Agricultural Technology Transfer

to Developing Countries

SUNG-CHING HSIEH

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About the author

Sung-Ching Hsieh

Born in Taiwan in 1928. He received primary, secondary and university educations in Taiwan, and Ph. D. degree from Hokkaido University, Japan. He is presently a Professor of the National Pintung University of Science and Technology.

He held several positions in the past: (1) Professor of Cytogenetics at National Chung-Hsing University; (2) Research Professor of National Science Council; (3) Concurrent Professor of Advanced Genetics at Chinese Cultural University; (4) Concurrent Associate Research Fellow, Institute of Botany, Academia Sinica; (5) Research Fellow and Head of Agronomy Department, Taiwan Agricultural Research Insitute; (6) Director General, Taichung District Agricultural Improvement Station; (7) Senior Officer, Joint Division of FAO/IAEA, International Atomic Energy Agnecy (IAEA) of United Nations (Vienna); (8) Excecutive Secretary General, Committee of International Technical Cooperations (CITC); (9) Deputy Sectretary General, International Coopeation and Development Fund (ICDF).

During his tenure as the officers of international business related oraganizations (IAEA, CITC and ICDF), he travelled extensively throughout the world, covering Europe, North America, Central and South America, Africa, Mideast and Asia-Pacific regions. His world-wide tour enabled him to observe and study international agricultural situations of various countries which served as the basis for writing this book.

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Preface

The modern agricultural technology developed in 1960s has been instrumental to the growth of agriculture in various parts of the world, especially in the developed countries. The success, often referred as "Green Revolution", was brought about mainly by efficient combination of high yielding varieties, improved cultural technologies and investment in irrigation, fertilizer and other inputs. Transfer of newly developed technology also contributed greatly to enhance agricultural productivity in many developing countries.

In the initial period of "Green Revolution", adoption of the technology was skewed toward larger, better-off farms in developed countries. In contrast, technology adoption in the developing countries was very much left behind. This delay in technology adoption resulted in much larger gap between developed and developing countries in economic development. This is a serious problem required special attentions and resources to find ways for its solution.

In order to address this problem, National Pingtung University of Science and Technology, offered a course of "Technology Transfer in Agriculture" designed mainly for international students, at its Graduate Institute of Tropical Agriculture and International Cooperation. Dr. Sung-Ching Hsieh has been invited to give lectures for this course since 1998. His lectures are now collected and compiled into this book, consisting of fourteen chapters on various aspects of agricultural technology transfer. These chapters focus primarily on agricultural technology development, technology transfer, constrains of technology transfer, and impact of agricultural technology transfer on the socioeconomic conditions in the rural area.

The results of various case studies on technology transfer experienced by Dr. Hsieh in Southeast Asia, Africa and South America are included in this book. Research findings of transferring technology for rice production from Taiwan to thirteen African countries helped solve food security problems in those countries through technology transfer. This book provides the basic philosophy of technology development, technology transfer, and technology adoption in developing countries. It is especially worth mentioning that this manuscript is written largely on the basis of the author's first hand experiences in onsite surveys of agricultural production, in relation to technology transfer, in various developing countries of the world.

Dr. Hsieh, though trained as geneticist and earned a distinguished professorship of genetics at the National Chung-Hsing University, has devoted much of his time in international cooperation in recent years. This book accumulates his rich experiences in research and teaching in the agricultural technology transfer. I believe it serves not only a good textbook for students to study, but also a good reference for those who are interested in the international agriculture development and technology transfer.

Chang-Hung Chou, Ph.D.
President,
National Pintung University of
Science and Technology; and
Member, Academia Sinica
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Foreword

Development professionals often ask: why is the world unevenly developed? why is the world divided into 'developed' and 'developing' countries in terms of per capita income and living standards? Some observers have stated that poor countries have been unable to absorb necessary development technologies because of inadequate educational development, a surfeit of languages and dialects, and lack of business management skills (Marlowe, 1988).

The poor performance of developing countries is also blamed on poor resource situations. Small-scale farmers in the Asia-Pacific region, Central America and most African countries are typically resource-poor, possessing only small plots of land. They must rely on traditional farming of short-term crops, and seldom have experience accessing outside sources of assistance and essential development technologies.

