variety application

⁹³See Chaps. 4 and 5 above.

trends in India further revealed that although there was evidence of sub-optimal farmer level innovations, particularly in crops others than rice and wheat, no scientific, legal or economic literature was found which explained the reasons or the factors that potentially influence this trend. Given the vast variety of crops cultivated in various regions of India, however, these questions were not specific enough to enable the collection of meaningful and manageable data. It was therefore necessary to further delimit and focus the scope of the empirical research to be conducted among farmers.

A second look at the plant variety application trends discussed in Chap. 4 provided the necessary guidance for this purpose. The data revealed, that similar to the trend in the private sector, in the farmers' sector also, there is a significantly lower number of applications for new pulses varieties than for other self-pollinating varieties such as wheat and rice. The sub-optimal innovation in pulses, therefore emerged as an appropriate starting point for the farmer surveys as well.

6.3.1.2 Methodology

The following facts about India (the geographic area where the empirical research was to be conducted) helped determine the appropriate research method:

- (i) A large majority of Indian farmers are likely to not have received a formal education. It would therefore not be practical to expect farmers to respond to mailed surveys, even if they were written in the local language.
- (ii) However, farmers in India are known to be co-operative and willing to provide detailed information, especially if approached via people whom they know and trust (i.e., interact with on a daily basis).
- (iii) In the researcher's own prior experience, rural Indian folk are patient and happy to spend as much time as is necessary to answer questions that pertain to their daily lives, occupation etc.
- (iv) The agricultural extension service consisting of Regional Agricultural Extension Officers (RAEOs) are in constant contact with farmers and interact with them on a daily basis. It was therefore considered feasible to approach farmers through the RAEOs, who, in turn, are closely connected with State Agricultural Universities (SAUs).

Given the breadth of the questions identified as relevant for empirical research, the mixed method research framework was once again considered to be most suitable.⁹⁴ However, unlike in the private sector survey where the researcher was relying heavily on voluntary responses to surveys sent by post or email, in the

⁹⁴As discussed in Annex 1 above, the mixed methods approach gives the researcher the flexibility to use both qualitative and quantitative means for conducting investigations and analyzing results. In the farmers' sector, it was foreseen that it would be difficult to collect all relevant information via a survey questionnaire administered to farmers alone, especially if the primary aim would be the collection of quantitative data.

farmer survey, it was possible and necessary for the researcher to envisage personal interviews with farmers within an appropriate geographic region. Accordingly, the mixed methods approach for the farmer survey adopted a dominant quantitative design supplemented by qualitative research.

The quantitative segment of the research adopted a non-experimental approach where data was collected via survey questionnaires within actual farmland/village settings. In order to avoid sampling bias while also ensuring that the area in which the surveys would be administered fulfilled the minimum criteria necessary to collect meaningful information, a stratified random sampling method was adopted.

As in the private sector survey, the farmer survey was also structured for parallel collection of information for both the quantitative and the qualitative segments of the research through one instrument. To supplement the qualitative end of the farmer-level study, more detailed interviews with several stakeholders in both the nested and multi-level research frameworks were envisaged using different instruments, particularly questionnaires designed to extract information that might help explain any trends emerging from the collected quantitative data.

6.3.2 The Farmer (Informal Sector) Survey: Structure and Content

6.3.2.1 Direct and Indirect Factors Affecting Cultivation and Innovation

Following the identification of the broad research questions (as detailed in Part I above) and the more focused scope and methodology for the farmer level empirical research, a list of the key direct and indirect factors that are likely to affect cultivation and innovation trends in villages was formulated in an attempt to design a survey with a proper structure and flow.⁹⁵ The following factors were identified as most significant:

(i) *Farmer Survey: Cultivation Choices*

⁹⁵Direct factors that affect a phenomenon are so called if these factors are specifically designed to affect the phenomenon in question, or are (by operation of logic, for example) known to impact the phenomenon. For example, intellectual property protection regimes can be considered a direct factor that influences innovative behavior among breeders or farmers. However, these direct factors may not lead, in all cases, to desired or uniform results because of the operation of indirect factors. For example, despite the adoption of intellectual property protection regimes, a 90 year old farmer may be less or more likely to innovate. For example, age may be associated with experience, which can assist the innovative process. Age can, however, also relate to energy and enthusiasm to innovate, which may be absent in older farmers. Therefore, age is an indirect factor that may affect innovation, while IP regimes are a direct factor influencing innovation.

a. Direct Factors (affecting choice of cultivation)

- Availability of seeds (from local, government or market sources)
- Price of seeds
- Expected yield/produce
- Certainty of sale of produce
- Expected sale price of produce
- Climatic and soil conditions
- Cost of related inputs such as fertilizers and pesticides
- Other incentives for cultivation – e.g. guaranteed minimum support price given by government

b. Indirect Factors (affecting choice of cultivation)

- Size of land holding
- Ownership of land
- Sex of farmer
- Age of farmer
- Education level of farmer
- Other (significant) sources of income

(ii) *Farmer Survey: Conservation/Innovation Patterns*

a. Direct Factors (affecting *in situ* conservation/innovation)

- Existence of intellectual property rights or similar exclusive rights regime
- Awareness of the existence of such a regime
- Possibility of rewards or recognition under the regime or under other government/private schemes
- Existence of a 'demonstration effect' resulting from seeing the award or recognition under above regimes/schemes being given to other farmers in the village
- Market for higher quality seeds
- Knowledge of how to improve seeds
- Actual and continuous usage of traditional seeds or of improved seeds for several generations without buying seeds from the market or government in between
- Saving seeds for the requisite number of generations

a. Direct Factors (affecting decision to save seeds v. buy seeds from the market)

