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Farmland Marginalisation in Critical Areas of China:
Economic and Ecological Concerns

by

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Acknowledgements

The dream of being a Ph D started in the late 1980's. In 1989, I was one of the most fortunate Chinese youngsters of being admitted to the University of Illinois at Urbana-Champaign. Yet due to very unexpected reasons, the dream was broken into pieces.

"Chance only favours the mind which is prepared". In 1993, fortune came to me again. I was then selected as a recipient of British Foreign and Commonwealth Senior Fellowship withholding a higher rank of IELTS exam. I was able to go to the University of Manchester, studying urban ecology and environment under the supervision of Professor Ian Douglas. There I would have pursued a Ph D candidate status should I had not committed to coming back to the Chinese Academy of Sciences.

It was only in 1998, did my dream come true. Professor Sun Honglie kindly accepted me as one of his Ph D students. Though part time, it was the culminating event in my indifferent life! By then, I had already been in my mid-career.

At this point, I could not help thanking my former boss, Professor Lu Yazhou, then academic secretary of the Bureau of Resources and Environment, Chinese Academy of Sciences. Without his encouragement, I would not have dared to apply for a studentship under Professor Sun.

De facto, I have been treating Professor Sun as my supervisor since 1993, when I became one of his assistants to his chairmanship of Working Group on Environmental Scientific Research, Technological Development and Training, in the first phase of China Council for International Cooperation on Environment and Development (CCICED), though I was not officially admitted then. We experienced the second phase from 1997 to 2001 when I was assisting him on the Sustainable Agricultural Working Group. In the third phase starting from 2002, I have been honoured the precious opportunity to assist him with the Lead Expert Group. I would rather think his tuition to me should be 10 years since 1993 instead of 5 years since 1998.

Standing on the front-line to address the dilemma of environment and development in China, Prof Sun has fathered the Chinese Ecosystem Research Network (CERN), now one of the most important networks in the world. However, this is only one of the millions of pearls he has produced. In 1999, I was appointed as the director of CERN, yet I would not have been able to polish it into such a shiny pearl in the world without his kind support, experience and patience. This has been another extraordinary opportunity solely to me, to which his other students have not had access.

The last 10 years from 1993 through 2003 has been the most important period in my personal development. I do have learnt a wealth of knowledge much more beyond science from Professor Sun. I have been very much enriched with his sharp insights into problems confronting China, and far beyond, his clear mind of solving the problems. There was a lot of knowledge

that I would not have learnt if I had not been his student, ranging from resources, environment, agriculture, regional development, social economic issues as well as people's livelihood. Only after following him for years, have I been able to jump from theory to reality. Facing the reality of China and finding the practical way of solving problems has become the most important weapons now in my work today, and will be forever.

There is a Chinese saying that "one day a teacher, forever a father". This expresses exactly my gratefulness to him for his endless tuition, kindness and patience.

CCICED granted me another supervisor, Professor David Norse of University College London (UCL), without him, the thesis would not have been accomplished. Not knowing when David has started his tuition to me, I would like to put a date in March, 1993, when he also joint the same working group. I have been learning from him ever since. I really appreciate his kindness accepting me without any hesitation when I asked humbly in 1999. In particular, I feel very much in-debt to him for the two invaluable learning opportunities at UCL that he provided, January 2000, and March 2001, with which, I was able to learn European experiences on marginal land management, generate ideas on similar studies in China, and draft the framework of the study and accordingly the thesis.

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"There must be my teacher amongst three people walking on the street", Another Chinese saying to show my thanks and gratitude to colleagues and friends working in and outside the CAS. They have provided their support, encouragement and help by every possible means. Most of them are more or less of my age, yet have become Ph D supervisors. They have not only been providing support, but tuition and supervision as well. A lot of new ideas were

inspired during the discussion with them. I have long been enjoying the long-lasting friendship from which I have been being nourished very much. I am really touched by the manner they offered help whenever there is a need. I do not even know how to express my appreciation to this invaluable contribution to the accomplishment of the thesis, yet much more beyond. I am a bit hesitating to put names here because one name here represents a group of names helped me during my study. Yet, I could not help listing the following for their generous help: Zhang Linxiu, overall design, modelling, and economics; Yang Linzhang, Wang Dejian, Sun Ruijuan, Data and information of Changshu City and CERN Station; Liu Guobin, Wang Jijun, Data and information of Ansai County and CERN Station; Gu Shuzhong, Chinese literature and comments; Yu Guirui, overall comments on draft; Liu Chengfang, Li Qiang, Jiang Nan, Lou Dong, Chen Yisong, Geng Haiqing, Lv Yao, Jin Donhai, translation; Yu Xiubo, Overall design and criticism; Huang Tieqing, Comments on draft; Li Yan, Soil and water conservation policies and comments on draft; Goerild Heggeland, Comments on draft. Finally, I also want to show my gratitude to Wang Qiufeng and Lai Pengfei for formulating and editing both the English and Chinese version.

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I was brought up in the love of a small family in the countryside. Though borne in the difficult time of Great Famine and experienced the hardship of the childhood during the Cultural Revolution in the 1960's, I was always the one loved and cared most in the family. My dear parents, though they had very limited education, they do know how important it is to have higher and better education. Though they are very senior by age now, they are still doing everything possible to create such a relaxed environment for me to proceed. Without their understanding and encouragement, my study would not have been possible. Even when they were in hospital, they were quite reluctant to call me back. My sister bears most of the family burden looking after my parents, which enabled me more time and flexibility with my study. I owe her a lot.

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Jian LIU, July 03, 2003 Beijing

Farmland Marginalisation in Critical Areas of China: Economic and Ecological Concerns

Abstract:

The interaction between economic development and change of farmland area is a dynamic, multi-determinant, multi-consequence and sometimes an abrupt process. Since 1980, China has been experiencing rapid transition from planned to market economy. Farmland marginalisation has been accelerating ever since, due mainly to comparative economic disadvantages to other off-farm sectors, and strong government policy intervention on ecosystem restoration.

The next 10 years will be crucially important to China in almost all aspects. Entering WTO means that some components of China's agriculture are becoming less competitive internationally and more economically marginal. While the National Eco-environment Improvement Program recognizes that cropping in fragile areas like the Loess Plateau is ecologically marginal. On the other hand, farmland is a strategic resource in China, yet to be used wisely. There is a growing concern on the aggravating dilemma between farmland protection, urban area expansion and ecosystem restoration in China.

The term, "farmland marginalisation" is considered to be a process, by which certain areas of farmland cease to be viable under an existing land use and social-economic structure, driven by a combination of social, economic, political and environmental factors.

The objective of the study is to gain a better understanding on the process of farmland Marginalisation under current economic and ecological pressures, and to provide policy recommendations on more effective management of marginalized farmland in China.

The methodologies deployed in the study include reference review, identification of typical and case study areas, field survey, interview with farmers and local authorities, data and information collection and processing, empirical analysis, modelling and scenario analysis. The study covered European and American experiences, the overall picture of national farmland management in China, economic and ecological farmland Marginalisation in susceptible regions, the Southeast Coastal Area and the Loess Plateau, detailed analysis of economic and ecological Marginalisation processes in the cases of Changshu City and Ansai County, respectively. Various issues concerned farmland loss and gains have been addressed: economic structure change, urbanization process, population, labour, and most importantly, policy intervention.

Two scientific merits were explored. The first is the identification and definition of ecological Marginalisation process, inherited by fragile ecological situation and intervened by government environmental policy. The second is establishing linkages between causes, processes and consequences of both economic and ecological farmland Marginalisation.

Major findings of the study are:

- Farmland Marginalisation has been happening on a signal scale and it is an inevitable process in China, driven by both economic and/or ecological determinants. The process was dominated by economic forces from 1957 to 1998, yet has been being dominated by ecological forces since 1999 till 2010 when the government decided 5 million ha of ecologically marginal farmland be converted to forest and grassland. Policy intervention poses the greatest impact on farmland management and will shape the overall structure of land cover in the future.
- Compared with EU and US, there are a lot of similarities and differences in the process of farmland Marginalisation. The major differences lie on the differentiation of development stages. Most of the experiences can be used for future policy improvement in China.
- Economic farmland Marginalisation has been accelerating in the southeast coastal area since the 1980's, and the trend will continue in the next 15 years. In Changshu City, per capita farmland decreased from 0.073 ha in 1980 to 0.061 ha in 1999, and will further down to 0.051 ha by 2015. The process has been being driven mainly by urbanization process and decreasing share of agriculture in total GDP. The pace of future farmland Marginalisation process will be mainly dependent on both determinants. The process of farmland loss has been corresponded with intensification of crop production, which in turn poses negative environmental impacts such as non-point pollution and lake eutrophication.
- On the contrary to what happened in the southeast coastal areas, farmland area had expanded from 1949 to 1996 in the Loess Plateau. Since 1997, ecological Marginalisation has been taking place. The expansion of slope cultivation was mainly due to population pressure, less developed economy and its primitive structure. Yet the ecological Marginalisation process was the result of strong set-aside policy intervention.
- Set-aside policy has been tested and performed well in the last 4 years

from 1999 to 2002. The most important success of the policy was the incentive mechanisms to encourage farmers withdraw from slope cultivation. 8% of the territory in Ansai County has been set aside. Still there are rooms to adjust the proportions of eco-forest, cash-forest and grassland to the local situation. The limitation of 80% of the slope land set aside should be eco-forest is now in question in terms of farmers' incentives and long-term maintenance. Building levelling terraced land has been and will still be the key to address issues of both soil and water conservation and people's livelihood, which can reduce 98% of soil erosion on slope farmland as well as increase farming opportunities.

Based on the findings, main recommendations are given:

- Though food security is the primary concern, the quota of grain production should be adapted to the local context of development. Concerted measures should be taken to prioritise the use of farmland in a site-specific manner and maximize the efficiency of farmland use. National policy intervention should integrate law enforcement, economic incentives and employment opportunities.
- The farmland Marginalisation process in southeast coastal area should be slowed down and/or stopped through an integrated approach, but mainly through Unitary Development Plan and its implementation. As environmental pollution has become a compelling case in this area, there is an urgent need to drastically reduce non-point pollution from the farmland intensification process that is now a significant share of pollution source to the eutrophication in Taihu Lake.
- In the Loess Plateau, alternative income generation and employment opportunities should be sought for the future; where off-farm opportunities are not available, building terraced land, cash tree planting and grassland-based animal husbandry should be given priority in the implementation of the set-aside policy.

Still there are more gaps for future studies:

- *Inadequacy in process analysis.* Due to the lack of data and confidence on data reliability, it has not been possible to develop comprehensive and dynamic model to simulate the process in detail both spatially and sequentially. There are rooms to improve data quality, expand the scope of variables on land use and determinants interaction analysis and selection and revision of appropriate models for national analysis.

- *Policy regionalization and localization.* Further study on national policy should be focusing on regionalization as land issue are very much diversified due to significant biophysical and social economic variations. There is an urgent need to develop provincial and/or regional regulations responding to the national policy. Another aspect on national policy is how to implement it at the grassroots.
- *Methodology issues*
  - Regional indicator systems. There should be at least two indicator systems for future Marginalisation studies in China, economic and ecological. The one to analyse economic Marginalisation may include share of crop production in agro-GDP, share of agricultural production in total GDP, urbanization rate, and income level etc. Setting up thresholds of those indicators is crucially important for regional analysis. However, the other on ecological Marginalisation is different. Indicators may include mostly biophysical factors such as slope degree, soil texture, water regime, and vegetation coverage etc.
  - Capitalization of compensation policy. The current compensation of grain and money needs further review and revision. The concept of ecosystem services should be introduced to analyse the services provided through the set-aside and/or building terrace practices. And those services should be given an economic value to answer the following questions: a) How much is adequate for the compensation? b) How long should the compensation period be? c) The cost of degradation, new dam construction and flood damage etc.
  - Participatory approach. This should be used to answer the question on what should be the appropriate way to compensate. Not many local people like the idea of just being compensated with grain or money. Some may seek more off-farm employment opportunities, others may think of land tenure issues, and/or other kinds of incentives from the government. This should be the way leading to the point meeting short-term farmer's needs and long-term national goals.

Key words: Farmland Marginalisation, economic, ecological, policy, China

1. Introduction

1.1 Background

- The interaction between economic development and change of farmland area in China has long been being a dynamic, multi-determinant, multi-consequence and sometimes an abrupt process since 1949, the founding of the People's Republic of China. The first period from 1949 through 1957 observed the expansion of farmland area. From 1957 onwards, farmland area has been declining due mainly to industrialization, urbanization and ecosystem restoration. This can be regarded as farmland Marginalisation.
- In the last 20 years since 1980, China has been experiencing rapid transition from planned to market economy. The development of China's rural economy has been a record high thanks to the economic policy change, institutional reform and technological advancement in the agricultural sector. Farmland marginalisation has been accelerating ever since, and now it is no longer an emerging but a significant issue, which can be attributed to comparative economic disadvantages to other off-farm sectors, and strong government policy intervention on ecosystem restoration.
- The next 10 years will be crucially important to China in almost all aspects. Entering WTO means that some components of China's agriculture are becoming more economically marginal, while the National Eco-environment Improvement Programme recognizes that cropping in fragile areas like the Loess Plateau is ecologically marginal. For example, the policy for ecosystem restoration in the west area is to encourage farmers to set aside the slope farmland with tree/shrub/grass planting, by means of compensating the loss of grain production. The strong political intervention and investment on the ecosystem restoration will have the biggest influence ever on the ecologically marginal areas. Land marginalisation has been happening in the developed Yangtze River delta as declining grain prices and rising off-farm employment opportunities and incomes results in widespread rural-urban migration. The latter can also lead to rural-rural migration with farmers from bio-physically marginal areas occupying the better land abandoned in the richer areas. Therefore, both economic and ecological determinants will be driving farmland marginalisation process in an unprecedented speed and magnitude, eventually leading to the abandonment and/or redeployment of more marginal lands.

- On the other hand, farmland is a strategic resource in China, yet to be used wisely. Rational farmland policy means adequate supply to meet the market demand of agricultural products, ecosystem improvement and conservation and increase of farmer's income. How could the government take advantage of the farmland marginalisation process to fulfil the three goals at the same time? It is obvious there is an urgent need for right policy setting for marginal land management. This has generated the study of farmland marginalisation driven by economic and ecological forces.

1.2 Emergence and thematic questions

- There is a growing concern on the aggravating dilemma between farmland protection, urban area expansion and ecosystem restoration in China. First, food security still remains the primary concern in the long-term as the gap between increasing demand for agricultural products due to population and income growth and farmland loss is becoming wider. Second, economic safety can only be secured with accelerating industrialization and urbanization process, which in turn, will inevitably occupy prime farmland in peri-urban areas. Third, as environmental protection is China's basic national policy, ecosystem improvement and conservation efforts should be made in fragile areas to ensure environmental safety. This requires a large amount of ecologically marginal land be set aside for forests, grasslands, or wetlands. It is obvious that food security, economic safety and environmental safety should be integrated and optimised if the goal for sustainable development is to be achieved.
- As the issue of farmland Marginalisation is emerging as one of the significant environmental as well as economic issues, there is an urgent need for integrated policy and plan to respond. To meet this challenge, credible information should be provided to answer the following questions:
    - What is the general picture of farmland Marginalisation in China?
    - What is the general trend as such in susceptible regions?
    - What are the dominant determinants? How do they interact with land use change in typical areas?
    - What are the environmental consequences?
    - What will be the future scenarios?
    - What will be the policy implication and best management option?
    - Are there any experiences that we can learn from other countries?

1.3 Objectives

The general objective of the study is to gain a better understanding on the process of farmland Marginalisation under current economic (e.g., China's entry into WTO) and ecological (national ecological improvement/west development policy) pressures, and to provide policy recommendations on better management of the marginalized and/or abandoned farmland in China. The specifics are:

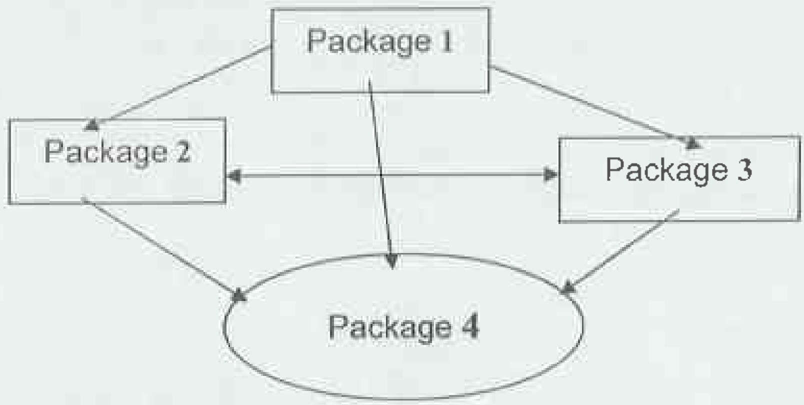
- To review national policy change and its impact on farmland management in China; and to make comparisons between China and other countries on marginal farmland management;
- To investigate the situation of typical regions susceptible to farmland Marginalisation;
- To obtain better understanding of the farmland marginalisation process in selected cases (city/county) representative of major socio-economic and agro-ecological situation in China, and to identify the dominant determinants and their interaction with land use change;
- To assess environmental consequences of farmland Marginalisation in case study areas;
- To project future scenarios under specific economic and ecological pressures and to provide policy recommendations on how to manage the marginalized/abandoned farmland.

1.4 Definition and work packages

- **Definition**: The term, "agricultural marginalisation" is considered to be a process, driven by a combination of social, economic, political and environmental factors, by which certain areas of farmland cease to be viable under an existing land use and social-economic structure (Baldock et al, 1996). The term for marginalisation has long been referring to economic means, yet for agriculture, the concept of ecological marginalisation should be incorporated into the process. The reason for that is not only because agriculture is the industry dependent very much on the quality of ecosystem, but also because of the increasing interaction between agricultural development and ecosystem improvement due largely to the government pro-environmental policy. Therefore, detailed analysis of farmland Marginalisation in China will address two typical yet different processes; one is driven predominantly by economic determinants in the developed southeast coastal areas, the other by ecological determinants in the less developed and fragile northwest areas.

- **Work packages**
  - **Package 1:** Review of marginal land management programs, policies and the concerned studies in China, Europe and the United States.
  - **Package 2:** Analysis of farmland management and policy implications in China and the two typical areas susceptible to either economic or ecological marginalisation.
  - **Package 3:** Detailed analysis of Changshu City, case of economic Marginalisation, and Ansai County, case of ecological Marginalisation, including process in the last 20 years from 1980 to 1999, interaction with determinants and future scenario projections; Appropriate model was deployed for the above analysis.
  - **Package 4:** Policy advises for best practice of marginal land management through bottoms-up and top-down approaches.

The inter-linkage between the packages:



- **Important issues covered**
  - **Land use:**

    (a) Land use change from 1980 through 1999, including land use pattern, agriculture/forest/grassland structure and farmland structure;

    (b) Soil quality change: organic carbon, N/P/K, pollution---use data of the 2nd soil survey, to be compared with updated data and research findings (e.g. data from research stations of the Chinese Ecosystem Research Network (CERN), and ongoing 973 projects);

    (c) Farmland productivity change: mainly yield per unit farmland, using statistical data.
  - **Determinants:**

    (d) Biophysical factors: soil, climate, water supply, slope, pollution etc.

    (e) Social-economic factors: population growth, labour distribution structure in different sectors, the growth of non-agricultural population, urbanization rate, overall economic structure and share of agricultural production, the structure of agricultural GDP and the share of crop production, competition from other agricultural areas and production systems, competition from other kinds of land uses, alternative employment possibilities, and development in agricultural technology.

(f) Policy factors: national land laws and policies, national plans and programs on land and ecosystem management, national agricultural policy on regionalization and related support/restriction measures—designated areas, land use planning, land taxes, environment and nature conservation policies in the west etc.

1.5 Methodology

The methodologies deployed in the study include reference review, identification of typical and case study areas, field survey, interview with farmers and local authorities, data and information collection and processing, empirical analysis, modelling and scenario analysis.

1.5.1 Data collection and processing:

- Research station-based observations in designated catchments on biophysical variables;
- Investigation of social-economic variables;
- Information on land use, agricultural production and ecosystem improvement;
- Statistical data.

1.5.2 Empirical analysis and modelling:

Apart from sequential analysis, a multivariate statistical model (Cobb-Douglas) was tested and used to identify the most important determinants, to resemble the Marginalisation process, and to project future scenarios

1.5.3 Approaches

- The study starts firstly with the review of international experiences and lessons focusing on mostly the Europeans and Americans. Field surveys and investigations were conducted in the United Kingdom in January and February of 2000, March, 2001, United States in September of 2000, and Germany in February and March of 2001, respectively.

- A state-of-the-art analysis was conducted to introduce related studies both in China and abroad, then a general analysis of Chinese circumstances and critical regional trends. Field survey and investigation was undertaken in Loess Plateau Region in May 1999, and Southeast Coast Area including Zhujiang and Yangtze Deltas in April 2001 respectively. In depth interview, investigation and survey were conducted in both Ansai County of the Loess Plateau and Changshu City of the Yangtze River Delta, taking opportunities of the above occasions.
- Detailed analysis was made at county level, Ansai and Changshu, their socio-economic causes and responses of agricultural Marginalisation in areas most susceptible in China. Biophysical factors at catchments level were also deployed for process analysis. The above two typical counties are chosen for conducting the study under greater economic and greater ecological pressures respectively:
  (a) Changshu City of Jiangsu Province in the Yangtze River Delta in southeast coastal area, representing the southeast developed area of China. It is more exposed to economic marginalisation, subject to urbanization, pollution and migration due to its rapid economic development, and has low comparative advantage for agriculture though productivity is high;
  (b) Ansai County of Shaanxi Province in the Loess Plateau, less developed west area, exposed to ecological marginalisation, extensive agriculture, erosion-prone and ecosystem improvement policy, less opportunity of urbanization and migration.

  Within each case selected, there is a research station of CERN[1], enabling the collection of biophysical data for dynamic analysis.
- Synthesis and modelling: the conceptual model
  - After the discussion on the general trend of agricultural marginalisation (mainly measured as farmland loss), modelling work will be attempted to analyse the determinants of farmland change. It is expected that there are at least three groups of variables that would have impact on land area: 1) policy intervention; 2) population increase and urbanization; 3) changes in economic structure, such as the share of agricultural GDP, and etc.
  - After identified the best model and the major influential factors, projections on land area for next 20 years or so could be estimated based on the past trends and the new assumptions for future trend on

[1] China Ecosystem Research Network

determinants.

1.6 Structure of the thesis

The thesis was divided into the following eight chapters

- Chapter 1: Introduces the background, emergence and significance of the study, identifies thematic scientific questions, set up objectives and defines the concept and scope of the study, lists methodologies and approaches used and lays out the overall structure of the thesis.
- Chapter 2 provides international experiences managing marginal farmlands, particularly policy development of marginal land management in European countries and the United States.
- Chapter 3 reviews what has been being conducted on the study of farmland Marginalisation, with broad coverage of concerned international programs such as Land Use and Land Cover Change (LUCC) and the Millennium Ecosystem Assessment (MA).
- Chapter 4 draws a general picture of land management in China, focusing on dynamic interaction between policy change and farmland Marginalisation process, and identifies room for policy improvement.
- Chapter 5 describes regions susceptible to economic and/or ecological Marginalisation and brings the issue from emerging to significant.
- Chapter 6 surveys the Marginalisation process driven mainly by economic forces in case study areas, assesses environmental consequences and proposes policy implications (Changshu City, Jiangsu Province).
- Chapter 7 analyses the Marginalisation process driven mainly by ecological determinants in case study areas, assesses environmental consequences and proposes policy implications (Ansai County, Shaanxi Province).
- Chapter 8 discusses major findings drawn from the above analysis, concludes future trend of farmland Marginalisation in China, and makes policy recommendations.

2 European and American experiences

2.1 Marginalisation process and policy responses in Europe

2.1.1 Introduction

- Europe has the most authentic, unitary yet diversified practices and policies on marginal land management. Its member countries have a long history and diversified ways of managing marginal land, which can be dated back to the High Middle Ages till the formation of European Committee. Even within the EC, there is a reciprocal process of bottoms-up and top-down. One or more member countries pioneered an optimum practice and policy on marginal land management, others followed suite, then common policy or regulation formed. This can be regarded as bottoms-up approach. In the agricultural sector, it was most likely the case that a compromise reached on the allocation of agricultural production quota in terms of both quantity and the variety of products. This would lead to a top-down resolution.
- The fundamental milestone on land management in Europe was the set-up of the principles of the Common Agricultural Policy (CAP) in 1958, and in1962, the CAP came into force. However, the CAP's initial objective was to increase agricultural productivity, market competency and livelihood of rural community. Environment was put on the agenda in 1992 as a result of cutback production and set-aside of marginal farmland. The agenda 2000, with a vision to the future, has been the most radical and comprehensive reform of the Common Agricultural Policy since its inception, covering all functions of the CAP, economic, environmental and rural.

2.1.2 The Contribution of Marginal Lands since the Middle Ages

- Up to the High Middle Ages, cutting down the forest in order to convert it to arable land and settlement was considered an action beneficial to society and to progress all over Europe. The point in time at which forests came to be valued and thus to be preserved and husbanded, differed greatly in different regions. It became widespread in many parts of Europe in the twelfth century when population growth led to steady encroachment on all marginal lands, including the forests. Forest protection laws were enacted in Berne in 1304, in Schwyz in 1344, and from 1500 onward there were repeated bans on glass-making in the Swiss cantons because of its vast consumption of timber. In England several areas had to cease iron production in the early fourteenth century because of a shortage of charcoal fuel. The decline of population from the fourteenth century onward relieved the pressure on the forests temporarily, and the area covered by trees may even have expanded in places, but in the sixteenth century widespread anxiety began to grow about the continued survival of forests, and about the problems of timber and fuel shortage, which has, with some exceptions, continued until the present day.

- When population extends its agrarian occupation, its edge of settlement becomes a moving margin. This phenomenon of the moving margin had an important influence on Europe, until region after region became fully settled, and no room was left for further special extension. What is notable is that as long as the process continued, some of the key changes and developments of the age took place at the margin, where new land was being won.
- Migration and marginal lands: The incentive to migration can be divided into push and pull factors. Pulls play a part, but what we are concerned with is push, negative factors expelling people from their regions. The pushes can be classified into three groups: (1) an increase of population which exceeded the capacity of the land to carry it; (2) the decline of a local resource; and (3) deliberate human action, such as clearances or expulsions. In the marginal areas considered here, the first of these was much the most important. Its variations provided an indication of the range of disabilities suffered by people living in these lands. Table 1 shows emigration rates from some European regions and countries in the 19th century, in each case taking the emigration rate for Europe as a whole measured in emigrants per 100,000 people as unity. Only periods in which the rate exceeded the European rate by more than 2.5 times are entered.

Table 2.1 Rates of Emigration from Some Selected European Areas and Countries, 1841 – 1900 (annual averages, by decades)

	1841-50	1851 -60	1861-70	1871-80	1881-90	1891-1900
Ireland	21.4	16.7	11.4	13.8	9.3	9.0
Sweden	--	--	2.8	3.3	4.4	3.1
Norway	--	--	3.9	4.2	5.8	--
Scotland	--	6.2	2.8	2.8	3.4	--
Wuttemburg	4.0	6.9	3.0	3.7	4.2	3.8
Alsace-Lorraine	5.1	6.1	--	3.9	--	--
Baden	3.8	4.8	4.6	7.9	2.6	--
Italy	--	--	--	--	--	3.9

Source: based on Erickson (1976), 29 (cited by Sidney Pollard 1997)

Depopulation, abandonment of settlement and intensification of land use were among the features common to most of the high mountain regions of Europe.

2.1.3 The complementary practice

One of oldest and most common ways in which marginal area can establish mutually beneficial economic relations between itself and a "core" area, appropriate particularly to mountainous grounds, is the practice of *transhumance,* the movement of domesticated animals for pasturing among different regions in certain seasons of the year. Transhumance was widely practiced in classic times in the Mediterranean basin, and is believed to have played a part in affecting and transforming the vegetation of many of the areas concerned. Far from being isolated, as they were frequently described, most marginal areas of Europe have been shown to make up an important part, of the complex and intricately patterned network of the European economy at every stage from the High Middle Ages onward. Moreover, far from being always the weaker and more backward partner helped along by the advanced inhabitants of the cities, they were not infrequently the source of activity and initiative, and sometimes even of the capital (Sidney Pollard, 1997).

2.1.4 Effects on the environment of the abandonment of agricultural land in the 1960's and 1970's

- There has been increasing land abandonment in Europe since the turn of the century, especially after the World War II, as a result of industrialization, urbanization and agricultural intensification. In 1960's, the percentage employed in agriculture in Europe dropped from 35% to 15%. The "reverted land" refers to agricultural areas which have been abandoned and provided a picture of fallow vegetation in various stages, but for which rural amenity or re-cultivation measures are still possible. Reverted land was very important to Federal Republic of Germany, France and Italy. Since the start of the 1950's the area of reverted land in these countries had been a record high, which was a very important component of agriculture. The extent of reverted land in F. R. Germany, France and Italy in 1976 can be seen in Table 2.2.
- The reason listed for land reversion (or abandonment) includes topographical, ecological, structural, speculative, sociological and economic. There were detailed reasons for each of the above. For example, economic reason can further be classified as market,

mechanisation, profitability and rationalization. They could also be re-grouped into three broad clusters: economic, social and natural determinants.

Table 2.2 Reverted land in Europe in 1976

Country	Significance of reverted areas (exc. Bare fallow)
F. R. Germany	300,000 ha
France	1,500,000 ha
Italy	2,293,000 ha
U.K.	No reverted land, but under-use of marginal areas
Ireland	No reverted land, but under-use of marginal areas
Netherlands	No reverted areas of any significance
Demark	No reverted areas of any significance

Source: Commission of the European Communities, No 62, 1978

- Land reversion had both negative and positive effects on environment, but most likely negative impacts on agriculture. From the environmental point of view, it protected soil and water resources, enriched flora and fauna, and created countryside landscape for recreation activities. Yet, the negative impacts on agriculture were weed invasion from airborne seeds, danger of water logging in moist areas, and fewer opportunities for farmers though there was a relief of pressure on agricultural markets as large areas of agricultural land fall idle.
- The main aims then to prevent reversion and manage the reverted land in EC member countries were to maintain agricultural productivity and to keep a good countryside landscape. However, the call on farmers to be countryside managers was then the loudest in the regions with sub-marginal agricultural production. Large areas of such farmland were withdrawn from agricultural use. Statutory regulations and measures for preventing land reversion and caring for reverted land were not formulated unitarily in the EC. Yet member states had developed specific laws, policies and programs. In F.R. Germany, recognizing the particular importance of land for food security and national culture, they set up laws against disposition of land such as “Law on commerce in land”, “National law on building development”, “Law on leasing of land”, “Federal law on nature conservation”. France developed legislative measures to encourage farmers to re-cultivate the reverted land by either broadening the scope for taking over land, or simplifying legal and administrative

procedures. There was also a consideration of introducing “reverted land tax” to charge farmers abandoning the agricultural land, yet far from realization. It seems that UK had different policy on unused land. For instance, the Ministry of Agriculture supported the Forestry Commission to buy up marginal land for forestation, while the laws on nature conservation enable the Nature Conservancy Council to protect ecologically valuable areas (Commission of the European Communities, No 62, 1978).

- **Agro-Environmental Reforms in the European Union**

  - **Issues raised**

In 1975, EC agreed the Less Favoured Areas Directive (LFA), which permitted the use of EC funds to keep marginal farmers on the land by designating disadvantaged regions and offering annual headage payments and other forms of assistance to the farmers concerned. A decade later over 48% of the Community’s land base had been so designated and by 1995, 56% of the Utilized Agricultural Area (UAA) of the EU was designated under the Directive (Table 2.3). Annual expenditure on these supports in that year totalled 1.4 billion ECU (CEC, 1995). Policymakers were now in pursuit of two apparently contradictory policy goals: keeping large umbers of farmers on the land while at the same time attempting to bring about a significant improvement in average farm incomes (Clive Potter, 1997).

Table 2.3 Less Favoured Areas within the EU (thousands hectares)

	Mountain areas	Other LFAs	LFAs with specific handicaps	LFAs	Country total	LFA as % of total UAA
Austria	2047	208	164	2419	3524	69
Belgium	--	273	--	273	1357	20
Denmark	--	--	--	0	2770	0
Finland	1407	536	220	2164	2549	85
France	5284	7809	804	13,897	30,011	46
Germany	336	7987	199	8522	17,012	50
Greece	3914	964	402	5280	6408	82
Ireland	--	3456	12	3468	4892	71
Italy	5218	3405	218	8841	16,496	54
Luxemburg	--	122	3	125	127	98
Netherlands	--	--	111	111	2011	6
Portugal	1227	2056	150	3433	3998	86
Spain	7503	11,343	700	19,546	26,330	74
Sweden	526	1011	333	1869	3634	51
UK	--	8341	1	8342	18,658	45
Total EU	27,462	47,511	3317	78,290	139,777	56

Source: CEC1996c

Technological change has driven farm policy forcing policymakers to acknowledge the chronic tendency of the agricultural industry towards over-supply. The policy influence is often surprisingly specific (Table 2.4).

Table 2.4 Independent short-run effects of agricultural policy on environmental quality. Net effect on:

Agricultural policy instruments that:	Total soil erosion	Loss of wildlife habitat	Rates of agrochemical use	Total use of agrochemicals
Raise commodity prices	↑	↑	↑	↑
Tie farm income support to production levels	↑	↑	↑	↑
Reduce risk	↑	↑	↓	↑
Subsidize credit	↑↓			
Require short-term land retirement	↓	No effect	↑	↓
Establish cosmetic standards	No effect	No effect	↑	↑

Source: Reichelderfer (1990)

■ Agricultural Change in the European Garden

Continental agriculture after World War II was under-capitalized and still overwhelmingly peasant based, with any technological improvement in the inter-war period limited to minority of farms. Over the next three decades, European agriculture would undergo a remarkable transformation "changing from a kind of handcraft to an industrial operation". The modernization process occurred in two stages: an early restructuring stage, during which farm size increased, many marginal peasant farms disappeared and modern methods of livestock and animal husbandry were widely adopted; and a later stage, when even more advanced techniques were taken up by the most productive farmers. Between 1970 and 1990 applications of N-fertilizer in the original EC-6 increased significantly. With later members experiencing dramatic increases in use (Table 2.5). it was estimated that utilization rates overall increased by over 75% between 1970 and 1989. The large-scale use of pesticides is similarly a phenomenon of the last 30 years.

Table 2.5 Average N-fertilizer application rates in the EU, 1970/1990* (Kg/ha)

Country	1970	1990	% change 1970-1990
Belgium & Luxembourg	106	125	+18
Demark	99	142	+43
France	53	94	+76
F.R. Germany	88	129	+47
Greece	24	85	+248
Ireland	18	92	+408
Italy	36	63	+87
The Netherlands	188	196	+4
Portugal	N/A	58	--
Spain	N/A	48	--
United Kingdom	66	122	+62

* Figures show average application rates for arable and improved grassland.
Source: Clive Potter, 1997

Beginning in the 1960's, farmers in North-western Europe started to abandon the mixed farming systems that had traditionally been adopted to spread risk and maximize the 'joint economies' of having crops and livestock on the same farm" economies of specialization" with the inevitable result that 'output soars but the environment suffers'. A broadly similar process of intensification on the best land, coupled with the Marginalisation or slow decline of traditional farming practices elsewhere, can now be seen taking place in the agricultural landscapes of the south.

Table 2.6 High Natural Value (HNV) Farmland in Europe (Land areas in Mha)

Country	Land surface	UAA	Farmland under HNV	HNV farmland as % of Country UAA	% share of total EU HNV farmland
France	54.7	31.0	7.7	25	13.7
Greece	13.2	9.2	5.6	61	9.9
Hungary	9.3	6.5	1.5	23	2.7
Ireland	7.0	5.7	2.0	35	3.6
Italy	30.1	22.6	7.1	31	12.6
Poland	31.3	19.1	2.7	14	4.8
Portugal	9.2	4.5	2.7	60	4.8
Spain	50.5	30.6	25.0	82	44.4
United Kingdom	24.4	18.4	2.0	11	3.6
Total	229.7	147.6	56.2	38	100.0

Sources: McCracken and Bignal, 1995

Soil erosion in the EU is primarily a problem of Mediterranean regions, which a combination of steep slopes, fragile soils and dry climatic conditions have produced rates of soil loss in excess of 10 t/ha regarded as tolerable (von Meyer, 1988). Over 44% of the surface area of Spain is affected by soil erosion of some sort compared with 20% of Greece, 10% of Italy and 1% of France (Burch et al., 1997)

There has been a powerful transformation of the relationship between agriculture and environment since 1945. While farm policy may not have instigated all of the changes in farming practice and land use, it has powerfully reinforced the trend towards greater intensification and specialization. The farm support in EU has provided an irresistible economic incentive to expand output and to do so in a land saving way. Harnessed to technological revolution in farming, the result in the rapid intensification, specialization and concentration of agricultural production lies behind many of the agro-environmental problems reported above.

The impact of the EU's CAP (Common Agricultural Policy) on the environment has been just as complex. The decision to follow a farm survival policy which attempts to solve the income problems of large numbers of marginal producers by encouraging more production on the back of modernization rather than through restructuring, has made a deep impression on the ecology, appearance and character of the European countryside. It is debatable whether the streamlined industry of fewer, larger farms would have been any more environmentally friendly than the currently existing polarized one. The decline of mixed farming and the advance of intensive arable production throughout North-western Europe in the 1970s, for example, gave rise to many of the changes in agricultural landscape that first stimulated public concern. Agricultural pollution, landscape change and the loss of biodiversity due to the intensification and concentration of production in some locations offset by Marginalisation and even land abandonment elsewhere, remain very European concerns. The recent intensification of dryland production in southern member states, combined with the decline of traditional, high natural value systems of farming, is merely the latest manifestation of this paradox of agricultural change (Table 2.6).

■ Pressure for Reform

In 1969, Bowers and Cheshire had argued that 'society could pay farmers to produce countryside instead of food, if it decided that was a better use of public funds'. Awareness of the destructive potential of the CAP strategy of site safeguard and nature reserve and heritage landscape designation was not working and could not be sustained. In 1977, the UK Nature Conservation Committee (NCC) had argued for the first time that agricultural expansion was seriously threatening the conservation resource in the wider countryside.

Policymakers in EU had come under intense pressure to tackle overproduction and reduce agricultural spending. This not only made officials more receptive to the multi-purpose agro-environmental schemes that were by now being put forward by reformers; it also facilitated a rapprochement between agro-environmentalist and a farm lobby now increasingly anxious to invent alternative, politically more defensible ways of supporting farmers' incomes.

■ Agricultural Stewardship in the UK and An Evolving Agenda in EU

Since 1980's, UK government took the lead in paying farmers to produce countryside, designating Environmental Sensitive Areas (ESA), and launching "Countryside Stewardship Scheme (CSS)". Yet, its ability to expand agro-environmental policy in a more substantial, long-term sense depends increasingly on decisions made at EU and even WTO level. The suspicions of the southern member states seemed confirmed as Germany and The Netherlands both followed the UK's lead in setting up ESAs during the next 5 years, designating over 2.5 Mha as 'environmentally sensitive area' in order to be able to offer payments to farmers practicing environmentally friendly farming. Following approval of Regulation 1760/87, they were further able to claim a 25% reimbursement from Community funds. By 1990, over 4 Mha had been designated as Denmark, Italy and Ireland followed suit (Table 2.7).

Table 2.7 Land designated under Article 19 of EU Regulation 797/85 (1990)

Country	Area designated (ha)	Eligible area (ha)	Enrolled area (ha)	Number of participants
Denmark	127,970	--	28,060	3459
France	114,620	83,000	36,620	--
Germany	2,560,000	1,223,000	291,646	40,780
Ireland	1140	--	--	--
Italy	944,430	820,740	229,359	6038
Luxembourg	2800	600	610	4
Netherlands	75,800	27,000	26,815	5013
UK	740,930	396,570	282,351	4997
Total	4,567,690	2,550,910	895,461	60,291

Source: CEC (1991b)

The provision of Article 19 is for maintaining traditional farming practices in order to protect landscape and habitats. After all, the regulation required that the adoption of environmentally sensitive farming methods should contribute to farming incomes. France's new ESAs are largely coincided with the areas of marginal agricultural production in the mountainous regions of the Alps, the Jura, the Pyrenees and the southern parts of the Massif Central.

- **Consequences of The EU's Agro-Environmental Program (AEP)**

The gravity of the situation, in particular as regards water pollution, calls for rules to be adopted concerning the use of fertilizers, herbicides or, more generally, any chemical practice which may be harmful to the environment. At the same time, it is equally important to adopt a consistent approach to safeguarding biotopes and preserving genetic diversity. The farmer fulfils, or at least could and should fulfil, two functions, viz., firstly that of producing and secondly, of protecting the environment. Concern for the environment means that we should support the farmer also as an environmental manager through the use of less intensive techniques and the implementation of environment-friendly measures (CEC, 1992).

Under the terms of the Regulation, all member states are required to set up rolling programs designated to subsidize environmental management on farm. Schemes should apply to all agricultural land, though provision is made for targeting areas of high nature conservation value or acute environmental vulnerability as required. Agricultural departments in member states were now obliged to implement schemes in order to achieve:

1) A substantial reduction in the use of fertilizers and/or plant protection products, or maintaining reductions already made, or the introduction of organic farming methods.
2) A change, by means other than those referred to more extensive forms of crop, including forage production, or the maintenance of extensive production methods introduced in the past, or conversion of arable land to extensive grassland.
3) A reduction in the proportion of livestock per forage area.
4) The use of other farming practices compatible with the requirements of protection of the environment and natural resources, as well as maintenance of the countryside and landscape, or to rear local breeds in danger of extinction.
5) The upkeep of abandoned farmland or woodland.
6) Set aside for at least 20 years for purposes connected with the environment, in particular the establishment of biotope reserves or natural parks for the protection of hydrological systems.
7) Land management for public access and leisure

In southern member states, meanwhile, the new Accompanying Measures, of which the agro-environmental program was a part, came to be seen by farming unions and regional officials as offering a supplementary source of income at a time when agricultural activity in marginal areas seemed closer to extinction that ever before (Garrido and Monyano, 1996). Within 3 years all member states would have an agro-environmental program in preparation or on stream. These comprised:

1) Schemes to reduce nitrate and pesticide pollution so as to protect water supply aquifers.

2) Measures to extensify arable farming by reducing inputs, and livestock farming by reducing stocking densities.

3) Conversion and maintenance payments for organic farming.

4) Schemes to encourage conversion of arable land to grassland, wetland, coastal marsh and river margins.

5) Payments to farmers within ESAs to protect landscapes and wildlife habitats.

6) Measures for maintaining and improving cereal steppe-lands.

7) Schemes to protect perennial crops of cultural, landscape and wildlife value such as olive groves in Greece, Portugal and Spain, and old orchards in the UK and Germany.

By October 1996, the Commission had provided an estimated 1.4 billion ECU or 3.6% of total farm support expenditure to co-finance these schemes and projected that it would invest a further 4.3 billion ECU over the next 5 years of the program (Table 2.8, 2.9).

Table 2.8 EU expenditure on Regulation 2078 in 1996.

Country	Expenditure on Reg.2078 schemes (million ECU)	% of EU budget
Austria	541.0	38.9
Belgium	1.5	0.1
Demark	5.8	0.4
Finland	256.6	18.4
France	118.9	8.5
Germany	231.7	16.7
Greece	1.5	0.1
Ireland	43.4	3.1
Italy	41.5	3.0
Netherlands	7.6	0.5
Portugal	40.0	2.9
Spain	32.8	2.4
Sweden	43.4	3.1
UK	25.5	1.8
Total	1391.2	100.0

Source: CEC 1996c

Table 2.9 Area designated under EU Regulation 2078 (1995).

Country	Area approved for EU funding (thousands of hectares)	Area approved for funding as % of country UAA	Area approved for funding as % of EU designated area
Demark	44.2	2.1	0.4
France	5061.6	16.8	42.5
Germany	5380.0	31.3	45.2
Ireland	56.2	1.3	0.5
Netherlands	16.1	0.8	0.1
Portugal	471.3	14.8	4.0
Spain	89.8	0.4	0.8
UK	796.2	4.6	6.7
Total	11,915.4	11.8	100.0

Source: CEC 1996c

- **AGENDA 2000**

- **Issues raised**

In July 1997, the European Commission proposed the reform of the CAP within the framework of Agenda 2000, which was a blueprint for the future of European Union policy, in view of the expected enlargement. Agenda 2000 has been the most radical and comprehensive reform of the Common Agricultural Policy since its inception. It built on the process begun in 1992 and it provided a sound basis for the future development of agriculture in the Union, covering all functions of the CAP, economic, environmental, and rural. The reform will create conditions for the development of multi-functional, sustainable and competitive agriculture in the EU. There are also accompanying measures of 1992 regulations. Amongst, there list agro-environment and Less-favoured areas and areas subject to environmental constraints (EU, 2002).

- **Agro-environment**

The policy on agro-environment under the Agenda consists of two parts:

a) Support can be granted to farmers who, for at least five years, use agricultural production methods designed to protect the environment and maintain the countryside (agro-environment) in order to promote farming methods which are compatible with the protection of the environment, environmental planning in farming practice, extensification, the conservation of farmed environments of high natural value and the upkeep of the landscape.

b) This aid is calculated on the basis of income forgone, additional costs and the financial incentive needed to encourage farmers to make agro-environmental undertakings. However, such aid may not exceed EUR 600 for annual crops and EUR 900 for specialised perennial crops. Aid for all other land uses may not exceed EUR 450 per hectare per year.

- **Less-favoured areas and areas subject to environmental constraints**

LFAs are treated with special and detailed measures composing four parts:

a) Farmers in less-favoured areas, i.e. mountain areas, areas affected by specific handicaps and other areas to be treated in the same way as less-favoured areas, may be supported by compensatory allowances to ensure continued and sustainable agricultural land use, preservation of the countryside, and the fulfilment of environmental requirements.

b) To that end, farmers undertake to pursue their farming activity for at least five years, applying usual good farming practice which is compatible with the requirements of the protection of the environment, maintenance of the countryside and sustainable farming. In this spirit, no aid will be paid where residues of prohibited substances or substances authorised but used illegally are found on a holding.

c) Compensatory allowances must be sufficient to contribute effectively to a compensation for handicaps without leading to overcompensation. They therefore range between EUR 25 and 200 per hectare, taking account of relevant regional development objectives, natural handicaps, environmental problems and type of holding.

d) Farmers in areas subject to environmental constraints may also receive support of up to EUR 200/hectare to cover the additional costs and losses of income resulting from implementation of Community environmental rules.

- **Mid-term review of CAP**

- **Objectives of the review**

The European Commission tabled a mid-term review of the EU's Common

Agricultural Policy (CAP) in mid-July 2002. The Commission is of the opinion that public expenditure for the farm sector must be better justified. To achieve those objectives, the Commission proposes 1) to cut the link between production and direct payments, 2) to make those payments conditional to environmental, food safety, animal welfare and occupational safety standards, 3) to substantially increase EU support for rural development via a modulation of direct payments with the exemption of small farmers, 4) to introduce a new farm audit system, 5) new rural development measures to boost quality production, food safety, animal welfare and to cover the costs of the farm audit. (EU, 2002)

- **Environmental integration and animal health and welfare concerns**

Environment – getting the incentives right, increasing compliance. The reforms undertaken as part of the Agenda 2000 package represent another significant step forward in putting *the integration of environmental goals* into practice. Member states are obliged to undertake appropriate environmental measures. In fulfilling their obligation, they have several options at their disposal: agro-environmental measures, environmental legislation, and specific environmental requirements. The decoupled farm income payment will be established at the farm level. Such transfers would need to meet a certain number of obligations:

- to ensure that agricultural land throughout the EU is maintained in good agricultural condition and continues to be managed in accordance with mandatory environmental standards;
- …
- and to conserve the WTO-Green Box compatibility of the payments.

