RICE DIVERSITY AND THE POLITICS OF GENETIC RESOURCES IN THAILAND

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Natural Resources and Environment)
in The University of Michigan
2009

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To *Papa* and *Mamy*

ACKNOWLEDGMENTS

This dissertation has been smoothly and pleasantly completed with both direct and indirect support from several organizations and individuals, whom I cannot fully acknowledge here. In the following acknowledgments, I recall cherished moments of their support and stories, which have emerged from the beginning of my PhD studies at the University of Michigan.

My first expression of appreciation goes to my advisor, Prof. Arun Agrawal, who has provided critical comments and offered continued support from start to finish. I am privileged to have worked with him over the past five years, and wish I could have learned more from him, if not due to my poor communication. I also would like to offer my sincere thanks to the other committee members, Prof. Gloria Helfand, for her constant, yet thoughtful attentiveness and encouragement; Prof. Maria Lemos, for her wise counsel and direction; and especially Prof. Frederick Wherry for his empathy and practical guidance. Special thanks are also extended to Prof. Michael Kennedy, who formerly served on my preliminary examination committee, for his excellent and inspiring teaching in the winter 2006 class of Culture and Knowledge. I learned a lot more from him than I ever thought on cultural sociology, which in many ways enlarged the scope of inquiry in this dissertation.

I would like to express my deep gratitude to the Royal Thai Government, specifically the Ministry of Science and Technology, for the full financial support for my PhD studies in the US. I am indebted to the National Institute of Development Administration and the Agricultural Land Reform Office for giving me an opportunity to pursue my studies abroad. Furthermore, I am very grateful to the Rackham Graduate School, the School of Natural Resources and Environment, and the Southeast Asian Regional Center for

Graduate Study and Research in Agriculture (SEARCA) in funding this dissertation fieldwork in Thailand. Especially, I am also thankful to SEARCA for supporting my internship from April-May 2008 in Los Baños, Philippines, where I had chance to share my preliminary research results as well as had invaluable learning opportunities at the International Rice Research Institute (IRRI). I have greatly appreciated the kindness of Dr. Darshan S. Brar and other senior scientists, researchers, scholars and staff at the Plant Breeding, Genetics, and Biotechnology Division at IRRI who shared with me the most challenging tasks of rice breeders. Many thanks are also due to Challenges of Agrarian Transition in Southeast Asia (ChATSEA) faculty and students at the dissertation workshop in the Philippines for valuable comments and feedback on the first draft of Chapter 1 in this dissertation, the final version of which has consequently been improved considerably.

This dissertation might not be finished without help and cooperation during my fieldwork in Thailand. I am very thankful to the Plant Varieties Protection Division, especially former Director Surakrai Sangkasuban for his pleasant and enthusiastic responses in our correspondence; the Bureau of Rice Research and Development and several senior scientists for our lengthy interviews; and the Biological Diversity Section under the Office of Natural Resources and Environmental Policy and Planning, which facilitated my observation in a policy implementation meeting and access to related documents. My search for potential research sites went forward with much less difficulty, given the information and transportation support from officials in the Provincial and the District Agricultural Offices as well as in local non-government organizations. I also owe a great deal to the respondents in the research sites, whose real identities I chose not to disclose to protect them. I have always appreciated the warmth and hospitality of the directors, rice breeders and staff of government and non-government research/project stations, while I was accompanying them to during their routine work. My challenging fieldwork in farm villages was easily done through the help of village leaders and farmers, who spared their busy time to share their rice and stories with me.

I would like to extend my thanks to staff at the Office of Academic Programs, School of Natural Resources and Environment, especially Jennifer Taylor for timely bureaucratic assistance throughout my PhD studies, and Kim LeClair for forwarding the last-minute research funding package to me during my fieldwork. Many thanks are also due to instructors at the Sweetland Writing Center and at the English Language Institute (ELI) for constructive feedback on countless drafts of dissertation proposals and chapters. In this regard, I would like to specially acknowledge the continued work and advice of Chris Feak at ELI throughout the final year, which considerably helped set my steady work pace. Before I could realize it, I finished writing the whole dissertation!

This research could not have been more pleasant with both well-established and newly-arising friendships from my fieldwork. I would like to thank N'Noi, who was formerly my motorcycle trainer and field assistant, and is currently my dearest girlfriend, for always tolerating my venting and providing constant comfort and encouragement. I am very thankful to P'Meow for her warm welcome and provision of transportation and lodging upon my arrival in her hometown; P'Jane for coloring some of my dull weekends; and P'Kaew, who generously shared her place for temporary stay. Special thanks are also extended to Nutt, N'Ple, and N'Nee at a small-but-busy public health station for giving me five beautiful stitches in my chin, friendly and yummy lunches, and particularly the only phone/internet access point in the locality, which made possible my connection to the outer world. To all my past and present friends in Ann Arbor, I have always been grateful for enriching my student life throughout the five years.

Finally, my deepest gratitude is expressed to my parents in Thailand, to whom I dedicate this dissertation, for rendering my good times more cheerful and my bad times much less substantial. I am sure they enjoy the fruits of my endeavor more than I or anyone else. To my only brother and his wife, I am indebted for all-around support, and in particular, twice taking good care of our parents, while I can comfortably be away from home and concentrate on my studies.

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LIST OF ABBREVIATIONS

CBD	Convention on Biological Diversity
DUS	Distinctiveness, Uniformity and Stability
FFS	Farmer Field School
IPRs	Intellectual Property Rights
NGO	Non-Government Organization
PDP	Plant Diversity Promotion
PGRs	Plant Genetic Resources
PPB	Participatory Plant Breeding
PVP	Plant Varieties Protection
PVS	Participatory Variety Selection
R&D	Research and Development
RD	Rice Department
TRIPs	Trade-Related Aspects of Intellectual Property Rights
UPOV	International Union for the Protection of New Varieties of Plants

ABSTRACT

There could be no more appropriate time to revisit the issues of rice diversity and the politics of genetic resources in Thailand, as its farming and policy environments are transformed. In this transitional phase, much remains unknown about the direction of on-farm rice diversity and the outcome of rice genetic resource management policy, particularly with regard to equity and sustainability outcomes. In addressing these gaps in the literature, this dissertation presents three separate studies focusing on research themes: i) the dynamics of on-farm rice diversity, ii) the politics of scientific and indigenous knowledge, and iii) the management of rice genetic resources.

This dissertation employs a multi-sited ethnographical approach that covers research sites in farm villages, government and private plant research and development centers, and a non-government organization. This approach provides the three studies a comparative examination of various trajectories of changes, practices of scientific or indigenous knowledge inclusion, and effects of regulatory and policy advisory frameworks, respectively.

These three studies highlight the role of global discourses in shaping local practices and politics of genetic resource management. The interactions between global policy discourses, national policies and existing material structures and symbolic cultures at the local level lead to different trajectories in the dynamics of on-farm rice diversity and its management. The incorporation of scientific and indigenous knowledge can be viewed as a new political practice of knowledge formation and utilization. This new politics needs to be re-conceptualized as global politics of scientific and indigenous knowledge that is situated in local politics of genetic resources. Changes in plant genetic resource management policies have inadvertently diverted local practices away from sustainability and equity. Such divergence in local conservation and development

practices is due to the re-situation of local institutional processes within new global and national political spaces, not just the result of institutional incompatibility or political resistance. The dissertation's findings suggest a need for better integration of theoretical insights into policy interventions so as to take into account possible interactions between a) material and symbolic structures and b) local and extra-local processes that determine on-farm rice diversity and the politics of genetic resources.

INTRODUCTION

Thailand is located in the center of rice origin and diversity, for both wild and cultivated species. The richness of these rice genetic resources has been maintained for hundreds of years in farmers' fields across different rice farm ecosystems and cultures in the country. However, within only the past two decades, this on-farm rice diversity in Thailand has undergone significant decline, the remnants of which are over 20,000 accessions of traditional rice varieties collected at the country's gene bank. The loss of rice genetic resources on farms is not only attributable to a shift toward commercial rice farming, but changes in subsistence rice farming itself. Farmers have faced both biophysical and socio-economic pressures toward intensive rice farming practices. At the same time, modern high-yielding varieties have also encroached into the core of on-farm rice diversity in subsistence rice farms. The adoption of modern varieties has, in some way, replaced local diverse germplasm in many farm communities. In a fluctuating biophysical and socio-economic environment, these modern varieties and other technologies have not only been more efficient and convenient, but have also become essential for farmers to cope with frequent droughts, soil nutrient depletion, and other cash crop farming.

In the destruction of local rice germplasm, there have recently been notable attempts by government and non-government organizations to revive farmers' conservation and use of rice diversity on farms. The resurrection of on-farm rice diversity is prevalent in forms of participatory projects at the community level. In the implementation of these projects, the integration between scientific and local knowledge is highlighted as key to conserving rice diversity on farms and especially, to empowering farmers in rice genetic resource management. Such effort toward farmers' empowerment is in line with recent establishments of intellectual property rights (IPRs) in plant genetic resources. While the protection of new plant varieties in the private sector is necessary to promote rice research and development (R&D), such empowerment in on-farm conservation and utilization is necessary to promote local rice germplasm and thereby farmers' autonomy in rice genetic resource management.

Objectives

These issues surrounding on-farm rice diversity in Thailand signify important changes not only in farming contexts but also in policy environments. These changes have inevitably altered the practices and politics of rice diversity and genetic resource management at the local level. Changes in farming conditions have largely depreciated traditional farming practices, including the maintenance of rice diversity on farms. Policy interventions to promote on-farm rice diversity have introduced new conceptions and practices in conservation and utilization of rice genetic resources. These conceptions undoubtedly vary among practitioners in government and non-government organizations (NGOs), and differ from those among local farm communities. At the same time, the rise of deliberative democracy has directed policy implementation toward integration of scientific and indigenous knowledge. Furthermore, the implementation of international mandates concerning the protection of IPRs and the conservation of biological diversity has led to establishments of both regulatory and policy advisory frameworks in plant genetic resource management.

This dissertation seeks to address several questions arising from recent transition of rice diversity and the politics of genetic resources in Thailand. In particular, can traditional practices of on-farm rice diversity persist in the face of recent changes in farming technologies and conditions? On the other hand, can new conceptions and practices from policy interventions be actually embedded in farmers' conservation and utilization practices? Or are these new practices included as mandatory activities? Is integration of scientific and indigenous knowledge the beginning of more democratic resource management, or the advancement of knowledge politics in resource governance?

Similarly, can these new regulatory and advisory frameworks actually result in more sustainable use and equitable access in rice genetic resource management?

These questions draw attention to three main bodies of research: i) the dynamics of on-farm crop diversity, ii) the politics of scientific and indigenous knowledge, and iii) the management of plant genetic resources. Available research in these three research strands has, however, failed to address these questions as regards the recent transition of on-farm rice diversity and the politics of genetic resources. Therefore, this dissertation aims at furthering understandings on these three research themes in the changing farming and policy environments. New insights into these issues provide a significant contribution not only to theoretical developments in the respective literature, but also policy recommendations for promoting on-farm crop diversity, equitable access and sustainable utilization of plant genetic resources.

Research Design

The account of recent transition of rice diversity and the politics of genetic resources challenges existing approaches in related literature. Available theoretical frameworks are quite limited in explaining these new phenomena occurring not only across disciplinary perspectives, but also across two or more conceptual domains. This dissertation is mainly concerned with these cross-cutting issues, including the interactions between material and symbolic mechanisms in shaping on-farm diversity, the integration between scientific and indigenous knowledge, and the cumulative outcome of conservation and development with regard to sustainability and equity. This drawback suggests a need for more comprehensive and systematic research that derives from evidence, rather than from available theoretical frameworks.

To address such need, this dissertation uses a multi-sited ethnographic approach to explore specifically local practices arising from recent changes in farming and policy environments, and to derive general conclusions about the transition of rice diversity and the politics of genetic resources. Each research theme was investigated in four research sites, accounting for a total of seven research sites for the dissertation. These research sites include farming villages, government and non-government rice research and development units, which were identified in three sets of comparative studies. Each set demonstrates differences in practices as applicable to the research themes, rather than fundamental differences among the research sites themselves. Table 0-1 presents these research sites according to the three research themes in this dissertation. The names of the sites as displayed in the table are pseudonyms, assigned to protect the identity and confidentiality of the respondents in the study.

Table 0-1: List of research sites according to research themes

Research themes / **Research Sites**	Dynamics of on-farm rice diversity	Politics of scientific and indigenous knowledge	Management of rice genetic resources
Ban Nam Lad	x		
Ban San Khong	x		x
Ban Nam Cham	x	x	
Ban Don Mun	x	x	x
Ton Kla Learning Center		x	
Northern Rice Research Center		x	x
Kaset Pattana Farm			x

In the study of on-farm rice diversity, I examined four farm communities—Ban Nam Lad, Ban San Khong, Ban Nam Cham, and Ban Don Mun—as characterizing different trajectories in the dynamics of on-farm rice diversity. In these research sites, I seek to understand how local farmers conserve and use rice diversity in the transition of farming and policy environments. In exploring knowledge inclusion practices, I examined Ban Nam Cham and Ban Don Mun—two indigenous farm villages and sites of participatory projects, along with Ton Kla Learning Center and Northern Rice Research Center—a non-government and a government organization, respectively, in the scientific domain that incorporate indigenous knowledge in their practices. For the genetic resource management theme, I explored both conservation and development practices in another set of research sites as the target sites for either the plant varieties protection or the plant diversity promotion policy. Ban San Khong and Kaset Pattana Farm are a farming community and a private rice R&D station, where their exclusive rights over community varieties and new varieties are respectively certified by the plant varieties protection law. Ban Don Mun and Northern Rice Research Center are sites that implement plant diversity promotion. Research in these sites sought to evaluate the impact of such policies in terms of sustainability and equity in rice genetic resource management.

Organization

This dissertation is composed of three chapters, presenting three separate studies on the respective research themes: the dynamics of on-farm rice diversity, the politics of scientific and indigenous knowledge, and the management of rice genetic resources. Chapter 1 attempts to develop a general theory of on-farm crop diversity by exploring the interplay between material and symbolic mechanisms as shaping farmers' conservation practices. Chapter 2 argues that the integration of scientific and indigenous knowledge constitutes a new politics at the local level, instead of doing away with the politics between the two domains, and develops an approach to re-conceptualizing scientific-indigenous politics concerning plant genetic resources. The last chapter in this dissertation presents evidence of divergence of local practices from resource sustainability and equity in the face of conforming policy implementation. It explains this divergence as the result of the reconsideration of local institutional factors within global political spaces, and argues for a more integrated approach in policy assessment and design. Findings from these three studies highlight the interplay of material and discursive entities in shaping the transition of on-farm rice diversity and the politics of genetic resources.

CHAPTER 1

GENERALIZING THE SPECIFICITY

This chapter presents an alternative, generalizable explanation of on-farm crop diversity, which has long been believed to be determined only in a specific locality. This study approaches local community practices of on-farm crop diversity from a dynamic perspective, using multi-sited ethnographic research among farm communities in northern Thailand. This chapter proposes that four distinct trajectories in the dynamics of rice diversity— deformation, performation[*], reformation and transformation—are visible in the studied communities. These trajectories usefully bring together specific factors and general mechanisms related to the dynamics of rice diversity formation. The case studies demonstrate that on-farm rice diversity is not simply determined as a result of variations in such factors as socio-economic conditions, ecological conditions, farming practices, and community networks. Rather, the role of these specific factors needs to be understood in relation to distinctive material and symbolic mechanisms. Especially, these relevant material and symbolic mechanisms provide competing rather than mutually constitutive explanations for the recent dynamics of on-farm rice diversity. The findings suggest that a new theoretical approach is necessary to understand on-farm conservation of crop diversity.

The Specificity of On-Farm Crop Diversity

Crop diversity, or the richness of crop genetic resources, provides the biological basis of agricultural production and development. Plant breeders have constantly drawn on these diversified crop genetic resources for modern crop improvement. This advancement in crop production and improvement, however, can potentially be at the expense of crop diversity—particularly that preserved in farm habitats. Over the past decades, there has been a significant decrease in the number of domesticated crop

[*] This term is purposely used in this chapter to denote the process after formation.

varieties, as farmers shift toward intensive monocultures of improved varieties (Brush, 2000; Byerlee, 1996; Tripp & van der Heide, 1996). This loss of on-farm crop diversity not only hampers crop research and development (R&D), but also threatens food security and ecological sustainability (Altieri & Rosset, 2002; Cleveland et al., 1994; Thrupp, 2000). Especially, the significance of *in situ* conservation of crop diversity on farms, in contrast to *ex situ* conservation in gene banks and laboratory collections, is increasingly acknowledged as constituting potential germplasm of an evolutionarily dynamic population of crop species (Love & Spaner, 2007; Qualset et al., 1997). Therefore, the issue of on-farm crop diversity has garnered much attention in scholarly research.

The large body of literature on the subject has sought to explain the existence of on-farm crop diversity in a specific locality or the differences across localities. Existing research has identified multiple human and ecological factors that determine crop diversity. The emphasis different scholars place on individual factors, however, varies. The earliest research on crop diversity, especially on its geographical distribution, can be dated back to the 1920s. Plant ecologists and scientists view crop diversity as evolving genetically through natural selection and evolution in highly diverse ecological environments favoring particular crops (Frankel et al., 1995); such areas of diversity and specificity have been referred to as centers of crop origin and diversity (Vavilov, 1926). Therefore, an account of local plant diversity involves understanding a range of complex interrelated factors, rather than simplified general ecological theories (Tilman & Pacala, 1993).

Since the 1980s, the human ecological aspect of crop diversity has increasingly been emphasized as integral to human culture through crop domestication, artificial selection, and cultural adaptation (Brush, 2004, p. 7). Ethno-botanists and anthropologists tend to regard crop diversity as a product of cultural rather than ecological specificity (Baco et al., 2007; Elias et al., 2000). In agricultural studies, crop diversity is considered in relation to farmers' decisions, as determined both by their specific socio-economic attributes (such as attitudes, household income, social norms, size/number of land parcels, and labor availability); and by their specific farming technologies (such as crop varieties, use of fertilizer and pesticides and access to irrigation) (Fu et al., 2006; Jarvis & Hodgkin, 1999). Geographers, on the other hand, often explain the existence of crop diversity in particular areas as a function of specific community attributes, such as location, farm ecosystems, distance to urban centers, market orientation, and community networks (Clement et al., 2003; Zimmerer, 1998).

These studies of crop diversity in multiple disciplinary domains, although they collectively provide a multi-faceted approach to understanding crop diversity, have nonetheless produced inconsistent findings. Many of these findings are in tension as regards human influence on crop diversity. In fact, the literature agrees on a set of factors that influence on-farm crop diversity, but not on the direction of such influence. These factors include, but are not limited to farming practices, individual or household attributes linked to knowledge and capability, and community attributes related to varietal distribution and exchange. Certain factors regarding farming practices such as modern technology and market accessibility have been cited as having both positive (Rana et al., 2008) and negative impact on crop diversity (van Dusen & Taylor, 2005). Conflict in research findings is also present among farm household attributes, including the gender role in terms of ethnobotanical knowledge (compare Chambers & Momsen, 2007; Gedebo et al., 2007; Reyes-Garcia et al., 2008). In addition, the conservation of on-farm crop diversity is, on the one hand, perceived as a result of the economic and cultural isolation of marginal communities (Brush, 1995; Negri, 2003), but on the other, as a result of their wide interactions with other communities for seed exchange and replacement (Barnaud et al., 2008; van Etten, 2006).

Despite the long history of research on crop diversity, this problem of inconsistency continues to restrict theorization as well as generalizability of research findings. Indeed, many scholars seem to agree upon the specificity of on-farm crop diversity—an idea that crop diversity can only be understood in a specific context (Brush, 2003; Gonzales, 2000; Kizito et al., 2007). Available theorists describe on-farm crop diversity broadly as the generalized processes of biological and cultural co-evolution that are refracted through local contextual factors into different patterns (Brush, 2004; Smale et al., 2001). Following this theoretical development, a majority of on-farm crop diversity research tends to focus on the occurrence or variation of specific factors in a locality and disregards the role of general mechanisms underlying various patterns of crop diversity across localities (Bisht et al., 2006; Cutforth et al., 2001). As a result, these studies have further confirmed and strengthened the assumption of contextual specificity.

This chapter challenges this long-held, dominant assumption regarding the specificity of on-farm crop diversity and argues that a general theory may be possible by examining its underlying mechanisms from a dynamic perspective. Specifically, the dynamic perspective adopted in this chapter emphasizes the role of crop diversity in farmers' livelihoods and examines how this role changes over time (Bellon, 1996). Crop diversity can play roles in both material structure and symbolic culture. Available research has, either implicitly or explicitly, acknowledged these material and symbolic mechanisms in explaining why and how farmers maintain crop diversity on their farms.

The material role of crop diversity is manifest through farmers' rational choices. In the material aspect, farmers decide to maintain crop diversity because it can fulfill their material interests, for instance, to secure food, optimize risk and productivity, and diversify consumption and other uses (Bisht et al., 2007; Tsegaye, 1997). Such decisions are also based on farm ecological conditions, available resources and technologies (Setyawati, 1996), and other management factors, such as local seed management (Nagarajan et al., 2007). The symbolic role of crop diversity is articulated through societal ideals that transcend utilitarian values (Barrera-Bassols & Toledo, 2005). For example, traditional festivals have played a key role in maintaining crop diversity in central Himalaya through assigning special meanings to particular crop species or varieties (Nautiyal et al., 2008). In this line of study, the role of symbolic culture is especially apparent in explaining variations in crop diversity among communities with similar material conditions (Perales et al., 2005). All in all, these two distinct lines of theoretical development have generally accepted the notion that material structure and symbolic culture constitute each other in reinforcing ways to produce variations in crop diversity (Brush, 2004; Gade, 1999). Biodiversity and genetic resources are inseparable from its cultural and belief systems (Lacy, 1994); simultaneously, human's knowledge and view of nature do not exist in a socio-economic and technological vacuum (Scoones & Thompson, 1994).

Notwithstanding such acknowledgment, few studies have explicitly elaborated on material and symbolic mechanisms. Instead, many scholars opt to examine concrete, measurable factors as proxies of these abstract mechanisms. This approach exhibits at least two drawbacks. First, available studies have attributed specific factors to either material or symbolic mechanisms. In this regard, scholars tend to take one or the other aspect as dominant in explaining on-farm crop diversity. An extensive review of on-farm crop diversity indicates that the tendency to focus on material or symbolic mechanisms is not related to the factors themselves, but rather to disciplinary perspectives.

Disciplinary studies focusing on the material dimension usually translate sacred or spiritual values as having a utilitarian basis. Indeed, these studies often view these values as a special category of use. For instance, many scholars account for utilitarian values of specific crop varieties in local diet, sweet delicacies and ritual offerings (Carpenter, 2005; Zimmerer, 1992). By doing so, these studies have underestimated not only the scope (by including only those for which material uses can be imputed), but also the importance of symbolic mechanisms that constitute material uses. The same problems are also present among studies emphasizing the symbolic role of crop diversity. Cultural scholars tend to deal with material mechanisms implicitly by examining utilitarian values as embedded in symbolic meanings and practices. For example, these scholars have examined indigenous culture of crop diversity as having utilitarian and practical values in specific ecological, technological and socio-economic contexts (Carney, 1991; Iskandar & Ellen, 1999).

Second, scholars have emphasized the role of contextual factors in explaining the discrepancies of on-farm crop diversity among specific localities. In contrast to previous studies, I argue that these variable influences are attributed to the role of general mechanisms in which such factors operate, not to the role of contextual specificity *per se*. In fact, many factors can operate within either material or symbolic mechanisms. Depending on underlying mechanisms, the same factors can lead on-farm rice diversity into several and at times contradictory directions. Taking modern crop varieties as an example, the introduction of modern varieties, on the one hand, can add to diversified local germplasm in a cultural pursuit of crop diversity (Bellon, 1991; Khlestkina et al., 2004). On the other hand, modern varieties can outperform traditional varieties in material terms (i.e. yield and quality), resulting in the displacement of many traditional varieties and consequently the reduction of on-farm crop diversity (Teklu & Hammer, 2006). Therefore, the role of these specific factors in shaping on-farm crop diversity can only be understood within material and symbolic mechanisms.

Given the dominant role of mechanisms, on-farm crop diversity should be understood as the result of interactions between material and symbolic mechanisms, not as the result of specificity of contextual factors. Most studies implicitly consider the interactions between material and symbolic mechanisms as underpinning the role of such factors. Existing literature often assumes that specific factors represent the co-constitution between material structure and symbolic culture. This assumption of co-constitution has led to conflation between material and symbolic mechanisms. As a result, the distinctive roles that material and symbolic mechanisms play in shaping on-farm crop diversity have largely been obscured in existing literature.

This chapter proposes that an explicit account of material-symbolic interactions is necessary in order to understand how different, and especially contradictory, impacts of these factors are mediated through farmers' perception and practice regarding crop diversity. To address the gaps of existing literature, this study examines the interrelations of material and symbolic forces as determining the impact of specific factors on crop diversity. Understanding of these interactions provides answers to such questions as whether and how on-farm crop diversity can be sustained in the face of modern farming practices and with the new conception of crop diversity.

Dealing with such interactions requires a clear distinction between material and symbolic mechanisms. In this chapter, such distinction lies in how farmers interact with crop diversity. Table 1-1 lists some examples from existing literature of material and symbolic properties with which farmers are concerned as they conserve and utilize on-farm crop diversity.