- i. Costs
- ii. Quality (determined by factors such as yield, pest resistance etc.)
- iii. Ease/comfort
- iv. Tradition/Custom/Belief

b. Indirect factors (affecting decision to save seeds v. buy seeds from the market)

- i. Age of farmer
 - ii. Sex of farmer
 - iii. Education level
 - iv. Size of land holding
 - v. Other sources of income
 - vi. Ownership of land
- b. Indirect Factors (affecting innovation)
- Size of land holding
 - Ownership of land
 - Sex of farmer
 - Age of farmer
 - Education level of farmer
 - Other (significant) sources of income

6.3.2.2 Pulses Crops v. Preferred Crops

Following the identification of the above direct and indirect factors affecting cultivation, *in situ* evolution, and innovation in seeds by farmers, a preliminary survey was designed for the parallel collection of qualitative and quantitative data at the farmer level. In accordance with the delimited scope of the empirical research, detailed crop-specific information was not collected for the entire gamut of crops being cultivated by farmers within an identified region. Instead, emphasis was laid on collecting information pertaining to pulses crop cultivation patterns and preferences. In addition to the reasons already discussed in this Annex and in Chap. 2, pulses crops were chosen as the central focus for the empirical research for several reasons. Pulses cultivation in India has been inadequate for several decades and the government of India had, in recent times, adopted several policies to promote pulses cultivation in order to make its cultivation as attractive as the cultivation of staple crops such as rice and wheat. In the 7th five-year plan,⁹⁶ for example, it was stated:

1.14 *Pulses*: Growth in the production and improvement in the productivity of pulses have not been quite satisfactory largely due to factors like high risk and low profitability, small proportion of irrigated area, inadequate use of modern inputs and gaps in technology and extension. The major elements of the strategy envisaged for achieving the Seventh Plan target of pulses production are the following:

⁹⁶See '1. Agriculture and Allies Activities' in Government of India, 7th Five-Year Plan, Vol 2 <<http://planningcommission.gov.in/plans/planrel/fiveyr/index7.html>> accessed November 1, 2014.

- (i) introduction of pulses in irrigated farming systems;
- (ii) bringing additional area under short-duration varieties of moong and urad in rice fallows in the rabi season and as a summer crop where irrigation facilities are available;
- (iii) inter-cropping of arhar, moong and urad with other crops;
- (iv) multiplication and use of improved seeds;
- (v) adoption of plant protection measures;
- (vi) use of fertilizers and rhizobial culture;
- (vii) improved post-harvest technology;
- (viii) remunerative prices relative to competing crops; and
- (ix) marketing support.

India's 8th 5-year plan⁹⁷ further stated:

1.2.3 *Pulses*: Pulses are essentially grown under rainfed conditions and hence the production is widely influenced by the rainfall pattern. The production of pulses reached a record level of 14.06 million tonnes in 1990–91. This has been partly due to the increase in area of tur (Arhar). However, the productivity of pulses especially tur of about 779 kg/ha and gram of 753 kg/ha can be substantially improved. Major efforts were made to intensify pulse production by taking up the National Pulses Development Programme and the Special Foodgrain Production Programme - Pulses. It was also decided to bring pulses under the Technology Mission during 1990–91.

In order to have a framework for comparison however, in addition to the 'pulses crops', a second category, namely the category of 'preferred crop' was introduced into the survey. 'Preferred crop' was defined as the crop that the farmer gives greatest importance to in his/her annual cultivation (i.e. if he/she were permitted to cultivate only one crop per year, which crop would he/she choose to cultivate?). All questions (pertaining, for e.g., to reasons for cultivation, seed saving and seed exchange practices etc.) were asked for both 'pulses crops' as well as 'preferred crop' to permit a clear comparison of trends while keeping the volume of collected data manageable.

6.3.2.3 The Key Questions Included in the Survey and Their Underlying Rationale

The literature review that preceded focused investigations into the identified phenomenon (namely sub-optimal farmer-led/informal innovation in pulses seeds), revealed several reasons that could justify or explain low pulses related innovation among farmers. These reasons lead to identification of several issues that also helped finalize the content and structure of the survey, as explained below:

- (i) One of the possible reasons for sub-optimal grassroots innovation in pulses could be the focus on the cultivation of rice and wheat, which are not only the key staple crops in India, but are also crops for which farmers have a

⁹⁷See '1. Agriculture and Allies Activities' in Government of India, 8th Five-Year Plan, vol 2 <<http://planningcommission.nic.in/plans/planrel/fiveyr/8th/vol2/8v2ch1.htm>> accessed November 1, 2014.

guaranteed buyer (namely the government, which maintains the buffer stock of staple food grain and therefore buys all the supply at the minimum support price).⁹⁸ Non-cultivation pre-empts innovation/crop improvement and *in situ* evolution. Actual cultivation of pulses was therefore identified as a key direct factor influencing farmer-led innovation in pulses seeds. Accordingly,

- a. the survey asked what the farmers' 'preferred crop' is (i.e. which crop does the farmer give the greatest importance to in his cultivation choice each year).
 - b. The key reason for this preference was asked as an open-ended question.
 - c. The survey then asked whether the farmer cultivated pulses and if yes, which pulses.
 - d. It further asked why the farmer chooses (or does not choose) to cultivate pulses as an open ended question.
- (ii) Regular purchase and reliance on market or government seeds over traditional (farmers saved) seeds (for cultivation) would also pre-empt innovation. However, the economic (cost-saving) incentives associated with saving and resowing seeds as opposed to buying new ones would permit *in situ* conservation and evolution of plant varieties in the informal sector. Thus, seed replacement behavior was identified as the second key direct factor affecting farmer-led innovation in pulses seeds.
- a. To confirm the above presumption, the survey asked the farmers the frequency with which they replace seeds (i.e. purchase new seeds from the market or from the government).
 - b. To determine whether there was any difference in seed replacement rates for pulses versus other crops, the survey asked the farmers the frequency of seed replacement for (a) their preferred crop, and (b) pulses crops.⁹⁹