- **Reinforcement of environmental, food safety, animal health and welfare and occupational safety standards**….

Cross-compliance will be applied as a whole-farm approach with conditions attached to both used and unused agricultural land including the possibility, where Member States consider this necessary, to apply conditions to prevent the conversion of pasture land to arable land. On used and unused land, cross-compliance will involve the respect of statutory management requirements and the obligation to maintain land in good agricultural condition. A whole farm approach follows directly from the logic of decoupling and will emphasise the main purpose of cross-compliance: to support the implementation of environmental, food safety and animal health and welfare legislation. In the case of non-respect of cross-compliance requirements, direct payments should be reduced while maintaining proportionality with respect to the risk or damage concerned.

- **Environmental set-aside**

In order to maintain the supply control benefits of set-aside, while reinforcing its environmental benefits under the new decoupled system of support, the Commission proposes introducing compulsory long-term set-aside (10 years) on arable land. The replacement of rotational set-aside by long-term environmental set-aside will increase its benefits in many regions while simplifying administration and control, particularly in the framework of 22 decoupling. Farmers would be obliged to put an amount of arable land equivalent to current compulsory set-aside on their holding into long-term non-rotational set-aside as an element of cross-compliance requirements they have to meet in order to receive direct payments.

- **Support for energy crops – a carbon credit**

Under the Commission proposals the current set-aside arrangements will be replaced by long-term environmental set-aside. Currently, support for energy crops is provided through the possibility to grow industrial crops on set-aside land. Energy crops account for the largest amount of non-food production on set-aside land. They will be of increasing importance should bio-fuel incorporation become compulsory as foreseen in the Commission's recent Communication. However, the new set-aside arrangements would no longer lend themselves to the production of energy crops. The Commission therefore proposes replacing the existing arrangements for non-food crops with a carbon credit, a non-crop specific aid for energy crops with the objective of achieving carbon dioxide substitution. Such an aid would complement investment and establishment measures under the second pillar. The aid level will be 45 EUR/ha of energy crops with a maximum guaranteed area of 1.5 million hectares and would be paid to producers entering into a contract with a processor. The area allocation between Member States will take into account historical energy crop production on set-aside and $C0_2$ commitment burden sharing arrangements. The arrangements will be reviewed five years after its entry into force taking into account the implementation of the EU bio-fuels initiative.

- **Enlargement and CAP: New EU members receive CAP implication**

Rural development measures are eligible in the following aspects (max. 80% EU financed):

- Early retirement of farmers
- Support for less favoured areas or areas with environmental restrictions
- Agro-environmental programmes
- Afforestation of agricultural land
- Specific measures for semi-subsistence farms
- Setting up of producer groups
- Technical assistance
- Special aid to meet EU standards

2.2 Marginalisation process and policy responses in the United States

- **Major land uses in the Contiguous States**

The four major uses of land in the contiguous 48 States are grassland pasture and range, forest-use land, cropland and special uses. Total cropland (used for crops, used for pasture, and idled) has trended down slightly since the late 1960's. Greater variation has occurred in cropland used for crops, largely reflecting changes in cropland idled in Federal crop programs. Also, weather, such as the drought in 1988 and the heavy rains in 1993, can strongly influence the mix and acreage of cropland used for crops (Table 2.10, USDA, 2001).

- **Grassland pasture and range,** the largest use of land, accounted for 31 percent of major land uses in the 48 States in 1992. However, grassland pasture and range has declined since the mid-1960's. One reason for this decline has been that farmers have improved the forage quality and productivity of grazing lands. A second reason is that the number of domestic animals, particularly sheep and draft animals, has been declining in recent years.

- **Forest-use land**, the second largest area among major uses, declined from about 32 percent of total land in 1945 to less than 30 percent in 1992. All land with a forest cover comprises an even larger area—nearly 32 percent in 1992. However, much forested land is in special uses (parks, wilderness areas, and wildlife areas) that prohibits forestry uses such as timber production. These areas increased from 22 million acres in 1945 to 89 million acres in 1992. As a result, land defined as forest-use declined consistently from the 1960's to 1987, while special uses increased rapidly. There was a slight increase in forest-use land from 1987 to 1992, primarily in commercial timberland.

- **Cropland** comprises the third largest use of land (24 percent in 1992). Total cropland in the contiguous States varied about 8 percent between 1945 and 1992—ranging from 478 million acres in 1949 to 444 million acres in 1964. The 1992 cropland base of 460 million acres was the lowest since 1964.

The cropland base includes cropland used for crops, cropland idled, and cropland used only for pasture. These components vary more than total cropland. The amount of cropland used for crops has ranged from 383 million acres in 1949 to 331 million acres in 1987. There has been no trend, but instead seemingly two major cycles, with cropland moving from idle into crop use and back again. Between 1945 and the 1949 peak, cropland used for crops expanded rapidly to meet increased foreign demand for U.S. grain. After the post-war agricultural recovery in these foreign nations, cropland used for crops gradually declined until the early 1970's, when a second round of strong foreign demand occurred for U.S. grains. In 1982, a severe recession in the United States and in other major markets weakened the demand for U.S. agricultural products and grain surpluses piled up. Annual Federal crop programs and the long-term Conservation Reserve Program (starting in 1986) idled additional cropland, again reducing the acreage used for crops. Cropland is idled every year for reasons other than government programs, including weather or soil conditions at planting time, low crop prices, or holding for eventual conversion to non-agricultural uses. Between 1945 and 1992, cropland used for pasture ranged from 47 million acres in 1945 (10 percent of total cropland) to 88 million acres (19 percent) in 1969. Cropland pasture averaged about 14 percent of total cropland.

Table 2.10 Major uses of land in the contiguous 48 States, 1945-92 (Million acres)

Land use	1945	1949	1954	1959	1964	1969	1974	1978	1982	1987	1992
Cropland	450.7	477.8	465.3	457.5	443.8	471.7	464.7	470.5	468.9	463.6	459.7
Cropland used for crops	363.2	382.9	380.5	358.4	334.8	332.8	361.2	368.4	382.6	330.7	337.4
Cropland idled	40.1	25.6	18.7	33.6	51.6	50.7	20.8	26.0	21.3	68.0	55.5
Cropland used for pasture	47.4	69.3	66.1	65.4	57.4	88.2	82.7	76.1	65.0	64.9	66.8
Grassland pasture and range	659.5	631.1	632.4	630.1	636.5	601.0	595.2	584.3	594.3	588.8	589.0
Forest use land	601.7	605.6	615.4	610.9	611.8	602.8	598.5	583.1	567.2	558.2	558.7
Forestland grazed	345.0	319.5	301.3	243.6	223.8	197.5	178.9	171.3	157.5	154.6	145.0
Forestland not grazed	256.7	286.1	314.1	367.3	388.0	405.3	419.6	411.8	409.7	403.6	413.7
Special uses	100.0	105.3	110.2	124.4	144.5	143.1	148.0	167.2	176.9	191.2	194.4
Urban land	15.0	18.3	18.6	27.1	29.2	30.8	34.6	44.2	49.6	55.9	58.0
Transportation	22.6	22.9	24.5	25.1	25.8	25.7	26.0	26.3	26.4	25.2	24.8
Recreation and wildlife areas	22.6	27.6	27.5	31.9	49.7	53.4	56.9	66.0	71.1	84.1	86.9
National defense areas	24.8	21.5	27.4	28.9	29.3	22.9	22.4	22.3	21.8	18.9	18.6
Misc farmland uses	15.1	15.1	12.2	11.3	10.5	10.3	8.0	8.4	8.0	7.1	6.2
Miscellaneous other land	93.4	84.0	80.5	78.9	63.0	78.4	90.6	91.9	88.5	93.9	92.4
Total land	1905.4	1903.8	1903.8	1901.8	1899.6	1897.0	1897.0	1897.0	1895.7	1895.7	1894.1

Source: USDA, ERS, based on Krupa and Daugherty, 1990; Daugherty, 1995.

- **Special uses** include urban; rural transportation; rural parks and wildlife; defence and industrial uses; and farmstead, farm roads and lanes, and other miscellaneous on-farm uses. These uses increased from 100 million acres (5 percent of the loss of grassland to urbanization, and concentration of the dairy industry). Decreases in the Corn Belt, Northern Plains, and Mountain regions were likely associated with the conversion of some grassland pasture or range to cropland as demand for grain intensified. In most regions, the changes in forest-use land were relatively small. The Northeast and Appalachian regions gained 7 million and 8 million acres of forestland, mainly from farm fields reverting to forest. The Pacific and Mountain regions lost forest-use land to recreation and wildlife areas. One-quarter of forest-use lands were grazed in 1992, down from over half in 1945. The proportional decline was greatest in the more heavily forested Northeast, Lake States, Appalachian, and Southeast regions. The decline in grazing derives from an increased emphasis on improving and managing farm woodlands. In the 1940's and 1950's, the Cooperative Extension Service encouraged farmers to fence livestock out of farm woodlands and to manage these areas for increased productivity of timber and other wood products. In some areas, such as the Appalachian region, many small farms ceased crop and livestock production and became forested. These reforested areas were generally not grazed. The reduced grazing of forest-use land also reflects major changes in livestock production, including increased emphasis on improved grassland pastures; greater use of controlled, rotation grazing; and increased concentration and specialization in the dairy and beef cattle industry (as opposed to earlier general farming practices). By-products of other industries—such as beet and citrus pulp—now substitute for forage. Also, some of the larger, more concentrated dairy farms have moved to confined animal operations, where the cows are not pastured during their production cycle.

The location of special-use lands shifted considerably during 1945-92. Urban-use lands expanded most rapidly in the warmer Sunbelt States of the South and Southwest. Land in rural transportation uses increased in 8 of the 10 farm production regions, while land in recreation and wildlife areas increased in all regions. In contrast, land in national defence areas and miscellaneous farm uses declined in all regions.

■ Cropland Use and Programs

Total cropland consists of cropland used for crops, cropland idled, and cropland used for pasture. While total cropland has varied up and down and generally declined since 1969, even greater shifts have occurred between cropland used for crops and cropland idled, mostly because of Federal programs. Cropland used for pasture has shown less variation (Table 2.11).

Table 2.11 Major uses of cropland, United States (1986-96 Million acres)

Cropland	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	19962
Cropland used for crops	357	331	327	341	341	337	337	330	339	332	346
Cropland harvested	316	293	287	306	310	306	305	297	310	302	314
Crop failure	9	61086	7	811	7	810					
Cultivated summer fallow	32	32	30	27	25	24	24	22	22	22	22
Cropland idled by all Federal programs	48	76	78	61	62	65	55	60	49	55	34
Annual programs	46	60	53	31	28	30	20	23	13	18	0
Conservation Reserve Program	216	2530	3435	35	363636	34					
Total specified uses	405	407	405	402	403	402	392	389	388	388	380

Source: USDA, ERS, based on a variety of published and unpublished data from FSA (formerly ASCS), ERS, and NASS.

■ **Cropland Used for Crops**

Most cropland used for crops is harvested, but typically 2-3 percent experiences crop failure and 7-10 percent is cultivated summer fallow. In 1996, farmers harvested an estimated 326 million acres of crops (314 million acres of principal crops). About 12 million acres of the total harvested were double-cropped. When double-cropped land is counted only once, the *cropland harvested* estimate rounds to 314 million acres, up 12 million acres from 1995 as a result of no land idled in annual Federal programs and a larger acreage planted. The 346-million cropland acres estimated to have been used for crops (cropland harvested, crop failure, and summer fallow) in 1996 were up about 14 million (just over 4 percent) from 1995. This is the largest area used for crops since 1986, the year in which the Conservation Reserve Program (CRP) began. The increase in cropland used for crops reflects higher plantings and less land idled in Federal programs. The decrease of about 21 million acres in cropland idled in Federal programs from 1995 was a result of elimination of annual commodity programs and of changes to the CRP. Four crops—corn for grain, wheat, soybeans, and hay—accounted for nearly 80 percent of all crop acres harvested in 1996. The additional 15 "principal" crops accounted for another 16 percent of harvested area. Vegetables, 1995 included castor beans, chia, crambe, crotalaria, cuphea, guar, guayule, hesperaloe, kenaf, lesquerella, meadowfoam, milkweed, plantago ovato, and sesame. Deficiency payments were not reduced when these crops were planted on diverted acreage (Table 2.12).

Table 2.12 Acreage Reduction Program (ARP) requirements for participation in major program crops (1985-96, Proportion of crop acreage base to be idled from program crop and placed in a conserving use Percent)

Program crop	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Corn	10	17.5	20	20	10	10	7.5	5	10	0	7.5	*
Sorghum	10	17.5	20	20	10	10	7.5	5	5	0	0	*
Oats	10	17.5	20	5	5	5	0	0	0	0	0	*
Barley	10	17.5	20	20	10	10	7.5	5	0	0	0	*
Wheat	20	22.5	27.5	27.5	10	5	15	5	0	0	0	*
Upland cotton	20	25	25	12.5	25	12.5	5	10	7.5	11	0	*
Rice	20	35	35	25	25	20	5	0	5	0	5	*

*Authority for ARP eliminated by the 1996 Farm Act.

Source: USDA, ERS, based on unpublished material from the FSA (formerly ASCS).

- **Cropland Idled Under Federal Programs**

The Federal Agriculture Improvement and Reform Act of 1996 (the 1996 Farm Act) eliminated the authority of USDA to implement an annual Acreage Reduction Program (ARP) and other annual acreage diversions. As a result, no land was idled under annual commodity programs in 1996. This, combined with the expiration of some CRP contracts, reduced total land idled under Federal programs to about 34 million acres in 1996 down from 1995 and well below the 1983 peak of 78 million acres. The extent of idled acres from participation in the CRP varied by farm production region. In 1995, land idled in annual programs totaled 18 million acres, compared with a range of 13 to 60 million acres idled since 1986. The CRP was initiated in 1986 to help owners and operators of highly erodible cropland conserve and improve the soil and water resources on their farms and ranches through long-term land retirement.

CRP pays farmers to retire highly erodible and other environmentally sensitive lands from crop production for 10-15 years and to convert them to perennial vegetation. Since its authorization, 37 million acres of cropland have been enrolled in the CRP. With some producers opting lands out of the CRP in 1995-96 and some terminating prior to early-out, the program in December 1996 stood at just under 33 million acres. Prior to 1996, producers of corn, rice, sorghum, oats, barley, wheat, and cotton under USDA commodity programs had to idle a proportion of the crop acreage base and place it in the Acreage Reduction Program (ARP). These proportions (ARP requirements) varied by crop and year from 0 to 35 percent (Table 2.13).

Table 2.13 Cropland idled under Federal acreage reduction programs (1986-1996, Million acres)

Program	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
CRP idled base acres	1.2	10.0	15.5	19.0	21.8	22.0	22.6	23.3	23.3	23.3	22.3
Base acres idled	47.4	70.5	68.8	49.9	49.5	52.1	42.1	46.7	36.1	41.7	22.3
CRP idled nonbase acres	0.7	5.7	8.9	10.9	12.1	12.4	12.8	13.2	13.2	13.2	12.1
Cropland idled-under Federal programs	48.1	76.2	77.7	60.8	61.6	64.5	54.9	59.8	49.2	54.8	34.4

Source: USDA, ERS, based on various published and unpublished data from FSA (formerly ASCS).

■ Agricultural Land Use Issues

Agricultural uses of land are being affected, and in some cases challenged, by factors other than changing demand for agricultural products and changing agricultural programs. Some continuing or emerging issues include farmland preservation from urbanization, conflicts with other uses of Federal lands, conflicts with environmental preservation, the use of agricultural lands for fuel and biomass production, and potential impacts of global climate change.

- **Preservation of Agricultural Lands**

Preservation of agricultural lands for future food and fibre production and for open space is a concern because conversion, particularly to urban and other special uses, is largely irreversible. Urban and built-up land in the United States constitutes less than 3.5 percent of total land area. However, 75 percent of the U.S. population lives in urban areas. Even with large increases in urban area, percentage decreases in rural area are small because rural area is much larger than urban area. The rate of expansion in urban area has decreased from 39 percent during the 1950's to 18 percent during the 1980's (The Natural Resources Inventory (USDA, SCS, 1994) shows a 26-percent increase from 1982-92.) Land converted to urban uses comes from several different major land uses. From 1982 to 1992, 46 percent of new urban development came from cropland and pasture. The average annual expansion in urban area was about 1.3 million acres. Even so, losing farmland to urban uses does not threaten total cropland or the level of agricultural production, which should be sufficient to meet food and fibre demand into the next century (Vesterby, Heimlich, and Krupa, 1994).

Land use change is dynamic. With the exception of urban land, changes occur to and from major land uses. For example, 26.4 million acres (of prime and nonprime land) left cropland and pasture from 1982 to 1992 but 16.3 million acres came into the category, resulting in a net loss of 10.1 million acres. Forestland lost 14.2 million acres, but gained 15.2 million acres for a net gain of 1 million acres. Issues include farmland preservation from urbanization, conflicts with other uses of Federal lands, conflicts with environmental preservation, the use of agricultural lands for fuel and biomass production, and potential impacts of global climate change.

Prime agricultural land has the growing season, moisture supply, and soil quality needed to produce sustained high yields when treated and managed according to modern farming methods (Heimlich, 1989). About 24 percent of rural non-Federal land is prime. Of land converted to urban, 28 percent is prime, so that urban conversion takes prime land in a slightly greater proportion than its occurrence. Of total cropland and pasture, 48 percent is prime and prime cropland is converted to urban uses at about the same rate as nonprime cropland.

Concerns about preserving agricultural lands and open areas have resulted in the use of a variety of instruments, including property, income, and estate tax incentives; and the use of easements and land trusts

- **US. Cropland Programs**

- **Conservation Reserve Program (CRP)** was designed to voluntarily retire from crop production about 40 million acres of highly erodible or environmentally sensitive cropland for 10-15 years. In exchange, participating producers receive annual rental payments up to $50,000 and 50 percent cost-share assistance for establishing vegetative cover on the land. The Federal Agriculture Improvement and Reform Act (1996 Farm Act) of 1996 limited CRP enrolment to 36.4 million acres.

- **Acreage Reduction Program (ARP)** was a voluntary land retirement program in which farmers reduced their planted acreage of a program crop by a specified proportion of that crop's acreage base to become eligible for deficiency payments, loan programs, and other USDA commodity program benefits. Crops under this program included corn, sorghum, oats, barley, wheat, cotton, and rice. The 1996 Farm Act eliminated the authority of USDA to implement an annual ARP.

- **Production flexibility contract payments** are authorized under provisions of the 1996 Farm Act as a replacement for deficiency payments, and cover the 1996 through 2002 crops of wheat, feed grains, upland cotton, and rice of landowners or producers with eligible cropland. In exchange for a series of annual contract payments for the 7-year period based on a predetermined total dollar amount for each year, the owner or producer agrees to comply with specified conservation requirements concerning the use of highly erodible cropland and wetlands; to comply with planting flexibility requirements of the Act; and to use contract acreage for agricultural or related activities, not for non-agricultural commercial or industrial use.

- **0/85-92 Provision**, an optional, Federal acreage diversion program, allowed wheat and feedgrain producers to devote all or a portion of their permitted acreage to conservation uses or to a minor oilseed crop, sesame, or crambe and, under some conditions, receive deficiency payments. At least 8 but no more than 15 percent of the producer's maximum payment acres had to be maintained in conserving uses or other allowable crop use. Eliminated by the 1996 Farm Act.

- ***50/85-92 Provision***, an optional, Federal acreage diversion program, allowed upland cotton and rice producers to underplant their permitted acreage and, under some conditions, receive deficiency payments on part of the underplanted acreage. At least 50 percent of the crop's maximum payment acreage had to be planted. An additional 8 percent but no more than 15 percent had to be designated for conserving use. Minor oil-seeds could not be planted on the 50/92 conservation-use acres but sesame or crambe could be planted, with producers still qualifying for deficiency payments. Eliminated by the 1996 Farm Act.

- **Crop acreage base**, for 1995 wheat and feedgrains, was the average of the acreage planted and considered planted to each program crop in the 5-year-period, 1990-94. For upland cotton and rice, the crop acreage base in 1995 was the average acreage planted and considered planted for 1992-94, with no adjustment for years with zero planted or considered planted acreage. The 1996 Farm Act used crop acreage base only in determining eligible production flexibility contract acreage.

- **Deficiency payments** were payments made to farmers who participated in feedgrain (corn, sorghum, oats, or barley), wheat, rice, or upland cotton programs up to 1996. The payment rate per unit crop production was based on the difference between a target price and the market price or loan rate, whichever difference was less. The total payment a farm received was the payment rate multiplied by the eligible production. Eliminated by the 1996 Farm Act and replaced by production flexibility contract payments in 1996.

- **Production flexibility contract acreage** is equal to a farm's crop acreage base for 1996 calculated under the provisions of the previous farm program, plus any returning CRP base acreage and less any new CRP acreage enrolment. A landowner or producer can enrol less than the maximum eligible acreage. In 1996, contracted acreage totalled just over 207.5 million acres, 98.8 percent of the eligible 210.2 million acres (USDA, FSA, 1996).

■ Conflicts Among Uses of Federal Lands

Nearly the Federal Government owns 29 percent of the Nation's surface area, some 650 million acres (U.S. General Services Administration, 1995). USDA's Forest Service (FS) and the Department of the Interior's Bureau of Land Management (BLM) administer most of this land, with lesser amounts by the Fish and Wildlife Service (FWS) and National Park Service.

- **National Forest System** (NFS) lands total 191.6 million acres (USDA, FS, 1996). By law, NFS lands are managed to promote multiple uses. Logging and grazing are the principal commercial activities. The NFS includes about 85 million acres of timberland and 96 million acres of rangeland. FY 1995 production from these resources included 3.9 billion board feet of timber (about 13 percent of the national harvest) and almost 9.3 million animal-unit months (AUM's—1 AUM is forage for a 1,000 lb. cow, or the equivalent, for 1 month) of livestock grazing. Other commercial activities include oil, gas, and mineral production. Recreation and conservation are also major uses. The Forest Service manages over 18,000 recreational facilities within the NFS, along with over 125,000 miles of trails and 4,385 miles of wild and scenic rivers. FY 1995 recreational use of NFS lands exceeded 4 billion visitor hours (USDA, FS, 1996). The NFS also includes 35 million acres of designated wilderness. Within the continental United States, NFS lands provide habitat for 113 animal species and 87 plant species listed by the Federal Government as threatened or endangered (BioData, Inc., 1995). The NFS also accounts for about one half of the West's water supply (USDA, FS, 1996).

- **Bureau of Land Management** (BLM) lands total 264 million acres, most of which are in Alaska and 11 Western States (USDI, BLM, 1996). BLM lands are managed for multiple uses, primarily commercial production. The main commercial activity is grazing, with 19,048 grazing permits or leases covering 166.9 million acres in FY 1993 (USDI, BLM, 1996). About 8 million acres of BLM land are classified as timberland. BLM's recreation management efforts target high-use areas that cover about 10 percent of agency lands. These areas contain 4,869 miles of trails and about 2,000 miles of wild and scenic rivers. FY 1995 recreational use of BLM lands was

> about 880 million visitor hours. As with the Forest Service, BLM has given increasing importance to conservation uses—protecting wetlands and riparian areas, endangered species, and important wildlife habitat. Within the 48 States, BLM lands provide habitat for 61 federally listed threatened or endangered animal species and 77 listed plant species (BioData, Inc., 1995). BLM lands include 5.2 million acres of designated wilderness and 17.4 million acres that are being studied for future designation.

Debate over the use of public lands, particularly those under FS and BLM jurisdiction (that is, those explicitly managed under multiple-use objectives), has become increasingly contentious over the last 20-30 years. Critics argue that FS and BLM give grazing, logging, and mining priority over other land uses (primarily environmental uses but also, to a lesser extent, recreational uses). Private landowners in nearby areas, for example, generally well below fees charge federal grazing fees. In 1995, the Federal grazing fee was $1.61 per AUM. For the 11 Western States where BLM and FS lands are concentrated, private land grazing fees (for cattle) averaged $10.30 per AUM (USDA, NASS, 1995a). Similarly, the FS often pays for construction of access roads, which is a major cost component in bringing NFS lands into timber production. With respect to mining, Federal law allows prospectors to take title to public lands, and the minerals they contain, for as little as $2.50 per acre.

Commercial users of Federal lands defend existing policies on a number of grounds. Ranchers argue that Federal rangelands are, on average, of lower quality than private rangeland. Ranchers also fear that raising Federal-grazing fees would reduce ranch land values because the value of access to Federal lands is capitalized into the value of ranches. Loggers argue that roads into previously inaccessible areas of the NFS provide a stream of future recreation and logging benefits and that these benefits justify their construction by the Federal Government. The economies of many rural communities, particularly in the West, are heavily dependent on access to Federal lands; reducing this access, it is argued, would increase unemployment in these areas. In 1995 and 1996, a number of administration and congressional efforts attempted to effect changes in the management of federally owned lands. Whether designed to encourage economic development or promote conservation objectives, these efforts generally met with stiff opposition, and no major reforms affecting commercial or conservation activities on Federal lands were signed into law. While the debate over the use of Federal lands is unlikely to be resolved in the near future, elements of the debate have been reflected in land-use patterns. Both NFS and BLM lands saw a marginal decrease in the amount of grazing allowed during 1983-95. Both agencies also sharply decreased their timber sales, largely due to court injunctions brought to address environmental issues, but also reflecting changes in forest management objectives and policy within BLM and FS. Recreation and conservation uses of BLM and FS lands increased significantly between 1983 and 1995. For the two agencies combined, the number of recreational visitor days rose almost 64 percent while the area of designated wilderness expanded 14.6 million acres. There were also significant increases in the number of trail miles and wild and scenic river miles on both FS and BLM lands.

■ Conflicts With Environmental Preservation

Virtually all of the Nation's 460 million acres of cropland and much of its 591 million acres of grassland pasture and range were once wetlands, forest, native grassland, or some other natural ecosystem. In converting these lands to agricultural uses, many of their environmental goods and services have been damaged or lost. Additionally, incidental consequences of crop and livestock production, such as soil erosion and farm chemical runoff, can stress connected ecosystems. Conservation has become a recurring issue in agricultural policy for two reasons.

First, government policies have often encouraged the conversion of natural areas to agriculture and the use of production practices with negative environmental impacts (for example, chemical-intensive monoculture systems). Second, the private benefits of conservation are often insufficient to induce farmers and ranchers to protect natural resources at levels that are optimal from a social perspective. This section briefly discusses five areas where conflicts between agricultural and environmental uses of land are likely to become important policy issues.

- **Endangered Species**. As of September 30, 1995, 663 plant and animal species inhabiting the contiguous 48 States (during at least some part of their life cycle) were listed by the Federal Government as threatened or endangered. Of these species, 380 are listed, at least in part, due to activities typically associated with agriculture. Agricultural development (that is, the conversion of land to agricultural production) and grazing threaten the most species, 272 and 171. Exposure to fertilizers and pesticides is a factor in the listing of 115 species. While farm production accounts for the large majority of such listings, some listings are due to non-farm uses of these chemicals. Of the species listed due to the use of fertilizers and pesticides, 28 have been linked to fertilizers, 85 to herbicides, and 80 to other pesticides. Competition between agriculture and endangered species for land has heightened due to the Endangered Species Act (ESA) of 1973. The stated purpose of the ESA is to provide a means for protecting ecosystems upon which threatened and endangered (T&E) species depend and to provide a program for the conservation of such species. Several sections of the ESA have important implications for agriculture. Section 6 prohibits State laws protecting federally listed T&E species from being less restrictive than the ESA. Hence, States have limited ability to grant exemptions to ESA restrictions regardless of compliance costs. Section 7 requires Federal agencies to ensure that actions they fund, authorize, or carry out are not likely to jeopardize the survival of T&E species. Potentially, this brings commodity program participants, users of federally supplied irrigation water, and holders of Federal grazing permit and leases within reach of the ESA. Additionally, Section 11 allows private agents to sue Federal agencies to force their compliance with ESA provisions. This has caused concern that the ESA may be used to restrict pesticide use because these products can be distributed in the United States only if they have been registered or exempted from registration by the Environmental Protection Agency. Finally, Section 9 makes it illegal to take, possess, transport, or traffic in listed animals except by permit; for plants it is illegal to collect or maliciously damage endangered species on Federal lands. For listed animal species then, the ESA can affect land-use decisions on both public and private lands; for listed plant species, it can affect land-use decisions only on Federal lands.

- **Wildlife Habitat.** Agriculture affects the welfare of wildlife populations beyond endangered species. While a few species have adapted well to farm systems (for example, white-tail deer, Canada geese, raccoons, and coyotes), agriculture has negatively impacted most species. Over the last 30 years, habitat loss due to conversion of land to agriculture has reduced wild species numbers more than any other human activity (McKenzie and Riley, 1995). In prairie regions between 1980 and 1989, for example, populations of grassland-nesting birds declined 25 to 65 percent. Many duck populations have also fallen dramatically. Mallard, winged teal, and initial populations, for example, have declined 43, 45, and 71 percent since the 1970's. At the same time, agriculture must be a key component of any national wildlife conservation program. Within the 48 States, the farm sector owns vast quantities of valuable wildlife habitat, including over 60 percent of all wetlands and 38 percent of all forests and woodlands. Agricultural producers also have senior use rights to millions of acre-feet of surface water in the West. Finally, tens of millions of acres of cropland and pasture have high wildlife producing potential and are thus prime candidates for habitat restoration. Additionally, the success of the Conservation Reserve Program (CRP) in enhancing many wildlife populations is promising.

- **Wetlands.** In 1780, there were an estimated 221 million acres of wetlands in what is now the contiguous 48 States; a recent estimate is less than 124 million acres (see table 6.5.1 in chapter 6.5, *Wetland Programs*). Bringing land into agricultural production accounts for more than 80 percent of all wetlands lost since colonial times (U.S. Congress, OTA, 1993). Nearly a third of all wetlands losses have occurred in the farm-intensive States of Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin (Dahl, 1990).

In recent years, the full range of ecological functions and economic benefits associated with wetlands has become much better understood; these include critical wildlife habitat, temporary stormwater storage, groundwater recharging, pollution control, sport hunting and fishing opportunities, wildlife viewing, and breeding grounds and nurseries for many commercially important fish, fur, and game species. As a result, Federal wetlands policy has increasingly emphasized conservation, and much of this policy shift has been directed at agriculture. Swampbuster provisions of the Food, Agriculture, Conservation, and Trade Act of 1990, for example, denied crop subsidy payments to farmers who converted wetlands to boost commodity program acreage—even if the converted wetlands were not directly used to produce program crops (U.S. Congress, OTA, 1993). Violation of Swamp buster regulations can mean the loss of eligibility for all farm program benefits—including commodity program participation, crop insurance, and disaster payments—until the violation is remedied. The Wetlands Reserve Program and the Emergency Wetlands Reserve Program pay farmers to preserve their wetlands and offer cost shares to encourage wetlands restoration. Agriculture's role in converting wetlands to other uses has been declining. Between 1954 and 1974, agriculture accounted for 81 percent of all gross wetlands losses; between 1982 and 1992, it accounted for only 20 percent (see table 6.5.2 in chapter 6.5, *Wetlands Programs*). Furthermore, this percentage change reflects a decrease in conversions of land to agriculture rather than an increase in wetlands losses due to other activities. About 90 percent of the 124 million acres of wetlands remaining in 1992 in the 48 States was on rural non-federal lands. Given its ownership of these land resources, the farm sector will likely remain a primary target of wetlands conservation efforts.

- **Water Quality.** Agriculture threatens many wetland and aquatic ecosystems via the discharge of runoff laden with sediments and chemical residues. Nationally, runoff from agricultural land accounts for 60 percent of the sediment and about half of the phosphorus and nitrogen reaching freshwater systems (Crutchfield and others, 1993). This can create a variety of environmental problems in aquatic ecosystems. Nutrients from fertilizer applications can increase algae and plant growth, which in extreme cases can promote eutrophication of streams, lakes, and estuaries. Residues from pesticide applications can have toxic effects on freshwater and marine species as well as their predators. Soil sediments can decrease sunlight penetration in water bodies, deteriorate spawning grounds, and reduce supplies of dissolved oxygen. Because of the widespread nature of environmental problems associated with agricultural runoff, water quality will continue to be an important source of conflicts between the farm sector and the environment.

- **Air Quality.** On farm air pollution has recently received increased attention. Principal concerns include crop damage, noxious odours, particulate matter or dust, and wildfires. Crop damages occur due to off-farm pollution, such as ozone and other airborne pollutants, drifting into agricultural areas reducing growth and seed formation of field crops. These yield reductions of 5-10 percent are concentrated in areas near large population centres (Westenbarger and Frisvold, 1995). While airborne pollutants do not directly cause a severe reduction in yields, they can weaken plants and make them more susceptible to disease or insect damage.

On farm odours have brought about legal action by nearby property owners, who have seen their quality of life and property values suffer. These odours are generally a problem around large-scale livestock facilities, as well as near farms that fertilize with stored manure sludge. Anticipated odour problems have delayed or prevented construction of some livestock or poultry operations. The backlash against noxious odours has prompted some farmers to band together to create “right-to-farm” zones that protect farm operators against lawsuits by newcomers who were aware of the farms' existence before purchasing their property. Particulate matter, or “fugitive dust,” is a problem in dry areas where wind erosion is high. The Agricultural Research Service (ARS) and the Natural Resources Conservation Service (NRCS) are working with the Environmental Protection Agency (EPA) to study conditions that lead to excessive airborne particulate pollution. Wildfires affect respiratory health in rural areas, and the Forest Service and other agencies manage controlled burning programs to reduce their incidence. In a controlled burn, dry brush and dead trees are removed by burning to remove the kindling that contributes to uncontrolled wildfires.

■ **New US Farm bill (2002)**

The "Farm Security and Rural Investment Act of 2002" replaces the "FAIR Act of 1996" and sets out various agricultural programmes under 10 titles, notably the commodity (farm subsidy) programmes, conservation and trade. It will last for 6 years. The expected spending on commodities is projected to be in the order of $15-20 billion per year for crops alone, which represents a 70% increase (some calculations put the spending higher at an 80% increase) on the amount foreseen at the end of the FAIR Act. The overall Farm Bill budget has been calculated in the US on a 10-year basis at $180 billion. As the Farm Bill will have a price-depressing effect on world markets, and in the absence of a dramatic increase in demand, the cost is likely to be in the higher range of the estimates.

- **What environmental programmes are included in the Farm bill?**

Under the heading of "conservation" a number of new incentive programmes are introduced and others are expanded. In particular:

- **NEW** Conservation Security Programme ($2 billion over 6 years) will provide payments for farmers who maintain (as yet undefined) stewardship practices or who improve the environmental care for the land.
- **NEW** Grasslands Reserve Programme ($254 million over 6 years) will pay livestock producers who farm on grasslands. It is aimed to enrol 2 million acres in the programme.
- **EQIP**, Environmental Quality Incentive Programme, which pays farmers who make environmental investments to their land, including compulsory works such as to deal with animal waste, is expanded to a level of $9 billion over 6 years or $1.3 billion per annum (a six-fold increase compared to the current $200 million per year).
- **Other programmes,** such as Conservation Reserve (a long-term set-aside/ retirement programme; $1.5 billion/6 years) and Wetlands Reserve ($1.5 billion/6 years) and Farmland Protection ($1.0 billion/6 years) are expanded and continued.

3 State of art

3.1 Concerned international programs

3.1.1 Global context

The issues of land use have long been being the primary concern of all countries because of its crucial importance to agriculture, food security, ecological safety and other activities of human livelihoods. However, concerted international efforts were only eminent till the Rio summit in 1992. Where, Conventions of Combating Desertification, Biodiversity and Wetland Conservation were agreed upon and took effect. Land issue were also reflected in the UN Millennium Development Goals (MDGs) declared in 2000, and reiterated in the action plan of the World Summit on Sustainable Development (WSSD) held in 2002. The MDGs have listed ensuring environmental sustainability as one of the important goals, in which land degradation control is on the top of the priority list. The first two indicators of the goal are "proportion of land area covered by forest", and "land area protected to maintain biological diversity". In the WSSD action plan, there are many chapters stressing the importance of land and the need to combat land degradation.

- **LUCC & recent progresses**

  - **LUCC overview**

In response to need of the above UN conventions and action plans, the International Geosphere-Biosphere Program (IGBP) and the International Human Dimensions Program (IHDP) jointly launched a core project—Land Use and Land Cover Change (LUCC) in 1993. This is a global interdisciplinary approach to address the interaction between land and human beings. The Science/Research Plan (IGBP Report No. 35, HDP 7), a landmark of global land use and land cover study, was published in 1995, and the implementation plan was drafted in 1999.

The research plan of the project is guided by five overarching questions:

1). How has land cover been changed by human use over the last 300 years?

2). What are the major human causes of land-use change in different geographical and historical contexts?

3). How will changes in land use affect land cover in the next 50-100 years?

4). How do immediate human and biophysical dynamics affect the sustainability of specific types of land uses?

5). How might changes in climate and global biogeochemistry affect both land use and land cover, and vice versa?

These questions are addressed by three research foci:

Focus 1 Land-Use Dynamics is an approach aimed at improving understanding of the variation in the nature-society dynamics of land management.

Focus 2 Land-Cover Dynamics involves regional assessments of land-cover change as determined from direct observation (e.g., satellite imagery and field studies) and models built from these observations.

Focus 3 Regional and Global Models aim to improve existing models and build new ones that provide a basis for projecting land-use changes based on changes in the underlying causes or driving forces. These models will incorporate the regional and situational sensitivity provided from Foci 1 and 2 to generate more spatially explicit outcomes from regional and global models.

Apart from the three foci, there are two cross-cutting activities to fulfil the objectives of LUCC:

Activity 1: Data and Classification, analyses data availability and quality and devises a classification structure suitable for the various needs of the research foci.

Activity 2: Scalar Dynamics, recognizes that the different scales at which LUCC processes operate, and the different scales at which they are analyzed, pose major impediments to developing a comprehensive understanding of LUCC. This activity seeks to identify the major rules and lessons that should guide LUCC efforts in this regard, thus improving the integration of the three foci.

- The recent progress of this project was reflected in the LUCC NEWSLETTER No. 8, summarized by Eric F. Lambin as:

LUCC has been making rapid progress on the understanding of land-use dynamics (Focus 1). The large number of detailed case studies and meta-analyses to gain a generalised understanding of the causes of forest-cover changes, land degradation and agricultural intensification prove this. The modelling of land-use change (Focus 3) also made great strides recently. This increases the realism of simulations of processes leading to land-use change. The measurement of land-cover changes (Focus 2) has been progressing as fast as the other two "pillars "of LUCC. After several years of methodological research on monitoring techniques and environmental indicators, a number of teams have started to actually produce global scale databases on a range of processes of land-use/cover change. These typically merge remote sensing information with fine scale statistical data or expert opinion. Processes of land cover conversions are generally best documented.

- **The Millennium Ecosystem Assessment (MA) program**
  - The MA is an international process designed to meet the needs of decision makers and the public for scientific information concerning the consequences of ecosystem change for human well-being and options for responding to those changes (W. Reid et al, 2001). The MA is designed to meet some of the assessment needs of the Convention on Biological Diversity, Convention to Combat Desertification, and the Wetlands Convention, as well as needs of other users in the private sector and civil society. U.N. Secretary-General Kofi Annan launched it in June 2001. The first products will be released in 2003, and the main products will be released in 2004. It is anticipated that the MA will be repeated every 5 to 10 years.

The Millennium Ecosystem Assessment (MA) will provide public and private sector decision makers with an authoritative synthesis of scientific knowledge concerning the impact of changes to the world's ecosystems on human well-being. The MA will assess the broad scope of social and natural science pertaining to the current condition of the world's ecosystems, the consequences of ecosystem change for human well-being, and the policy, technology, and institutional options available to conserve and enhance ecosystem services thereby improving human livelihoods and contribute to poverty alleviation and a better environment.

The MA seeks to address needs that are at the core of human development concerns (Ayensu et al. 1999). All countries and communities are grappling with the challenge of meeting growing and sometimes conflicting demands for food, clean water, health and employment. All of these concerns are linked directly or indirectly to the world's ecosystems. The MA process, at all scales, will bring the best science to bear on the needs of decision makers as they relate to this link between ecosystems and human development.

The MA focuses particular attention on the linkages between ecosystem services and human well-being. Ecosystem services are the benefits people obtain from ecosystems. These include goods such as food and water, services such as flood and disease control, and non-material benefits such as spiritual, recreational and cultural benefits.

- MA, though a very young programme crosscuts and interacts with various programmes, amongst, LUCC is the closest. A typical example of the integration with LUCC is initiative on the synthesis of knowledge of rapid land-cover and land use change. As part of the MA programme, joint efforts of IGBP/IHDP LUCC and the Global Observations of Land Dynamics project (GOLD/GOFC) were launched to provide a synthesis of the knowledge of areas affected by rapid land-cover change during the last fifteen to twenty years for various change classes.

Areas of rapid land-cover change are areas affected by either land conversion or modification and which have experienced high rates of change in the recent past. This definition does not include areas where land cover change is likely to occur in the future or locations experiencing a severe impact of a change. In this assessment, only actual land-cover changes are identified, not the vulnerability of regions to possible changes.

The exercise, based on existing databases, helps to focus attention on “hot spots ”of land-cover changes and to identify change processes for which poor information and data are available. The areas affected by significant land-cover change are outlined on top of the new GLC 2000 global land cover map. Different thematic codes are used for different processes of change. For each change patch, a description of the nature of the change, causes, impacts, detection method and references is included.

3.2 Advancement on methodology

There have been a lot of progresses on methodology development since the launch of the LUCC project, driven by the enormous demand of dynamic analysis of crosscutting issues, and propelled by the development of RS, GIS, computer sciences and integration of physical and social sciences. The methodology advancement concerned with this exercise can be arbitrarily divided into two categories/parts: LUCC mainstreaming and specific farmland Marginalisation process analysis.

3.2.1 LUCC mainstreaming

Pre and post the launch of the LUCC project, various activities have been going on, either as contributors or respondents to the LUCC plan. Amongst, EU countries, particularly United Kingdom, The Netherlands, and Germany are the major players on mostly LUCC issues in Europe as well as the rest of the world. There are several landmark activities and particularly their consequent methodological outcomes that are worth to mention.

- The Conference on Land Use Change: Causes and Consequences, organized by Natural Environment Research Council (NERC) in 1992, provided a panorama of LUCC studies systematically for the first time, based mainly on UK experiences. The wide range yet important issues raised at the conference covered policy, technology, environment, farmers etc. as either driving forces or consequences (mostly referring as driving forces) on land use change, methods of monitoring the change, data collection, integration and analysis. Research priorities were set and some case studies were explicated, with most impressive analysis of UK land use evolution.

- J. Knill pointed out that the research setting on land use change should be: Firstly, analysis of the cause of change, in which social and economic factors are major determinants need to be quantified; Second, the assessment of the consequences of change from which to identify one of the vital tools needed by policy makers; Third, the detection of change, data and application of RS/GIS/Internet; Fourth, the assessment of land use options. The greatest challenge is to develop reliable models that combine research results and knowledge so as to permit both researcher and policy makers to explore the controls on, and options for, change and thereby to develop decision support systems.
- R G H Bunce on his paper ' Integration of methods for detecting land use change', listed the following methods: field survey, aerial photography, satellite imagery, local and regional surveys, thematic surveys, social-economic surveys
- A A C Phillips from the policy perspective on land use research, listed five methodologies as: studies on past land use change, development of alternative scenarios, possible land use implications of alternative strategies for the countryside, experimental and monitoring work and environmental inventories, and interdisciplinary approaches.

a) ITC hosted Congress on Geo-Information for Sustainable Land Management (SLM) (1997, ITC, Enschede, The Netherlands). The congress dealt with the role of geographic information, particularly soil information, to support sustainable land management (SLM). The topics were focused on concepts; user needs; SLM possibilities; a land use system approach to SLM; biophysical and socio-economic sustainability of land use systems; the integration of biophysical and socio-economic analyses; and applications at regional, national, project and farm levels. Attention was also paid to the need for a geo-information infrastructure, i. e, a policy framework to ensure that geo-information can be absorbed and can make a cost-effective impact at all levels of planning, decision making and land management, while ensuring the integrity of the underlying data and the quality of the information. The potential role of remote sensing and geographic information systems was highlighted.

b) Methodological issues raised by the Electronic Conference on Land Use and Land Cover Change in Europe, 1997

- Decision making processes at the land-management level;
- River-basin level 'horizontal' biophysical/geo-chemical and spatial economic relationships;
- The impacts of landscape changes on ecological complexity and on the quality attributes of environmental resource stocks;
- Description and valuation of environmental functions and services of land and land cover (other than production);
- Embedding of spatially explicit (biophysical, biological, ecological, etc.) research into economic analysis;
- Integrated LUCC system modelling, and
- Cultural, ethical and normative aspects of land use. Other methodological questions include investigating the causes of past land-use changes, irreversibility of LUCC, the integration of quantitative with qualitative methods of analysis, and critical appraisal of the appropriateness of different methodologies and models for various issues and scales of analysis.

c) While the above mentioned are concentrated mostly on the quantity of land use change, specific focus on land quality was drawn by J. Domanski. On his paper in ITC Journal 1997-3/4 titled: 'Criteria and indicators for land quality and sustainable land management (SLM)', quoted as saying 'Five criteria to evaluate progress towards SLM were identified: productivity, security, protection, viability and acceptability. Much progress has been made in identifying criteria and indicators for SLM. To date, international agreement has been achieved on the following land quality indicators: (1) five sets of indicators that can be developed in the short term, i.e, nutrient balance, yield trends and variability, land use intensity, land use diversity and land cover; (2) three sets of indicators, requiring longer-term research, on the themes soil quality, land degradation and agro-biodiversity; and (3) four sets of indicators that are being developed by other working groups, i. e, water quality, forest land quality, rangeland quality and land contamination/pollution. These are the land quality components of SLM and still must be complemented with indicators of the other pillars—economic viability, system resilience, and social equity and acceptability.