Table 1-1: Examples of material and symbolic properties of on-farm crop diversity

Material properties	**Symbolic properties**
Consumption	Beauty
Productivity	Spiritual connection
Resistance to environmental stress	Farming traditions
Risk management	Routine and ritual elements
Adaptability to soil and climatic conditions	Memory
Technological practicality	Social identity (e.g. family inheritance)

Material mechanisms encompass tangible aspects, mostly related to economic and technological factors, whereas cultural mechanisms involve intangible properties such as aesthetics, spiritual references and emotional attachments. For instance, farmers' conservation practices may be motivated by material mechanisms dealing with consumption, yield, and crop resistance, but also influenced by cultural mechanisms because farmers are interested in spiritual, cultural and aesthetic properties of rice. With this distinction, the degree to which material structure and symbolic culture are constituted can also be clearly elaborated. It should be noted that material mechanisms may be determined not only by utilitarian or practical values, but also by cultural values. The use of particular varieties of rice to make local dessert or ritual offerings are some examples of material uses that are founded in cultural values. Likewise, some symbolic mechanisms have been derived over time from utilitarian and practical features of crop diversity. Some routine and ritual practices of on-farm conservation of crop diversity clearly reflect farmers' strategies in managing soil, water, labor, and environmental risks in crop farming.

The explicit consideration of material-symbolic interactions is especially necessary to understand recent dynamics of on-farm crop diversity in the change of farming and policy environments. Agricultural modernization, i.e., shifting toward high-yielding varieties, modern technologies and intensive farming practices, results in significant changes in the material foundations of crop diversity (Pfeiffer et al., 2006; Samaddar & Das, 2008). Given these changes, scholars have called into question the existence of on-farm crop diversity maintained through traditional farming practices (Keleman et al., 2009). At the same time, both government and non-government actors have launched new efforts to enhance on-farm crop diversity at the community level in developing countries (Wood & Lenné, 1997; Worede et al., 2000). These community-based conservation attempts usually embed the dominant conception of on-farm crop diversity in policy and scholarly domains. This conception undoubtedly differs from what farmers perceive (Caillon & Degeorges, 2007). The implementation of these conservation efforts as a new symbolic culture of crop diversity in farm communities has led to resurrection of crop diversity in the face of modern farming practices.

The following sections explore these key issues empirically through case studies of rice farm communities in northern Thailand. First, I provide a brief background to rice diversity in northern Thailand, and then introduce four farm communities as representing different trajectories in the dynamics of on-farm rice diversity. In each farm community, I describe how on-farm rice diversity has changed in response to new farming conditions and conception. Based on the case studies, I discuss in the following section the role of specific factors as well as general mechanisms underlying the dynamics of on-farm rice diversity. I then elaborate on the findings and to examine some of their implications for the development of a theory of on-farm crop diversity.

The Dynamics of On-Farm Rice Diversity in Northern Thailand

Thailand lies one of the world's center for rice diversity (Chang, 1976). As in other centers of crop diversity, on-farm rice diversity in Thailand has declined substantially during the past years (Rerkasem, 2005; Senanarong & Sadakorn, 1992). However, the northern region of Thailand remains with relatively higher diversity of rice than the central and the northeast regions (Rerkasem & Rerkasem, 2002). Farmers in northern

Thailand grow rice primarily for consumption under diverse farm environments of upland and lowland ecosystems. In this context of subsistence rice farming, modern farming practices and technology including high-yielding cultivars of rice and cash crops have been widely integrated into the fabric of traditional rice farming even in marginal communities (Tipraqsa & Schreinemachers, 2009; Tungittiplakorn & Dearden, 2002). Although a few modern high-yielding cultivars are prominent in many subsistence rice farms, scholars have also found many traditional rice varieties, along with modern varieties, maintained in dispersed patches of farm communities (Chaitap, 2003; Dennis, 1987).

In recent years, government and non-government efforts to reinstate on-farm conservation of rice diversity have been evident among farm communities in Thailand. These efforts have imposed contemporary meanings of rice diversity in farm communities through a number of participatory projects. Since 2004, government rice breeders have initiated a participatory variety selection (PVS) project in local communities in the northern and northeastern regions (Jongdee & Pantuwan, 2006). The aim of this project is to increase the adoption of new rice varieties thus enhancing rice diversity in farmers' fields. Similar participatory learning and training projects implemented by local non-governmental organizations can also be found in the north as well as other regions (CBDC, 2001; GRAIN, 2003). These community-based projects seek to raise farmers' awareness about the loss and importance of rice diversity, and provide them with resources and technical knowledge necessary to conserve and utilize the diversity on farms (BUCAP, 2002).

On-farm rice diversity in northern Thailand has undergone changes in farming and policy environments. In this transition, the dynamics of on-farm rice diversity lead to at least four distinct trajectories of change to which I refer as deformation, performation, reformation and transformation. Deformation denotes the decline in rice diversity in the new farming environments, evident in many farm communities. Performation, or the persistence of traditional rice diversity in the new farming conditions, is also manifest in some communities. The third dynamic is reformation, or the introduction of new meaning of rice diversity into a community that has witnessed an earlier decline in its rice diversity. Finally, transformation refers to the alteration of existing rice diversity culture in response to the new rice diversity meaning and farming conditions.

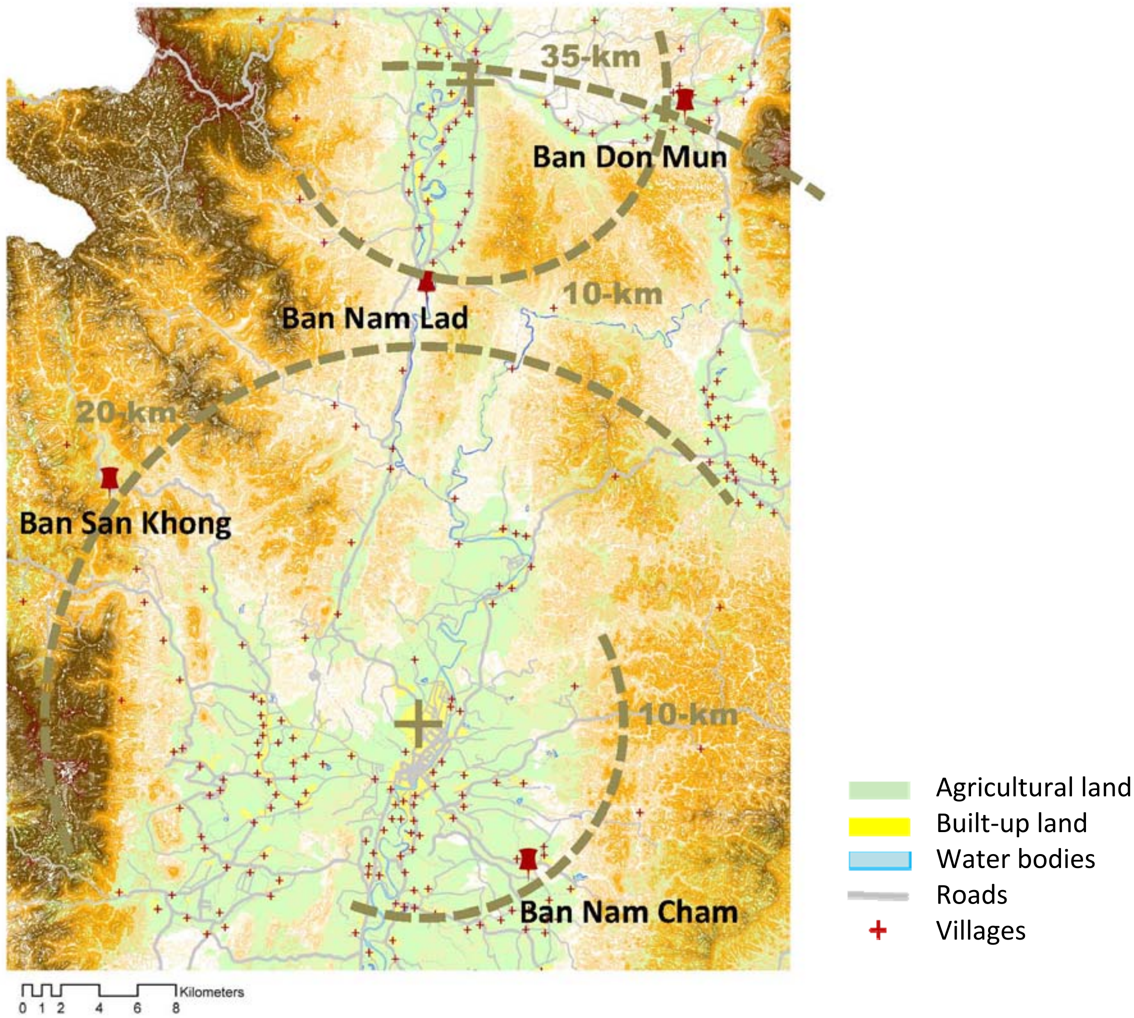


Figure 1-1: Location of research sites

Table 1-2: Basic attributes of four research sites

	Farm Ecosystems	**Rice Genetic Resources**	**Distance to town centers**
Ban Nam Lad	Upland & lowland	Less-diversified rice (2-3 varieties)	10-20 km
Ban San Khong	Upland	Diversified rice (>20 varieties)	20 km
Ban Nam Cham	Lowland	Less-diversified rice (2-3 varieties)	10 km
Ban Don Mun	Lowland	Diversified rice (>6 varieties)	10-35 km

This study elaborates these four dynamics of on-farm rice diversity through case studies of farm communities in northern Thailand, namely Ban Nam Lad, Ban San Khong, Ban Nam Cham, and Ban Don Mun, respectively. Table 1-2 displays key attributes of the four farm communities. These research sites are typical farm communities of approximately 100 households with similar demographic and socio-economic conditions (CDD, 2007). In identifying the research sites, I attempted to minimize variations of factors that may affect rice diversity existence or practices. All four sites are within the range of 10-35 km from two urban agglomerations, which indicate similar access to market, farm inputs, labor supply, commercial rice varieties, and support from NGOs or government agricultural extension office. In these sites, farmers are involved in similar, subsistence rice farming in rain-fed lowland and upland systems, along with other cash crop farming. My main concern in site selection is the difference between upland and lowland farm ecosystems, since variations in ecosystems and climate conditions can significantly affect farmers' decision about crop diversity (Rigg, 1985). In this regard, I incorporated the difference in my study by selecting the research sites that represent both diversified and less-diversified rice in upland as well as lowland ecosystems. Additionally, in minimizing the difference between upland and lowland ecosystems, the two upland sites are located at the moderate altitude of 300-500m above sea level with no extremely harsh climate.

Research fieldwork was conducted during the main rice crop cycle of 2007, i.e. from May to November. I obtained necessary data through such ethnographic methods as participant observation, key informant interviews, and document studies. During the fieldwork, I visited each farm community at least three times at different stages of rice cultivation: planting, maintaining, and harvesting, to observe different sets of practices and to approach farmers with corresponding sets of questions. The schedule of my visits was primarily based on the time lags and duration of farmers' practices across these villages. The length of my visits lasted from a few days to a few weeks, depending both on the stages of rice cultivation and the paces of my investigation. Most interviews were conducted in the informal settings of both group and individual discussions. In some villages, I could additionally obtain hand-written records and drawings from farmers as they described their practices.

With the research sites and methodology, I explored how rice diversity has changed along the four trajectories of deformation, performation, reformation, and transformation in response to new farming and policy environments. In exploring these different trajectories in the dynamics of on-farm rice diversity, I focused on how general mechanisms and specific factors, as identified in the existing literature, have contributed to such change. In the following, I present evidence of the four trajectories of rice diversity dynamics as they unfold in these farm communities in northern Thailand. The evidence across the case studies helps uncover general mechanisms underlying the various trajectories of transition of on-farm rice diversity.

Deformation

Ban Nam Lad is an indigenous farm community consisting of both upland and lowland farm ecosystems. Despite the diverse farm environment, the community has maintained relatively few varieties of upland and lowland rice. Most of these varieties can be found elsewhere or in the seed market. Most farmers in Ban Nam Lad have long shifted from swidden to permanent, intensive farming of rice and other cash crops, such as corn and peanuts. Ban Nam Lad had far more rice varieties of different maturing dates and grain characteristics in the past as compared to the current situation. At least 13 different names of varieties were mentioned as once existing in the community. As far back as the early 1990s, late maturing varieties lost their popularity and were finally discarded due to farmers' perceptions about declining rainfall. As a result, available varieties in Ban Nam Lad are only of modern, early maturing rice varieties, with superior yield performance and high-quality grains.

As with other villages, traditional rice varieties in the lowland ecosystem were among the first to be displaced owing to the advent of a modern variety—*RD6*, a glutinous derivative of the famous Thai jasmine rice. Given the exceptional grain quality of *RD6*, Ban Nam Lad farmers have started appreciating its small and slender rice grain, and at the same time devaluing their available local varieties, most of which have large-sized grains. Most households have discarded their old varieties and shifted to rice varieties that, despite comparatively lower yields, produce preferable small-grain in their diet. Several farmers told me that once they experienced the softness of *RD6*, they never wanted to get back to the old, large-grain varieties. Based on this experience, farmers in Ban Nam Lad seem to conflate the softness and the small-grain appearance of rice varieties. Such conflation is quite obvious in their talks. In farms with less water, the later versions of modern small-grain varieties, namely *RD10* and *SPT1*, are used instead of *RD6*.

The trend of change toward small-grain varieties in lowland ecosystems has expanded to upland rice farmers. Many farmers in Ban Nam Lad have adopted a popular upland variety, *Sew Mae Jan (1979)*, which possesses a small grain similar to modern varieties in lowland farms. The small-grain property was surprisingly the very first answer I got when I asked them about why they adopted this variety. Commonly known among farmers as *'Premium' Sew,* this variety was originally found in another province and was later purified and distributed by the government rice department. The word *'Premium'* signifies the variety's high quality grain, the property that is derived from its genetic uniformity and varietal purity. This and the other genetically uniform varieties appear to be planted suitably almost regardless of soil conditions, with the help of chemical fertilizer and/or pesticides. Since these technologies are available, planting diverse local varieties to suit with different soil types has become unnecessary for Ban Nam Lad farmers. In fact, as many farmers confessed, these chemical substances were applied to local varieties as well to cope with the decline in soil nutrition and the rise of pests resulting from current farming practices that are more intensive than those of past swidden rice farming.

New farming practices and technologies have also furthered the destruction of rice diversity and simultaneously facilitated a new culture of rice uniformity. In the past, most farmers usually identified a number of farm plots that seemed to have the best physical appearance as seed bases, threshing and storing the seed separately from rice grain. However, since the introduction of threshing machines that help separate the grain from husk, seed management has become a highly demanding task, not to mention the difficulty of managing more than one variety. In the age of convenient machinery threshing, Ban Nam Lad farmers generally separate the desired amount of grain for seed from harvested grain and put the seed in separate bags or containers. Since they normally share the same threshing machine, some farmers are especially careful, before threshing their own rice, about grain left in the threshing machine that could cause contamination. They usually arrange the order of threshing upland and lowland rice to match with the leftover. This concern about contamination has facilitated rice uniformity within the community and nearby communities in which farmers usually share the same threshing machines. Modern threshing technology has made farmers prefer the same variety for the entire community, and if possible, for both upland and lowland rice.

The decline in diversity and simultaneously the growth of uniformity in rice varieties are not without problems. Unlike the fairly stable performance of traditional varieties that are well adapted to local conditions, the performance of new rice varieties declines after a few years without seed refreshment. The renewal of seed to regain optimal performance, however, requires intensive selection in controlled farm condition, and thus it is possible only by specialized seed producers. To address this problem, farmers generally have to refresh their seed by obtaining new seed from the market at least every two years.

Nonetheless, seed regeneration of the upland *Sew Mae Jan* rice has been nearly impossible in recent years. The government rice department has seemingly discontinued supplying the foundation seed of this upland variety, given limited capacity in seed production and especially low overall demand for the variety. Although this upland variety is popular among upland farmers, the quantity demand is incomparable to that of lowland varieties for the majority of farmers. This suspension has resulted in lack of commercial seed supply in the market. As seed purchase appears no longer possible, several farmers have observed a “mutation” in the variety, especially in terms of plumper grain as compared to the slender grain of the original. This "mutant" variety is commonly referred to as *Sew* to distinguish it from the original, *'Premium' Sew*. Speaking of this change, many farmers appear to have no other choice but to anticipate the availability of new seed of this variety or any better upland alternatives. In addition to varietal performance issues, farmers have encountered another problem of labor shortage. By planting the same variety of rice, Ban Nam Lad farmers have shared the same work schedule in rice farming, thereby creating high demand for labor, especially during harvesting period.

However, these problems are being alleviated by emerging social and institutional mechanisms that are established through a strong network among Ban Nam Lad farmers. In fact, these mechanisms have facilitated the culture of rice uniformity from its beginning. As one farmer recalled, when *Sew Mae Jan* was first brought into the community, only a few progressive farmers, who found its slender grain appealing, obtained seed from the market during that period. In the following year, the variety rapidly diffused through an extensive network for seed exchange throughout the community. Currently, this seed exchange network has additionally been used for seed management, especially to effectively deal with the problem of deterioration of modern, purified varieties. Through the network, Ban Nam Lad farmers can obtain seed from (a few) farmers who recently purchased seed without having to purchase it themselves.

A similar adaptation of existing community networks is also evident in rice harvesting. Ban Nam Lad farmers rely on a community pool of labor that has increased considerably in size to allow farmers to manage the harvest of rice varieties that mature at the same time. This labor gathering in Ban Nam Lad involves approximately 30-50 people as compared to just about 10 people in other villages. According to the village head, this growing trend of community labor pool has recently caused problem of excessive labor. He noted that the labor agglomeration costs Ban Nam Lad farmers more than hiring labor from outside the village, considering the actual amount of labor needed to get same amount of work done within the same time.

In Ban Nam Lad, deformation occurs through the deterioration of material values owing to changes in conditions in which such values are situated. Since the introduction of modern rice varieties, farmers preferred these small-grain varieties to their traditional, large-grain varieties for their culinary. Additionally, with new technologies such as chemical fertilizer and pesticides, farmers no longer require rice diversity to optimize varietal performance across different farm conditions. The deterioration of utilitarian values has led to the discarding of traditional varieties and the destruction of rice diversity culture that appears impractical and inefficient given new farming conditions and technologies. These mechanisms leading to decline of on-farm rice diversity have proceeded through existing community networks that once facilitated the formation of rice diversity but now served the new culture of rice uniformity.

Performation

Ban San Khong is an upland indigenous community settled within the last thirty years. The community currently maintains several indigenous and modern rice varieties. Compared to adjacent communities where there are relatively few varieties, Ban San Khong has maintained a diversified pool with at least 20 varieties of upland rice. Included in this number are both glutinous and non-glutinous rice varieties from other ethnic groups and government officials, including *Sew Mae Jan (1979)* and *Jow Haw (1987)*. These exogenous varieties are often nicknamed to acknowledge their origins, for instance, with names of ethnic groups, villages, or persons who first acquired varieties. Other than the naming distinctions, Ban San Khong farmers make no distinction of these varieties from their own ethnic varieties, since the varieties have been maintained to adapt well to local farm conditions. However, farmers brought in most of available varieties originally as they arrived from their previous settlements. The number of these ethnic varieties is, however, much smaller today compared to that in the past. As with Ban Nam Lad, a significant amount of rice varieties with late maturity were discarded due to uncertain, shorter period of rainy season. Those with desired culinary characteristics but low yield were also displaced by varieties with higher yielding varieties with a shift toward more intensive rice farming in combination with cash crops, particularly corn. During my interviews, many farmers still have a good memory about these lost varieties. One farmer said that he would not discard these varieties, if only chemical fertilizer were available to boost their yield at that time.

The conservation of rice diversity in Ban San Khong has occurred at the household level. Individual farmers manage their own seed selection and storage for the following season. Only in exceptional circumstances do Ban San Khong farmers depend on a community network for seed management. Every year, seed selection is done at the same time as harvesting. During rice harvesting, Ban San Khong farmers cut only rice panicles for grain; only healthy panicles of each variety are selected for a desired amount of seed, sun dried with other harvested panicles. The seed is then manually threshed and kept in separate from rice grains that are machinery threshed and stored as a mixture. This method of seed management requires same amount of labor and time regardless of the number of rice varieties that farmers maintain on their farms. Furthermore, this household-based seed management practices allow each household to make an independent decision from others in regard to which rice varieties to plant.

However, there are some similarities in how Ban San Khong farmers decide about rice germplasm. These similarities can be observed across households with different socio-economic conditions. Most farmers in Ban San Khong maintain 3-4 varieties with the following common characteristics:

- "Grandmother" or specific varieties with black seed—believed to protect other rice varieties in the field,
- Glutinous varieties for specific culinary use,
- Non-glutinous varieties that are their main staple, and
- Optionally, non-glutinous varieties with early maturing traits.

Most of these varieties have been maintained for generations as family inheritance. For many households, these varieties remain the same as previous years. Some households have changed varieties in recent years; however, these changes were the varieties, not the number they plant. When asked for their reasons for planting a specific number of varieties, most farmers said they just do what they (and their parents) used to. As I insisted to know more, a few farmers even questioned me why one variety is good; for them, more is always better.

In fact, Ban San Khong farmers have maintained this typical set of varieties in the field, but rarely use all of them. Glutinous rice is often not used much because it is not their main staple. Therefore, the amount of glutinous rice that is planted is very low—just enough for seed maintenance but usually insufficient for consumption. When glutinous rice is needed (for instance, to make dessert), they often buy some from town. The same situation can also be applied to "grandmother" rice, the color of which appears inadequately dark for a special black dessert for a community ritual, according to Ban San Khong women. As a result, these women typically mix black ash derived from burning wood with white glutinous rice to make the dessert more uniformly black. For non-glutinous rice, farmers' decisions on rice collection are shaped by compromises they make among several desirable traits, generally between yield performance and eating quality. However, most households do not distinguish among different varieties for consumption. Farmers usually store all varieties of harvested rice in the same barn and thus varieties are mixed before consumption. In fact, they may be already mixed during threshing, since the community shares the same threshing machine.

For Ban San Khong farmers, the conservation of rice diversity is related to specific attributes of rice varieties. Several farmers mentioned the color of rice plants or grains as their reasons to maintain specific rice varieties. The most popular color, for instance, is silver, which symbolizes prosperity. Some varieties are maintained as family inheritance, or because of their good names and other properties that may be just different from their neighbors' varieties. Some farmers reported that they prefer planting different rice varieties from their neighboring farms to create visual farm boundaries. In fact, this tendency of farm boundary construction is quite obvious, as I could clearly observe each of farm territories during the harvesting season.

The maintenance of this diversified rice germplasm has been facilitated by modern technologies in farm management. Unlike Ban Nam Lad, the availability of modern farm management technologies to control optimal farm conditions allows Ban San Khong farmers to plant any available variety in their farmland. As reported by several farmers, the use of chemical fertilizers has made possible for them to plant some varieties that previously did not “like” particular types of soil in their farms. The village head proudly presented to me specific techniques for using chemical fertilizers that nourish rice plants and also reduce and destroy grass pests on their farms. These new fertilizing techniques have been widely adopted by Ban San Khong farmers in recent years and have increased the overall rice yield. In favorable years many farmers even have some rice beyond their subsistence needs. The improvement in rice productivity has lessened the demand pressure on rice yield and has permitted Ban San Khong farmers to maintain a larger portion of their desirable varieties that have low yield performance.

The community has established various systems of exchange and lending to help maintain varieties in years that those cultivars are not cultivated. These systems are however meant mainly for conservation, and not so much for seed distribution or labor management. Through the networks of relatives, ethnic groups, and other personal relationships within and outside the community, Ban San Khong farmers can acquire varieties that have been lost from their own farms. In years when rice is not planted because they still have rice excess, farmers will lend their own varieties to others to plant and save seeds for their use in the following years. The individual network system in Ban San Khong is quite small and limited in comparison to that in Ban Nam Lad. Therefore, the distribution of new rice varieties among Ban San Khong farmers is not very efficient. Not most households possess a few popular varieties that give good yield. Similarly, the labor pooling system in Ban San Khong is very limited in scope. During rice harvesting season, some households encounter problems because of insufficient labor supply, and thus decide to maintain early-maturing varieties along with regular varieties on their farms to offset the labor problem.

Rice diversity still persists in Ban San Khong, although its utilitarian values decline as farming practices and conditions change. This persistence of rice diversity has been primarily possible through symbolic values attached both to specific rice varieties and to rice diversity itself—the same values that were initially founded on the old-fashioned use of rice diversity. In Ban San Khong, this symbolic culture of rice diversity has not only operated independently from its old material foundation, but has also been re-articulated with new uses with changes in material conditions. Farmers have conserved a diversified set of rice varieties on their farms, even when these varieties have little to do with consumption, farm conditions and farming practices. Furthermore, viewing rice diversity as cultural repertoires, farmers have assigned the symbolic property of rice diversity new utilitarian values, including spiritual protection and visual farm boundary construction. The abandonment of traditional farming practices has not destroyed the culture of rice diversity. Instead, the adoption of modern practices and technologies in Ban San Khong has supported rice diversity conservation.

Reformation

Ban Nam Cham represents a typical lowland farm community in northern Thailand, planting rice for consumption along with beans, fruits and vegetables as cash crops. Each household normally plants one variety of glutinous rice as their staple. Only a few households plant non-glutinous rice for special occasion consumption, because farmers can easily purchase it from the market. For more than two decades, these farmers have replaced diversified, traditional rice varieties with modern ones. For Ban Nam Cham farmers, however, the replacement is regarded as gain rather than loss of rice genetic resources. Traditional varieties are considered outdated and thus abandoned for the improved, modern ones as developed by government rice experts. Since the introduction of modern varieties, Ban Nam Cham has discarded their traditional rice varieties, opting instead to keep up with newly released varieties that perform comparatively better. Currently, there are a few varieties of modern rice in Ban Nam Cham, including the most popular *RD6* and two increasingly popular shorter-lived varieties—*RD10* and *SPT1*, owing to frequent water shortage. The only available traditional variety, *Tam Dor*, has been conserved for more than three decades by a few households because of its suitability for specific farm conditions under which modern rice varieties cannot grow.