⁹⁸The exception appears only with regards the cultivation of chickpeas following the introduction of a new variety of chickpea by the ICRISAT. Interview with Pooram Gaur, Principal Scientist, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (Hyderabad 30 January 2012), available with author. Here again, however, the exclusive cultivation of chickpea ignoring all other varieties of pulses may be a source of concern as it may also lead to problems associated with mono cropping as was witnessed following large scale adoption of new soybean varieties, *inter alia*, in Brazil. See Ulrike Bickel and Jan M. Dros, 'The Impact of Soybean Cultivation on Brazilian Ecosystems: Three Case Studies' (World Wildlife Fund, Forest Conservation Initiative 2003) <<http://awsassets.panda.org/downloads/impactsofsoybean.pdf>> accessed November 2, 2014. The Government of India is now attempting to give greater incentives for cultivation of a diverse variety of pulses by increasing the minimum support price. Interview with Kannan Bapu, Professor (Plant breeding), Department of Pulses, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University (Coimbatore (India) 17 January 2012), available with author.

⁹⁹It was anticipated that in the two regions studied, the pulses crop may or may not be the preferred crop. However, this distinction was retained in the survey in order to determine whether the preferred crop is the pulses crop, and if so, in how many instances and why (or why not).

- (iii) In order to determine whether the farmer primarily relied on farmer-to-farmer seed exchange to acquire ‘new’ seeds, a separate question in the survey asked whether their primary mode of acquisition of seeds is the market/government or other farmers.
- (iv) In India, given the continuing practices of using farm-saved seeds (including landraces) and engaging in farmer-to-farmer seed-exchange, coupled with the growing popularity of seeds provided by the private and the government sector, it was expected that parallel existence of high yielding/formally bred as well as traditional seed varieties (landraces, preserved and improved *in situ*) would be witnessed in most rural areas for both pulses seeds and seeds of the preferred crop.¹⁰⁰ According to the scientific literature surveyed, as well as on the basis of interviews with experts, it was anticipated that the source of the seeds used for cultivation would be a third and important direct factor affecting innovation. This is because landraces (traditional seeds) contain a much wider range of genetic diversity (than pure lines and improved varieties developed by the formal sector), thereby giving the farmer a much wider scope for innovation.
 - a. The survey therefore asked what the source of the seeds used by the farmer for cultivation is. This question was asked for pulses crops as well as the farmers’ ‘preferred crop’.
 - b. This question was also asked in order to determine what the starting point of any farmer-led innovation is more likely to be – i.e., are farmers improving (or more likely to improve) seeds that are bred by the formal seeds sector (public and private sector seed companies and universities) or are they improving seeds that have been in their homes/villages for generations (traditional seeds).
 - c. By asking the above questions, the survey also sought to determine whether there was evidence of higher innovation in relation to the preferred crop than in relation to pulses.
- (v) A central presumption underlying the adoption of intellectual property regimes is that they act as an incentive for innovation. However, in developing countries, the mere existence of a law cannot be considered adequate incentive as there is a great likelihood that the intended beneficiaries or target group are not aware of the existence of the law or of their rights. Knowledge about the existence of the Indian PPV&FR Act was therefore considered a fourth direct factor affecting farmer-led innovation. Hence, the survey asked the farmer-respondents whether they were aware of the Indian PPV&FR Act.

¹⁰⁰The existing literature suggests a strong tendency to save and resow seeds and engage in local seed exchanges, there was a strong likelihood that the small and marginal and perhaps also the medium land holders were, because of their customs or poverty (socio-economic situation) engaging in agro-biodiversity preservation. Alongside, therefore, the survey wanted to understand whether there was a gap in the thinking and the actions of the farmers vis-à-vis seed saving, seed exchange and use and preservation of traditional seeds.

- (vi) The literature review suggested that farmers in developing countries are often guided by cultural practices and beliefs that are contrary to the presumptions underlying an exclusive rights regime embodied in the plant breeders rights regime. As a first step in this direction, however, it was also necessary to check whether, in the areas studied, there indeed was any evidence that suggested the existence of this culture. The survey therefore asked questions in an attempt to determine the existence of this culture in the first place.
- a. In order to determine the existence or not of the culture of sharing, the survey asked four questions – 2 pertaining to seed saving and 2 pertaining to seed exchange. The first question in each of the 2 categories attempted to gauge the actual practice – i.e. is the respondent farmer actually and currently saving seeds? Is he/she actually and currently exchanging seeds? The second question in each category sought to elicit the farmers' opinion on seed saving/seed exchange. A direct question was deemed to be counterproductive in this regard. Therefore, instead of framing the question such as: 'Do you think that seed exchange is a good or necessary practice?', the questionnaire asked 'If you were to be awarded exclusive rights or a cash prize over a new plant variety created by you, would you stop the practice of exchanging seeds with other farmers?' Through this question, the researcher also attempted to gauge the willingness of the farmers to change the culture of seed exchange (which is an important subset of the culture of sharing). A similar indirect question was asked in relation to the farmer's opinion on seed saving practices.
 - b. The survey sought to determine whether the trend of sharing/seed exchange was different for pulses versus preferred crops and whether farmers that fall into different land holding categories engage in more or less seed saving and/or seed exchange.
 - c. The survey also asked the farmer-respondents a series of questions eliciting their views on sharing of new varieties with Universities, private companies and fellow farmers.
- (vii) The literature review also revealed that grassroots innovations are widespread in India (albeit not just in the agricultural seeds sector) and that news of such innovations, being confined to local areas, remains unknown to the rest of the world (including to academic researchers). These innovations do not come into the limelight also because farmers are often uninformed about their legal rights or do not have the resources needed to file applications for protection. It is likely, therefore, that there exists hidden grassroots innovation, including in the pulses seeds sector. The existence of such innovation, coupled with non-filing or no knowledge about the PPV&FR Act would suggest that the existence of the regime has not been properly advertised among the intended beneficiaries, or the regime lacks the capacity to attract farmer-innovators, or that it is considered unnecessary by farmers as an incentive to undertake innovation/improvement of seeds. The

survey accordingly asked several questions designed to elicit information that could be evidence of ‘hidden’ or ‘unknown’ innovation by farmers.