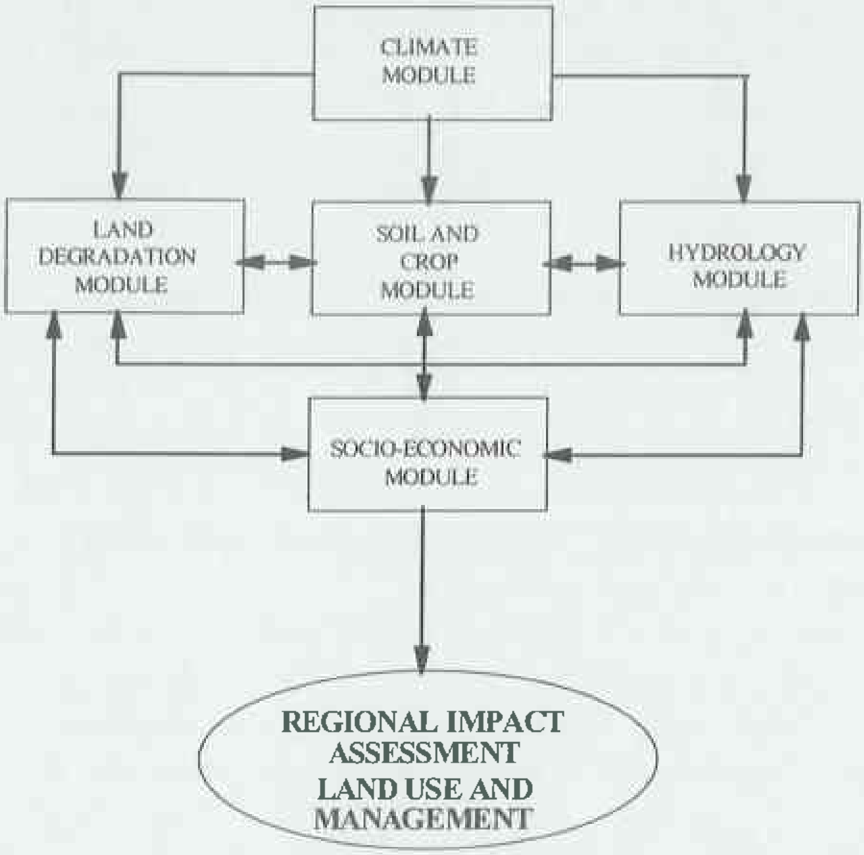
d) M.D.A. Rounsevell et al, from Cranfield University, conducted a more detailed study entitled 'Integrating Biophysical and Socio-Economic Models for Land Use'. They used the IMPEL project (Integrated Model to Predict European Land use) to integrate physical and socio-economic modelling procedures to evaluate the impact of climate change on European land use systems at the regional scale. The key IMPEL modules comprise:

- A **climate module** (named EuroSCEN) to downscale baseline climate data (gridded to 0.5° Lat/Long) and GCM climate change scenario datasets, using a stochastic weather generator.
- A **soil and crop module** (named ACCESS, Agro-Climatic Change and European Soil Suitability) to evaluate the soil water balance and crop yields for a wide range of European crops at the scale of soil map units.
- A **land degradation module** to evaluate the impact of soil erosion and changes in soil quality on crop productivity at the scale of soil map units. The module uses mechanistic approaches to simulate surface runoff and decision trees to accommodate the influence of management practices.
- A **socio-economic module** to evaluate optimal land use allocation and management requirements at the scale of individual (generic) farms. The module is based on linear programming and assumes farmers make land use decisions that maximize profitability whilst averting risk. The module takes account of farm sizes, existing farm

systems, and other demographic factors. This enables predictions of the likely rate of change of land use, based on the difference in profit between existing and proposed systems caused by variations in yields, prices, soil workability and resources such as irrigation.

- A **hydrology module** to evaluate runoff at the catchments scale.

The interrelationships between the climate module, the soil and crop modules and the socio-economic module are described below:



The key challenge for the IMPEL project is the successful integration of the modules into a single computer framework. The key inter-module linkages between the soil and crop and socio-economic modules are:

- Primary yield,
- Soil type,
- Workable hours as a function of soil type and climate,
- The effect of rotations on soil, *e.g.* soil water contents, N status,
- Fertiliser and irrigation effects,
- Monthly soil moisture content.

e) E.F. Lambin et al, examined the different modeling approaches used in LUCC study from the perspective of their utility for the study and prediction of changes in land use intensification. The analysis suggests that dynamic, process-based simulation models appear to be better suited to predict changes in land use intensity than empirical, stochastic or static optimization models. They further suggests that in the future, an integrated approach to modeling –multidisciplinary and cross-sectoral combining elements of different modeling techniques probably serve the objective of improving understanding of land use processes.

About LUCC (Source: E.F. Lambin, etc 2000)

What is already known on LUCC	What one needs to know on LUCC	Model category	Modelling approach
Where and when in the past	When in the future (short-term)	Stochastic	Multivariate statistical modeling Spatial statistical (GIS-based) models
	Why in the past (proximate causes) Where in the future (short-term)	Empirical, statistical	
Where, when and why in the past	When in the future (long-term) When and where in the future (long-term)	Process-base, mechanistic	Dynamic simulation models Dynamic spatial simulation models
	Why in the future (underlying causes) Why in the future (underlying causes; scenarios)	Analytical, agent-based, economic	Von Thunen-like models Optimization models

f) Agent-Based Models (ABM): Interest in the application of ABM to the study of land change has been growing rapidly in recent years, as more researchers seek to apply increasingly sophisticated models to understand and project the land-use dynamics that give rise to changes in the Earth's land cover. Agent-based models of Land-use and Land-Cover change (ABM/LUCC, 2001 4 27, Dawn Parker et al) combine a cellular model representing the landscape of interest with an agent-based model that represents decision-making entities. The cellular model may include a variety of spatial processes and influences relevant for LUCC. The agent-based model provides for an extremely flexible representation of heterogeneous decision makers, who are potentially influenced by interactions with other agents and with their natural environment. Thus, ABM/LUCC are well suited for analysis of spatial processes, spatial interactions, and multi-scale phenomena. These models therefore can potentially represent the interaction of complex decision making with a complex natural environment.

g) International Institute of Applied System Analysis (IIASA): Without mentioning the excellent work of IIASA, the description of the methodology advancement will never complete. Their research in the project on Modeling Land-Use and Land-Cover Changes in Europe and Northern Asia (LUC) concentrated on compiling comprehensive biophysical and socio-economic databases for countries in North and East Asia (in particular, China), on adapting existing and developing new model components in support of an integrative assessment approach, and on establishing collaborative relationships with scientists and institutions in the region. LUC also extended its global analysis and developed another detailed CD-ROM application presenting the approach and findings of the Global Agro-Ecological Zones (GAEZ) assessment, carried out jointly with the United Nations Food and Agriculture Organization (FAO) and constituting perhaps the most detailed study of this kind to date.

h) People and the Environment: Approaches for Linking Household and Community Surveys to Remote Sensing and GIS appeals to a wide range of natural, social, and spatial scientists with interests in conducting population and environment research and thereby characterizing (a) land use and land cover dynamics through remote sensing, (b) demographic and socio-economic variables through household and community surveys, and (c) local site and situation through resource endowments, geographical accessibility, and connections of people to place through GIS. Case studies are used to examine theories and practices useful in linking people and the environment. Land use and land cover dynamics and the associated social, biophysical, and geographical drivers of change articulated through human-environment interactions were also described.

People and the Environment: Approaches for Linking Household and Community Surveys to Remote Sensing and GIS addresses a need for a comprehensive and rigorous treatment of linking across thematic domains (e.g., social, biophysical, and geographical) and across space and time scales for research and study within the context of human-environment interactions. The human dimensions research community, LULCC program, and human and landscape ecology communities are collectively viewing the landscape within a spatially-explicit perspective, where people are viewed as agents of landscape change that shape and are shaped by the landscape, and where landscape form and function are assessed within a space-time context. Current researchers and those following this early group of integrative scientists face challenges in conducting this type of research, but the potential rewards for insight are substantial. (Jefferson Fox, E-W Centre Honolulu, 2002)

3.2.2 Analysis of marginalisation process

a) **Methodologies developed by Commission of European Communities (CEC)** Methodological development on Marginalisation of agricultural land can be dated back to 1970's, when the Commission of the European Communities started its mission on the analysis of "Effects on the environment of the abandonment of agricultural land (CEC, 1978).

1. The methods used include: 1) In each member state, concerned yet well-informed institutions were consulted, individual scientists and official representatives were interviewed, including written comments from the interviewee. 2) Literature concerned with reverted land problems was evaluated with the aid of a check-list, particular importance being attached to an analysis of the statistics, maps, papers and extensive "background literature" which exist over and above the standard publications. 3) Reports on the discussions with experts and on the keyword-based evaluation of the literature have been arranged by country and topic, and both concurring and conflicting statements are compared. Each section carries a concluding comment expressing the opinion of the authors.

2. The analysis had to be based predominantly on German literature because the topicality of the reverted land problem in the Federal Republic

of Germany means that it was in this country that the most research results are available. In the very beginning, even the terms had to be coordinated to reach consensus as follows: 1) **Abandoned land:** completely abandoned agricultural areas for which there is no prospect of re-cultivation; 2) **Reverted land:** Agricultural areas which have been abandoned and provide a picture of fallow vegetation in various stages, but for which rural amenity or re-cultivation measures are still possible (**Social reverted land:** abandoned agricultural land as a result of social attitudes, occurs basically on agriculturally favourable soils, not on marginal soils; **Structural reverted land:** abandoned land due to the change of agricultural structure; **Marginal reverted land:** marginal soil or marginal sites of low natural productivity or on soils which necessitates a high expenditure of labour to be worked); 3).**Unmanaged land:** land which is not managed or tended. Comprises the first stages of reversion; can be used again as agricultural land at any time by means of management or tending; 4). **Neglected land:** land which has been abandoned recently and displays at most initial reversionary stages in the natural succession, can easily be re-cultivated; 5). **Under-used land**: Land which could be used more intensively under suitable social-economic conditions, since the natural management capacity is greater than that used at present.

b) **The following 20 years** witnessed the advancement of monitoring technologies including ground truth and remote sensing, the evaluation and analysis technologies such as computer and GIS, and other crosscutting and interdisciplinary methodologies on the study of agricultural Marginalisation process. This has enabled the monitoring and evaluation of large-scale agricultural land Marginalisation process, identification of principal driving forces and assessment of environmental consequences.

- Studies by David Baldock etc.: "Farming at the Margins: abandonment or redeployment of agricultural land in Europe". Two approaches were used to analyse Marginalisation. One is to identify specific regions in twelve EU countries that might be susceptible to Marginalisation on the basis of indicators chosen from a range of European databases. These indicators cover agricultural structures and economic performance, social conditions, regional development, etc. The approach offers a relatively consistent and systematic method of attempting to identify agriculturally marginal regions in the Union and provides a basis for examining the role of agricultural policy in influencing farm incomes in such regions.

The other approach was to examine aspects of the process of Marginalisation and the environmental effects arising from it in a set of case study areas. Such case studies potentially offer insights into the variety of conditions and processes to be found within the EU and provide an empirical basis for some of the more abstract work derived from the use of indicators.

They concluded that there is a need for an integrated EU strategy towards the management of farmland (either by farmers or others) for environmental reasons. It could include species-rich grassland, some stretches of low intensity arable, some traditional mixed production systems, areas where afforestation would diminish the landscape, etc. What is required is the formulation of environmental and land use objectives which feed up into agricultural policy so that change is not driven purely by adjustment in agriculture. They further recommended the following undertakings:

- Detailed evaluation of how farmers in marginal regions and production sectors have adapted to change in the economic and political climate since 1992
- Further development if efforts in operationalizing indicators of marginalisation and abandonment
- Studies of the potential effects of possible changes in policy in marginal areas.

3.3 Studies on China

Studies on China's land use focus on three dimensions: land and food, land and economy, and land and environment. However, as the above issues are inter-linked with each other, the analysis on land use was conducted with holistic approaches by agencies in China such as the Chinese Academy of Sciences, IIASA, and USDA, though some of the reports are provisional and regional.

3.3.1 Land and food

Food security for this most populous nation has long been being the primary concern of both the Chinese Government and the rest of the world.

The Study on Land Productivity and Carrying Capacity in China in 1980s' was based on the data from the maps mentioned, and also quantitatively employed social-economical factors to project future population growth, demand, technology change, input scenario etc. It was the first time in China, that advanced methodologies and techniques were used in land use study, including the information from land resource satellite (Landsat V), the incorporation of social-economic factors into biophysical factors and so on. Those studies were mostly serving farmland production, with some exceptions on the plan of tree planting, control of soil erosion etc. The conclusion was that China's farmland has the carrying capacity to support the largest projected population 1.6 billion in 2025 (Chen BM, 1992).

However, in 1995, Lester Brown's doubt on "Who will feed China?" stimulated, in international arena, the study on land and water resources on which future China's agricultural development bases. Land resources and its carrying capacity were chosen as a particular topic in searching for an answer to Brown's enquiries (Brown 1995).

In response to this query, FAO, USDA, Chinese Government and other concerned agencies committed enormous efforts either conducting similar studies and/or revisiting the previous results. The unanimous conclusion was that China could feed herself though with limited land resources. Amongst, a typical systematic analysis was conducted by IIASA.

- A System for Evaluation of Policy Options', is the most updated using most of the available data in China and the methodologies of LUCC, coming up with the conclusion that China has the potential to produce adequate food for itself in the future, which is in harmony with lots of projections from the international and national agencies, such as FAO, World Bank, USDA, and individuals.
- As China's food security is a complex problem, at least seven dimensions were included in the study: (1) population growth, (2) diet change, (3) urbanization, (4) size and quality of arable land, (5) supply of water, (6) policies and economic arrangements, and (7) scientific and technological developments. The application includes three major components: An **analysis** of China's food prospects, translated into arguments, a large archive of corresponding **data sets** (including tables, figures, maps, and remote-sensing images), an extensive set of **references**, including a bibliography and a large selection of Web links. The arguments are organized in an evaluation matrix that: (a) describes current ***trends*** in

food-related sectors; (b) outlines the ***impact*** of these trends; (c) evaluates ***data quality*** and (d) prediction ***errors;*** (e) describes ***intervention*** *possibilities*, and (f) discusses the ***costs*** of these interventions.

- The conclusion was that China has enough arable land and water to feed its projected population of 1.48 billion in 2025 - even at *currently* available levels of agricultural technology. According to a detailed Agro-ecological Assessment model (AEZ), which was developed by IIASA and FAO and recently applied to China on the basis of greatly improved soil, terrain, and climate databases, the country has enough cultivation potential to produce about 650 million tons of grain. This production potential meets most food *demand* projections, such as those from the World Bank, from the US Department of Agriculture, or from the Food Demand Scenarios for China reported in this application. The assessment takes into account that about 25% of the arable land will be reserved for other types of agricultural production, such as cultivation of vegetables or fruits; it also takes account of land needed for infrastructure.
- Findings on agricultural land use: China's farmers are currently cultivating some 132 million hectares - an area which is almost 40% larger than previously estimated. Therefore, grain yields in the 1980s and early 1990s were inflated (due to the overestimated denominator), which - on the other hand - means that the farmers actually have "more room" to increase productivity. In addition there are some 30 million hectares of land reserves - primarily in the North. Most of the reserves in arid regions could be cultivated, if irrigation water would be available.

3.3.2 Land and economy

Entering WTO attracts more attention on land tenure and land rental market. USDA-ARS through its efforts on household survey and retrieving existing data in 1998, has found that:

b) The potential for expanding cultivated land in China is extremely limited. Urban, industrial, commercial, and residential uses are competing with agriculture for China's limited land resources. By 2020, China expects to have at least 50 percent of its population living in urban areas, up from 36 percent in 2000;

c) Due to a variety of land-tenure policies, the *right to independently transfer* land between households in rural China has not always been clearly extended to farm households. With increasing non-farm employment opportunities and growing recognition that economies of scale can be achieved by consolidating farmland, farmers have begun to demand independent land transfer rights. Local and national policymakers have responded by offering new land-tenure arrangements that could significantly affect agricultural production in China (Land contract law 2002);

d) Land rental activity is widespread but not across all regions in China. Part of the variation in land rental activity may be due to other tenure policies that tend to encourage or discourage land rental activity, such as grain quota obligations and village land reallocation activity.

Based on the analysis, they made the most important conclusion that land rental activity increases aggregate agricultural production by transferring land from low intensity farm households to households willing to farm the land more intensively. The marginal product of land for households renting land in is 50-90 *yuan/mu* higher than for households that do not rent land. Policies that discourage land rental activity, such as grain quotas and arbitrary reallocation policies, indirectly hold back agricultural production increases through their effects on land rental activity. Interestingly, agricultural taxes encourage households to rent out their land, presumably to seek higher payoff economic activities, thus agricultural taxes serve to increase agricultural production by encouraging land transfer from low to high intensity users, but with possible negative environmental effects due to more fertilizer and pesticide use.

Marginal Land Abandonment and Redeployment (MLAR) in China is driven largely by economic pressures and incentives. It is occurring in environmentally fragile and poverty stricken areas as: (a) low agricultural productivity and incomes drive farmers to abandon the land and migrate permanently or temporarily to urban areas, and (b) the State Programme for W. China provides incentives (set-aside measures and aid for reforestation) for farmers to stop cropping steep slopes. MLAR is happening in the richer areas of the Middle Yangtze and SE coastal region as declining grain prices (Hu Tao, 1999) and rising off-farm employment opportunities and wages results in widespread rural-urban migration. The latter can also lead to rural-rural migration with farmers from bio-physically marginal occupying the better land abandoned in the richer areas (NORSE D. 2001).

3.3.3 Land and environment

MLAR can have a range of socio-economic and environmental benefits. For example, it can reduce soil erosion from the slope lands of the Loess Plateau and the Middle Yangtze region. This erosion causes siltation of lakes and rivers, and contributes to floods and disruptions in river traffic that in some years cause major loss of life and major economic losses (Smil, 1996). The revegetation of abandoned or redeployed land can provide feed for livestock, contribute appreciably to carbon sequestration and hence to climate change mitigation, and lower drought vulnerability by reducing rainfall runoff, improving rainfall infiltration and improving the moisture holding capacity of the soil (Norse D, 2001).

China has made considerable progress on reforestation, and recent decisions of the State Council to promote the sustainable development of Western China through a new programme of land set asides and reforestation should add significantly to this progress. Moreover, if the Kyoto Protocol does eventually recognise C sequestration from agricultural soils China's croplands could become an important sink for carbon dioxide as well as providing other environmental and economic benefits (CCICED-SAWG report, 1999)

3.3.4 Holistic approaches/analysis (IIASA)

a) China has experienced a net loss of arable land since 1958. During the reform period, i.e. after 1978, there appeared to be an accelerated decrease of farmland stock. The paper by Li XB examines the major driving forces of arable land conversion during the reform years and assesses the proportional changes of farmland conversion with respect to these driving forces. The major causes are identified as industrialization, construction of residential buildings, and land degradation. They establish a well-specified econometric model of farmland losses and construct the appropriate proxies of these driving forces based on pooled data from 21 provinces of the eastern part of China and across the period of 1990-1995. The model shows that both industrialization/urbanization and land losses induced by land degradation have played an equally important role in reducing the total acreage of cultivated land (Li Xiubin etc, 2002).

- With a population of more than 1.2 billion and despite of very limited farmland resources, China has successfully supplied enough food for its growing and increasingly wealthy population. This accomplishment has been achieved primarily by increasing the intensity of land use in China's fragile agro-ecosystems and the level of modern material inputs in order to make up for farmland losses. This may enhance the risks of soil degradation, water pollution and scarcity, and other environmental impairments. Farmland has become a scarce strategic resource in China. Its strategic importance would be greatly undervalued if one only takes into account the short-run or medium-run economic benefits obtained from it.

- Studies show that the proportional decrease of farmland with respect to the increases of fixed investment, to the increase of non-agricultural employees, and to the areas affected by natural disasters is relatively quite high. In order to maintain the current level of farmland acreage, it is necessary and important to reduce the magnitude of the elasticity by various economic, legal, and administrative means. First, strengthening the capacity of farmland-protection-system against land degradation and natural disasters will certainly reduce the elasticity of farmland loss with respect to natural disasters. This means that marginal land should be restored to earlier, less intensive uses through reforestation and pasture restoration. Erosion-prone areas should be stabilized by means of terracing, contouring, tree planting, and other protection methods. Areas prone to salinization should be properly treated or put to fallow for a sufficient period. Irrigation and drainage infrastructures should be restored, maintained, and renovated in time. All of these measures require larger investments. However, they complementary to economic development and will lead to a higher productivity of land and an improving environment for agriculture in the long run. Second, in parallel with the improvement of the land protection system, a quantitatively equally but qualitatively more important measure for saving the strategic farmland is to intensify non-agricultural land uses. In most cases non-agricultural industries occupy high-quality farmland around major cities or other economic and transportation centers. For the purpose of saving high-quality farmland, which is more than just reducing the elasticity of farmland loss with respect to industrialization pressures, it is important to increase the intensity of land uses in urban areas and in rural towns. It is crucial to develop a number of central towns by investing in infrastructure construction and service sectors so as to attract the scattered TVEs into these central towns. It is also absolutely necessary to transform the traditional mode of rural housing into a more land-saving one by various incentives and regulations. Such measures would be strengthened by both economic and administrative means that aim to increase the comparative profitability of agriculture.
- As China is just in the take-off stage of industrialization, arable land losses to non-agricultural uses cannot be avoided in the next decades, although the proportional decrease of farmland with respect to the industrialization factors may be reduced. In view of the unavoidable farmland losses, apart

from the choice to increase productivity per unit of farmland by technical progress and by increasing modern material inputs, a complementary measure would be to gradually increase the share of net grain import in total domestic grain supply. In 1995, China's net import of cereals of 18.7 million tons accounted for about 4 percent of domestic cereal supply and for about 9 percent of world imports of cereals. China's cereal imports were dominated by wheat and maize, which made up more than 80 percent of the total (Yearbook 1996, pp. 371, 589-592; *Food Outlook*, no. 3/4, 1997, p. 31). If China would gradually increase its share of cereal net import to 8 or 10 percent of the domestic supply, the tension between agricultural and non-agricultural land uses could be substantially reduced. In this case, China's share in world cereal imports would rise to 15-20 percent, slightly more than Japan's current share (14 percent). This would only moderately increase the pressure to the international cereal market.

b) Land availability is of crucial importance for China's development in the 21 century. Economic growth, urbanization, changes in life styles such as diet changes, and population growth will influence both the demand for and the supply of land. In this study, an input-output model expanded by a set of land categories is developed to synthesize various scenarios of changes in the economy and society, and to evaluate their impact on land-use changes in China. The scenario analysis is conducted at both the national and regional levels and for a time horizon of over 30-years. The analysis aims to show how different development paths will influence the available land base as well as the inter-regional and international trade flows of primary products for China in the coming decades. To do this a mixed model with supply-constraints for the major land-consuming sectors is used (Klaus Hubacek LX Sun, 2001).

Given the moderate pace of technological progress, as commonly assumed in the literature, the resultant increases in final demands and sectoral outputs would drive the associated land requirements to exceed the then available land area. Scarcity of cultivated land, grassland, and forestland will be persistent. If the traditional policy of grain and food self-sufficiency were maintained intact, to keep the farmland requirement feasible, an annual growth rate of land-productivity of about 1.28 percent would be required, which is higher than what is usually expected for the next 30 years. In addition, faster technological advancement in the livestock sector will be necessary.

3.3.5 Recent development

- Armed with RS and GIS technology application, and the China Ecological Research Network composing 29 field stations covering most of the land use types in the country, we are now able to monitor land use and land cover change at the national, or regional level from time to time, which provides invaluable data from the space and ground truth for LUCC studies. With social-economic information and methodology to be integrated, we now possess the capability for LUCC study on different scales and different foci, and also to join the global program to make our contributions.

- Another aspect of land use study is now concerned with land/soil quality change. We have developed methodologies and technologies to control soil salinization, desertification, soil erosion, restoration of degraded woodland and grassland. As soil pollution is increasingly a problem on land use, land quality is becoming more important in future land use. Any projection on future land use change without quality information would be considered incomplete, especially in developed areas in China. The Ministry of Science and Technology has launched a national basic research project on the 'The Dynamics of Soil Quality Change and Consequence Prediction', aiming to identify two major process within China's dominant soil types: soil pollution and fertility depletion.

4 Land management and agriculture in China

4.1 Briefing goals and dilemmas for sustainable agriculture in China

a) Three goals:

Agricultural and rural development in China has proceeded beyond the subsistence stage, thanks to the reform in agricultural policy since 1979. Looking ahead to the new millennium, China's agriculture must be more sustainable and therefore should have three major objectives yet to be fulfilled, food security, environmental safety and rural economic safety.

- ***Food Security*** has been being a constant and pressing goal put on the top of the national priority list. Yet, the task of sustainable agriculture should not be limited to provide adequate food supply in quantity, rather, in quality by means of nutrition and health. The new objective for food security can be divided into three categories: a) to increase food quantity steadily to meet the population growth from the current 1.2 billion to the expected 1.6 billion by 2030; b) to meet the increasing yet diversified demand for more nutritious food due to people's income growth, implying an increase of animal products, vegetables and fruits; c) to provide green food to meet the health safety requirement, indicating an important transfer to pollution-free production.

- ***Ecological/environmental safety*** is the second goal to sustain China's agriculture in long term. Ecological safety means a sound ecosystem to ensure adequate resource supply (esp. land and water) and clean environment for agricultural production. Having realized this, the Chinese Government is increasing her investment on ecological improvement and conservation. In 1998, the state council approved a nation-wide ecological improvement program for the next 50 years proposed by State Development Planning Commission (SDPC). In August 1999, Premier Zhu Rongji proposed to conduct a 10 years ecological rehabilitation program with total input of 20 billion RMB in loess hilly area of the Loess Plateau. Another tree planting program in the upper reaches of Yangtze River has been being implemented as well. In spite of the improvement in previous years, soil erosion, pollution, desertification, salinization and fertility depletion will still be limiting factors in increasing food quantity and quality, particularly soil erosion and pollution.

- ***Rural economic safety*** refers to the rural capability to increase farmer's income and provide employment opportunities continuously in the long term. The goal is proposed based on the agricultural-rural diversities and the coupling mechanism between agricultural growth and rural development. Regardless of geographical differences, the agricultural-rural interaction can be divided into four types: a) low yield / poor farmer; b) high yield / poor farmer; c) low yield / rich farmer; d) high yield / rich farmer. Agriculture in most areas in China is the major source of farmer's income and employment opportunities. Yet, agriculture could hardly be sustainable without rural economic safety.

b) Four dilemmas:

Successful agriculture requires adequate resource supply, clean environment, a sound rural economy and viable science and technology. Yet, on the way to success, we have to take the following dilemmas into the whole process of planning and implementation.

- ***Increasing demand for more agro-products with depleting resources***

Adequate land and water resource (in terms of both quantity and quality) is rudimentary to sustain agricultural development. Unfortunately, while we are expecting more qualified products from agriculture, land and water resources are depleting and degrading. This should be the principal challenge in the next 50 years.

Land: China's land resource for agriculture is big in total, small per capita (1/3 of world average), and low in quality. What is more, as urbanization process is accelerating, we are losing some of the most fertile cropland to urban construction. Although we are undertaking the policy to remedy those occupied with reclaimed area, the price for the compensation is very high, and we could hardly anticipate a new land with the same productivity.

China has as much grassland as cropland. But the productivity is basically very low. Most of northern grassland is suffering degradation due to over-grassing and low investment for rehabilitation. Although the southern grassland has great potential, there is a long way to go before the development is economically feasible.

Water: China suffers severe water scarcity. In terms of per capita water resource, China ranks No. 121 in the world, although ranks No. 6 by means of total. What is more, annual and seasonal rainfall fluctuation could easily result in flood or draught. Agricultural use of water accounts for 70% of the total resource, yet as industrialization and urbanization speed up, the quota for agriculture will be decreasing.

Land and water combination: Geographically, land and water do not match well. In the north, there is 64% of the total cropland with only 17% of total water resource. Yet in the south, there is only 36% of total cropland with 83% of water resource.

- ***Demanding for more and greener food and increasing ecological /environmental constraints***

  While soil erosion, salinization and desertification continue to be the pressing ecological constraints on agriculture, soil pollution is becoming the most threatening constraint, not only reducing productivity, but also undermining food quality. Pollution sources are initially from industry and cities. TVE (Township and Village Enterprise) development and intensification of farming practices have turned the rural area from a down stream suffer of industrial pollution to source of pollution. This can mainly be attributed to the over-use of herbicide, pesticide, plastic film and chemical fertilizers (CCICED, 1996)

  Each year, China produces 500-600 million tons of crop residues, and 600 million tons of waste from animal farms. The burning and dumping of those wastes create a considerable amount of pollutants.

- ***Rapid technology advancement, low economic feasibility and slow social acceptability***

  Development is becoming more and more dependent on technology advancement. Agriculture has no exemption. Yet only economically feasible and socially acceptable, could the technology play important role. This is very much the case in the agricultural sector in China. Rural employment will be the one of the most important issues in rural areas. Labour education level is very low in most rural areas. These induce serious conflicts among technology advancement, economic feasibility and social acceptability. Technology will advance, no matter what will happen. But the point is to what direction should the technology advance?

- ***Increase of agricultural production and growth of farmer's income.***

  Food self-sufficiency in the long term is both politically and strategically important. But production increase does not necessarily mean the growth of farmer's income. Table 4.1 shows the small share of agricultural production in the total GDP, only 15.2%, yet the rural population is 70% of the total. Though the table shows regional disparities of per capita GDP, yet the disparity of per capita income between urban and rural areas is much bigger in any region. This forms the rural economic constraint and provides a very strong signal of agricultural Marginalisation in China.

Table 4.1 Major economic indicators in seven regions of China (RMB), 2000

	Population(Million)	Per capita GDP	AgGDP/GDP (%)	Per capita income	
				Rural	Urban
Northeast	104.54	9,328	12.9	2,175	5,027
North	297.10	8,241	14.6	2,876	6,689
Northwest 1	47.28	6,412	22.4	1,619	5,843
Northwest 2	65.31	4,455	17.8	1,532	4,984
Central	224.28	5,795	20.5	2,134	5,535
Southeast	128.72	14,885	9.2	4,482	9,266
Southwest	190.27	4,496	22.5	1,662	5,904
South	155.45	10,280	14.8	2,733	7,097
National	1,212.95	7,986	15.2	2,401	6,306

Sources: State Statistical Bureau, China Statistical Year Book 2001.

4.2 National farmland Marginalisation process in China

4.2.1 Farmland change in the last 50 years

- In the last 50 years since 1949, the year of foundation of the People's Republic of China, There have been five periods of farmland change: increasing period from 1949 to 1957, which was followed by three consecutive decreasing period caused by different determinants: 1957—1965, 1966—1977, 1978 – 1997, and 1998 onwards (LU CH, Yasushi MOTOKI, LIU JY).
- The increasing period from 1949 through 1957 experienced a dramatic increase of farmland area by 13.95 million ha. This could be mainly attributed to the urgent need for food production. The major means to increase food production was expanding cropland area by reclaiming pastureland, wetland and forestland.
- The first farmland-decreasing period was from 1957 through 1965, with total amount by 8.24 million ha. There were mainly two causes for that decrease: 1) that was the period of "Great Leap Forward" during which a large amount of farmland area were given to urbanization, industrialization,

infrastructure (rail and road) and other construction programs (Yasushi-MOTOKI); 2) due mainly to environmental constraints in newly claimed areas such as draught, desertification and soil salinization, a large area of new farmland were abandoned (LU CH). This period also includes the "Great Famine" time in early 1960's when thousands of people died of hunger due to agricultural failure. There were both economic (though arbitrary) and ecological farmland Marginalisation processes, but mainly caused by strong political interventions.

- The second farmland-decreasing period from 1966 through 1978 was a slower process compared with the first. The total amount lost was 4.2 million ha, about half of that as in the first period. This was the period of "Cultural Revolution", when there was also a leverage of farmland loss to non-agricultural uses from newly claimed farmland in remote areas such as Xinjiang, Inner Mongolia and Northeast provinces.
- The third farmland-decreasing period was from 1978 to 1998. About 4 million ha of farmland were lost mainly to urbanization, infrastructure and industrialization, especially in rural areas. It was observed as a typical economic Marginalisation process, though there was some ecological Marginalisation happened in northwest during the enforcement of soil and water conservation law. Take Beijing for example, The average rate of farmland loss to urbanization was 865.4, 1055.5, 2855.5, and 1452.6 ha/yr during the periods from 1979 to 1985, from 1985 to 1990, from 1990 to 1995 and from 1995 to 1998 respectively (Zhang Wenxin 2000).

- From 1998 onwards, the magnitude of farmland decrease has been very high, though there are policy to balance those lost farmland (Liu JY, 2002). This was an aggregation process due to the government ecosystem restoration policy. The policy started to be effective in 1999, for instance to encourage farmers to set side slope farmland susceptible to erosion by compensating them with the same amount grain and/or money that used to be produced. In 1999, the area of set-aside slope farmland was 395 thousand ha, yet by 2000, that figure was almost doubled! It is obvious that there is an ecological Marginalisation process going on with very strong government policy intervention. Of course, there are also economic Marginalisation processes giving up land to infrastructure and other non-agricultural activities, which has, presumably, been countered by the farmland leverage regulation.

- Table 4.2 summarises the above analysis. If we compare the process from 1978 to 1998 with that of 1998-2000, it is worth to note that the first process was very slow, that is, in 20 years, the rate of average farmland loss was only 0.185 million ha/yr, whereas that of the second process was 0.58 million ha/yr, three times of the first.

Table 4.2 Five periods of farmland change (million ha)

Period	1949-57	1957-1965	1966-1978	1978-1998*	1998-2000*
Area	13.95	-8.24	-4.2	-3.7	-1.16
Annual loss/gains	1.74	-1.03	-.035	-0.185	-0.58

Sources: Zhang Fengrong (2000), Chen Baiming (2001), Lu Changhe (2002)

4.2.2 Shift of land use pattern: determinants and consequences

The above process of farmland change has been being accompanied with the shift of land use pattern, which was fallen in the overall economic context.

Over the period of half a century, from 1949 to the present, China has achieved major milestones. Like Europe and North America before, China has moved from a position where the bulk of its economy was agriculture-based, to its current status in which agricultural share in the total GDP is 15.2% (Statistics, 2000). The standard shift from an agricultural to manufacturing and services economy has been happening quickly. Between 1980-1999 the agriculture share of GDP declined from 30% to less than 18% and its share of the workforce from 69% to 47%. During the 1990's, agriculture shed jobs at a rate of 3.4 million jobs per year, while the service sector created nearly 8 million jobs per year. This shift out of agriculture was accompanied by movement of people from rural to urban centres. The growth in China's economy, over this period, made it not only capable of growing its own food, but also provided it with the option of using its international purchasing power to ensure the nation's food security. China, has thus come from the status of a country which experienced famine as recently as the middle of the last century, to its current status as a country which can feed itself either through Chinese agriculture alone, or supplemented by food purchases from overseas (Sonntag B. Sun HL, 2002)

- **Farmland: from grain to cash crops.** Before 1984, the year of record high in grain production in China, the farmland in China was dominated by grain production due to the insufficient supply of grain and the grain priority policy. However, that was changed thanks to the household responsibility system and related agricultural policies. There were an increasing demand for animal products, fruits and vegetables as income level of both urban and rural population increased. Driven by these determinants, the farmland use pattern has been gradually being shifted from grain to other cash crop production. Yet this process does not necessarily mean that there was a Marginalisation or abandonment process happened as farmland for both grain and other cash crop production are interchangeable.

- **Overall land: from agriculture to urbanization/industrialization**. Since 1978, large amounts of prime farmland have been being lost to urbanization and industrialization process, which has been necessary in most cases to China's modernization process. This is a typical economic Marginalisation process as agriculture has always been being in an inferior position compared with other sectors.

- **Overall land: from agriculture to environment** (forest/grassland /cropland). Since the mid 1990's, ecosystem degradation has been emerging as a dominant factor compromising both agricultural sustainability and livelihood in the long run. This triggered policy intervention from the government. Typical example is slope farmland set aside policy started in 1999 in the Loess Plateau region, compensating farmers leaving slope farmland for ecosystem restoration. Large areas of environmentally sensitive area have been converted into grassland/rangeland, bush land, forest etc. This is a process of ecological Marginalisation, but with very strong government policy intervention

4.2.3 Example 1: Farmland abandonment in Chaohu City, Anhui Province

Zhu Dingjiu, XU Dawen (Issues of Agro-economics, 2000) have identified that 16,000 ha of farmland have been abandoned, accounting for 6% of the contracted land. Amongst, 54% have been abandoned permanently and 46% seasonally. The abandoned farmland area increased by 77% in 2000 than in 1998, and the trend continues. The total abandoned farmland can be classified into five types:

- Those susceptible to drought or water logging can easily be abandoned, for example, in Hanshan County, there were 400 ha of farmland abandoned due to drought and logging, accounting for 20% of the total abandoned. This can be taken as a natural ecological Marginalisation process.

- Farmland in peri-urban area can easily be abandoned. This can be attributed to the high labour flow from farmland to other off-farm employment opportunities that offer high salaries. For example, in Zhongtang village close to Lujiang County Town, 46 household left their land for off-farm/industrial activities, resulting in 16.6% of the total farmland in the village abandoned. This can be treated as economic Marginalisation.
- Another type of economic Marginalisation takes place in less developed areas. This is mainly due to the migration of labours from those areas to better places, urban and rural alike. The extreme case in Jianwan village of Lujiang County, is that 221 households left, accounting for 42.2% of total households in that village. Of the 75 ha contracted farmland, 50 ha transferred to other households, the rest were abandoned.
- Abandonment is also likely to happen in areas with less farmland per capita. Due to the labour surplus, most of capable labours have to find a job outside their hometown, resulting in large scale of migration. Xincang Group of Zaogang Village, Lujiang County, 32% of their farmland abandoned.
- Migration induced abandonment: In Gongqiao Township, Hexian County, 7,500 out of the 13647 labours left their land to undertake other off-farm activities, mainly migrating to urban areas. This has resulted in the abandonment of 200 ha of farmland. Another extreme case took place in Tian Village, Wuwei County, where all the labours migrated to other places, leaving all the farmland abandoned

The above phenomenon can be attributed to three reasons:

- Low economic comparative advantage of agriculture resulted in large scale of labour loss from the farmland. In 1999, there were 560,000 labours migrated to urban areas in Chaohu City, accounting for 27.4% of the total labour force.
- Poor infrastructure and more natural disasters such as drought and logging discouraged farmers from cultivation.
- Incomplete farmland transfer mechanism resulted in difficulties for those who want to take care of the land.

There are both ecological and economic losses of the above Marginalisation process.

- The abandoned land, once turned into industry and/or urban construction, will be irreversible back to farmland again, resulting both land resource depletion and ecological side effects.
- There were also economic losses. In Lujiang County, economic loss has been 3.6 million USD/Yr.
- The above also results in social problems such as increasing taxes against those remain in hometown, and will cause a new round of migration.

4.2.4 Example 2, Economic determinants of farmland abandonment in Zhejiang Province

- Chen. X.X. etc. analysis of 10 villages in Zhejiang, designated for long-term rural economic observation.

Table 4.3 Per capita net income comparison of households with different areas of farmland (100 RMB Yuan)

Year	Nil	<1 Mu	1-3 Mu	3-5 Mu	5-10 Mu	≥10
1986	10.36	9.91	8.59	8.07	7.77	9.73
1988	25.70	16.17	14.95	12.72	12.08	11.95
1990	18.31	13.92	14.81	13.53	14.08	13.17
1995	99.16	73.28	68.60	48.38	37.10	53.29
1997	112.80	83.04	83.35	52.38	39.31	55.58
1999	141.25	65.20	78.79	50.65	42.57	58.60

Source: Chen XX (No 12, 2000, Issues of Agro-economics)

The table indicates that those without land earn more money than any other groups. The second highest income group is the one with less than 1 mu of farmland. The income level of the mentioned two groups explained why people in developed areas leave farmland for off-farm activities. It can be concluded that farmland Marginalisation is a natural economic process driven by comparative disadvantages in terms of both on-land agricultural production activities and agricultural land use competency.

Another interesting phenomenon was that those households with more than 10 mu of farmland fall the third highest income group. This indicates that in the future, farmland use right transfer process is likely to take place to enable the concentration and/or scaling up of those allocated equally to each household. It also implies that the household responsibility system may be changed accordingly to adjust to economic situation. The government has issued a series of new policies and regulations that expect to help facilitate the process of land use right transfer. Also, the land contracting law has been effective since March 2003 enabling households to hold their land use rights and preventing illegal removal of the right without farmer's approval. These measure serves two purposes: 1) make sure farmer's land use rights protected; 2) promote efficient use of farmland, which is a scarce resource by any means.

4.2.5 Farmland loss to urbanization

- Two phases of China's urbanization process. In the last 50 years since the establishment of P. R. China, urbanization has experienced two different phases. The first phase was a long and slow process from 1949 to 1977, during which period urbanization rate increased from 11.2% to 17.5%, left far behind other developing countries on an average (17.9% to 33.4%). However, since the open door policy in 1978, China has been witnessing unprecedented urbanization process. From 1992 to 2000, the number of city and town inhabitants had multiplied from 320 million to 460 million (Yan & Cai, 2002). The urbanization rate increased from 27.6% to 30% (CN WSSD Report 2002). The number of designated towns increased from 2581 in 1979 to 19,000 in 1998. It was predicted that urbanization rate would be 45-50% by 2020, and 60-65% by 2050.

- Urbanization is a process marked by the increase of the number of new cities and towns, and the area expansion of existing cities and towns. It is inevitable for China in pursuing her modernization process. Yet, in both cases, there must be a trade-off between urban expansion and farmland loss.

Table 4.4 China urban expansion

Region	Urban build-up area (km^2)		Average growth rate (%/Yr)
	1985	1994	
National total	9522.4	17939.5	7.3
East	3757.6	8360.1	9.3
Middle	3659.2	6540.9	6.7
West	1625.4	2638.5	5.5

Source: Zhang Wenzhong (1999)

- Both small town development and rural residence construction are great consumers of farmland. In 1998, there were an area of 17161.1 km^2 occupied by the 19,000 designated towns in China, increased to 2.08

times as much as those occupied by the 10,000 towns in 1990. In terms of per capita land use, those living in large and middle cities consume much less land than those in towns, the same case between town and village land use. For the time being, it is 155 m^2 per capita for village build up area, 149 for designated town, about 1.5 times of those in cities.

Most of the cities and towns, existing and establishing alike, are surrounded with fertile farmland. It is most likely that this farmland will be lost to the expansion of urban areas. The loss of prime farmland to urban and industrial development has been proceeding nationally at a rate of about 0.2% per annum. If this trend continues, China could lose 10% of its farmland over the next fifty years (CCICED 1996). An extreme case in a small town in the south is that build-up area will expand from 0.6 km^2 to 50 km^2 by 2010 in the plan. This means that 35% of the farmland will be lost to town development.

4.3 Policy issues on land management

4.3.1 Land laws, policies and programs

- **Legislation and Regulations**

The Chinese Government has issued the following laws and regulations on land management: the Land Administration Law, the Regulations on the Implementation of Law on Land Management, the Regulations on Protection of Basic Farmland, the Regulations on the Rehabilitation of Land, the Provisional Regulations on Land Appreciation Tax, the Administration Measures on Land Use for Construction, the City Planning Law, Regulations Governing the Development Planning for Village and Towns, Law on Soil and Water Conservation, Grassland Law, etc.

The Land Administration Law was revised at the 4th Meeting of the Standing Committee of the Ninth National People's Congress on August 29, 1998. The newly revised Law was enacted in accordance with the Constitution for the purpose of strengthening land administration, protecting and developing land resources, making proper use of land, effectively protecting cultivated land, and promoting sustainable development of the society and economy. The revised law classifies land into three categories: land for agricultural use, land for construction use and unused land. Land use management should be based on overall land use planning. Government at all levels should work out unitary land use plan according to long-term development needs. Within the unitary plan, agricultural use of a particular piece of land can be prescribed. The prescription cannot be changed once it is confirmed.

Farmland protection is an independent chapter in the revised law, in which government encourages individuals or collectives to reclaim unused land into arable land. Leave prime farmland unattended is prohibited. "The duration of a farmland contract is extended by 30 years. Farmer's use rights to contracted land are protected by law."

Moreover, illegal land use was included in the revised Criminal Law of the People's Republic of China issued in 1997. Land management monitoring and inspection systems have been gradually established and completed, thus bringing land management onto the realm of legal administration. In 1996, the State Land Administration engaged, for the first time, a number of inspectors for land management supervision and set up a social supervision system, an important measure towards strengthening the supervision of land law implementation.

Preferential policy from the Ministry of Land and Resources: a) to ensure necessary land supply for infrastructure to serve the need for economic development and domestic demand expansion, to prioritise industries and key projects on land use; b) to coordinate the land demand for urbanization and farmland reservation; c) to set aside ecologically fragile farmland for ecosystem improvement. (Xinshe LU, No.6, 2000, China Land)

- **Plans and implementations approved by State Council**

The Chinese Government has issued the Outline for General Planning of National Land Use from 1997 to 2010, the National Planning Program on the Control of Desertification from 1991 to 2000, and the National Action Plan on Desertification Control. The macro-adjustment and control system has been established with the main contents of the overall plan for land use, the five-year plan for land use, and the annual plan for land use. The Government has set up a primary system of basic land zoning in order to protect farmland and is establishing a management system for land use. It has also drawn up the utilization and management control system, which provides rational regulations on the location and scale of the land for urban and other kinds of construction. In addition to these steps, the Chinese Government has implemented the construction land management method, which focuses on land scales and allocation of projects, so that construction projects will use areas that are not useful for agricultural purposes. Examination and approval systems for all kinds of land use have been adopted. The management system, which focuses on the identification of ownership, registration, and granting of certification, has been established for the rural collective land ownership, reclamation, and development.

- **Farmland protection and development**

Since 1989, basic farmland reserves have been established in China. For the time being, 83% of the farmland is under effective protection. The problem of farmland misuse has been solved to a certain degree. A compensation system has been set up, namely, that farmland used for necessary construction must be "compensated with the same amount of land with same quality". In areas where it is impossible to reclaim new land, an equivalent amount of reclamation fee must be paid to balance the total farmland area (China National WSSD Report, 2002).

- **User's right on wasteland and abandoned land.**

A policy of "whoever develops it enjoys the benefit" was launched to encourage farmers to undertake, hold shares for cooperation, to lease or sell the rights of use of the land by auction to farmers. Breaking up administrative demarcation lines is permitted, and various economic entities are allowed to buy land use rights of the "four waste lands" (waste mountains, hills, slopes, and beaches?). The longest land use period is 50 years, and the contract can be extended when expires. The gains through development can be inherited or transferred, and if required by government, it must be compensated.

- **Farmer's involvement**

Farmers have been encouraged to carry out comprehensive management of mountains, rivers, farmland, forests, and roads in the 10,000 small key catchments with serious soil erosion. From 1991 to 1995, 30,000 km^2 of soil erosion area and 10,000 km^2 of wind erosion area were brought under control each year. The Government has formulated the encouraging policy of those who control the area, get the benefit and carried out family contracting, corporate sharing, leasing, and auctioning of the usage rights of the land, as well as other kinds of control measures. These steps have protected the legitimate rights of farmers and aroused their enthusiasm to harness bare mountains and land. As a result of their efforts farmers have gained profits.

- **Soil and water conservation**

In recent years, the Chinese Government also promulgated and enforced the Law on Soil and Water Conservation and the implementation regulations.

All of these have encouraged the control of water loss and soil erosion. Soil and water conservation projects have been carried out in the seven large river basins. The accumulated eroded soil area under control is 67 million hectares. The integrated soil erosion control area in the Loess Plateau is 15 million hectares, putting 30% of the eroded soil area under control to some extent and decreasing the annual discharge of silt to the Yellow River by more than 300 million tons.

- **Land reclamation**

In1988, the Chinese Government promulgated the Regulations on Land Reclamation. Great progress has been made in the rehabilitation of abandoned land ever since. According to statistics, 163,300 hectares of abandoned land have been rehabilitated or reused, 75% of which have been used for farmland or other agricultural purposes. In 1995, the State Coal Industry Ministry arranged 10 key demonstration projects such as the project in the area at the conjunction of Shanxi, Shaanxi, and Inner Mongolia that rehabilitates 4,500 hectares of land annually (this being 22.5% of the total subsidized area caused by coal mining in that year). Moreover, 1,770 hectares of slag hills were rehabilitated in open coal mine areas (amounting to 33% of the total slag hill area created that year). The accumulated rehabilitated area was 4,700 hectares, a rehabilitation rate of over 50%.

