Zhenghong Xiao

Environment and Selection of Technology

The Historical Agrotechnical Geography of West China During the Qing Dynasty

Springer

Environment and Selection of Technology

Zhenghong Xiao

Environment and Selection of Technology

The Historical Agrotechnical Geography of West China During the Qing Dynasty

Springer

Zhenghong Xiao
School of History and Culture
Shaanxi Normal University
Xi'an, Shaanxi, China

Translated by
Xiaomin Xu
School of International Studies
Shaanxi Normal University
Xi'an, Shaanxi, China

ISBN 978-981-97-1851-1 ISBN 978-981-97-1852-8 (eBook)
https://doi.org/10.1007/978-981-97-1852-8

Translation from the Chinese Simplified language edition: "环境与技术选择: 清代中国西部地区农业技术地理研究" by Zhenghong Xiao, © The author 1998. Published by China Social Sciences Press. All Rights Reserved.

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Foreword

When summer was approaching in 1998, the middle and lower valleys of the Yangtze River (长江) were experiencing severe flooding. While I am writing this Foreword, the sixth flood crest is threatening Wuhan City (武汉). It is reasonable to believe that when the floods pass, people will ponder over the causes of the floods in the Yangtze River valley. This situation is strikingly similar to what occurred in the Yellow River (黄河) valley. Whenever floods occur, in the Yangtze River valley or the Yellow River valley alike, it is far from enough if we consider only the superficial factors, blaming the catastrophes on either abnormal weather conditions or inadequate irrigation projects in the areas where disasters take place.

Years ago, I took the Yellow River as an example to study the river regulating measures from the changes of the Yellow River in history and posed an opinion, writing, "In the past hundreds and thousands of years, most people focused on the lower valley, tending to build dams to tame rivers, while few noticed the middle valley." This is typical of the "Lower Valley School." This mistake in regulating rivers has lasted for over 1000 years. Now, when talking about controlling rivers, we should eradicate such a mistake and consider the whole river, focusing our eyes on the river as a whole instead of the lower reaches only. The measure taken at present is only an emergency approach to lessen the urgent pressure; therefore, taking the river as a whole is equally important when dealing with urgent problems. "Taking a river as a whole" means mainly not ignoring soil and water conservation in the upper and middle reaches in addition to taking measures to remove the silt, since soil and water conservation are the core of river regulation. To try to control the floods in the lower river valley without considering the upper river valley will be as difficult as attempting to cure a serious chronic ailment without considering the cause. It is definitely unwise to remedy disasters after they have occurred instead of preparing in advance to avoid the approaching trouble.

I have such a broad perspective because a river, whether the Yellow River or the Yangtze River, is a complete ecosystem. The eco-environment of the upper reaches of the Yellow River causes dams to collapse easily, as history has demonstrated. While regulating the Yangtze River, how can we ignore the soil and water conservation of the upper river? The problems of West and East China are inextricably linked. Therefore,

the usual way of focusing only on the eastern region should be changed. We should investigate the western region in depth, including not only the eco-environmental problems but also economic, social, and cultural problems. That is the requirement of the present situation, which is in accordance with the relationship between the western region and the eastern region in history. For example, during the Qing Dynasty, the development of the western region was linked to that of the eastern region in many ways, and the agro-technological development in the western region differed from that of the eastern region.

However, this connection was often ignored. When discussing agricultural problems, researchers tend to lay their eyes on the eastern region only and judge the western region by using the development level of the eastern region as the only measuring scale. This lack of knowledge of the western region indicates a lack of research into the region. Dr. Xiao Zhenghong's study uses the agro-technical geography of the western region as its subject to investigate the uniqueness of the western region's agricultural development, particularly the relationship between agro-technical options and the environment, which is novel and with which I am pleased. The topic's value stems from two factors: first, the practical significance of this study on the western region; and second, the novelty of this topic because in previous historical agricultural geography studies, the problems of the western region were typically ignored, and historical agro-technical geography was merely mentioned. Therefore, this study is valuable, and some of the views posed by the author in this book are also worthy of special attention.

The western regions of China during the Qing Dynasty were characterized by the great diversity and complexity of their environmental conditions. As a result, agricultural technology naturally takes many different and complex forms. By studying agricultural production conditions, agricultural technology types, and other agro-technical factors, this book demonstrates that it is the correlation between technical forms and environmental conditions that determine the selection of agricultural technology in a certain area, and the diversity of agricultural technology in the western regions during the Qing Dynasty is determined by the complexity of geographical conditions. The author goes on to say that one of the most notable features of agriculture in West China is the uneven development in different regions, with extensive agriculture dominating. In different geographical conditions, the technology portfolio shows significant differences, and in the spatial process of technology development, there exists a prominent "technology-isolated island" phenomenon. The utilization efficiency of agricultural technology is also not the same. A regional imbalance of technology options caused the technical interaction between regions, including the interdependence between regions in terms of agro-technical forms and the spread of agro-technology between regions. Agro-technology is surely mainly determined by climate, soil, terrain, and other natural environmental conditions, but socio-economic and cultural factors are equally significant in the formation of agro-technical forms and agro-technical innovation, such as population, property rights, national policies, and customs.