- (viii) It was considered possible that the role of preserving and improving landraces would most likely be undertaken (consciously or unconsciously), by small, marginal or even semi-medium landowners due to their inability to afford improved or hybrid seeds from the market. It was also possible that the medium and large land owners would likely prefer to buy new seeds from the market each season and not engage in farm-saving of seeds or in farmer-to-farmer seed exchanges, guided, *inter alia*, by convenience or availability of adequate resources. Affordability of market seeds and overall economic condition of the farmer (as gathered primarily from land holding size and alternative sources of income) was therefore identified as a key (in)direct factor affecting farmer-led conservation and *in situ* evolution of seeds.
 - a. In order to determine whether farmers were unconsciously engaging in *in situ* preservation of landraces, the survey again relied on the seed replacement rate. Alongside, the survey also asked the farmers how long they had used the current seeds for (i.e. used seeds preserved from the previous harvest and not bought seeds from the market).
 - b. Data of farm landholding size was collected for each farmer in the preliminary section of the survey.
- (ix) It was considered likely that cultivation and innovation trends would be affected by other indirect factors such as the respondent-farmers’ age, education level, availability of alternative sources of income etc. This information was also collected in the preliminary part of the survey.

6.3.3 Identifying Pre-Test and Test Locations

Following the formulation of a draft survey, the next step was to determine where the empirical research could most ideally be conducted. Although India needs to increase its overall pulses production, there are regions within India that produce more or less pulses for reasons other than climatic and soil conditions. A comparison of pulses production and innovation trends in a high pulses producing state and a low pulses producing state was therefore envisaged as a means of identifying a comprehensive set of reasons for the lack of pulses related R&D and production in the farmers’ sector. As is recommended in studies involving a test location and a control location, however, ‘other things’ that might affect pulses cultivation and innovation trends within the test locations needed to be the same or nearly the same in the selected locations (the criteria of *ceteris paribus*).

The literature review revealed Madhya Pradesh (MP) as the largest producer of pulses within India. MP was therefore chosen as the main test location for conducting the farmer surveys. The neighboring state of Chhattisgarh was then chosen as the State in which a control group of farmers would be studied.

Chhattisgarh was chosen as the ‘control’ state because it was, until recently, a part of MP itself. MP and Chhattisgarh, therefore, have a common and shared history, culture and language, as well as similar soil conditions and dietary habits. However, unlike MP, Chhattisgarh is not a significant producer of pulses from the perspective of its contribution to the overall national production of pulses. A study situated in these two states was therefore considered quite ideal to determining the reasons why there exists such stark differences in pulses production trends in these two neighboring states despite the identified similarities, *inter alia*, in their cultural, soil/climatic, and dietary habits. These two states were also ideal to determine whether there were any differences in the level of innovation or *in situ* preservation and evolution of pulses seeds, and if yes, what factors were influencing these differences.

The criterion of choosing the specific regions within the chosen states where the farmer surveys would be conducted was determined next. At the broadest level, the survey, as designed, sought information on the following: (i) the reasons that dictate the choice of cultivating or not cultivating pulses and the preferred crop within each of the chosen States, (ii) the seed saving practices, including the use of traditional seeds/landraces within these locations (for both the pulses and preferred crops), and (iii) studying the innovation trends (if any) vis-à-vis pulses and preferred crops within these two locations. In order to collect the maximum amount of relevant data from the perspective of these three information heads, the test locations needed to fulfill a minimum of three criteria (hereinafter, the ‘identified criteria’), namely:

- (i) The location must be known to cultivate at least one variety of pulses;
- (ii) The location must be known to cultivate at least one traditional variety of pulses (i.e. pulses landraces must be known to be in active cultivation in the area); and
- (iii) The location must be known to cultivate at least one non-pulses crop, and this non-pulses crop must ideally be the known staple food crop of the state.

Following the identification of the above criteria, despite best efforts, the ideal local test locations within the chosen states could not be determined via a literature review. This was due, primarily, to unavailability of reliable and comprehensive district and village level data relating to cultivation practices in the chosen states. The final identification of specific local areas for conducting the pre-tests and final tests was therefore done with the help of interviews with State-level government officials and experts in the local agricultural universities as described below.

6.3.3.1 Expert Views

Following the identification of direct and indirect factors affecting cultivation choices and innovation trends, and the identification of the broad test locations, a first draft of the survey questionnaire was prepared. Comments were then obtained

on this first draft from a team of experts¹⁰¹ as well as from colleagues. Following the incorporation of several inputs and suggestions as given by colleagues and experts, a second draft of the questionnaire was designed containing fewer and more focused questions. The second draft of the questionnaire contained questions under the following 5 categories (hereinafter, the ‘5 broad categories’):

- (i) *Preliminary Questions* (constituting the list of in-direct factors affecting both cultivation and conservation/innovation practices), namely, age, sex, education of farmer, alternative sources of income, ownership of land etc.
- (ii) *Cultivation Trends/Practices* (constituting the list of direct factors affecting cultivation choices, with flexibility for farmer-respondents to include other reasons, for preferred crops and pulses crops).
- (iii) *Seed Purchase, Seed Saving, and Seed Exchange Choices and Trends* (constituting some of the important direct factors affecting innovation and conservation trends, with flexibility for farmer-respondents to include other reasons, for preferred crops and pulses crops).
- (iv) *Seed Replacement Practices* (constituting an important direct factor affecting innovation and conservation trends).
- (v) *Innovation trends* (constituting a list of questions designed to gather evidence of informal innovations and *in situ* conservation and improvement of traditional varieties beyond the scope of the PPV&FR Act).