4.3.2 National Program for Ecological Environment Improvement

The overall objective of the above program launched in 1998 by the Chinese Government, is that in the next 50 years, the eco-environment will be improved fundamentally. The outline of that program was issued in 2000 with the following specific objectives in different phases:

- By 2010, the trend of eco-environmental degradation will have been basically held down. Indicators are:
  - Soil and water conservation: an area of 600,000 km^2 suffering water loss and soil erosion will be brought under control;
  - Desertification control: 22 million ha;
  - Afforestation: forest coverage to 19%, including 6.7 million ha of hillside afforested, 5 million ha of slope farmland converted to forest area; and 13 million ha of prime farmland sheltered with forest network;
  - Grassland improvement: 50 million ha improved and 30 million ha degraded (desertification/alkalinisation etc.) under control;

- Water-saving and rain-fed agriculture projects be launched;
- Monitoring systems in key campaign areas established.

- By 2030, eco-environmental degradation will have been completely under control. Indicators are:
  - Soil and water conservation: 60% of soil erosion area will be brought under control to various extents;
  - Desertification control: 40 million ha under control;
  - Afforestation: forest coverage rate to 24% with 46 million ha afforested;
  - Grassland: improved area up to 80 million ha and half of the degraded grassland;
  - Water-saving technologies extensively used across country.
- By 2050, the eco-environment in China will have been grossly improved.
  - Soil and water conservation: approx. 100% under control;
  - Afforestation: forest coverage 26% with tree planting in all the target areas with appropriate species;
  - Slope farmland: all will be built to terraced land or converted to forest or grassland, or left to set-aside;
  - Grassland: degradation will be under complete control;
  - Substantial improvement with green mountains and clean water in China.

- Due to China's diversified geography, the country has been divided into 8 regions: the upper and middle reaches of Yellow River; the upper and middle reaches of Yangtze River; Three North Areas, namely NW China, N China and NE China; South China red soil hilly area; north China rocky and soil area; NE China black soil area; Tibetan Plateau permafrost area and overall grassland/rangeland area.
- The program will have enormous impact on farmland Marginalisation process in China. In particular, large areas of slope and other marginal farmland will be set-aside to afforestation, grassland improvement, and/or simply left unattended for natural vegetation regeneration. The whole process can be taken as an ecological Marginalisation process with unprecedented magnitude driven by policy intervention.

4.3.3 National Land Re-organicultivation (re-organization and re-cultivation) and Development Program

- **Overview**

The Ministry of Land and Resources have launched the program nationwide in March 2003. The mission is to increase the sustainability of land resources, particularly farmland resources, to increase farmland productivity and improve the environment. The mandate consists of three parts: land re-organicultivation, land reclamation and land development.

Land re-organicultivation is a new term merged from both land re-organization and re-cultivation. It includes land re-organization in the field, water body, road, forest and village, through which process land can be saved and converted to farmland area for re-cultivation. Both engineering and biological measures will be adopted in the course. Land quality and use efficiency can duly be increased. **Land reclamation** will be restoring the damaged or degraded land during such activities as mining, natural disasters and other constructions through appropriate technologies and approaches. **Land development** refers to the utilization of waste and/or used land resources, but on the condition that soil erosion and land desertification be under control.

Prior to this, there has been three years test period from 1997 to 2000. Through the test period, there has been an increment of 849.3 thousand ha farmland nationwide, 212.3 ha thousand each year. Amongst, land re-organicultivation and reclamation added 282.7 thousand ha, and land development 566.7 thousand ha. There has been leverage through this program to the farmland lost to construction. This period also witnessed the increase of land quality and productivity, optimisation of land use structure and intensification, and improvement of environment.

- The full potential of the program is 13.4 million ha, of which land re-organicultivation 6 million, 45% of the total; land development 5.87 million ha, 44% of total, and land reclamation 1.53 million ha, 11% of the total.

  However, the goal to develop the potential by 2010 is 2.74 million ha, of which, land re-organicultivation contributes 60.5%, land reclamation 12.8%, and land development 26.7%. This needs a total investment of 333 billion RMB yuan, of which 78% for land re-organicultivation, 13% for land reclamation and land development 9%. Detailed breakdown of targeted areas in each provinces of mainland China can be seen in Table 4.5.

Table 4.5 Breakdown targets for each province in the Land Re-organicultivation Program from 2001 to 2010 (10000 ha)

Province	Total	Re-Organicultivation	Reclamation	Development
Nation	274.00	165.87	35.05	73.04
Beijing	1.73	0.99	0.68	0.06
Tianjin	1.27	0.54	0.42	0.30
Hebei	10.40	7.55	1.32	1.52
Shanxi	11.26	6.00	2.66	2.60
IMAR	20.00	13.80	0.67	5.53
Liaoning	6.13	4.01	0.91	1.21
Jilin	14.20	7.96	1.19	5.04
Heilongjiang	11.93	7.73	2.87	1.33
Shanghai	2.07	0.86	1.12	0.09
Jiangsu	11.60	7.00	3.73	0.87
Zhejiang	4.53	2.27	0.46	1.80
Anhui	7.60	6.57	0.71	0.27
Fujian	5.40	3.33	0.33	1.73
Jiangxi	7.13	4.71	1.49	0.93
Shandong	12.13	9.00	2.00	1.13
Henan	9.53	6.86	1.27	1.40
Hubei	12.80	9.87	1.00	1.93

Hunan	14.53	11.80	0.60	2.13
Guangdong	12.47	3.27	1.20	8.00
Guangxi	7.40	5.22	0.66	1.52
Hainan	1.60	0.60	0.20	0.80
Chongqing	4.38	3.50	0.38	0.47
Sichuan	11.53	8.53	0.55	2.46
Guzhou	6.09	3.14	1.88	1.07
Yunan	10.27	3.00	1.00	6.27
Tibet	2.39	1.63	0.29	0.47
Shaanxi	9.00	5.50	1.00	2.47
Gansu	4.00	2.00	0.28	1.73
Qinghai	1.33	0.33	0.27	0.73
Ningxia	3.43	2.10	0.60	0.73
Xinjiang	10.27	0.67	0.03	9.62
Miscellaneous	25.60	15.53	3.27	6.80

Source: Ministry of Land and Resources

4.3.4 Western Development Program

- China's western regional development coverage: In view of economic and technological levels as well as geographic location, and with a view to assisting the minority areas in their development, the policy of Western Development applies to 12 provinces, autonomous regions and municipalities. They are: Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia, and Guangxi, covering a total area of 6.85 million km^2, 71.4% of China's territory. At the end of 2000, the total population was 355 million, 28.1% of China's total, and GDP 1.65 trillion yuan, 17% of China's total. In addition, the same policy will be applied to Xiangxi Autonomous prefecture of Hunan Province, Enshi Autonomous Prefecture of Hubei Province, and Yanbian Autonomous Prefecture of Jilin Porvince.

- Priorities in Western Development Program: a) Infrastructure construction includes water resource development and conservation, the building of highways, railways, airports, inland waterway systems, projects to transfer electric power and natural gases from west to east as well as construction of telecom, radio & TV and city infrastructure. b) Great efforts in eco-environmental protection encompass protection of natural forests, afforestation, building the "Three-North" shelter belts, desertification control and sandstorm prevention in peripheries of Beijing and Tianjin, rehabilitation and construction of natural grasslands, improvement of ecosystems in key areas, soil and water conservation, and farmland set-aside for forests, bushes and grasslands. c) Unique and high valued farm produce will be encouraged and acceleration of industrial restructuring will be strengthened. Tourism will be taken as one of the key sectors to be developed and invested. d) Human resource development will be strengthened and invested, including science, technology, education and training. Talented people from other areas will be attracted to the west with various favourable policies.
- Progress has been made in the above sections since the beginning of the programme, and has had a great impact on land use pattern in the west. The end of 2001 had completed the experimental work of converting 1.24 million hectares of farmland to forests, shrubs and grasslands, which was the greatest magnitude of ecological Marginalisation process in Chinese history. In addition, both infrastructure construction and industrial development (agricultural industrialization) will also have great impacts on land use pattern change, though not as substantial as the implementation of set-aside policy on slope farmland.

4.3.5 WTO and land management

WTO entry will strengthen the economic driving forces to farmland Marginalisation. This trend will continue in the projected years to come.

- It is estimated that China is attracting US $ 50 billion a year from overseas investors. Obviously, this will stimulate off-farm land development;
- Agricultural modernization process will speed up, which will result in labour

flow to non-agricultural sector. Farmland will have three destinations: loss to urban and town expansion, aggregation from small patches to large-scale farms, and abandonment. It is quite unlikely that some farmland areas still be used for agricultural purposes due to the comparative disadvantage to other off-farm sectors;

- Regional competition to attract investments forces the authorities concerned to improve investment environment, which will undoubtedly increase land use for infrastructure and environment;
- Real estate sectors will reserve more land than they need to have superior advantage against upcoming competitors from abroad.

4.4 Policy consequences on marginal land management

- **Implementation guideline for farmland set-aside policy**

After more than two years of test period since 1999, the State Council issued implementation guideline for the set-aside and compensation policy in April 2002. It further stressed the following principles: a) Ecosystem restoration should be given the first priority, yet farmers' livelihood, income generation and local economy development should be incorporated into the whole process.... Policy intervention must be based on farmers' willingness, nature evolution law, ecological condition and plant adaptability, unitary planning, and practical effect; b) The proposed measures of "Set farmland aside for forest and grassland, close mountains for revegetation, provide grain for aid, household contract" must be thoroughly implemented.

Practically, the government will provide to those farmers who have to stop cultivating marginal land with grain and cash. The standards are: a) in the Yangtze River Basin and south China, 150 Kg grain will be granted for the set-aside of 1 mu set-aside land, and b) in the Yellow River Basin and north China, 100 Kg grain for 1 mu set-aside land. In both cases, 20 RMB yuan will also be compensated for per mu set-aside farmland. The period of compensation is dependent on the type of vegetation restored: grass for 2 years, cash tree orchid 5 years, and ecological forest 8 years. All the compensation, grain and cash will be covered by the central government (State Council 2002).

In 2001, the Chinese Government allocated 6.2 billion RMB yuan (US$ 775 million) for nursery and breeding on tree plantation from national debt, and increased an extra 9.3 billion RMB yuan (US$ 1.163 billion) on grain and cash compensation from the national revenue. The plan was to set-aside another 5 million mu (333 thousand ha) of marginal farmland, and plant trees and grasses on 7.4 million mu (493 thousand ha) waste mountains and hills (SDPC).

- **Implementation results**

From 1999 to 2001, there were 1.24 million ha marginal farmland set-aside for trees and grass, and 1.09 million ha waste mountains and hills planted with trees. Amongst, within the three provinces, Sichuan, Shaanxi and Gansu started in 1999, there were 397 thousand ha marginal farmland set aside, and another 70 thousand ha waste mountains and hills planted with trees. Farmers have been fully compensated and stimulated by the policy, which ensured the implementation of the policy in the years to come (SDPC, 2002).

- **Trend of land use change in China**

According to the official communiqué of the Ministry of Land and Resources, in 2002, farmland area decreased by 1.32%, mainly attributing to marginal farmland set-aside and adjustment of agricultural structure. Farmland area was 125.93 million ha, forest 230.72 million ha and grassland 263.52 ha. The most significant land use change was the implementation of farmland set-aside, together with agricultural structural adjustment; the net loss of farmland was 1.68 million ha.

Of the total farmland loss, 196.5 thousand ha lost to construction in 2002, accounting for 48% of the net increase of construction land. Set-aside marginal land was 1.43 million ha, farmland converted to garden/orchid was 349 thousand ha, and farmland lost to natural disaster was 56.4 thousand ha.

Meanwhile, through remedy or balancing measures such as land reclamation, there were 250.8 thousand ha newly developed farmland, more than countering those lost to construction and natural disaster. There was also 80.4 thousand ha conversion from garden/orchid back to farmland. Farmland lost to construction was basically leveraged in the 31 provinces, autonomous regions and municipalities in Mainland China.

5 Typical regions of farmland Marginalisation: the Southeast Coastal Area (SECA) and the Loess Plateau (LP)

Based on the national analysis and field surveys in the last 5 years from 1997 through 2001, two typical regions were selected, one is the Southeast Coastal Area, the most developed region in China, susceptible to economic Marginalisation, and the other, the Loess Plateau, less developed area with fragile environment, where ecological Marginalisation is most likely to occur. Their locations are shown in Figure 5.1.

Figure 5.1 Location of the Southeast Coastal Area (SECA) and the Loess Plateau

5.1 The Southeast Coastal Area (SECA)

5.1.1 Background

The southeast coastal area (SECA) is the most developed economic zone in China and is the forefront of ongoing globalization and modernization. It includes Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong and Hainan provinces and municipalities. SECA has played a vital role in China's recent economic development. Although it accounted for only some 5 % of China's total land area, 19 % of the national population, and 21 % of the urban population, it provided about 36 % of GDP in 1999 (China Statistical Year Book 2000). Moreover, the economic disparities within the region are even greater. Nonetheless, the Pearl River (Zhujiang River) and Yangtze River (Changjiang River) deltas have per capita GDP some 2-3 times the national average, and GDP growth rates that are close to twice the national rate.

Over the past 20-30 years there have been rapid changes in all aspects of the South East (SE) coastal economy. Agriculture has played a central role in these changes and is undergoing a massive structural and technological transformation in response to market opportunities, competition for resources from other sectors, joint venture investments within the Special Development Zones, and entry to the World Trade Organisation (WTO).

The coastal provinces have a good physical foundation for agriculture. The climate is favourable for agriculture in a sub-tropical to tropical environment, although seasonal floods and drought are problematic. The region features a very diverse agricultural sector. Triple cropping on paddy lands is common – double rice followed by rapeseed or a green manure crop. Upland crops include tree fruits, tea and nuts. Pigs and poultry dominate livestock production. While these traditional commodities still dominate the landscape on an area basis, the agricultural sector is rapidly becoming more diversified with increasing output and value of horticultural crops, floriculture and various aquatic products for export and domestic markets. These latter enterprises are characterized by larger scale, high technology and large capital investment, often from offshore sources.

In many instances the rapid pace of development has caused two problems. First, it has overtaken the environment's capacity to absorb the changes leading, for example, to serious water pollution. Second, it has exceeded the capacity of public and private institutions to manage the changes in a sustainable way. Fortunately, with the exception of the loss of prime farmland to urban and industrial development, much of the environmental damage can be reversed in time, so that the region can continue to make a major contribution to China's development. In the main, the key and most difficult responses involve policy and institutional reform rather than technological change, and there are examples at the city or county level of how these difficulties can be overcome and appropriate reforms can be implemented successfully. Wuxi, a medium size city in Jiangsu Province, for example, has encouraged the adoption of integrated pest management (IPM) which now covers a large proportion of the cropped area, and is lowering pesticide pollution. In addition, Wuxi operates strict bans on organo-chlorine insecticides and heavy restrictions on organo-phosphorous insecticides that are amongst the most environmentally dangerous of pesticides.

Industrial and commercial development in the Pearl River and Yangtze River deltas has been a major driving force for regional and national economic growth. The ready supply of labour and good access to major seaports and international markets have been important factors in this expansion as were (1) government policies to favour the development of special economic zones; and (2) the inward flow of capital and technology from Hong Kong and various overseas sources.

This expansion led to substantial improvements in people's welfare as reflected in higher incomes and better nutrition. Average per capita income in year 2000 reached 4,482 RMB that is nearly double the national average. Thus, for example, Zhejiang moved from being one of the poorest provinces in China in the 1970s to the fourth richest in 2000 in terms of GDP per capita and only slightly lower than Shanghai and Beijing. Average per capita calorie intake rose from about 2000 kcal/capita/day in the mid-1970s to over 2800 kcal/capita/day together with important qualitative improvements in protein and vitamin intakes, with the largest gains in the Hong Kong SAR (3,200 Kcal/person/day), which is within the range prevailing in OECD countries. These gains were appreciably greater than the marked improvements at the national level, up from 2120 kcal/day in 1976/1978 to 2840 kcal/day in 1995/1997.

However, these economic and welfare gains carried a high price for agriculture, human health, and for the environment as reflected in: (1) loss of prime farmland and changes in land use or land cover; (2) water pollution from crop, livestock and inland fisheries production and from domestic and industrial wastes; (3) accumulation of pesticide residues in soil and food and damage to farm worker health from pesticides; and (4) reduction of crop and fisheries production by urban and industrial pollution e.g. from air pollution and acid rain.

The land use pattern in the coastal area is changing rapidly in response to various forces. The product mix is changing in response to market opportunities both domestic and offshore. There is intense competition for land) from urbanization, rural residential construction, industrialization, transportation and recreation. Considerable prime farmland is being lost to these uses despite the food grain security policy and its regional production quotas. The scale of farm operations is increasing as investment increases and markets demand assurances of quality and supply continuity.

5.1.2 Economic driving forces

A central feature of regional development has been structural change in the whole economy, in the agricultural sector, and in rural and farm employment and incomes, with a number of consequences for agricultural sustainability.

- **Structural change in the economy:** Twenty years ago the economy of the region was dominated by agriculture (Table 5.1) as in the rest of China. Thereafter, it changed rapidly driven by the open market reforms of 1978 and substantial public and private investments. Zhejiang and the parts of the Yangtze River Delta in Jiangsu Province showed the greatest change where agriculture accounted for about 20% of GDP in 1980 but less than 5% in 2000, a pattern likely to be observed throughout the region in the next decade or so (Zhang 2002).

Table 5.1 Changes in the general economy, Southeast China

Province	1980	1985	1990	1995	2000
	% of non-farm employment as total rural employment				
Fujian	6.1	19.8	23.8	32.4	38.2
Guangdong	5.7	23.6	31.0	44.7	43.6
Shanghai	19.1	58.7	70.0	71.5	66.9
Jiangsu	13.8	34.4	38.5	44.4	44.9
Zhejiang	8.1	32.3	34.4	45.4	51.9
	% of agricultural GDP as total GDP				
Fujian	36.7	34.0	28.3	22.2	16.3
Guangdong	33.8	31.1	26.1	16.1	10.4
Shanghai	3.2	4.2	4.3	2.5	1.8
Jiangsu	29.5	30.0	25.1	16.5	12.0
Zhejiang	36.0	29.0	25.1	15.9	11.0

Source: B. Sonntag & H.L. Sun, 2002

- **Structural change in rural and agricultural employment and incomes:** Past public policies favoured rural industrialisation so farmers were able to compensate for their small land holdings by working part or full time in local small factories (township and village enterprises -- TVEs). Part time working has led to the situation where even on the best rice lands farmers are gaining 20 % or less of their incomes from crop production and have little incentive to use their land, mineral fertilizer and pesticide inputs in the most economic or environmentally beneficial way. Moreover, as rising rural and urban incomes led to increasing demand for consumer goods and services, many farmers switched to non-agricultural self-employment to meet this demand. Associated with these changes has been the rise in rural-rural and rural-urban migration, which has slowed in recent years but could accelerate again with future boosts to economic growth.

- **Changes in agricultural structure**

Although SECA is in a superior position for agriculture, with the changes in external environment, the comparative advantages in agricultural sector has decreased dramatically. As the functions of a grain production base are declining, the shift of agricultural structure is inevitable. China's accession to the WTO will accelerate the whole process.

- **Adjustment of agricultural structure**

After a score of years of efforts, China has basically solved its food supply problem and grain has even entered a stage of relative surplus. Since 1995, the total grain supply has exceeded total demand, with inventories growing sharply and market prices falling steadily. Although, from a long-term point of view, China's national condition featuring more population and less land determines that grain supply is tight and it remains an arduous task to ensure effective supply. But the fact that there is currently a grain surplus calls for corresponding adjustment. At present, China has about 8-9% surplus of grain and other major agricultural products. This has provided an opportunity to adjust the mix of crops grown to make it more compatible with the market and relieve the long-standing tremendous pressures of grain production on agricultural resources and ecosystem. The central task in the new stage of agricultural development is strategic structural adjustment.

Meanwhile, changes have also taken place in comparative advantage of regional grain production. Grain production tends to move northward, to central and northeast China. The steady increase in the investment in agriculture in the coastal areas has pushed up labour cost and land prices, hence the steady rise in the cost of agricultural production, thus losing its competitiveness as compared with inland areas. The major changes in the economic context and pattern of grain production have driven the objective of eliminating commodity grain production in the coastal areas (mainly Jiangsu and Zhejiang). When the state has relaxed its policy control over grain production in the five coastal provinces and cities and done away with grain production targets and deregulated the prices, the area should take further steps to effect a shift of agriculture and strategic structural adjustment.

- **Impacts of China's accession to the WTO**

After China becomes a WTO member, foreign products will inevitably challenge agricultural product markets. Yet it is also a good opportunity for China's agriculture to adopt a comparative advantage strategy. At present, each agricultural labour has only less than one hectare of land to till while in the United States, every agricultural worker has to till 118 hectares. If calculated by the 1987 US dollar price, the agricultural productivity of each agricultural worker in 1994-1996 was only 1.1% of the US agricultural labour productivity in 1979-1981. Entering the mid-1990s, due to several price hikes, the prices of China's major agricultural products have become one third higher than the international market level. Generally speaking, China has lost some of its comparative advantage in the production of land-intensive agricultural products (grain crops, cotton and oil-bearing crops) but still retained its comparative advantages in labour-intensive products (vegetables, fruits and flowers) and some of animal by-products and aquatic products (Zhang, 2002).

In the context of continuing reform and economic globalization, the baseline thought for easing the supply of agricultural products, especially food grain is to shift from the traditional "highly self-reliant" grain security to a new food security by adjusting its agricultural structure, displaying comparative advantage in agricultural production, increasing agricultural productivity enhancement investment such as agricultural R&D, rural infrastructure and water control. The so-called new food security is to ensure the supply of food grain needed by the whole population, which means not only providing adequate food but also helping them raise the ability to improve the living standards and to buy grain. The heart of China's agricultural structural adjustment is to display comparative advantage, produce agricultural products with comparative advantage, increasing labour-intensive products, gradually raising the net import of grain and other land-intensive products, raising agricultural labour productivity and industrialization of agricultural operations, greatly developing ecological agriculture, water-efficient agriculture and diversified modern agriculture, increase investment into agricultural R&D, helping farmers improve strains of seeds to increase production and income, thus easing the pressure of agriculture on resources and environment.

5.1.3 The way of grain production

In grain production, it is, first of all, necessary to rationally arrange the proportion of grain production and regulate the self-sufficiency level in light of local conditions. Special economic zones, which have a low self-sufficiency rate, should ensure grain supply through the market or by signing contracts with farmers. At present, the regulation and balancing of grain self-sufficiency should be based on the country as a whole. At the same time, it is necessary to take into consideration international market development and regulate grain supply within a region or among different regions. In the restructuring, it is necessary to ensure the stability of the basic farmland. Once needed, the land occupied may be reclaimed for grain production. Central and local authorities have acknowledged this as an approach known as "reserving grain in the land".

- **The nature of agricultural change**

Agriculture is beginning to shift from traditional cultivation to modern industrial mode production, from mainly plant culture to greenhouse and livestock production, from inward looking to outward looking, from labour-intensive to technology-yet-labour-intensive, from monopoly operation to diversified integrated operation, from small to larger scale operation, with the level of industrialization of agricultural operation increasing steadily.

The proportion of crop cultivation has dropped and livestock production and aquatic industry has increased and diversification has occurred under the precondition of ensuring the basic farmland and grain production capacity. Guangdong province was the first to adjust its agricultural structure. Its crop culture has dropped from 65.4% in 1980 to 43.9% in 1999 and livestock production and fisheries have risen from 25.4% and 21.2%. The ratio of grain crops and cash crops is 62:38 and the ratio of their output value is 26:74, more than reverse proportion. Garden crops, vegetables and aquatic production have risen sharply. The Yangtze River Delta has begun to reduce the area of wheat and rapeseed and increase the area of seeds, vegetables for export, flowers and specialty, highly efficient economic crops.

The distribution of agricultural zones is tending to become more and more rational, with a diversified modern agriculture emerging. A number of agricultural production bases with local characteristics and crop culture advantages have been built during the structural adjustment that is oriented toward the market and looking outward. Production is moving toward larger scale, regional and specialized operations. The Pearl River Delta, for instance, has made great efforts to develop quality fruit, off-season vegetables and other economic crops and the Yangtze River Delta has taken up crab production. Modern agriculture of all descriptions has appeared in the two areas, including greenhouse agriculture, export agriculture, ecological agriculture, precision agriculture and tourism agriculture.

Output of quality agricultural products has increased and efficiency has improved; the market has been enriched and farmers' incomes have risen. In Guangdong for instance, through structural adjustment, the province has encouraged farmers to develop marketable famous brands, quality and specialty products, to boost their incomes. If calculated according to the 1990 price, per capita income reached 3654 yuan in the whole province, about one third more than in 1995.

The successful experience of the Yangtze and Pearl River deltas in building modern agriculture, in addition to the support of natural and geographical advantages and township enterprises, include mainly: (a) carrying out large scale agricultural modernization demonstration. Guangdong Province, for instance, has built ten major agricultural modernization demonstration zones in the Zhujiang River Delta, and, through standardized farmland and basic facilities and the all-round development of market-oriented products, built wholesale markets for agricultural produce, which, together with "dragon head" enterprises, has promoted the industrialization of agricultural operations. By signing production and sale contracts with neighbouring farmer households, it has effectively promoted the optimization of agricultural structure in the areas; (b) through various demonstrations and training, spreading advanced technical equipment and management methods, raising the level of farm mechanization, including modern biotechnology, irrigation and information technologies, adopting modern management methods and means to manage agriculture and lowering transaction costs; (c) Importing, cultivating and disseminating new varieties, including the import of foreign vegetables, flowers and aquatic species to expand the areas for plant culture and animal industry. Good results have also been achieved in cultivating new varieties at home.

5.1.4 Farmland loss and soil degradation

- **Loss of farmland**

Competition for land in the coastal area is intense. Farmland has been being lost to urbanization, rural residential construction, industrialization, transportation systems and recreation. In most cases these uses are more profitable. Agriculture is becoming a relatively smaller proportion of economic activity as a consequence of rapid development in other sectors; a norm in all developing countries. The extent of the land loss to agriculture is well documented elsewhere. Most of the land use change is irrevocable.

Laws are in place to protect arable land for agriculture, yet arable land continues to be developed for non-agricultural uses, often in a fragmented manner that hampers efficient agricultural use of remaining areas. The current policy on land user rights affects the utilization pattern of land resources. Where tenure is unclear, occupying land for non-agricultural use is considered to be rather easy. Local government rather than farmers decides most of the land conversion to other uses, especially for development zone uses. It is an emerging yet serious issue that farmer's was taken by local government for so-called development purposes. This is not only a problem of unclear land tenure, rather a higher-level government policy issue. In past, when farmers land was taken away, that was a policy that they have to solve employment problem for farmers first. Yet, it is no longer the case. Therefore the bottom line should be: administrative decision is above all the laws and regulations that are in place to protect farmer's land rights.

A large amount of arable land is being lost to non-agricultural uses, yet agricultural output in value terms is increasing rapidly. The net loss in the five provinces was over 400,000 ha in the 1988-1995 period (Table 5.2), but has accelerated since then with the loss of some 200,000 ha in the past four years from 1995 to 1999. Arable land is being lost to industrial and urban development, transportation infrastructure, recreation and fishponds. In most cases these uses are more profitable than traditional agricultural uses. There is a concern, however, that China's future food supply capacity is being jeopardised through irrevocable conversion of some of its most productive land to non-farming uses (Alexandratos et al. 2000).

Table 5.2 Change of use to (%) and net change of cropland between 1988-1995 (ha)

	Construction*	Horticulture	Forestry	Fish ponds	Net change
Fujian	2.2	0.7	0.1	1.7	- 23,566
Guangdong	6.4	6.9	1.3	33.6	- 96,104
Jiangsu	8.4	9.5	1.6	15.3	- 178,058
Shanghai	4.0	na	0	0.2	- 34,402
Zhejiang	5.0	2.1	0.5	2.5	- 68,974
Total					

*All kinds of industrial and residential infrastructure including highways, railways and water reservoirs.

Source: Heilig, G.K. 1999

The occupation and reduction of farmland is an inevitable consequence of local economic development and also a restricting factor to agricultural development. Statistics show that in the last 50 years, the cultivated land in the Yangtze River Delta has been reducing at an average annual rate of 0.57-1.15%. But, in the last four years from 1995 to 1999, land use as gardens has increased by 6,100 hectares; land for construction purposes has increased by 163,100 hectares; and land use for communication has increased by 32,300 hectares, exceeding the national average by five times. From 1989 to 1999, farmland was reduced by 160,000 hectares, averaging 16,000 hectares annually in the Pearl River Delta excluding areas under the administration of Huizhou and Zhaoqing. This was 65% of the total arable land reduction in the whole province. The per capita farmland is only 0.031 hectares, much under the FAO limit of approx 0.05 ha. In Guangdong Province as a whole, the total land reduction in the six years from 1993-1999 was 165,500 hectares. It is estimated that about one third of the existing farmland will be lost to other uses rather than agriculture by 2010. In the last 15 years, the farmland has been reduced by 32,00 hectares in Shenzhen, accounting for 89% of the total cultivated land area, 21,000 hectares in Zhuhai, 38% of the total farmland in the city and 61,000 hectares in Shanghai, 20% of the total farmland. Further reduction of land is expected (CCICED-SAWG, 2001).

- **Soil quality degradation**

The areas subject to water loss and soil erosion in the 1990s was twice as much as in the 1970s. Although the soil erosion areas have been reduced to 25%, new water loss and soil erosion areas have appeared due to stone quarries, mining and reclamation of land on slopes. At present, the new areas suffering from water loss and soil erosion in the Pearl River Delta are 5% of the total land area and it is 6% in Zhuhai, 8% in Shenzhen and 4.2% in Guangzhou. Irrational land use has resulted in an imbalance in soil nutrition. Nitrogenous fertilizer has been over-applied; phosphate fertilizer has been accumulated in the soil; the application of potash fertilizer is inadequate. About 90% of the cultivated land lacks boron and molybdenum and 40% lacks zinc. Due to blind application of nitrogenous and phosphate fertilizer, soil and water have been polluted by nitrogen and phosphate. The nitrogen content of the soil is greater than 1.5g/kg in Yixing City in the Taihu Lake basin. It rose from 31.4% to over 80% in the 17 years from 1982 to 1999. The soil with an instant phosphate content greater than 15mg/kg rose from 2.6% to 20%. The nitrogen and phosphate movement from soil to water is twice as high as in other areas, causing serious pollution of water and soil. In addition, heavy metal accumulation in the soil is another concern on safe food production.

- **Causes of land loss**

In a market economy it is inevitable that there will be a conversion of low return agricultural land to other more profitable uses. The returns to both farm labour and to farm capital are too low to prevent this without interventions that distort market mechanisms (Table 5.3).

Table 5.3 Average and marginal returns to production factors in 1994 (in RMB) (Units)

Production factor	Average return	Marginal return
Farm labour (day)	10.7	0.82
Nonfarm labour (day)	15.9	8.0
Farm land (*mu*)	776.2	94.9
Farm capital (yuan)	1.3	0.1
Nonfarm capital (yuan)	1.6	1.0

Source: Song Lina, 2000

- Urbanization: The urban population in Yangtze River Delta (YRD) adds up to 25 million and the urbanization level had increased from 12% in 1950 to 34% in 2000 (Yao, 2001). This has taken up a large amount of farmland.
- There has been widespread development of small, geographically dispersed, urban centres and industrial sites that lead to pockets of wasteland and inefficient land utilisation. There are widely differing views between state agencies, provincial planners and commercial developers. On the other hand, the lack of an urbanisation strategy could lead to many urban centres merging to create huge conurbations of 20-30 million people or more, which will generate large amounts of air pollution, such as nitrous oxides and other ozone precursors that will be blown into rural areas and damage crops.
- One of the factors behind rural-rural and rural-urban migration is small farm size that makes it impossible for farmers to raise their incomes substantially. Thus, even on some of the most productive rice farms in Jiangsu, crop sales account for only 10%-20% of household incomes -- the rest coming from non-farm employment (Zhang, 2002). Hence there are increasing pressures to revise land tenure systems to allow farm consolidation and prepare the way for mechanisation and other productivity raising measures.

5.1.5 Farmland Protection

- It was suggested by Sustainable Agricultural Working Group of the China Council for International Cooperation on Environment and Development (SAWG-CCICED) that the Chinese Government should re-enforce its policy on user rights and protection of land resources to ensure that it meets China's long-term needs regarding domestic food production capacity. Land use planning should be strengthened to ensure appropriate land allocations among competing uses. Flexibility should also be given to allow land consolidation so as to benefit from economics of scale.
- It is imperative to strengthen planning for land use and pay attention to the protection of land under cultivation, strictly control the areas of basic farmland under priority protection and prevent unwarranted occupation of farmland for urban development. Efforts should be made to strengthen overall control of water loss and soil erosion resulting from the levelling of

hilly land in the development zones. Adopting such method as "dynamic balancing" or "creating an equal plot of land that is used" should compensate for the land occupied. In the development of new land reclamation areas, special attention should be given to the assessment of environmental impact. One of the important reasons for the existing utilization pattern of land resources is the policy on ownership rights to resources. As the tenure of land is often not clear, it is easy to occupy land for other non-agricultural uses. The inevitable result is excessive development and destruction of land resources. It is, therefore, essential to revise the ownership policy and control of land resources.

5.2 Specifics in Jiangsu Province

5.2.1 Background

Jiangsu is one of the five SECA provinces, with total land area of 102,600 km^2 and total population 72 million in 1999. Total farmland area was approximately 5 million ha, per capita farmland was only 0.07 ha. The dilemma between increasing demand for land and decreasing supply becomes a significant issue. Potential resources for farmland reclamation are limited unless some beach areas can be developed.

5.2.2 Agricultural-rural development

- Rapid development of non-agricultural industry: From 1978 to 1995, the share of industrial production in the total GDP of rural areas of Jiangsu province increased from 42.5% to 84%. In 1995, the proportion of rural labour engaged in non-agricultural sectors was 44%, a 24.3% increase than that of 1980. The major body of non-agricultural industries is Township and Village Enterprises (TVEs). It has become the main source rural income and recipient of rural labour surplus.
- Rapid development of small town, yet, urbanization is still far behind industrialization process. The number of designated towns in 1995 was 8.8 times of that in 1978. However, urbanization process still needs to be speeded up to catch up with the urgent need to improve the livelihood of rural population, and to generate new incomes. There are a lot of opportunities for tertiary industrial development.
- Agricultural intensification and commercialization: farmland productivity in Jiangsu is much higher than national average, for instance, grain production is approximately 30% higher. Commercialization process develops rapidly as the economy changes from planned to market, from

food self-sufficiency to income generation. The mode of agricultural production is changing accordingly, which resulted in: a) enterprise involvement in the production and marketing process; b) transfer of land use rights enabling larger scale production to increase profit and competency. The commercial rate of agricultural products has increased to 64%, of which livestock production reached 78.6%. Meanwhile, urban and export agriculture are developing rapidly, although from a small base, and generating more income for farmers. In brief, the agricultural sector has been growing with less labour input and decreasing farmland area.

5.2.3 Land loss and protection

From 1949 to 1996, farmland lost to non-agricultural sectors has been 1.1 million ha (Wang Fei, 1999). In the corresponding period, per capita farmland possession was down from 0.16 to 0.07 ha, a 60% decrease. The whole process can be divided into the following three phases.

- From 1949 through 1956, there was an increase of farmland area due mainly to the reclamation of wasteland and beach land. The average increase then was 67,000 ha per annum.
- From 1956 to 1978, farmland started to lose to agricultural infrastructure construction, especially, hydraulic facilities, and later to urban, industrial and traffic development. In general, farmland loss during this period was 640,000 ha, of which half were given to hydraulic construction.
- From 1979 to 1996, there has been an accelerating process of farmland Marginalisation. Though statistics show that the approved farmland given to other uses was about 300,000 ha, the real figure is estimated rather large. There were cases that the area of farmland lost to other uses was larger than the approved, and also cases that farmland was lost without reporting to land authorities. It was estimated from various sources that the real figure of farmland loss was about 400,000 ha. This can be attributed to the following factors.
    - The expansion of the whole bulk of land due to infrastructure construction such as urbanization, industrialization and transportation. For instance, the construction of residential area in cities increased from 76 million m^2 in 1978 to 408 million m^2 in 1996, 4.3 times increase in less than 20 years. Another example is road construction. The mileage in 1979 was 18,351 km, and increased to 26,659 km in 1996. Table 5.4 shows farmland losses to urbanization process in different cities

Table 5.4 Decreasing Arable land of Different Year in the Cities in Jiangsu (‰)

	1980~1985	1985~1990	1990~1995
Nanjing	-3.20	-1.58	-4.54
Wuxi	-6.63	-10.63	-8.08
Changzhou	-2.18	-1.94	-3.49
Suzhou	-3.52	-4.03	-15.65
Nantong	-2.96	-0.75	-1.17
Yangzhou	-4.21	-2.03	-11.38
Zhenjiang	-1.63	-2.13	-4.53

Source: Chenwen, The Analysis on the Relation between Changes in Arable and Economy Development in Yangtse River Delta, 1997.

- The share of township construction and farmer's residential construction was the major cause of farmland loss. Due to the booming of the Township and Village Enterprises (TVEs), more than 100,000 ha of farmland lost. Together with village residential construction, both uses accounts for 55% of the total land for construction.
- The wave of developmental zone in the 1990's caused a large amount of farmland loss.
- According to the samples taken from 22 townships of 22 counties (cities), farmland given to national construction accounts for 26.7%, TVEs 31.2%, small town and industrial park 20.4%, village residential construction 21.7%.

5.3 The Loess Plateau

5.3.1 Background

The Loess Plateau in northwest China is the world's largest loessial deposit, formed as the result of wind-blown materials accumulating east of the Pleistocene Eurasian glaciers (Figure 5.1). It has been subject to both natural and accelerated erosion cycles since the Holocene period 10 000 years ago (Tang and He 1999). It covers an area of 580,000 km^2, with total population of 90 million in 1999. It includes the total territory of Ningxia Hui Autonomous Region (NHAR) and Shanxi Province, majority of Shanxi and Gansu Princes, and part of Inner Mongolia Autonomous Region (IMAR), Qinghai and Henan

Provinces. It has rich mineral and energy resources such as coal, natural gas, and heavy metals that of national importance, yet it is also the most vulnerable area ecologically and economically. Particularly, soil erosion in this area may trigger conversely extensive siltation and reshaped new flows that may cause huge flood in lower reaches of the Yellow River. Together with poverty, this region has become a national concern.

The history of land use change in the Loess Plateau is dominated by the interaction between farmland expansion and progressive soil erosion. Agriculture started on the Loess Plateau 7-8,000 years ago and hence can be considered one of the important birthplaces of Chinese and World agriculture. The favourable land resources permitted a productive agriculture that allowed the Zhou, Qin, Han and Tang Dynasties to flourish. Since then, however, there has been progressive land degradation. Deforestation from the Qin dynasty onwards degraded the land and exposed the fragile soil to water erosion. Increasing population pressure from 500 B.C. and particularly during the past 500 years of almost exponential population growth, led to extensive clearance and cultivation of highly erodible slopelands, and to the most serious soil erosion in the world. This, in turn, has induced frequent floods in the lower reaches of the Yellow River, causing enormous losses of life and property. Therefore, land use pattern change in the Loess Plateau is not only a local issue, but a national, and probably global issue as well.

- **Soil erosion**

In 1989 government agencies formally reported that soil erosion area in the Loess Plateau was 465,000 km^2 (water erosion area 74.6% and wind erosion area 25.4%) by using remote sensing data. The average annual stream runoff of the Yellow River is 58 billion m^3 with a sediment load of 1.6 billion tons per year. The runoff from the upper reaches accounts for 54% of the discharge, but only 9% of the sediment. Whereas the stream runoff from the middle reaches accounts for 44% of the discharge and 90% of the sediment, which comes mainly from soil erosion on the Loess Plateau. There is a transitional geomorphology of wind erosion and water erosion along the Great Wall.

On the basis of bio-climate characteristics and the primary erosion agents, the Loess Plateau can be divided from south to north into the forest- or forest-steppe water erosion region, the steppe water-wind erosion region and desert-steppe wind erosion region. The water erosion area accounts for 46 %, the water-wind erosion area for 29 % and wind erosion area for 25 % respectively. The area with the erosion rate of more than 10,000 tons/km^2.a accounts for 8% in the water-wind erosion region, and 4% in the water erosion region (Table 5.5).

Table 5.5 Area of different soil erosion types of the Loess Plateau

Soil erosion agent and rate of loss (Annually)	Area (10^4km^2)	Percentage of the total area (%)
Wind Erosion	15.65	25
Water-wind Erosion	17.82	29
>5,000t/km^2.a	10.57	17
>10,000t/km^2.a	4.84	8
Water Erosion	28.93	46
>5,000t/km^2.a	10.56	17
>10,000t/km^2.a	2.75	4
Total Area	62.40	100

Source: CCICED-SAWG, 1999

The annual sediment load of the Yellow River is commonly given as 1.6 billion tons, but it has been less since 1970s (Table 5.6).

Table 5.6 Average sediment load of the Yellow River since 1920

Year series	Sediment load (Billion tons)	Runoff (10^8m^3)	Concentration of sediment (kg/m^3)
1920-1929	1.2	351.8	35.3
1930-1939	1.8	442.5	39.8
1940-1949	1.7	483.8	35.4
1950-1959	1.8	432.1	39.1
1960-1969	1.7	433.0	39.5
1970-1979	1.4	360.5	37.5
1970-1984	1.2	348.1	33.2

Source: CCICED-SAWG, 1999

Since 1950, the Yellow River has run safely because great embankments have been constructed along the main stream of the River in the lower reaches.

These embankments have been raised and consolidated three times during this period. A lot of dams and reservoirs have also been constructed. As shown in Table 6, the extreme drought in 1920's resulted in average annual sediment loads of 1.2 billion tons, but in the next four decades, the annual sediment load was continually up to 1.7 billion tons. Extreme rainstorms and floods or extreme floods occur once in about 30-40 years.

- **Population growth**

Population growth is the dominant factor causing the expansion of slope farmland and consequent soil erosion. In the year of 608, the population of the Loess Plateau accounted for 25.4% of the nation's population (Table 5.7).

Table 5.7 Population of the Loess Plateau in history

Century (A.D)	Population on Loess Plateau (10^4 persons)	Population of whole Country (10^4 persons)	Percentage of the Loess Plateau in whole Country (%)
2	1128.5	5959.5	19.6
609	1195.2	4601.9	25.4
1102	650.3	4532.4	14.3
1457-1571	1515.7	6259.5	24.2
1820	2995.6	35340.0	8.4
1840	4100.2	42126.7	9.7
1928	3132.9	44185.0	7.1
1949	3639.5	54167.0	8.7
1982	7811.3	100402.1	7.8
1985	8139.2	105851.0	7.7

Source: CCICED-SAWG, 1999

Since the beginning of the nineteenth century, the population on the Loess Plateau has accounted for 7-9% of the nation's total, but with a growth rate higher than the national average. In Qinghai, Ningxia and Inner Mongolia, the population growth rate is much higher, yet with low literacy rates - 25% of the population are illiterate or semi-illiterate.

From recorded history up to the 16th century, the plateau supported between 15 and 25% of the Chinese population, but continued cycles of deterioration of environment, and the relatively higher productivity of coastal regions led to a relative decline in population and productivity over the past four centuries (Figure 5.2).

Today approximately 90 million people occupy the Loess Plateau, amongst, over 75% are in rural areas (Zhang 1999). This constitutes 7% of China's total population.

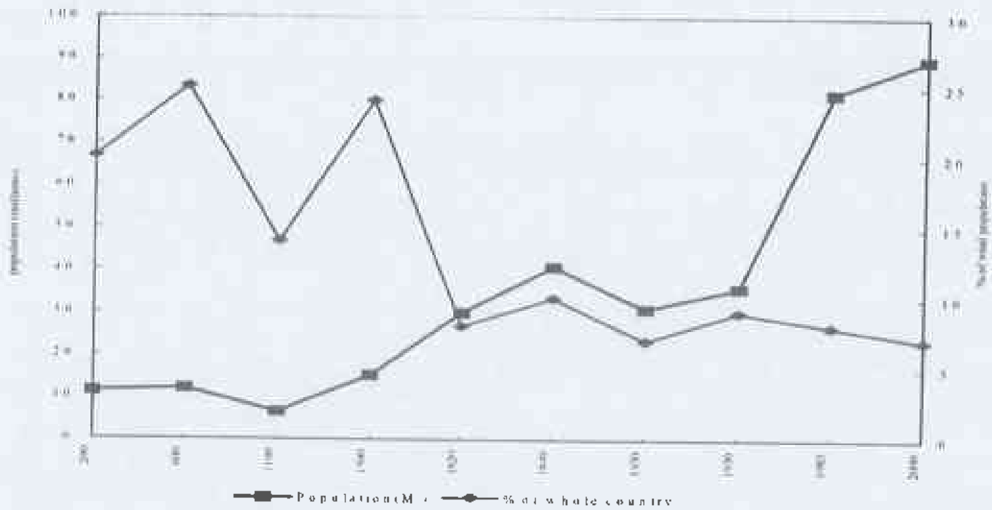


Figure 5.2 Long-term historical trends in the population of the Loess Plateau relative to the total Chinese population (Source: Zhang 1999).

- **Land use and soil erosion**

The slope farmland of the Loess Plateau suffers from sheet or rill erosion, as well as shallow gully erosion. The latter mainly occurred on the slope farmland with more than 15 degree, especially on the slope farmland with more than 25 degree. The density of shallow gully may be up to 64.1 km/km^2. Erosion rates on the slope farmland with shallow gully erosion have increased two or three times. The shallow gully erosion is the original type of modern gully erosion. Thus control of shallow gully erosion on the slope farmland should be given greater attention.

The regional distribution of vegetation types shows that 70% of the Loess Plateau would not have been eroded or only weakly eroded if human activities had not destroyed the natural vegetation. The data from large experimental plots in Ziwuling shows that once the forestland was reclaimed, soil losses tended to rise from human induce accelerated erosion with the erosion rates increasing by 7,000-8,000 times from tens of tons to 10,000 tons km^2.a (Tang, 1999). Even in plots with felled trees but no land clearance, soil erosion was very weak (Table 5.8) due to the protection of roots and litters. It shows that once the loose loess soil is covered with vegetation, even with grass or leaves, it is possible to reduce appreciably the erosivity of rainfall and water flow.

Table 5.8 Comparison of erosion intensity on different landforms and land use

Landform vs. Land use	Period	Plot area (m^2)	Slope degree	Runoff ($m^3/km^2.a$)	Erosion ($t/km^2.a$)	Times	Plot number
Slope land							
Forestland	1989-91	965.8	32	215.	1.29	22	5
Reclaimed farmland	1990-91	1144.3	34	32335.	9703.	22	7
Reclaimed bareland	1990-91	995.2	32	27479.	10324.	22	6
Gully-slope Land							
Forest	1989-91	253.5	37.42	1481.	14.41	28	1
Reclaimed farmland	1990-91	406.5	38.41	39109.	13179.35	24	8
Reclaimed bareland	1990-91	243.8	37.42	41123.	21774.12	24	2
Slopeland plus gully slopeland							
Forestland	1989-91	1664.	32.38	296.	0.99	20	4
Felling residual land	1990-91	2262.	34.38	47.91	0.48	17	9
Reclaimed bareland	1990-91	1409.	32.38	2425.	15286.	24	3

Source: Tang, 1999

5.3.2 Farmland gains and losses

On the contrary to farmland loss in the coastal areas, there has been a farmland expansion process from 1949 through 1996 in Loess Plateau. However, farmland started to decrease since 1997, due principally to the state regulation to set aside those slope farmlands steeper than 25 degrees, and the set aside compensation policy later afterwards.