How can these technoloies and resource-poor farmers be helped? This is the most important question that development professionals need to answer. Agricultural potential in underdeveloped countries, where soil is rich and rainfall is abundant, is considerable. To be able to exploit this potential, it is essential to consider a number of issues and constraints that hinder higher productivity and concomitant improved welfare. Different agricultural technologies need to be developed and adopted, in order to replace inefficient traditional farming techniques and practices. Poor farmers in developing countries also require policy support from governments.

How various agricultural technologies were developed, and how they were transferred to and adopted by farmers in developing countries in the past needs to be understood before developing new technology transfer strategies. Different countries have different technology transfer systems. Some systems are functioned well under given conditions, while some do not under alternative conditions. The reason why this happens needs to be clarified before new strategies are developed.

The author took part in international coordinated research on agricultural technology transfer, sponsored by the Asian Productivity Organization (APO). He learned about general agricultural technology transfer situations while visiting the coordinating Asian countries in 1989. In the past years, the author served as Executive Secretary General of the Committee of International Cooperation (1993-1997), and Deputy Secretary General and Adviser of the International Cooperation and

Development Fund (1998-2002). During his tenure in these organizations, he visited many developing countries in Southeast Asia, Africa, Central and South America, and the Middle East, and learned how agricultural technology has been transferred to these countries from developed countries. The main concerns of the studies were government policies and programs, technology development and adoption, accessibility of technology for institutions and support services, socioeconomic analysis, and the roles of agricultural development extension work in each country.

The results of various case studies on agricultural technology transfer from developed countries to developing countries are compiled in this book. The following subjects are included: (1) Concepts and practices of agricultural technology transfer; (2) Impact of new agricultural technologies on the socioeconomic conditions of rural communities in developing countries; (3) Effects of dissemination of appropriate agricultural technologies to small farmers; (4) Integration of traditional farming techniques and practices with modern technology; (5) Problems and constraints, and various measures employed by the government to resolve them; (6) Follow-up activities to more fully address the requirements of countries in these areas.

The past and present status of agricultural technology transfer from Taiwan to developing countries in Africa, Central and South America and the Asia Pacific region are used as case studies in this book. It is hoped that this book will serve as a useful reference to those interested in the concepts and practices of international cooperation and technology transfer. The author wishes to express his sincere thanks to National Pingtung University of Science and Technology for printing this manuscript as a textbook. Finally, thanks are due to my wife Hui-Hsing for her patience, support and understanding.

Sung-Ching Hsieh

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Content

Part 5. Case Studies on Technology Transfer for Rice Production to African Countries

Part 6. Studies on Transferring Technologies of Production and Marketing of Horticultural Crops to Africa and South America

CHAPTER 1. INTRODUCTION

1-1. Definition of technology transfer

The definition of transfer can be broken down into three phases. First, technology should be developed. Then, the developed technology should be utilized. Finally, developed technology should be transferred to the needed parties for diffusion. The full utilization of newly developed technologies contributes greatly to the economic growth of a country. According to Spencer (1967), "technology transfer means a reasonable inter-flow of information and technologies to achieve the objectives of a project or business." The flow of technological information should be at both national and international levels, including diffusion of technology within (domestic) and among (international transfer) nation-states.

Technology transfer is a kind of natural or spontaneous process, from people to people, and from one field to another, with the ultimate aim of promoting human welfare. In the field of agriculture, food production is enhanced through the effective transfer of modern farming technology.

1-2. Development of agricultural technology

Agricultural technology can be classified into three areas: (1) systematic technology; (2) specific technology; and (3) individual technology. Systematic technology can be of varied kinds, such as rice production technology, vegetable production technology, animal husbandry technology, etc. All of these technologies can be developed and integrated into effectively managed farm production skills. Specific technology refers to techniques applied in each step of crop production. For instance, for tilling, specific farm machinery technology should be developed. For crop cultivation, new varieties should be developed; for which specific technologies, such as fertilizer and pesticide technology are needed. All of these technologies should be upgraded from time to time through continued research (Figure 1).