Despite the significant reduction in scope and length of the farmer survey, significant uncertainties persisted among the experts, *inter alia*, as to (i) the ability of the rural population to understand the broad subject matter of the research as well as the individual questions within the survey, and (ii) the willingness of the villagers to give the amount of time needed to answer all the questions that were included in the survey. It was considered necessary, therefore, to make the resulting second draft of the questionnaire undergo an extensive pre-test among several farmers (with varying landholding sizes and education levels) before commencing the actual data collection process.

6.3.3.2 Pre-tests

The second draft of the questionnaire was accordingly pre-tested twice. The first pre-test was conducted with a highly educated, large landholding farmer personally

¹⁰¹These experts were invited to comment on papers presented by Ph.D. research scholars at the 2nd Workshop for Junior Researchers on the law and economics of intellectual property and competition law, Wildbad Kreuth, Germany, 5–7 June 2011 (hereinafter, Wildbad Kreuth Workshop). The group providing feedback included senior researchers experienced in the field of plant variety protection and/or related intellectual property laws and junior researchers familiar with ground realities in rural India.

known to the researcher.¹⁰² On the basis of the detailed responses and comments received, a third draft of the questionnaire was made and translated into Hindi (the local language spoken and understood by farmers of the regions where the survey was conducted). The second pre-test was a significantly larger one (aimed primarily at comprehensively testing instrument fidelity). It was conducted over a period of 4 days, among over 90 farmers and a few regional agricultural extension officers (RAEOs)¹⁰³ hailing from approximately 10 villages.

The pre-test locations (i.e. the 10 villages) are situated in a region that was originally considered a good test region as per the identified criteria. Although these locations were revealed, during the course of the pre-test, to be inappropriate for the study,¹⁰⁴ the interviews conducted within these locations nonetheless helped identify a large number of problems in the 2nd draft of the survey (instrument). These problems ranged from unclear questions leading to inconsistencies in the understood meaning and resulting inconsistent responses, to the non-emergence, from the survey, of information needed for the study, *inter alia*, due to language-related and structural defects in the survey. At the end of each day of pre-test interviews, modifications were therefore made to the questionnaire. A number of redundant/repetitive and missing questions were also identified. Implementing the insights obtained during the 4-day pre-test, a final version of the survey was drafted directly in Hindi.¹⁰⁵

The modified (final) survey questionnaire contained a mix of multiple choice and YES/NO style questions necessary for quantitative data collection and analysis, as well as open-ended interview style questions necessary to gather enough information for the supporting qualitative study.¹⁰⁶ Although the wording and structure of the questionnaire was significantly altered, the final questions remained within the 5 *broad categories* identified above.

¹⁰²Interview with Mr. Narendra Mittal, Farmer (Subhash Nagar 15 January 2012), available with author. Mr. Mittal cultivates over 150 acres of land in the State of Uttarakhand in India. He has a degree in law and is a property dealer alongside with being a farmer.

¹⁰³RAEOs are persons within the government machinery who interact with villagers on a daily basis and are most familiar with the agricultural practices and trends in these regions

¹⁰⁴Following large-scale deforestation in the forest area surrounding the pre-test locations, monkeys displaced from their natural habitat commonly destroyed or consumed crops, particularly pulses crops, in the agricultural fields in these locations. This “monkey problem” revealed itself to be one of the key reasons why several farmers of the region were choosing to focus less on pulses than on rice cultivation in the area.

¹⁰⁵Rather than a translation from English, as was done in the earlier version. The Hindi version (i.e. the 4th and final draft of the survey) was written by the researcher herself with concurrent assistance from a locally trained lawyer/translator, Ms. Mandakini Singh.

¹⁰⁶See Burke Johnson and Larry Christensen, *Educational Research: Quantitative, Qualitative and Mixed Approaches*, 49.

6.3.3.3 Final Test Locations

As mentioned above, the pre-test locations, although originally chosen because they met the ‘identified criteria’, were eventually rejected as test locations. Another set of interviews and discussions was then undertaken with local government authorities, administrative officers, university professors and RAEs to identify the locations within the two chosen States best suited for the study in the light of the identified criteria. Following several discussions, the locations that were unanimously suggested by almost all those who were consulted, were chosen as the final study areas.

The chosen final study areas were considered adequately homogenous with respect to the ‘identified criteria’ relevant for the study: One of the regions was the main test region and the other was the control. The main test region was located in Madhya Pradesh (the State that produces the maximum amount of pulses in India) and the area within Madhya Pradesh chosen for the study was the Narsinghpur region, well known for its traditional Red gram (locally known as *Arhar* or *Rahar*) varieties.¹⁰⁷ Red gram, however, is not the main crop of the region. The main (preferred crop) of the region is wheat or sugarcane (i.e. crops other than pulses). The control group was located in the neighboring State of Chhattisgarh. The area chosen for the study within Chhattisgarh was Deobhog – an area well known for its traditional Green gram (locally known as *Mung*) variety. Again, the main (preferred) crop of this region is not green gram, but rice (i.e. a crop other than pulses).

