THEORY OF THE CONVERSION OF FARMLAND TO FORESTS AND APPLICATION OF FOREST-GRASS MODE

退耕还林理论基础及林草模式的实践应用

李贤伟　张　健　胡庭兴　罗承德等　著

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内 容 简 介

退耕还林（草）工程是国家西部生态环境治理的一项重要举措，对加快西部地区生态环境建设具有重要的现实意义。本书从中、外退耕还林研究历史入手，系统阐述了退耕还林的概念、理论基础、技术模式，并形成理论体系；筛选出适合在四川盆周低山推广应用的多种技术模式；以典型林草模式为例，对植被结构及产量特征、细根生物量及特性、种间竞争、复合生态系统生物多样性、养分动态及管理、土壤水分生态及水土保持效益、以及经济效益进行了研究；探索了退耕还林可持续经营的理论与方法，为退耕还林工程实施提供技术支撑。

本书可供生态学、恢复生态学、林学、环境科学、可持续发展等领域的研究、管理人员及高等院校相关专业师生参考。

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序

退耕还林是我国具有重大意义和成效显著的生态工程，被认为是我国政策性最强、投资最大、涉及面最广、群众参与程度最高的生态建设工程。它不仅使我国广大陡坡耕地退换成林，减少了水土流失，增加了森林覆被率和水源涵养能力，有了明显的生态效益，而且促进了三农的发展。虽然耕地减少了，但在退耕还林工程补偿机制下，农民集中精力把基本农田做好，粮食产量反而上去了；农民也有资金去调整农业生产模式，使之更合理，更稳产高产；产品更加丰富多样，农民比以前更富裕了；农民同时经营农业林业，对林业关心了，生态意识提高了，科学经营的理念增强了，社会、经济和生态三大效益都很显著。

这本由李贤伟、张健教授为首的科研教学团队在国家几个重大研究项目、国家自然科学基金和省级项目支持下所完成的研究专著，以西部实施退耕还林工程为重点，从工程的必要性、必然性，它的理论基础、技术途径和总结出的最佳产业模式及其机理，它们的生态经济效益，管理技术重点，今后可持续经营的对策，后续的政策性问题和建议做出了详尽的阐述。首先，该专著非常有特色地把国外有关国家类似退耕还林工程的历史给予回顾，与我国的工程进行比较，恰当地评估了各有关国家工程的特点，同时对我国实施退耕还林工程的历史背景进行了分析和对工程的进展、存在的问题进行了评价。在进行理论分析和提供研究结果之前，对陡坡耕地，以及一些重要的术语、会涉及的临界值做了说明，为后来的理论与技术展开论述提供了明确和严格的内涵。

该专著对退耕还林的理论基础研究提出了有独到的且比较深刻的和全面的分析，例如从自然特征、经济特征、社会特征、可持续经营的综合特征做了切合我国实际的分析；也为退耕还林工程涉及的几个不同学科（生态学、经济学、生态经济学、林学、社会学）相关部分整合构成其基本理论作了有意义的工作。该专著的这一部分为退耕还林工程的理论认识发展了一步，赋以这一工程较充实的理论意义。该专著以第一手的调查研究资料进行分析，特别是在模式机理上做了自己的实验研究，这是其它对退耕还林工程总结时较少涉及的。如对优选出来的复合经营模式，对物种组成变化、植被改土效应、生物量结构变化、土壤养分动态，以及设计群落特征的邻体干扰指数等理论性问题都有较深入的研究，还注重系统集成的技术路线和创新地提出生态价值集成技术。该专著还提供了复合经营模式的经济效益的示范作用，为今后的工程也提供了一些有价值的建议。

对于此专著的出版问世，我寄予了热切的希望，它的出版肯定会给今后工程的巩固发展，在政策上、技术上有重要的参考作用，在学术研究上也会对农林复合经营、配套经营的理论和实践发展有重要影响。我十分高兴为我熟悉的李贤伟、张健团队做出的此贡献写出我的感想，是为评，也为序。

蒋有绪

（中国工程院院士）

2008 年 12 月 23 日

前　言

退耕还林工程是我国六大重点林业生态工程之一，也是世界十大重点林业生态工程之一，在西部地区实施的退耕还林（草）工程，是党中央、国务院针对我国西部生态环境状况，站在国家和民族长远发展的高度，着眼于经济与社会可持续发展全局做出的重大决策，是实施西部大开发的根本和切入点。