Dr. Xiao's points of view on the relationship between agro-technical options and the environment, as well as the impact of changing climates on agricultural production and the economy, are clearly stated in this book. For example, how can one understand the respective roles of intensive and extensive farming in the development of agriculture in western regions during the Qing Dynasty? The author believes that to apply a specific technique to a region, it must be closely associated with the economic styles that are based on a specific natural environment. People in an area may choose extensive farming for some objective reasons; however, to a certain degree, extensive farming will severely affect the natural environment because of the interaction between changes in the eco-environment and the selection of agricultural technology. In turn, agricultural production and economic development become more difficult because of the damaged natural environment. The deforestation and deterioration of conditions for agricultural production in southwestern China during the Qing Dynasty are typical of this problem. In regions of this kind, the significance of forest vegetation is much more complex and comprehensive. Deforestation causes erosion and flooding while changing the way we produce and live is the key to preventing the destruction of forest vegetation, with the replacement of extensive farming with intensive farming being especially important. Apparently, this problem is of important practical significance.

This book was based on Xiao Zhenghong's doctoral dissertation. The defense committee, chaired by Prof. Zhou Weizhou (周伟洲), agreed that this dissertation established the fundamental academic framework of historical agro-technological geography. The committee also commented that this study is excellent as a dissertation and has remarkable originality in the field of historical geography because it takes agro-technical geography in the western regions as the object of research and explores important theoretical issues in depth by applying comprehensive methods from several disciplines such as historical geography, agronomy, economics, and others. They agreed that it was an excellent doctoral dissertation. This evaluation shows the full recognition and encouragement of the committee members toward Xiao Zhenghong. Now I am truly delighted to see that this book, which is based on the dissertation, is about to get published. However, as Xiao's dissertation advisor, I wish this work were only the beginning of more studies on the western regions contributed by Dr. Xiao Zhenghong and others.

August 1998

Nianhai Shi
Shaanxi Normal University
Xi'an, China

No Competing Interest Statement

The author declares there are not any competing financial and/or non-financial interests in relation to the content of the book.

About This Book

Historical agricultural geography is the study of the geographies of historical times, involving the reconstruction of a wide range of phenomena and processes relating to agriculture, such as the agricultural region, landscapes, and their relations to the natural environment and social circumstances. Historical agrotechnical geography is one of the branches of historical agricultural geography. Its main task is to investigate the regional differentiation of agricultural techniques in the historical period. For the most part of human history, the majority of people lived in rural areas and their primary source of income was almost always agriculture. However, because of differences in geographical features and social circumstances, the ways and modes of obtaining the means of subsistence varied not only over time but also across places.

The physical environment and the social and economic circumstances that were connected with the adoption of agricultural techniques in West China during the Qing Dynasty were characterized by significant diversity and complexity. The main spatial characteristic of the agricultural techniques was the coexistence of shifting cultivation, extensive cultivation, and intensive cultivation, and the second one occupied the dominant place in most areas. The shifting mode existed mainly in southwest China and most parts of the Qinghai-Tibet Plateau (青藏高原). The extensive mode of cultivation could be found in the Loess Plateau (黄土高原), the western part of Gansu Province (甘肃), Xinjiang (新疆), the Qinling-Bashan Mountainous Region (秦巴山地), and some mountainous areas of Southwest China. Intensive farming was only practiced in the Guanzhong Plain (关中平原) in central Shaanxi, the Sichuan Basin (四川盆地), and some other places with favorable irrigation systems.

The relations between the geographical environment and certain agricultural technical factors are discussed in the book, and much attention has been paid to investigating the distribution and differentiation of agricultural technology. The author holds that the adoption of certain technical modes or means was mainly determined by their suitability to the particular environment and circumstances, and no clear line of demarcation between intensive and extensive cultivation existed because of

the geographical conditions. One of the major characteristics of agrotechnical distribution in West China in the Qing Dynasty was the phenomenon of a "technology-isolated island", i.e., a relatively advanced technical system existed in a district, around which was a wider area with a backward technical system, and vice versa. The agro-techniques were different not only in modes and types but also in productive efficiency. In fact, people cannot make a correct judgment on the technical efficiency of one production means, skill, or tool without considering the environment in which it has been adopted and practiced. The presence of spatially unbalanced differentiation in agricultural techniques resulted in a technical interaction process. During the Qing Dynasty, the diffusion and exchange of technology played the most important role in West China, where very little technical innovation could be found. The diffusion paths and exchange patterns varied considerably in different places. The most efficient paths and patterns were those suiting particular geographical and social conditions.

The diversity of agrotechnology in West China during the Qing Dynasty was determined mainly by the eco-geographical conditions. So, such factors as heat, moisture, topography, soil, vegetation, and calamity are discussed in the book. These eco-geographical factors were different not only from those in East China but also from each other in the different regions of the western part. On the one hand, the formation of regional characteristics of agricultural technology depended upon the synthetic effect of these eco-geographical factors. On the other hand, the modes and types of technology practiced regionally also had important effects on the eco-geographical environment. One of the conclusions the author has drawn from the discussion is that the unsuitable adoption of agricultural techniques characterized by "slashing and burning" (刀耕火种) and extensive cultivation resulted in the deterioration of the ecological environment, which in turn weakened the sustainable development ability of agriculture itself.

The diversity of agrotechnology in West China during the Qing Dynasty was also heavily influenced by socia-economic and cultural factors, which had distinct characteristics that differed considerably from the eastern part. All social, economic, and cultural factors played specific roles in the adoption of agro-techniques. Slashing and burning, as well as extensive types of cultivation, were typically practiced in sparsely populated areas. Irrigation water distribution was almost always correlated with technical type and efficiency, especially in arid areas like the Loess Plateau and Northwest China. Religions and specific cultural customs in the Qinghai-Tibet Plateau and some mountainous areas of southwest China significantly influenced the trend of agrotechnology development, and the exchange and diffusion of technology were to a great extent limited by unfavorable transportation conditions. People can also see the correlations between agricultural technology adaptation and the geographical environment here.