6.3.4 Sampling

Following a stratified random sampling scheme,¹⁰⁸ once the two areas for conducting the study were chosen, public announcements were made in the villages of these regions requesting villagers to come to pre-decided locations at specified

¹⁰⁷Interview with Anita Babbar, Senior Scientist (Chickpea Breeding), Department of Plant Breeding & Genetics, Jawaharlal Nehru Krishi Vishwavidyalaya (Jabalpur 21 February 2012), available with author. According to her and others who are familiar with agriculture in the region, the red gram from Narsinghpur (particularly the Gadarwara area) is famous for its peculiar taste and aroma. According to her, the red gram variety from Narsinghpur has not moved around too much (beyond the Narsinghpur area) because of lack of seeds. She also stated that the wild red gram varieties in this region are known to be insect resistant and disease resistant. However, see survey results in Annex 7 below.

¹⁰⁸Anthony J. Onwegbuzie and Kathleen M.T. Collins, ‘A Typology of Mixed-Methods Sampling Designs in Social Science Research’ (2007) 12 *The Qualitative Report* 281. Also Anthony J. Onwegbuzie and Nancy L. Leech, ‘A Call for Qualitative Power Analysis’ (2007) 41 *Quality and Quantity: International Journal of Methodology* 105, 110.

times for the purpose of answering some questions.¹⁰⁹ The villagers who chose to come to the announced locations in the given time interval were interviewed using the final survey questionnaire by a group of interviewers consisting of the researcher and local RAEOs.¹¹⁰ A total of 143 villagers were interviewed in the 2 locations.¹¹¹

The samples for the qualitative and quantitative components of the farmer level research were partly identical and partly parallel.¹¹² For example, each of the villagers who was answering the survey (multiple choice / YES/NO questions) was also asked interview style open ended questions at appropriate places within the survey questionnaire.¹¹³ Some of the villagers who were open to spending more time with the interviewers were asked more detailed questions to understand the context in which he/she had answered the questions in the survey and to know more about the history and evolution of agriculture in the village and region. The multi-level sample consisted of detailed, open-ended interviews with the RAEOs who had volunteered to help conduct the surveys among the farmers.¹¹⁴

¹⁰⁹These general announcements were made by RAEOs in several areas of the village. The announcements informed the people that a team of researchers would be conducting interviews and that their presence would be appreciated. While no monetary incentives were given to the farmers to contribute their time and inputs for the research survey (by answering the questions), the farmers that did turn up for the interviews were provided snacks and tea while they waited for their turn to be interviewed.

¹¹⁰No monetary incentive was given to the RAEOs for helping with the conduct of interviews. As the route which was adopted to identify the districts in which to conduct the interviews was official (i.e. via the government and the local Agricultural University) and involved a central government legislation that is aimed at improving agricultural productivity as well promoting farmer innovations in relation to seeds, the RAEOs, who are government employees, volunteered their time for the work within their official working hours.

¹¹¹While this is a relatively small sample size for quantitative studies that seek to be primarily confirmatory, according to experts, smaller sample sizes such as the one used in this study are sufficient in research studies utilizing the mixed methods approach. Onwegbuzie and Collins (n 607) 287–288. Small sample sizes are also acceptable when the data collected is rich and comprehensive and the farmers surveyed are randomly selected.

¹¹²Kathleen M.T. Collins et al., ‘A Model Incorporating the Rationale and Purpose for Conducting Mixed-Methods Research in Special Education and Beyond’ (2006) 4(1) *Learning Disabilities: A Contemporary Journal* 67, 70.

¹¹³For example – “Q. 30 Do you think farmers should have a right to save seeds for the next season? Yes / No. Q. 31 Why, in your opinion, should the farmers have (or not have) such a right?”

¹¹⁴Kathleen M.T. Collins et al., ‘A Model Incorporating the Rationale and Purpose for Conducting Mixed-Methods Research in Special Education and Beyond.’

6.3.4.1 Collected Sample Size

The planned sample size for each of the test locations was 80–100 or more. This number had, however to be reduced due to a number of practical difficulties.¹¹⁵ The final number of received responses, however, was adequate to conduct a mixed methods research analysis that provided informed explanations for the observed phenomenon, and therefore to make recommendations for amendments in relevant laws and policies. The sample size for the farmer surveys also proved adequate to conduct quantitative analysis using Stata. Furthermore, since the quantitative elements of the farmer survey was the dominant paradigm, and the collected sample size was adequately large, the findings from the survey could be used to make statistical generalizations.¹¹⁶ However, since the conducted survey was the first of its kind, several more confirmatory studies are necessary before policy changes can be authoritatively recommended.

6.3.4.2 Collecting Qualitative Data Among Farmers

In order to complement the findings from the quantitative data collected via the surveys (the Farmer Survey was translated into English and is attached herewith as Annex 7), the surveys contained within them, several open ended questions designed to acquire a deeper understanding of the thinking and culture underlying the various answers given by the farmers. In addition to the structured questions contained within the surveys, the researcher asked several additional, unstructured questions to some of the farmers as well as to the regional agricultural extension officers. These questions were asked to gain a better understanding of the trends that were already seen as emerging at the time the surveys were being administered.¹¹⁷

¹¹⁵Primarily, time constraints that prevented the RAEOs from being able to spend more than 3–4 days out of their daily work schedules to assist in the process and due to the researcher’s own time and resource constraints.

¹¹⁶See Annex 1, Part 1.1 for details. The statistical generalizations are justifiable within the region where the survey was conducted, because this is the region which fulfills the criteria used for the collection of stratified random samples.

¹¹⁷For example, as a number of farmers in the Madhya Pradesh region were answering “no” to the question “do you use traditional seeds for the cultivation of pulses crops”, the researcher asked why it was that in a region which was known for its traditional red gram variety, farmers were not using traditionally saved seeds, the RAEOs as well as farmers responded that the a new red gram variety had been introduced by the government in 1973, which had now become “traditional.” However, the seeds of this variety were also available in the market. Therefore, the farmers did not feel the need to save pulses seeds season after season for generations and often bought fresh seed from the market.