Statistics show that there was an increase period from 1949 to 1957, an increase of 7.9%, seems similar to the situation of other regions in

China (Zhao 1991). Then there is a decrease period from 1957 through 1985, a decrease of 16.9%. However, there is a big gap between statistics and remote sensing data of the farmland areas, and the latter is now considered to be more credible. The fact given by the remote sensing data in 1985 was that farmland area has been increased by 30.6% since 1949! (Table 5.9)

Table 5.9 Farmland losses and gains in Loess Plateau* (1000 ha)

	Statistical data				R.S. data	Gains** (1985-49)
	1949	1957	1978	1985	1985	
Henan	681.06	722.89	601.05	579.9	703.79	3.3%
Shanxi	4281.51	4427.09	3925.63	3758.47	5233.25	22.2%
Shaanxi	3257.72	3412.04	3062.38	2919.95	4424.91	35.8%
IMAR***	1233.24	1414.01	970.11	863.12	1369.8	11.1%
Gansu	2426.95	2654.69	2476.19	2411.06	3319.35	36.8%
Ningxia	647.53	892.6	919.87	844.93	1323.27	104.55%
Qinghai	421.73	452.37	422.37	403.57	535.68	27.0%
Total	12949.75	13975.67	12377.59	11781.01	16910.05	30.6%

Source: Land Resources in Loess Plateau (Zhao C, Liu J.1991)

* The farmland of the provinces in the table is only the LP part, except for Ningxia and Shanxi.

** The increase rate is based on the RS data in 1985 and the data in 1949.

*** IMAR Inner Mongolia Autonomous Region

From 1985 through 1996, farmland gains continued in some provinces, yet started to lose in other provinces in the region. Farmland areas in Shaanxi, Ningxia, Qinghai provinces expanded during this period, though with a slow pace. However, farmland area started to decrease in IMAR and Gansu province.

The period from 1997 through 2000 witnessed almost an overall loss of farmland in the Loess Plateau, except for Ningxia. Most of the farmland lost could be attributed to slope farmland set aside to ecosystem restoration program. About 43.2% loss of farmland was given to ecosystem restoration (He, Wang 2002, Land Cover Change and Environmental Consequences). This can be regarded as ecological farmland Marginalisation process with strong policy intervention.

5.3.3 Past experiences of watershed management

Before the 1980s, the main method of land management on the Loess Plateau was tree and grass planting. The objective was simply ecological improvement, which did not integrate farmers' food security and welfare. It obviously received little support from farmers and progress was very slow.

Since 1980s, small catchments management was identified as an efficient approach to soil and water conservation. It was formulated from the experiences in the hilly and gully area of the Loess Plateau. The measures include terracing farmlands, restoring the forest from farmlands on steep slopes of more than 25^{o}, building dams for silting the valley plain and storing the water, and so on. Small basin management has three advantages. First, it changes the landscape and controls ecological degradation. Second, it aims to increase agricultural productivity and improve the local farmers' welfare. Third, it reduces the amount of soil loss. Since the integrated small catchments management approach took effect in the context of ecosystem improvement with direct means of raising farmers' welfare, the results have been better. Today, more than one thousand small catchments have been selected for improvement. However, it is still difficult to extend these experiences to a larger scale.

In 1990s, with the boosting of national power and more attention being given to improving socio-economic progress in west China, the Loess Plateau Region is facing a new opportunity for development. The active national financial policies have led to more funds being invested in the ecosystem improvement of the Loess Plateau. Various ministries and departments have set up a lot of key counties and demonstration regions for soil and water conservation, ecological agriculture and eco-restoration in Loess Plateau. International organisations such as World Bank and concerned research institutions have also set up demonstration projects for research and poverty alleviation in order to speed up the regional development. Consequently, the above-mentioned measures are fostering integrated management and large-scale control of soil erosion is entering a new stage.

5.3.4 Policy intervention and implications

Since the establishment of P. R. China, governments at all levels has paid much attention to the Yellow River flood control, and hence to the soil and water conservation in the Loess Plateau. Policies to that area have been particularly favourable after 1970s, but progress has been slow, and much remains to be done.

The next 10 years will be another critical period for the Loess Plateau. The Chinese Government has determined to launch the Great West Development Program, aiming at: a) restoring the degrading ecosystem; b) Improving infrastructure; c) human resource development; and d) developing the economy.

Loess Plateau is one of the key areas for ecosystem restoration. There is now a very strong policy intervention on the land use pattern. The general policy for the ecosystem restoration is to encourage farmers to set aside the slope farmland for tree/shrub/grass planting, by means of compensating the loss of grain production. The strong political intervention and huge investment on the ecosystem restoration will have the biggest influence ever on the land use and land cover change.

Holding the biophysical change on land use as a constant, the policy impact on farmers is a divide. As food security is not the primary concern for the farmers, there should be a strong argument on whether the grain compensation policy works, and farmers' behaviour is now very much oriented by market, not necessarily by government programs, in the context of transition from planned to market economy. The farmers are not necessarily caring their rice bag as they already have sufficient food to eat. The major concern for farmers for the time being and onward is the household income increase, yet both the market and government does not have adequate off-farm opportunities for farmers to leave the land. Of course, one may argue that planting trees and grasses with payment is a kind of opportunity for farmers to set aside the cropland on steep slope, yet whether the magnitude and time sustainability could fulfil the farmers' ambition to this end is another question. Therefore, the consequences of ecosystem restoration and grain compensation policy on land use and land cover change remains to be seen.

In China's Tenth Five Year Plan, announced in March 2001, unprecedented importance has been attached to environmental protection and sustainable development. The new five-year plan also emphasises speeding up economic growth in the western part of the country, in an attempt to bridge disparity that has developed between the very rapid expansion in the eastern coastal provinces and the rest of the country. This is good news for the west, and it is hoped that some of these initiatives will assist the development of local industry, local employment in non-agricultural activities, and the retention of more of the wealth that is generated from coal, gas and minerals being retained in the plateau regions. This will provide unprecedented opportunity to diverge rural labour flow to different sectors rather than farmland production, and to diversify the local agricultural dominated, slope-farmland based economy. This will help to implement the slope farmland set-aside policy throughout the plateau area.

Within the next 10 years, policy, farmer and land interaction will be very strong in such a condensed time scale. There are rarely cases like this in the world, in terms of both magnitude and complexity. The consequences on land cover change will be lasting into the next 30 to 50 years.

5.4 Specifics in Shaanxi Province

5.4.1 Background

Shaanxi Province is located in the middle reaches of Yellow River, with total territory of 205,600 km^2 and population of 36 million. It is a typical area of the Loess Plateau, characterised by severe soil erosion and water loss, increasing pressure on land, and less developed economy. Large proportion of slope farmland and large proportion of rural population are the major causes of soil erosion and stagnated economy.

5.4.2 Population, Land, Grain Production, and Rural Income

- In Shaanxi, rural population increased significantly over the years. In 1975, the total rural population was only 22.8 million and it increased to over 27 million in 1997 (Figure 5.3). Given such a situation, much of the pressure has been placed on to land. The statistics of the same period shows that per capita farmland decreased from 0.16 ha in 1975 to 0.11 ha in 1996 (Figure 5.4). In other words, the number of people that each ha of land should support increased from 6.25 persons in 1975 to 9.09 persons in 1997. Demand for increased production is even higher than the income increase.

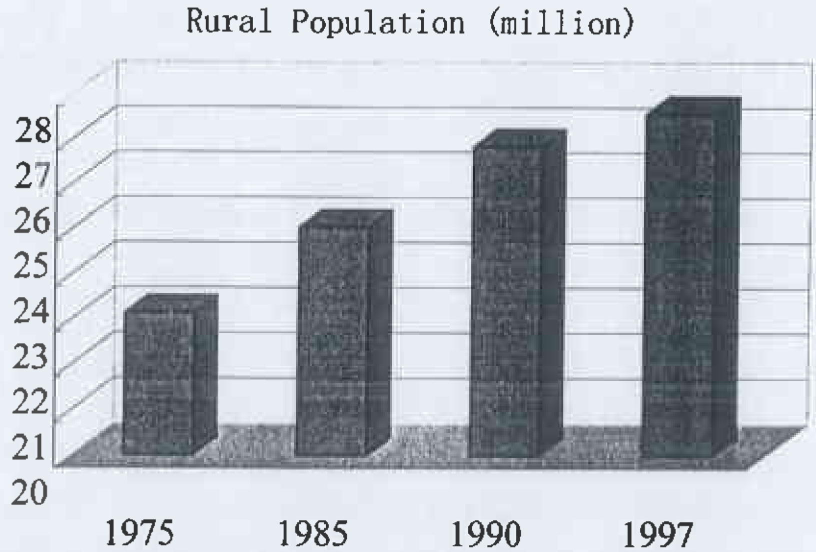


Figure 5.3 Increase in Rural Population in Shaanxi Province.
Source: Agricultural Statistical Yearbooks, SSB, various years.

- There is a declining process of per capita farmland possession as population increase and slope farmland set aside for restoration (Figure 5.4)

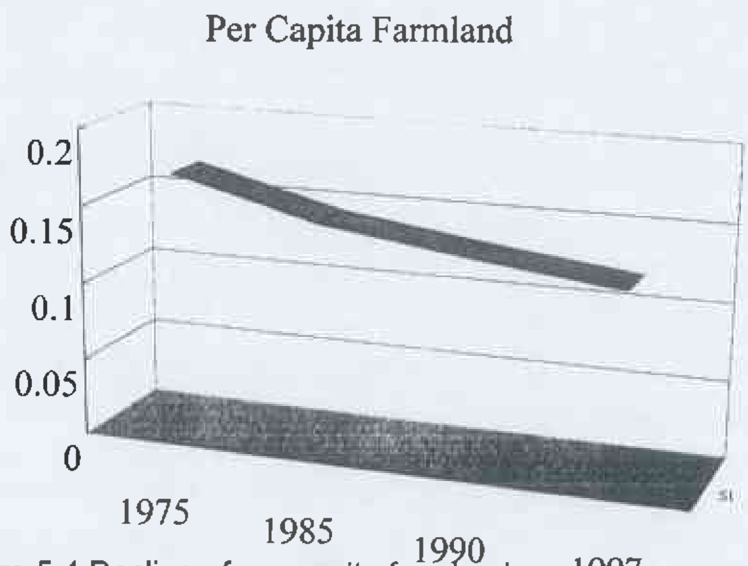


Figure 5.4 Decline of per capita farmland
Source: Agricultural Statistical Years of Shaanxi Province, SSB, various years.

- Like in other parts of China, agriculture has had significant development in Shaanxi since the economic reform in early 1980s. The achievements could be reflected by the significant increase in grain production and per capita income (Figures 5.5, 5.6). Both figures show that there has been a continuous increase in total grain production and the rural household per capita income. However, the agricultural and rural development has been encountering various problems. Amongst all, the following are shortlisted as dominant ones. From 1975 onwards, per capita grain production increased significantly up to 1990. However, after that, it is in a declining trend. In 1997, per capita grain production was only 376kg, about 20kg lower than the 1990 level (Zhang 1999).

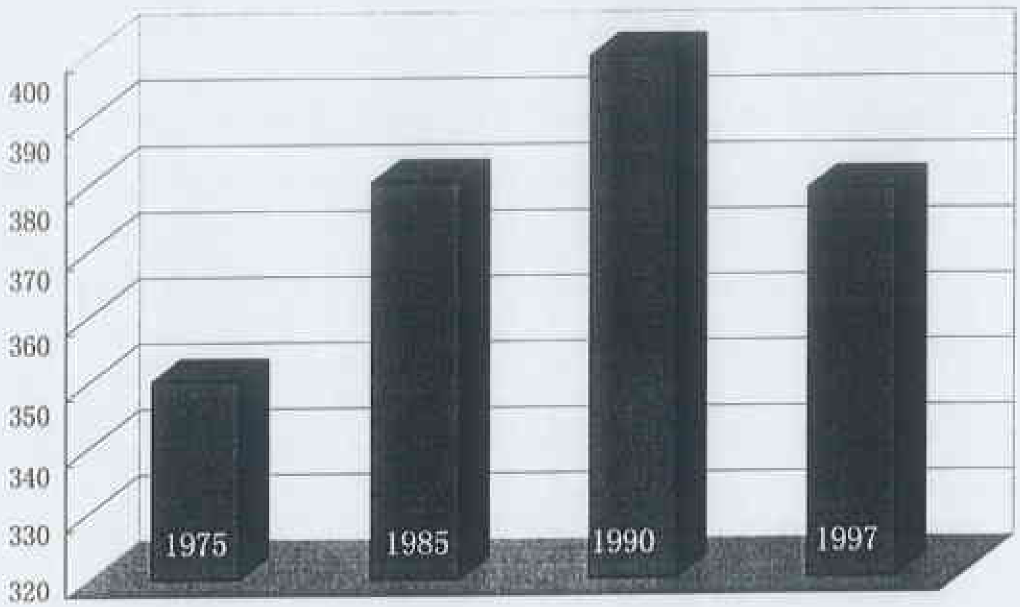


Figure 5.5 Per capita grain production in Shanxi
Source: Agricultural Statistical Years of Shaanxi Province, SSB, various years.

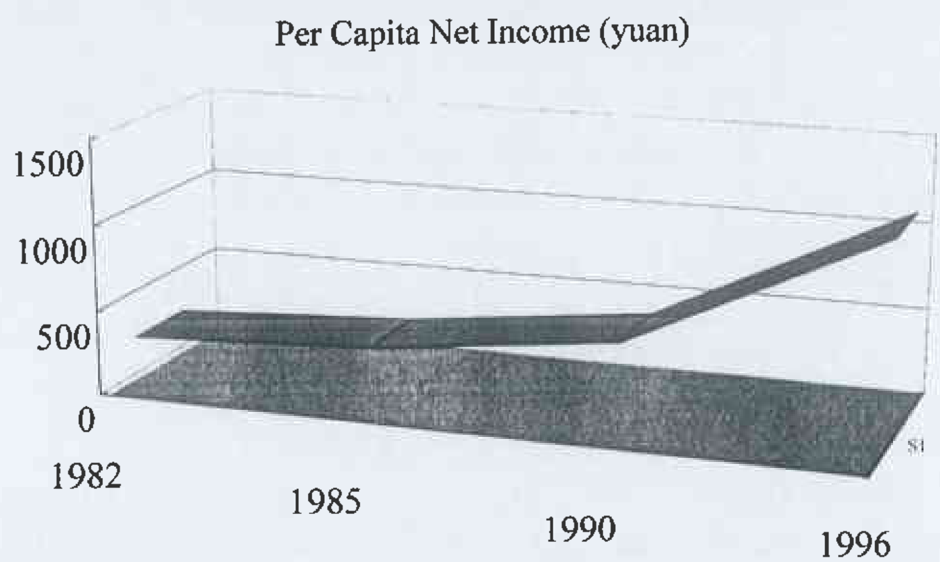


Figure 5.6. Per Capita Net Income (yuan) in Shaanxi Province

Source: Agricultural Statistical Yearbooks, SSB, various years.

5.4.3 Less migration from farmland: income and employment concerns

- **Rural income diversification: Crop/grain dominance**

Figure 5.7 and Table 5.10 show that although the government has made great efforts in diversifying the rural economy, farmers in Shaanxi province still rely heavily on crop production to generate income. It is shown in the table that until 1996, the major part (70 percent) of rural household income is coming from crop production. Figure 6 shows that from 1975 up to 1997, grain crops occupied more than 90 percent (compared with 73 percent nationally) of the total cropping area.

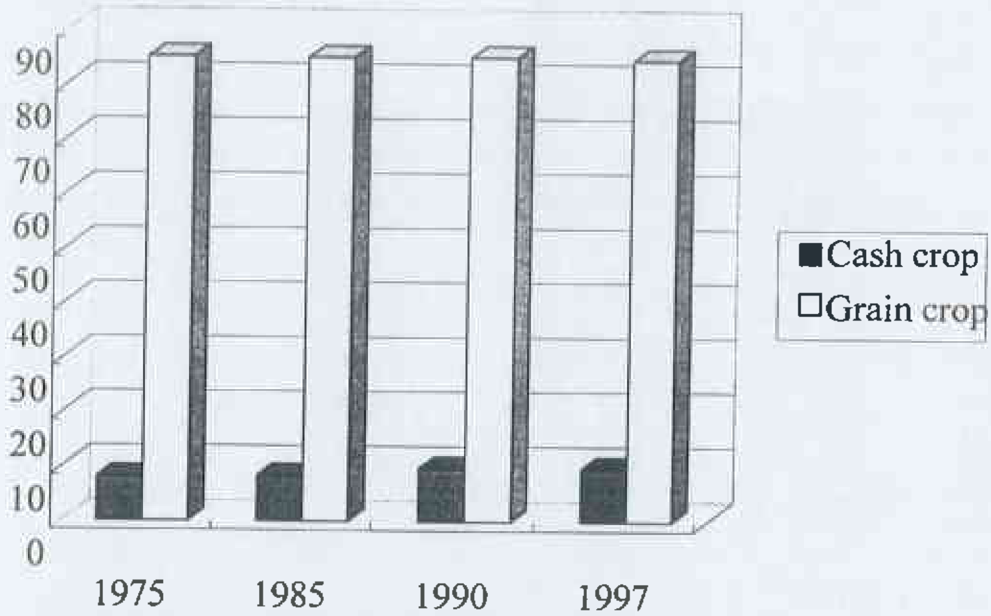


Figure 5.7 Land Use Pattern in Shaanxi Province.
Source: Statistical Years of Shaanxi Province, SSB, various years.

Table 5.10 Per Capita Farming Income Composition (%) in Shaanxi Province

Year	Total	Crop	Grain
1985	100	61.84	37.82
1990	100	60.91	35.79
1996	100	70.06	44.48

Source: SSB rural household survey, various years.

- **Rural employment diversification: a slow process**

In Shaanxi, the share of primary production is declining since the middle 1970s and both the shares of industry and service sector have increased. It is expected that such a change would induce labour employment adjustment in that more people should be employed in the industry and service sectors rather than in agricultural sector. However, The shift of employment away from agriculture in Shaanxi is much slower than the national average. In 1980, 96% of rural labour worked in agricultural sector. However, in 1996, there was still 78% of rural labour remained in agricultural sector (SSB). This is much a higher level than the national average.

The question aroused is that why when the industrial and service sectors have already accounted a larger share in terms of GDP, non-agricultural employment is still relatively low? Part of the problem may rest at the macroeconomic system at the national level. Loess Plateau is rich in energy resource. Both energy production and potential is very large in the region. But, the macroeconomic system sets barriers for rural economy to benefit from the rich energy production due to its fiscal, employment as well as revenue systems. Thus, limited amount of revenue generated from energy production goes to local governments and farmers. According to a survey by the author in 1998, most of the counties that were visited did not pay salaries on time (with possible 7-10 months delay) in Shaanxi province. Lack of funds for development is a very critical issue in the area.

Therefore it is quite unlikely that economic Marginalisation process will happen to slope farmland in Shaanxi province due to the above two constraints. Yet there might be land conversion from grain production to cash crop or fruit production when market demand increases. Ecological Marginalisation process is also likely to happen should there be a policy intervention.

5.4.4 Slope farmland and projection of ecological Marginalisation

- **Slope farmland**

Out of the 4,429,067 ha total farmland area, slope farmland accounts for 48.4%, which is the major cause of soil erosion. Different categories of slope farmland are given below (Table 5.11, Zhao C, Liu J. 1991)

Table 5.11 Slope farmland classification in Shaanxi Province (Thousand ha)

	0-3°	3-7°	7-15°	15-25°	>25°	Total
Area	2283.15	217.84	760.47	771.03	392.41	4429.07
%	51.60	4.92	17.17	17.41	8.86	100

Source (1991, Zhao, Liu)

Out of the slope farmland, there are 643,920 ha of terraced land, accounting for 30.06% of the total. This can be regarded as basic/prime farmland on which the people living in loess hilly areas can depend as major food security measures. The terraced land is also less erodible, and should not be subject to set aside policy. There were times in the early 1980's that farmers were compensated for building the terraced land and free of tax for a certain period of time.

- **Projection of ecological Marginalisation**

It is mandatory to set that farmland steeper than 25° aside for natural or cultivated re-vegetation according to the National Law of Soil and Water Conservation (Enacted in 1991). Yet for those slope farmland less than 25°, there are two options: a) to set it aside for government compensation. Now it is quite likely to happen due to the government compensation policy piloted in 1999 and formulated in 2002; b) to build terraced land through various loans and other financial assistance programs such as World Bank program operating in Yan'an city, north of Shaanix Province.

According to the findings of the Institute of Soil and Water Conservation, Chinese Academy of Sciences (Li R., Liu GB, 1999), slope farmland is the major cause for soil erosion, accounting for 40-60% of the sediment load to the Yellow River. Experiments show that sediment from slope farmland is 5 times that of uncultivated slope land, 50 times of grassland, 66 times of shrub land, and 100 times of forest.

Another important justification for future projection of ecological farmland Marginalisation is that when the slope is steeper than 15°, shallow erosion occurs, soil erosion will aggravate remarkably. Therefore, it was suggested to the government that those farmland steeper than 15° should be either set aside or built to terraced land in the next 3-5 years, and those steeper than 7° should be treated the same within the next 10 years. This will dramatically reduce the sediment load eroded to the Yellow River, to strengthen policy intervention to promote the ecological Marginalisation process in the Loess Plateau area.

6 Economic Marginalisation: case study in Changshu City

6.1 Background

Changshu, a county level city, is located in the most developed Circum-Taihu Lake Area, in the vicinity of three most advanced middle cities, Suzhou, Wuxi and Changzhou. In terms of land area and population, the Circum-Taihu Lake Area only accounts for less than 15%, yet rural GDP more than 50% of Jiangsu Province. Though agricultural sector has been very much intensified, and productivity per unit area is 50% higher than national average, the total production is stagnated due to agricultural Marginalisation caused by rapid economic development, resulting in severe farmland loss and labour flow from the agricultural sector.

Changshu City has a population of about 1.04 million in 1999 with total land area of 1142 km^2 and farmland area of 63400 ha. The population density is 910 people/ km^2, and per capita farmland area was only 0.06 ha (0.9 Mu) in 1999. The shortage of land is a compelling case on farmland protection as most of the sectors have much more comparative advantage than agricultural sector in economic terms. The last 20 years, although population increase happened at a relatively fast pace (Figure 6.1), rural per capita income surged from 184.8 RMB Yuan in 1980 to 4948 RMB Yuan in 1999 (Figure 6.2) in Changshu.

Figure 6.3 compares the trends between population and cultivated land area. It is clear that between 1980 and 1999, farmland in Changshu experienced a sharp decline. As the population increase, cultivated land area is having a reverse trend. Although the cause of farmland loss is not solely associated with the population increase, however, increased population did put pressure on the land area.

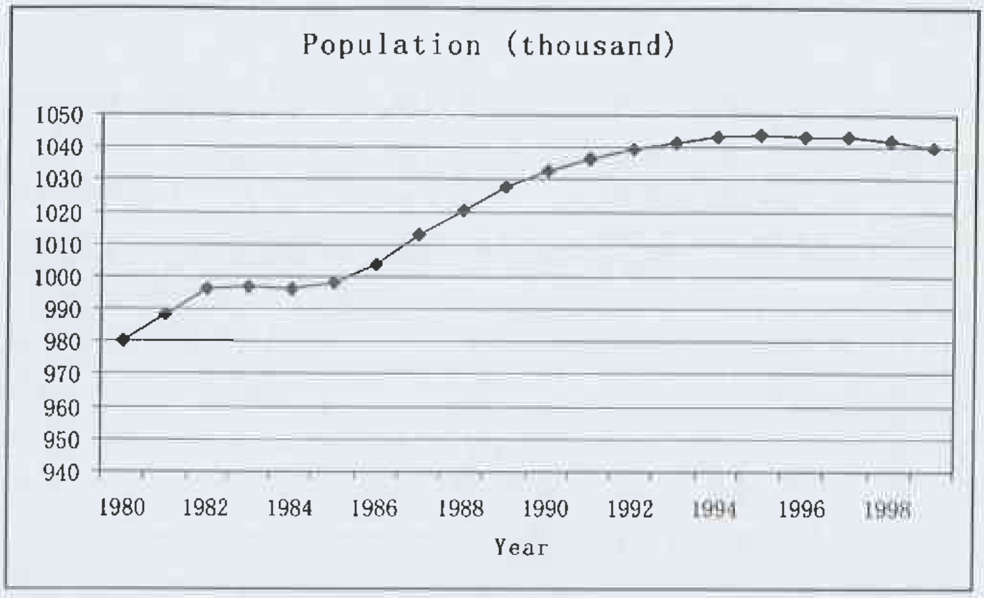


Figure 6.1 Population increase from 1980 to 1999
Source: Statistical data of Changshu City

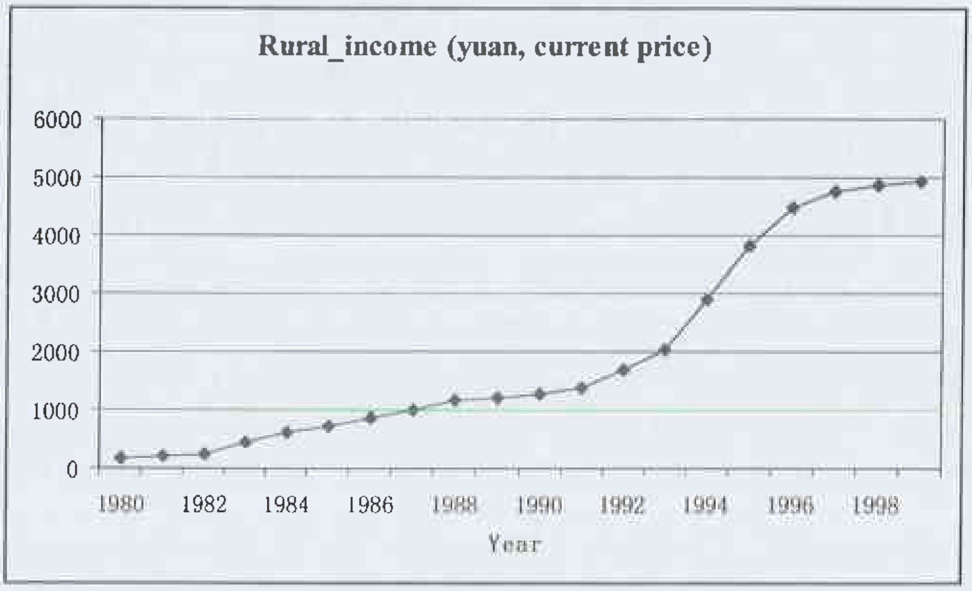


Figure 6.2 Farmer's per capita income in Changshu (1980—1999)
Source: Statistical data of Changshu City

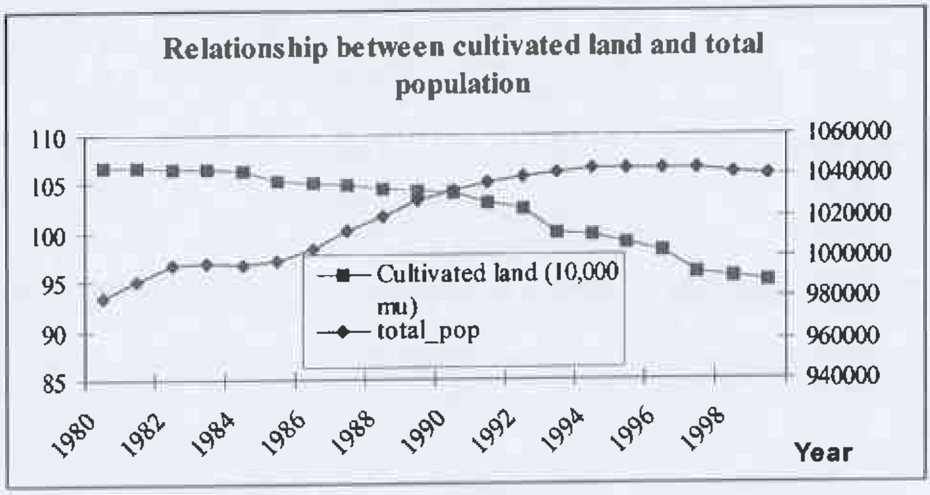


Figure 6.3 Population growth vs. farmland loss
Source: Statistical data of Changshu (2000)

6.2 Farmland change processes from 1980 to 1999

6.2.1 Overall analysis

From 1980 to 1999, farmland decreased from 71,193 ha to 63400 ha, 10.94% farmland lost to other uses in the past 20 years. The most concerning indicator is total sown area, losing 35% over 20 years, down 1.75% a year on an average. This has been caused by a combination of determinants, but mainly the two major factors – cultivated land area decline and the decline of intensity of cultivation (multiple cropping index-MCI). The share of Agriculture to the total GDP decreased dramatically from 31.8% in 1980 to 7.3% in 1999, 24.5% decrease in the last 20 years. The share of crop production to total agricultural GDP was down from 66.2% in 1980 to 31.9% in 1999. Rural labour force engaged in agricultural sector was down from 58.76% in 1980 to 24.5% in 1999. (Table 6.1)

Table 6.1 Farmland loss vs. change of major determinants

	1980	1999	Decrease %
Farmland (ha)	71,193	63,400	10.94%
Sown area (ha)	152,873	100,033	35%
Cropland share in agro GDP (%)	66.2	31.9	34.3%
Agro share in total GDP (%)	31.8	7.3	24.5%
Agriculture labour force in total (%)	58.8	24.5	34.3%

Source: Statistical data of Changshu, 2000

6.2.2 Trend of farmland loss from 1980 to 1999

From 1980 to 1999, farmland has continued to decline at an average annual rate[1] of 0.61% from 71,193 ha to 63,400 ha. When break the process into different periods, e.g. between 1980 and 1985; 1986-1990; 1991-1999, it can be seen that there existed variations overtime (see Table 2 and Figure 4). The fastest declining period appeared between 1990 and 1995 when there were as much as 696 ha of farmland lost every year. This coincided with the overall macro-development situation when there were large expansions on urbanization, designating high-tech industrial zones that occupy a lot of farmland. Similar trend happened then after but with a slightly slow rate. This also coincided with some government actions taken to prevent farmland losses after the policy was issued. However, there were exceptional years in which land area experienced sudden increases or decreases (Figure 4), such as 1991, 1992, 1993 and 1997. The reasons are yet to be understood.

[2] Calculation of annual rate using the formula: $Y_n = (1+r)^N Y_0$, where Y_n is the land area in 1999 and Y_0 is the land area in 1980. N is the number of years between base year (1980) and target year (1999). r is the average rate of declining. By taking the natural log form, the final equation for calculate the annual rate is: $r = (e^{\ln(Y_n/Y_0)/N} - 1)$.

Table 6.2 Rate of cultivated land declining by periods (1980-1999)

Periods	Average area decline each year (mu)	Annual area declining rate (%)
1980-1999	6153	0.61
1980-1985	3200	0.30
1985-1990	2120	0.20
1990-1995	10440	1.02
1995-1999	9525	0.98

Source: Statistical data of Changshu, 2000

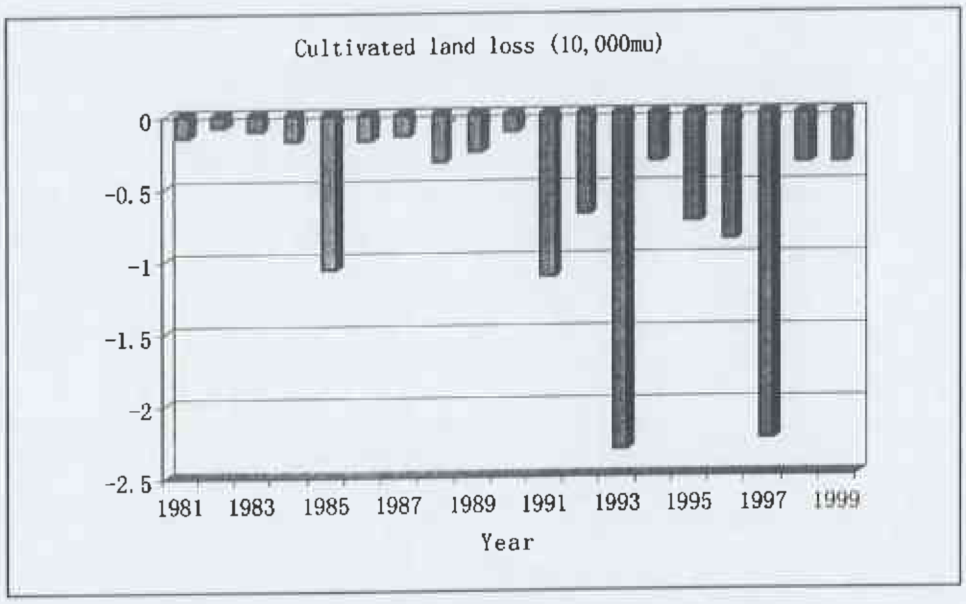


Figure 6.4 Farmland loss from 1980 to 1999 in Changshu city

Source: Statistical data of Changshu City, 2000

6.2.3 Impact on agricultural production

In the mean time, total crop sown area, grain crop area and cash crop area decreased accordingly, though not correspondingly (Figures 6.5, 6.6). However, cropping index has a negative relationship with farmland loss. The argument is that the higher the cropping index, the less farmland needed to produce the same amount of agricultural products (Figure 6.7).

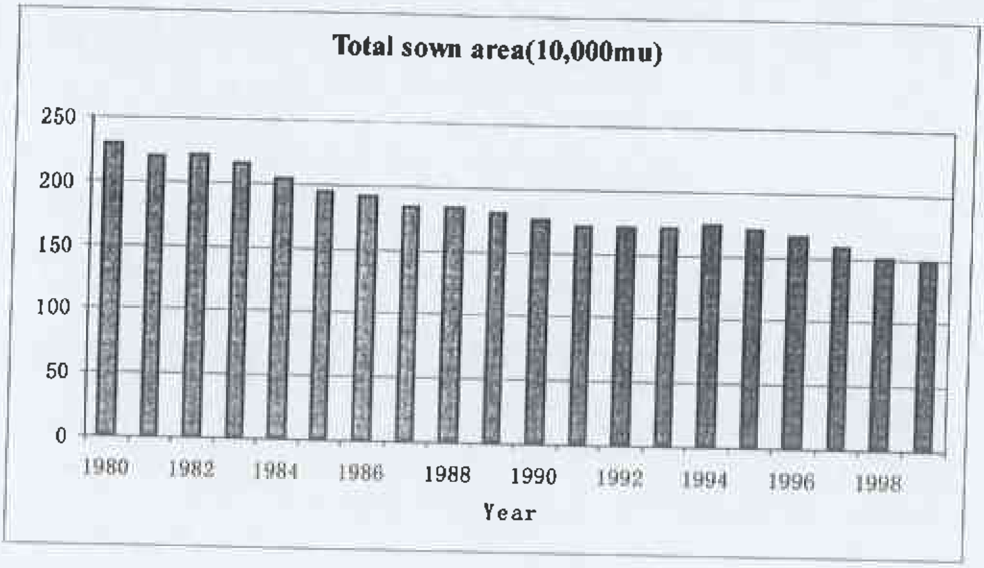


Figure 6.5 Total crop sown area
Source: Statistical data of Changshu City, 2000

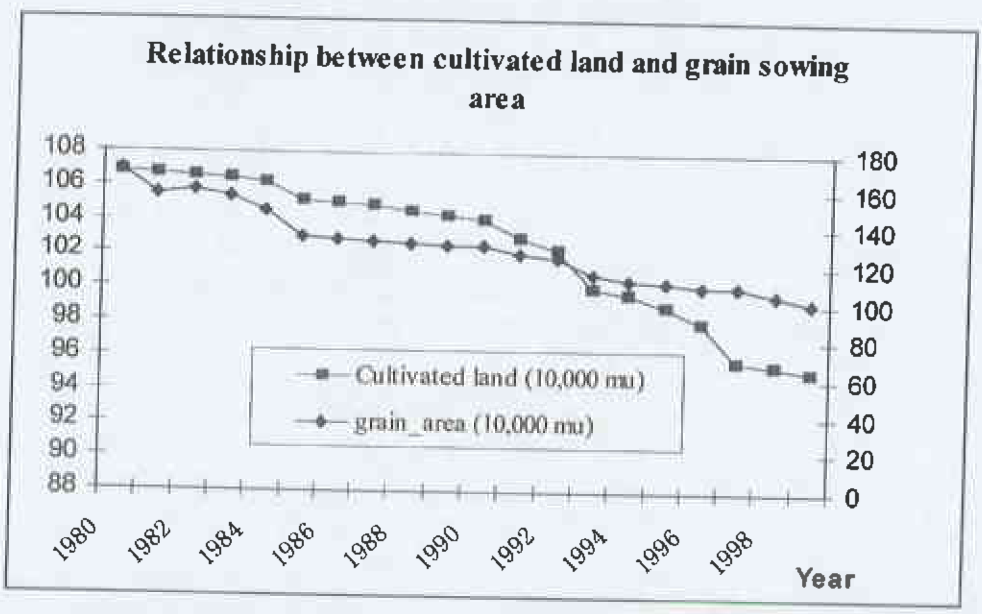


Figure 6.6 Relationship between grain crop sown area and farmland loss
Source: Statistical data of Changshu City, 2000

Grain production partially reflects government grain policy and partially explains increased food demand due to population growth; the above relationship shows that with the declining farmland, grain-sown area also declined in the past 20 years.

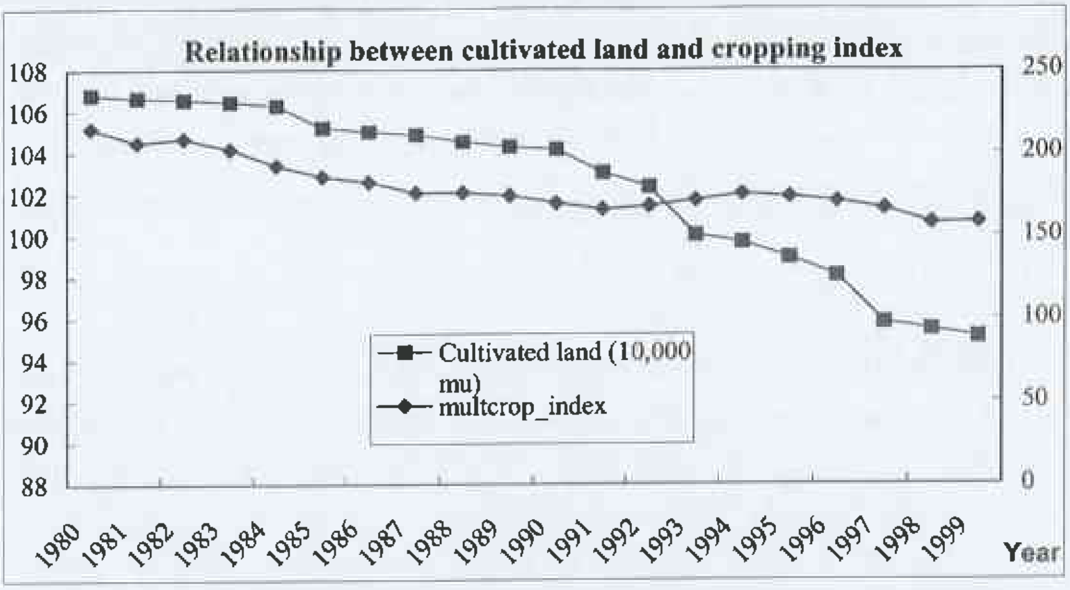


Figure 6.7 Relationship between cropping index and farmland decline
Source: Statistical data of Changshu City, 2000

However, cash crop sown area fluctuated a lot during the same period, not necessarily correlated with the decline of farmland area. This implies that cash crop sown area was possibly dependent on market demand (Figure 6.8).

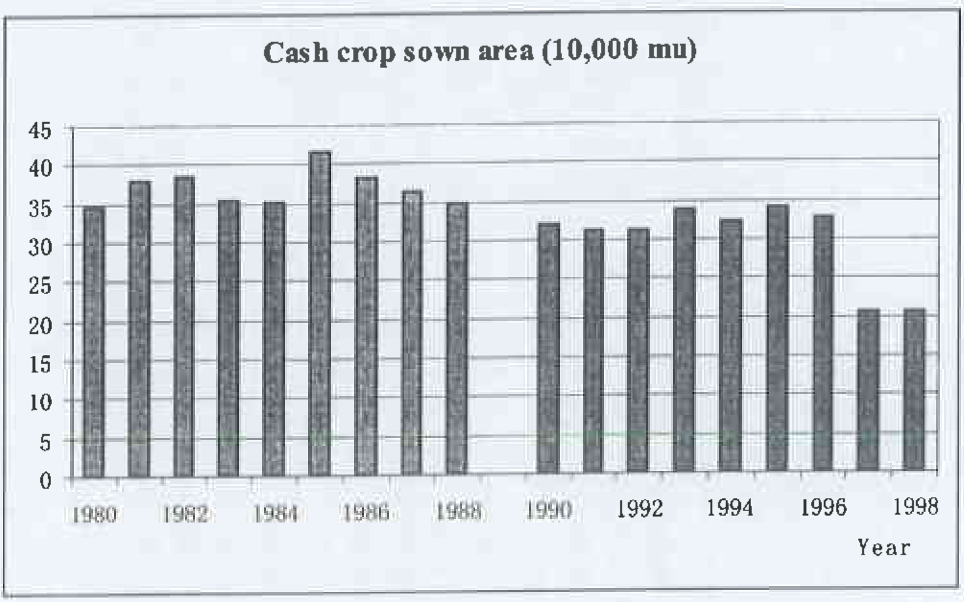


Figure 6.8 Cash crop sown area
Source: Statistical data of Changshu City (1980 --- 1999)

6.3 Determinant analysis

The loss of farmland area and decrease of crop-sown area in the past 20 years are governed by a couple of determinants. Major determinants can be identified through preliminary analysis of the statistical data. There are three dimensions of determinants driving the process of farmland loss: economic disadvantage of agriculture, especially crop production, labour loss from agriculture to other sectors, urbanization process marked by the increase of non-agricultural population.

6.3.1 Economic concerns

There are two categories of economic disadvantage in agricultural sector. The first category is the share of agriculture in the total GDP. The second is the share of crop production in total agricultural GDP. Statistics show a dramatic decline in both categories in the last 20 years.

- Statistics show that in the past 20 years from 1980 to 1999, the share of agriculture in the total GDP decreased from 31.8% to 7.3% (Figure 6.9), although the absolute increase in agricultural sector experienced an increase from to 400 million RMB Yuan in 1980 to 1.58 billion RMB Yuan in 1999, an average annual growth rate of 14.66%. The overall trend of the decrease of the agricultural share is steady and gradual. The last 20 years also witnessed the dramatic increase of the share of tertiary industry, from 13% in 1980 to 40.7% in 1999. The share of secondary industry experienced a period of steady increase from 55.25% in 1980 to 65.73 in 1987, and then decreased back to 52% in 1999 (Figure 6.10).

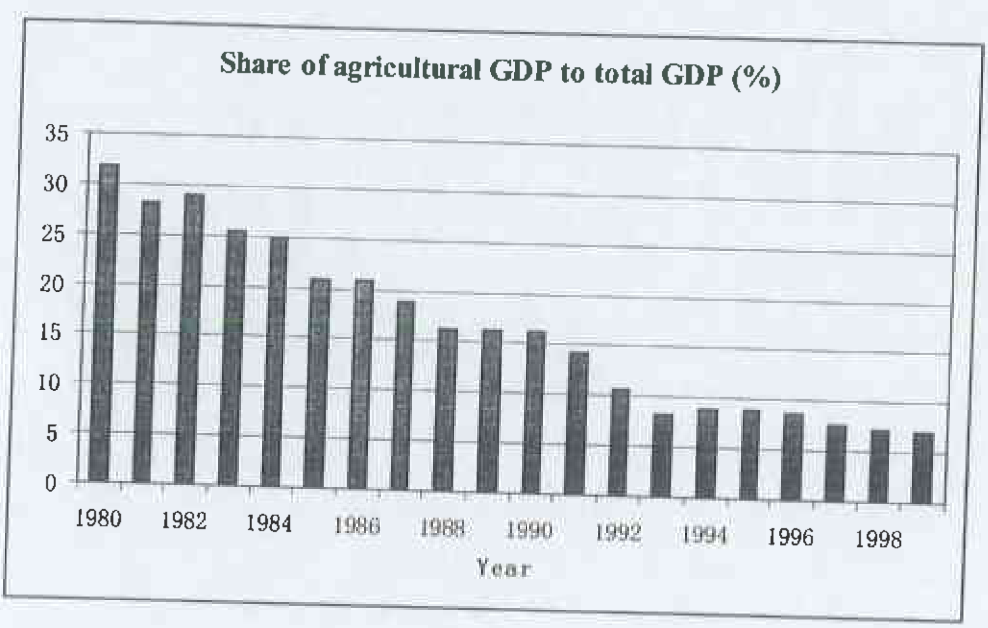


Figure 6.9 Share of agriculture in total GDP
Source: Statistical data of Changshu City (1980 --- 1999)

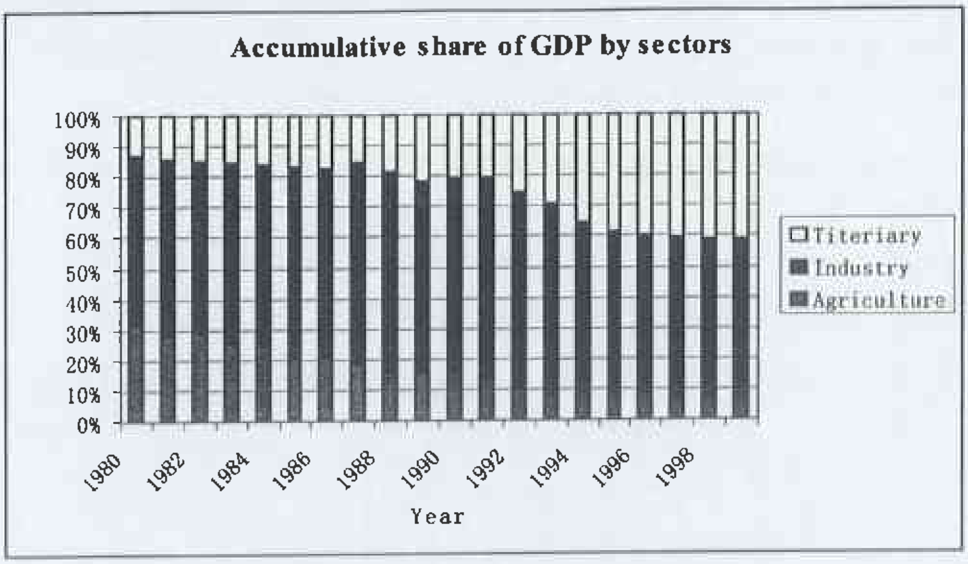


Figure 6.10 Comparative disadvantage of agriculture in total GDP in Changshu
Source: Statistical data of Changshu City (1980 --- 1999)

Figure 6.11 shows that with the expansion of non-agricultural sectors, shown as the increasing GDP share of non-agricultural sectors, the cultivated land reduced significantly. This can be regarded as one of the major determinants for farmland loss.