Contents

Author and Translator

About the Author

Zhenghong Xiao, Ph.D. in Historical Geography and a professor at School of History and Culture in Shaanxi Normal University, Xi'an, China. His research fields include Chinese historical geography, ancient Chinese economic history, and the history of the Ming and Qing Dynasties. e-mail: xiaozh@snnu.edu.cn

About the Translator

Xiaomin Xu, Ph.D. in History and an associate professor at School of International Studies in Shaanxi Normal University, Xi'an, China. She specializes in translation studies and Chinese modern history. e-mail: xxiaomin@snnu.edu.cn

Chapter 1
Preface

Forty years ago, I was a farmer in a village named Nanniwan (南泥湾) in northern Shaanxi Province (陕西省). Each early spring, the men in the "production team" (生产队) went to the nearby hills, chopped down the bushes, and burned the grass around the farmland, so the farmland kept expanding each year. The farmland was mainly located on the hillsides of two narrow valleys, both having a length of around 20–30 km and a width of no more than 200–300 m. In this condition, as the area of farmland increased, the slope of the farmland became steeper, and the field became farther from the farmers' residence. On the Loess Plateau, the farmlands with steep slopes were severely eroded. As a result, it was not uncommon for the newly cultivated field on which laborers had spent the entire early spring to transform overnight into a part of the gully valleys. In addition, farmers spent more time on the way to and from the field, which might be as much as 1–2 h, and less time on farm work. Farmers also spent more time collecting firewood as the woods retreated and and got further from their residential areas.

When I first went to that village, farmers spent about 2 h going to the hills for firewood. Three years later, no firewood was available unless people ventured to the steep hills only accessible by goats. The farming tools in the region were mainly ordinary plows, hoes, and pickaxes. This combination of tools had no fundamental difference from the tools used in the Yellow River valley during the Northern and Southern Dynasties (南北朝, 420–589). The farming method was also very extensive. Farmers went to the field, which was far away from the village, two or three times a year, sowing, weeding, and harvesting. Farmers invested little in farming, not to mention any technical innovations, year after year. This type of farming was called "sowing vastly and harvesting little", which is similar to the descriptions in the local records one or two hundred years before. In comparison with the agro-technical conditions I had become acquainted with during my brief stay in the countryside of the southern part of China, I wondered why the farmers weren't giving up some of the hilly fields and concentrating their time and other investments on the relatively flat and fertile land.

Z. Xiao, *Environment and Selection of Technology*,
https://doi.org/10.1007/978-981-97-1852-8_1

This is a problem with the interaction of the natural environment and technical selection. This problem is of great practical significance because no matter how fast the economy develops in the future, agriculture will always be the foundation, and the relationship between technical options and the environment will still be one of the most important problems. How to select a suitable technique in complex conditions is not only associated with the continuous development of agriculture but also with the preservation and everlasting applicability of the natural environment. Therefore, this problem is far more significant and complicated than imagined.

From the perspective of historical geography, the relationship between the environment and technical options is the focus of agro-technical geography in the history, while one of the goals of this book is to broaden the scope of historical agricultural geography.

Historical agro-technical geography, though an under-explored area, should be considered a relatively independent branch of study. Agricultural geography is a well-known branch of economic geography that studies agricultural zones, agricultural regions, and agricultural landscapes as well as their relationships with natural, economic, and social backgrounds, whereas historical agro-geography studies roughly the same content as general agricultural geography but over a different time span. Of all the problems in the field of historical agro-geography, technological geography is the most important one because agricultural production is deeply affected by technical factors in addition to natural, social, and economic ones. The natural environment and socio-economic factors influence agriculture mainly through the selection of methods and types of technology.

Since the dawn of agricultural civilization, there has been a link between technical options and the environment. According to the literature, farmers in China have been considering the local conditions in farming activities since the pre-Qin Period (先秦). "Adjusting measures to local conditions" is the essence of the relationship between technical options and the environment. In the early stages of agriculture, "adjusting measures to local conditions" referred to merely the physical environment; therefore, it was called "considering the soil types" in ancient classics such as *Zuo's Commentary on Spring and Autumn Annals* (《左传》) and *the Book of Rites* (《礼记》). However, during the period from the Han Dynasty (206BC–25AD) to the Six Dynasties (207BC–589AD), people took some social factors into consideration and expanded the meaning of "considering the local conditions". For example, it has been noted that agricultural technology selection must be combined with labor resource allocation, recognizing the impact of social and environmental conditions on agriculture. Furthermore, in the Han Dynasty, the technical difference applied to geographical physical conditions was also discussed, providing more rational thinking to this principle, which has been inherited by later generations and has become an important part of Chinese traditional agro-technical principles.

Agricultural technique selection is closely linked to environmental conditions, according to traditional agricultural technological ideas. This idea gave us inspiration. The development of modern history and geography further broadens our scope of view. Combining history, agricultural technology theory, and geography can help us make our task, nature, and approach to this research clear. In my opinion, historical

agro-technical geography is an important branch of historical agricultural geography, as well as an important part of history, which mainly aims to study the rules of regional differentiation in terms of agro-technical selection in history. Agricultural technology has always changed throughout human history, though it may change quite slowly in the long run. Since different areas of agricultural production activities occur in different geographical and social environments, agricultural technology itself has significant regional differences, but it is also the result of economic activity throughout the agricultural sector. Regional differences, therefore, form an important reason.