According to Suzuki (1997), macro- and micro-conditions are of concern in the course of agricultural development. Macro-conditions (regional conditions), involve natural and socioeconomic factors. Natural factors include geography, weather, soil and plant growth conditions. Socioeconomic factors involve social systems and life habits, extension organization, banking systems, and supply and marketing systems (Figure 2).

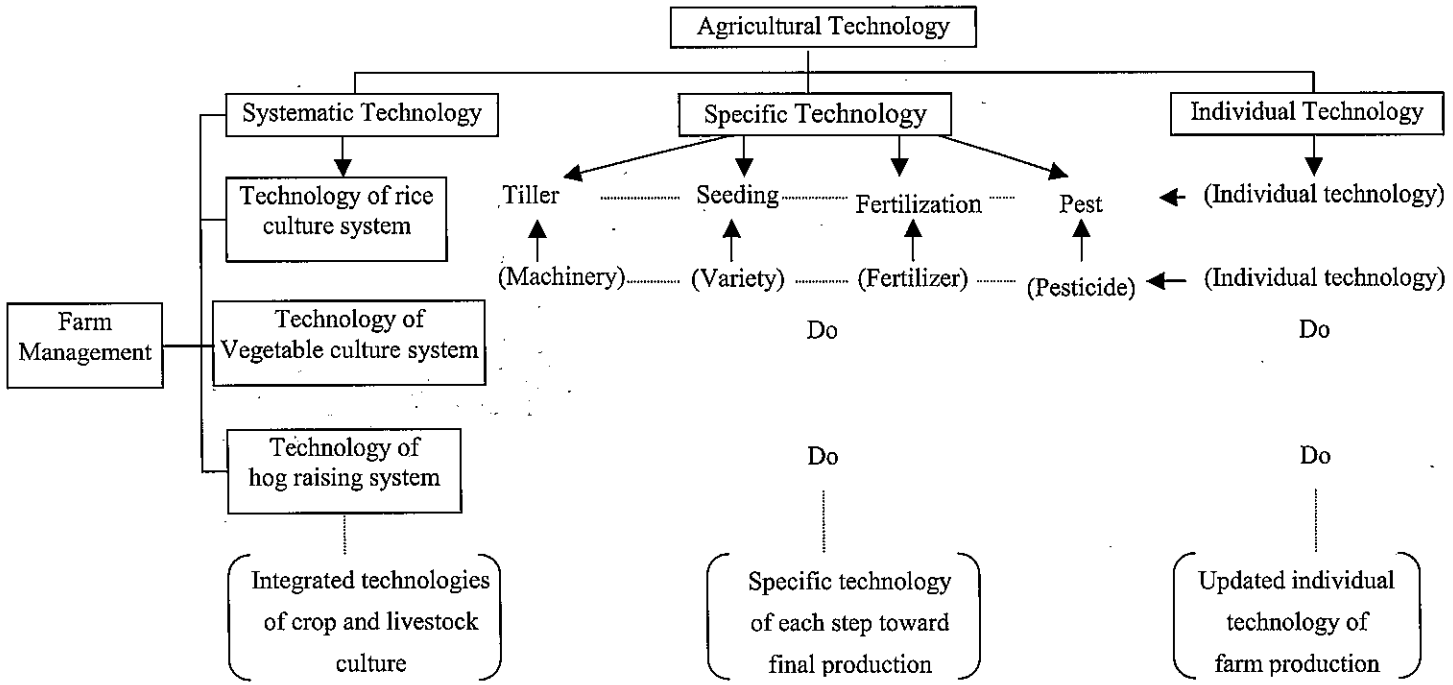

Fig. 1. Classification of agricultural technology (Source: Suzuki, 1997).