Since the adoption of modern rice, seed management tasks have become very demanding and difficult in Ban Nam Cham. A number of reasons are at play. Modern rice varieties are genetically purified and therefore do not adapt well to local farm conditions. Although these varieties produce high performance from their genetic purity, they often lose such performance through re-planting seed in the following years. Additionally, farming conditions and practices in Ban Nam Cham do not accommodate seed management. Whole-plant harvesting and machinery threshing practices also prevent careful seed selection, as these practices require additional time and labor. Given these conditions, Ban Nam Cham farmers use the same varieties on all farmland and have to purchase new seed every other year. They organize a seed-buyer group to obtain seed in a mass so as to reduce the costs of transportation. According to these farmers, they buy seed because of their convenience and labor/time saving for other cash crop farming, not because of their lack of seed selection knowledge and techniques. In the past, when traditional varieties were still prominent in Ban Nam Cham, these farmers used to do both extensive and intensive seed selection to maintain the performance of their rice varieties. However, being well-adapted to farm conditions in Ban Nam Cham, traditional varieties of the past did not require as much intensive seed selection as the present modern varieties do.

Since 2003, Ban Nam Cham has learned a new conception of rice diversity through a community conservation and development project implemented by cooperation between a local NGO and government rice scientists. Practically speaking, this project has successfully raised farmers' awareness of on-farm rice diversity. All farmers whom I interviewed, mostly participating farmers and their relatives, have expressed some concerns about community rice diversity. However, their understanding of rice diversity has been articulated in reference to their potential uses of rice genetic resources. On-farm rice diversity is generally considered in terms of the number of rice varieties that are available in the community. When asked about the importance of rice diversity, these farmers mentioned having diversity either as a source of varietal alternatives or of breeding materials.

In Ban Nam Cham, this new understanding of rice diversity has not altered existing farmers' practices outside the scope of project activities. Yet, the project-initiated community conservation and breeding activities have been geared toward supporting existing farmers' practices. The community varietal studies have failed to persuade farmers to adopt additional rice varieties from the conservation field. For these farmers, not a single variety can beat *RD6*, and even their second-best *RD10*. In fact, even if better alternatives were available, farmers might not adopt the varieties. One male, progressive farmer spent a few years searching for better alternatives and found one promising variety among those planted in the conservation field. But, he eventually abandoned this variety as he realized it was difficult to make seed available in sufficient quantities for actual planting. Among farmers I interviewed, seed availability in the market was frequently mentioned as a major criterion when choosing modern over other rice varieties. Ban Nam Cham farmers seemingly adhere to the seed purchasing habit, despite availability of genetic resources and seed management skills. As a response to their persistence in modern varieties, "…we become either too busy or lazy to do what we used to manage seeds; now things are convenient and we can just pay for them". I second his statement as I found some farmers in Ban Nam Cham even purchase seeds every year, compared to every two years, which is typical without seed selection. In these farmers' opinion, buying seed does not cost them a lot of money, because they have such small rice farms. But in the eyes of community leaders, farmers' reliance on seed purchase is identified as a major obstacle toward the adoption of new varieties in addition to those available in the market.

These issues of varietal adoption are also resonant in the development of community rice varieties. Comparatively, Ban Nam Cham lags behind other project sites in regard to the community breeding activities. Although persisting into the fifth year, farmer breeders appear to lack motivation in rice breeding. One of the few farmer breeders expressed a lack of promise in the development of new varieties from a cross between *Tam Dor* and *RD6*. Considering available lines of the fourth generation, he doubted that the new varieties could outperform the popular *RD6*. Even if they could, he would expect farmers to adopt them only for a few years and then return to old varieties because of seed availability for purchase. This outlook was based on his own experience. This farmer breeder told me about several cases of rice varieties that were once popular in the community but were totally discarded afterward.

To address the problem of seed reliance, a community-based seed production organization was established a few years after the start of the project, with funding support from the local government. The group is run by a few village leaders and progressive farmers committed to producing seed for Ban Nam Cham. However, community seed production appears to serve the interest of Ban Nam Cham farmers by producing comparatively low-priced seed of modern varieties instead of varieties unavailable in the market. As explained by a group leader, community seed production was so limited that the group can target only the varieties with high demand, although these varieties are already available in the market. It appears that the purpose of community seed production in Ban Nam Cham is actually to make seed available to farmers at cheaper prices as compared with the market, which is easily achievable because of local government subsidization. He said the group would potentially attract more members and could thus increase community seed supply, since farmers can earn more money producing seed for planting than selling rice as grains. At the time of my fieldwork, a kilogram of *RD6* seed costs 18-20 baht, compared to 10 baht for grain. If efficiency and profit are the group's motivation, community seed production may likely foster the planting of a few modern varieties, but not to expand new opportunities for rice diversity for Ban Nam Cham farmers.

The new conception of rice diversity has also given rise to seemingly innovative techniques among Ban Nam Cham farmers in the past as they attempted to take advantage of rice diversity. Specifically, some farmers combined the seed of two modern varieties, *RD10* and *SPT1*, and planted the mixture in the same plot to obtain both relatively high grain quality of the former and relatively high yield and resistance of the latter. A few farmers went even further and explained the promise of variety mixture as the result of competition between the two varieties. Although this technique was widely adopted by Ban Nam Cham farmers at the time of my fieldwork, it had been discarded by the time I re-visited the village the following year. As stated by one farmer who just experimented with this technique for a year, the technique only looks appealing, but in fact resulted in poor performance, both in terms of yield and resistance.

The introduction of *in situ* rice conservation has altered farmers' perception and practices regarding rice diversity in Ban Nam Cham, where old-fashioned rice diversity has already deformed. In such case, reformation does not necessarily promote on-farm rice diversity. As the Ban Nam Cham case shows, the new symbolic values are re-situated in existing material condition in a way to advance farmers' pursuit of material interest. Therefore, increased access to genetic resources and institutional capacity has facilitated the re-situating processes, instead of establishing material structure of rice diversity. In Ban Nam Cham, the translation of rice diversity into varietal alternatives and community seed production practices has reinforced existing material values and practices of single-variety planting.

Transformation

Ban Don Mun is an indigenous, lowland farm community that has inherited diverse rice varieties. Because of this promise in rice conservation, the community was identified as the first site among others for the community rice conservation and development project. According to the project's unpublished studies in 1999, each household traditionally maintained 2-3 rice varieties, accounting for at least 6 varieties in the community. These are early-maturing rice varieties, which allow the planting of second (cash) crops, such as chili, cabbage and cucumber. Early planting of these vegetables is necessary in Ban Don Mun, because the earlier their produce can be taken to the market, the higher price advantage farmers can take from their produce.

Before the implementation of the project, traditional varieties were conserved sparingly by individual farmers along with the widespread adoption of modern rice varieties from a government irrigated rice breeding program, *RD10* and *SPT1*. Based on the interviews, farmers in Ban Don Mun prefer modern varieties to traditional varieties not only because of their grain quality, but also because of their short and fixed maturity period. As stated by these farmers, these properties allow farmers to designate planting and harvesting time independently of seasonal variations, and thus they can have more flexible schedule for planting of cash crops. Some households had also maintained traditional varieties on farms, though in a relatively small proportion. Some farmers told me that they reserved these varieties just in case they would like to use it in the future. Most of these farmers, however, preserved them because they wanted their children to see the varieties their parents cultivated.

Despite seed availability for modern varieties in the market, most farmers in Ban Don Mun have managed to reserve their own seeds of modern rice for planting. Seed management practices have, however, been adjusted to retain the performance of modern rice varieties without buying new purified seeds. Specifically, farmers rely on "casual" seed selection as they did with traditional varieties, but adopt a variety of techniques to restore varietal performance every two years or when declining performance can be clearly observed. Some farmers engage in intensive seed selection, by having separate seed plots with special care given to the different stages of rice farming. For example, harvested rice panicles for seed are generally put into the threshing machine before others for grain. Some exchange seeds with others in the community, especially a few households that usually buy seeds, or rotate seeds or varieties among their own plots. Several farmers plant different varieties in the same plots in consecutive years to avoid problems of decreasing yield for modern rice varieties. Since the adoption of modern rice several years ago, these seed exchange and rotation techniques have played a central role in managing local rice genetic resources in Ban Don Mun.

Since the beginning of participatory learning and training in 2000, Ban Don Mun farmers have gained increased access to rice genetic resources that are available as both varietal and genetic alternatives. Several farmers with whom I talked expressed their continuing interest in these rice varieties. They usually obtained information from their neighbors about any rice varieties newly included in the community field. Not only are typical farmers interested in rice varieties, but participating farmers are also particularly enthusiastic about new varieties as potential genetic material. With basic knowledge of genetics and simple techniques for conventional rice breeding, these progressive farmers have been studying diverse characteristics of traditional and modern rice varieties, searching for potential genetic material to be used in breeding of new varieties tailored to meet farmers' needs and conditions in Ban Don Mun.

The production of new community rice varieties has been aimed at addressing the shortage of rice straw for second crop farming in Ban Don Mun. Available rice varieties with short maturity generally produce less amount of rice straw than its actual demand for planting second crops. In the seventh year of breeding, there were several potential lines from a few crosses between good-height, traditional varieties that give lots of straw and popularly adopted modern varieties that exhibit high grain quality and short maturity. In fact, one of these potential lines was unwillingly distributed through informal network of seed exchange throughout Ban Don Mun. Thus, farmer breeders realized that they could not earn any monetary benefit from their enduring attempts as initially expected from selling seed. Despite minimal chance for benefit, attempts to produce new rice varieties have continued in earnest in Ban Don Mun. Along with little hope to sell seeds to farmers in other villages, these farmer breeders have shared the desire to see new varieties they can proudly tell anybody and their children that these varieties belong to the community. Such aspiration is similar to what they had told me when I asked about their earlier conservation of traditional rice varieties.

This new conception of rice diversity led to the establishment of a farmer organization within the existing community fabric responsible for rice genetic resource conservation and development. The community-based activities have altered both conservation and utilization practices in Ban Don Mun. The project-initiated community field conservation has maintained existing traditional varieties that were dispersed across individual farmers' hands, along with several traditional and modern varieties as introduced by the project. Eight varieties were collected from their own and nearby communities in 2000. Many of them are, however, obtained from the network of the project, accounting for 44 rice varieties available in the conservation field in 2007. At the time of my fieldwork, this field site was a center of community rice genetic resources that in many ways altered local conservation and utilization practices. In recent years, the conservation field has been turned to a Saturday class for high school students in the community to learn about rice diversity and farming. A progressive farmer, who has become a teacher, told me that he wanted these children to know all about rice varieties that were carried on for generations. He hoped that, after all, this younger generation would continue to protect the community's heritage.

Since the project establishment of the conservation site, the task of conserving local varieties has shifted from individual households to the community organization in the community field site. Individual farmers have begun to rely on the community group to maintain local genetic resources. Many farmers with whom I talked have stopped maintaining their rice varieties, knowing that they are kept securely in the community field. Correspondingly, farmers who run the community field stated that they were more frequently asked to maintain old or to test new rice varieties than they used to be at the beginning of the project. However, given the limited supply of land and labor, the group has recently begun to discard or give out to other farmers some varieties that have been shown to have low promise for Ban Don Mun.

In regard to utilization, Ban Don Mun farmers have drawn on these diverse genetic resources from this community pool for use in their farmland. Most farmers have discarded their existing varieties and instead adopted *Hawm Sakon*, a modern variety from northeastern Thailand, and a potential *Don Mun* line from community breeding as a replacement. One of my key informants talked about the high dynamics of variety turnover as an exceptional phenomenon that had never happened before the community conservation field was established. In the past, Ban Don Mun farmers hesitantly adopted new varieties by planting them in small parcels of land for a couple of years to ensure that the new varieties are really good. However, with the current, centralized conservation field, farmers can switch totally from one variety to another new trendy variety. In fact, most varieties they adopted have been very popular at most for a few years then discarded for new or old varieties. When I visited the village in the year following my fieldwork, many farmers were prepared to plant another variety recently obtained from a nearby village in place of *Hawm Sakon* and the *Don Mun* line.

The establishment of new symbolic values related to rice diversity conservation has significantly changed existing rice genetic resource management practices in Ban Don Mun. Collective practices of individual on-farm rice conservation transferred to the responsibility of a new community organization, thereby improving efficiency in genetic resource management. Through increased efficiency, the culture of rice diversity is re-oriented from conservation to utilization. As a result, while community rice genetic resources become highly dynamic with frequent varietal replacement, they forgo the evolutionary merit of on-farm conservation. Community conservation and breeding initiatives have proceeded in pursuit of new aspirations to cultivate their children's care for community rice heritage and to establish a symbolic identity through the production of new rice varieties. These continued efforts of these progressive farmers clearly resonate with their previous attempts to conserve traditional varieties as community inheritance. In Ban Don Mun, transformation thus occurs through the re-interpretation of symbolic meaning to advance existing symbolic values, with increased access to genetic resources and enhanced institutional capacity.

Table 1-3: Four trajectories in the dynamics of on-farm rice diversity in northern Thailand

	Ban Nam Lad—the decline in rice diversity in the new farming environment	Ban San Khong—the persistence of traditional rice diversity in the new farming environment	Ban Nam Cham—the introduction of new meaning of rice diversity in the new farming environment	Ban Don Mun—the change in traditional rice diversity in response to new meaning and farming environment
	Deformation	**Performation**	**Reformation**	**Transformation**
Factor explanations	A few modern varieties replace several local varieties. Chemical fertilizer and pesticides renders multiple-variety planting unnecessary, while machinery threshing promotes single-variety planting. Community networks facilitate modern variety distribution, seed acquisition, as well as large labor agglomeration during harvesting period.	Modern varieties add to a diversified pool of community inherited varieties maintained as tradition. Rice diversity has little or no material, but rather symbolic use such as spiritual protection and visual farm boundary creation. Chemical fertilizer increases flexibility in maintaining the diversity. Community networks support variety lending and exchange in conservation.	Diverse rice varieties in community field serve as varietal alternatives from which the best candidate is selected. As sources of genetic materials, community rice breeding uses these rice varieties to produce new varieties that are better than existing ones. A community organization supplies cheap seed of existing popular varieties to the community.	Community management adds to individual practices, leading to more efficient resource management. Community activities proceed with desire to establish community identity in new rice varieties and to cultivate their children's care for community rice heritage. This aspiration resonates with previous individual efforts in conserving their traditional varieties.
Underlying mechanisms	The deterioration of material values due to change of existing structure/culture in which such values are situated	The operation of symbolic culture separately from its material foundation	The re-situation of symbolic meaning in existing material structure	The re-interpretation of symbolic meaning to advance existing symbolic values
Implications on genetic resource management	The destruction of rice diversity culture that appears inefficient and impractical in new farming conditions	The re-articulation of rice diversity culture with new practical values in new farming conditions	The reinforcement of existing single-variety planting through increased access to genetic resources and improved institutional capacity	The re-orientation of rice diversity culture from conservation to utilization by increased efficiency in genetic resource management

A Theory of On-Farm Crop Diversity: The Interplay of Material and Symbolic Mechanisms

The previous section described four trajectories of changes in rice diversity as these unfolded in four farm communities I studied in northern Thailand. Table 1-3 provides summary of the four trajectories. Drawing on the evidence, this section presents two main findings related to on-farm crop diversity in general. The first finding is central to the role of specific factors and general mechanisms in shaping on-farm crop diversity. The second argument is related to the interplay of material and symbolic processes that has resulted in different trajectories in the dynamics of on-farm crop diversity. Toward the end of this section, these findings are discussed with regard to their theoretical implications for on-farm crop diversity research in general.

First, on-farm rice diversity can be perceived as the outcome of general mechanisms that shape the effects of factors specific to a locality. Farmers appear to maintain rice diversity on farms because of local contextual factors, but these specific contextual factors are nested within more general material and symbolic mechanisms. Therefore, focusing on the factors alone, and ignoring how they are embedded within systems of meanings, can in fact obfuscate the way specific contextual factors shape farming practices related to on-farm rice diversity. As revealed in the previous section, the meaning systems associated with the material and symbolic mechanisms encompass the role of specific factors that secure or undermine on-farm rice diversity. Additionally, the same factors can work to further either material or symbolic mechanisms to shape on-farm rice diversity—depending on how farmers make use of them.

As described in the case studies, specific factors such as modern technologies, availability of rice varieties, seed management knowledge and capability, and seed exchange network can promote or undermine on-farm rice diversity in different farm communities. Farmers manage these factors as they are influenced by material and symbolic mechanisms. For example, the network of friends and relatives in Ban Don Mun has facilitated seed exchange and distribution in the maintenance of rice diversity on farms. However, the same type of network in Ban Nam Lad has supported the decline in rice diversity. Likewise, modern farming practices and technologies do not always result in the destruction of on-farm rice diversity, for example in Ban San Khong. On the other hand, providing farmers with increased access to genetic resources and institutional capability may not necessarily promote on-farm crop diversity. As the Ban Nam Cham case shows, such provisions can even reinforce the persistence of single-variety planting.

The case studies of on-farm rice diversity also reveal that material structure and symbolic culture may compete rather than constitute each other in shaping on-farm crop diversity. Therefore, the long-held assumption of material-symbolic co-constitution, derived from a static perspective, may not be applicable in accounting for the dynamics of on-farm crop diversity. As the cases demonstrate, recent dynamics of rice diversity in northern Thailand have involved multiple conditions and conceptions that operate independently in shaping local practices of rice genetic resource management. The interrelations between these material and symbolic entities are not always accommodating; rather, they are also sometimes in tension and conflict. The resolution of these conflicting relationships often means that in a given case, either material or symbolic mechanisms can have dominating impact on outcomes. They do not exist in a balanced syncretic relationship.

In the case of deformation, changes in farming conditions and practices have directly affected the foundation of utilitarian values embedded in traditional rice varieties and in the diversity of rice itself. Influenced mainly by material mechanisms, rice diversity in Ban Nam Lad has undoubtedly been on the decline. But similar shifts in farming conditions and practices have led to different results in Ban San Khong where the symbolic foundation of rice diversity is established firmly. Performation occurs through the operation and re-articulation of existing symbolic culture within the new material structure. Although the material use of rice diversity has declined in Ban San Khong, the sustenance of symbolic mechanisms embedded in traditions and rituals in rice farming has led to farmers' conservation of rice varieties, some with new symbolic "uses".

In the reformation case, a new conception of rice diversity is re-situated within the existing material structure. In Ban Nam Cham, farmers re-interpret rice diversity definition and management initiatives to advance the pursuit of their material goals. As a result, the process of re-interpretation has reinforced rather than discouraged existing single-variety planting. In contrast, transformation is due to the dominant role of symbolic mechanisms in Ban Don Mun. The introduction of new rice diversity definition and management initiatives consequently advances the pursuit of existing symbolic values. Progressive farmers have continued community-based conservation and breeding with aspirations to imbue their children with values that would lead to a concern for community rice heritage and help establish a community identity through the creation of new rice varieties. These aspirations resonate with their previous effort to conserve traditional rice varieties as community inheritance.

These findings highlight important problems regarding two leading theoretical assumptions in the existing literature. The first concerns the multi-faceted impact of a factor as shaped by its underlying material or symbolic mechanisms. To deal with the complexity of locally specific conditions, existing studies have used a variety of approaches and focused on a multiplicity of variables, and tended to conclude that on-farm crop diversity is an outcome of locally salient contextual factors. This line of theoretical development in on-farm crop diversity research follows a tendency of being overly inclusive in accounting for causal variables and makes it difficult to draw general conclusions (Agrawal, 2003). Second, the intricate interaction between material and symbolic mechanisms underlying the impact of a factor has led to the assumption of co-constitution of material structure and symbolic culture. This assumption often leads to misleading conclusions about the causal processes that produce on-farm crop diversity and the prospects of future diversity.

To address these drawbacks, this study proposes a more general approach to understanding crop diversity by examining the material or symbolic mechanisms within which specific contextual factors are embedded. This alternative approach rests on a different perspective compared to much of the existing literature that highlights the role of contextual factors and fails to examine related underlying mechanisms. My theoretical approach requires an explicit account of the overarching role of general mechanisms that determine how specific factors contribute to the dynamics of on-farm crop diversity. The study suggests that the role of general mechanisms can be understood through the independent and interactive effects of material and symbolic mechanisms. In understanding on-farm crop diversity, these material-symbolic interactions should play a central role in both conceptual and methodological frameworks.

Conceptually, different trajectories in the dynamics of on-farm crop diversity can be understood as the interactive outcome between internal systems and external forces that influence local practices of crop genetic resource management. The four case studies serve as laboratories in which different conceptual models of crop diversity are at play. As depicted in Table 1-4 below, deformation, performation, reformation and transformation are possible outcomes of such interactions. These outcomes vary according to the presence or the dominance of material and symbolic mechanisms. The combination of dominant internal systems and external forces can signify different patterns in the dynamics of on-farm crop diversity. To be specific, the exercise of material intervention is likely to result in deformation—decline in crop diversity in new material conditions—in a locality with dominant material structure. But where symbolic culture dominates local practices, the same type of intervention can instead lead to performation—re-articulation of crop diversity culture in new material conditions. Likewise, the introduction of new symbolic culture in a location where material structure is dominant can cause reformation—reinforcement of existing practices in pursuit of material goals. Under the condition of dominant symbolic culture, the symbolic intervention to promote crop diversity can lead to transformation—advancement of existing practices in pursuit of symbolic goals. In general, this theoretical framework suggests that the nature of interventions should take into account whether material or symbolic mechanisms dominate in influencing existing on-farm practice in a locality.

Table 1-4: Theoretical framework for on-farm crop diversity research

		Dominant external forces	
		Material intervention	**Symbolic intervention**
Dominant internal systems	**Material structure**	Deformation	Reformation
	Symbolic culture	Performation	Transformation

Methodologically, the aforementioned theoretical framework signifies the importance of research design and site selection for local crop diversity studies. Research design and site selection necessitate an appropriate conceptual model, because the influence of these factors can be accurately understood in reference to dominant mechanisms, not simply based on the context itself. Both qualitative and quantitative research assessing the impact of specific factors on on-farm crop diversity can use the theoretical framework to conceptualize potential dominant mechanisms in a case study, or to identify potential sites that are applicable to the same conceptual models to ensure comparability among case studies.

These proposed conceptual and methodological frameworks can help guide future studies of on-farm crop diversity. This theoretical development is derived from empirical studies of on-farm rice diversity in northern Thailand, and thus by no means is sufficiently proven as a general theory. It should be subjected to empirical tests and modifications as applicable to the diversity of other crops in different regions of domesticated crop diversity. After all, the proposed theoretical development only introduces material-symbolic interactions as a mode of inquiry that opens up new questions for further research.

Conclusion

Attempts to develop a general theory to explain on-farm crop diversity practice appear unfortunately limited, given inconsistent findings across disciplinary studies. Therefore, theoretical conceptualization of on-farm crop diversity is generally applied to specific localities, and tends to view crop diversity as the result of intricate interactions among locally specific human and ecological factors. This chapter challenges this restricted, locally-based approach in the existing literature by proposing a new perspective that focuses on material and symbolic mechanisms that encompass specific factors and the nature of effects these factors produce. It thus enables broader generalizations in relation to on-farm crop diversity research. Using case studies of farm communities in northern Thailand, the chapter explores four distinct trajectories of on-farm rice diversity dynamics—namely deformation, performation, reformation and transformation. By pinpointing these dynamics, the study has sought to explain how general mechanisms and specific factors contribute to different trajectories of on-farm rice diversity.

The case studies reveal that farmers maintain rice diversity on farms because rice diversity is important to them, either materially or symbolically. The material and symbolic mechanisms play distinctive roles in specific locations leading to different trajectories of on-farm rice diversity across the four studied communities. Deformation results from the deterioration of utilitarian values associated with rice diversity owing to changes in farming contexts in which the values are situated. Under this shift of material conditions, performation is dominated by the symbolic mechanism through which sacred and intangible values are constructed, embedded in community norms and rituals, and operated autonomously from the material foundation. The introduction of new definition of rice diversity results in reformation—the re-situation of new symbolic values in the material or practical context, which may not lead to the alteration of existing practices. Finally, as the modern definition of rice diversity is added onto traditional definition, transformation is subjected to farmers' re-interpretation through which new meanings have advanced the pursuit of existing symbolic values. These findings have suggested a major development of theoretical approaches and policy applications for on-farm crop diversity in recent transition of the society.

CHAPTER 2

DE-CONTEXTUALIZED KNOWLEDGE, SITUATED POLITICS

Recent practices of knowledge inclusion in Thailand surrounding rice diversity and genetic resources have led to new phenomena, which I call knowledge deviation. This chapter explores several "deviant" forms of scientific and indigenous knowledge—"participatory" science, "localized" science, "scientized" knowledge and "hybridized" knowledge—as new loci of political practices among government rice breeders, non-governmental officials, and farmers. The ethnographic studies reveal that, through selectively incorporating elements of each other's knowledge, these scientific and indigenous knowledge practitioners have drawn on the discourses of scientific-indigenous knowledge to their political advantage. The ramifications of the new politics, however, vary accordingly to different political arenas in rice diversity and genetic resource management. Based on this finding, I argue that political practices of knowledge inclusion should not be obscured by the notion of situated knowledge, but should be understood as situated politics of de-contextualized knowledge in biodiversity and genetic resource management. The argument re-conceptualizes the new scientific-indigenous politics as a synthesis between the power-knowledge relationship and the power-structural context in which biodiversity and genetic resource management takes place.

The Divide between Scientific and Indigenous Knowledge, and the Politics of Genetic Resources

The early 1990s marked the beginning of significant change in how the world's genetic resources were being regulated. In 1992, the Convention on Biological Diversity formally defined the term, biological diversity, hereafter biodiversity, as a desirable property across all forms of genetic resources, and acknowledged the rights of sovereign nations, as well as indigenous communities, over their genetic resources (United Nations, 1993, see Article 2, 3 and 8j). In the following year, the agreement on Trade-

Related Aspects of Intellectual Property Rights was established under the World Trade Organization, requiring intellectual property rights on genetic products of scientific invention. As suggested by both agreements, the intellectual property rights regime is believed to address the exploitation of genetic resources between developed and developing countries under the common heritage doctrine. Coupled with the access and benefit-sharing scheme, the regime also provides incentives for the conservation and development of biodiversity and genetic resources. Under this regime, "modified" genetic resources are the property of the intellectuals who improve them from their national condition. "Raw" genetic resources belong to the countries or local communities where the resources exist in natural habitats. Despite the global acknowledgment of these rights, the implementation of intellectual property rights over "raw" and "modified" genetic resources still falls under national jurisdiction, and thus varies significantly from country to country.