These time and spatial features determine the focuses of historical agro-technical geography, which mainly includes three aspects:

First, the types of agro-technical zones in history and the process of change. As early as the pre-Qin Period, Chinese traditional agro-technology already had the division of intensive, extensive, and primitive farming. The three types can indicate both the different stages of development diachronically and regional differences at the same time. In the later generations, the gap between the three types has been broadening instead of getting narrower. Actually, during the Qing Dynasty, all agro-technical types, ranging from primitive agriculture to intensive agriculture, existed in West China, and the different stages of development over thousands of years co-existed simultaneously. Therefore, what we can see is the diverse agro-technical zone types, which were the layout of a long historical period, and each type had its special track of generation, development, and evolution.

Second, the uneven regional development of agro-technology and the spatial relevance between different stages of development. The diverse regional types are mainly caused by the different speeds of agro-technical innovation and development in different regions, as well as their different directions of development. For a certain period of time, zone types are the result of development, and the course of development is shown in the dynamic imbalance of development between regions. Regional imbalance in agricultural technology is very prominent, either from a time or a space perspective. During the Qing Dynasty, in West China, an imbalance existed between not only regions but also small districts within a region. Even in a small area, remarkable technical differences still existed between a river valley and a hilly field, or the north and south sides of a hill. However, there was hardly a clear-cut difference between regional types because usually there was a transitional area. Thus, the differences between large regions were reflected in the different agro-technical types, while the technical differences between small scopes were usually in the form of specific technical modes or elements.

Anyway, the agro-technical imbalance indicated the interaction between technological zones. The technical imbalance between regions was one of the causes of this interaction, while sometimes spatial interaction breaks the original balance. The spatial interaction of agro-technology consists of two aspects: first, there is always a way of interdependence between agro-technical modes at any level of space division; and second, the selection of agro-technology is affected by the technical transference between regions. To a certain extent, it is safe to say that at any time, the process of agricultural products is the result of interaction between technological zones,

although technical innovation and transference were rather slow during the ages of traditional agriculture.

Third, various relevant elements contribute to the formation of regional agro-technological differences. The different pace of agro-technical innovation and development in different regions owes to the different environments, including the natural, socio-economic, and cultural environments. Although all these elements affect the course of agricultural development, their roles, effects, and ways of taking effect are different. The natural environment is the foundation of agriculture, while socioeconomic and cultural environments determine the direction and speed of agricultural development and the effectiveness of natural resources. In terms of agriculture, they are both exogenous elements, while technology is the endogenous element, which is the means of agricultural production and cannot be isolated from agricultural activities. In that case, the development of agro-technology, as well as agricultural activities, is restricted by natural and cultural environments. Therefore, to study the regional agro-technical difference in historical period, relevant factors such as the natural and cultural environmental conditions must be examined in order to explain the reasons for the difference between regions in terms of agro-technology.

The features listed above indicate that the interdisciplinary nature is the most critical feature of the agro-technical geography in historical period. Its scope of study overlaps to a certain extent with agricultural science, the history of agricultural technology, history, economics, economic historiography, and other subjects, which reflects the compatibility of this subject, but there is a remarkable difference, distinguishing itself from other subjects by its independence. The methodology of this subject is basically the methodology of geography, but by combining methods from other relevant subjects, the historical geography of agro-technology develops its unique methodology.

Agro-technology geography in history is closely related to agricultural science because it frequently encounters agro-technological problems in historical periods. Regional differences in agro-technology are not an abstract concept; instead, they are reflected in a variety of technology types, such as land utilization, irrigation and drainage, farming systems, crop cultivation, and soil and fertilizer. Therefore, to explain the regional differences in agro-technology, it is necessary to investigate the principles and reasonableness of applying that specific technique in a certain geographical environment. It is self-evident that there are differences between historical agro-technology geography and general agriculture science because the former is a branch of geography, which studies the agricultural zones, agricultural regions, and agricultural landscape instead of the agro-technology itself.

Agro-technology geography in history is also different from the history of agro-technology, though they also overlap. They both study agro-technical problems in historical periods, but their focuses and research methods are quite different. In terms of time, historical agro-technical geography mainly studies the spatial process of agro-technology in historical periods, but not the connotation of the development of technology in historical periods. In terms of space, historical agro-technical geography does not discuss technical details in each agricultural zone; instead, it focuses on the spatial distribution of characteristic types and modes of agro-technology. In a

word, historical agro-technical geography is to research into the relationship between spatial process and distribution of agro-technology and environment in either aspect of the time or space.