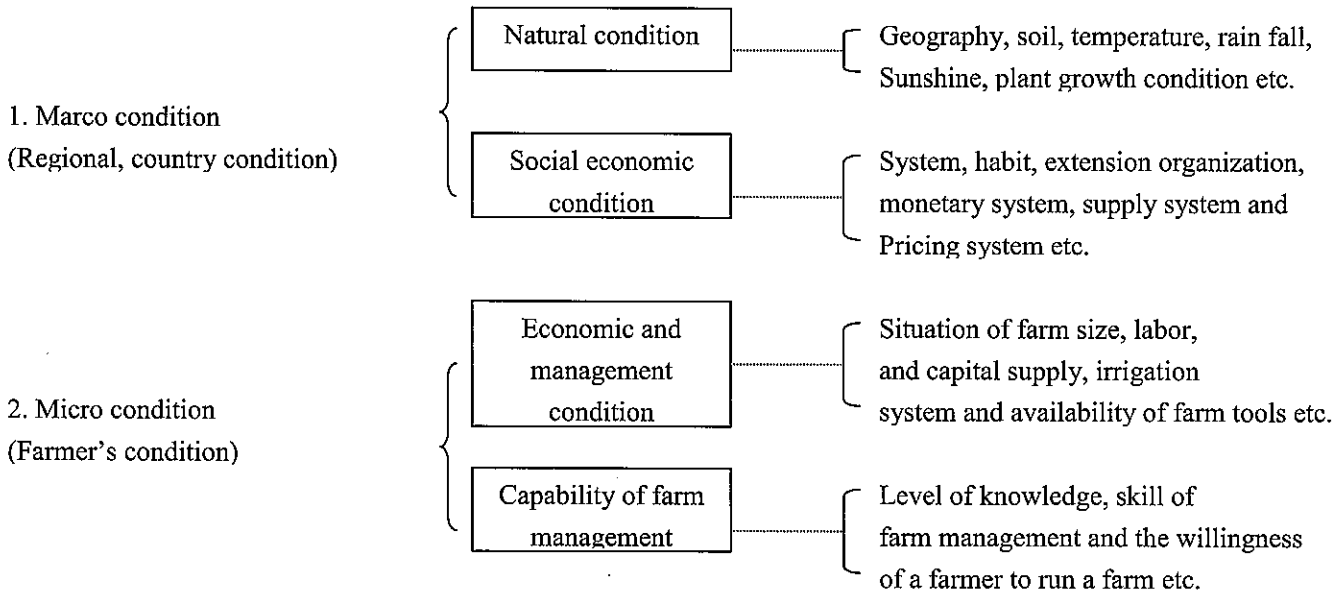

Fig. 2. Condition of agricultural technology development (Source: Suzuki, 1997).

Micro-conditions (farmers' conditions) can be twofold. First are economic factors, such as farm size, capital and labor supply. Second are farm management capabilities, which include educational levels, administration skills and the willingness of people to operate a farm.

Looking at these overall conditions, one can get a general picture of factors involved in agricultural technology transfer. Since so many factors are involved in agricultural technology transfer, people should upgrade their skills and strive to absorb more knowledge in varied fields upgrading skills is especially important for people who are directly engaged in technology transfer or extension work.

1-3. Importance of agricultural technology transfer

In spite of decades of modern agricultural research, small farms in most developing countries are still farming with traditional technology, and productivity remains low. Traditional methods of farming often co-exist with modern high-input farming.

Modern technology is not specifically developed for wealthier farmers, and neither has it been developed strictly for poor farmers. Farming success depends completely on which farmers are best able to adopt new technologies. Opportunities to acquire new technologies are available to most farmers in virtually every country, but in developing countries the results of agricultural research should be more effectively transferred to farmers. If agricultural research is aimed at helping small farmers, there must be a selective emphasis on developing specific technology for these farmers. For instance, drought resistant varieties should be developed to suit upland fields. If a newly developed drought resistant variety is not introduced to farmers through on-farm demonstrations or other means, it may never be used by the farmers. The adoption of new technology through extension service is thus very important.

PART 1

GENERAL DESCRIPTION OF TECHNOLOGY TRANSFER

CHPTER 2. A REVIEW OF PREVIOUS RESEARCH ON AGRICULTURAL TECHNOLOGY TRANSFER

2-1. History of agricultural technology transfer

In the 19th century, agricultural technology transfer was primarily conducted by pastors through church activities. With the realization of the importance of agricultural technology to economic development, people began to look into various other aspects and methods of technology transfer at the beginning of the 20th century. In Europe, French scholars first studied various social phenomena related to economic development. Later, they studied the role that communication played in economic growth in rapidly changing societies. In 1920, research on government extension programs was conducted in the USA. With the results of extensive studies on this subject, people realized the importance of technology development and information collection and dissemination in agricultural extension work.