Although the shift from free to regulated access to genetic resources has ended the age-old conflicts over genetic resources, it has generated new conflicts at the knowledge or discourse level about the sustainability of biodiversity and genetic resource management. In the 1990s, biodiversity emerged as a burning issue on the political agenda, changing the focus of state environmental policies from biological resources themselves, such as wildlife or plants, toward management issues, such as conservation biology, biosafety and sustainable use of biodiversity and genetic resources. In the transition phase, the relationship between biodiversity and intellectual property rights was widely debated in the scholarly literature and also in policy conservations. Central to the discourses were such questions as whether and how scientific and indigenous peoples in light of their knowledge should have rights to access and use of resources for sustainable management of biodiversity (Brush, 1996). These debates pinpoint fundamental differences of scientific versus indigenous knowledge and genetic resources.

Certain aspects of the knowledge and practice of scientists and indigenous peoples have been advocated in the discourses of biodiversity and genetic resource management.

Science, on the one hand, constitutes the concept of biodiversity, characterizing biodiversity, identifying critical species or habitats, and conserving important species and restoring ecosystems. Scientifically-derived technology also provides the most effective means to utilize biodiversity and genetic resources for agricultural production and development. However, it is becoming increasingly evident that such technology is producing unsustainable costs in the development, leading rather to the destruction of biodiversity (Conway, 1998). In agricultural development, for instance, science has produced modern high-yielding varieties, which have significantly replaced a vast diversity of traditional landraces and led to the reduction of other beneficial species in farmland (FAO, 1998, pp. 33-40). Indigenous knowledge and practices, on the other hand, are recognized for their positive contribution to biodiversity. For example, the knowledge and practices of indigenous peoples have been related to the richness of crop varieties maintained in marginal areas (Altieri, 2004; Rao et al., 2003). Furthermore, farmers' knowledge of local cultivars and seed management systems has been shown to contribute to the diversity in the genetic structures of populations (Brocke et al., 2003). Advocates of indigenous knowledge highlight its "practical" nature for development (Geertz, 1983), and increasingly its "adaptive" characteristics in coping with ecological resilience for the sustainability of biodiversity and genetic resource management (Berkes et al., 2000; Eden, 1998; Kimmerer, 2002).

Claims on contributions to biodiversity in both intellectual and policy debates have established a political boundary between scientific and indigenous knowledge. This scientific-indigenous dichotomy has become manifest, not only in their respective characteristics and contributions, but also in their authorities over genetic resources and development in past decades. For example, state officials have denounced such indigenous knowledge and practices in upland swidden agriculture and forest extraction (Dove, 1983; Jarosz, 1993) as deleterious and have simultaneously legitimized their control over biodiversity and genetic resources. On the contrary, other people have valorized indigenous knowledge and stewardship practices in the failure of state control to attain self-regulation of natural resources in their territories, as presented by community-based resource management supporters (Gadgil et al., 1993; Gibson & Marks, 1995). Regional and national non-government and indigenous organizations have also mobilized the discourses of cultural identity in which they claim access and control over resources in their territories (Li, 2000; Perreault, 2001; Ross & Pickering, 2002). These practices in knowledge demarcation has made the scientific-indigenous boundary a site of political contestation and strategic negotiation between scientists and indigenous peoples (Gieryn, 1983).

Therefore, several scholars have attempted to understand the politics of natural resources and development through the study of knowledge formation and practices. Throughout the long histories of the evolution of knowledge and genetic resources, it is generally accepted that both scientists and indigenous peoples have borrowed from one another through interactions among socio-natural entities that result in knowledge hybridity (Gieryn, 1999; Gupta, 1998). However in reality, the hybridization of knowledge has often been obscured (Ellen & Harris, 2000, p. 7). This myth of epistemic origins in knowledge formation and practices has been related to the strategies of knowledge producers/practitioners to exclusively obtain rights and authorities over genetic resources and development. These sources of political power are given by the scientific-indigenous dichotomy, and fostered by specific neutralizing mechanisms to which scholars refer as scientization and indigenization. Through these respective systems of interpretation and verification, knowledge and genetic resources from different sources become neutralized by social actors in both scientific and indigenous domains. Through systematic collection, classification and generalization, natural and techno-scientists have claimed their work as “scientific” knowledge and invention, regardless of significant contribution from indigenous knowledge and genetic materials (Agrawal, 2002). Using similar ways of documenting and verifying, social scientists, development officials, and non-government organizations (NGOs) have abstracted indigenous knowledge from their contexts, and successfully promoted it as invaluable resources and knowledge for development to attract funding donors (Jasanoff, 1997; Taylor, 2004). On the other side, indigenous peoples have also re-claimed knowledge and technology from the globalized, scientific world (Dove, 2002). Such re-appropriation of science and technology by indigenous peoples usually results in unsustainable practices due to misinformation or lack of information (Rogers, 2003), or "perverse" practices due to misperception of scientific knowledge (Guivant, 2003).

Critical studies uncovering these political myths in knowledge formation and practices have proposed that the study of knowledge should not be constrained by the discursive boundary between scientific and indigenous knowledge, but rather considered in a "hybrid" category (Murdoch & Clark, 1994) that is situated in a particular epistemological context (Browder, 1995; Nygren, 1999). The divide between scientific and indigenous knowledge has proven to be without substantive or epistemological ground (Agrawal, 1995). Yet, the only distinction between scientific and indigenous knowledge is not related to knowledge itself but to the institutional difference in knowledge formation and utilization in their respective domains (Ellen, 2004). Putting emphasis on knowledge therefore perpetuates the politics of scientific-indigenous knowledge, yet disregards the essential politics of genetic resources and development. The argument of "situated" knowledge has largely influenced not only the scholarly literature but also policy advocacy regarding genetic resource management and development.

In an era of a more deliberate and inclusionary politics, recent policy advocates have argued for the incorporation of both scientists and indigenous peoples in knowledge formation and utilization in development, as well as genetic resource management (O'Riordan & Stoll-Kleemann, 2002). This inclusion is seen as a more equitable and democratic approach in policy-related literature (Cash et al., 2003; Guston, 2001; Jasanoff, 1990), a more empowering and holistic approach in rural-agricultural development (Altieri, 2002), and a more adaptive and sustainable approach in natural resource management (Curtin, 2002). However, I contend that these sound supports for knowledge inclusion have laid the groundwork for new political practices of scientific and indigenous knowledge and have simultaneously obscured the resulting politics of biodiversity and genetic resources. In recent years, practitioners of scientific and indigenous knowledge alike have clearly articulated their incorporation of fragmentary knowledge and resources from one another in deploying images of either scientific or indigenous knowledge for political means. Unlike the old politics where exclusion of the other's contributions plays a key role, recent practices have drawn on the inclusion of the other knowledge to derive power from scientific and indigenous knowledge in controlling over genetic resources and development. In this chapter, I therefore refer to these neither-scientific-nor-indigenous practices as knowledge deviation, that is, a shift toward inclusion strategies in knowledge formation and utilization. The rise of "deviant" knowledge has created new spaces for power negotiation not only in the scientific but also in the indigenous communities.

The practices of knowledge deviation suggest a need to re-conceptualize the politics of scientific and indigenous knowledge with regard to biodiversity and genetic resources. The existing literature has not adequately elaborated on the emergence and existence of recent modes of political practice, given a lack of scholarly research on scientific and indigenous domains regarding the same resources in the same settings. Available studies on the politics of biodiversity and genetic resources are often restrictive, and at best empirically draw on political "implications" in one domain to derive the consequences in others. These implications are heavily based on assumptions that the scientific and indigenous communities only gain and suffer respectively from the other's exclusion or inclusion strategies. As a result of these general assumptions, current views of the politics of biodiversity and genetic resources appear overly romanticized by examining political practices in the scientific community, even as they ignore political practices in the indigenous community. This void in the existing literature opens up such empirical questions as whether, how and to what extent relevant social actors benefit from the practices of inclusion, and likewise, whether, how and to what extent those actors suffer any loss resulting from the practices. These questions necessitate comprehensive, empirically-grounded research in order to understand the recent politics of genetic resources underlying knowledge formation and practices in which epistemic origins of genetic resources and knowledge are no longer concealed. Such an understanding warrants more effective, equitable and sustainable management of biodiversity and genetic resources.

This study seeks to fill the literature gaps by examining the scientific-indigenous politics in rice genetic resource management in northern Thailand. Rice genetic resources are not only crucial in Thailand among scientific communities in agricultural development, but also among rural communities in securing their livelihoods and food security. In the following section, I describe the politics underlying "deviant" forms of science and indigenous knowledge as empirically evidenced in northern Thailand. Based on the findings of knowledge politics, I then discuss the new politics of rice genetic resources and to re-conceptualize the role of scientific-indigenous knowledge as becoming political symbolism in biodiversity and genetic resource management.

Knowledge Inclusion in Rice Genetic Resource Management in Thailand: Deviation of Scientific-Indigenous Knowledge

Recent literature on knowledge formation and utilization has evidenced several "deviant" forms of knowledge. The practices of knowledge deviation vary considerably according to different epistemic communities or knowledge practitioners. With specific focus on biodiversity and genetic resource management, this chapter considers at least four epistemic communities, i.e. scientists, NGOs, modern local communities, and indigenous local communities. Scientific or research and development (R&D) communities most often appear as the appropriators of biodiversity and genetic resources in local communities. On the other side, local communities are both regarded as the owners of knowledge and genetic resources and the users of scientific innovation. To avoid over-simplification of local communities, I include both modern communities that adopt and depend solely on outside knowledge and resources, and indigenous communities that maintain their own knowledge and resources and generally assimilate scientific knowledge and technology into their own cultures and settings. In between scientific and local communities, I also consider NGOs that pursue their career as the mediators between scientific R&D agencies and local peoples. Table 2-1 summarizes what existing literature views as conventional practices, and compares that with recent "deviant" practices: "participatory" science, "localized" science, "scientized" knowledge, and "hybridized" knowledge, which I will elaborate in more detail subsequently in this section.

Table 2-1: Conventional versus "Deviant" knowledge

Epistemic community	Scientific and R&D communities	Non-government organizations	Modern local communities	Indigenous local communities
Conventional practices	Scientific knowledge and technology with universality and wide application are systematically produced, (often) from local knowledge and genetic resources.	Local knowledge and practices are advocated through systematic document and verification of local knowledge and practices.	Local knowledge and resources are replaced as scientific and technological innovations are adopted given local relevancy and affordability.	Scientific knowledge and technology are assimilated into local cultures and settings, while local knowledge and genetic resources are maintained.
Problems	Local knowledge and genetic resources are appropriated and re-claimed through scientization.	Scientization legitimizes local knowledge and practices, yet accessible and appreciable to donors.	"Direct" adoption usually leads to unsustainability and high dependence on external inputs.	Science and modern technology are misappropriated and re-claimed through indigenization.
	"Participatory" science	**"Localized" science**	**"Scientized" knowledge**	**"Hybridized" knowledge**
"Deviant" practices	Local knowledge and genetic resources are incorporated in decision making and production for local need and adaptation.	Science is integrated into local practices and conditions through participatory learning and training.	Science is formally learned and practiced by specific groups of participants and is then diffused to the whole community.	Science is formally integrated as a sub-system into the whole local perception and production systems.
Rationales	Improved practicality and deliberate democracy	Empowerment of local peoples	Sustainability and self-reliance	Improved quality of knowledge formation and utilization

This section discusses these forms of knowledge deviation independently in four subsections, using the actor-oriented approach (Long & Long, 1992) to emphasize different perspectives of these social actors. In each subsection, I first present recent scholarly developments of a particular form of knowledge deviation in the relevant epistemic community as the conceptual framework of the study. Following the framework, I describe the politics underlying knowledge formation and utilization, which is lacking in the current literature, through the ethnography of a government rice research station, a local NGO, a modern farm village, and a traditional farm village, with regard to their respective knowledge and practices in rice genetic resource management in northern Thailand context. Based on such ethnographic methods as participant observation, archival studies, and key informant interviews, I explore knowledge inclusion practices that I label as "participatory" science, "localized" science, "scientized" knowledge, and "hybridized" knowledge, respectively. General research questions were specifically i) how each epistemic community as a group of social actors operationally and/or strategically uses its own and others' knowledge to fulfill its interests in rice diversity and genetic resources, and ii) how these practices result in the outcome situated within the actor's particular conditions.

"Participatory" Science

The rise of participatory approaches in techno-scientific communities was primarily an effort to utilize non-science or indigenous knowledge in response to the limitations of science in understanding and dealing with such complex issues as environmental problems (Thrupp, 1989). Participatory approaches have been advocated to enable more democratic management and a greater influence on priorities and practices among participators, more relevant technology and greater economic impacts, and research cost distribution among the beneficiaries (Johnson et al., 2003). The growth of participatory approaches in natural resource management is reflected in several efforts, for example, in the development of locally meaningful indicators of sustainability or environmental quality (Fraser et al., 2006; Gasteyer & Flora, 2000), community-based adaptive management (Stringer, 2006), and other participatory R&D projects, including participatory plant breeding (PPB), which is the focus of this study.

The goals of PPB is not only to enhance the performance of centralized breeding, especially under low-input conditions, by combining both local and formal institutional systems (Bänziger & Cooper, 2001; Lançon et al., 2004), but also to enhance on-farm crop diversity at both the intra- and inter-varietal levels (Joshi et al., 1997; Witcombe et al., 1996). PPB is also a conservation strategy by creating incentives for farmers to continue growing traditional varieties, involving close matching of the characteristics of traditional varieties with those of advanced breeders' lines (Maurya et al., 1988). In practice, participatory varietal selection (PVS)—a more rapid and cost-effective version of PPB—is generally preferable to the more time/resource-consuming PPB that is appropriate in marginal, highly variable environments (Bänziger & de Meyer, 2002). The PVS model only incorporates farmers' selection of stable varieties, unlike the full participatory PPB approach, which incorporates farmers' participation early in identifying parental materials or selecting from segregating (genetically unstable) materials. However, the idea that PPB is a logical extension of PVS is questioned, given that both signify fundamentally different purposes and methods (Sperling et al., 2001).

While participatory approaches deserve much attention as attempts to guide or corroborate the process of scientific inquiry at the local level, they receive as much criticism as efforts to democratize science and to improve the voice of local peoples in development. Available literature reveals that these approaches are usually governed by the expert-client relationship in participatory processes, not to mention dominant scientific theoretical and methodological frameworks in knowledge formation processes. For instance, the main concerns in participatory approaches are still rigor and validity, as science derives its authority from embeddedness within scientific institutions (Calheiros et al., 2000; Carberry, 2001). Such concerns have certainly constrained the development of fully participatory methods. Similarly, the pathways of PPB as pursued by scientific plant breeders are usually "locked-in" by their previous choices of germplasm and agro-ecological classifications (McGuire, 2008).

Using a case study of a government rice research station in northern Thailand, this section describes PPB as an instance of what I refer to as "participatory" science in this chapter. The purpose of this case study is to elaborate more on political implications of PPB with regard to rice diversity and genetic resources. This section pays specific attention to how public rice breeders operationally and strategically incorporate farmers' knowledge into breeding and how knowledge incorporation legitimizes their product and improves their tarnished images in on-farm diversity discourses.

Northern Rice Research Center is a government rice research station located in northern Thailand. The organization comprises 8 rice scientists and technicians and 227 hectares of area used in rice breeding and seed production. In cooperation with other research stations in the North and the Northeast regions, the center has carried out several glutinous rice breeding projects under region-wide rice improvement programs including upland and lowland rice, the latter of which is the focus of this study. The lowland rice breeding programs comprise the rain-fed and the irrigated laboratories, both using conventional breeding methods in developing new rice varieties. In practice, the two laboratories are responsible for two distinct traits of rice that suitable to their respective farm ecosystems; that is, the rain-fed laboratory focuses on the development of photo-sensitive varieties, while the irrigated laboratory specializes in photo-insensitive ones.

Recently, the northern and other government rice breeding stations have been encountering serious challenges regarding their contributions to rice diversity and genetic resources. In recent years, research funding for rice breeding has significantly declined, in part reflecting the poor past performance in rice breeding and seed supply, as well as the deleterious effects of modern high-yielding varieties on rice diversity. The logic of beating the existing performance records of "check" varieties (benchmark) under optimal growing conditions has screened-out many promising lines that may exhibit high grain quality, or perform well in stressed environments. At the same time, the government seed supply system has fallen short in supplying foundation and commercial certified seeds. Given these limitations, only three varieties of glutinous rice: *Niaw Ubon2* (1998), *Sakon Nakhon* (2000) and *SPT1* (2000) were released in the last decade (before PPB attempts), yet even fewer were ultimately adopted by farmers. Out of this number, the rain-fed laboratory lags behind the irrigated laboratory in terms of both released and adopted varieties. To illustrate this point, only a few varieties released years ago—*RD6* (1977), *RD10* (1981) and *SPT1* (2000)—were found in the study area (rain-fed), only the first of which belongs to the rain-fed laboratory. Given their wide adaptation, these few varieties are seemingly popular among farmers, but unfortunately replaced the vast diversity of local varieties once available in farmers' fields. The public blames the government rice breeders for the huge loss of local rice varieties in farmers' fields, despite the fact that these traditional varieties have been conserved *ex situ* in the government rice gene bank, and that farmers can improve their well-being by adopting the improved varieties.

In response to the growing pressures from the public, the rain-fed lowland rice improvement program started a participatory variety selection (PVS) scheme in 2002, with support from the Rockefeller Foundation in several farm villages in northern and northeastern Thailand. In principle, government breeder's PVS incorporates farmers' need and preferences through the selection of potential stable lines. In targeted farm villages, the PVS staff planted twenty-two promising lines of glutinous rice that passed the inter-station yield trials in the rain-fed program in mother-baby trials. According to the project report, the first round of farmers' selection from breeder lines in the mother trial (the controlled plot) was based solely on agronomic traits during the grain filling period. Then from those lines selected in the first round, the staff organized the second round of farmers' selection by grain quality in three stages: paddy rice, milled white rice, and cooked rice. They also conducted a focus group discussion to identify farmers' preference underlying their selection. Based on the number of farmers' votes for particular lines in both rounds, the PVS staff identified potential lines with the highest votes. Since the end of the project in 2005, the rain-fed breeding program has included these participatory variety selection procedures as a final testing trial to identify potential lines to be released in rain-fed farm ecosystems.

Practically, the extent of farmers' participation in rice breeding as provided by the PVS scheme appears limited with regard to the whole breeding process. In these PVS procedures, farmers' preferences for potential breeder lines have been processed and comprehended systematically, from research design, data collection, data analysis, to decision making. These science-based methodologies may at best only approximate farmers' knowledge. Specifically, the identification of participating sites was primarily based on the target environments, rather than the local demand for new varieties. The mother-baby trials were specifically intended solely for rice breeders to gather statistically reliable and comparable data across trial locations. In voting for their preference, participating farmers had limited information about the provided samples, which were numerically coded, in making a selection. Farmers' votes for varieties based on agronomic traits were thus independent from their votes based on grain quality. This voting procedure does not represent the reality of farmers' decision-making process that taking into account of these properties altogether in a variety. In identifying a promising line to be released, government rice breeders made their decision based solely on statistical comparison among the candidates. As a result, they logically released a variety—*RD12 (2007)* for rain-fed farms on account of acceptance of local farmers, and of optimal performance in local farm environment.

The PVS platform has addressed recent challenges and limitations faced by government rice breeders in the rain-fed laboratory with regard to on-farm rice diversity. First, on-farm rice diversity interpreted in terms of farmers' adoption can be enhanced through PVS. Based on project documents and staff interviews, PVS provides farmers with information and genetic resources that meet local farm conditions and needs, and leads to farmers' adoption. As a breeding strategy, PVS also opens up new possibilities in breeding for locally specific adaptation, provides new channels for information and varietal distribution, and to some extent, ensures the target group's adoption of released varieties. Overall, the PVS scheme has made significant progress within the rain-fed breeding program in terms of restoring bad images of government rice breeders as well as receiving credit for a newly released variety of glutinous rice—*RD12*.

However, the PVS scheme has led to paradoxical conflicts between the rain-fed and irrigated laboratory and also paradoxical outcome with regard to rice diversity. For example, the implementation of PVS in one rain-fed farm community in northern Thailand has contributed to the wide adoption of *Sakon Nakhon (2000)*—a variety initially introduced to the Northeast region by the irrigated rice laboratory. Purposively, the PVS scheme is implemented as an initiative under the rain-fed program, aiming for enhancing a diverse pool of rice varieties as adopted by local farmers in such diverse conditions as in the rain-fed ecosystem. Thus in principle, PVS emphasizes rice varieties with specific adaptation, rather than those with a wider adaptation—a property that would rather promote genetic uniformity. However, in reality farmers prefer varieties that are non-selective to soil conditions and that have exceptional short-duration maturity to cope with the lack of water toward the end of rainy season. Therefore, rice varieties with wide adaptation and photo-insensitivity tended to be selected in PVS. Additionally, these characteristics of wide adaptation and photo-insensitivity are nonetheless the emphasis of the irrigated program, not the rain-fed program that implements the PVS scheme.

The choice of this limited PVS instead of the full PPB scheme is due to several constraints of the government rice breeding station. Government rice breeders generally have just enough resources and personnel to carry on scientific experiments, but not to work at the local level as some local NGOs do. Lacking these financial and human resources makes it hard for government agents to implement the full participatory scheme. While their relationship with local NGOs is viewed as rivalry, participatory attempts of government rice breeders have fortunately matched with recent strategies of a local NGO in the field, and thus a cooperative relationship has been established. In this forged cooperation, public rice breeders have accessed the extensive network of the NGO, and in return have served the NGO with their genetic materials and expertise in breeding and seed production. Additional activities were set up specifically for the research sites to compromise their interests, including a full PPB and community-based seed production. At the local level, PPB was mainly implemented in the first year in the community and followed by PVS in subsequent years. Government breeders' decentralized seed production and NGOs' community seed production initiative were conflated to address the limitations of centralized seed supply for major rice varieties and to supply qualified seeds for local-specific varieties. However, the contribution of rice scientists was not much acknowledged, compared to that of NGOs. For instance, behind the NGO's credit in building the first and foremost farmer breeder figure, a formal rice breeder had provided another advance selection technique to genetically stabilize the first new farmer variety. The contribution from the rice breeder to the farmer variety, while substantial, was never acknowledged to the public. Nevertheless, government rice breeders have benefited from such cooperation to have their potential breeder lines tested in community or farmers' fields in a targeted farm environment without sharing any cost of trials. During my fieldwork, local NGO staff organized and distributed their 50 promising lines of *RD6-blast resistant* to several villages within its wide network in the area.

The government-operated PVS has recently emerged as an innovative, multi-pronged strategy to address the challenges and limitations of the rain-fed rice breeding laboratory by incorporating local farmers in the final testing procedure. The purpose of the PVS scheme is to validate potential breeder lines according to locally-specific preference and adaptation. The incorporation of farmers' input, along with varietal performance using scoring and statistical procedures does not, however, reflect farmers' decision in reality. Yet, the outcome of incorporating farmers' knowledge and decision can paradoxically raise conflicts between rain-fed and irrigated programs. As evidenced by this case study, the implementation of PVS in the rain-fed laboratory has instead given rise to the distribution of rice varieties with relatively wide adaption from the irrigated rice laboratory. This paradox can decrease genetically diversity on rice farms. Furthermore, the partnership between government breeders and local NGOs, who are generally perceived as rivals, has been forged to achieve mutual benefit in designated activities. Therefore in practice, PVS has been silently compromised in order to serve the interests of both.

"Localized" Science

Another locally-driven model of participatory approach is to empower local peoples to generate their own knowledge under specific local conditions for sustainable development (Scoones & Thompson, 1994). Participatory learning and training, commonly known as farmer field school (FFS), has received growing attention among NGOs in the developing world as an innovative means to empower local peoples, mostly in agricultural development. This FFS approach focuses on discovery-based learning and experimentation as a mode of knowledge creation and transfer (Braun et al., 2000). Unlike formal science, this locally-driven science emphasizes knowledge relevancy and validation according to local demand and conditions. This implementation of the FFS model is evident in the full participatory plant breeding (PPB) scheme usually implemented by NGOs to incorporate farmers' participation from the very beginning of breeding (Salazar et al., 2007). The full PPB offers the promises of power shifting, through the decentralization of decision making in plant breeding (Bellon et al., 2000). Moreover, FFS involves non-breeding approaches, such as diversity fairs and rural poetry journeys, in order to create incentives for promoting conservation and use of local crop genetic resources (Rijal et al., 2000).

However, existing literature has raised several questions about the emergence and implementation of FFS, especially on its true beneficiaries. Regardless of whether local peoples benefit from scientific lessons and experiments, NGOs can take advantage of the FFS projects in capitalizing on local knowledge and resources to attract potential donors (Fernando, 2003). In this patron-client relationship between NGOs and project donors, research or project activities are likely to be directed to match the donors' agenda, rather than that of the local peoples (Ellis, 2005). Furthermore, the growth of FFS is often viewed as not real development, but as expansion and proliferation of such projects to further extract resources from donors (Shrum, 2000). In fact, moving to new project sites has provided financial sustainability by shifting operational costs to the local community, as training responsibilities are primarily handed over to already-trained farmers (Quizon et al., 2001).