Hence, it is safe to say that the research object of historical agro-technical geography is the types and modes of agro-technology, advanced or undeveloped alike, in diverse geographical conditions. In contrast, the history of agro-technology examines the connotation development process from a power level to a higher level. It has two features: Usually, its research object is the advanced technological types and modes in a certain period of time; its research content is usually the development process of intensive farming and considers intensive farming as the standard for evaluating all kinds of technological types and modes, which is reasonable for such a subject whose major task is to explain the evolution rules of technology itself. However, it is apparently limited. First, the history of agro-technology ignores the spatial difference in technological development level in the same period, so it cannot elaborate properly on the diversity of agro-technological development in different regions; second, it fails to take the difference in agro-technological types into consideration, so it cannot explain the association between the diversity of agro-technology and the selection of agro-technology in a specific environment. The critical consequence of this approach is that researchers usually take intensive farming as the basic characteristic of agro-technology during the Ming-Qing Period, and the positive materials are mostly restricted to the middle and lower basins of the Yangtze River in southeastern China, the Zhujiang River (珠江) delta and the Guangzhong area in the middle basin of the Yellow River, while the agro-technological development and its relationship with the geographical environment in the rest regions, though a more extensive area, are often ignored.

Since western regions took up a great percentage of the area in China and extensive farming was the prevailing practice in the western region, it is doubtful whether it is sensible enough to use "intensive farming" to conclude the basic features of agro-technological types and modes during the Ming-Qing Period. To change the bias, it is necessary to carefully examine the relationship between the regional distribution of agro-technological types and modes and the specific geographical environment in the western regions, which is impossible for the history of agro-technology due to the limitations discussed above. It is the historical agro-technological geography that is due to take on the task. This is the most remarkable difference between historical agro-technological geography and the history of agro-technology.

Historical agro-technological geography also overlaps with history in its general sense. They are closely related not because the research objectives of the two subjects both existed in historical periods or because the majority of materials in historical agro-technological geography are also historical records, but because the former is included in the latter and historical agro-technological geography is an extension of modern history. Historical geography has a dual nature. It is both a branch of geography and an extension of historical study because it studies geography in the historical period. Such a kind of crossing and blending of disciplines has existed for a long time and is now one of the trends in academic development. Occasionally, it is required to distinguish historical geography from general history. If there

are distinctions, they exist mainly between modern historical geography and history in its traditional sense. History in its traditional sense is related to geography, but geography is always the background or setting while the political, economic, and cultural activities of human beings, which are stated in the sequence of time, are the focuses. Modern historical studies have broken through these conventions and greatly extended their scope of research, taking the historical evolution of man-land relationships, changes in the environment, and other problems as the focal points. Therefore, as a branch of historical geography and a subject mainly elaborating on agricultural zones, agricultural regions, and agricultural landscapes as well as their relationship with the natural and cultural environment, historical agro-technological geography is both historical and geographical in its theoretical basis and methodology.

Other theories and methodologies of historical agro-technological geography are primarily attributed to economics and economic history. Compared to other branches of historical geography, historical agro-technological geography gets more involved in economics and covers a larger portion of the realm of conventional history of economics, for technology is essentially a form of labor, which relates directly to the activities of human beings. Therefore, in a sense, the technological act is an economic activity. As stated above, historical agro-technological geography is constrained by social and cultural conditions. Practically, the spatial differences in historical agro-technology also profoundly affected the socio-economic development of the relevant regions. These associations determine that historical agro-technological geography is bound to apply the theories and methods of economics as well as the results of historical economics research. Certainly, there is a distinction between the two, because historical agro-technological geography studies the impact of people's technological choices on agricultural zones, regions, and landscapes in a given socioeconomic environment rather than the economic relationship underlying this behavior.

This book investigates issues concerning the relationship between agro-technology selection and the environment based on the nature, subject, and methodology of historical agro-technological geography as stated in the preceding paragraphs. This study is restricted to the western region of China for two reasons. Firstly, the western region is to be a focus of China's economic and social development in the following century. At the turn of the century, it is necessary to understand the agrotechnology-environment relationship that existed centuries ago in the western region, as well as the generation and results of its problems. In fact, some of the problems haunting the western region today already existed in the Qing Dynasty. The lesson of history is not far away; how dare we ignore it? Secondly, the previous historical geographical study, in particular the historical agro-geographical study, on the western region is relatively weak. People tend to focus on the eastern region of China when studying agriculture and distribution during the Qing Dynasty because the higher level of intensive agriculture and advanced technology can better reflect the highest level of China's agriculture. However, the western region is not negligible; otherwise, the diversity of China's agricultural development will become unknown, and it will be impossible to understand the relationship between the western and eastern regions in history.

One more reason why I focused on the western regions of China during the Qing Dynasty is my affection for the western regions. I was born in the South, but I have lived on the Loess Plateau for nearly 20 years. Meanwhile, I have been to the Tianshan Mountainous area (天山), Hexi Corridor (河西走廊), Qinling-Bashan Mountainous Region (秦巴地区), and the Qinghai-Tibet Plateau(青藏高原). All the sights—the vast deserts, the rolling snow-capped mountains, the roaring rivers, the imposing history, and the poverty-stricken rural places—are unforgettable to me. I wish I could contribute to the development of the western regions, including the Loess Plateau, with my academic studies, following the steps of Professor Shi Nianhai. This book is only a starting point, and I wish to do further work on West China.

Chapter 2
Environmental Characteristics and Morphological Features of Agricultural Technology in West China During the Qing Dynasty

2.1 Characteristics of Natural Environment and Social Circumstances in the Selection of Agricultural Technology in West China During the Qing Dynasty

The spatial reach of this book covers the western region of China during the Qing Dynasty, which can be divided into four zones: the Loess Plateau, the Northwest District, the Qinghai-Tibet Plateau (青藏高原), and Southwest China. According to the current administrative division, it includes the present Shaanxi Province, Gansu Province (甘肃), the Ningxia Hui Autonomous Region (宁夏), the Xinjiang Uygur Autonomous Region (新疆), Qinghai Province (青海省), the Xizang Autonomous Region (西藏), Sichuan Province (四川), Guizhou Province (贵州), Yunnan Province (云南), and the western Neimenggu Autonomous Region (内蒙古).[1] In this book, all the data relating to "West China during the Qing Dynasty" is restricted to this spatial dimension.