西部地区因其特殊的生态区位、恶劣的自然条件、严酷的生态环境脆弱性，成为我国生态环境治理的重点区域。长期以来，由于对坡耕地不合理的利用及粗放经营，致使水土流失严重，土壤退化，粮经作物产量低而不稳，土地沙化、石漠化面积越来越大，区域生态环境日趋恶化。而生态环境是人类生存和发展的基本条件，是社会经济发展的基础。生态环境恶化与社会可持续发展的矛盾有力地推动了生态环境建设的发展。退耕还林工程的实施可以加快西部地区生态环境建设，大大改善这一地区的生态环境，拓展中华民族的生存空间，为西部开发创造良好的生产建设条件和投资环境；加速推进西部大开发进程，推动西部地区农业生产要素优化配置和农村经济结构调整，促进西部贫困地区脱贫致富；有效扩大西部农村需求，拉动经济增长，加快全面建设小康社会，增进民族团结，巩固国防；从根本上扭转长江流域水患灾害，为长江上游提供生态屏障，具有重要的现实意义和深远的历史作用。

退耕还林（草）工程的实施，有力地推动了我国西部林业的发展，也使更多的人关心西部林业生态环境建设的发展。退耕还林从试点至今，开展了大量的研究与示范工作，但这些研究大多是停留在政策、基本思路、植被恢复技术与模式优化等内容上，更多的是对个别问题、案例的研究，没有形成较为系统的理论、技术、模式和相应的效益评价标准。此外，许多地区在发展项目（或建设模式）上存在较大的盲目性和随意性，没有进行充分的可行性论证或将生态建设与生态产业发展割裂开来，使耕区农民在退耕后的增收致富、产业结构调整方面出现问题，如何使退耕还林工程能够“退得下、稳得住、不反弹”？退耕还林工程如何布局、如何发展后续产业才能最大限度地发挥其效益？另外，退耕还林工程的实施，其水土保持、涵养水源、积累营养物质、净化大气环境、生物多样性保育等作用到底有多大？这些问题一直是困扰退耕还林工程建设的难题，也是退耕还林的关键所在。因此，研究退耕还林的理论基础、主要技术模式及产业化技术体系、林草复合模式的生态学过程很有必要。

著者及其所在的科研团队在国家“九五”、“十五”科技攻关、“十一五”科技支撑

计划、国家自然科学基金和省级项目的资助下，从1999年开始从事退耕还林工程相关研究与示范，四川农业大学在全国首先开展了退耕还林的系统研究，建立了天全、洪雅、沐川、丹棱、雨城、大英等多个退耕还林示范样板、水土保持定位观测站，从退耕还林理论基础、退耕还林技术模式试验示范、植被结构与产量特征、林木细根特性、种间竞争和物种多样性、退耕还林工程效益监测、退耕还林与可持续发展等方面对退耕还林工程及林草复合模式进行了深入系统的研究，取得了显著的研究成果。2001年天全县示范点成为全国南方片区退耕还林经验交流会议参观现场，时任国务院总理朱镕基等多位党和国家领导人亲临现场视察，并给予较高评价；接待了来自国内外多个考察学习团；2003年12月英国天空电视台到洪雅、天全退耕还林示范区进行现场采访，并做了专题报道。基于这些研究成果，出版了《退耕还林理论基础及林草模式的实践应用》一书，以期为第二期退耕还林工程实施提供理论依据和技术支撑，丰富恢复生态学的研究内容。