Development of hybrid corn and its extension in 1943 contributed greatly to national corn production in the USA. The success of the extension work on hybrid corn production prompted scholars at Ohio State University to undertake extensive research on extension systems for other crops. Later in 1950, many advanced countries in Europe, as well as Japan, launched similar research. In 1960, many developing countries, including Bangladesh, the Philippines, India and Colombia, joined in similar research efforts. People in Bangladesh conducted a survey on the impact on rural development of adopting new agricultural technologies through extension work. People in Columbia also conducted a study on the transfer of new agricultural technology.

In 1971, based on the results of communication research, Rogers published his popular book "Communication of Innovations." The book served as a good guide for formulating the concept and practice of modern technology transfer. After several years of study, M. Saito published a book entitled "A discussion on technology transfer" in 1979. Saito emphasized the importance of the inter-flow of new technologies among different countries.

With active research in agricultural technology transfer, many papers and books have been published since 1967, including: (1) "Transfer of technology to developing countries" (Spencer 1967); (2) "Theory and history of international

technology transfer" (Hayami and Ruttan, 1971); (3) "Prospects of research on technology transfer" (Kobayashi, 1972); (4) "The process of agricultural growth in Japan" (Hayami, 1973); (5) "Economy of rice and technology transfer in Indonesia" (Hara, 1975); (6) "Technology transfer in agriculture" (Saito, 1979); (7) "The process of rice production and its future prospects in Hokkaido, Japan" (Takahashi, 1979); (8) "A thinking of technology transfer" (Kobayashi, 1977); (9) "Technology transfer" (Kobayashi, 1981); (10) "Small is beautiful" (Schumacher, 1989); (11) "Discussion in agricultural technology transfer (Suzuki, 1997). The results of research on technology transfer by these scholars served as the bases for developing modern concepts and practices of technology transfer.

2-2. A brief review of previous research on agricultural technology transfer

(1) Hayami and Ruttan (1971). The authors evaluated the feasibility of adopting the established Griliches communication model in international technology transfer. They found that two factors limited international technology transfer: (1) the ability of research institutes to develop biological technology, and (2) the industrial capacity to develop mechanical technology. They proposed three steps for technology transfer: (1) material transfer; (2) design transfer; and (3) capacity transfer.

(2) Hayami (1973) analyzed the process of technology transfer for rice production from Japan to Korea and Taiwan. The study focused on the impact on the Japanese rice market with increased imports of Korean and Taiwanese rice. The increase of rice production in Korea and Taiwan resulted from adopting new Japanese technology. Hayami concluded that the success of transferring rice production technology to Korea and Taiwan was due to two factors: (1) the ability of the people in these two countries to adopt the new technology, and (2) their ability to cope with the natural environment (weather, soil and water conditions) for newly introduced varieties of rice.

(3) Schumacher (1989) indicated that during the course of technology transfer, methods used for the transfer should be adjusted according to the ability of people to accept the new technologies in a country. To ensure successful technology

transfer, he stressed the importance of setting up an intermediate step for gradual transfer of agricultural technology in given nations.

(4) Hara (1975) pointed out the importance of environmental factors and rural infrastructure in international agricultural technology transfer. In this context, he analyzed the economy of rice production in Indonesia, linking rural infrastructure systems and dynamic methods of technology transfer. He concluded that to effectively transfer technology, extension workers should seek advanced farmers or core farmers as the targets for extension work. He found that Indonesia needs to reorganize its existing extension system, to suit the fast-changing environment. He then theorized that if technology transfer were targeted to increase production, it would usually achieve this goal. However, excess production of rice often leads to lower prices, which in turn can have a negative effect on social welfare. In this respect, in the course of government policymaking, possible negative effects of technology transfer should be considered.

(5) Saito (1979) performed an overall study of technology transfer. He suggested combining all individual technologies into one system and operating it in an integrated manner. His proposal of integrated operation of technology transfer has been well received and is highly regarded by the public.

(6) Takahashi (1979) performed a historical review of rice cultivation in Hokkaido, where rice was once regarded as impossible to grow due to the island's cold climate. However, rice has become the main crop in that region today. The rapid expansion of rice acreage in Hokkaido was primarily due to the development of low-temperature resistant rice varieties, and Japan's effectual extension system.