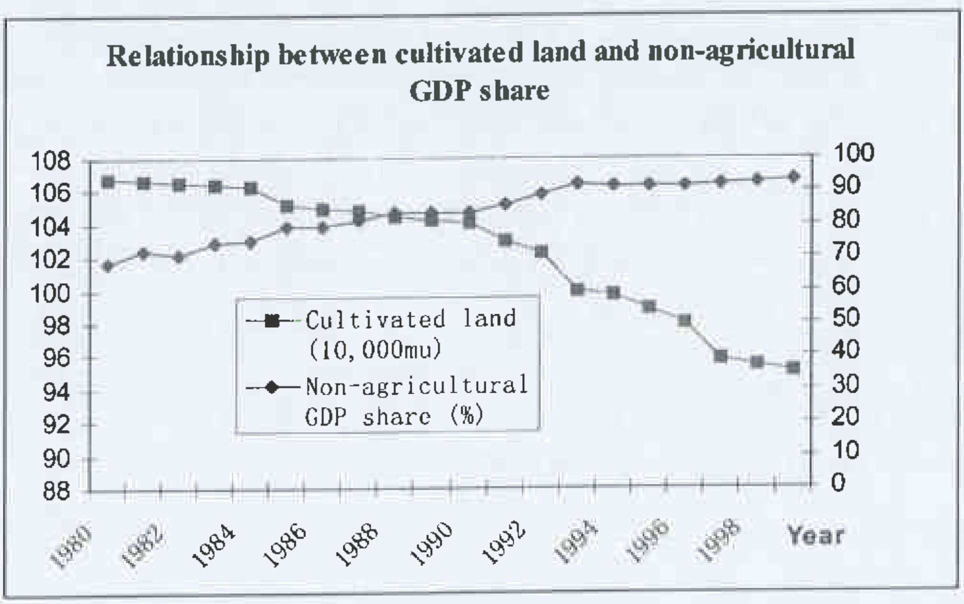


Figure 6.11 Relationship between non-agricultural growth and farmland loss
Source: Statistical data of Changshu City (1980 --- 1999)

- Coincidentally, the share of crop production in total agricultural GDP also decreased more than half in the same period, from 73.6% in 1980 to 35% in 1999 (Figure 6.12), which implies that farmland had to give way to other sectors which are more profitable in economic terms.

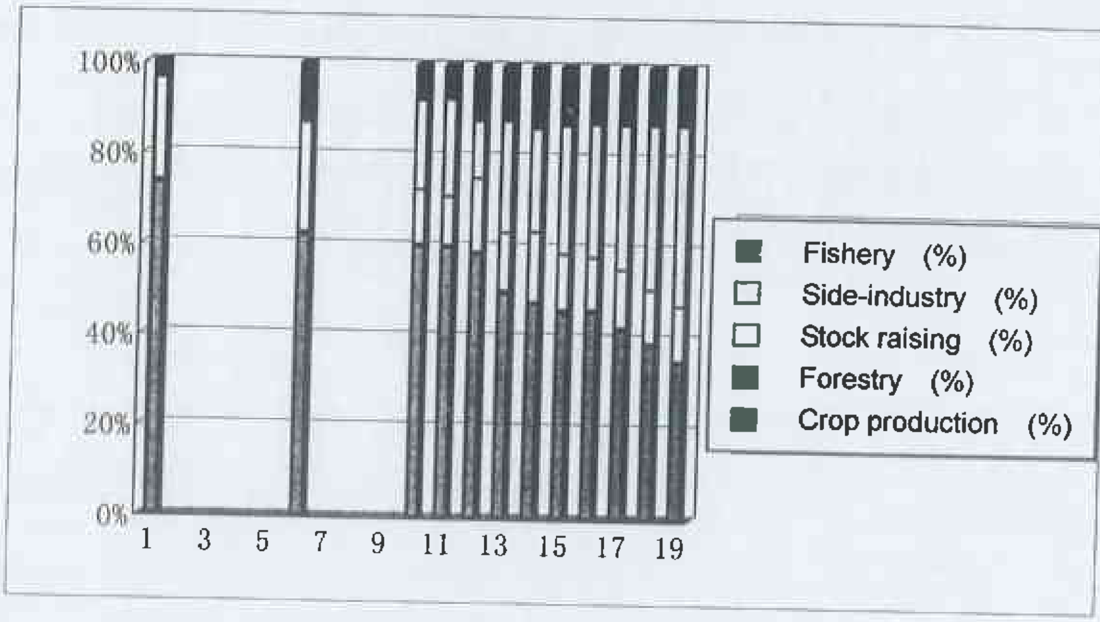


Figure 6.12 Share of crop production in total agricultural GDP
Source: Statistical data of Changshu City (1980 --- 1999)

6.3.2 Labour loss from agriculture to other sectors

- There is remarkable loss of rural labour from agriculture to non-agricultural sectors, decreasing from 58.76% in 1980 to 24.5% in 1999. The sharpest decrease has been in the period from 1980 through 1986, while the share of rural labour in agriculture decreased from 58.76% to 31.49%, a drop of 27.27% in 6 years, 4.55% decrease a year. The period from 1986 through 1991 experienced a stable process that rural labours remained in agricultural sector. However, between 1991 and 1992, there is another sharp decrease of rural labour from agriculture to other sectors, indicated by a 5.2% loss in 1 year. Recent years from 1992 onwards, the labour force stayed in agricultural sector accounts for around 25% (Figure 6.13)

Figure 6.13 Declining trend of rural labour force in agricultural sector.
Source: Statistical data of Changshu City (1980 --- 1999)

- Figure 6.14 show that before 1991, rural labour force from agricultural sector shifted mainly to industry (or secondary industry). Yet, from 1992 onwards, labour force from agricultural sector shifted mainly to services sector (or tertiary industry). It seems that the employment opportunities in industry in this period was also declining.

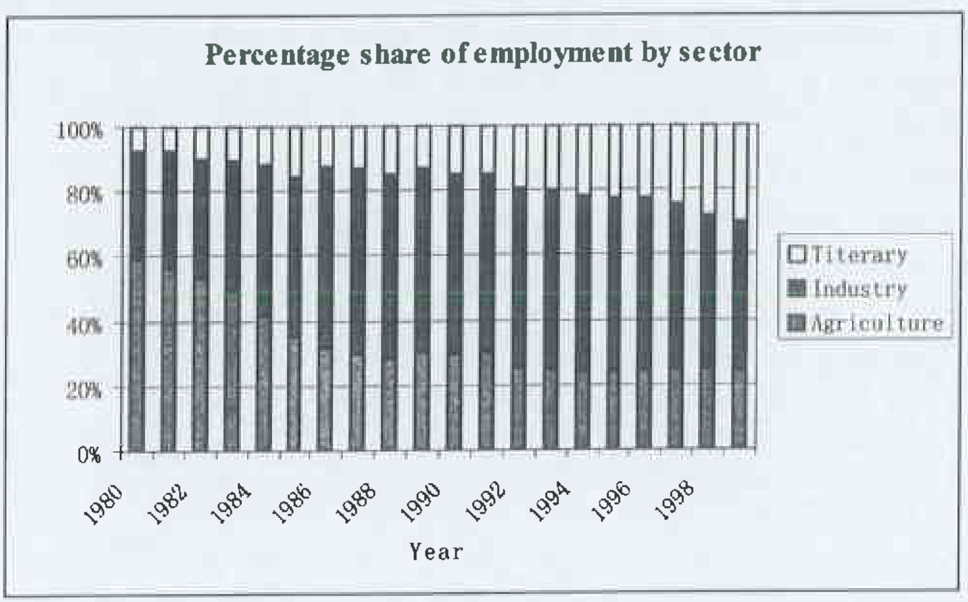


Figure 6.14 Labour force shifting from agriculture to non-agricultural sectors.
Source: Statistical data of Changshu City (1980 --- 1999)

- The reasons for rural labours shifting from agriculture to other sectors were very simple, higher salaries and more employment opportunities. Figure 6.15 shows the rapid increase of the salaries in township and village enterprises (TVEs). From 1980 to 1999, annual income per labour increased from 637 Yuan to 9324 Yuan, 15 times increase, which was most attractive to labours.

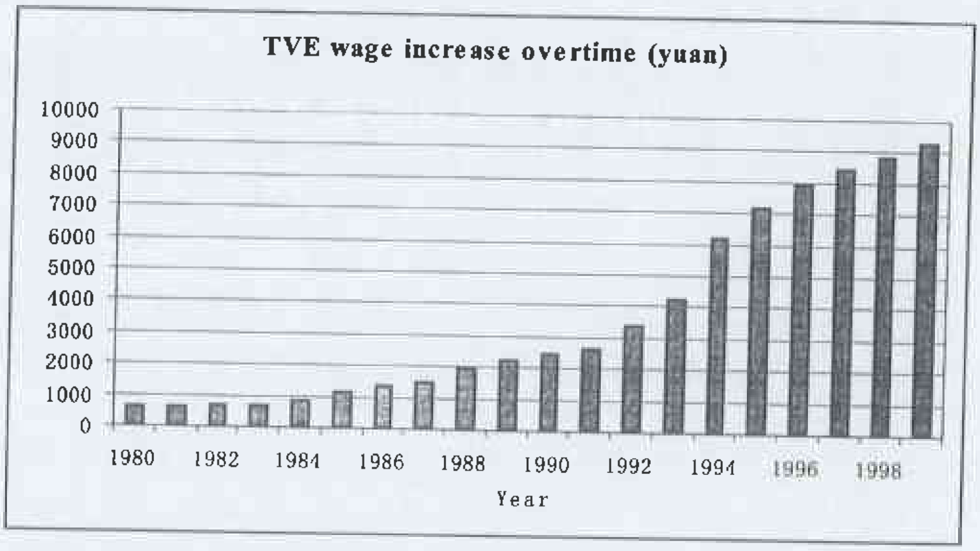


Figure 6.15 Salary increase in township and village enterprises
Source: Statistical data of Changshu City (1980 --- 1999)

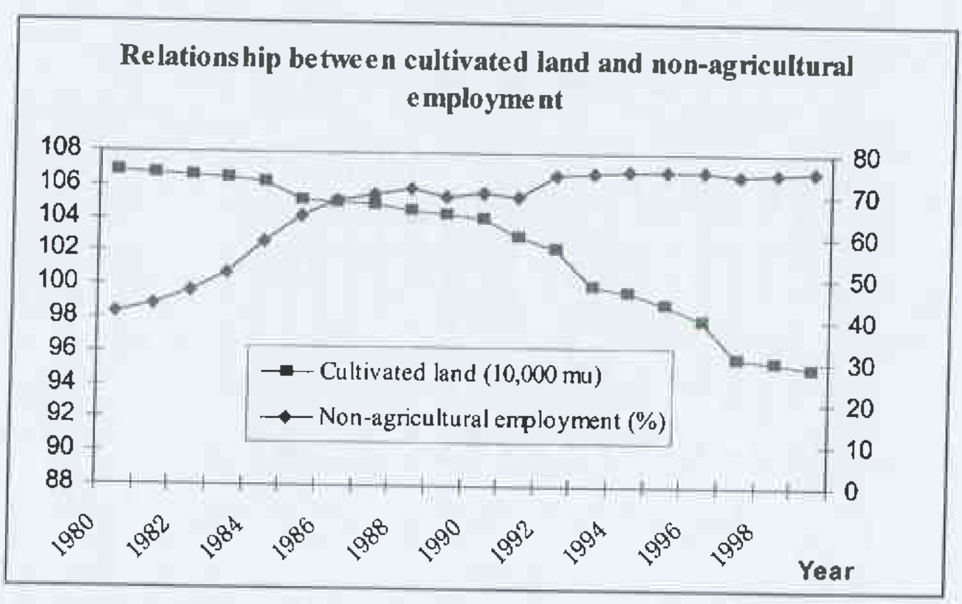


Figure 6.16 Comparison between farmland loss and growth of non-agricultural employment
Source: Statistical data of Changshu City (1980 --- 1999)

Non-agricultural employment can also be used to reflect the economic structure. The more people employed in the non-agricultural sector, the less important the agricultural sector is. The relationship shows that as more people are employed off the farm, farmland also declined (Figure 6.16).

6.3.3 Urbanization

The only indicator available for urbanization process in Changshu is the steady growth of urban (non-agricultural) population. From 1980 to 1999, urban population increased by 147%, an average growth rate of 7.3% a year (Figure 6.17). The expansion of urban areas is definitely one of the major causes of farmland loss. Yet, that is not the whole story. Rural residence construction and TVE development must have a large share to the farmland Marginalisation process.

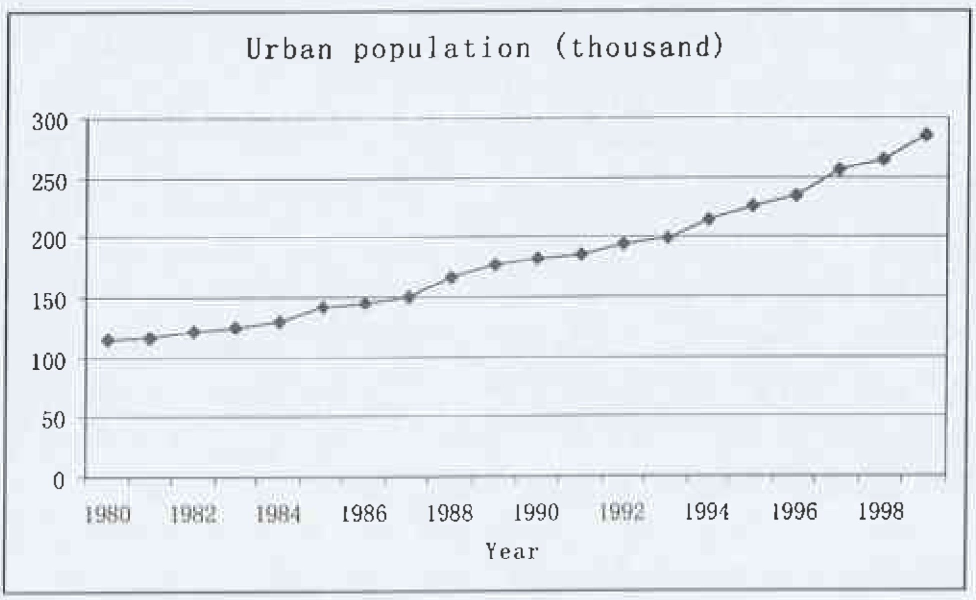


Figure 6.17 Steady increase of urban population
Source: Statistical data of Changshu City (1980 --- 1999)

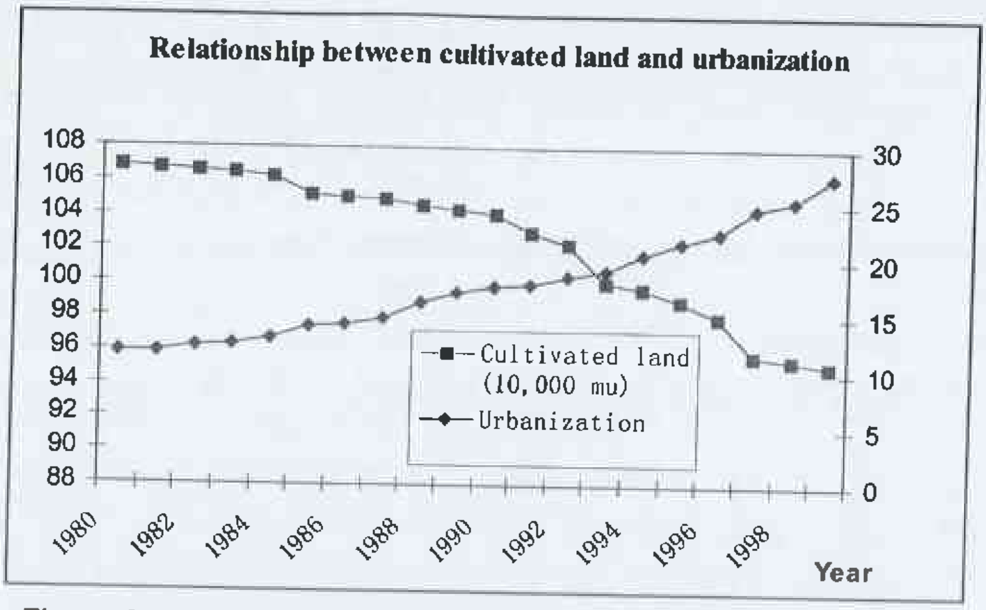


Figure 6.18 Relationship between farmland loss and urbanisation
Source: Statistical data of Changshu City (1980 --- 1999)

Figure 6.18 shows that with the growth of urbanization rate, farmland decreased. Negative relationship can be expected during the above period.

6.4 Farmland Marginalisation process: interaction with determinants

The previous analyses have shown that urbanization, population growth (result in increase in residence area or more demand for food), and economic structure change are the most important factors that causing farmland loss. The following models are built based on the above assumptions.

6.4.1 Model specification

Farm land (-LAND) is determined by urbanization (percentage of urban population to total population-URBAN), economic structure (GDP structure –Nonagr_GDP and employment structure- Nonagr_E), population growth, grain sown area (GA), and etc.

6.4.2 Calculation of model variables

Dependent variable: Total farmland measured at 10,000 mu.

Independent variables (explanatory variables):

Urbanization = rate of urban population to total population in percentage form; it is expected that the expansion of urban population will cause farmland loss due to urban construction;

Share of non-agricultural GDP to total GDP in percentage form. The expected effect of this factor on farmland is negative based on the argument that with the development of non-agricultural sectors, farming became less comparative, thus land became a less important factor.

Share of non-agricultural employment to total employment in percentage form. The same relationship as it was seen between farmland and GDP. As more people been employed in other sectors, farming became less attractive.

Population variable measured as total population at yearend. The relationship between farmland and population growth is complicated. On the one hand, increased population will result in increased demand for food, thus more farmland is needed for crop production. On the other hand, more people means more demand for residential area, thus more farmland is required to be converted into residential plot.

Grain sown area is discussed here either as a policy indicator or demand driven factor that help prevent farmland from other uses. On the one hand, government grain purchasing policy requires that a minimum amount of grain had to be produced so certain farmland would be required. On the other hand, increased population will require more grain output to meet the demand. Thus, more farmland is required.

Cropping index is considered in this study mainly to represent technology combination that farmers use for production. It is expected that the higher the cropping index, the lesser land that was needed for crop production.

The following models attempt to test what factors are the most significant determinants that contributed to the loss of farmland in Changshu City.

6.4.3 Model results

- **The first model** tried is: land is a function of grain-sown area (GA), urbanization (URBAN), non-agricultural GDP share (Nonagr_GDP), and population (Pop). In order to understand the degree of each factor affecting the farmland, the estimation uses Cobb-Douglas form in that all the estimated coefficients are elasticitics.

$Land= \alpha GA^{\alpha 1}URBAN^{\alpha 2}Nonagr\_GDP^{\alpha 3}POP^{\alpha 4}$

Where: α_i are coefficients need to be estimated.

Taking the log form of the equation, we get:

$Log(Land)= Log \alpha + \alpha_1 Log(GA)+ \alpha_2 Log(URBAN)+ \alpha_3 Log(Nonagr\_GDP)$
$+ \alpha_4 Log(POP)$

The above model can be estimated using a linear estimation and the model result is presented in Table 6.3.

Table 6.3 Estimation results on factors affecting farmland area (Model I)

Variables	Coefficient	Std. Error	t-value	P > t
GA	0.0499	0.1057	0.47	0.644
URBAN	-0.1897***	0.0409	-4.64	0.000
Nonagr_GDP	0.0647	0.1786	0.36	0.722
Pop	0.6562	0.5129	1.28	0.220
Const.	-4.4401	6.0843	-0.73	0.477
Adj_R^2	0.9447			0.0000(F)

Note: *** represents significance at 1% level.

- **The second model** is similar to the first model but with only one variable difference in model specification. The model replaced the grain area with the cropping index (INDEX) variable. The results are presented in Table 6.4.

Table 6.4 Estimation results on factors affecting farmland area (Model II)

Variables	Coefficient	Std. Error	t-value	P > t
INDEX	-0.1764***	0.0494	-3.57	0.003
URBAN	-0.2119***	0.1916	-11.06	0.000
Nonagr_GDP	-0.1346	0.0862	-1.56	0.139
Pop_growth	0.8084***	0.2949	2.74	0.015
Const.	-5.2585	3.8233	-1.38	0.189
Adj_R^2	0.9697			0.0000(F)

Note: *** represents significance at 1% level.

- **The third model** uses similar variables as it was in Model II. The only difference is: instead of using the share of non-agricultural GDP as an indicator of economic structure, we uses share of non-agricultural employment. The results are presented in Table 6.5.

Table 6.5 Estimation results on factors affecting farmland area (Model III)

Variables	Coefficient	Std. Error	t-value	P > t
INDEX	-0.1354*	0.0685	-1.98	0.067
URBAN	-0.2248***	0.1920	-11.71	0.000
Nonagr_E	-0.0042	0.0257	-0.17	0.871
Pop_growth	0.4758*	0.2470	1.93	0.073
Const.	-1.2556	3.3480	-0.38	0.713
Adj_R^2	0.9648			0.0000(F)

Note: * and *** represent significance at 10 and 1% level, respectively.

6.4.4 Comparison of the three models

Comparing the above three model results, it can be seen that all the general performance of the three is good. This is shown by the adjusted R squired values. All the adjusted R squired values are ranged between 0.9447 and 0.9697. However, detailed comparisons on the statistical significance of individual variables have concluded that amongst the three models, Model II performed the best. The following are the summary of similarities and differences by variables on the three models.

- **Grain-sown area:** This variable was used only in Model I. By expectation, this variable will have positive impact on the farmland area. The reason for this was discussed earlier. The model result shows that although the coefficient came out positive, but it is statistically insignificant. In other words, the grain-sown area was not an important factor that influences the farmland change. This was why it was not included in the second and third model.
- **Urbanization:** Given the fact that urbanization process has been claimed to be one of the most important factor that caused the loss of cultivated land in many areas of China, we included this variable in all the three models. To our expectation, this variable performed consistently well in all the three models. All the coefficients have the expected sign (negative in relation with the cultivated land) and all are statistically significant at one percent level.
- **The share of non-agricultural GDP:** This variable was included in both Model I and Model II. However, the performance of this variable in the two models is different. By expectation, this variable should have negative relationship with the farmland change as it was discussed earlier. In Model I, the coefficient of this variable has a wrong sign. Because of its

insignificance, we could say that it is not an important determinant of farmland area. In Model II, however, the sign of the coefficient is negative and expected, and also nearly significant at 10% level.

- **The share of non-agricultural employment:** This is the variable just like the one discussed above. Normally, the sign of this coefficient should be negative. It is included only in model three. The result shows that although the sign of the variable is expected but it is insignificant. That is to say that this variable is not a significant determinant of farmland change.
- **Population:** This variable was included in all the three models. All positive and significant coefficients in all the three models approved our assumption in that the faster the population growth, the more farmland needed for agriculture.
- **Cropping index:** This variable was introduced in both Model II and Model III. It performed well in both models in terms of the expected sign and the level of significance.
- **In summary**, although all the three models performed well in one way or another, Model II performed the best both in terms of the overall performance and each individual variable. Thus, Model II is chosen for the following extended discussion.

6.4.5 Discussion of the model results (Model II)

In Table 6.4, the coefficient of cropping index is –0.1764. This means that holding all other variables constant, if the cropping index increase by 1%, the farmland area used for crop production would decrease by 0.1764%. Cropping index here is rather the consequences of farmland loss than the cause. This can be attributed to the rice bag policy forcing the local government to maintain a fixed amount of grain production in spite of farmland loss. This can also be regarded as a kind of agricultural intensification process in the context of farmland loss. The urbanization variable coefficient says that holding all other variables constant, if the rate of urban population increase by 1%, the farmland area would decrease by 0.2119%. The coefficient of non-agricultural GDP says that holding others constant, if non-agricultural GDP share increases by 1%, the farmland area would decrease by 0.1346%. However, the coefficient of population increase means that holding all other variables constant, if population increases by 1% each year, the farmland needed would increase by 0.8084%. However, this result could only be viable if all the agricultural products needed by the increased population are supplied by local farmland, yet the real picture may not be the case.

From the above discussion, it is not difficult to see that with the high likelihood of urbanization process, it will pose the biggest challenge to farmland protection. So, in the following section, attempt will be tried to predict how the farmland in Changshu will likely be changed in next 10 to 15 years based on the results represented in Model II.

6.4.6 Predictions on farmland areas in Changshu by 2010 and 2015

In order to project the possible trend of farmland change, it is firstly required to discuss what is the likelihood of those determinants. Thus, the first part of this section will discuss the possible trends of cropping index, urbanization, share of non-agricultural GDP as well as the yearly increase of population in Changshu for the next 10 to 15 years.

Table 6.6 Annual rate of increase/decrease of selected variables

Period	Cropping index(%)	2 Urbanization	Non-agri_GDP	Population increase
1980-1999	-1.61	+4.56	+3.23	+0.31
1980-1985	-2.90	+3.73	+9.38	+0.36
1985-1990	-1.80	+4.48	+1.72	+0.69
1990-1995	+0.46	+4.20	+1.48	+0.21
1995-1999	-2.30	+6.16	+0.05	-0.09

Table 6.6 summarizes the past trends of the above variables by period. For cropping index, there has been a declining trend in general but some periods declined faster than other periods. The period between 1980 and 1985 experienced the sharpest decline. There was one period that this index experienced a slight increase (1990-1995). Given the variations in the annual decreasing rates, we choose 0%, -1.6% and -2.6% (all within the range of the past trends) to represent low, medium and high case scenarios in cropping index decline. Urbanization process also developed unevenly between periods. The slowest urban population increase was in the early 1980s while the fastest growth period is in the late 1990s. For projection purpose, we choose 3.5%, 4.5% and 6% of annual growth rate to represent low, medium and high proportion of urban population, respectively. In the same way, we choose 0%, +1.7% and +3% to represent three scenarios of the annual increasing rate of the share of non-agricultural GDP. For the population growth, we choose –0.05%, +0.3% and +0.6% of annual growth rate to represent low, medium and high population growth rate scenarios. The assumed growth rates are

summarized in Table 6.7. The predicted level of each variable under different scenario by year 2010 and 2015 are listed in Table 7. In calculation, we use 1995-1999 average levels as the base period level for projection.

Table 6.7 Scenarios of determinants (%)

Variables	Low	Medium	High
Cropping index decrease	0	-1.6	-2.6
Share of urban population increase	+3.5	+4.5	+6
Share of non-agricultural GDP increase	0	+1.7	+3
Population increase/decrease	-0.05	+0.3	+0.6

Table 6.8 Predictions on selected indicators

Variables	Cropping index	% Urban population to total	Share of non-agricultural GDP	Population level
2010:				
Low	1.65	35.48	75.45	1036678
Medium	1.38	39.44	87.92	1077317
High	1.23	46.13	90.82	1113297
2015:				
Low	1.65	42.14	75.45	1034089
Medium	1.27	49.14	94.25	1093574
High	1.08	61.73	98.81	1147099

Based on the predicted values of the dependent variable for cultivated land, using Model II to project the cultivated land area in year 2010 and 2015. The equation used for projection is:

$Land = e^{-5.2585} \cdot INDEX^{-0.1764} \cdot URBAN^{-0.2119} \cdot Nonagr\_GDP^{-0.1346} \cdot POP^{0.8084}$.

The results are shown in Table 6.9.

Table 6.9 Projections of further farmland area (10,000mu)

Scenario	2010	2015
I. All "Low"	88.66	85.32
II. All "medium"	90.41	87.81
III. All "High"	91.25	88.90
L. Most likely[2]	87.65	83.93

[2] Most likely scenario consist of "medium" of cropping index, "medium" of urban population share, "medium" of share non-agricultural GDP, "low" in population growth.

Table 6.9 provides three scenarios. Under scenario I, where all the determinants (cropping index, urbanization rate, non-agricultural GDP and population growth rate) are low, farmland area will be 886.6 thousand mu in 2010, and 853.2 thousand mu in 2015. Similarly, in scenario II, when all the determinants are at medium level, farmland area will be 904.1 thousand mu in 2010, and 878.1 thousand mu in 2.15. The projected farmland area under scenario III will be 912.5 thousand mu in 2010 and 889.0 thousand mu in 2015.

However, it is most likely that population growth is at "medium" level, and other determinants (cropping index, urbanization rate and non-agricultural GDP) also are at "medium" level. In this case, the projection on farmland area in Changshu will be 876.5 thousand mu in 2010, and 839.3 thousand mu in 2015.

6.4.7 Policy implications

The above analysis did not reflect policy implications of Basic Farmland Reserves and Balancing Mechanism. There is, of course, a time lag between the time of issuing the policy and implementation. However, we did not find such reflection either. The Basic Farmland Reserve and Compensation Policy was issued in 1994 and revised in 1998, yet, there was no figure, whether original and/or generated, indicate that basic farmland was under protection or remedied after occupation. The above trend will continue in line with the scenarios listed if there is no policy intervention to take.

6.5 Environmental consequences

6.5.1 Assumptions and counter-policy facts

- The assumption of the environmental consequences of farmland Marginalisation in area should logically be the depletion of soil fertility. But the fact is on the contrary, the comparison of major indicators (soil organic matter, nitrogen, phosphorus and potassium) between 1981 and 2000 shows an overall increase of soil fertility.
- The reason behind it was the **governors' rice bag policy**. It means that the provincial governor has to be responsible for adequate grain supply to the people within the province, which was accordingly adopted in the city government. The major means (to maintain or increase grain supply) to compensate the decrease of grain production in the context of farmland loss was to increase productivity per unit area through increased input including machinery, energy and fertilizers.

- The increase of fertilizers did ensure the soil fertility improvement and increase of crop productivity in per unit area. However, this did not guarantee a sound environment. Overuse of fertilizers in farmland resulted in the leaching of excessive nutrients to ground water, rivers and lakes, caused non-point pollution, and consequently, lake eutrophication problem. Now, the blue algae blooming problem has been put on the top of the national priority list on pollution control.

6.5.2 Increase of agricultural input and productivity response

- The last 20 years from 1980 to 1999 witnessed a steady increase of machinery and energy input to the agricultural system. Figure 6.19 and Figure 6.20 show that the increase of machinery power was 91%, and the increase of electricity consumption in rural areas was 648% from 1980 to 1999.

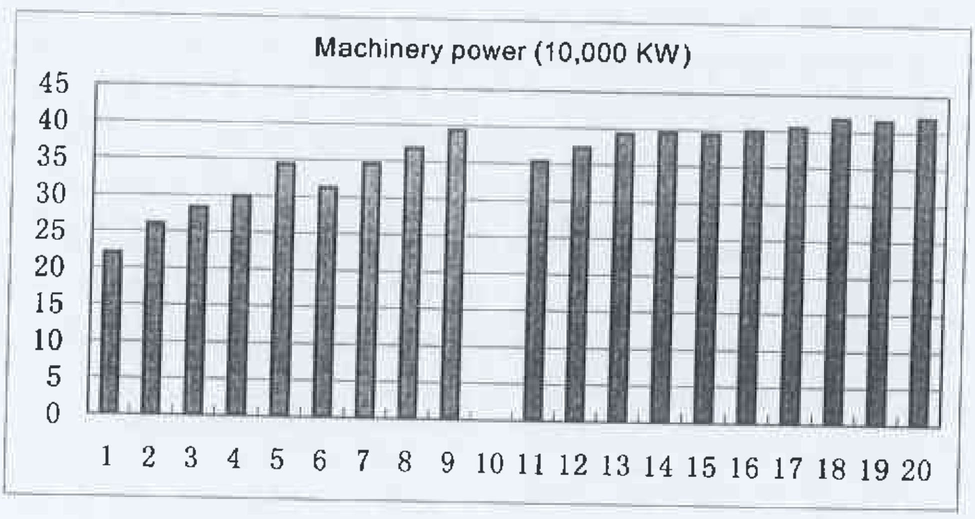


Figure 6.19 Increase of machinery power
Source: Statistical data of Changshu City (1980-1999)

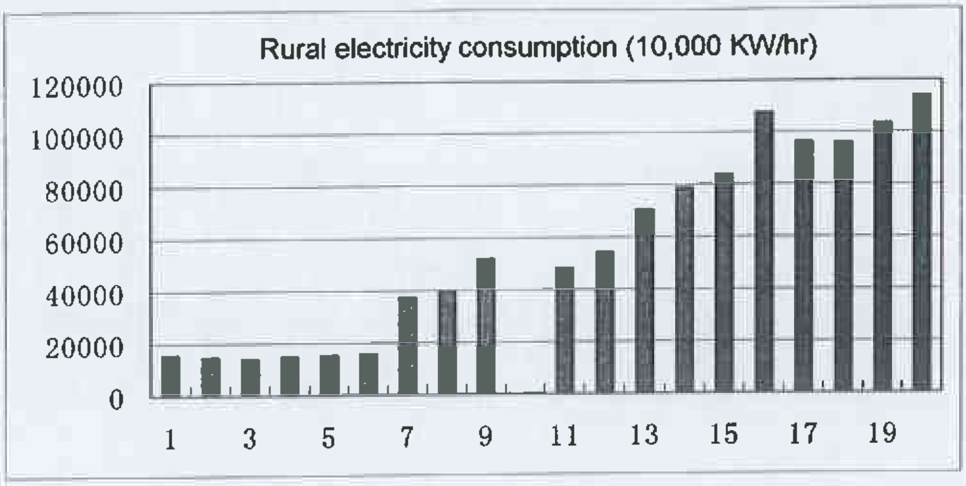


Figure 6.20 Increase of rural electricity consumption
Source: Statistical data of Changshu City (1980-1999)

- The increase of fertilizers input has experienced a structural change shifting from single nutrient fertilizers (such as N, P, K) to compound fertilizers. There were declining process of applying single nutrient fertilizer, Nitrogen by 25%, Phosphorous by 68%, Potassium by 83%, respectively and increasing process of compound fertilizer application, by 480%. The data in the last 10 years from 1990 to 1999 shows the trend (Figure 6.21, and Figure 6.22). The corresponding figures of both soil fertility and productivity proves the fact.

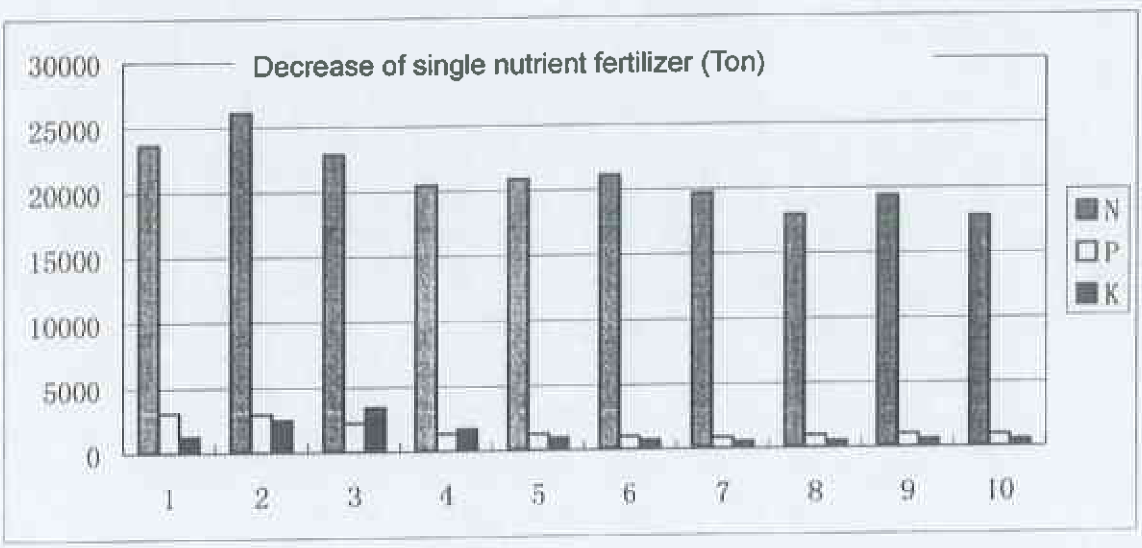


Figure 6.21 Decrease of single nutrient fertilizer application (N/P/K)
Source: Statistical data of Changshu City (1990-1999)

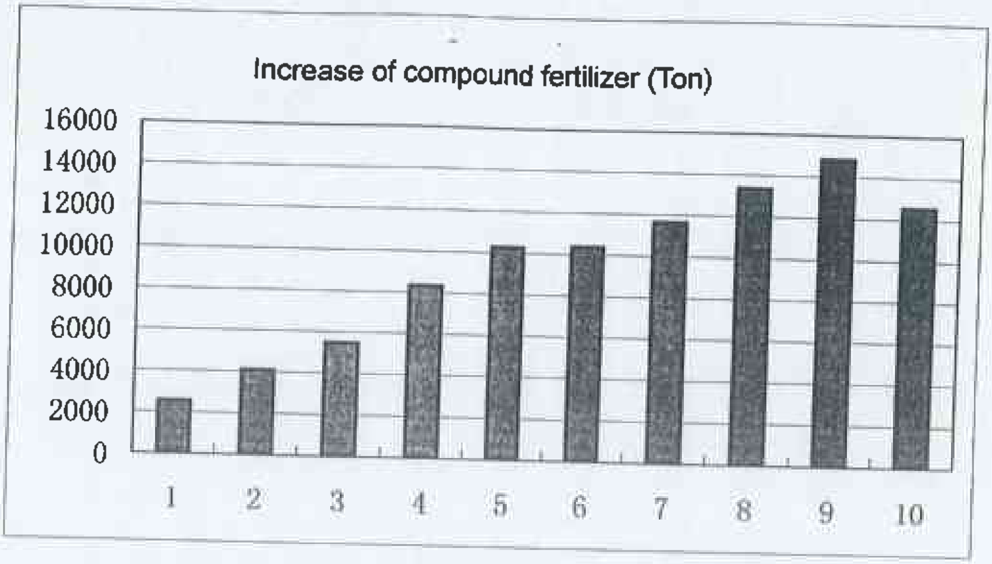


Figure 6.22 Increase of compound fertilizer application
Source: Statistical data of Changshu City (1990-1999)

- Crop productivity did increase dramatically during the last 20 years due mainly to the intensification process of the existing farmland. This has been elaborated by the increment of rice production dominating the farmland activities in Changshu in the last 20 years. Figure 6.23 shows a productivity increase from 4423.5 Kg/ha in 1980 to 7689.15 Kg/ha in 1999.

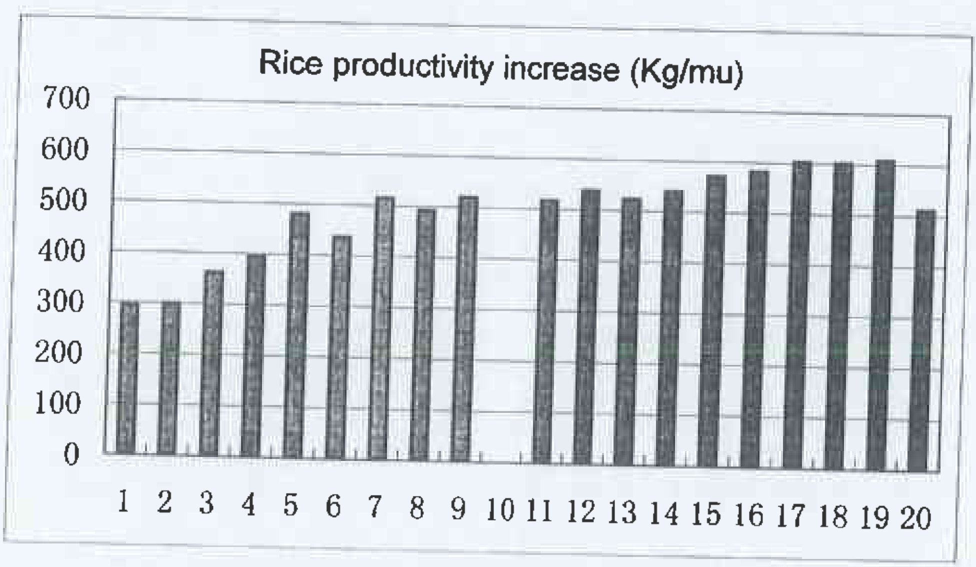


Figure 6.23 Increase of Rice Productivity
Source: Statistical data of Changshu City (1980-1999)

6.5.3 Soil fertility: gains and losses

In the course of existing farmland intensification, there were both gains and losses of soil fertility. The comparison between the data collected during the second general soil survey in 1981 and the recheck in 2000 shows that soil organic matters increased dramatically, so did total nitrogen content in the soil. But, there are losses of phosphorous and potassium in the corresponding period (Figure 6.24, 6.25, 6.26)

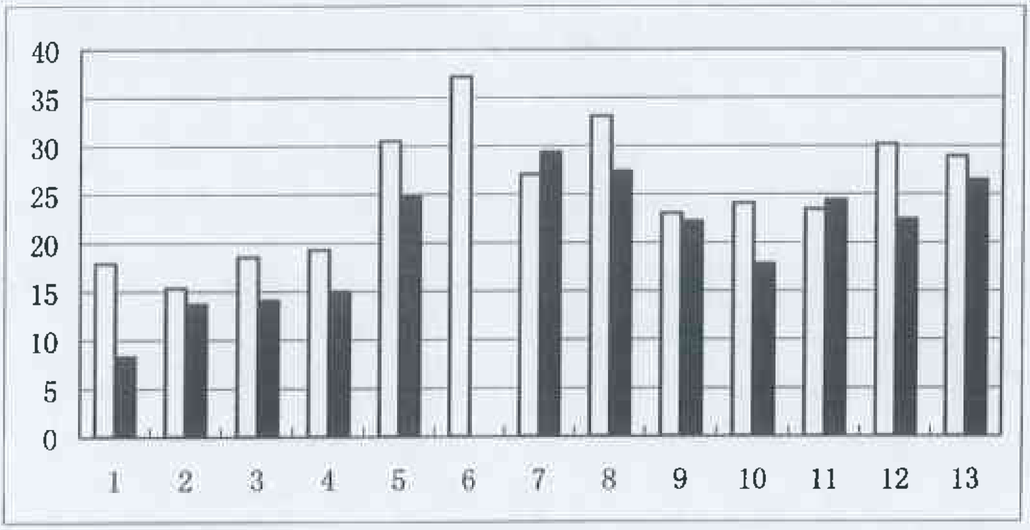


Figure 6.24 Soil organic matter gains (1981 vs 2000)
Source: Nanjing Institute of Soil Science, CAS

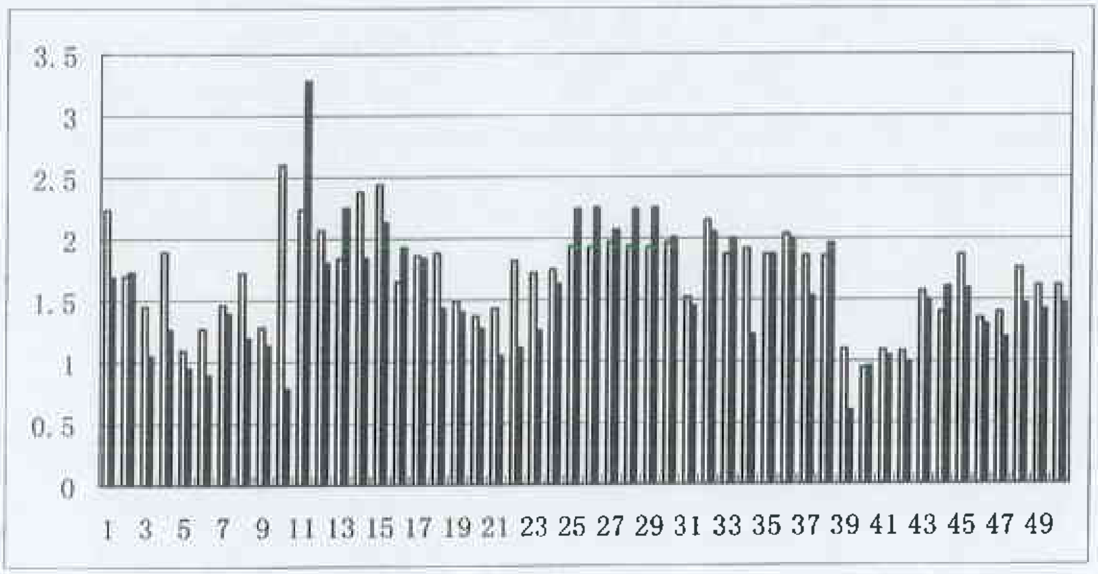


Figure 6.25 Total nitrogen gains in the soil (1981 vs 2000)
Source: Nanjing Institute of Soil Science, CAS

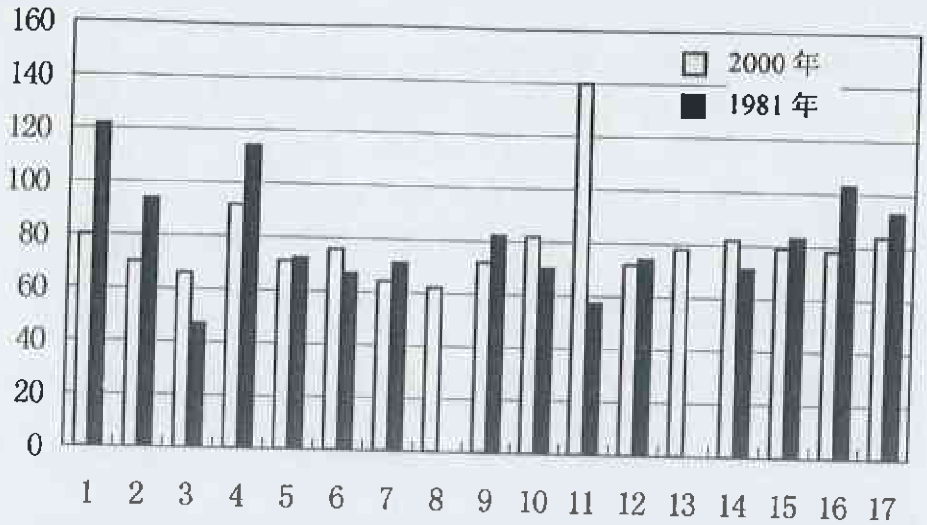


Figure 6.26 Potassium losses from the soil (1980 vs 2000)
Source: Nanjing Institute of Soil Science, CAS

6.5.4 Environmental impacts: non-point pollution and lake eutrophication

Due to the obligation of "Rice Bag Policy" to maintain or increase grain production, while facing the challenge of farmland loss, intensification process occurred inevitably on the existing farmland, desperately increasing productivity on per unit farmland. One of the dominant means was to increase the amount of chemical fertilizer. The over use of fertilizer, especially nitrogen fertilizer, has caused environmental problems such as lake eutrophication, surface and underground water contamination, resulting in shortage of high quality water, in particular, drinking water supply.

The nitrogen fertilizer used in this area was as high as 600 Kg/ha in 1998. It was observed that the nitrogen loss from farmland contributed 24% of the nitrogen pollution in Taihu Lake in 1999, accounting for a significant share against industry (22%), rural waste (18%), animal waste (16%), sewage (14%) and aquaculture (6%) (Figure 6.27, LZ. Yang, 2002 CCICED report).