Other FFS studies have highlighted the relationship between NGOs and local peoples as important to participatory learning and training, and thereby also to subsequent project success (Fernandez-Gimenez et al., 2006). NGOs have greatly relied on such informal personal resources as respect, trust and friendship that have considerably been "invested" especially during the start-up phase through regular contact, personal ties and shared values (Hailey, 2001). In this type of the patron-client relationship, however, it seems that NGOs have necessarily maintained their clients or local communities with high satisfaction, through strategically selecting delivery methods and project sites, to stay competitive in their "business" (Barr & Fafchamps, 2006).

This section explores another locus of political practice in regard to biodiversity and genetic resources through these knowledge deviation practices, which I call "localized" science to distinguish it from formal "participatory" science. Through a case study of an NGO in northern Thailand, I uncover power underlying the practice of localization in the midst of the politics of rice diversity and genetic resources. Here, specific questions are how and to what extent the practice of "localized" science is mediated by the patron-client relationship between scientific practitioners and local beneficiaries.

Ton Kla Learning Center is part of a major NGO network in a province in northern Thailand. The center comprises the first generation of local peoples from a non-elite peasant background to have college/university training in agricultural science. Two out of eight staff members (and occasionally a few interns) have obtained master's degrees in environmentally-related social science. The goals of the learning center, formerly an assemblage of local crop varieties conservation, are generally to promote local autonomy and specifically to enhance local crop diversity. In order to achieve these organizational goals, the main strategy is to enhance farmers' knowledge and resources. This study is specifically concerned with one of its on-going projects, funded by foreign donors, aiming at enhancing rice diversity at the community level. In many publications, the project is cited as a best practice in northern Thailand, for the reinvention of community rice diversity, the incorporation of both scientific and local knowledge, and the empowerment of local farmers, especially women, in rice diversity management.

The center has applied the FFS model in several villages in the province to foster farmers' conservation, development and utilization of rice plant genetic resources by following the project's field guide (BUCAP, 2002). The field guide specifies detailed implementation procedures, from site selection to baseline research, on the condition and management of biodiversity in the site, and the training of local farmers using participatory classroom learning and field experiments. Classroom learning is specifically designed to raise farmers' awareness of the loss and significance of rice diversity. Following this manual, the field staff asked farmers to compare current varieties with those that had existed in the past, i.e. more than 10 years ago, in terms of number and desirable characteristics. The shortfall between the current and the past were then highlighted as the problems of genetic deterioration. To address these problems, the staff introduced a series of field studies and experiments as in formal breeding institutions, including varietal evaluation, plant breeding, line selection, and seed rehabilitation. In practice, Ton Kla staff included some of these activities based on farmers' interests and potentials in a specific farm community. Along with these field activities, Ton kla center usually provided farmers with genetic materials.

In conveying the scientific package of rice diversity management, Ton Kla center heavily relies on the distinctions between modern and traditional rice varieties in both classroom learning and field studies. In classroom learning, modern varieties are pinpointed as replacing most traditional varieties. By doing so, Ton Kla staff can criticize modern varieties and at the same time, valorize traditional varieties as rare precious resources. In field studies, the staff designed most field experiments to demonstrate or confirm the outcomes that are already predicted, a soft technique to coerce farmers to believe or behave in some ways. To illustrate, one research topic in varietal evaluation—the comparative yield performance of traditional landraces vs. modern high-yield varieties under stressed and low-input condition—is intended to show that modern varieties are relatively more prone to pest and plant disease, and thereby more fertilizer-dependent. These types of messages, which have been repetitively conveyed to farmers, clearly depict modern varieties as engines of biodiversity loss and chemicaldependent agriculture, and simultaneously consider local varieties as saviors of biodiversity and sustainable agriculture.

Additionally, Ton Kla center has intentionally raised the global conflicts between scientists and farmers over plant genetic resources to point out the potential of local genetic resources and the importance of local autonomy in accessing and managing seeds. Ton Kla staff used this strategy to point out the significance of farmers maneuvering scientific techniques, i.e., plant breeding, line selection, and seed rehabilitation. They told farmers that without scientific knowledge and skills, the farm community is likely exploited and threatened by scientific invention and the seed industry. This view of Ton Kla center is, however, opposed by government breeders who are invited to join the project as rice experts. As expressed by rice scientists, this outlook is fairly overstated given the presence of government rice R&D and seed production. Yet, rice varietal selection and breeding techniques are too complicated farmers with no knowledge or background in genetics to comprehend. Therefore in the view of rice experts, these techniques are unnecessary for local farmers. Nevertheless, as long as the center facilitates their varietal trials in local communities, these rice experts seemingly have nothing to lose in providing their expertise and genetic materials per requested.

To appeal to the eyes of project donors, Ton Kla center has persisted with the most sophisticated but affordable techniques in plant breeding and line selection, indeed the most challenging but accessible science farmers have ever practiced. In farmer field schools, Ton Kla staff simplified breeding techniques by decoding the principle of genotype-phenotype into lay language, and applying a “ready” model of modern-traditional hybrid breeding. This breeding model is founded on a simple belief that modern and traditional varieties have their own merits. Modern rice varieties possess exceptional grain and eating characteristics; on the other hand, traditional varieties have superior resistance to environmental and pest/disease stresses. The field staff explained rice breeding as the re-combination of “small units” called genes inside these two types of varieties that are responsible for desirable traits. Specifically, by applying pollens from modern "father" varieties onto the flowers of local "mother" varieties, farmers can easily transfer genes that produce desirable grain and eating characteristics in modern varieties are transferable to farmers' traditional varieties. From a segregating population of artificial hybridization, Ton kla staff told farmers to perform a mass selection under a particular set of desired characteristics and plant in the following years the bulk samples until the seventh or eighth generations become readily stable. As stated by Ton kla director, through farmer breeding, farmers can conserve their inherited genetic resources and at the same time develop their "dream rice varieties". Farmers' new varieties would better satisfy their own needs and more readily adapt to local farm conditions, than varieties developed by formal rice breeders.

As an inspired example, Ton Kla staff often referred to the foremost farmer breeder and seed producer—*Hwan*, who invented a rice variety named after him, *Hwan1* by crossing a local variety—*Hawm Thung*, and a popular modern variety—*RD6*. This and his later varieties, *Hwan2* and *Hwan3*, have been widely distributed to neighboring and other communities in Ton Kla network. As the leader of Ton Kla center repeatedly said to me, no farmer would take any rice variety as private property. In fact, *Hwan*—the farmer breeder have enjoyed a lot of benefit by *de facto* monopolizing seed selling of his varieties in the niche market, given high demand, limited seed supply, and farmers' habit of buying commercial seeds. As I met this farmer breeder in 2008, he continued studying and crossing available varieties to release more rice varieties under his name, apart from selling commercial seed. He further planned to sell only foundation seed to other farm communities in Ton Kla network that producing commercial seed.

In every one-year project term, the center systematically reported information on these practices across different project sites to the donors. The director told me that the donors used this annual report to evaluate or revise the activities and ultimately to determine renewal of funding support. In the report, the stories of successful merging of scientific and local knowledge/resources and fruitful cooperation between scientists and farmers are presented along with inspired examples of best practices. Model farmers, preferably a female figure, are the ones who articulate their stories and learning experiences from the project. Photos of active participation in classrooms (with no walls) and field experiments with farmers' working on tables, charts or drawings usually serve as evidence of success. As far as the management of rice genetic resources is concerned, the promises of common property offered by farmers' varieties are emphasized over the private, intellectual property right regime.

Both personal and professional networks are additionally crucial for Ton Kla center in implementing the project. Personal acquaintance and interactions are key criteria in selecting project sites with high promise of success. Therefore, the project sites were initially in Ton Kla network of friends and relatives, and further expanded into the wider network of community leaders and government partners. Professional networks also provide sources of expertise and genetic materials that are lacking. From time to time, Ton Kla center invited rice scientists from universities and government rice breeding stations to give lectures and advice on field experiments as a way of verifying their scientific practices. These professional networks also supply the center with potential breeder lines (unreleased) and other traditional varieties stored in the genebank. Apart from these networks, Ton Kla center has created a network among project locations for the exchange of knowledge and genetic resources. In doing so, the center has assigned different specifications, i.e. rice breeding, seed production, and varietal testing, to each project site according to their highest potential and has facilitated exchange among them. For instance, breeder seeds of promising lines from one community were given to another community for trials or seed multiplication, and again distributed for testing in other nearby communities. To facilitate communication within the network, Ton Kla center organizes the annual meeting among farmer leaders in project sites to share lessons, experiences, and available genetic resources.

The reinvention of community rice diversity is not only linked to concerns about loss of local rice germplasm, but also strategized as a farmers' movement to counteract potential exploitation by modern rice breeders and seed industries through the intellectual property rights regime. As the case illustrates, Ton Kla staff have intentionally invoked scientific-indigenous politics as they communicated science to farmers. Such communication unnecessarily involved the imposed distinctions between modern and local varieties, their conflicting contributions to biodiversity and sustainable agriculture, and their conflicts of interest and technology in accessing and controlling seed supply. By positioning in the same side as the local community, Ton Kla center can win trust and respect from local peoples. Accumulated over time, this becomes the center's social capital used to influence farmers' decisions as well as to attract scientists and donors in their mediating service in community development. To the public and project donors, however, the center reported the relationship between scientific and indigenous peoples and knowledge as productive. The project report clearly described how both scientists and farmers share common values and how their distinctive knowledge and resources complement each other in efforts to achieve on-farm rice diversity and sustainable agriculture.

"Scientized" Knowledge

Equally significant questions to knowledge transfer issues are how and to what extent knowledge of local peoples changes following the implementation of participatory schemes. Following theorists in the diffusion of innovation (Rogers, 2003; Wejnert, 2002), the adoption of science and technology is largely determined by the characteristics of innovations, the attributes of adopters or local innovators, and the contexts of adoption that determine the compatibility between the two. Discovery-based learning and experimentation provided in the FFS model can lead to the creation of appropriate practices and technology in local contexts. Similarly in PVS or PPB, farmers select plant varieties or genetic materials based on their interests in plant varieties (D. A. Cleveland et al., 2000) and their perception about modern compared with local varieties (Sall et al., 2000). Differences among farmers' choices of varieties and farm conditions can lead to crop diversity at the local level. Adopted knowledge and resources by a group of farmers will naturally spillover to other farmers throughout the community network (Röling & van de Fliert, 1994, 1998).

According to evaluation studies of participatory projects (Koggel, 2008; Winarto, 2002), farmers' adoption of science and technology varies as much among different communities as among individuals. Not to mention factors on the facilitator side, variations across participatory sites are mostly explained by cultural factors underlying farmers' learning and adoption processes. These cultural issues are viewed both as barriers for communication to local peoples and thus also for adoption of science-based knowledge and practices as founded in different institutional and cultural contexts (Ellis, 2005; Martin, 2003). However, simultaneously these cultural issues are viewed as opportunities to influence collective learning and practice (Palis, 2006). Variations among individual farmers are also observed within the same FFS site, where the adoption appears sustained only in specific groups (Winarto, 2007). This finding has led to questions with regard to the validity of the farmer-to-farmer spillover assumption (Feder et al., 2004; Tripp et al., 2005), and possible modification of the assumption to account for temporal effects and spatial interactions among neighboring farmers (Yamazaki & Resosudarmo, 2008). Moreover, the adoption of scientific practices is as equally political as technical. In pursuit of their own interest, local peoples may adopt scientific packages in order to benefit from the facilitator's or NGOs' linkages to larger systems of knowledge, information, and other resources (Austin & Eder, 2007). These political motivations may influence the adoption and the spillover of scientific practices and resources, but are rarely the focus of available FFS studies.

Even without these technical and political barriers, discovery-based learning may not result in sustainable practices or appropriate technology, as presumed in participatory learning and training. Given the power imbalance between science and indigenous knowledge, farmers' adoption usually involves rejecting or transforming their traditional knowledge and values into scientific or modern ways of thinking (Ellis, 2005). Similarly, the adoption of new plant varieties or scientific breeding technology by local farmers does not necessarily lead to the increase or the sustainability of on-farm crop diversity. There are also the dynamics of natural and human selection in varietal and seed replacement in farm communities to consider (Rice et al., 1998).

Recent farmers' practices regarding crop diversity and breeding represents another "deviant" form of knowledge, which I call "scientized" knowledge. This type of knowledge deviation signifies the central role of farmers in scientizing their knowledge, i.e. learning and adopting science and technology. I thus examine the practices of "scientized" knowledge from the farmer's perspective, rather than from the diffusion viewpoint. The case of Ban Nam Cham, a project site for community rice diversity conservation and development in northern Thailand, illustrates how farmers perceive and adopt scientific knowledge and resources.

Ban Nam Cham is a modern farm community located 10-km from the town center of the province. This community has long been recognized for its strong community network and organization with several locally-initiated projects supported by local government funds. In 2003, the community rice diversity project started a farmer field school (FFS) in the community, at the request of a community leader who learned about the project in other locations. Before the advent of the project, most traditional rice varieties had already been replaced with *RD6*—so far the best-quality glutinous rice, and increasingly with *RD10*—an early-maturity rice of lower quality, where the availability of water is limited. To maintain optimal performance of these varieties, Ban Nam Cham farmers purchase seeds annually or every other year from trusted sources, i.e. government seed producers. This seed turnover rate in Ban Nam Cham is high for subsistence rice production, compared to the average 2-3 years in other villages in the province.

When FFS was first organized in Ban Nam Cham, the leaders of the village carried out the selection of participants. After the initial village-wide call for interested farmers, at that time only a few individuals were interested in and able to commit to FFS over the entire rice cultivating season. Given the low number of active participants, the leaders pursued a second plan to include their relatives and friends. As I asked these participants about their reasons for joining the project, the very first response I got was that they simply wanted to "help" their relatives/friends by devoting some of their limited time to FFS. In the end, the participants in the FFS are mostly community leaders and their network of relatives and friends.

As with other project locations, the transfer of scientific knowledge of rice diversity to farmers depended on two conceptual establishments: the distinction between modern and traditional rice varieties, and the conflicts between modern seed industries and local farmers. However, these two propositions appear not to align with existing knowledge and practices in Ban Nam Cham. First, modern varieties seem more valuable to Ban Nam Cham farmers than traditional ones. According to Ban Nam Cham farmers, the outdated "old" varieties were decisively replaced by the improved "new" ones. Participating farmers thus expressed no concern about the loss of traditional varieties. However, they perceived value in rice diversity as genetic materials, as they witnessed the different characteristics of modern and local varieties in the variety evaluation study. Given this deficit in farmers' perception, rice diversity is generally articulated as provision of alternatives for current use and future development, while conservation of rice diversity is simply ignored. As stated by some farmers, conservation is essentially not the task of farmers but of the government genebank. Yet, as was the case before the introduction of new rice varieties by the variety evaluation study, the participants adopt the same variety, the one which is considered the best based on the performance in their fields and the availability of seed from trusted sources. As elaborated by a farmer, who once picked out and experimented with one variety from several others in the community plot, he decided not to adopt the variety after all, despite its desirable performance, because of the difficulty in producing seeds for all of his farms. In the fifth year of the project, the on-going variety evaluation study in Ban Nam Cham actually became a "passive" learning platform for local farmers, but remained an "active" project showcase for NGOs and local trial plot for government rice breeders to experiment their unreleased lines.

Second, there are no such things as local genetic resource or local seed autonomy to be exploited or threatened in Ban Nam Cham. This fact completely nullifies the second proposition on the struggle between biotechnologists or seed industries and farmers. Therefore, this proposition failed to convince most participating farmers to adopt scientific knowledge and practices as obtained during FFS. Since rice is a self-pollinated crop, the breeding of rice is very intricate for farmers, and even the least-complicated seed rehabilitation is considered overly labor/time-consuming. Like other farmers in Ban Nam Cham, most participants opt to buy seed for convenience. However, seed rehabilitation has appealed to farmer leaders, who then established the community seed production initiative.

Community-based seed production appears the most concrete outcome of the project in Ban Nam Cham. In fact, this activity initiated by NGOs and the leading group of farmers, involves producing qualified seeds for sale to farmers at lower than the market price. In recent years, the FFS topics in Ban Nam Cham have therefore been geared toward skills and standardized procedures necessary for commercial seed production. With this specialized knowledge, these farmers have successfully formed a network of community seed producers, which can enable them to make more profits from selling seeds than selling grains, even at such a low price. Furthermore, these leading farmers have utilized their strong ties to local government to gain funding and credit support in obtaining foundation seed from the government rice research center. With highly purified foundation seed to compensate for inefficient production, the price and quality of community seeds is quite competitive with other seed producers in the market. Yet, the personal relationship between community producers and buyers raises the demand for community seeds. As a result, community seed production is fairly a lucrative business, not to mention the fact that there is insufficient supply to meet farmers' demand.

However, not many farmers are interested in seed production, partly because they have limited land for rice cultivation. A farmer told me that he preferred not to deal with such difficult seed production tasks. Yet, if he did, he had to buy rice to eat. Given limited number of seed producers, community seed production has so far produced only seeds of the popular *RD6* and *RD10* that are also available in the market, despite an opportunity to exploit the niche market of new varieties. These new rice varieties from government rice stations or farmer breeders were frequently made available to them through the project network.

Another on-going activity resulting from the project is community rice breeding, although few individuals have actually carried out the breeding tasks after the first-year FFS. Though guided by the model of modern-traditional hybrid, the so-called community farmer breeding in Ban Nam Cham has significantly deviated from the breeders' norms in plant breeding. Given limited knowledge and availability of genetic materials, the identification of "father" and "mother" varieties by farmers themselves is undoubtedly restricted. Specifically, farmers chose to combine varieties that are already "good" in the farmers' sense, rather than those with "strong" characteristics. For instance, aiming for a better-grain, higher-yield and early-maturing rice, participants picked as potential parents two "good" modern relatives of short-duration, *RD10* with relatively better grain characteristics and *SPT1* with relatively higher yield and resistance. Selection of parents with little genetic variations can generate a low productive rice population from which farmers can select, resulting in breeding inefficiency. At the time of my fieldwork, there were no promising achievements, but unstable breeding lines (the fourth generations) had been planted in the breeders' individual farms. One farmer breeder admitted that available breeding lines may not be as competitive as existing modern varieties. But he would just have to keep doing things for the next four years until the eight generations of lines eventually became stable. Inspired by the case of *Hwan*, the first farmer breeder in the province, he expected to obtain a potential variety that could be sold or at least make him renown to reward his lengthy endeavor.

The case of Ban Nam Cham reveals farmers' selective adoption of scientific package. Most farmers realized the importance of rice diversity but were prevented by high-level skill and knowledge in utilizing these rice genetic resources. Local participant selection process has made such sophisticated knowledge package accessible just for the leading group of farmers who called on the project in the village. As a result, these leading farmers have effectively monopolized seed production, which turns out to be a legitimate way to extract resources from other community residents. Ironically, whereas the so-called community seed production initiative is highly subsidized by local government and the project, most farmers in Ban Nam Cham are persistently drawn to seed dependence and are little better off buying seeds from community or previous sources. Given the heterogeneity of Ban Nam Cham, the selective adoption of scientific knowledge and practices has undoubtedly reinforced existing power relations among the various social groups within the community.

"Hybridized" Knowledge

According to constructivist theory, new knowledge and technology are not simply adopted but translated or assimilated into local systems of knowing and doing. This knowledge translation model highlights the translator's perception with regard to the context to which the translation applies (Johnson & Hagstrom, 2005; Kelsey, 2003). This hybridization of knowledge has resulted not only in promising (Bentley, 2006; Johan Iskandar & Ellen, 2007) but also "perverse" incentives and practices (Guivant, 2003). This line of studies believes that formal scientific learning and training through such a participatory platform as FFS can enable a fruitful combination between scientific and local knowledge systems in sustainable agriculture and development (Pretty, 1995). The translation model is specifically applicable where local cultures are still dominant.

Empirical studies on recent practices of knowledge hybridization at the local level have revealed deliberate attempts to construct hybrid cultures to their cultural advantage, instead of spontaneous combinations of different ideologies and social practices (Hill, 1995). For example, Stolle-McAllister (2004) reveals the construction of a contingent hybridity by local social activists, which reflects their deliberate efforts to negotiate between global and local discourses in order to maintain some level of local control over both ideological and material resources. Dove et al. (2007) also demonstrate the hybridization of knowledge systems as strategic efforts of marginalized groups who employ positive images of their indigeneity to their own advantage. Similar attempts may also be observed in crop hybridization. For instance, the articulation of the sources of germplasm and the end-product of hybrid modern-local varieties reflects political struggles under the intellectual property rights regime (McGuire et al., 1999).

These deliberate hybridization attempts suggest a need for an additional perspective to understand political conflicts and negotiations at the discourse level, specifically between scientific and indigenous knowledge and genetic resources. Cultural theorists have long developed the concept of hybridity to capture recent combinations of cultural and/or institutional forms that are otherwise suppressed into dichotomies (Nederveen Pieterse, 1998). In their view, hybridity is by no means politically neutral, involving the use of cultural identity to render "conceptually and normatively indefensible the political claims of culture (Kompridis, 2005, p. 318)." Hybrid forms of knowledge as well as genetic resources are determined by the relative power and status of dualistic elements in particular contexts. Cultural hybridity thus needs to be understood in terms of: i) the nature of adoption, i.e. transformative vs. contextual, ii) the intensity of hybridization, and iii) the gravitational center of the hybrid form (Frank & Stollberg, 2004).

Combining the constructivist and cultural theories, I seek to explore both political claims and motivations underlying deliberate attempts to construct hybrid knowledge and genetic resources, which in this chapter are referred to as "hybridized" knowledge. The case of an indigenous farm community in northern Thailand elaborates the incorporation of scientific packages into existing systems of understanding and managing rice diversity and genetic resources. Specific questions are how local peoples perceive and strategize power attached to their identity and non-identity in order to pursue their interest in rice diversity and genetic resources.

Ban Don Mun is an indigenous farm community where the project's FFS has been carried out since 2000. The implementation of this project in the community followed the training of a (currently former) village leader and progressive farmer at the International Rice Research Institute during the initial project phase. Based on preliminary studies of local plant diversity at the province level, this village was identified as a project site due to its potential in on-farm conservation. Prior to the project, Ban Don Mun had consistently maintained several varieties of glutinous rice in the community, including the popular *RD10* and *SPT1*. All of these varieties were early maturing rice as preferred by Ban Don Mun farmers who after rice harvesting rely on second crops for monetary income. In regard to seed management practices, farmers have long managed to select and store seeds for their own cultivation and thus rarely obtain seeds from the market. Individual seed management was prominent, although some farmers reported that varietal performance is relatively more difficult to maintain in modern varieties than traditional ones. In dealing with this problem of declining performance, Ban Don Mun has developed an exchange network in rotating (the same) varieties over different soils. The method was practically proven to be able to regain the average performance of modern varieties.

The community-based management of rice diversity and genetic resources in Ban Don Mun is usually cited as best practice in northern Thailand. However, the so-called community initiatives appear restricted only to progressive participants, which have continually decreased in number since the start of the project. First-year FFS activities were operated by a group of ten participating farmers, only four of which have actively been involved in current activities. New community activities include the conservation of rice in a community plot, which was also used for varietal evaluation studies. Since the start of the project, field practices have been ongoing with at least 44 collections of traditional landraces, modern rice varieties, and potential breeder lines.

Among all lessons in FFS, participating farmers expressed no interest in scientific seed selection and rehabilitation practices, because they already know and do similar ones in seed management. On the contrary, these farmers were interested in and paid special attention to rice breeding that was regarded as "scientific". Community rice breeding practices have been set to achieve "dream rice varieties" that are as good as the popular *RD10* in terms of early maturity and grain quality and that produce a lot of straw, which will be used in subsequent cash crop farming. Under the project's guidelines, participating farmers made crosses between *RD10* and two traditional varieties—*Daw Mah Lae* and *Daw I-San*, and selected some promising lines out of their segregating populations, according to pre-defined sets of desired traits.

Beyond the project's guidelines, these community practices, however, deviated from formal scientific practices. After the first-year FFS, these progressive farmers came up with several other crosses, most of which are no longer a hybridization of local and modern varieties, including *RD6*/*RD10* and *SPT1*/*RD10*. Their parental choices reflect a deviation from the breeders' norm in achieving genetic variability, and also an assumption on the part of typical farmers that two good varieties give promising progenies. Additionally, the selection of potential lines, even with a nearly stable population, was based rather on intuitive observation than precise statistical measurement of performance, as in formal breeding practices.

In fact, the claiming of these deviated practices as science has provided these farmers with a kind of benefit that seems unrelated to the knowledge and practices themselves, but rather to the perception of "science" and its practitioners. These progressive farmers, as students of real scientist experts, have become widely recognized among village residents as farmer experts. Female participants, who perform such masculine roles as rice farmers and breeders, reported a significant improvement of her status in the community. One of them repetitively expressed greater self-esteem, when male villagers started seeking her advice about rice farming and the like. The new status attached to knowledge possession does, however, conflict with the persisting gender role in the community. This female farmer and breeder still perceives agricultural expertise as a masculine property, stating that she inherits her curiosity and observation skills from her father, who is renowned for discovering a red fragrant rice, once widely planted in Ban Don Mun.

These community-based practices have been conveyed to other farmers as serving the interest of the community, while the real motivations underlying their practices seemingly involve the interest of this progressive farmer group. The community plot, where a variety evaluation is carried out to search for potential genetic materials, has been portrayed as community rice conservation. Furthermore, recent operation of this community plot as a Saturday class, aiming to educate high-school students about rice diversity and farming practices, has provided the group with free labor in planting the vast collection of rice varieties. Similarly, the development of Ban Don Mun's "dream rice varieties" is actually an opportunity to own and sell seed of new rice varieties that suit the needs and farm conditions in the community. But, in the seventh year of the breeding practices, these progressive farmers realized that this opportunity may not be realistic. While these farmers feel pride and dignity in performing these challenging scientific tasks, the progress of their rice breeding is slow and inefficient. At the time of my fieldwork—seven years after the start of community rice breeding, the farmer breeders are able to identify only one promising line that was yet stable. Additionally, the promise of selling new varieties has been shaken due to failure to control their varietal product. Potential lines, though unstable, have already been released as a new variety in Ban Don Mun through the network of relatives and friends, and moreover, in other communities though the project network. Given their social obligations to their own community and to the project staff, these farmer breeders have no other choice but to share their varieties as being demanded. A farmer breeder told me that she was unwilling to give them out, because this could mean less chance of selling them as seeds to other farmers either inside or outside the community. Despite this minimal chance for monetary benefit, these progressive farmers have still committed their labor and time to these community activities.