The high yielding variety Akage (selected by farmers) and other low-temperature rice varieties developed in experimental stations were soon adopted by the farmers. The technology transfer capabilities of the suppliers (experiment stations and extension agents) and the adoption capabilities of the receivers (farmers), were evaluated. Takahashi stressed the importance of extension work, through which new varieties of rice were quickly distributed in northern Japan.

The above mentioned studies focused on technology development, methods of technology transfer, and the attitudes of supplying and receiving sides. Some scholars combined these factors in order to effectuate technology transfer in an integrated way. Some researchers studied individual factors concerned with

technology transfer in more detailed ways, while others analyzed the positive and negative effects of agricultural technology transfer on socioeconomic development. The results of this research have contributed greatly to the development of technology transfer concepts.

Research on agricultural technology transfer during 1980-1984 will be introduced next, based on the following published papers and books. (1) Seeking a solution for the conflict between adopting innovation through technology transfer and maintaining existing traditional cultures (Kawano, 1982); (2) Technology transfer (Kobayashi, 1981); (3) Agricultural development and technology transfer (Yamada, 1981); (4) Human and social background of tropical agriculture in relation to technology transfer (Ochiai, 1982); (5) Japan experience of technology transfer (Ieinaga, 1982); (6) On the appropriate technology in developing countries — the case of Bangladesh (Nakada, 1983); (7) Agricultural extension: the training and visiting system (Benor and Harrison, 1984); (8) Technology transfer, modification, and development – Japan experience (Hayashi, 1984).

(7) Kawano (1982) pointed out that, in theory, economically important new technologies should be easily accepted and adopted by farmers in any society. In reality, however, this is not always true. The cause of unsuccessful technology transfer in some countries is primarily attributable to societal attitudes. People may be satisfied with traditional living styles, and reluctant to accept new things. In this regard, Kawano (1982) stressed the need to study social background and from there to work out proper solution measures. Education of farmers, particularly regarding language problems, should first be implemented in order to facilitate communication between extension workers and farmers.

(8) Yamada's research (1981) pointed out that agricultural production in Asia depends largely on limited land, and stressed the importance of biological and chemical technologies to enhance per-unit production. In this context, the importance of human exchange and human contact was stressed. Ochiai (1982) stressed the importance of interdisciplinary research in relation to technology and social science in the course of technology transfer to developing countries.

(9) Based on his studies on transferring Japonica rice to Taiwan and Malaysia, Ieinaga (1982) classified technology transfer into three categories: (1) material transfer, (2)

design transfer and (3) capacity transfer. Capacity transfer is considered the most important among the three, but also the most difficult to carry out. Capacity transfer is firstly concerned with farmers themselves, stressing that farmers should be able to develop their own agricultural technology. Secondly, it is concerned with the necessity of providing updated laboratory equipment and facilities to expedite work in research institutes. Thirdly, capacity building is needed to make pesticides, fertilizers, plastic buildings and other materials. These three factors should be closely linked together so that to have an effective farming. This kind of linkage is seriously lacking in most developing countries.

(10) Nakada (1983) studied agricultural technology transfer to Bangladesh during his seven-year stay in the country. He stressed that the acceptability of new technology to poorly educated farmers should always be considered during technology transfer, especially in developing countries. Human relationships, he found, are essential to effective agricultural technology transfer.

(11) Benor and Harrison (1984) evaluated the operation of the Training and Visit (T&V) system devised by the World Bank. The T&V technology transfer system is regarded as a good extension system for rural development, and has been used extensively in various countries around the world, especially in Africa.

(12) Hayashi (1984) studied the process of developing modern technology transfer in Japan. He pointed out that successful technology transfer in Japan was due to the following three factors: (1) Japan is a sovereign country and not under the control of a foreign country; (2) there is a good technical base, making the adoption of advanced western technology much easier and more effective; and (3) Japan is composed of a long archipelago from north to south, with mountainous geography. This complicated geographical situation required the people in Japan to solve different problems in diverse conditions. Their experiences have been extremely valuable.