本书共十二章，第一章在对国内外退耕还林（草）实施的历史研究分析的基础上，翔实地分析和评价中外退耕还林在政策、技术、理论、生态学过程和综合性研究等方面的异同点，为我国退耕还林工程实施和研究提供参考经验。第二章对陡坡耕地以及一些重要的术语，会涉及的临界值做了说明，为给理论与技术的论述提供明确与严格的内涵。第三章集成、吸收与融合生态学、林学、经济学、社会学等其他基础学科的现有理论，系统阐述了退耕还林理论基础，形成退耕还林的理论体系。第四章根据四川盆周低山丘陵区退耕还林科技示范工程的实施，筛选出适合在盆周低山不同生态类型区推广应用的开发增值型退耕还林技术模式、生态产业模式、生态恢复型治理技术模式，最后提出了盆周低山区退耕还林适宜的物种、品种和技术指南。第五至十章对林草模式植被结构及产量特征、细根生物量及特性、种间竞争、林草复合生态系统生物多样性、养分动态及管理、土壤水分生态及水土保持效益、经济效益进行了相应研究。第十一至十二章通过对退耕还林（草）系统可持续发展评价理论与方法、退耕还林工程可持续经营对策的深入研究。为全面开展退耕还林工程，准确评估退耕还林的生态效应、经济效益和社会效益提供理论和技术基础。

本书的出版得到了国家自然科学基金“林草复合模式细根特性及对土壤碳储量和营养循环的调控机制”（30771717）、国家自然科学基金“巨桉人工林生态系统生物多样性形成过程”（30872014）、高等学校博士学科点专项科研基金“四川盆地西缘林草复合模式细根性质及动态研究”（20050626001），国家“十一五”科技支撑项目“长江中上游西南山区退化生态系统综合整治技术与模式”（2006BAC01A11）、国家“十五”重大科技攻关项目“四川盆周低山丘陵区水土流失综合治理技术与示范”（2001BA606A－06）、国家科技部“西部专项”、“四川省退耕还林科技示范工程”（2000－K01－04－05）、国家“九五”后启动项目“四川盆周西缘退耕还林区现代农业生产系统综合试验与示范”（K98－05－19－1）等项目的资助。

在本书研究和成书过程中，四川农业大学科研团队中宫渊波教授、杨万勤教授、朱天辉教授、万学琴副教授，范川、陈文德、张学权、荣丽、吴勇博士，余波、李艳、李德会、王敬硕士等提供了大量的研究成果并承担部分章节编写任务。书中图件由王鹏、

冯帅等编绘，前言英文由张良辉翻译。中国林业科学研究院蒋有绪院士和国家林业局退耕还林管理中心总工程师杜纪山研究员非常认真地审阅了本书初稿并提出了宝贵的修改意见，蒋有绪院士在百忙之中为本书作序。考虑到全书的系统性，书中参阅了大量参考文献，在此一并表示衷心的感谢！

由于编写时间仓促，积累的资料有限，同时退耕还林相关理论及林草复合模式的实践还有许多内容需要进行长期研究，因此，书中难免存在缺点和不足，我们恳请读者批评指正！

Preface

The Conversion of Farmland to Forests Project (CFF) is one of the six great forestry ecological projects in China and one of the ten great forest ecological projects in the world. It is a major policy decision initiated officially by the Central Party Committee and the State Council with the responsible consideration of the environmental status in Western China and the focus of the long-term sustainable development of national social-economy. It is thought to be the fundament and entrance of the Development of the West Regions.

Due to the harsh natural conditions and the vulnerable ecological region, Western China has been the main area of environment protection and enhancement. For a long time immoderate and extensive use of sloping farmland in this area, many serious environmental problems have appeared today, such as soil erosion, soil degradation and desertification, low and unstable productions, and increasing land desertification area. While, from the postulate of human's survival and growth to the base of social—economic development, ecological environment is irreplaceable. But the conflict between the society development and the environment degradation as we have known today can be a promotion of the ecological construction, such as the CFF. The CFF is concerned to be an effective way to promote the construction of ecological environment, expand the living space of Chinese, and improve the manufacture and investment conditions; and then accelerate the progress of the Development of the West Region, optimize the configuration of agricultural productive resources and economic structures, and reduce the poverty of the West China; enlarge the rural requirement, facilitate the economic growth, expedite the construction of a Well-off Society, and even promote the national unity and defense. Providing an ecological barrier to the upper reaches of Yangtze River and reversing the flood disaster radically can possess great practical significance and far—reaching historical role to the Chinese.