In a farming culture like Ban Don Mun, it seems that the (re)claims over rice genetic resources are possible only through the system of variety (re)naming. Failure to provide systematic account of varietal characteristics and performance makes it impossible for these progressive farmers, unlike for scientific rice breeders, to claim ownership of their newly-developed varieties through the plant variety protection law. The desire to claim ownership reflects in their plan on employing the system of naming used in formal breeding institutions—the breeder plus the serial number of release, i.e., *Don Mun1*, *Don Mun2* and *Don Mun3*. Different naming systems are used if they were not concerned with claiming ownership. For instance, *Sakon Nakhon*—a modern variety from northeastern Thailand that is prevalent in Ban Don Mun is renamed to *Hawm Sakon*, acknowledging its aromatic trait, as well as its original name. Nevertheless, the ownership of rice varieties has nothing to do with farmers' adoption of rice varieties. Farmers choose rice varieties mainly based on their performance not on the distinction of whether or not it belongs to the community or whether it is a traditional or modern variety. After all, *Don Mun* varieties may not be continued in the community. Yet, these varieties can be reclaimed through farmers' system of renaming in other communities that happen to like the varieties, as in the case of *Hawm Sakon* shows.

Despite being a separate entity at the beginning, these community-based practices have eventually been integrated into the entire fabric of community rice genetic resource management. Community rice conservation started to provide Ban Don Mun with new varieties and reserves of traditional rice varieties, which farmers can readily access or retrieve as whenever they needed. Most farmers, who by nature are eager to try new varieties, have never before been able to access such a large pool of information and genetic resources. As a result, the varietal turnover rate in Ban Don Mun has become exceptionally high, as farmers continuously experiment with new varieties in their farms and return to the old varieties, if the new ones do not perform well. When I visited the community again in the following year, a new variety from a neighboring community had been widely planted instead of previously popular varieties.

The introduction of scientific knowledge and practices to Ban Don Mun has altered existing social and political relationships within the community. The new conception of rice diversity and genetic resource management has been translated into the interest of a group of progressive farmers, who consequently become actively involved in community-based conservation and breeding practices. Specifically, these progressive farmers have the potential to realize several opportunities as offered by scientific knowledge and practices. While pursuing these opportunities, they have strategically utilized the discourses of "science" as well as "community" to obtain high respect and social status in the community from conservation and breeding practices. However, given these new social relations and obligations, these farmers have unavoidably struggled to enjoy some benefits from their practices, and have even been exploited by other community residents for their endeavors.

Table 2-2: Four "deviant" forms of knowledge in the management of rice genetic resources

Nature of Community	Northern Rice Research Center—a government rice research station, focusing on glutinous rice breeding	Ton Kla Learning Center—an NGO with an extensive provincial network, strengthening local autonomy and crop diversity	Ban Nam Cham—a modern farm village, planting glutinous rice for consumption	Ban Don Mun—an indigenous farm village, planting glutinous rice for consumption
Conventional Practices	Rice breeding for wide adaptation, along with *ex situ* collection of rice genetic resources and centralized seed production	Farmers' empowerment through scientization of local knowledge and practice and reification of sacred local genetic resources	Rice farming relying on a few modern rice varieties that are annually purchased from only entrusted seed producers	Rice farming relying on several rice varieties that are collectively maintained and exchanged within the network of relatives
	"Participatory" science	**"Localized" science**	**"Scientized" knowledge**	**"Hybridized" knowledge**
Recent "deviant" practices	Rice breeding practices in the rain-fed program are geared toward specific adaptation to diverse farm environments at the local level. Emphases are placed on *in situ* conservation and decentralized seed production.	Empowerment by incorporating scientific knowledge and genetic resources into local practice and farm conditions through farmer field schools or participatory learning and training.	Community-based seed production is carried out by a leading group of farmers. Varietal studies and breeding are marginal. Rice farming still relies on the same rice varieties now available from local seed producers.	Community-based rice varietal studies, conservation and farmer breeding serve as sources of new rice varieties that are integrated into the existing network of varietal maintenance and exchange in rice farming.
Political explanation	Participatory plant breeding is in fact an effort to corroborate potential breeder lines based on farmers' preference and performance in specific localities. This scheme has also opened up new possibilities in rice varietal	Hidden under the language of the cooperative and synergistic relationships between scientists and local farmers as it seeks to facilitate, the localization of science by this NGO is no less political. To foster the	Selective adoption of scientific knowledge and techniques is meant for political ends of an elite group in the community. For them, community seed production is not only a lucrative business drawn upon personal trust with other	This hybridization of scientific and local knowledge occurs amidst the existing fabric of collective management of rice genetic resources. The "community" components run by a group of progressive farmers produce several

	development. Farmers' knowledge is treated equally as another scientific process; however, the outcome seems at odds with the purposes. In implementing this participatory scheme, government rice breeders have no other choice but to cooperate with local NGOs, which brings them free-trial opportunities as well as free-service burdens.	adoption of scientific knowledge and practices, this NGO infuses farmers with the language of conflict between scientists and local farmers as well as between modern and traditional varieties. Entrusted by local farmers, this NGO further accumulates social capital as the facilitator of community-based projects.	residents, but also a "community" initiative, which successfully draws external support from rice experts, the local NGO and the local government, in terms of informational, genetic and financial resources, respectively.	"public goods", at the same time obscure their self-motivated benefit. Paradoxically, while attaining such a high social status as "farmer experts", these progressive farmers are socially obligated to carry out the tasks that force them into the continuing process of exploitation by other residents.

De-contextualized Knowledge, Situated Politics: The New Scientific-Indigenous Politics of Genetic Resources

Using the case studies in northern Thailand, the previous section examined four "deviant" forms of scientific-indigenous knowledge in the management of rice diversity and genetic resources. The findings are summarized in Table 2-2. Recent practices of knowledge inclusion in Thailand demonstrate new political practices regarding biodiversity and genetic resource management. As the case studies show, by including the other party's knowledge, both scientific and indigenous knowledge practitioners gain political advantage from knowledge inclusion itself, not from the outcome of knowledge formulation and utilization. In contrast to claims of knowledge practitioners and assumptions in scholarly literature, the incorporation of scientific and indigenous knowledge does not lead to more efficiency, more democracy or more sustainability in genetic resource management.

On both sides of knowledge inclusion, the superiority of scientific over indigenous knowledge has resulted in substantive and practical control over farmers' management of rice diversity and genetic resources. Substantively, the dominance of science is evident in how rice diversity is conserved and how these genetic resources are utilized. As the case studies show, both the incorporation of farmers' knowledge by rice breeders and the inclusion of scientific knowledge by indigenous farmers more or less result in the same practice in the scientific perspective of conservation and development. Therefore, scientific practitioners can exert an indirect, moral control over farmers' management of resources.

Practically, the manifestation of the expert/patron-client relationship, rather than the partnership in knowledge inclusion, has given the practitioners of science authoritative power to force farmers into certain practices that are less likely to benefit farmers. Under this scientific domination, local farmers have persisted in ineffective "*in situ*" rice conservation and development of rice diversity and genetic resources through scientific rice breeding. By adopting the "*in situ*" conservation, these farmers have foregone several opportunities for utilizing “on-farm” diversity to manage consumption preferences, farm labor, and environmental risks. Yet, given the community resource and institutional constraints, farmer breeders cannot fully exploit the potentials of rice breeding under environmentally variable conditions in the locality. After all, the real beneficiaries from farmers’ conservation and breeding practices appear to be government rice breeders and NGOs, who achieve their agendas in R&D and empowerment, respectively.

Knowledge inclusion also involves political practices among communities on the same side. Despite the scientized vs. localized ideological conflicts, government rice breeders and NGOs are drawn into a cooperative, exchange situation, where their respective technical and facilitating expertise are both required to pursue their political agendas. In return, both actors have reluctantly compromised the scope and design of participatory farmers’ activities. Similar tensions are present among farm communities with different specializations, i.e. varietal evaluation, seed multiplication, and rice breeding, as they are mutually obligated to commit to the project’s network of information and resource exchange. Under the expert/patron-client relationship, this social obligation unintentionally fosters exploitation among these communities with unequal potentials and resources. Farmer breeders in a community are mostly exploited by other farmers, and especially by farmer seed producers in other communities.

Moreover, political struggles occur within the same scientific or indigenous community. The incorporation of farmers’ knowledge has brought out paradoxical conflicts in the government R&D community. In departure from the irrigated rice program, the rain-fed rice program has launched participatory variety selection as a new breeding strategy that emphasizes local adaptation in order to enhance on-farm rice diversity. However, this account of farmers’ preferences and decisions has, instead, resulted in the increase of farmers’ adoption of wide-adaptation varieties from the irrigated laboratory, thereby fostering the culture of rice uniformity. Likewise, the incorporation of scientific knowledge and practices has diverted social and/or monetary resources to new practitioners of science; the majority of them are elite farmers with a great deal of resources and time. These elite farmers have enjoyed benefit both from the farmer expert status and from scientific practices in rice breeding and seed production. However, in a community where local knowledge and practices are still prominent, such elite group's effort in conservation and development is likely exploited by the whole community through existing institutions of sharing and exchange in rice genetic resource management.

Table 2-3: Ramifications of the scientific-indigenous politics of genetic resources

Political arenas	**New scientific-indigenous politics of genetic resources**	
	Scientific-indigenous politics	**Genetic resource politics**
Between scientific and indigenous communities	On-farm or local rice diversity is an invaluable resource and should be conserved or managed effectively through scientific account and practices.	Scientific practitioners can control morally the direction of on-farm genetic resource management through scientific knowledge and practices.
	Practitioners of science are entrusted to provide expertise and resources to serve the interest of their local clients.	Experts or patrons can exercise their authoritative power on their clients in resource management to their benefit.
Among different scientific communities	Scientific management of rice diversity is discursively formulated to accommodate conflicting interests.	Tension can occur within the cooperative practices in the management of genetic resources.
Among different indigenous communities	As clients, farm communities in the project network feel mutually obligated to conform to knowledge and advices that their patron scientific practitioners provide.	Exploitation of genetic resources among local farm communities can be facilitated by the power of external social actors, who differ in their interests.
Within the same scientific community	Farmers' preference and knowledge provide legitimacy to decision making and practices in the scientific community.	Farmers' input can influence the formation of scientific knowledge and the outcome in unintended directions.
Within the same indigenous community	Science is crucially effective in local genetic resource management, and thus, its local practitioners are respected and entrusted to carry out the task.	Science can provide its local practitioners opportunities to exploit genetic resources, as well as to be exploited through existing local institutions.

The case studies show that recent practices of knowledge inclusion, not only fail to diminish the scientific-indigenous politics, but also create a new space of contestations over rice diversity and genetic resources. These contestations are not only manifest in the conventional political arena between scientists and indigenous peoples, but in other political arenas as well. Table 2-3 summarizes the findings of the new scientific-indigenous politics across case studies on rice diversity and resource management according to each political arena. These findings suggest at least two theoretical contributions, central to the study of the scientific-indigenous politics in biodiversity and genetic resource management.

First, I argue that recent politics of scientific-indigenous knowledge should be considered as de-contextualized rather than situated knowledge. As found in this study, both scientific and indigenous knowledge have recently been abstracted from their institutional contexts preparatory to utilization. The process of abstraction indicates the utility of de-contextualized knowledge. Fragmentary knowledge from a system is deliberately reinserted into another knowledge system for the advantage of the scientific-indigenous discourses on biodiversity and genetic resource management. In the discourses, indigenous knowledge and genetic resources are crucial components for sustainable and equitable development, while scientific knowledge and technologies are entrusted to drive development tasks. The new politics of scientific and indigenous knowledge is therefore founded on the distinctive images of the scientific and the indigenous regarding the issues of biodiversity and genetic resources. This scientific-indigenous politics of genetic resources advances the old model of appropriation, i.e. through the so-called scientization or indigenization.

This argument of de-contextualized knowledge lends support to the second claim regarding the ramifications of scientific-indigenous politics that extend beyond the conventional political arena, i.e. between scientific and indigenous communities. According to Table 2-3, the new politics of de-contextualized knowledge is however situated in various political arenas in biodiversity and genetic resource management. Scientific as well as indigenous peoples have obtained and utilized power, attached to scientific-indigenous knowledge they incorporate, to access and control over genetic resources as applicable in their contexts. As de-contextualized knowledge is put into political action, the discursive power of such knowledge is determined within the existing institutions and power relationships in particular contexts.

The same scientific-indigenous politics has therefore led to variations in terms of rice genetic resource politics across political arenas. Between scientific and indigenous communities, the inclusion of the other party's knowledge results in advancing existing politics of direct exploitation to moral and authoritative control over biodiversity and genetic resource management. Among different communities of the same side, there exist continuing tensions in knowledge incorporation that appear on the surface to foster cooperation but in fact reveal contestations over biodiversity and genetic resource management. Inside both scientific and indigenous communities, the introduction of the other side's knowledge additionally reinforces the hidden, asymmetrical power relationships that exist in most heterogeneous communities. Differences in existing socio-political relations and institutions among political arenas influence access and adoption (or translation) of external knowledge and genetic resources in the first place, and determine the direction of knowledge and resource appropriation in the end.

Conclusion

The integration between scientific and indigenous knowledge has recently been promoted as a more effective, democratic, and sustainable approach in biodiversity and genetic resource management. Many scholars also believe that knowledge inclusion can address the politics of genetic resources between scientific and indigenous communities. However, evidence of recent knowledge inclusion practices in managing rice diversity and genetic resources in Thailand shows otherwise. This chapter has demonstrated that various types of knowledge inclusion, "participatory" science, "localized" science, "scientized" knowledge, and "hybridized" knowledge, are in fact political practices in biodiversity and genetic resource management.

Government rice breeders, NGOs, and local farmers have selectively incorporated elements of each other's knowledge as political strategies to serve their own particular goals. This selective incorporation of knowledge has opened up a new space of political contestations that transcends the institutional domains of scientific and indigenous knowledge. The adoption of scientific knowledge in indigenous communities not only reinforces the hidden, asymmetrical power relationships among community members, but also exposes them to greater control by scientific practitioners over biodiversity and genetic resource management. Similarly, the incorporation of indigenous knowledge into scientific methodologies is fraught with tensions among scientific practitioners.

These findings suggest a need to re-conceptualize the new scientific-indigenous politics as a synthesis between de-contextualized knowledge and a situated politics of biodiversity and genetic resource management. Specifically, this new politics involves abstracting scientific and indigenous knowledge from their institutional contexts, and then re-inserting fragmentary knowledge into another system. On the one hand, the process of abstraction indicates the utility of de-contextualized knowledge. Practitioners of scientific and indigenous knowledge draw on the foundational distinctions between scientific and indigenous knowledge to obtain power attached to their respective contributions to biodiversity and genetic resource management. The process of knowledge re-insertion, on the other hand, is determined within an existing social and political context. Having explored the interplay between the power-knowledge relationship and the power-structural context in which genetic resource management takes place, this chapter furthers our understanding of the recent scientific-indigenous politics of biodiversity and genetic resources.

CHAPTER 3
CONFORMITY YET DIVERGENCE

Conformity to intellectual property rights and biodiversity-related schemes is generally believed to result in more equitable access and sustainable use of plant genetic resources. However, evidence of local conservation and development practices in Thai rice farming and breeding communities, despite conformity in implementation, suggests divergence from the goals in the management of rice genetic resources. This chapter closely examines how rice farmers and breeders respond to both regulatory and policy advisory frameworks in Thailand's rice genetic resource management, i.e. the plant varieties protection law and the plant diversity promotion policy, respectively. This study finds that such divergence from sustainability and equity has stemmed from the reconsideration of local institutional factors within new global political spaces, rather than simply from institutional incompatibility or political resistance. The finding draws attention to the mutual role of institutional and political processes in shaping local practices and policy outcome, thereby demanding new perspectives in policy studies and design.

Intellectual Property Rights, Biodiversity-Related Proposals, and the Management of Plant Genetic Resources

Plant genetic resources (PGRs) for food and agriculture are increasingly recognized as significant in overcoming challenges in production constraints posed by other natural resources, as well as pressures on food security and economic demand. While the advent of biotechnology has advanced the possibility in utilizing PGRs, the richness of the resources, assessed in terms of plant diversity, has decreased significantly. The decline in plant genetic diversity has not only occurred as a result of continuous urban encroachment on natural habitats and agricultural land, but also within the cultivated areas themselves (FAO, 1998). Farmers have opted for genetically uniform cultivars improved by modern plant breeders and simultaneously destroyed their own genetically diverse pool of genetic resources (Byerlee, 1996; Tripp & van der Heide, 1996). These on-farm plant genetic resources constitute the evolutionarily dynamic population on which plant breeders rely to develop new plant varieties to tackle the development of new strains of pest and disease (Erwin, 1991; Simpson & Sedjo, 1998). Greater advancements in plant development without conservation effort can in return hinder further development of new plant varieties and thereby potential societal benefits (Goeschl & Swanson, 2002). Furthermore, whereas plant breeders and farmers have enjoyed the benefit of current plant development, minority farmers, given their ecologically diverse farm conditions, have been marginalized from such benefits and have continued to rely on their diverse pool of local plant varieties (Merson, 2000). Despite the potential value of these genetically diverse resources on these marginal farms, the conservation of PGRs by these farmers has rarely been compensated (Fowler et al., 2001; Gepts, 2004). These situations have posed major challenges and dilemmas for policy makers with regard to sustainability and equity in the management of PGRs.

In PGR management, policy development has been shaped by multiple international regulatory conventions, as concerned with resource conservation and/or development (Lettington, 2001). The Convention on Biological Diversity (CBD), for instance, aims at promoting conservation and sustainable utilization of biological resources with fair and equitable access and benefit sharing (Article 2), assigning the rights over natural biological resources to the country or the community of their origin (Article 15). The agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs), a multilateral agreement under the World Trade Organization, aims at promoting technological innovation and transfer (Article 7) through protection of intellectual property rights (IPRs) in essentially derived plants. The TRIPs agreement signifies an "effective" sui generis system as the minimum requirement for such protection (see Article 27.3 [b]), which commonly refers to the International Union for the Protection of New Varieties of Plants (UPOV) guidelines that emphasize the recognition of Breeders' Rights and Farmers' Rights.

Despite their distinctive focuses, these regulatory frameworks are found to have overlapping, non-hierarchical, and especially conflicting norms and regulations with regard to PGR conservation and development (Raustiala & Victor, 2004). At the national level, these inconsistencies have usually undergone negotiation and legalization during policy formulation, and have thus resulted in board rules that allow for multiple interpretations (Rosendal, 2001). The compromise of norms and regulations, especially from CBD and TRIPs, is evident in the formulation of regulatory and policy advisory frameworks aimed at facilitating both conservation and utilization of PGRs (Dutfield, 1999). For instance, the IPRs regulatory system, originally aimed at supporting biological invention, has further been employed to promote biodiversity conservation through establishment of the access and benefit sharing (ABS) scheme—a mechanism of benefit distribution to reward genetic resource conservation—in most developing countries (Chakravarty et al., 2008; Utkarsh et al., 1999; Zerbe, 2005). On the other side, the implementation of the CBD proposals, though limited in scope, has been integrated with the board sustainable development goal. As stated in CBD, the importance of biodiversity and the recognition of indigenous PGRs and knowledge have served as a policy advisory framework in alignment with the objectives of government and non-government organizations (Frisvold & Condon, 1998; Jarvis et al., 2004). These strategic objectives have been translated into specific development projects, including participatory learning-based conservation projects (Rijal et al., 2000) and participatory plant improvement efforts (Maurya et al., 1988; Witcombe et al., 1996).

These (international) regime interactions have raised potential problems in both regulatory and advisory frameworks in PGR management at the national level. These problems are evident in two distinct lines of existing research on PGR management. Based on institutional theory, the first line of research pays attention to the problem of institutional compatibility. Institutional scholars have highlighted several policy incompatibilities between policy and local institutions in PGR conservation and development. Although considered necessary to protect scientific products derived from biological resources and distribute benefits fairly to local communities (Bhat, 1996), the use of the private IPRs system to protect indigenous PGRs can conflict with local institutions in PGR management (Dennis et al., 2007; Dutfield, 2000) and undermine the social and cultural structure of the local community (King & Eyzaguirre, 1999). In addressing this problem, these scholars have argued for other forms of IPRs, including common and collective IPRs, which are compatible with existing genetic resource management in local communities (Brush, 2007; Salazar et al., 2007). Similar concerns of policy incompatibility are also applicable to the biodiversity-related schemes. The top-down implementation of biodiversity-related schemes in PGR research and development can be problematic, given the obvious trade-offs between on-farm plant diversity and highly client-oriented breeding (Virk & Witcombe, 2007).

Additionally, dealing primarily with cost and benefit issues, institutional scholars have also highlighted related problem of transaction costs that could hamper policy implementation at the local level. In PGR management, the implementation of new proposals in PGR management has been restricted by existing local organizational structures and resources particularly in developing countries (Anderson, 2008; Brush, 1998), thus resulting in high transaction costs that are considered as unnecessary barriers to germplasm exchange (Gepts, 2006).

Aside from institutional issues, another line of scholarly developments is largely concerned with local politics. This literature considers implementation of these international regimes as power/knowledge struggles among various stakeholders in both developing and developed countries. In policy formulation, powerful actors in plant breeding and seed industries have successfully put forward the IPRs system as a key instrument for both trade-related and biodiversity-related objectives in PGR management (Silva, 1993). Similarly, the advancement of Farmers' Rights as a strategy of resistance to the dominant IPRs system has instead enacted Breeders' Rights, thereby reinforcing power inequalities through asymmetrical legal structure (Borowiak, 2004; Peterson, 2001). Successful implementation of policy is therefore related to the balance of power and knowledge, through local empowerment, decentralization, participation and knowledge incorporation (Austin & Eder, 2007; Delgado, 2008; Wale et al., 2009).

For instance, public-private partnerships and capacity building are key to the success of IPRs and conservation schemes (Falcon & Fowler, 2002; Mburu & Wale, 2006).

The two approaches in current literature, however, may be too simplistic to deal with the complexity of institutional and political issues in PGR management. One drawback is related to theoretical assumptions of mechanisms that underlie local practices in response to policy interventions. Existing research has tended to underestimate either the role of local politics or of policy institutions. By paying attention to the issue of compatibility, the literature has presumed policy institutions as major determinants of policy effectiveness, while neglecting the active role of plant breeders and/or farmers in response to policy. On the contrary, research taking on political determinants has overemphasized their struggle over power and/or knowledge in local practices, and thus overlooked the substantive effect of policy institutions. In fact, there are cases where neither perspective can be account for, for instance, a case showing that the IPRs system as a private property regime is complementary with local institutions for collective action that rest on a common property regime (Eyzaguirre & Dennis, 2007).

Another drawback of existing research is rooted in policy assessment approaches. Several studies focus on immediate policy outcome either in conservation or development domain. This emphasis in the literature can be problematic, given that sustainability and equity in PGR management are mutually determined across conservation and development domains. As empirical studies show, the effectiveness of the access and benefit sharing scheme depends on the compatibility of regulatory framework between the providers' and the users' domains (Rosendal, 2006). Mismatches of institutional arrangements and capacity can heighten transaction costs, given the disjuncture between genetic information and product (Swanson & Göschl, 2000). Similarly, the management of PGRs in developing countries involves global politics between plant breeders and farmers, as manifested through policy formulation and implementation (Deere, 2009), rather than local politics between the governor or policy makers and those who are governed.

In this chapter, I contend that plant breeders as well as farmers can manipulate policy substance to fulfill their own interests. Such potential integrations between institutional and political processes may, in fact, account for sustainability and equity in PGR management. Therefore, despite prominent compatibility and conformity between policy and local structures, these interactions can possibly divert local practices from sustainability and equity in PGR management. To fill the gap in previous studies, this chapter explores the mutual role of institutional and political processes across the conservation and development domains in shaping policy outcome in terms of sustainability and equity in PGR management. Through the case of rice genetic resource management in Thailand, this chapter demonstrates possible integrations of institutional and political processes. This study relies on multiple case studies of both rice farming and breeding communities representing the conservation and development sides. Each community from both sides has undergone either regulatory or policy advisory framework. Understanding this integration provides not only theoretical contributions, but also practical implications for policy intervention to the sustainability and equity in PGRs conservation and utilization in Thailand, as well as other developing countries.

This chapter is organized into three sections. The following section serves to provide some general background of rice genetic resource management in Thailand, specifically the regulatory and policy advisory frameworks, as well as to introduce the research sites. The outcome of these policy frameworks will then be individually described, based on changes in local practices in the respective contexts of rice genetic resource conservation and development. The discussion section evaluates these changes in management practices in individual communities with regard to sustainability and equity, and uncovers motivations and conditions of such changes. Based on the findings, I attempt to suggest theoretical and policy implications for the sustainability and equity of PGR management.

Local Practices of Rice Genetic Resource Management in Thailand: Evidence of Conformity

Rice is the main staple food crop in Thailand. Its renowned, distinctive, and high quality has made Thailand the leading exporter in the world's rice market. The merits of Thai rice are attributed not only to the fact that Thailand is considered to be one of the centers of diversity for both wild and cultivated rice (Chang, 1976), but also to the historical conservation and development of rice genetic resources. The role of farmers in careful conservation and selection of the diverse rice gene pool has long been recognized along with the ecological diversification (Brush, 1991). However, not until 1950 did modern rice breeders become key players in establishing the standard and improving the performance of Thai rice (Chitrakon & Somrith, 2003). Since then, modern rice breeding has faced continuous challenges in boosting the productivity of Thai rice, while maintaining the uniqueness of Thai rice in the world's market. Despite the economic contribution of modern rice breeding to the nation as well as Thai farmers, the modern system of rice development has unfortunately displaced the traditional system of rice genetic resource conservation (Rerkasem, 2005; Senanarong & Sadakorn, 1992). This destruction of local rice germplasm has occurred not only in commercial but in subsistence rice farming. This imbalance between the conservation and development of Thai rice signals a crisis with regard to sustainability.