6.3.5 Coding and Arrangement of Data for Analysis

The data set collected via the above described process was initially tabulated in an excel file and has been published as a supplement to the eBook version of this book.¹¹⁸ Prior to using the raw data for analysis on Stata, various fields of information were split into separate files for ease of analysis.¹¹⁹ The key segments of the data were:

- (i) Farmer Cultivation Choices in Deobhog/Narsinghpur (as described in Sect. 5.2.1). The answers to questions pertaining to cultivation choices (as detailed in Chap. 5) received from the farmers were further split into sub-categories before coding to determine how many farmers cited each category as being the primary reason underlying the specific cultivation choice rationale.
- (ii) Farmer Seed Replacement and In Situ Conservation Practices (as described in Sects. 5.2.2 and 5.2.3). For this segment, it is noteworthy that each farmer surveyed was surveyed for two crop categories – preferred crop and pulses crop. In other words, each farmer was asked to answer questions pertaining to seed replacement behavior, seed purchase, seed exchange behavior etc., vis-à-vis each of these crop categories separately. In order to permit analysis of the differences in responses for each crop category, the data set was re-arranged by crop category, making the final data set have two entries for each of the surveyed farmers.¹²⁰
- (iii) Socio-Cultural Practices in the Surveyed Districts (Sect. 5.2.4) and in relation to each crop category. Here again, the data was re-arranged by crop category.
- (iv) Farmer level Innovations and Village Level Agrobiodiversity. Although the provided data set includes the responses to questions that were relevant for this analysis, due to the reasons stated in Sect. 5.2.5, the data was not coded or used for detailed analysis on Stata.

¹¹⁸Note: The raw data (and not the coded and re-arranged data), is made available as a supplement to the eBook version of this book.

¹¹⁹Accordingly, the number of columns in the data set provided in the eBook supplement is more than the number of columns in the coded data used for the analysis contained in Chap. 5.

¹²⁰The corresponding number of columns in the final coded data set was therefore proportionately reduced, while the number of rows doubled. It is for this reason that the total number of entries in the tables included in Chap. 5 is, in some instances, more than the total number of entries in the attached data set.

Annex 7: Farmer Survey: Chhattisgarh & Madhya Pradesh (Translated from Hindi by the Author)

1. Name of Farmer
2. Age of Farmer
3. Gender: Male Female
4. Education: Illiterate Primary Secondary Higher secondary
 Graduate Post Graduate
5. Agricultural land area over which you farm (in acres):
6. Are you (the farmer) yourself the owner of this land area? Yes / No
7. If you (the farmer) are not the owner, who is?
8. Do you any source of income other than sale of agricultural produce? If yes, what is/are the other source(s) of income?
9. If the answer to question 8 is yes, how much income do you get from the alternative source, as compared to the income you get from selling agricultural produce?
 - a. More than the income from farming
 - b. Equal to the income from farming
 - c. Less than the income from farming
 - d. Other
10. Which crops do you routinely cultivate in your field?

Rice Wheat Jute Cotton Vegetables
Pulses (describe):
11. Do you grow the same crop(s) every year?
12. If the answer to question 11 is 'no', what are the reasons for changing the crop this year?

13. Of the routinely cultivated crops, which crop do you consider your main or preferred crop? (“Preferred Crop”)?
14. Why is this crop your preferred crop?
15. Do you also cultivate pulses crops on your land?
- Yes, every year
 - Yes, once every 2-3 years
 - Sometimes (e.g. once in 5 years)
 - Never
16. If you don't cultivate pulses, why not?
17. If you do cultivate pulses, why do you do so? Give top 2-3 reasons.
18. What were the various types of pulses you cultivated on your land last year and what was the yield from each type?
- Mung (Green gram): _____ (yield per acre)
 - Urad (Black gram): _____ (yield per acre)
 - Rajma (Kidney beans): _____ (yield per acre)
 - Kabuli Chana (White Chickpeas): _____ (yield per acre)
 - Kala Chana (Black Chickpeas): _____ (yield per acre)
 - Lobia (Cow peas): _____ (yield per acre)
 - Green Peas: _____ (yield per acre)
 - Other: _____ (yield per acre)
19. Over how much land area do you cultivate preferred crop (in acres)?
20. Over how much land area do you cultivate your pulses crop (in acres)?
21. Do you use fertilizers to cultivate your preferred crop? If yes, how much per acre?
22. Do you use fertilizers to cultivate your pulses crops? If yes, how much per acre?
23. How much seed per acre of land do you need for your
- Preferred Crop
 - Pulses crop?
24. What is the source of the seeds that you use to cultivate your crops:
- Preferred Crop
 - Traditional seeds
 - Seeds saved from the previous harvest
 - Market Seeds
 - Government seeds

b. Pulses Crop

- i. Traditional seeds
- ii. Seeds saved from the previous harvest
- iii. Market Seeds
- iv. Government seeds

25. If traditional seeds or self-saved seeds are the source of the seeds you use for your crop, for how many years have you been using these seeds?