2.1.1 The Features of the Natural Environment in West China

The total area of West China in the Qing Dynasty was about 5.5 million square kilometers. In this vast area, the natural environmental conditions had great diversity, which had a significant impact on the selection and development of agricultural technology.

In terms of topography, plateaus, and mountainous areas accounted for a greater portion of this region, while plains, basins, and river valleys played a much smaller

[1] For political reasons, this book basically excludes the areas that were once within the territory of China during the Qing Dynasty but now belong to other countries, such as the People's Republic of Mongolia and the Republic of Kazakhstan. Except for those specifically mentioned, all of the notes in this book are written by the author.

Z. Xiao, *Environment and Selection of Technology*,
https://doi.org/10.1007/978-981-97-1852-8_2

role. Consequently, the altitude of most parts of the western region was over 1000 m. The surface of the Losses Plateau, which had been cultivated for a long time before the Qing Dynasty, revealed a gully and crumpled landscape. In the northwest, the agricultural zones were mostly on plateaus, but they were relatively smooth. In the southwest, the terrain was much more undulating, with many high and craggy mountains and deep valleys, where temperatures showed prominent vertical differences. The zones suitable for farming on the Qinghai-Tibet Plateau were primarily broad valleys located on the hilly plateau. In addition, the Tianshan Mountains, the Qilian Mountains (祁连山), the Qinling Mountains (秦岭), the Bashan Mountains (大巴山), and the Hengduan Mountains (横断山脉) in the west were all immense mountains, profoundly affecting both the climate zones and human activities.

During the Qing Dynasty, in the western region, the majority of agricultural activities took place on plateaus, which had a very cold climate and a long frost period. Such poor heat conditions make crop planting difficult, and the annual one-crop system was the dominant planting system. On the Qinghai-Tibet Plateau and the Mongolia-Xinjiang Plateau (蒙新高原), husbandry occupied an important position, while crop planting often existed merely in a couple of basins and river valleys. Only the Guanzhong Plain and the Sichuan Basin (四川盆地) had more concentrated and intensive crop planting. The complicated orographic conditions in the vast mountainous area indicated the vertical heat differences, which determined a prominent vertical zone differentiation in agriculture, especially in the mountainous areas in the southwest. This feature affected crop combinations and farming systems in different zones, even leading to different types of agricultural economy. In this terrain condition, when compared with East China in the Qing Dynasty, the western region was distinguished by the great complexity and diversity of agrotechnology, even within a small area.

The climates of West China ranged from the monsoon agro-climatic zone, the northwest arid agro-climatic zone, to the Qinghai-Tibet alpine agro-climatic zone. The types of heat conditions roughly fell into the following classifications: south temperate zone, covering the Loess Plateau and the Guanzhong Plain; northern subtropical zone, including upper reaches of the Hanjiang River (汉江); middle subtropical zone, including the Sichuan Basin, the Western Sichuan Plateau (川西高原), the Eastern Yunnan (滇东高原) and Central Yunnan Plateau (滇中高原) and Guizhou Province; south subtropics, including Southern Yunnan Plateau (滇南高原); subtropical zone, including northwest Yunnan and southern Xizang (Tibet); highland temperature or highland sub-arctic temperature, including the Southern Qinghai Plateau (青南高原), the Qinghai Lake Basin-Qilian Mountains area (青海湖盆地-祁连山区), the Western Sichuan-Eastern Tibet Plateau (川西-藏东高原) and western Xizang; the arid south temperate zone, including Tarim-Hami Basin (塔里木-哈密盆地); and arid middle temperate zone, including the majority of Gansu and Xinjiang.

Precipitation in different climate zones had significant differences: in the northwest arid areas, except for some mountainous areas, the average annual precipitation was less than 400 mm. The southwest region had more precipitation, but it had an

unbalanced time and space distribution, and the precipitation variability was prominent since plateaus and mountains make up the majority of the region. Autumn usually has more precipitation than spring. The southern part of the Qinghai-Tibet Plateau, including the Lancang River (澜沧江) and the Nujiang River (怒江) valleys, had an annual precipitation of nearly 1000 mm. The precipitation in the central and western parts of southern Xizang was less than half the amount in the southeast part, and in the east, there was merely half. In terms of surface water resources, southwest China had abundant surface water resources, while the Loess Plateau and other northwest regions were lacking in surface water resources, and seasonal variation in river flow was very obvious.

Since the majority of West China was short of water resources during the Qing Dynasty, water conservation technology was extremely important. In the driest areas in West China, including the western Ningxia Plain (宁夏平原), the Hexi (河西)area in Gansu, the north and south of the Tianshan Mountains and the central and western Qinghai-Tibet Plateau, there would have been no agriculture without irrigation. On the Loess Plateau, the moisture guarantee rate was low, so agricultural yields were not stable without irrigation. However, the lack of surface water resources made most irrigation technologies impossible. In the Southwest, agricultural moisture conditions were better than in the other regions of West China. Generally, the Sichuan Basin and the Yunnan-Guizhou Plateau (云贵高原) region had abundant rainfall. However, due to the uneven distribution of rainfall during the year, irrigation was also a necessary technical measure. However, due to the complex terrain conditions in the southwest, most regions were unable to take the diversion approach used in the Dujiangyan Dam Irrigation Project (都江堰). Owing to the low moisture guarantee rate in West China, how to improve the utilization of water resources through technical measures, such as channel construction, canal distribution, and water distribution and regulation, was an important factor of agriculture in West China during the Qing Dynasty.