In Thailand, the implementation of multilateral CBD and TRIPs have resulted in the formulation of regulatory and policy advisory framework to promote both conservation and utilization. In 1999, Thailand passed the Plant Varieties Protection (PVP) Act, B.E. 2542, to regulate varieties of specific plants including rice as intellectual property. Having undergone the process of negotiation among different interests, this regulatory framework endorses the rights of all concerned stakeholders: plant breeders' rights to their newly developed varieties, indigenous communities' rights to their native varieties that have been selected and conserved over generations, and farmers' rights to save seed for their own use. Essentially, the PVP law provides material incentives, coupled with the access and benefit sharing mechanism, for sustainable development of PGRs, by rewarding plant breeders for their development of new elite varieties, and farm communities for their on-farm plant diversity conservation. The implementation of the PVP law has given rise to the emergence of rice breeding in the private sector and has lessened the role of government in the long history of rice breeding in Thailand.

Biodiversity-related proposals have served as an advisory framework in government and non-government organizations, resulting in the emergence of participatory projects that include biodiversity as strategic objectives. These participatory, plant diversity promotion (PDP) projects emphasize the incorporation of local knowledge in rice conservation and breeding. In government rice R&D institutions, the participatory variety selection (PVS) project was first implemented among farm communities in northern and northeastern Thailand from 2002 to 2005 (Jongdee & Pantuwan, 2006). After the project period, PVS has then been permanently incorporated into the rain-fed rice breeding program, as another testing procedure before release of new varieties. PVS is taken as a countermeasure against the growing discontent with the performance of government rice breeders. As stated in an official report on PVS, the aim of PVS is to incorporate farmers' knowledge and to promote *in situ* rice conservation. A similar participatory project has been implemented by a local non-government organization (NGO) with the objective of promoting conservation and utilization of rice genetic resources in local communities (CBDC, 2001; GRAIN, 2003).

In this section, I present the impact of the PVP system and these participatory plant diversity promotion projects, as regulatory and advisory frameworks respectively, in the context of Thailand's rice conservation and development. Specifically, I describe how these policy frameworks affect the perception of plant breeders and farmers and their respective practices in conservation and development. To examine these policy frameworks, I collected data through in-depth interviews with the heads and implementation officials in the government PVP office, the government rice R&D office, and the NGO that carries out the participatory rice diversity conservation project. The multiple case studies method was employed in exploring the impact of these policy frameworks, with the community as a unit of analysis. Four different communities in rice farming and breeding were purposively selected as research sites, each of which represents the role in conservation or development and the target of policy intervention. A summary of key variables in the four research sites is shown in Table 3-1. In these research sites, I conducted semi-structured interviews of key informants, including community leaders, professional rice breeders, farmer rice breeders, farmer conservators, and other community members who were willing to respond to my questions.

Table 3-1: Research operational framework

	Conservation	**Development**
Plant varieties protection	Ban San Khong An indigenous farm community	Kaset Pattana Farm A private rice R&D unit
Plant diversity promotion	Ban Don Mun A typical farm community	Northern Rice Research Center A government rice R&D unit

Conservation under Plant Varieties Protection

Under the 1999 plant varieties protection law, indigenous communities may claim rights over their native plant varieties that are unique to their localities. These rights granted to the community include not only rights over the propagating materials, but also rights to share of any commercial benefit derived from their genetic materials. In order to acquire these rights, the communities must file a community registry and a varieties claim through their local government. The claim is then forwarded to the plant protection office in which an ad hoc committee will make a discrete decision as to whether the rights will be granted. Practically, the decision is judged on the basis of the community and native plant varieties, respectively. First, the community needs to meet the criteria of sharing the same cultures or participating in common activities; second, the varieties in consideration must meet the criteria of uniqueness, i.e. with no presence in other localities. Traditional varieties that exist in more than one locality are considered by law as in the public domain under national sovereignty. Under current provisions, the government can enjoy the same rights over unclaimed native varieties, including shared benefits that may be derived from domestic and foreign plant development entities.

Since 2006 when the specific implementation procedure was established, the PVP agency has taken an assertive role in putting these unclaimed native varieties into the community ownership. According to the director, the PVP officials have employed such active strategies as information dissemination networks and field studies to explore potential candidates of native varieties, presuming that native landraces rarely exist only in one locality. Based on the field studies, they could however find several rice varieties that meet the criteria but the communities that seem problematic to the purpose of the PVP law. To illustrate, an individual who is a local conservation activist has filed a doubtful claim over a traditional rice variety that exists only in his village. Only the activist currently maintained the variety in consideration; in fact he just obtained this variety from a farmer who was about to discard the variety. Yet the community in question has quite transformed into a modern community with minimal unique culture and shared activities.

Ban San Khong is an indigenous, upland farm community at 300-400m above sea level in northern Thailand with no skepticisms with regard to the definition of community according to the law. According to most current governmental statistics (CDD, 2007), Ban San Khong has approximately 100 households, with an average rice farmland of 8-16 hectares for household consumption. Diverse varieties of upland rice, both glutinous and non-glutinous were found among households. Each household maintains 3-4 different rice varieties with a total of at least 20 different names mentioned during my fieldwork. This number is quite high, compared with only a few varieties found in its neighboring upland communities. Most of these varieties belong to the community's ethnic group, which were brought in during the settlement about 40 years ago. The rest were introduced later from other communities of different ethnic groups in the upland area. The origins of these varieties are acknowledged through farmers' variety naming system.

Farmers in Ban San Khong have conserved this vast diversity of rice as inheritance for their children, and in some years lent them out to others to maintain the seeds. Within their networks of relatives and friends, these varieties were exchanged as seeds (sometimes as grains) among households as no one can own varieties. Apart from this network for conservation and exchange, Ban San Khong has a very limited system to account for the community varieties. Senior villagers reported some varieties they could not find years ago had already been lost; however, at least two of these varieties (based on naming) were found in other households in the same community. Given restricted information beyond their networks of relatives and friends, the villagers tended to overestimate the number of lost varieties and underestimate the number of remaining varieties in the community.

Plant varieties protection is little known to Ban San Khong, even among the community leaders and progressive farmers. Some farmers have learned very little about protection for new varieties developed by modern plant breeders, but had no idea that similar type of protection was available for native cultivars. They have heard about this protection for their cash crops, but not for rice—the staple subsistence crop. With some ideas about the protection, these farmers expressed several concerns over technical and moral justifications in claiming their rice cultivars. For instance, some farmers were uncertain if particular varieties they had historically given out elsewhere are still present. Others wondered if their ethnic varieties may be the same, but known under different names as those preserved by other ethnic groups. The law has raised moral concerns in claiming ownership of their native varieties. Some felt uneasy to claim varieties, especially those of their ethnic group that were formerly obtained from other communities, but preserved in their own community. Lacking a clear account of rice varieties, farmers in Ban San Khong are still hesitant to claim legal rights and ownership of their native varieties.

Though quite alien to Ban San Khong, the idea of plant variety ownership is not completely beyond the scope of their interest. As I discussed with them about potential rights and benefits, farmers first expressed the most interest in the monetary benefits, though perceived as personal rather than communal, but later realized as too good to be true for them. These farmers doubted if they could enjoy such benefit in the reality, without proper accounting and monitoring over the community property. Specifically, they were concerned about their ability to restrict the use of their genetic resources and to verify their benefit-sharing claims over their genetic resources within new varieties. There were also several instances as regards land occupancy that make Ban San Khong farmers distrust the government. In fact, they mentioned only one kind government official who once gave them a modern variety named *Jow Haw*. Based on their experience, these farmers felt that they should protect their own varieties themselves, rather than having the government do it.

With knowledge about PVP, farmers have become more aware and selective about sharing their varieties with outsiders than before. With limited ability and resources, they realized that they could be exploited rather than exploit the legal system. Deriving from the case of hybrid corn, one of these farmers even envisaged the future of their rice that he and his children may have to buy seeds of modern rice varieties even for their staple consumption, not just for their cash crops. He said if these good varieties were in the hands of scientific breeders, these experts would be able to develop new varieties that certainly are even better than their varieties and could eventually replace them. In support to his statement, he whispered me about some good varieties of corn that he maintained secretly in his farmland.

Development under Plant Varieties Protection

The 1999 plant varieties protection law also grants similar ownership rights to individuals as well as organizations over new plant varieties that meet the distinctiveness, uniformity, and stability (DUS) requirements and are not significantly derived from a particular existing variety. Unlike local-specific and traditional varieties, the rights over new plant varieties include exclusive rights over the propagating materials only without the access and benefit sharing benefit. In claiming these rights, individuals or a group of individuals must prove to the PVP officials that their variety meet the DUS criteria and that the variety has been released in the public domain for less than a year. According to the PVP director, this responsibility can impose both financial and technical burdens to verify the new characteristics and arrange for comparative trails that can take at least two years (cultivating cycles) for rice. This certification procedure ensures information disclosure, including detailed information about varietal characteristics and performance of the new plant variety, and most importantly, the methods of their derivation and sources of genetic materials. The exclusive benefit from any certified, new plant variety is, however, limited, e.g. 25 years for such perennial crops as rice, during which time the owners or beneficiaries are subject to some annual fees to maintain the rights or else they will be revoked. These fees are placed in the PVP fund, which is intended for the conservation of PGRs. For a variety derived from any traditional varieties, the law additionally requires a benefit-sharing agreement with the respective owners, either the state or local communities, of those general and specific traditional varieties. The purpose of this requirement is to ensure legal enforcement of proper benefit sharing, thereby rewarding the guardians of traditional varieties.

Rice research and development in the business sector is quite new in Thailand. According to the PVP office records, so far there are about 10 requests pending for certification as new rice varieties, most of which are from the government rice R&D bureau. While the plant varieties protection law is aimed to provide some economic incentives to profit-motivated enterprises, few claims have come from academic research institutions and none from rice breeders in the private sector. This low number may be explained by the nature of rice breeding business. Though rice is the main staple in Thailand, rice breeding appears not to be a lucrative business because rice is a self-pollinating crop, producing almost undistinguished seeds in its harvest. As a result, rice breeding has long been solely a government task, but has recently been of increasing interest among domestic and foreign seed companies. However, the very first few new rice varieties as released from these companies have not undergone legal certification. To further explain this issue, I use the following case of a private rice breeding laboratory to illustrate the perception and responses to the plant varieties protection regulation.

Kaset Pattana Farm is a private rice research and development (R&D) unit operating under an integrated agricultural-related business company in Thailand. In regard to rice, the company pursued only commercial seed production, especially of government rice varieties, long before launching its own R&D unit to develop their own varieties. Since 2001, following the success of hybrid corn, the company has greatly invested in technology for hybrid rice, which normally exhibits higher performance than inbred rice. This advantage of hybrid rice is related to the superiority, usually in terms of high yield and stress tolerance, of the first-generation hybrid over its inbred parents. Additionally, hybrid rice technology can de facto prevent farmers' seed-saving practices. The second generations or the seeds of the first-generation hybrid rice do not retain hybrid performance; in fact, their genetic instability will be revealed in highly segregating populations. The challenge of hybrid rice breeding is to locate potential parental materials and more importantly, techniques for synchronizing and crossing two varieties with differing flowering periods, which determines efficiency in hybrid seed production. Despite this challenge, hybrid rice is still promising for the seed production business because the company can sell hybrid seed every cultivation period. Currently, Kaset Pattana Farm has a leading role in the hybrid rice market, while other private and government institutions are still unable to release hybrid rice varieties commercially. So far, the company has sold hybrid rice seed of two newly-released hybrid rice varieties, along with traditional seed production of inbred varieties.

The PVP law does not preclude the protection of new rice derived from hybrid technology; in fact, a good number of hybrid varieties of other crops have already been protected by the law. When I asked questions about the law, the director of Kaset Pattana Farm seemed very knowledgeable about the PVP law, including detailed procedures, enforcements, and other requirements that must be followed to get new varieties certified. Although fully informed, he nevertheless deliberately opted not to place their rice under legal protection. Benefit-wise, he thought the farm would benefit little under PVP regulation. During the interview, he complained that the compensation for rights infringement that is already specified by law is very low, incomparable with the actual, huge loss of R&D investment. Yet, the claiming of compensation from farmers is viewed as morally and culturally inappropriate in the context of Thailand. Instead of being sympathetic, the company would be harshly criticized for suing violating farmers. He seconded that the public and the media were often on the farmers' side, especially because the majority of rice production (even commercial rice production) is done by small-scale and poor farmers.

On the cost side, the head of Kaset Pattana Farm expressed no concern regarding direct costs in the form of initial certification and annual maintenance fees. Instead, he was explicitly concerned about the verification tasks that seem demanding and bureaucratic in getting the varieties certified, not to mention the fact that hybrid rice requires even more time and resource consuming than conventionally bred rice varieties. But it appears to be the essentially public information disclosure during the verification procedure that makes the head very reluctant. He mentioned that he might be interested in having the varieties certified, if only the verification trials were to be carried out in the company's fields, so that genetic materials and breeding techniques would not have to be revealed. The disclosure of information about genetic materials can result in potentially high costs through the required benefit-sharing agreement. Particularly, since the genetic materials used in the farm, unlike the government's laboratories, were informally collected and unsystematically developed from farmers' fields or international and national genebanks, the specification of all sources of genetic materials in a new variety can be absurdly difficult, if not impossible.

Furthermore, since these types of information are crucial for business, it is better for the company not to trust others (the government) to protect their investment, but to keep the information secret within the company itself. This is especially important at this beginning of highly competitive hybrid rice R&D in the business sector. According to the head rice scientist, Kaset Pattana Farm has strictly implemented restricted information management measures involving multi-task division and unique coding systems to prevent any leak of the whole workable information. Because of these preventive measures, the head rice scientist reported only two small instances of information leak from resigning personnel, since the starting of the R&D unit.

Conservation under Plant Diversity Promotion

Apart from PVP, there is an increasingly popular policy to revive community or local plant diversity. The on-farm conservation of plant diversity, unlike genebank collections, not only contributes to the natural evolution of plant genetic resources, but also empowers farmers to directly benefit from on-farm plant diversity. This idea has caught the attention of several international donors, leading to the policy being translated into several community-based biodiversity educational projects, implemented by both government and non-government organizations. These projects typically employ an experiential-based learning approach, commonly known as farmer field schools. These projects introduce participating farmers the importance and potential uses of on-farm diversity and providing farmers with knowledge and resources for conservation practice. With such knowledge and capacity building, these participating farmers and then the overall community are expected to conserve and utilize their plant diversity on their farms.

Among these community-based projects, one ongoing project focusing on rice diversity is implemented by a local NGO with support from foreign donors and expertise support from government and academic institutions. This community rice diversity project has been actively implemented in several farm communities in northern Thailand. This project has provided the local community the awareness and knowledge of rice diversity and conservation, and also helped revive on-farm rice diversity by introducing local farmers to new, diversified rice genetic resources from genebanks and other regions. The case of Ban Don Mun illustrates how this project has shaped the practices of local farmers.

Ban Don Mun is an indigenous, lowland farm community in northern Thailand, where the project has been implemented since 2000. Each farm household in the community has continuously managed to select and keep their own seeds for rice cultivation, though modern rice varieties that are relatively difficult to maintain have increasingly replaced traditional ones. Instead of buying new seeds of modern varieties, these farmers have learned to use their community network for seed exchange of the same varieties among different farm environments that help modern varieties adapt to and thereby perform consistently well in local farm conditions. These management traditions have contributed to the conservation of rice genetic resources in Ban Don Mun. According to the project's initial survey, at least 6 traditional and modern rice varieties were maintained in the community before the project implementation. These varieties, proven to be among best available varieties, have been conserved among Ban Don Mun households for utilization. Despite this contribution to on-farm conservation of rice genetic resources, Ban Don Mun has been excluded from the PVP system because the varieties existing in Ban Don Mun are not distinctive enough from those in other communities. In fact, expecting uniqueness of these rice varieties is somewhat unrealistic, given that Ban Don Mun usually exchanges rice varieties among its neighboring communities, where farming conditions are similar.

Since the implementation of the project, community-based conservation has been initiated and gradually integrated into farmers' existing practices of rice genetic resource management. Community rice conservation has started to provide farmers access to both new and backup sources of rice varieties, which farmers can readily access or retrieve when they want to return to previously used varieties. With the project's support and encouragement, farmers have increasingly experimented with new varieties from the project network, without bothering to keep the stock of good old rice varieties in their fields. As a result, rice genetic resources in Ban Don Mun have been very dynamic with exceptionally high varietal replacement rate. During my fieldwork in 2007, a potential breeding line was widely distributed among households. However, when I visited the community again in the following year, this variety had already been discarded and replaced by a new traditional variety from a neighboring community. According to a farmer in Ban Don Mun, this newcomer was introduced to that community in the previous year, but rumors said it is just very good. This farmer appeared to care little to learn more about the variety before actually adopting it. He said he would try it in order to learn by himself whether it is good and what is good about it. With such high variety replacement, Ban Don Mun households have consequently reduced their role in on-farm conservation by shortening the evolutionary process of rice genetic resources in natural farm settings.

While disregarding household conservation potentials, Ban Don Mun has performed a new role in rice genetic resource development. This development role has just been possible with the adoption of scientific knowledge and practices. Along with community-based rice conservation, rice breeding is another major, on-going activity in the project. Inspired by a successful farmer breeder, farmer breeders in Ban Don Mun have expected to make a profit from selling seeds of new varieties they developed. However, in the seventh year of their breeding, they started to realize that they could not sell seeds of their potential lines to farmers in the same community, because of the tradition of seed management and sharing rice genetic resources. Nevertheless, they still expect to sell seeds to nearby communities, where the new rice varieties may be suitable, before having them commercialized in their own community as well. In fact, the anticipated commercialization of their varieties has raised concerns about others taking advantage of their endeavor.

The idea of PVP has therefore initially appealed to these progressive farmers, introduced to them by the project staff. As the head of this group told me, this PVP system would allow them to sell their rights to commercial seed producers and benefit from the seed production business without conducting business, which is not their specialization. However, they later realized they did not need this formal protection, given the niche market for their varieties that are bred for specific needs and local adaptation and thus may not be highly interesting for commercial business. Yet, as typical farmers, these progressive farmers cannot afford to pay initial and annual fees for legal protection, given the uncertain promise of their varieties. Apart from the costs of protection, farmers' bred varieties are unlikely to meet the DUS criteria of new varieties required by the PVP law, given unsystematic breeding procedures and uncontrolled farm settings. As a result, though contributing to the development of rice genetic resources, farmer breeders in Ban Don Mun are likely neglected in the rewarding system of the PVP law.

Development under Plant Diversity Promotion

Along with the main objective in rice development, the implementation of biodiversity-related proposals has been evident as a secondary objective of the government rice breeding organization. While considered as the first priority, the development of modern rice varieties has created a dilemma in regard to the issue of rice diversity. For several decades, government rice varieties have continually replaced the vast majority of traditional rice varieties that are significant sources of invaluable genetic resources. These latter “evolving” genetic resources are incomparable with those “frozen” rice varieties in the government rice genebank. Though preserving the most of the rice varieties ever cultivated in Thailand, the frozen samples in the genebank cannot replace varieties that have naturally evolved and adapted to changing environment. Given the decline in the number of cultivated rice varieties over time, the collection of new samples has gradually decreased and often the collected samples are duplicates of existing stored samples or less distinctive. Though once regarded as the major source of rice genetic resource conservation, the government rice genebank currently appears inactive and burdensome, due to significant budget reduction.

While its role in conservation has decreased considerably, the government rice R&D office has no choice but to emphasize the development of rice genetic resources to pursue the goal of rice diversity. These practices of rice development are determined by how rice breeders in the government office perceive and implement biodiversity-related objectives through their professional lens. This section presents a case of the government rice R&D office, including one of its regional centers—Northern Rice Research Center, to elaborate on their perception or interpretation of rice diversity as evident in the government policy and their responses to fulfill the policy objectives.

Northern Rice Research Center is a government rice R&D center specializing in glutinous rice development for the north region of Thailand. For the center, the release of a new rice variety is not an easy task in the context of subsistence rice farming, where the best released variety, *RD6*—a glutinous mutation-derivative of the famous jasmine rice—is widely cultivated as the main staple for household consumption. Farmers' familiarity with the superior fragrant and soft *RD6* makes them unwilling to adopt other rice varieties with lower quality, despite with higher yield performance. Yet, potential breeder's lines that possess equally or similarly good grain quality are unlikely to outperform existing released varieties in terms of yield, given the natural trade-off between grain quality and yield performance. In some years, none of the several hundred candidates each year can be released, and therefore very few varieties have been released in the past decade. Specifically in 2000, the most recent glutinous variety—*SPT1* was successfully released for irrigated farms, where farmers are less concerned about the eating quality for rice to be sold, but not a single variety was released for rain-fed farms. Lacking comparable alternatives to *RD6* in the rain-fed farm ecosystem, the target area for rice diversity, the northern and other rice research centers in the rain-fed breeding program have faced real challenges.

The challenges related to on-farm rice diversity are perceived issues of farmers' adoption, as concerning with their specific needs and farm conditions. This perception of government rice breeders, according to a senior rice breeder, has led to a few drastic changes in breeding objectives as well as strategies, particularly within the rain-fed rice breeding program. In regard to the objectives, government rice breeders have shifted from varieties with optimal performance and wide adaptation toward those that meet local demands and easily adapt to specific farm environments. For instance, the rain-fed rice breeding program in the northern center and others in northern and northeastern Thailand started implementing a participatory plant breeding approach, known as participatory variety selection (PVS), the aim of which is to develop new rice varieties to meet local demands and to adapt well to local farm conditions. Practically speaking, PVS is not much of an account of farmers' needs and preferences in variety selection, because it is implemented only at the final stage in the development of new varieties. In fact, through the implementation of PVS, government rice breeders can more easily release rice varieties based on the farmers' scoring data, but not necessarily beat the performance benchmark of available rice varieties.

The inclusion of the rice diversity objective is also obvious in their new rice breeding strategies. Government rice breeders have shifted their breeding strategies from the development of new rice varieties to the improvement of already-existing rice varieties in particular localities. One conventional method known as pure-line selection has long been used to purify or genetically stabilize traditional varieties in farmers' fields to regain their optimal performance. But it is increasingly evident in on-going breeding projects that most improvements have targeted previously released government varieties, for example, *RD6-blast resistant*—an improvements of *RD6* with resistance to rice blast. Improved rice varieties are intended both to ensure farmers' adoption and to maintain or conserve local rice varieties, which otherwise would be replaced by the whole new varieties.

Though not targeted at the government sector, the PVP system turned out to be more appealing to the government rice breeding office than previously assumed. The PVP regulation was originally intended to protect only potentially commercialized varieties from exploitation by private seed producers. The rights over certified government varieties can be sold and transferred to private seed producers in exchange for some gratitude and funding for further R&D. However, current office policy demands all newly released varieties to become certified for legal protection. These include varieties with little potential or with locally specific needs and adaptation. According to a senior official, the PVP law may just be another means of public recognition; the more government varieties become legally certified, the more government rice breeders are recognized for their contribution. Given the zero cost and the DUS characteristics of government rice varieties, government rice breeders can come up with any reason to have their varieties protected. The PVP system is, therefore, misused by government rice breeders, yet is counterproductive to rice R&D in the private sector.

Table 3-2: Conformity to regulatory and policy advisory framework in rice genetic resource management

Assumptions	Potential conflicts between the intellectual property rights institutions and local cultures	High transaction costs due to disjuncture between genetic information and genetic product	Struggle over knowledge in PGR management given the dominance of science over local knowledge	Struggle with top-down approaches due to trade-offs between policy objectives and breeding norms
	Plant varieties protection		**Plant diversity promotion**	
Role of community	Ban San Khong—an indigenous farm community doing on-farm conservation	Kaset Pattana Farm—a private rice R&D unit doing rice development	Ban Don Mun—an indigenous farm community doing on-farm conservation	Northern Rice Research Center—a government R&D office doing rice development
Evidence of conformity	Farmers conserve native varieties as their intellectual property. Under the new law, farmers are more selective in variety/seed sharing and exchange to outsiders.	The company considers their new varieties as their intellectual property. Instead of legal protection, they opt for self-management of genetic material and information.	Farmers maintain on-farm diversity for utilization, by shifting toward centralized/ scientized conservation and breeding. They frequently utilize new varieties resulting in high varietal turnover rate.	Government breeders employ new breeding strategies to conserve on-farm diversity, by focusing on local adaptation, existing varietal improvement, and decentralized seed production.
Implications on PGRs	Restricted flow of PGRs to development	Reinforced inequity in PGR management	Declining evolutionary merit of on-farm conservation	Increased farmers' adoption of genetically-uniform varieties
Motivations & conditions	Lacking of accounting and monitoring systems, farmers are afraid of their native varieties being appropriated without benefit sharing and potential loss of their self-dependence if native varieties are replaced by improved varieties.	With capability in hybrid rice technology and information management, the company can avoid unnecessary cost of royalties for genetic input, and avoid problem in claiming infringement that can potentially destroy their image in the public eye.	Farmers' knowledge is limited in utilizing on-farm rice diversity. Under scientific and technological package, farmers can advance their limited capacity in rice genetic resource conservation and development.	By focusing on farmers' adoption and incorporating local knowledge, government breeders can claim on-farm conservation as a core breeding value, and increase breeding performance in terms of farmers' acceptance and use.