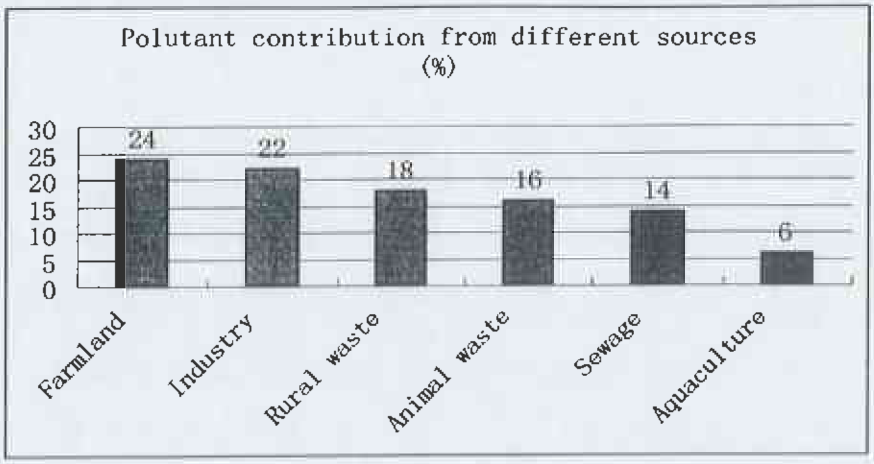


Figure 6.27 Pollution contribution from different sources (1999, Taihu Lake)
Source: LZ. Yang, 2002 CCICED report

Because of the non-point pollution, eutrophication in Taihu Lake has become the most significant environmental problem in China. The investment to control the blue algae blooming is estimated more than 30 billion RMB Yuan (US$ 3.75 billion), which is 20 times of the total GDP of Changshu in 1999! Of course, Changshu should not be accounted as a principal contributor to the pollution source. And the long-term environmental effects on both human health and aquatic ecosystems will be profound and enormous.

7 Ecological Marginalisation: case study in Ansai

7.1 Background

- Ansai County, located in the north of Shaanxi Province, is a typical loess hill-gullied area of the Loess Plateau. The total territory of the county is 2950 km^2, with elevation varies from 1010 to 1431m, gully density of 4.2--8km /km^2 and erosion module of 13,500t/km^2.yr. The county is in semiarid area in warm temperate zone with mean temperature of 8.8 °C and accumulate temperature 3,113.9°C. The frost-free period is 159 days; the annual sunshine duration and total radiation are of 2,416 hours and 548,000 J/cm^2, respectively. The annual precipitation, evaporation and aridity index are 541.2 mm, 1,464 mm, and 1.46, respectively. The vegetation in the region belongs to the temperate forest-steppe zone. However, the original vegetation has been destroyed already.
- Ansai County has a population of 151,672, with density of 51 persion/km^2 in 1999. This indicates the increasing pressure on the fragile slope land, and therefore constitutes one of the dominant determinants of the serious soil erosion and ecosystem degradation. However, it is a county with great potential still in agricultural sector, also great challenge on forestry and grassland management if there is not adequate policy intervention.
- Table 7.1 shows clearly that economic Marginalisation on farmland is not likely to happen and is unlikely to be the primary issue. This mainly due to the increasing share of crop production in total agricultural GDP, though overall share of agriculture in total GDP has been declining from 1990 through 1999. The slow shift of rural labour force from agricultural to other sectors does not promise a clear picture of agricultural Marginalisation either. This simple analysis of the determinants for farmland Marginalisation implies that ecological Marginalisation aiming at improving or holding the degradation process of the ecosystem in this area needs strong policy intervention.

Table 7.1 Simple determinant analysis of farmland Marginalisation

	1990	1999	Gains and losses (%)
Population	147914	151,672	+2.5
Farmland (ha)*	29370	28935	-1.5
Sown area (ha)*	33833	34266	-1.3
Cropland share in agro GDP (%)	61.3	69.8	+8.5
Agro share in total GDP (%)	73.3	41.9	-31.4
Agriculture labour force in total (%)	92.8	86.3	-6.5

Source: Statistical data of Ansai County (1990—1999)

*Farmland and sown area, statistical data.

7.2 Farmland change processes from 1980 to 1999

The major difference between the Loess Plateau and the East Coastal Area in terms of land is that the former is dominated with slope land with serious soil erosion, and the latter with plain. This has raised the issue of farmland definition and accurate accounting. Therefore, land specifics in Ansai have to be addressed firstly before the analysis of gains and losses of farmland. There are also remarkable differences in terms of determinants causing farmland change as well, economic, environmental and policy.

7.2.1 Specifics of land resources in Ansai

Table 7.2 shows that land types is dominated by steep slope land (SSL) and extreme steep slope land (ESSL), accounting for 59.23% of the total land area. While flat land is only 2.81% of the total。

Slope land is one of the dominant inherited causes of serious soil erosion, together with loose soil texture, dry climate and less vegetation cover. Another anthropogenic reason is growing population pressure on food production and cash crop dominated income generation. This implies that a large amount of slope land have to be built into terraced land as basic farmland if to achieve two goals of food security to cope with the increasing population and environmental safety to bring the soil erosion under control.

Table 7.2 Land types and characteristics

Land types	Land unit		
	Sub-types	Area （km^2）	Percentage in total（%）
Slope land	Flat (<3°)	6.81	0.23
	Gentle slope (3-15°)	540.8	18.27
	Steep slope (15-25°)	306.2	10.35
	Extreme steep slope (>25°)	453.5	15.32
	Subtotal	1286.31	44.17
Gully land	Gentle slope land gully	37.86	1.28
	Steep slope land gully	987.69	33.48
	Slide land	50.74	1.72
	Subtotal	1076.29	36.48
Flat land	Valley terraced land (>250m)	65.25	2.21
	Gully terraced land (<=250m)	17.73	0.60
	Subtotal	82.98	2.81
Woodland hills	Secondary and/or planted woodland hills	492.83	16.65
	Subtotal	492.83	16.65
	Total	2950.33	100

Source:(G.B. LIU 2001)

An indicator system has been developed according to the specifics listed to evaluate the suitability of the land resources (Table 7.3).

Table 7.3 Indicator system for land resource evaluation

Land resource	Suitability	Quality degree	Land type and slope degree	Topography	Soil erosion	Water regime
usable land	Farm-land	1st class	Valley & gully terraced land	Bottom	No	Good
		2nd class	3- 10°	Middle part	Slight-medium	Good
		3rd class	0- 3°	Top	Slight	Poor
		4th class	10- 15° small patch in forest	Upper part	Medium-strong	Poor
	Wood-land	1st class	Natural forest	Mid-upper	Slight	Good
		2nd class	Small patch woodland for soil and water conservation	Mid-lower	Slight-medium	Poor
		3rd class	10 -- 15°	Mid-lower	Medium-strong	Poor
	Shrub and grass	1st class	15 -- 25°	Lower	Strong	Poor
		2nd class	> 25°	Lower	Strong	Poor
		3rd class	Gentle slope gully	Bottom	Strongest	Poorest
Unusable land	Closed land		Steep slope gully	Bottom	Strongest	

Source:(G.B. LIU 2001)

According to the above indicator system, land suitable for cultivation is 88,362 ha, accounting for 29.95% of the total land area. Land suitable for woodland is 84,442 ha, 28.62% of the total. Land suitable for shrubs and grasses is 91,890 ha, 31.14% of the total. Closed area is 30339 ha, 10.28% of the total (Table 7.4).

Table 7.4 Land quality evaluation in Ansai

Land suitability type	Class	Area (ha)	Percentage to total (%)
Farmland	1st	7712	2.61
	2nd	16141	5.47
	3rd	1356	0.46
	4th	63153	21.41
	Subtotal	88362	29.95
Woodland	1st	42260	14.32
	2nd	7047	2.39
	3rd	35135	11.91
	Subtotal	84442	28.62
Shrubs and grassland	1st	17567	5.95
	2nd	66794	22.64
	3rd	7529	2.55
	Subtotal	91890	31.14
Hard to use	Closed	30339	10.28
	Total	295033	100

Source: (G. B. LIU 2001)

However, the real picture of land use pattern in Ansai is very much different from the evaluation. The current land use has the following characteristics.

- Farmland dominates the overall land use pattern. Investigation in 1999 shows that farmland area was 118088 ha, accounting for 40% of the total territory, more than 10% of the SUITABLE farmland area listed in the evaluation table. Woodland was 43951 ha, accounting for 14.90% of the total, approximately half of the SUITABLE woodland area in the evaluation. Grassland was 926.09km^2, 31.39% of the total, more or less the same as listed in the evaluation. Land for other uses was 403.60km^2, 13.68% of the total. Overall land use rate was 86.32%, much higher than national average.

- Inter-conversion process between farmland, woodland and grassland. In the past, it was most likely that forest and grassland converted to farmland due to the increasing population pressure and economic motives. While in unfavourable years when there is a draught or other natural disasters, it was most likely that the marginal land or land susceptible to erosion or draught be abandoned. From 1999 onwards, it is expected that land use pattern will shift along the line of the evaluation system, due mainly to the compensation policy implementation.
- Because of topographical reasons, land and water distribution varies within the territory, and water is the major constraints for agricultural production. Rain-fed farmland area, according to the recent remote sensing survey, is 111,183 ha, 94.15% of the total farmland. It means that the farmland production is very much vulnerable and dependent on precipitation. In the year of draught, the yield will be reduced by 30 to 40%, and in extreme cases, no harvest at all.

7.2.2 Data clarification and calibration

- Because of the various land types and the existence of large amount of slope land, it has been very difficult to have access to the REAL figure of farmland area in Ansai. However, statistical data will have to be used for dynamic analysis of farmland gains and losses, and its interaction with determinants of those changes. But that has to be calibrated with the data generated from remote sensing investigation and field survey, which appears to be close to REAL figure.

Table 7.5 shows the results of RS investigation on land use pattern change in the years of 1985, 1988 and 1999 respectively, which provides the calibration for dynamic statistical data analysis. It can be seen that over the course from 1985 through 1999, there is a decrease of both farmland and woodland area, while the grassland area has been increasing. The shrinking of woodland area reflects that most of the areas are handicapped with tree planting due to various reasons but mainly soil and water regime.

It also implies that the government tendency to plant more trees is against the land ecological suitability. Obviously, grassland should be the right way to implement the set-aside and compensation policy (Figure 7.1)

Table 7.5 Land use pattern in 1985, 1988 and 1999 (RS data, ha)

Year	Farmland			Woodland			Grassland			Other
	Subtotal	Flat*	Slope	Subtotal	Natural	Planted	Subtotal	Natural	Planted	
1985	120795	7698	113097	49873	42275	7598	81780	81780	0	42600
1988	119443			43420			90449			
1999	118088	9548	108580	43951	27470	16483	92609	92080	529	40360

Note * Flat refers to both valley and terraced land

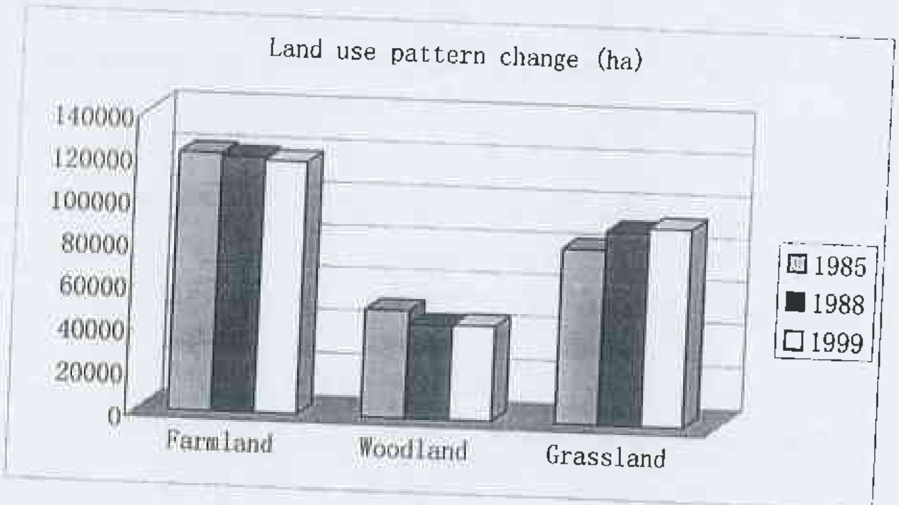


Figure 7.1 Land use pattern change from 1985 to 1999

Source: Combined sources (R Li, 1999, GB Liu 2001)

- Table 7.6 compared the figure of farmland area from different sources with statistics. Multi source data analysis from 1984 to 1999 shows that the real farmland area in Ansai is at least three times of the statistical data. Amongst the data from various investigation sources, it seems that the data collected in 1985, 1988 and 1999 are more reliable than other sources for the following three reasons: a) coordinated methodology including remote sensing (RS) and field survey was adopted; b) similarity of survey results and its reflection in overall land use pattern change (Table 7.5); c) high coefficient with statistical data (4 times of statistical data). This assumption will enable us to conduct detailed analysis of farmland loss and gains in the past 20 years, which lays the foundation for further analysis of the determinants for that change.

Table 7.6 Comparison of farmland area figures in 1985, 1988 and 1999: statistics vs. RS & field survey (km^2)

Year	Statistics (ha)	RS & field survey		Approx ratio (times)
		ha	Sources	
1984	31000	109993	Report of Agro-resource Survey	3.5
1985	29713	120795	Land use map (1:50,000)+RS	4.0
1986	29653	109333	Development Plan (1988-2000)	3.7
1988	29460	119443	RS (aero) + Field Survey	4.0
1989	29373	111000	Land Use Change Report	3.8
1996	29453	90733	Land Use Change report	3.1
1999	28933	118088	Land Use Map + RS + Field Survey	4.1
1999	28933	96067	Project Planning for Ecosystem Restoration	3.3

Sources: Multi-sources listed in the table

7.2.3 Losses and gains

- Figure 7.2 shows not much change of farmland area over the course of 20 years from 1980 to 1999, though the statistical data used has yet to be calibrated.

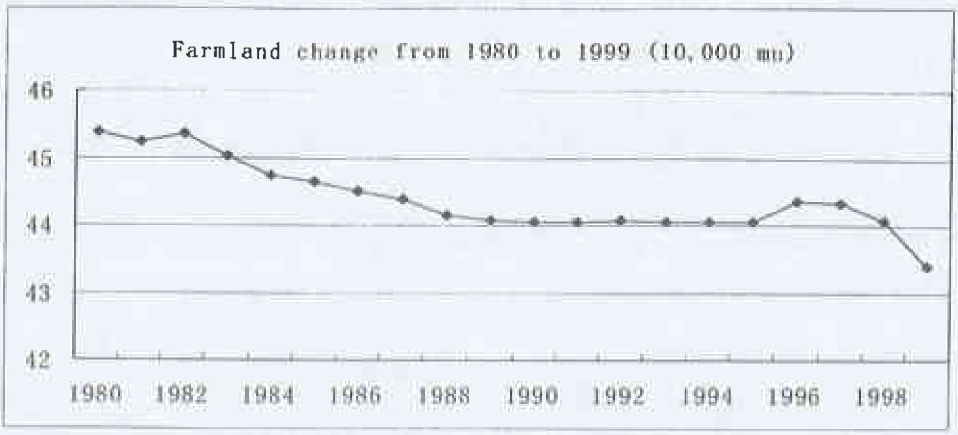


Figure 7.2 Farmland change from 1980 to 1999

Source: Statistical data of Ansai County

- It can be seen from Table 7.5 & 7.7 that from 1985 to 1999, farmland area decreased 2707 ha or less than 1% over the course of 14 years (Figure 7.3). But within the overall decrease of farmland area, there was a significant increase of terraced land from 0.25% to 0.88% (G.B. LIU 2001), increasing flat farmland area from 2.61% to 3.23%. This ensures 0.06ha basic farmland per capita for food security, laying the foundation for slope farmland set-aside for restoration. Meanwhile, slope farmland decreased by 1.54%. Where has the lost farmland gone?

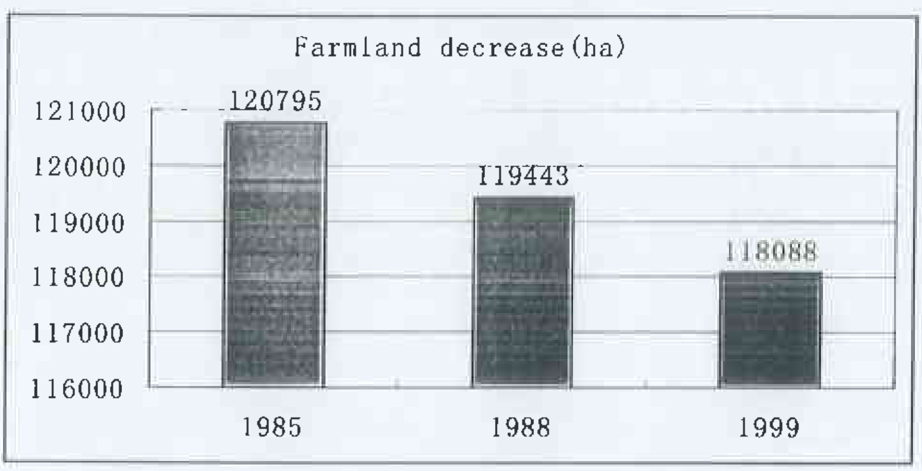


Figure 7.3 Farmland decrease from 1985 to 1999

Source: Institute of Soil and Water Conservation, CAS

- Table 7.7 indicated a significant increase of grassland, from 27.72% in 1985 to 31.39% in 1999, an increase of 3.67% over 14 years. It is also interesting to note that there is a small figure of 0.18% cultivated grassland, which can be taken as an emerging sign of the burgeoning of grassland-based livestock farming. The presumption of the loss of slope farmland was that has been converted to grassland, natural vs. cultivated. This is a period when there was macro-policy to encourage farmers to give farmland generally to grassland and/or woodland, yet no concrete financial mechanism like what is now known as compensation policy. The conversion process from farmland to grassland must have been driven by either comparative advantage to develop animal husbandry in economic terms and/or by the enforcement of law, i.e. those slope farmland steeper than 25° must be set aside.
- There was also an overall decrease of 2% of woodland or forest from 1985 to 1999. The most serious problem is the substantial decrease of secondary natural forest, from 14.33% to 9.31%, 5% over the last 14 years. But a good sign was that there was an increase of planted woodland area, an expansion of 3% during the same period. This is due partly the contribution from the expansion of fruit orchard, from 541 ha in 1985 to 2723 ha in 1999, 5 times as much, which has been possibly driven by market demand.

Table 7.7 Farmland loss or conversion rate from 1985 to 1999 (%)

Year	Farmland			Woodland			Grassland			Other
	Subtotal	Flat*	Slope	Subtotal	Natural	Planted	Subtotal	Natural	Planted	
1985	40.94	2.61	38.33	16.90	14.33	2.57	27.72	27.72	0	14.44
1999	40.02	3.23	36.79	14.90	9.31	5.58	31.39	31.21	0.18	13.68

Source: R Li 1999, GB Liu 2001

7.3 Farmland change process: interaction with determinants

Analysis from 7.1 and 7.2 shows that farmland area change was very slow and the scale can be almost neglected. The process can also be reflected from population growth, the slow processes of economic structural change, labour flow and urbanization process. However, law enforcement against soil erosion from slope farmland and incentive policy intervention will have long term impact on farmland change.

7.3.1 Population growth

Figure 7.4 indicates population has been growing steadily from 1980 to 1999, which is an obvious factor holding or expanding farmland area. The argument is because the local people are very much dependent on grain production both on slope and terraced land.

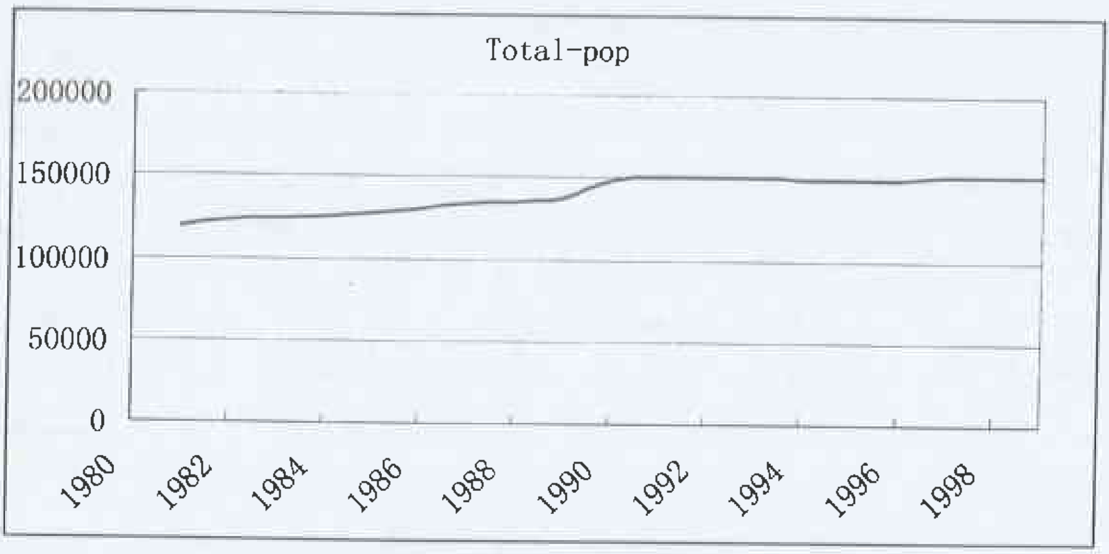


Figure 7.4 Population growth from 1980 to 1999

Source: Statistical data of Ansai

7.3.2 Economic structural change

As can be seen from Figure 7.5, the share of agriculture in total GDP as a whole declined from 87.33% in 1980 to 35.8% in 1999, while at the same time the share of secondary industry increased from 6.52% in 1980 to 36.7 in 1999. Tertiary industry increased from 6.09% in 1980 to 27.5%, with booming period from 1986 (23%) to 1991 (31.77%), then went into a stagnation period (Figure 7.6). Presumably, farmland area should have been declined as the share of agriculture in total GDP was down greatly in the last 10 years. Yet, that was not the case. The share is only a relative term. The absolute figure for agricultural GDP might be increasing. Thus, land decline does not have to be happening at the same time as GDP share declines. If we take a look at the share of crop production in agricultural GDP, the real determinant in economic terms can be found.

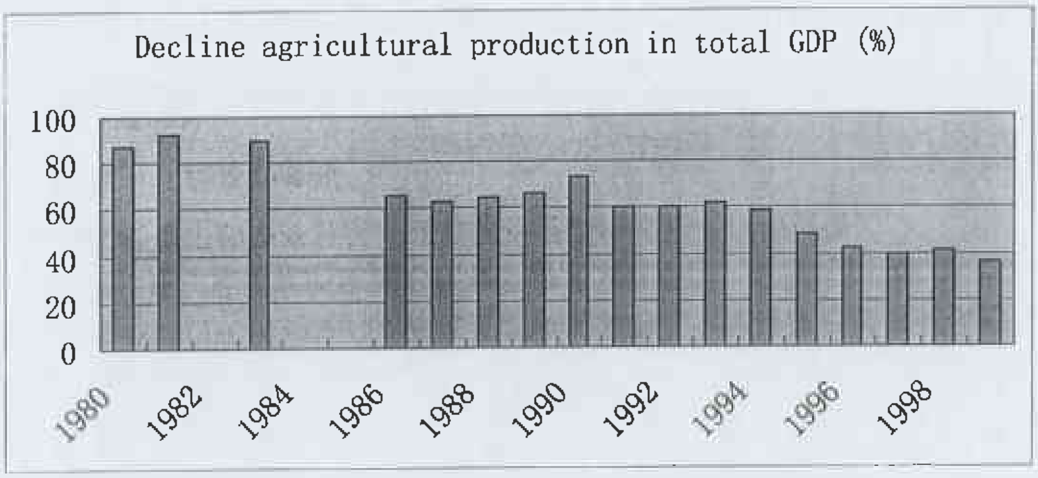


Figure 7.5 Decline of agricultural production in total GDP from 1980 to 1999

Source: Statistical data of Ansai County

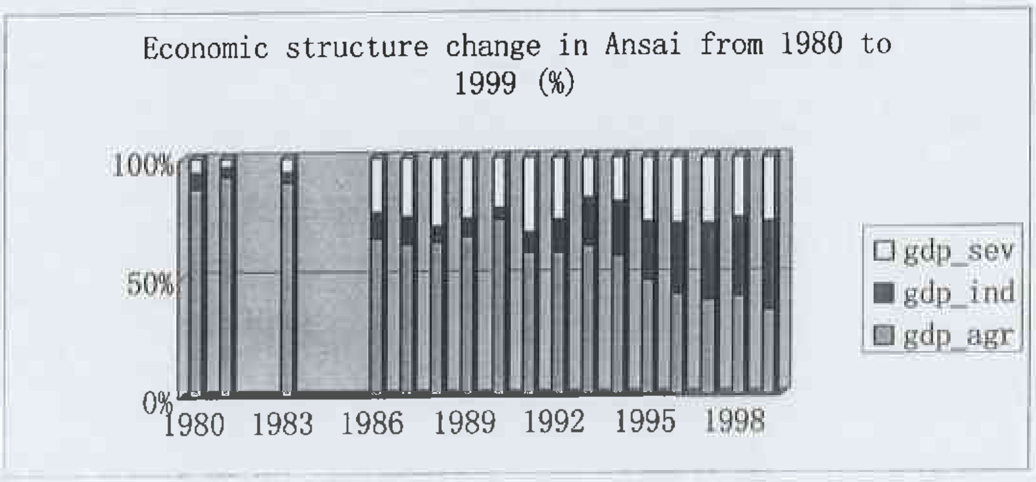


Figure 7.6 Economic structure change from 1980 to 1999

Source Statistical data of Ansai County

Figure 7.7 shows that no significant decline of the share of crop production in agro GDP, but a lot of fluctuations. The share of crop production ranged from 46.1% in 1997 to 69.1% in 1990. This means that the share does not decline sequentially. Actually the share increased back to 64% in 1999. Further analysis shows that the share of crop production corresponds to farmland area suffering draught. For example, the lowest share of crop production 46.1% in 1997 corresponded to the area of

21,113 ha suffering most severe draught, the biggest area in 10 years. In general, in the last 10 years from 1990 to 1999, whenever the share of crop production was below 60% percent, there must have been a disaster, most likely draught. Anyhow, this indicator shows the dependence of rural population on farmland, which can be taken as the main determinant controlling the decline of farmland area, though slope land.

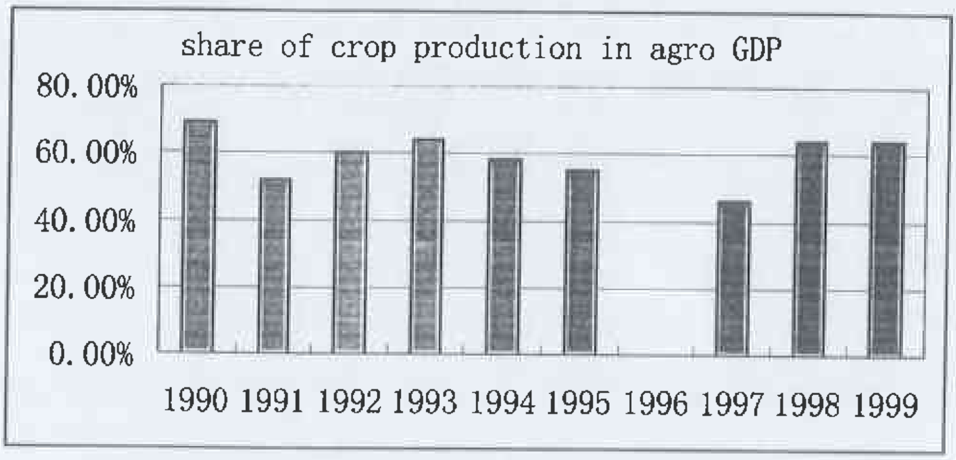


Figure 7.7 Share of crop production in total agricultural GDP

Source: Statistical data of Ansai County

7.3.3 Rural labour flow

Figure 7.8 shows continuous decline of labour in agricultural sector in the last 10 years from 95.58% in 1987 to 86.32% in 1999. This does not necessarily mean that labour loss was one of the causes of the slow farmland loss process in the corresponding period. On the contrary, there have been being labour surplus problems since the rural reform in 1980's.

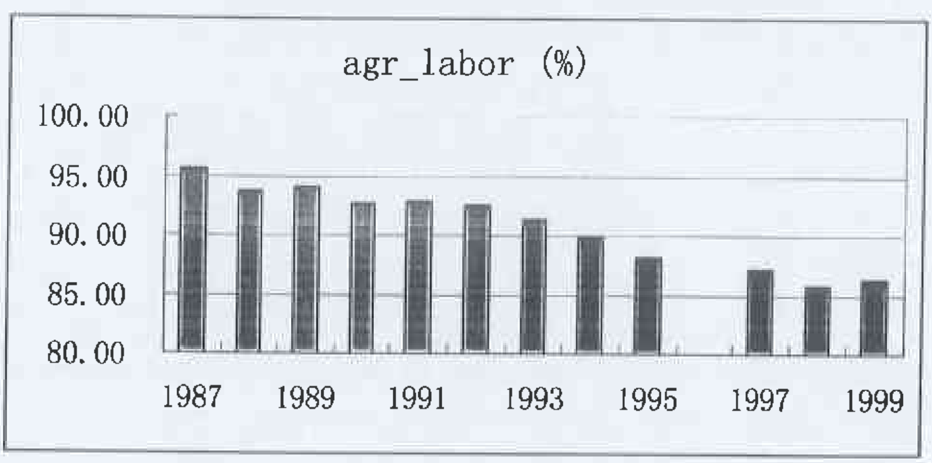


Figure 7.8 Labour loss to non-agricultural sectors from 1987 to 1999

Source: Statistical data of Ansai County

7.3.4 Urbanization process

Figure 7.9 reflects the slow urbanization process. Urban population rate increased from 5.9% in 1980 to 8.8% in 1999, an annual growth rate only 0.14% over the last 20 years (Changshu 0.78%/yr). Though very slow increase, it could be one of the determinants for farmland loss, not necessarily slope farmland, but valley land for urban construction!

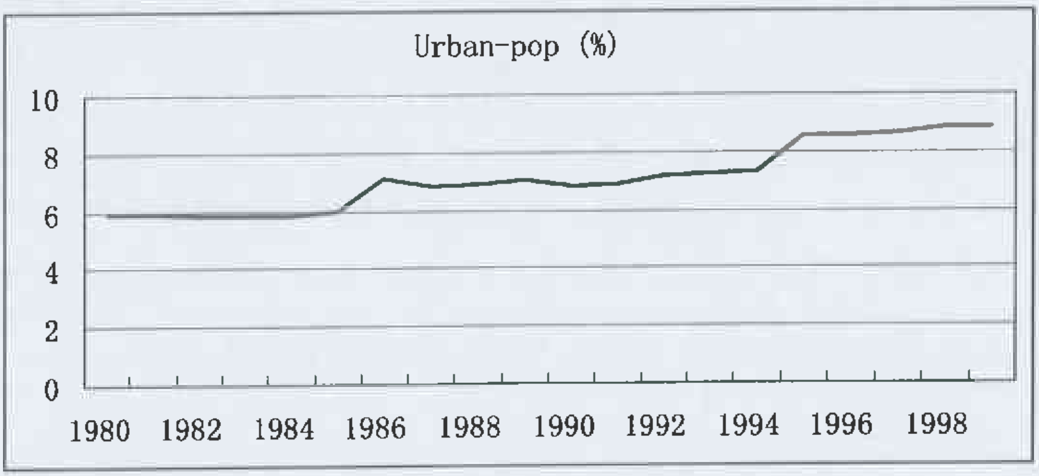


Figure 7.9 Slow increase of urban population from 1980 to 1999

Source: Statistical data of Ansai

7.4 Policy implications

7.4.1 Enforcement of Soil and Water Conservation Law

*"**Chapter 14.** Cultivation on slope land higher than 25° is forbidden. Provincial, auto regional and municipal government can determine the degree of the slope land less than 25° on which cultivation is prohibited. County government should define the prohibited area. For those that has already been cultivated before the law came into force, should be set aside, planted with trees and grasses, re-vegetated, and/or built into terraced land."(Law of Soil and Water Conservation, P.R.China)*

It was enacted in 1991. Yet, before that, Ansai had already started construction of terraced land. There were even incentive mechanisms in the mid 1980's to encourage farmers to build terraced land. For each mu (1/15ha) of terraced, provincial government subsidized 50 RMB Yuan and the built land would enjoy three years of tax-free period. But that was stagnated due to the lack of fund. There was an increase of basic farmland from 7688 ha in 1985 to 9548 ha in 1999, of which, terraced land increased from 723 ha to 2603 ha in the corresponding period, contributing 100% of the basic farmland growth. In the same period, slope farmland reduced form 38.33% to 36.79% of the total land area, a decrease of 1.54% in 14 years. In addition, cultivated grassland and orchard were also built as other signs of the enforcement of soil and water conservation law. It seems relevant law can only be enforced when local people's livelihood is cared within a right policy context. Though a slow process, we can see that the law enforcement has been being implemented. Stronger policy intervention and more investment should be made available if the ultimate goals to bring soil erosion under control and raise the livelihood of the local people in such a dilemma of degraded ecosystem and less developed economy.

7.4.2 Slope farmland set-aside and compensation policy

- **Policy development**

The policy was conceived in 1997 after a call by President Jiang Zemin to pursue "Green Mountain and Clean Water" in Northwest China. Premier Zhu Rongji made it clear that there should be measures to implement a policy which could set-aside the slope farmland for trees and grasses, that is mainly to encourage farmers to leave the slope land by compensating them with grain and money. It has been called the policy of 16 characters. That has been tested in three provinces including Sichuan, Gansu and Shaanxi provinces. Ansai was selected as a demo county in Shaanxi. The policy was developed through the last three years in those provinces, and enacted on December 14, 2002. Nationwide implementation has taken place ever since. However, it is worthwhile to examine how the policy has been being implemented in Ansai.

- **Policy test and implementation: farmland set-aside**

Investigation shows that the preparation begun in 1998, which enabled Ansai to start the implementation in 1999 and undertake the initiative in the last four years till 2002. Table 7.8 shows farmland set-aside process in the last four years from 1999 to 2002. The overall figure of slope farmland left for forest and grass was 355,600 mu (23707 ha), accounting for 20% of the farmland area in 1999 (Re. Table 7.6, RS figure, would have been 82% of total farmland area if use statistical data). Figure 7.10 shows the variation of farmland set-aside area in different years. With a reasonable start in 1999, 2000 witnessed a big surge of the set-aside area, then a sharp decrease in 2001, and slow increase in 2002. We can easily understand that the figure in 1999 should be small as that was the start. Though hard to believe, the surge in 2000 can be confirmed from the monitoring process of the upper authority, Yan'an City Government. There are tow possible explanations: a) that has been planned in the unitary plan; b) the compensation in 1999 stimulated the farmer's willingness, which can be traced in Table 7.10; or c) a+b. The reason why the figure in 2001 was so small remains to be explored.

Table 7.8 Farmland set-aside in Ansai from 1999 to 2002 (Mu)

Year	Eco-forest	Cash-forest	Grassland	Total
1999	7473	14227	900	22600
2000	138800	23300	70900	233000
2001	2030.7	16999.2	970.1	20000
2002	74129.2	5822.7	48.1	80000
Total	222432.9	60348.9	72818.2	355600

Source: Ansai County Government

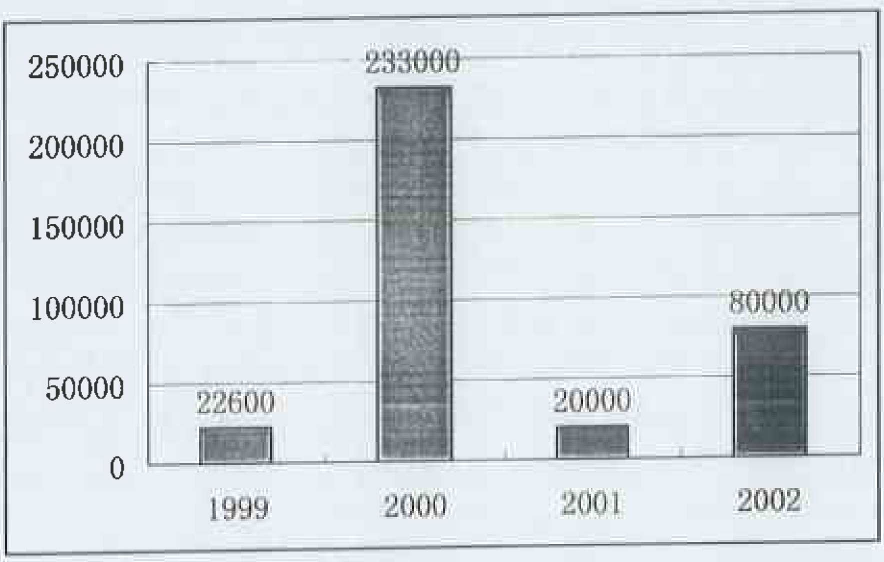


Figure 7.10. Variation of farmland set-aside from 1999 to 2002

Source: Ansai Government

The breakdown of vegetation restoration on the set-aside farmland is very interesting. The largest share has gone to eco-forest, which is 63%, but still under the government proportion of 80%. Grassland was also developed with a reasonable share (20%), but limited to specific years (2000). There should have been more grassland than any other types of vegetation according to the local biophysical condition. This can be attributed to the overall policy on shorter period of compensation for only two years for grassland, while eco-forest enjoys eight years. So it is obvious that national policy has to be revised site-specific when comes to implementation.

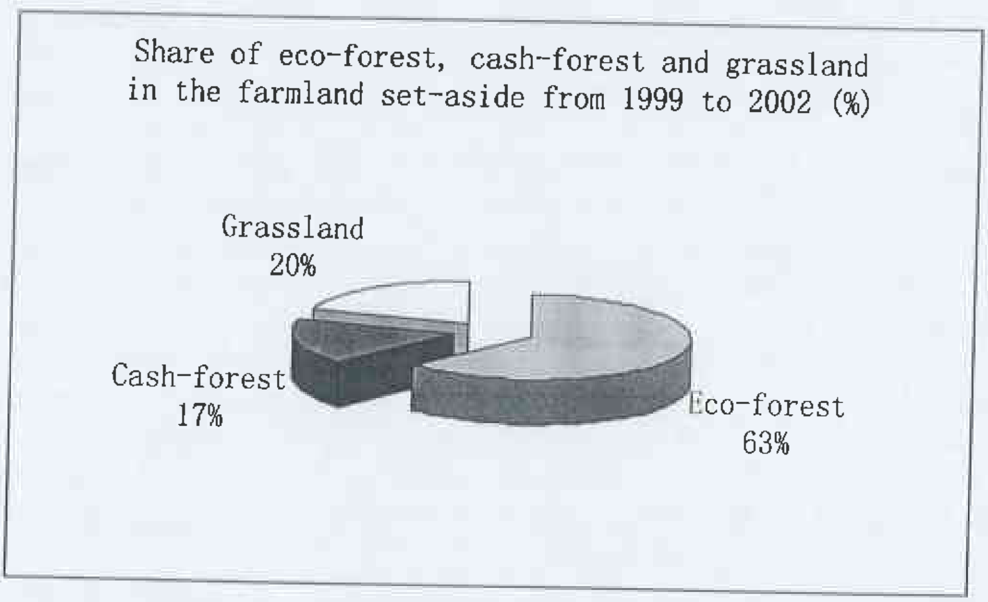


Figure 7.11 Proportion of eco-forest, cash-forest and grassland in Farmland set aside from 1999 to 2000 (%)

Source: Ansai Country Government (2003)

When the above total is broken-down into different years, we can see the significant fluctuations. The restoration of eco-forest had a good start in 1999, then a big surge in 2000, but down to almost nil in 2001, back to normal in 2002. It worth to note that cash-forest plantation does not have that scale of fluctuation as did the eco-forest. However, 2001 has seen the dominance of cash-tree planting. Grassland was only visible in 2000, possibly due to the expectation to development grass-based animal husbandry.

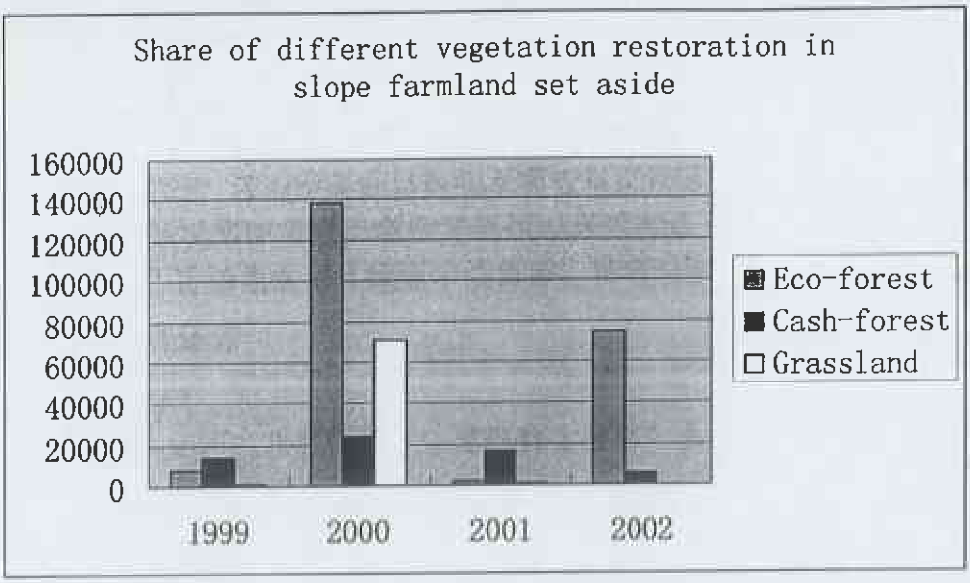


Figure 7.12 Breakdown of various types of vegetation in different years

Source: Ansai Government

- **Overall vegetation restoration initiative**

The overall picture of ecosystem restoration in Ansai has been quite promising since 1999. The area revegetating from slope farmland and waste hills accumulated to 550600 mu, 12.44% of the total territory in Ansai within only four years. The implication of policy intervention is enormous and significant. Yet the sustainability of the process remains to be seen. Peer demo and policy test was focused, but not limited to farmland set-aside. Planting trees and grass on waste hill was also an integral part of the programme. The contribution of waste hill restoration was 195000 mu, 35.41% of the total area restored. The only curiosity against this is that tree planting dominated the overall area of waste hills, with little grassland restored.

Figure 7.13 shows the variation in different years during the period in discussion. The years of 1999 and 2001 implemented much less than the years of 2000 and 2002. The biggest share was from 2000.

Table 7.9 Area of farmland set-aside and waste hill tree/grass planting

	Total				Farmland set-aside				Waste hill tree and grass planting		
Year	Subtotal	Eco-forest	Cash-forest	Grassland	Subtotal	Eco-forest	Cash-forest	Grassland	Subtotal	Tree planting	Grass planting
1999	15900	30773	14227	900	22600	7473	14227	900	23300	23300	
2000	294700	199500	23300	71900	233000	138800	23300	70900	61700	60700	1000
2001	50000	32030. 7	16999. 2	970. 1	20000	2030. 7	16999. 2	970. 1	30000	30000	
2002	160000	154129. 2	5822. 7	48. 1	80000	74129. 2	5822. 7	48. 1	80000	80000	
Total	550600	416432. 9	60348. 9	73818. 2	355600	222432. 9	60348. 9	72818. 2	195000	194000	1000

Source: Ansai Government

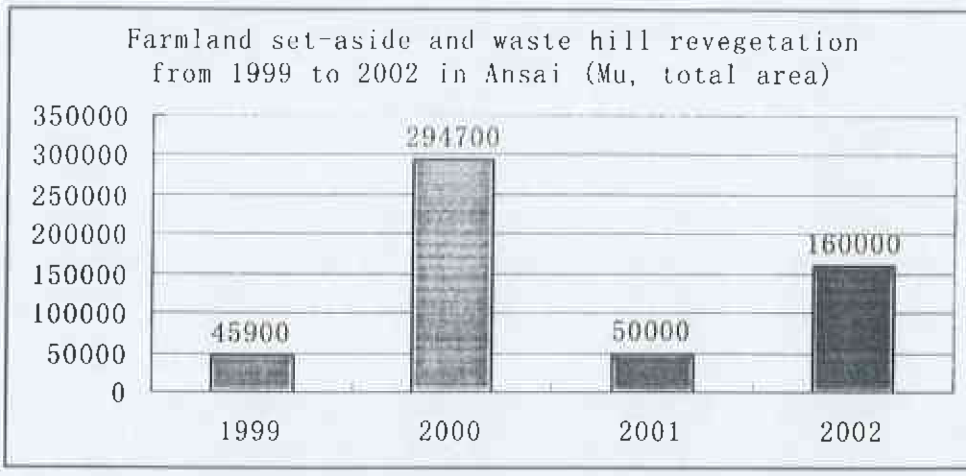


Figure 7.13 Breakdown of overall re-vegetation into different years

Source: Ansai Government

The breakdown by different types of vegetation in the overall restoration process is worth to analyse. The share of eco-forest accounts for 76% of the total re-vegetated area, very close to the national government general policy limit of 80%. But again, whether the local precipitation will sustain such a portion remains a big question mark. As the local precipitation is slightly under the tree line of 550 mm (R. Li etc. 1999), topography will be a principal determinant for the sustenance of the planted trees. What is more, as most of the slope can hold much less water than plain land, tree planting is limited to gully and valley area where water regime suites. Yet, the vast area of slope land should be covered with shrubs and grass. Obviously, there is a great potential to restore either slope farmland and waste hills into grassland or rangeland to firstly adapt to the local climate and topographical condition and develop grass-based animal husbandry to enable farmer's sustainable livelihood in the long-term.

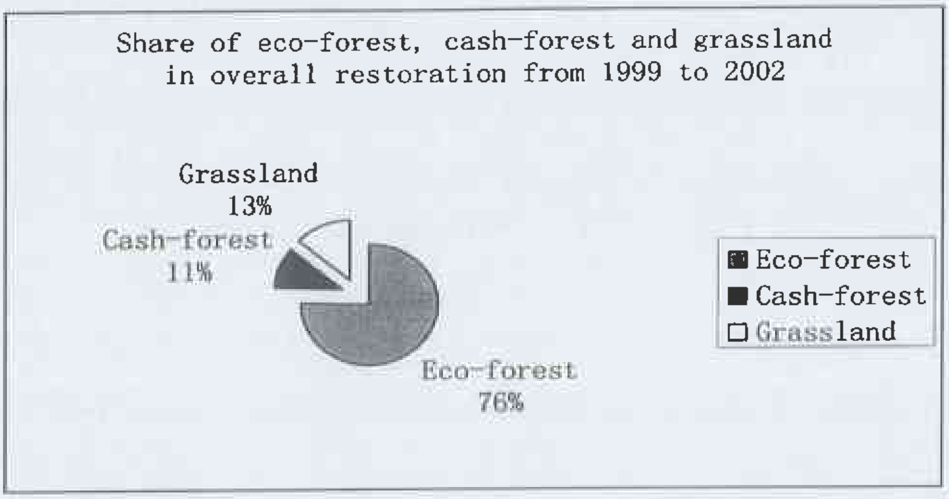


Figure 7.14 Proportion of eco-forest, cash-forest and grassland in overall restoration process

Source: Ansai Government

- **Incentives and compensation in place**

Table 7.10 shows the implementation of the compensation policy from the government. Although the government prepared the fund, there was still a time lag to allocate the resources to farmers. In accordance with the fluctuation of restored areas, one can find the corresponding variation of fund and grain allocation to the farmers. But whether the fund and grain can be secured in the future is still in question as can be seen from Table 7.10, compensation for 2000 and 2001 has yet to be completed.