The above mentioned studies primarily concentrated on the matters of receiving sides, such as the characteristics and methods of technology transfer, and the importance of farmer's education in extension work. They stressed the necessity of conducting interdisciplinary research in areas of crop production, livestock raising, extension work and economic analysis. They also stressed the

necessity of conducting in-depth research about the impact of technology transfer on economic development and the social welfare of rural people.

Papers published from 1986-1989 will be examined next. (1) An appropriate technology and economic development (Yoshida, 1986); (2) International technology transfer from first comer to late comer developing countries — An introductory note (Wang, 1986); (3) Strategies in the transfer of technology: The IBFEP approach (Duha, 1986); (4) Effective transfer of new technology (Issac, 1989); (5) A consideration on technology transfer and systemization (Kobayashi, 1988); (6) Technology transfer the Japanese immigrant — the case of Japanese immigrant in Brazil (Miyakawa, 1988).

(13) Yoshida's book (1986) is concerned with the evaluation of "intermediate technology" and "proper technology" used in Africa. He cites K. Hanzawa's paper (1986) and discusses the possibility of transferring the method of using cows to work in the fields of the southern Sahara in Africa. All of these efforts were made to support food production with locally available resources and technology in African countries.

(14) Wang (1986) studied the inter-flow of technology from advanced countries to developing countries using the successful case of Korea as an example. He stressed the importance of the role played by developed countries in technology transfer to developing countries.

(15) Dhua (1986) studied the successful Indo-British Fertilizer Education Project, carried out in six western states of India. He analyzed the factors contributing to successful technology transfer in this project. He concluded that education of citizens was especially important during the course of technology transfer.

(16) Issac (1987) studied ineffective technology transfer from developed countries to developing countries. He found that there is a significant difference between developed and developing countries in terms of farmers' ability to accept new technologies. To solve this problem, he stressed the importance of education for general citizens, and farmers in particular. The need for enhanced education for extension agents and government officials in developing countries was also emphasized. Governments should allocate more funding for this purpose.

(17) Kobayashi (1988) reviewed various international training courses and seminars organized by JICA (Japan International Cooperation Agency) with regard to their impact on technology transfer from developed countries to developing countries. He stressed the need of developing countries to establish unique extension systems, and to devise effective technology transfer methods. This study served as a good reference for developing countries to establish their own agricultural extension systems.

(18) Miyakawa (1988) studied the role of technology transfer played by the immigrants in developing countries. He concluded that immigrants from developed countries contributed greatly to cultural exchange and economic growth in developing countries. These phenomena can be commonly seen, especially in Africa and South America.

(19) Suzuki (1997) published a comprehensive 297-page book entitled "Discussion in agricultural technology transfer," describing the results of his wide ranging research work on agricultural technology transfer in both developed and developing countries. His book is concerned with the present status and subjects of agricultural technology transfer in developing countries, in terms of technology development, technology transfer; problems encountered and measures for their solution. He conducted various case studies covering less developed, developing, intermediately-developed and developed countries. He performed a historical review of agricultural technology transfer in Japan and illustrated cases in pre-war and post-war Japan. He also introduced the inter-flow of hydroponic culture technology from Japan to Taiwan and from Taiwan to other developing countries. His book allowed readers to see the overall picture of agricultural technology transfer from developed countries to developing countries.

From the review made in this Chapter, it can be seen that technology transfer was conducted on a limited scale by church workers in the 19th century, and later extended to government and private organizations in the 20th century. The review of agricultural technology transfer research in this Chapter was primarily based on papers published in Europe, the USA and Japan. The research focused on the impact of technology transfer on industrial and agricultural development. Education and proper extension systems in developing countries were extensively studied. It is hoped

that through discussions of this subject, readers will learn the philosophy of technology transfer and the experiences of executing effective transfer from developed countries to developing countries.