The edaphic conditions in West China were also quite diverse. The latitudinal zonality in the western region existed, though it is less apparent than that in the eastern regions. First, the farming history of West China was more diverse than that of the eastern region, so the regional diversity of agricultural soil also became prominent. The Loess Plateau, the northern valley of the Weihe River (渭河), and the eastern Gansu were composed of dark loessial soil, cinnamon soil, and loessial soil in hilly or valley areas. Dark loessial soil and cinnamon soil, being good at water conservation and fertile, have good soil structure, while loessial soil is highly susceptible to erosion. In the northwest area, the soil is mainly desert steppe soil, specifically brown calcic soil and sierozem soil, as well as some saline soil. The various types of calcareous soils are strongly alkaline, so the cultivation technology in the northwest area is also different from other places. In the northwest, most of the saline soil is secondary salinization soil, which is a consequence of specific agricultural technology. The Qinghai-Tibet Plateau mainly belongs to an alpine soil type, which is not conducive to crop growth. In Southwest China, in the Sichuan Basin and most of Guizhou Province, yellow soil is the major type of soil, while western Guizhou and Yunnan are mainly composed of red soil. These types of soil are generally sticky, sour, thin, and not conducive to the majority of grains, but they

are suitable for the growth of some commercial crops. This feature has a greater impact on crop distribution and regional structure, and also has higher requirements for cultivation technology.

Owing to the great diversity of terrain, climate, and soil conditions, agricultural natural calamities manifested themselves as extremely diverse and complex. Natural calamities in West China during the Qing Dynasty included mainly drought, waterlogging, hail, dry-hot wind, and low temperatures. Although natural environmental conditions were a major factor in the occurrence of natural calamities, calamities could not be attributed solely to natural conditions, no matter which form of natural calamity it was. Drought was mainly caused by inadequate precipitation, but planting and husbandry mix, water conservancy technology, and soil cultivation techniques were also important factors. Whether waterlogging could cause disasters was closely related to water conservation facilities. Moreover, in addition to climatic changes, natural agricultural calamities such as droughts, waterlogging, and low temperatures were also related to crop varieties and structures. Therefore, how to mitigate calamities was also a technical issue.

The diversity and complexity of the natural environmental conditions discussed above made the technological choice in West China during the Qing Dynasty very difficult. Although people took measures that suited the local conditions, making the technology choices diverse accordingly, under the conditions of traditional agriculture, a single technology had limited applicability. This situation increased the difficulties of technical innovation and promotion as well as the risk of applying new technology. Therefore, whenever discussing the difficulties of promoting new techniques in the western region, people need to consider natural environmental factors as their first concern.

2.1.2 The Features of the Social and Cultural Circumstances in West China

If the difficulty in selecting agricultural technology in the western region during the Qing Dynasty only came from the natural environmental conditions, the problem may be simpler. Indeed, cultural and social factors contributed to the tendency toward technology selection and the difficulty of technological development.

West China during the Qing Dynasty was characterized by its multi-ethnic and multi-religious nature. According to the present national distribution system, there were as many as 47 in the western region out of the total 56 ethnic groups in China. During the Qing Dynasty, because of the difficulty in identifying nationalities, it was hard to estimate the exact number of nationalities in the western region, but it is reasonable to estimate that the total composition and distribution should be more complex than in the present situation. Different nationalities usually have different cultures, which are demonstrated in their habits of life, types of the agricultural economy, land utilization, farming technology, etc. The cultural differences, cultural

barriers, and conflicts between different ethnic groups in West China during the Qing Dynasty had a great impact on the development and diffusion of agricultural technology, which was further worsened by the policy of the Qing Dynasty towards ethnic groups. In addition, ethnic culture is usually associated with religion. The influence of religious customs on the selection of agricultural technology can sometimes be quite significant. In areas where religion was very influential, in addition to factors of the natural environment, farmers' choices of technology were restricted by more non-economic factors than in other regions.

The labor resources in West China during the Qing Dynasty were generally inadequate. According to the official population statistics, West China had a population of 72 million[2] in the 10th year of Daoguang's (道光) reign (1821–1850), only 18% of the total population, while it covered about 57% of the country's total area. It can be inferred that the population density was very low. The sparse population and vast area were major obstacles to the utilization of certain technologies, especially their diffusion and promotion. However, the situation was worsened by the extremely uneven distribution of the population. Apart from the few traditional agricultural areas such as the Guanzhong Plain and the Sichuan Basin, the population of most regions in West China was sparsely populated. This labor resource condition was closely related to the extensive agriculture-based technology distribution in West China during the Qing Dynasty.