The implement of the CFF could play an important role in promoting the forestry

development in Western China, and more attentions could be attracted to the CFF and the western environment. Although a lot of studies and demonstrative implements have aimed to the policy, concept, techniques and models of the CFF through specific examples, little comprehensive results of theoretic, technique, model and its corresponding criterion of assessment were extracted and recognized. At the same time, some of the CFF cases were not arranged carefully without sufficient study, the ecological construction and economic increment was not combined well, and the farmers could not gain even more benefits from the reconstructed industrial structure. And then, several questions may be asked to address some of the concerns and challenges about the CFF now faces. How to keep the stability of the CFF especially concerned with the economic benefits of farmers? How to maximize the benefits through the arrangement of the project and its substituted industries of agriculture? What the ecological functions of CFF cloud be identified, like the water conservation, nutrient accumulation, air purification, and biodiversity maintenance, and how to quantify them? These problems are always the critical obstacle in concerning the forestry engineering, and also the core and focus of the CFF. Consequently, it is crucial to study the theory, technique mode and its industrial system, ecological processes of Forest-grass Compound Management Modes of the CFF, and then help to solve the problems and questions posed above.

Since 1999, the authors and the team in the Province Key Laboratory of Ecological Forestry Engineering in Sichuan Agricultural University have conducted the systematic research and technique demonstration of the CFF. Funded by the National Key Technologies R&D Program in the 9th, 10th and 11th Five-Year Plan, the National Natural Science Foundation, and the provincial projects, several CFF demonstration sites and water conservation observation station were established in Tianquan, Hongya, Muchuan, Danling, Yucheng and Daying counties, and made some remarkable results in the field of CFF theory, technique mode experiment and practice, vegetation structure and productivity, fine root characteristics, interspecies competition and species diversity, engineering benefit assessment, and the sustainable development of CFF. As a typical site in South China, Tianquan was assigned to be the locale of experience-sharing session in 2001, and Premier Zhu Rongji and other Party and Nation's leaders inspected the site themselves and highly evaluated the progress of the implementation. And we have received several investigation missions worldwide and, especially in December 2003, the Sky TV from England reported Hongya and Tianquan stations specially. Based on these studies, we prepared the book, *Theory of the conversion of farmland to forests and application of forest-grass mode*, aiming to offer the theory and technology to the subsequent secondary CFF, and enrich the theory of Applied Ecology.

Twelve chapters are involved in this book. Chapter 1 begins by the review of the history of the Conversion of Farmland to Forests worldwide, and the differences in poli-

cy, technology, theory, ecological process, and research progress are stated for the research in China. Chapter 2 expatiates the terms like steep—slope—land, and their related thresholds are illustrated strictly for the theories and approaches. Integrating other primary disciplines like Ecology, Silviculture, Economics, and Sociology, Chapter 3 expounds the source and formulation of the CFF theory. Chapter 4 concentrates on the mode selection of CFF in the low—mountain and hilly area around Sichuan basin, China, and some of the value—incremental modes, ecological-industry modes, and ecological—restoration modes are selected and performed through suitable species and technologies. Chapters 5 to 10 discuss some issues of the forest-grass modes, including the vegetation structure and productivity, fine root biomass and characteristics, interspecies competition, biodiversity, nutrient cycling and management, soil moisture and water conservation, and economic benefits. Chapters 11 to 12 contain the in-depth study of the theory and approach of sustainable development assessment and the strategy of sustainable management for the CFF system.

We are grateful to all the contributors to this book, who have provided information and research results, and compiled some chapters, they are Gong Yuanbo, Yang Wanqin, Zhu Tianhui, Wan Xueqin, Fan Chuan, Chen Wende, Zhang Xuequan, Rong Li, Wu Yong, Yu Bo, Li Yan, Li Dehui, and Wang Jing. Our sincere appreciation goes to Academician Jiang Youxu in Chinese Academy of Forestry and the Chief-Engineer Du Jishan in the CFF Administer Center of National Forest Administration who reviewed the book through and brought valuable advices. We thank Wang Peng and Feng Shuai for the refinement of graphics, and also thank Zhang Lianghui and Wang Peng for the translation and revision of preface separately. Finally, we thank all the authors cited in the references for their admitted work.

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R&D Program in the 10th Five-Year Plan (K98—05—19—1, *Comprehensive experimentation and demonstration of agricultural production system in the Conversion Farmland to Forests region of western edge of Sichuan Basin*). We acknowledge all the supports.

All suggestions are welcome.

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