	Traditional Seeds	Seeds saved from previous season's harvest
For your Preferred Crop		
For your Pulses Crops		

26. From which crop do you get maximum income (preferred or pulses crop)? If from pulses, then from which pulses crop?

27. To whom do you sell your crop yield?

a. Preferred Crop

- i. Government
- ii. Local buyer
- iii. Private wholesaler
- iv. Other _____

What is the price that you sell your produce for: _____

b. Pulses Crops

- i. Government
- ii. Local buyer
- iii. Private wholesaler
- iv. Other _____

What is the price that you sell your produce for: _____

28. How often do you buy seeds from the market for the following crops?

a. Preferred Crop

- i. Every season
- ii. Once every two seasons
- iii. Once every three seasons
- I never buy new seeds from the market / I only use traditional seeds in my agriculture

b. Pulses Crops

- i. Every season
- ii. Once every two seasons
- iii. Once every three seasons

I never buy new seeds from the market / I only use traditional seeds in my agriculture

29. If you buy seeds, where or who from do you mostly buy seeds?

- a. From the government
- b. From the open market
- c. From a Non-governmental Organization
- d. From another farmer
- e. Other source (please describe): _____

30. Which of the following uses do you put the produce of your crop to:

Preferred Crop

- a. Do you sell the produce (as food) in the market? Yes/No
- b. Do you save part of the produce as seeds for the next season's crop? Yes/No
- c. Do you sell part of the saved seeds to other farmers? Yes / No
- d. Do you sell part of the saved seeds (as seeds) in the market? Yes / No
- e. Do you exchange the saved seeds with other farmers? Yes /No
- f. Do you use the produce (as food) for your own family? Yes / No
- g. Other uses _____

Pulses Crop:

- a. Do you sell the produce (as food) in the market? Yes/No
- b. Do you save part of the produce as seeds for the next season's crop? Yes/No
- c. Do you sell part of the saved seeds to other farmers? Yes / No
- d. Do you sell part of the saved seeds (as seeds) in the market? Yes / No
- e. Do you exchange the saved seeds with other farmers? Yes /No
- f. Do you use the produce (as food) for your own family? Yes / No
- g. Other uses _____

31. If you do not sell your produce as seed and also do not exchange seeds with other farmers, what are the reasons for this?

- a. Preferred Crop
- b. Pulses Crops

32. If you do sell your crop produce as seed or if you exchange seeds with other farmers, what is the main reason for doing so?
- a. Preferred Crop
 - i. For some additional income
 - ii. To obtain the best seeds for this crop
 - iii. For traditional/cultural reasons
 - iv. Any other reason _____
 - b. Pulses Crop
 - i. For some additional income
 - ii. To obtain the best seeds for this crop
 - iii. For traditional/cultural reasons
 - iv. Any other reason _____
33. The seeds of which crops do you sell to other farmers?
34. The seeds of which crops do you sell to other farmers?
35. Can you distinguish the seeds that emerge from your cultivate crop from the seeds that are from other farmers' cultivated crop? If yes, on what basis can you distinguish your seeds?
36. Do your seeds have any unique identity? Please specify.
37. Do your seeds have any unique qualities? Please specify.
38. Are your seeds popular amongst other farmers? Yes / No
- a. Seeds of your preferred crop
 - b. Seeds of pulses crops
39. If the answer to question 38 is yes, what, in your opinion, are the reasons why your seeds are popular among other farmers?
- a. Preferred Crop seeds
 - b. Pulses crop seeds
40. Are any of your seed varieties such that, in your opinion, deserve an award from the government? If yes, please describe:
- a. The seeds of which crop deserve an award?
 - b. Which features/qualities of the seed deserve an award?
41. What efforts from your end led to the creation of these varieties with the above special characteristics?

42. Is there a specific person in your area/region from whom you buy seeds? Please provide their name and address.
- Seeds of Preferred Crop
 - Seeds of Pulses Crops
 - Seeds of other Crops
43. Is there a specific person with whom you always exchange seeds? If yes, please provide their name and address.
44. Why do you prefer to buy/exchange seeds from this person?
45. In your knowledge, is there any specific type of seed (seed variety) that is only available in your region and not in any other? If yes, please describe.
46. Can you distinguish the seeds that are from your village/region with the seeds that come from other villages/regions? Yes / No
47. Do any of the seeds in your village have a unique identity? If yes, please describe.
48. Do any of the seeds in your village have a unique qualities? If yes, please describe.
49. Do you think that the seeds from your village are famous in any neighboring village or region?
- Your preferred crop: Yes / No
 - Pulses crops: Yes/ No
50. If the answer to question 49 is yes, why do you think the seeds of these specific crops are famous?
51. Do you think that the farmers of your village deserve any special recognition or reward for creating/developing the special seeds available in your village/region? Yes / No
52. If Yes (to q. 51), then imagine you are given a choice between obtaining a 15 year exclusive rights certificate by which if any farmer living outside your village uses any of the special seeds developed by your village, your village will get a royalty, OR your village will receive a one time large cash award and recognition from the prime minister of India, what would you choose to have? Exclusive Rights Certificate / Cash Award
53. If a private company or a government agency were to use the seeds of your village to further create other (improved) seeds, should the farmers of your village get any special rights over the newly created (improved) seeds? Yes / No

If yes, what kind of rights? _____

54. Do you know about the Indian Protection of Plant Varieties and Farmers' Rights Act, 2001?

55. Do you think all farmers should have the right to save and resow seeds from his/her annual harvest?

Why? _____

56. If you are told that by buying new seeds from the market, your yield will increase, will you stop the practice of seed saving and resowing?

Why or why not? _____

57. Imagine that by repeated selection, saving and resowing, you are able to develop/create a new seed variety. Would you like to have any special rights over this new variety?

What kind of rights? _____

58. Imagine that you have a choice between having a 15 year exclusive rights certificate over your new variety, or a one-time cash award and recognition from the Prime Minister of India for creating the new variety, which would you prefer to have? Exclusive Rights / Cash Award

Why? _____

59. In case you receive an award for the creation of a new plant variety, would you stop selling or exchanging these seeds with other farmers? Yes / No

Why? _____

60. Will you give the award winning seeds also to seed companies (to permit them to further multiply or use it)?

Why? _____

61. Will you give the award winning seeds to the government (to permit them to further multiply or use it)?

Why? _____

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