Though the economic foundation of different areas in West China was significantly different, the prevailing poverty was the most common feature. The Guanzhong Plain, Ningxia, the Sichuan Basin, and the Hexi area had a long history of agriculture, though at different stages of development. The other areas in the western region had even worse agricultural production conditions and a lower agricultural economic level. In reading literature from the Qing Dynasty, the frequently seen expressions are "people have no savings" and "the soil is sterile and the people are in poverty" when describing the agricultural economy in the western region. The prevailing poverty in West China was much more prominent than that in the eastern region, which certainly had a profound influence on the selection of agricultural technology because technical change increased investment in farming and the risk of applying new technology also demanded farmers have a higher level of affordability. Farmers would rather plant low-yielding crops with traditional technology than invest their limited resources in an unfamiliar and newly introduced technology that had the potential to produce higher yields. Therefore, widespread poverty was also an important obstacle to the development of agricultural technology in the western region during the Qing Dynasty.

During the Qing Dynasty, the Loess Plateau, the Sichuan Basin, the eastern and northern Sichuan, the central region of the Yunnan-Guizhou Plateau, the Hexi area in Gansu, as well as the Ningxia Plain, had a very mature feudal landlord economy.

---

[2] See Li Wenzhi 李文治. (1957). *Data of Modern Agricultural History of China* (Vol. I)《中国近代农业史资料》. SDX Joint Publishing House. This data is based on the record in the *Board of Revenue* of the Qing Dynasty, and the number does not include the population in Xizang and western Neimenggu.

In accordance with it, the agricultural economy was mainly based on farming. In the Tibetan Plateau and the majority of mountainous regions in the southwestern region, there still existed an outdated slavery and serfdom system that was in conformity with a mixture of farming and husbandry economies. In many ethnic groups in the southwest, there also existed a communal system, in which the commune organized and implemented primitive agricultural production based on slash-and-burn farming. Vast areas of the north and south of the Tianshan Mountains had more developed irrigation farming or oasis agriculture, but animal husbandry still occupied an important position where social and economic relations were more complex, with both serfdom and landlord economy systems.

During the Qing Dynasty, in the Guanzhong Plain, Hanzhong (汉中), and the Sichuan Basin, agricultural production was typical of small-scale peasant production carried out independently by individual farmers, with a prominent tendency toward commercialization after the mid-Qing Dynasty. However, as for large-scale stationing of troops and cultivation in the western part of Hexi and Xinjiang, the planning and organization of production were controlled by the state and had almost no contact with the market. While the southern part of Xinjiang was different, where agricultural activities were carried out by individual farmers and seemingly had a higher level of commercialization than northern Xinjiang. In the mid-Qing and the late Qing Dynasty, southwest areas, such as the Qinling-Bashan mountainous region, southeast Sichuan, northern Guizhou, and Yunnan's northeastern region, had a remarkable development of market-related industrial crops and economic trees, but other southwestern areas, such as the southern and western Yunnan, the southern Guizhou, and the southern and western Sichuan, still maintained the traditional crop structure, with subsistence agriculture as the dominant form and low commercialization. In the majority of the areas on the Qinghai-Tibet Plateau, agriculture was basically isolated from the market.

The diversity and unbalanced levels of social development and economic production types undoubtedly had an important impact on agricultural technology selection. The problem became even more complex when these humanities and social factors were combined with natural environmental factors. We had a deep impression of the complexity and diversity of agricultural technology selection in the western region of China during the Qing Dynasty at the beginning of this study, and after probing into the impact of various natural and social factors on the selection and development of agricultural technology, we reached the conclusion that the diversity of agricultural technology in West China during the Qing Dynasty was determined by the diversity of the environment. This will be further discussed in the following chapters.

2.2 Major Morphological and Spatial Distribution Features of Agricultural Technologies in West China During the Qing Dynasty

Complex and varied environmental conditions would almost certainly result in the diversity of specific forms of agricultural technology, which consequently appeared differently in different areas, although they were completely different. There were always some transitional morphologies between the so-called "intensive cultivation type" and the "shifting cultivation type", so when dealing with a specific area, we often see only a mixture of multi-leveled and diversified agricultural technologies. However, if we analyze the types of agricultural technology from a macroeconomic perspective and on the basis of certain basic indicators, we are able to generalize the regional morphological characteristics.

In the vast area of West China during the Qing Dynasty, there was not only the oldest intensive agricultural technology in the country but also the most extensive agricultural technology. In fact, during the Qing Dynasty in West China, specimens of almost any kind of technology could be found, ranging from primitive agriculture to intensive agriculture, implying that the result of diachronic evolution over thousands of years also existed synchronically in the different spaces. Based primarily on the modes of agricultural production, agricultural equipment and farming systems, the agricultural technology of the West China during the Qing Dynasty can be divided into three major types: intensive cultivation, extensive cultivation, and primitive shifting cultivation.[3]

2.2.1 Intensive Cultivation Agricultural Technology

Intensive cultivation refers to labor-intensive agriculture. Technologically, intensive cultivation was mainly characterized by crop rotation, multiple cropping, extensive use of fertilizers, relatively careful technical management in the process of crop growth, advanced irrigation facilities and management technology, as well as relatively complete agricultural equipment. In the areas adopting this agricultural system during the Qing Dynasty, the technology arrangement throughout the year was usually a complete integrated system with higher land utilization, the tendency to pursue higher output per unit area, and a higher degree of agricultural commercialization.

During the Qing Dynasty, intensive agriculture technology in the West did not have a wide spatial distribution, nor could its technological level be parallel with that in East China. Generally speaking, in the West, intensive agriculture technology was only adapted in a number of valley and basin areas that had a long agricultural history,

[3] In some chapters of this book husbandry is considered as an independent areal type of agricultural technology, but in general this book applies the narrow meaning of the term "agriculture"—farming—as the major object of study.