References

1. Benor, D., J. Q. Harrison, and M. Baxter. 1984. Agricultural Extension: The Training and Visiting System. International Bank for Reconstruction and Development/The World Bank.
2. Dhua, S. P. 1986. Strategies in the transfer of technology: The IBFEP Approach. In G. E. Jones (ed.) Investing in Rural Extension: Strategies and Goals. Elsvier Applied Science Publishers pp. 129-135.
3. Hara, Y. 1975. Rice economy and technology transfer in Indonesia. In Agricultural assistance to developing countries, edited by Ichio Saito (in Japanese). pp. 197-225. Printed by Asian Research.
4. Hayashi, T. 1984. Technology transfer, modification and development — A Japanese experience (in Japanese). pp. 139-172. International Union University Press.
5. Hayami, Y. and V. W. Ruttan. 1971. Theory and history of international technology transfer, Agricultural Development: An International Perspective. pp. 169-190. The Johns Hopkins Press.
6. Hayami, Y. 1973. The growing process of Japanese agriculture (in Japanese). SoBunShia Press.
7. Isaac, A. 1987. Chapter VI. Effective transfer of new technology. In "Modernization of agriculture in developing countries". pp. 239-321. Wiley Press.
8. Iehmitzu, Y. 1982. Technology transfer and Japan experience. In "Discussion in International Agriculture- Mechanism of excess and deficiency" (in Japanese). pp. 3-63. Society for Statistics of Agriculture and Forestry Press.
9. Ieinaga, Y. 1982. Technology transfer and Japan experience (in Japanese). In "Discussin in International Agriculture – mechanism of excess and deficiency, Society for Agriculture and Forestry statistics", Press pp. 3-63.
10. Kawano, S. 1982. Technology transfer and cultural conflict. (in Japanese). DaiMeiDou Press.
11. Kobayashi, T. 1972. Prospects of research on technology transfer. In "History of Science technology" (in Japanese). pp. 236-240.
12. Kobayashi, T. 1977. The philosophy of technology transfer. In "The new profile of Science and technology" (in Japanese). pp. 195-202.

13. Kobayashi, T. 1981. Technology Transfer-Historical consideration with the cases of USA and Japan (in Japanese). BunSinDou Press.
14. Miyakawa, K. 1988. Technology transfers from Japanese immigrants- the case of Japanese agricultural immigrants to Brazil (in Japanese). In "Subject of Agricultural Development, Economy, Technology and Society". pp. 197-213. LiuKei Book Company Press.
15. Nakata, S. 1983. On the problem of suitable technology in developing countries- The case of Bangladesh (in Japanese). Taku-Shoku-Gaku Kenkyu. No. 191 pp. 1-7.
16. Ochiai, H. 1982. Human and society background of tropical agriculture-technology transfer and its position. In "Present Status and Subject of Tropical Agriculture" (in Japanese). Printed by the Committee of Memory for 25th Anniversary of Establishing Japanese Society of Tropical Agriculture. pp. 8-12.
17. Parry, T. G. 1981. The multinational enterprise and two-stage technology transfer to developing nations. In "Hawkins, R. G and A. I. Prasad (ed.) Technology Transfer and Economic Development". pp. 175-192. JAL Press.
18. Rogers, E. M. 1971. Communication of Innovation. Free Press.
19. Saito, M. 1979. Discussion in Technology Transfer (in Japanese). pp. 7-12. BunShinDou Book Company Press.
20. Shumacher, E. F. 1989. Small is beautiful. Translated into Japanese by Kozima K. Z. and Sakai. KoDanSha Press.
21. Spencer, D. L. and W. Alexander (ed.). 1967. The transfer of technology to developing countries. Frederick A. Praega Inc. Publishers.
22. Suzuki, S. 1997. Discussion in Technology Transfer (in Japanese). pp. 1-295. SinSanSha Book Co. Press.
23. Takahashi, M. E. 1979. " The process of forming rice culture in Hokkaido and the future prospect. In "Development of Hokkaido and Technology Transfer." (in Japanese). pp. 25-50. International Union University Edition.
24. Tajima, S. 1959. An evaluation of agricultural extension in Hokkaido. Obihiro Zootechnical University.
25. Wang, I. K. 1986. International agricultural technology transfer from first-comer to later-comer developing countries – An introductory note – in Rural Development Studies, Korea and developing countries. Seoul National Univ. Press.
26. Yamada, S. 1981. Agricultural development and technology transfer in Asia (in Japanese). Taku-Shoku-Gaku Kenkyu. No. 15, pp. 1-11.

27. Yoshida, M. 1986. Suitable technology and economic development- the problems faced in present Africa (in Japanese). Institute of Asian Economy Press.