Conformity yet Divergence: Sustainability and Equity Perspectives

This previous section described how rice breeders and farmers have conformed to the PVP law and the PDP norm, based on case studies of rice farming and breeding communities in Thailand. Table 3-2 provides a summary of evidence of conformity in these case studies. In the face of policy conformity, this study contends that local practices of rice conservation and development suggest divergence from the sustainability and equity goals. Following this line of argument, this section provides an explanation for such divergence, and then suggests some theoretical and policy implications to sustainability and equity in PGR management.

The case studies have showed that the PVP systems and the PDP schemes as regulatory and policy advisory frameworks have diverted local practices of rice farmers and breeders away from sustainability and equity in rice genetic resource management. The establishment of private property rights over native and new rice varieties has disrupted the normal flow of genetic materials and benefits between rice farmers and breeders. It has thus reinforced existing resource inequality in conservation and development of rice genetic resources. As result of the PVP law, indigenous farmers have become more selective in sharing their native varieties among the neighbors and especially the outsiders, while on-farm conservation practices remain unchanged. Private rice breeders, on the other side, have managed to keep their genetic information confidential to maintain their informal acquisition of genetic materials from farmers and other genebank sources without sharing any benefit.

Likewise, the implementation of the rice diversity norm as an advisory framework in local conservation and breeding projects has led to a shift in an unsustainable direction. Change in farmers' and breeders' perception has led to paradoxical conflicts in both farming and breeding practices. While potential use of rice diversity is introduced to encourage farmers' conservation, the conservation of local rice diversity has been intended for rice varietal development. As a result, farmers have focused on utilization rather than conservation of rice diversity. Individual practices of on-farm conservation have been replaced by community-based field conservation and breeding practices, which provide farmers with access to new sources of rice germplasm and increase trial-and-error cultivation practices. Though this community institution has increased efficiency and benefit in local rice genetic resource management, the resulting local rice germplasm has significantly decreased in its value in terms of genetic diversity and evolution. Such depreciation of local rice germplasm has been supported by the government PVS scheme. Breeding rice for on-farm conservation has placed an emphasis on farmers' adoption, especially through participatory varietal selection and improvement of existing varieties. These schemes have consequently facilitated the adoption of modern, genetically uniform rice varieties, thereby reducing genetic diversity of local rice germplasm. Furthermore, the establishment of community seed production has increased seed replacement rate, thereby shortening the evolutionary duration of rice varieties in natural condition.

Findings of local practices in rice genetic resources management run counter to available theoretical perspectives. According to institutional theorists, native farmers and rice breeders are not likely to conform to the PVP and PDP frameworks, given the frameworks are conflicting with existing local norms and institutions. Under the political view, progressive farmers should resist control over local rice genetic resource management as exerted through scientific knowledge. Likewise, private rice breeders should take advantage from the PVP law through the endorsement of their exclusive rights and control over new genetic resources. As these case studies show, local conservation and development practices neither follow the assumption of institutional mismatches nor the assumption of political struggle.

In response to the PVP law, indigenous farmers have conformed to this new system considering native varieties as their intellectual property and expressed their interest in sharing benefits derived from their native varieties. However, these farmers have not gone further to claim their native varieties in the legal system. In the absence of accounting and monitoring systems, indigenous farmers are uncertain about their intellectual property and their ownership. Opting out from the PVP system, therefore, farmers can be removed from the concern of uncertainty. Instead, by restricting seed exchange and distribution, farmers can ensure that their resources will not be freely exploited by modern rice breeders and that their native varieties will not be replaced by improved modern varieties. On the other side, private rice breeders have eschewed legal protection, despite their interest in protecting their new rice varieties. Disclosure of genetic information seemingly exposes them to risk for property infringement, which can also be hard to get appropriately compensated. Given the presence of technological and managerial alternatives, they have therefore chosen to protect their own intellectual property themselves, and also been able to maintain their free access to genetic materials from informal sources.

In response to the PDP implementation, farmers have adopted modern rice breeding and selection, not as compulsory project activities, but because these scientific packages can increase their potential in utilizing rice genetic resources. Similarly, the conformity of government rice breeders to enhance on-farm rice diversity, despite their conflicting norm, does not represent knowledge struggle. Rather, the implementation of PVS has been smoothly translated to address farmers' adoption of their released varieties, which can simultaneously provide them a concrete proof of their performance. Through the PVS scheme, government rice breeders have successfully utilized local knowledge to improve their professional image with regard to plant diversity and to validate their performance. The realization of the PVP law in these farming and breeding communities, despite their irrelevancy in regard to the law's target, also signifies the manipulation of policy substance in pursuit of their goals.

These findings have pinpointed possible interactions between policy institutions and local politics that result in divergence of local practices in rice genetic resource management. Based on these findings, I argue that local practices reflect the advancement of global politics into local institutional contexts. As demonstrated through the cases, the implementation of the PVP and PDP policy frameworks has not only constituted institutional arrangements, but also has created new political spaces at the local level. Through the new spaces, global politics as embodied in the policy frameworks have expanded to further the politics in genetic resource management at the local level. Local practices are therefore determined through the reconsideration of local institutional factors within the new political spaces. By conforming to policy frameworks, both farmers and breeders have re-assessed the cost and benefit of their practices considering the new politics. While existing theoretical perspectives are somewhat restricted to deal with policy (global) institution and local politics, this study demonstrates the interactions between global politics and local institutions to further explain such divergence in local practices.

The impact of policy frameworks on local practices is determined by resource or knowledge politics within the new policy spaces, either motivating or conditioning farmers' and breeders' practices. As illustrated by the case studies, the implementation of IPRs has invoked the global politics of genetic resources at the local level. This politics has motivated rice farmers and breeders to adjust their practices according to their existing constraints or possibilities. In Ban San Khong, in the lack of accounting and monitoring systems, farmers' fear of being exploited by plant breeders has led to the restriction of seed distribution. In Kaset Pattana Farm, concerns of free riding by farmers are the main reasons for opting out from PVP and instead adopting the hybrid rice technology to protect their property. Similarly, the implementation of biodiversity-related proposals has constituted new conditions in which the pursuit of existing farmers' or breeders' interests can be enabled or legitimated. By conforming to this policy advisory framework, local farmers and scientific breeders have obtained power, provided by the global politics of scientific and local knowledge, in pursuit of their respective motivation. In Ban Don Mun, the adoption of scientific knowledge and practices has attained new possibility in advancing farmers' aspiration in utilizing rice genetic resources. In the Northern Rice Research Center, the incorporation of farmers' knowledge has provided government rice breeders legitimacy to their breeding practices, thus restoring their image in the public eye with regard to on-farm rice diversity.

The exercise of these resource and knowledge politics within the new policy spaces has unfortunately led to policy paradoxes. Though both IPRs assignment and participatory projects are intended toward benefit redistribution and power/knowledge balance, they themselves have created new spaces for political exercise that even advance local practices into unsustainable and inequitable directions. These paradoxical outcomes suggest a need for new theoretical approaches in policy studies and policy interventions that are specific to the issues of PGR management. Especially, the nature of these issues is uniquely concerned with the multiplicity of resource dimensions, stakeholders, and policy objectives.

First in policy assessment, studies should focus on the goals of sustainability or equity in resource management, rather than the immediate outcome in local practices. In doing so, policy research should consider the mutual role of conservation and development sectors in contributing to the goals. In understanding policy outcome, research on PGR management should pay attention to possible interactions between policy institutions and local politics. Specifically, studies needs to reconsider the role of local institutional factors within the global political spaces. As the case studies demonstrates, the focus on either whether policy institutions are compatible with the local context, or whether policy implementation signifies balance of power or knowledge, may not be useful in understanding policy outcome. Rather, research on should consider that local actors can manipulate and translate policy institutions in pursuit of their political goals.

The possibility and the way in which these policy institutions can be maneuvered lend suggestion to the design of policy interventions. Policy designers should take into account this possibility, especially with regard to the politics of PGRs and their related knowledge. As suggested by the case studies, the re-constitution of global politics in policy spaces should not be discarded but to be integrated into the design of policy interventions in order to anticipate change in an appropriate direction. In this regard, specific interventions may be tailored to specific providers or users of PGRs. On the one hand, efforts in correcting local institutional structure along with policy institutions are necessary to achieve equity in PGR management. For instance, policy makers should provide local accounting and monitoring systems and strengthen the infringement compensation system in order to draw native and new plant varieties, respectively into the formal protection system. On the other hand, attention to various interpretations of plant diversity is crucial toward sustainability in PGR management. Specifically, policy designers should tailor the conception of plant diversity to fit conservation and development objectives. For example, the use of composite indicators that represent genetic adaptability, instead of simple, numeric indicators (i.e. the number of plant varieties) should be appropriate in PGR development. More specific definitions in both farmers' learning and breeders' evaluation system would direct on-farm and laboratory practices into the right track of sustainable management of PGRs.

Conclusion

The management of PGRs has been concerned with multifaceted issues of equity in resource access between native farmers and modern breeders and of sustainability in their respective conservation and development practices. Following multilateral conventions, intellectual property rights and biodiversity-related proposals have broadly served as regulatory and policy advisory frameworks in both conservation and development domains. These broad policy frameworks have been found with the issues of incompatibility in policy institutions and of power/knowledge struggle in local politics, either of which can potentially hamper the success of policy implementation. However, despite these prominent issues of incompatibilities and political struggles, conformity in the implementation of these policy frameworks is evidenced in local practices of rice conservation and development in Thailand. Based on four case studies of rice farming and breeding communities, this chapter has therefore challenged existing theoretical perspectives on institutional and political processes, yet questioned the validity of a single process in determining sustainability and equity in PGR management.

This study has shown that local practices in the management of rice genetic resources may conform to these policy frameworks. As demonstrated by the case studies, Thailand's plant varieties protection law and plant diversity promotion projects have successfully altered existing conservation and development practices at the local level. However, the implications of these practices appear diverted from sustainability and equity goals. These findings have highlighted possible interactions between policy institutions and local politics. Specifically, these unsustainable or inequitable practices at the local level have been found to be motivated or conditioned by global resource or knowledge politics as introduced by these policy frameworks into the local context. Through such integration, these policy frameworks have tended to expand existing local politics with discursive elements of global politics, thereby leading local practices off the intended direction. This chapter has therefore proposed new theoretical perspectives and policy interventions pertaining to the management of PGRs.

APPENDICES

APPENDIX A

GLOSSARY OF TERMS

Crop diversity

Crop diversity denotes the richness of crop genetic resources. It can be considered at different levels depending on how crop genetic resources are relevant to specific actors. For instance, farmers usually view crop diversity at the varietal level, because they deal with individual crop varieties in farming practices. Plant breeders, on the other hand, draw on a diverse gene pool in crop development. Thus, they are particularly concerned with genetic diversity, or the variations in the genetic composition within or across individual varieties.

Modern varieties

Modern crop varieties refer to genetically uniform varieties developed by plant breeders to have desirable properties and performance. The strong varietal performance of modern crops is usually derived from their genetic purity. Plant breeders can also develop promising traditional varieties to have this genetic purity through pure line selection techniques. *Sew Mae Jan (1979)*, *Jow Haw (1987)*, the famous Thai jasmine rice—*Khao Dawk Mali 105 (1959)* and its glutinous derivative—*RD6 (1977)* are examples of genetically purified traditional rice varieties. In general, these modern or improved varieties can easily lose their genetic purity in their progenies through the natural selection process in normal cultivation. Therefore, the performance of modern varieties can only be maintained by intensive seed selection under controlled farm environments in the specialized seed production process.

Traditional varieties

Traditional crop varieties are relatively more genetically diverse populations evolving through generations in natural farm conditions. Due to their genetic diversity, traditional varieties usually exhibit lower desired performance but better local adaptation and higher resistance to biotic (i.e., diseases and pests) as well as abiotic (i.e., drought/flooding and extreme temperature) stress, compared with modern varieties. Modern varieties can become more genetically diverse through generations by natural and farmer selection in local farm conditions without seed renewal or refreshment.

Material perspective

In the material view, material structure has a central role in determining human practice. Therefore, farmers' conservation of crop diversity is a purposeful and practical choice in response to farming and ecological conditions in pursuit of their material interests in consumption and production. These material mechanisms encompass all tangible aspects in human-nature interactions—particularly economic and technological factors on the one side, and genetic and ecological factors on the other side.

Symbolic perspective

In the symbolic view, symbolic culture plays a role in influencing human perception and practice. In the study of crop diversity, the role of symbolic culture occupies all intangible aspects beyond those accounted for by material mechanisms. With regard to crop diversity, farmers' conservation is concerned with aesthetics, social identity, spiritual references and emotional attachments. The role of cultural mechanisms is central not only in properties of the crop as a symbolic object, but also in the way crop diversity is integrated into farmers' belief systems and cultural practices.

Scientific knowledge

Scientific knowledge refers to knowledge produced and institutionalized by scientists or people with scientific training. Knowledge production involves systematic study and verification to derive general principles, theories or universal truths. Knowledge from other epistemic systems can be "scientized" through these well-established scientific methodologies.

Indigenous knowledge

Indigenous knowledge is produced by lay people in a particular community. The production of indigenous knowledge is situated in local wisdoms and contexts, through experiential learning and experimental evaluation under practical conditions. Scientific knowledge and technology are often “indigenized”, i.e., confirmed and adjusted in relation to local epistemic systems and conditions. In this dissertation, this term is also used interchangeably with local knowledge.

Sustainability

Crop improvement and development relies on diversified germplasm preserved in natural and farm habitats. On the other hand, on-farm conservation of this diversity may be declining, as improved varieties can replace the richness of crop genetic resources that are maintained on subsistence farms. This situation raises significant problems with regard to genetic resource management, since *in situ* conservation that allows crop-environment co-evolution is necessary to cope with new diseases, pests, and farm conditions in crop development. Therefore, sustainability in plant genetic resource management signifies the balance between conservation and development.

Equity

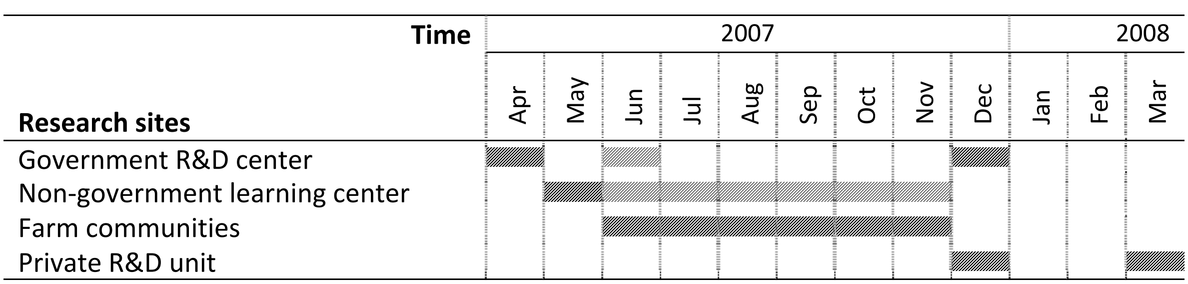
Sustainability in plant genetic resource management implies the respective roles of farmers and plant breeders in conservation and development. Plant breeders (and the society) can enjoy benefits from crop development that utilizes diverse crop genetic resources conserved in natural farm habitats. The idea of equity is concerned with the distribution of such benefits in order to reward farmers who conserve crop diversity on their farms.

APPENDIX B

DATA COLLECTION METHODS

This dissertation employs the ethnographic approach, relying on such key methods in data collection as participant observation, interviews, and documentary research. In addition to the description of specific research design and methodology in each chapter, in this appendix, I present general methodology of data collection in each research site that I included as case studies. These research sites do not include government offices that implement plant varieties protection and biodiversity promotion, where I only conducted a review of policy documents and interviews of key informants. As shown in Table B-1, my fieldwork began in March 2007 for the arrangement for my data collection, but the fieldwork actually started in April 2007. I describe the procedures in collecting data in my research sites in the chronological order, although the research sites were applicable for different research questions. In fact, I addressed all research questions at the same time during my visit to each research site.

Table B-1: Time frame of fieldwork by research sites



This appendix presents, in detail, data collection methods in five sections. In the order of my fieldwork, the first section describes how I conducted field research in the government rice research and development (R&D) center, especially one of its local stations in northern Thailand. In the second section, I then describe my fieldwork in a local non-government learning center. The third section presents research procedures and questions of data collection in farm communities. In the last section, I describe how I obtain data from a private rice R&D unit.

Government R&D center

I started my fieldwork in April 2007 at a local government R&D station in northern Thailand. I spent time in the research station as a trainee for a month. During the first week, I gathered general information about the organization from annual reports and interviews of the director of the research station. Then I rotated among several divisions in the organization, working with rice scientists and technicians who were responsible for particular rice breeding tasks. The visit to each division ranged from a few days to a week. They assigned me some readings and allowed me to ask questions regarding rice breeding. I also learned and got hand-on training in simple techniques, such as cross pollination, from field staff in the research station. Furthermore, I participated in a few meetings among representatives from other local research stations and seed production centers in the northern region, as well as between rice scientists and business people who sought some advice on rice varieties. In addition to such experience in the research station, I had an opportunity to observe their field research in a remote village. The purpose of this practical training was to learn about objectives, challenges and limitations, and breeding strategies to deal with rice breeding for northern Thailand.

During the training period, I paid particular attention to the participatory plant breeding project, as implemented by the research station. I studied the project documents and conducted several in-depth interviews with a senior rice technician, who was in charge of project implementation. Interview questions were about procedures, outcomes and problems at the local level in the implementation of participatory plant breeding, including the identification of targeted sites, beyond the description in the project reports. I also had chance to witness one lecture on community seed production that a rice scientist introduced to participating farmers during my fieldwork at farm communities in June 2007.

In December 2007, I had chance to interview the director and senior rice scientists at the main R&D office in Bangkok. These semi-structured interviews were targeted at the policy level on participatory plant breeding, especially the center's responses to the plant diversity promotion policies. The following are some interview questions:

- Can you tell me about the initiation of the participatory plant breeding project? Why is it applicable only for the rain-fed breeding program? What is the future direction of participatory plant breeding?
- What are the roles of the government rice R&D center in promoting on-farm rice diversity? How has breeding practices and strategies been adjusted to enhance rice diversity at the local level?

Non-government learning center

In May 2007, I entered the learning center as a trainee in the on-going community biodiversity conservation and development project. At the beginning of my training in the center, I examined several project reports as well as materials, such as charts, diagrams, and drawings used in participatory learning and training. I used these materials as the basis to ask the center's staff clarifying and elaborating questions, as well as observed how they prepared for their fieldwork in farm communities. After getting familiar with the project, I conducted an in-depth interview with the director of the center about the project as implemented by the learning center. The following are some starter questions I used in the semi-structured interview:

- What are the background and principles of the project? How do they match the beliefs and goals of the learning center?
- How do you identify the project sites? What criteria do you use?
- How should participatory learning and training be carried out in the project? What strategies do you used to promote farmers' learning?

- How can local and scientific knowledge be incorporated? How do you view the strength and weakness of local versus scientific knowledge in conservation and development? What about local versus modern varieties in rice diversity contribution?
- What do you consider a success of the project implementation? How do you assess this success? What factors determine the success of the project?

Apart from data collection in the learning center, I collected additional data using participant observation in their field sites. I accompanied field staff to observe how they actually carried out participatory learning and training in several farm villages in the project network. In each village, their field visits usually occur on a bi-weekly basis. Since it was not possible to observe complete procedures in participatory training, I mainly relied on a field manual used by the field staff to get and stay organized for my observation. However, I asked the staff to explain or elaborate on the practices I observed. During the field visits, I also gathered basic information about the field sites as potential candidates for my research sites.

While being at the learning center, I joined several informal over dinner meetings at the center as well as at farmers' places between the staff and some leading farmers in the project's network. These networking meetings were regular in May; the purpose of such meetings was mainly to get organized for activities in the coming cultivating season. At the beginning of June, I also attended a formal annual meeting with government officials and farmers from several villages. In addition to keeping record of these events and their talks, I also used these opportunities to establish and develop good relationships with farmers in the villages in which I would carry out my fieldwork.

Although I ended my formal training in the learning center at the end of May, I still maintained a close connection with the field staff and had several chances to meet them in farm communities (where I conducted my field research) and accompany them to other field sites until the end of November. I could derive general information regarding their strategies in knowledge inclusion practices by observing how these practices were similar or different among various locations.

Farm communities

I began my fieldwork in farm communities in June, the beginning of the new rice cultivating (rainy) season. I developed a list of potential farm villages based on information obtained from local government and non-government organizations. Based on the list, I spent the first two weeks conducting preliminary studies in order to identify four farm villages as my research sites. I paid a short visit to each village to gather necessary information, including the existence of rice varieties in the community, the adoption of modern farming practices and technologies, and the implementation of rice diversity conservation and development projects. Such information served as major criteria in selecting the research sites to match research design for each chapter of the dissertation.

The first time that I entered a chosen farm village, I contacted village heads and asked them to introduce me at the regular community meetings of villagers. In these meetings, I introduced myself and the purpose of my research to the villagers. I told them to expect my presence throughout the rice cultivation season and that I would like to learn about their rice varieties and farming. Before starting my fieldwork, I asked village leaders to identify potential key informants, who know about historical and current agricultural and cultural practices in the community. I relied on these key informants first in getting an overall picture about the village and frequently in elaborating on my subsequent observations and conversations with other farmers.

I organized my field research in each farm community in three data collection phases: planting, maintaining and harvesting. In each phase, I observed different sets of practices and approached farmers with corresponding interview questions. I scheduled my visits to each village mainly according to the time lags and duration of rice cultivation activities among them. As a result, my stay in each village lasted from a few days to a few weeks. The first phase of my fieldwork was generally longer than the maintaining and harvesting time. In the first stage, I primarily relied on interviews to understand farmers' motivations and conditions. This initial information served as a guideline for subsequent stages of my data collection that focused more on observation. In the second and third phases, I observed and asked for explanations of on-farm practices as farmers maintained and harvested their rice.

I employ the semi-structured interview method with open-ended questions in gathering most of required data. In general, I talked to all individual households that were available in the communities during my fieldwork to derive general phenomena of rice cultivation practices in farm communities. These talks were mostly in informal settings and were usually a group discussion, as more than one individual were available in a household when I conducted an interview. For each village, I also hired a local resident as my field research assistant to facilitate locating and approaching all households, and help translating or paraphrasing conversations between my Standard (Central) Thai and local spoken dialects. In each interview, I started with such basic questions as follows:

- What rice varieties do you plant this year? If more than one, how much of each variety do you plant, and how do you distribute them over farmland? Why? For consumption, high yields, or any other reasons?
- What about the varieties you planted the previous year(s)? If different from the present year, why? How do you learn about and acquire these varieties? Do you plan to change in the following years? Why?
- How do you obtain seed? If self-management, how do you manage seed to maintain the varieties? Any change from the previous years? Why?
- How do you practice rice farming? Do you use chemical fertilizers, pesticides, or any other technologies? Are these farming practices and technologies concerned with your selection of rice varieties and/or your practices in seed management? If so, how do they matter?

I then compared answers to all questions across households in the community and also to my own observation. Most answers regarding farmers' practices exhibited similarities and confirmed what I observed or got from prior interviews of other farmers. Unusual answers, usually less than 10%, were often related to individual, rather than community, factors. I drew on these similar responses and observations to derive general conclusions on farmers' practices. However, with regard to farmers' perceptions, I drew solely on farmers' responses to interview questions. I followed up these basic questions about their practices with more in-depth questions about their perceptions with regard to rice diversity.

I conducted additional interviews of key informants regarding farmers' perception and practices in regard to rice diversity. This key informant interview was applicable only in two communities that participated in the biodiversity conservation and development project. I asked both participating and non-participating farmers more direct questions as follows:

- How do you understand rice diversity? What does it mean to you or the community? Is it necessary? If so, how and who do you think should maintain it?
- Have you learned something new from the project? If nothing is new, where and how have you learned such things before? Can you give me some examples?
- How has the project benefited you or the community? Do you alter your practices as a result of the project? Do you notice these changes from your neighbors or the community?

I also used the key informant interview method to examine the impact of plant varieties protection in the farm community that maintained native varieties. The key informants in this case were progressive farmers and village leaders. The following are some questions I asked them:

- What do you think of rice varieties maintained in the community as being an intellectual property of the community?
- Are you interested in sharing benefits from the development of new varieties, if the community's varieties are used as genetic materials?

- Given your rights over these genetic resources and benefit sharing, would you do things differently? Why or why not?

During summer 2008, I visited all farm communities again. This revisit was to explore changes in practices or rice genetic resources, if any, compared to the previous year. In gathering most information, I talked to key informing farmers with whom I had good relationships. During a visit, I also met the field staff from the learning center as they continued on the project. Therefore, I had chance to observe their field visit, which however had not changed much from the previous year.

Private R&D unit

Data collection in a private R&D unit mainly involves key informant interviews and documentary studies. In December 2007, I conducted in-depth interviews of the director and the head of rice scientists regarding their hybrid rice breeding program and the plant varieties protection law. They also provided me with some documents containing information about the program and newly released rice varieties. Below, I list some example of interview questions:

- Can you tell me about the background of the rice breeding program? Why do you choose hybrid rice technology? What is the target of new rice varieties?
- What are sources of genetic materials? What do you consider as promising sources of materials?
- How do you manage these genetic resources and information in rice breeding? Any challenges and limitations?
- What factors accounts for the success in releasing new varieties? How much does each factor contribute to the success?
- About plant varieties protection, does the regulation affect any of your decisions about information management and breeding strategies? Why or why not?
- If you could suggest revision of the regulation, what would you recommend the government do in order to facilitate rice R&D in the private sector? What would you do differently after the revision?

In March 2008, the company allowed me to visit their hybrid rice farm. Apart from what I studied from the hybrid rice technology manual, I could understand the actual practices of rice breeding through a two-hour question-and-answer session by the head rice scientist with and through field observation. During this visit, I also had a chance to meet and talk over dinner with some junior rice scientists and technicians. Such informal talks about their stories provided me with more understanding about information management in this farm.

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