Table 7.10 Grain and cash compensated by government

	Nursery & breeding (Yuan)	Maintenance (Yuan)	Grain (Kg)	Note*
1999	2,295,000	904,000	4,520,000	Completed
2000	727,000	4,660,000	?	Uncompleted
2001	212,000	800,000	?	Uncompleted

Source: Ansai County Government and Yan'an City Government

7.5 Future scenarios

7.5.1 Dilemma of slope farmland set-aside and food security & income generation

- There has long been being a dilemma between slope farmland set-aside and food security for the growing population, and the increasing demand for more and better food per capita as income increases. It is still a primary concern in this county as there are frequent natural disasters such as draught and frost. Through many years of efforts, a reasonable amount of terraced land has been built to fulfil food security purposes for everybody in the county. Now per capita basic farmland is 0.06 ha, almost ensuring food demand of 300 Kg/Yr. Person. But, this is not enough to stop the slope land cultivation activities.
- Another dilemma has been emerging between slope farmland set-aside and income generation since 1980's. An investigation conducted in May 1999 shows that per capita slope farmland was about 0.5 ha, though the possession of the basic farmland of 0.06 ha. Less off-farm opportunities for income generation keep most of the labours on the farmland. Three significant indicators have been analysed against the slow process of slope farmland reduction (7.3.1). The first is the constant share of crop production in total agricultural GDP; the second is the slow process of labour transfer to non-agricultural sectors indicating little off-farm employment opportunities; and the third is the slow urbanization process which limits most of the rural labours, though in surplus, unmovable to urban areas.
- In the above cases, there should be both policy and technical interventions

to break the spiral. Alternatives or trade-off efforts should be sought, and compensation and/or incentive mechanisms be established. Although the compensation policy is being implemented (7.4.2), past experiences on technical and practical time frame should be taken, if we want to mobilise the technical, financial and policy means to find the way out.

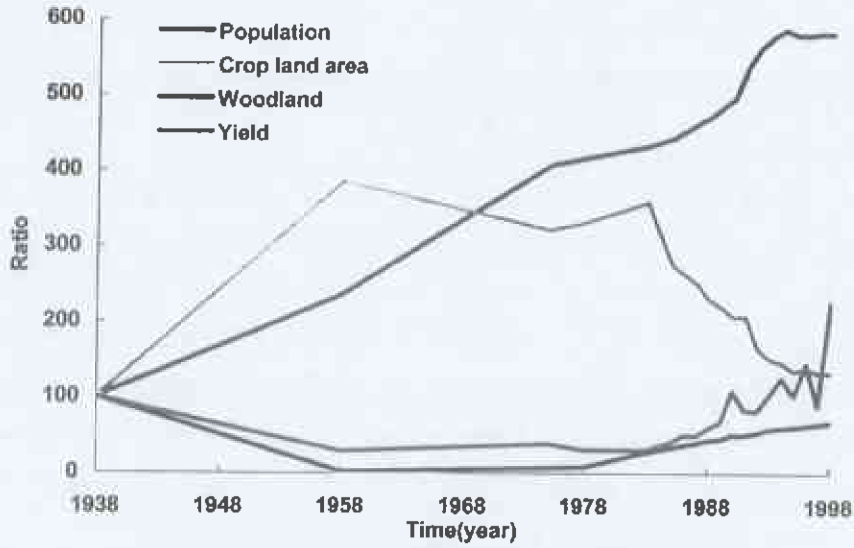
7.5.2 Zhifanggou case: a process of trade-offs and consequences

- **Land use change in the last 60 years**

An experimental and demonstration area--Zhifanggou gully watershed with an area of 8.27 km^2 to implement the research result and carry out some national research projects on soil erosion control, and to set up the model for conservation eco-agriculture, land management and ecosystem restoration. The following are some preliminary results of Zhifangou watershed, one of the observation and demo sites of Ansai County. Figure 7.15 shows the historical change of population, cropland area and yield, and woodland area in the past 60 years from 1938 through 1998.

It can be seen that during the last 60 years, farmland area experienced three stages, the first was the 20 years from 1938 through 1958, a rapid yet steady increase responding mostly to population growth. Consequently, woodland area decreased sharply, down to the lowest point in history. The second stage was the 26 years from 1958 through 1984, when cropland remained almost standstill, though a little down, while woodland a little up. But population was soaring, so people suffered most from hunger and poverty. According to the record of soil erosion or silt load to the Yellow River, this was also the most serious period (Wang ZX 1991). The third was the last 14 years from 1984 through 1998, when the farmland area declined dramatically, woodland area started to increase. The assumption for the substantial decrease of farmland area during this period is that the drastic increase of yield per unit area, which can be automatically attributed to the increase of terraced land and other agricultural inputs. It shows that a trade-off to change cultivation activities from slope to terraced land is very much likely, and a win-win solution can be sought over the course of building up basic farmland to reduce soil erosion as well as to provide adequate food supply. Simultaneous and/or future trade-offs can also be pursued to increase per capita income in the long term.

Apart from the shift comparison between farmland and woodland, Figure 7.16 also identified the shift from farmland to grassland. It can be observed that from 1938 through 1998, grassland area was almost a constant except the sharp decrease in 1983. However, in only one year from 1999 to 2000, grassland area expanded from 42.15% to 51.18%, an increase of 9.03%! Correspondingly, farmland decreased from 19.38% to 10.26%, a decrease of 9.12%. The immediate assumption is the pilot implementation of the set-aside and compensation policy.



Time trend of Population, yield, cropland and woodland area in Zhifanggou watershed

Figure 7.15 Population, farmland and conservation (1938 –1998)

Source: GB Liu (2001)

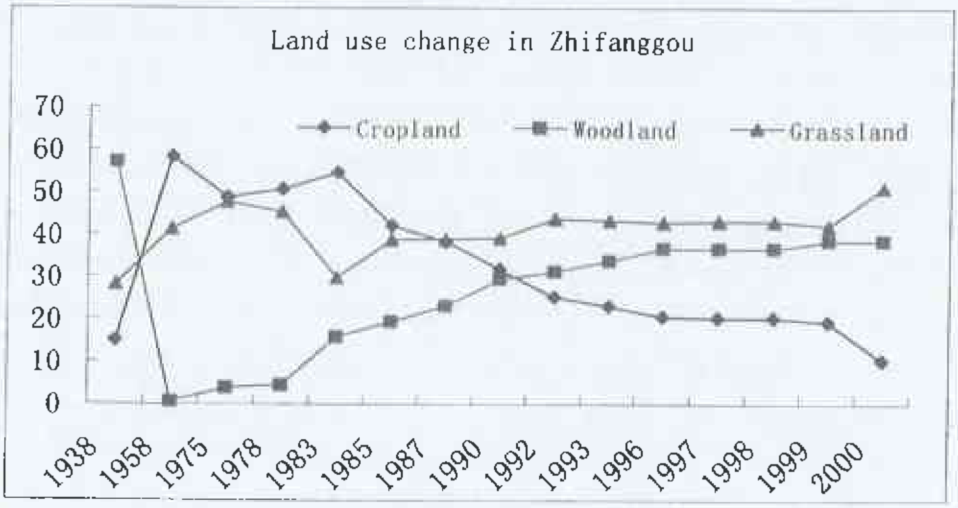


Figure 7.16 land use pattern change from 1938 to 2000

Source: G.B.Liu (2002)

- **Trade-offs, economic and environmental consequences**

There is a great concern on soil erosion caused by slope farmland cultivation activities. As can be seen from Table 7.4, slope farmland still accounted for 30% of the total land area, or 90% of the total farmland area. Experiments shows that the amount of soil eroded from slope farmland is 5 times of set-aside slope, 50 times of slope with grasses, 66 times of shrubs and 100 times of forest.

Table 7.11 shows the real case in Zhifanggou watershed. Conservation measures started from the concern of food security, that is, to build adequate terraced (basic) land to produce enough food. This was the foundation for the reduction of total slope farmland area, and consequently areas susceptible to soil erosion were under control. The first phase was from 1975 to 1985, when terraced land increased from 0.05 ha to 0.12 ha per capita, enabling yield increase to cope with population growth. Correspondingly, farmland area decreased from 0.92 ha to 0.73 ha per capita, and the ratio of farmland-woodland-grassland changed dramatically from 1:0.1:01 to 1:0.5:0.7. The second phase from 1985 to 1994, terraced land continued to increase to 0.16 ha, and total farmland area decreased further down to 0.48 ha. It is worth to notice that there were substantial increases of both yield and per capita income. With the change of land use pattern to 1:1.6:1.9, soil erosion module decreased drastically. Arbitrarily, from 1994 onwards, the situation has been improving continuously due mainly to the increase of terraced land, decrease of total cropland area and further improvement of land use pattern. There were sustainable increase of yield and rural income and substantial reduction of soil erosion.

Table 7.11 Trade-offs and consequences

YEAR	POPULATION	RATIO F:W:G	EROSION t./km2	YIELD kg./ha	CROPLAND (HA) total	CROPLAND (HA) terrace	INCOME yuan/p
1975	383	1:0.1:0.1	14000	444	0.92	0.05	---
1985	417	1:0.5:0.7	---	503	0.73	0.12	222
1990	476	1:0.9:1.2	7140	1350	0.48	0.13	667
1994	552	1:1.6:1.9	4160	1835	0.29	0.16	1631
1997	546	1:1.6:2.1	1630	2101	0.27	0.17	1461

Source: G.B. Liu (2001)

- **Conceptual model on slope land management:** Based on the above analysis, a conceptual model on stages and indicators of ecosystem improvement in small catchments has been developed (Table 7.12). There are roughly three stages with indicators ranging from terraced land to controlled area of soil erosion. This can be a model of future scenarios on land management in Ansai.

Table 7.12 Sequential stages and progresses in small watershed management

STAGES	REQUIRED YEARS	AREA CONTROLLED (%)	TERRACED LAND (ha/person)	TOTAL CROPLAND (ha/person)	AVERAGE YIELD (kg/ha)
1	10-15	40	0.06-0.1	0.5-0.8	600-975
2	5-10	60	0.1-0.13	0.4-.5	975-1350
3	10	80	>0.16	0.26-0.4	1875-2250

Specific analysis was made on the effects of conservation measures against soil erosion. Table 7.13 shows that the most effective way of controlling soil erosion is the building of levelling terrace, and several species of plants were also tested very effective, reducing the loss to up to 98% – 99%.

Table 7.13 Conservation and erosion control

Type	Reducing loss(%)	Type	Reducing loss(%)
Leveling terrace	98.0	Robinia	99.0
Sloping terrace	40.0	Caragana	99.8
Ridge furrows	47.5	Astragalus	98.0
Contour furrows	40.8	Pasture	62.2
Strip cropping	40-55	Strip grass	50-80

Source: G.B.Liu (2001)

- **Status of Zhifanggou Watershed Ecosystem**

Now, the ecosystem of Zhifanggou is more or less in the expected STABLE status marked with the following indicators: the increase of basic farmland area and increasing yield stability (Figure 7.17), the increment of grassland and woodland share in the whole land use pattern, increasing controlled area of soil erosion (Figure 7.18); increasing income and input/output efficiency (Figure 7.19).

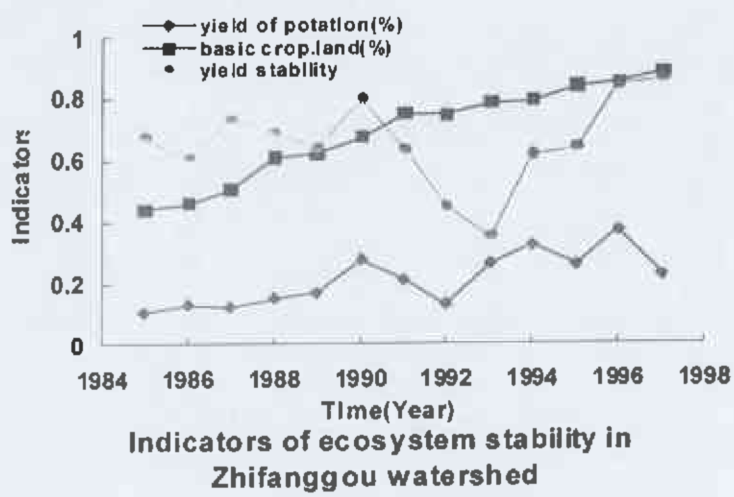


Figure 7.17 Increase of basic farmland area and increasing stability of yield in Zhifanggou Watershed

Source: G.B. Liu (2000)

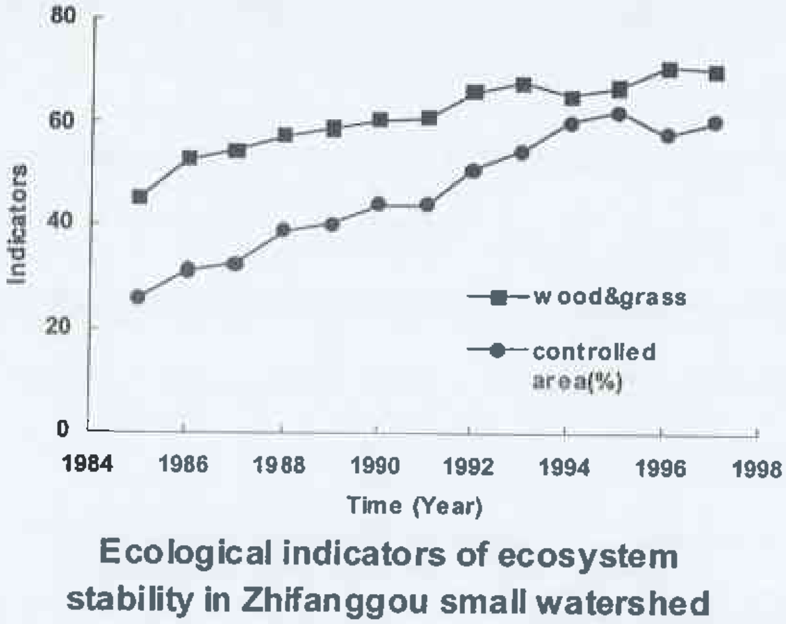


Figure 7.18 Increase of grassland and woodland share in the whole land use pattern in Zhifanggou Watershed

Source: G.B. Liu (2000)

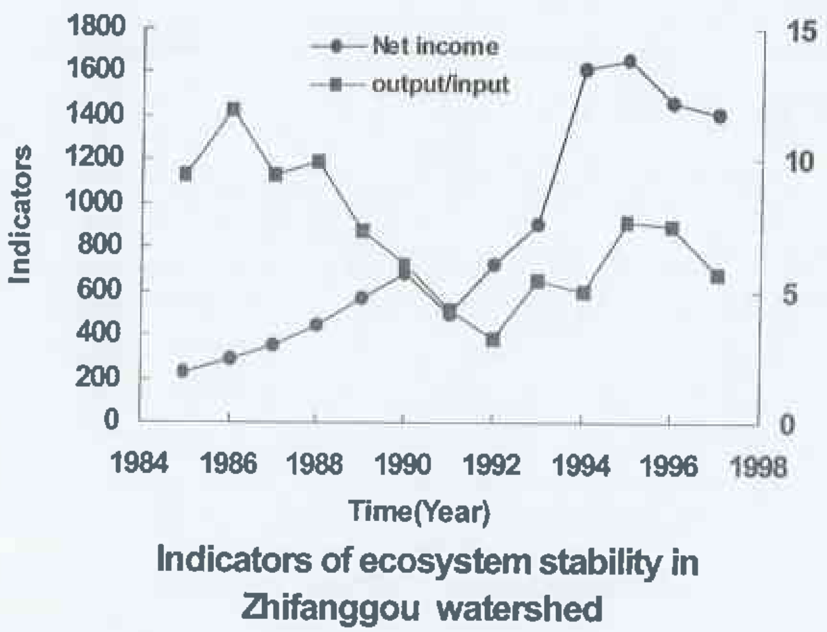


Figure 7.19 Increase of net agricultural income and input efficiency in Zhifanggou Watershed

Source: G.B. Liu (2000)

7.5.3 Future scenarios for Ansai County

The above analysis discloses that slope land and small watershed management needs long-term and multi-dimensional efforts. The conceptual model drawn from Zhifanggou case shows that the ambitious government objective to bring soil erosion under control in a short time span in the context of ensuring food security and income increase for the growing population in Ansai, or in the Loess Plateau at large needs strong policy intervention capitalized with more grain and cash input to compensate the large areas of slope farmland set-aside by local people. But, this is far from enough. To increase portion of the basic farmland (terraced, or dam land) and to produce more high value products should be a short term, but an imperative way out of the dilemma. However, off-farm employment and income generation opportunities will have to be found to make sure only a rational portion of the rural labour force on the agricultural sector to avoid the situation that most (if not all) the labours are kept on the farmland.

Due to data availability constraints, there will be no model to project the future scenarios for the set-aside and compensation policy implementation. But based on what we have observed and concluded from the previous analysis, a three-phase scenario can be proposed.

- *Policy intervention.* This should be the take-off stage. It is in the spiral of both ecosystem degradation and poverty. Without outside input, it is very hard to start the set-aside process. This is the stage that desperately needs national policy orientation and most importantly, incentive or compensation mechanism. Farmers should be encouraged to build basic farmland in a large scale to provide the basis for slope farmland set-aside. At the same time, the steep slope farmland (>15°) must be set-aside with proper compensation. Vegetation coverage rate should be increased and soil erosion reduced. Indicators at this phase should be basic farmland 0.1 ha per capita, total cropland per capita 0.5 ha, vegetation coverage rate 30%, yield per ha 600 – 1000 Kg/ha. This will last some 3 to 5 years.
- *Farmers' initiation and participation.* After the first phase, food security can be guaranteed and ecosystem improved substantially. Farmers start to realize the benefit of set-aside activities. The focus can then be on the balance of ecosystem improvement and income generation. The role of government is to enforce the goal of soil erosion control as well as create more off-farm opportunities. Indicators at this phase are: basic farmland per capita 0.13 ha, total cropland 0.3 ha, yield per ha 900 – 1400 Kg/ha,

vegetation coverage rate 40-50%, of which, fruit and cash trees should have a big share of the total agricultural GDP. This will last for 5 to 10 years.

- Overall slope farmland set-aside. After the last two phases, the overall standard of living of the farmer will have been increased dramatically. Awareness on environmental protection and population control became self-consciousness and automatic action. The share of fruit and cash crops dominates the total agricultural GDP, and off-farm income will have been the major source of income. Indicators at this stage are: basic farmland 0.13 ha, yield 2250 – 3750 Kg/ha, vegetation coverage rate 60%.

8 Main findings, discussion and recommendations

The study covered European and American experiences, the overall picture of national farmland management in China, economic and ecological farmland Marginalisation in susceptible regions, the Southeast Coastal Area and the Loess Plateau in the Northwest, detailed analysis of economic and ecological Marginalisation processes in the cases of Changshu and Ansai. Various issues concerned farmland loss and gains have been addressed: economic structure change, urbanization process, population, labour, and most importantly, policy intervention. Although there are not much comprehensive analysis based on complicated modelling due to data limitation, future projections were made using multi-variant statistical analysis in case studies. The initial objective was not to give a definite conclusion at national level, but to try to understand the farmland Marginalisation process in typical areas of China and to identify rooms for policy improvement. Therefore, main findings of the above study will be summarised and discussed, policy recommendations will be made in this chapter.

8.1 National trend

8.1.1 Overall analysis of national farmland Marginalisation process

- **Findings: Farmland Marginalisation is an inevitable process in China, driven by both economic and/or ecological determinants**

- **Discussion:** It is obvious that farmland Marginalisation process has been taking place from 1957 onwards, though the pace varied from time to time due to the magnitude of different diving forces as discussed in Chapter 4. Although there are leverage process by either wasteland reclamation process, or later basic farmland protection measures, it can still be roughly divided into two periods with two different dominant driving forces: a) the period from 1957 through 1998, mainly driven by economic forces, i.e. most of the farmland were taken for infrastructure construction, industrial development and urbanization; b) the period from 1999 onwards, mainly driven by ecological forces, i.e. strong policy intervention and law enforcement to set aside the ecologically fragile farmland for ecosystem restoration (Figure 8.1).

  No matter how serious the problem is, the farmland Marginalisation process is not going to stop. There will be a lot of driving forces, economic and ecological alike. Amongst, two are prominent: urbanization process will be far from complete compared with developed countries, that is, urbanization rate will increase from 30% in 2000 to 60-65% in 2050. Land has to be prepared for this anyway. The other was the farmland set aside policy demanding 5 million ha of slope farmland converted to forest by 2010.

This process pushes for differentiated regional development policy, agricultural policy, environmental policy and land management policy.

Table 8.1 Annual losses and gains of farmland in China from 1949 to 2002

Year	1949-57	1957-1965	1966-1978	1978-1998	1998-2000*	2001*	2002*
Annual loss/gains	1.74	-1.03	-0.035	-0.185	-0.58	-0.39	-1.68

Sources: various sources

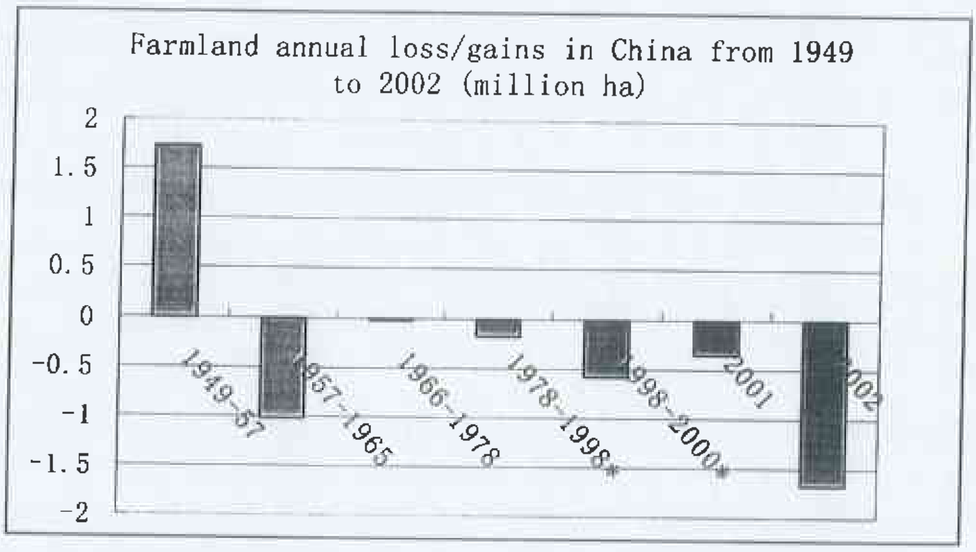


Figure 8.1 Annual losses and gains of farmland in China from 1949 to 2002

8.1.2 Magnitude of policy implication

- **Findings: Policy intervention poses the greatest impact on farmland management and will shape the overall structure of land cover in the future**

- **Discussion:**

We can see three periods with significant farmland changes. The period from1949 to 1957 experienced the expansion of farmland in an unprecedented magnitude, which was because of population pressure and government decision to combat hunger using the experiences drawn from Yan'an where the communist headquarters located during the World War Two. The period of 1957 to 1965 witnessed the Great Leap Forward era, when a lot of farmland was taken to industrialization. That was the result of another strong political intervention (Figure 8.1).

From 1999 onwards, the government slope farmland set-aside policy dominates the pace of farmland change, though there are influences of WTO entry, accelerated urbanization process, decreasing share of agricultural GDP and rural labour migration. For example, in 2002, the national net loss of farmland was 1.68 million ha, of which, marginal land set aside was 1.43 million ha, accounting for 85% of the total!

According to the national program for eco-environmental improvement described in chapter 4.3.2, the land cover will be greatly reshaped by planting more trees, improving grasslands, and controlling soil erosion and desertification. It seems that it is an ambitious plan. But if we take a closer look of what have been achieved in the last four years since the launch of the program, we have adequate evidence to believe that is most likely to happen. A typical example is slope farmland set aside. The objective was to complete 5 million ha by 2010, yet during the last four years from 1999 to 2002, 2.67 million ha slope farmland has been set-aside, 53.4% accomplishment! The government has another eight years to complete the rest 46.6%.

8.1.3 Comparison with EU and US

- **Findings: Compared with EU and US, there are a lot of similarities and differences in the process of farmland Marginalisation. The major differences lie on the difference of development stages. Most of the experiences can be used for future policy improvement.**

- **Discussion:**

Farmland Marginalisation process occurs under three conditions: a) food security ensured; b) need to reduce production to keep the price of agricultural produce, and/or need to ensure a reasonable portion of land for urbanization and other uses; c) environmental concern. Of course, there are differences on the way and timing of the Marginalisation process as well. The above are reflected from relevant policies and programs of EU, US and China issued to ensure good management of the marginal land. The similarity is that farmland Marginalisation concerned both economic and environmental issues.

Table 8.2 shows the differences in such policies amongst the three parties, China, EU and US. While the major concern for China is still on food security, EU and US have long been striving to increase their agricultural competency in the world market. And agriculture is highly subsidised in both EU and US, while China is still unable to do so. Another difference in terms of economic Marginalisation is that farmland is losing to urbanization process in China, while farmland reduction in both EU and US is mainly driven by the goal to keep the price. Another big difference is that China is addressing both food security and environmental improvement at the same time, while both EU and US have been forced to set aside farmland for environmental conservation whenever there is a surplus of production.

The comparison also proves the inevitable farmland Marginalisation in China. As China is still at the take-off stage and both EU and US have already been in post-industrial era, Marginalisation occurs in both developing and developed world. The better picture for China in the future would be, in addition to ensure food self-sufficiency to some extent, to reserve adequate farmland, and use them according to global market situation. Of course, environment should always be protected either for agricultural production itself, or national environmental security at large.

Table 8.2 Comparison of China, EU and US policies on farmland management

Country	Food security	Economic concern	Environmental concern
China	• Regulation on basic farmland protection • National Land re-organicultivation program • Agricultural Law, Chapter 8 • Land administration law, chapter 4	• Agricultural Law • Rural land tenure law	• Law of soil and water conservation • Grassland law • National Eco-environmental improvement program • West development program • Regulation/guidelines on farmland set aside
EU	• Common Agricultural Policy • Agenda 2000	• Common Agricultural Policy • Agenda 2000	• Less favoured areas directive • Environmental sensitive area payments program • Countryside Stewardship scheme • Agro-environment Program
US	New US farm bill	• Acreage Reduction Program • Production flexibility contract payments • Crop acreage base • Deficiency payments • **New farm bill**	• Conservation reserve program • Production flexibility contract payments • New farm bill • New conservation security program • New grassland reserve program • Environmental quality incentive program

Source: Various sources

8.1.4 Recommendations

- In the context of inevitable Marginalisation in the future, it is obvious that competition for farmland will be aggravating. As China is the world most populous country, adequate basic farmland reserve for food security is strategically important. Though food security should be put on the top of the priority list, both grain production quota and farmland protection measures should adapt to the local context of development, as China is such a large country diversified in almost all aspects, biophysical and social-economic alike.
- Farmland plays multiple roles in food security, rural income generation, environment improvement and construction, concerted measures should be taken to prioritise the use of farmland in a site-specific manner and maximize the efficiency of farmland use. We cannot afford to simply compromise economic benefit for environment in short term; we cannot do the other way in long term either. That is not the way it works in both EU and US.
- Policy intervention should look after both people's livelihood and environment by integrating law enforcement, economic incentives and employment opportunities. This means that an integrated working mode has to be created involving all the parties concerned, State Development Planning Commission, Ministry of Land and Resources, Ministry of Agriculture, Ministry of Water Resources at the central government and local authority and community to the grassroots. Policy intervention should be site-specific within regional economic and environmental context, wherever necessary, a provincial and/or county implementation guideline should be prepared.

8.2 Economic Marginalisation in southeast coastal area

8.2.1 Economic Marginalisation process

- **Findings: Economic farmland Marginalisation has been happening increasingly since the 1980's, and the trend will continue in the next 10 to 15 years.**

- **Discussion:**

As competition for land in the five coastal provinces (Fujian, Guangdong, Jiangsu, Shanghai, and Zhejiang) has been being intense, the net loss of farmland to non-agricultural uses was over 400,000 ha from 1988 to 1995, and it has been continuing with a further loss of 200,000 ha from 1995 to 1999. In Jiangsu Province, per capita farmland area decreased from 0.16 ha in 1949 to 0.07ha in 1996. In Changshu City of Jiangsu Province, per capita farmland area decreased from 0.073 ha in 1980 to 0.061 ha in 1999, an annual average rate of 0.61%.

In the next 10 to 15 years, it is expected that more farmland will lost to urbanization and other non-agricultural uses in this area if the current policy of basic farmland protection does not perform well. The projections in Changshu City shows that the most likely scenario of farmland possession per capita will be 0.056 ha in 2010 and 0.054 ha in 2015. The worst case will be 0.054 ha in 2010 and 0.051 ha in 2015. In all the scenarios given, none of them meets the national baseline for per capita possession of basic farmland.

8.2.2 Determinant analysis

- **Findings: The process has been being driven mainly by urbanization process and economic structural change. The pace of future farmland Marginalisation process would be mainly dependent on urbanization rate and the share of agriculture in the overall GDP**

- **Discussion:**

Regional analysis shows that there are obvious determinants driving the Marginalisation process during the last twenty years from 1980 to 1999. Statistics show off-farm employment rate in Guangdong increased from 5.7% to 43.6%, and agricultural production in the total GDP was down from 33.8% to 10.4%. In Jiangsu, off-farm employment increased from 13.8% to 44.9%, and agro-GDP share was down from 29.5% to 12%. Construction took a big portion of farmland as both urbanization and industrialisation processes have been accelerating in this region since the 1980's. For instance, construction of residential area in the cities in Jiangsu increased from 76 million m^2 in 1979 to 408 million m^2 in 1996, 4.3 times increase in less than 20 years. Even within the agricultural sector, crop production has given much of its way to aquaculture and horticulture due to its comparative disadvantage.

A detailed modelling of farmland change and determinants interaction of Changshu City in the last 20 years from 1980 to 1999 shows that urbanization process poses the biggest threat to farmland loss, followed by the decreasing share of agricultural production in total GDP (down from 31.8% to 7.3%). The result of the model shows that holding other variables constant, farmland area would decrease 0.2119% if the rate of urban population increases by 1%. In the same way, if non-agricultural GDP share increases by 1%, farmland area would decrease by 0.1346%. Empirical analysis shows that the declining share of crop production in agro-GDP (down from 66.2% to 31.9%) and the labour shift (down from 58.8% to 24.5%) from agricultural to other sectors also play a part.

8.2.3 Impacts on crop production and the environment

- **Findings: The process of farmland loss has been corresponded with intensification of crop production, which in turn causes serious environmental problems such as non-point pollution and lake eutrophication**

- **Discussion:**

A detailed study has been conducted in Changshu City. The rice bag policy forced the local authority to maintain or increase total grain production in the context of farmland loss. This triggered intensification process of crop production. Agricultural input increased dramatically in the last 20 years; machinery power 91%, rural electricity consumption 648%. What is more, the increase of chemical fertilizer is incredibly high. Compound fertilizer increased by 480% from 1990 to 1999, though the use of single nutrient fertilizers decreased to some extent. In extreme cases, nitrogen fertilizer application could be as high as 600 Kg/ha.

The assumption of environmental consequences of farmland Marginalisation should logically be the depletion of soil fertility. But the fact was that crop production intensification process increased both crop productivity and soil fertility. It consequently posed threat to the environment. It was observed that the nitrogen loss from farmland contributed 24% of the nitrogen pollution in Taihu Lake in 1999, accounting for the biggest share against industry (22%), rural waste (18%), animal waste (16%), sewage (14%) and aquaculture (6%) (Figure 6.27).

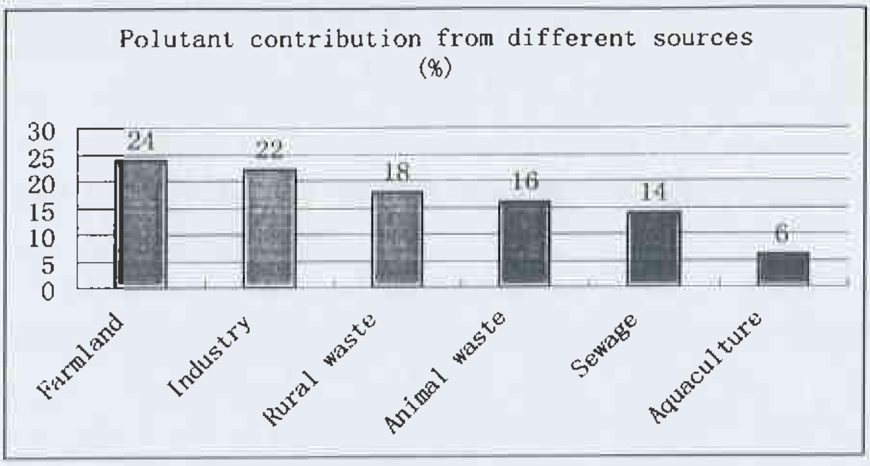


Figure 6.27 Pollution contribution from different sources
Source: LZ. Yang, 2002 CCICED report

Because of the non-point pollution, eutrophication in Taihu Lake has become the most significant environmental problem in China. The investment to control the blue algae blooming is estimated more than 30 billion RMB Yuan (US$ 3.75 billion), which is 20 times of the total GDP of Changshu in 1999! Of course, Changshu should not be accounted as a principal contributor to the pollution source. And the long-term environmental effects on both human health and aquatic ecosystems will be profound and enormous.

8.2.4 Recommendations

- **The farmland Marginalisation process in SECA should be slowed down and/or stopped through an integrated approach, but mainly through Unitary Development Plan and its implementation.**

Some of the areas have been or will be under the FAO warning line of basic farmland (0.55 ha/person, Shanghai 0.33, some parts of Jiangsu <0.5) in a matter of 10 years, yet urbanization process will be inevitable and accelerating. A Unitary Development Plan is needed from provincial to township level. The plan should architect the overall land use structure in the next 10 years, designate basic farmland area under protection, industrial zones or parks and residential areas, set up limit on yearly bases for the expansion of urban and residential areas, quota for industrial projects, and enforce farmland compensation or leverage policy for occupiers.

Means of implementation varies from place to place. The most important thing for the government is to formulate and issue the plan, and monitor the implementation process. There have been a lot of good experiences implementing the farmland leverage policy. In Shanghai, the authorities are reshaping the land use pattern to save farmland and increase land use efficiency through three CONCENTRATION measures: a) concentrate residential area in cities and towns; b) shift the TVEs to industrial parks; c) concentrate farmland into the hands of bigger specialised farmers. Similar approaches are being taken in southern part of Jiangsu Province, most important radiation area of Shanghai's urbanization and industrialization. In Xinqiao Township of Jiangyin City, all the natural villages have been concentrated together and merged into towns and village centres. 195 ha farmland was released for the reversion to farmland through this process. No better ways than the above so far to slow down or stop the loss of basic farmland, and it is therefore highly recommended.

- **As environmental pollution has become a compelling case in this area, there is an urgent need to drastically reduce non-point pollution from the farmland intensification process that is now a significant share of pollution source to lake eutrophication in Taihu. Reduction of fertilizer application is a key issue. Policies on grain production quota should be flexible so long as basic farmland can be reserved. Agricultural production should be oriented by market demand and be incorporated into the overall process of regional environmental management.**

There are policy approaches to reduce the production quota adjusting to the real farmland productivity as well as to adjust the price of fertilizers and grain products. This should be the source control to discourage farmer from over-using chemical fertilizers. There are also technical solutions to increase the efficiency of fertilizer application. The supply of chemical fertilizers has been shifting from single nutrient to compound, yet far from enough. There is an urgent need for slow release fertilizer, and more demand on controlled release fertilizer. The pricing system for agricultural input should be pro-environment, which means the environmentally friendly inputs such as the controlled release fertilizer and bio-pesticide should be sold at a lower price and subsidised by the government.

8.3 Ecological Marginalisation in the Loess Plateau

8.3.1 Farmland expansion and ecological Marginalisation

- **Findings: On the contrary to what happened in the Southeast Coastal Areas, farmland area had expanded from 1949 to 1996 in Loess Plateau. Since 1997, ecological Marginalisation has been taking place. The expansion was mainly due to by population pressure, less developed economy and its primitive structure. Yet the ecological Marginalisation process was the result of strong set aside policy intervention.**

- **Discussion:**

It has been difficult to get the real figure of farmland area and its change over the cause of the last 20 years since 1980. Multiple sources show that farmland area expanded from 1949 to 1996 (Table 5.9 & 7.6) in the Loess Plateau. Table 8.3 compares major determinants on farmland change in Changshu and Ansai in 1990 and 1999. The expanding gap of the share of crop production in agro GDP between the two places in the 10 years explains why there has not been a farmland loss in Ansai, but expansion. Other indicators show more or less the same conclusion, particularly the rate of urban population. It seems that income generation rather than food security that has been basically solved in mid 1980's drove farmland expansion in Ansai, or the Loess Plateau at large. Put it the other way, less off-farm opportunities for income generation and employment has long been being a constraint on the initiative setting aside the slope farmland.

Ecological Marginalisation took into effect since 1997. Evidences from both Shaanxi Province and Ansai County show that slope farmland have been being set aside in a very large magnitude. Till April 2003, Shaanxi has closed 11,000 Km^2 for revegetation. In Ansai County, set aside farmland area was 8 percent of the total territory within 4 years from 1999 to 2002. But whether the result can be consolidated or sustained will be dependent on how much local people can benefit in terms of income increase and employment opportunities, and how long they can benefit. This is very much concerned with the way of set-aside policy implementation.

Table 8.3 Comparison of major determinants causing farmland change

Items	1990			1999		
	Changshu	Ansai	Dif.	Changshu	Ansai	Dif
Crop production in agro GDP (%)	59.9	61.3	-2.2	31.9	69.8	-37.9
Agro production in total GDP (%)	16.2	73.3	-57.1	7.3	41.9	-34.6
Agriculture labour force in total (%)	29.7	92.8	-63.1	24.5	86.3	-61.8
Urban population rate %	17.6	6.8	+10.8	27.5	8.8	+18.7

8.3.2 Soil and water conservation

- **Findings: Because of its strategic importance to both the Loess Plateau and downstream areas, soil and water conservation has been being put on the top of the national priority list. But only did those measures integrating soil erosion into the overall watershed management and development have a chance to succeed. Building levelling terraced land has been the key to address both issues in the past and will still be in the future, though may not be the most cost-effective solution.**

- **Discussion:**

Because soil erosion is driven by both inherited biophysical factors and aggravated by population pressure, the best thing we can change the course is to change the land use pattern and manner on the bases of understanding the biophysical process. Land use and land cover change makes a big difference on soil erosion control. Successful experiences in Shaanxi Province in the last five years from 1997 through 2002 show that soil and water conservation is an integrated approach addressing both environmental degradation and people's livelihood. There have been 30,000 Km^2 area of soil erosion under control. Amongst the measures taken, the principal was building basic farmland. About half million ha of basic farmland was built to ensure food security and a reasonable portion of income. This is probably the very basic yet long-term measure to ensure the success of soil and water conservation. Comes to the soil erosion control itself, both Table 5.8 and Table 7.14 show the importance of landform. In particular, experiment shows that levelling terrace could reduce 98% of soil loss, more than twice as much as other measures.

8.3.3 Set-aside policy implementation

- **Findings: Set-aside policy has been tested and performed well in the last 4 years since 1999. The most important success of the policy was the incentive mechanisms to encourage farmers withdraw from slope cultivation. Still there are rooms to adapt the proportions of eco-forest, cash-forest and grassland into the local situation.**

- **Discussion:**

  Although 23706 ha of slope farmland, 8% of the total territory in Ansai has been set aside in the last 4 years since 1999, an unprecedented approach in record history, policy issues remain. The first is that how long the compensation can be guaranteed, not only for the set-aside of farmland itself, but for the longer period when maintenance needed for trees and grasses to grow. There was a period in some parts of Loess Plateau in 1980's that farmers were encouraged to build terraced land with some subsidy and three years tax-free period, but when the subsidy stopped, the process stagnated. The second is the diversification of both income and employment opportunities, which is the long-term strategy to mobilise large portion of labour force from farmland. Even within agricultural sector, how to diverge farmers from crop production to other sectors such as grassland-based animal husbandry and cash trees remains a big challenge to the current policy that 80% of the farmland set aside should be for eco-forest. Third, past experiences show that set-aside slope farmland has to be incorporated into the whole process of integrated watershed management that shoots three goals: food security, income growth and ecosystem improvement.

8.3.4 Recommendations

- Site-specific and alternative income generation and employment opportunities should be the major means in the future.
- Where off-farm opportunities are not available in short term, basic farmland construction, cash tree planting and grassland-based animal husbandry should be given priority in the implementation of the set-aside policy

- Past experiences of success in small watershed management should be deployed as both technical backup and the ground from which we proceed. The Zhifanggou case should be taken in overall policy revisit and improvement.

8.4 Accomplishments and gaps

8.4.1 Accomplishments

To judge what have been accomplished during the course of the thesis study, we can go back to 1.2 and 1.3, thematic questions and objectives:

- What is the general picture of farmland Marginalisation in China?
- What is the general trend as such in susceptible regions?
- What are the dominant determinants? How do they interact with land use change in typical areas?
- What are the environmental consequences?
- What will be the future scenarios?
- What will be the policy implication and best management option?
- Are there any experiences that we can learn from other countries?

And the five specific objectives:

- To review national policy change and its impact on farmland management in China; and to make comparisons between China and other countries on marginal agricultural land management;
- To investigate the situation of targeted regions susceptible to farmland Marginalisation;
- To obtain better understanding of the farmland marginalisation process in selected areas representative of major socio-economic and agro-ecological situation in China, and to identify the dominant determinants and their interaction with land use change;
- To assess environmental consequences of farmland Marginalisation in selected areas;
- To project future scenarios under specific economic and ecological pressures and to provide policy recommendations on how to manage the marginalized/abandoned farmland.

We can conclude in principle through a quick review of chapter 8 that most of the thematic questions from the very beginning have been answered and the objectives fulfilled.

The merit of this study has been focusing on the CAUSES rather than the phenomenon and consequences by identifying the major determinants of land use change with an emphasis on the policy implications. However, there are still gaps to fill in if we are to provide policy advocacy on the management of farmland Marginalisation.

8.4.2 Gaps left for future studies

- **Inadequacy in process analysis.** Due to the lack of data and confidence on the data reliability, it has not been possible to develop comprehensive and dynamic model to simulate the process in detail both spatially and sequentially. There are rooms to improve data quality, expand the scope of variables on land use and determinants interaction analysis and selection and revision of appropriate models for national analysis.
- **Policy regionalization and localization.** Further study on national policy should be focusing on regionalization as land issue are very much diversified due to significant biophysical and social economic variations. There is an urgent need to develop provincial and/or regional regulations responding to the national policy. Another aspect on national policy is how to implement it at the grassroots. Obviously, it is not as simple as 100 Kg/mu grain plus 20 Yuan as compensation, or a fine of 100,000 Yuan for the loss of one mu farmland in developed areas. Local implementation should be site-specific and through community-based participatory approach. In both cases, regional and local alike, there should be both obligations and flexibilities.
- **Methodology issues**
  - **Regional indicator systems.** There should be at least two indicators systems for future Marginalisation studies in China, economic and ecological. The one to analyse economic Marginalisation may include share of crop production in agro-GDP, share of agricultural production in total GDP, urbanization rate, income level and etc. Setting up thresholds of those indicators is crucially important for regional analysis. However, the one on ecological Marginalisation is different. Indicators may include mostly biophysical factors such as slope degree, soil texture, water regime, vegetation coverage and etc.
  - **Capitalization of compensation policy.** The current compensation of grain and money needs further revisit and revision. The concept of ecosystem services should be introduced to analyse the services provided through the set-aside and/or building terrace

practices. And those services should be given an economic value to answer the following questions:

◆How much is adequate for the compensation?

◆How long should the compensation period be?

■ **Participatory approach.** This should be used to answer the question on what should be the appropriate way to compensate. Not many people like the idea of just being compensated with grain or money. Some may think of more off-farm employment opportunities, others may think of land tenure issues, and or other kinds of incentive from the government. This should be the way leading to the point compromising short-term farmer's need and long-term national strategy.

■ **National preferential policy on industrial development.**

Comprehensive analysis should be made to identify regional comparative advantage of industrial development in the context of economic globalization. This should lay the foundation on regionalized farmland protection policy.

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Curriculum Vitae

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- December, 2001, Professor of Applied Ecology, Chinese Academy of Sciences,
- April,1999 – Director, Division of Agriculture, Ecology and Environment, Bureau of Science & Technology for Resources and Environment, and Director, Chinese Ecosystem Research Network, Chinese Academy of Sciences,
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- September 1995 - Associate Professor of Applied Ecology.
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- Council member, Chinese Soil Science Society

- Member, Chinese Society for Natural Resource Research
- Member, Chinese Ecology Society

Education:

Sep. 1998 —: Joint part time Ph. D Candidate of Chinese Academy of Sciences and University College London, major in land use and land cover change (LUCC), Thesis topic: "Farmland marginalisation in typical areas of China, economic and ecological concerns" (to be completed by the June, 2003)

Sep., 1993 -- Sep.,1994: Visiting Scholar and recipient of FCO (British Foreign and Commonwealth Office) Senior Fellowship, mainly studying Urban Ecology and Urban Environmental Management, School of Geography, University of Manchester, Manchester, England.

Sep.,1983 -- Sep.1986: Master of Soil Science, Department of Soil Science and Agro-chemistry, China Agricultural University, Beijing, China.

Sep.,1979- July, 1983: Bachelor of Soil Science, Department of Agronomy, Hebei Agricultural University, Baoding, Hebei Province, China

Summary of Professional expertise:

- **Major area(s) of specialization: Integrated resource management and rural development in mountainous areas, 15 years of research from 1986 to 2001.** From 1986 through 1993, my research area covered land resource classification, land use, land productivity and population carrying capacity, and unitary rural development. Geographically, I visited 280 counties in the vast mountainous areas of 7 provinces ((Qinghai (east of Tibet), Shanxi, Shaanxi, Gansu, Inner Mongolia, Xinjiang, Ningxia) in northwest China. From 1997 to 2001, I assisted the Co-chairs of the Sustainable Agriculture Working Group (SAWG), China Council for International Cooperation for Environment and Development (CCICED), to organize field survey, international workshop and other in-depth research activities to identify vital issues on China's ecosystem management and agricultural development, and to make recommendations to the Chinese Government as such. The period witnessed the expansion of my research area: from land resources to integrated natural resource management regarding agricultural production and ecosystem improvement, from physical science to social and economic sciences, and from study to policy consultation.
- **Project management: 12 years of management from 1991 to 2002**

My current position makes me responsible for planning and implementing R&D programs, coordinating inter-institutional research activities and cooperation with concerned ministries and local authorities, and building up links from research and development to demonstration and extension. Achievements can expressed through drafting: a) **relevant policy documents such as** "Report to the State Council of China: to harmonize ecosystem restoration and local community development in the Loess Plateau," and "General By-law" and "Criteria for Best Performance Assessment" of the Chinese Ecosystem Research Network (CERN); b) **Proposals such as,** "WTO and marginal land abandonment and redeployment in China (EU INCO-DEV project)" and "Priority area of land and water studies in China: report to Australian Centre for International Agricultural Research (ACIAR)." My management capability is also shown through **project implementation,** domestic and international alike, ranging from basic, applied research and high tech development to demonstration and extension, covering geographical areas such as Arctic and Antarctica, Tibetan Plateau, Loess Plateau and most parts in China. **Examples** are: a) ACIAR project: Integrated Management of Water and Nitrogen in the farmland of North China; c). Macarthur Foundation supported three academies (China, India and US) joint project: population and land use; d) Tibetan government and Chinese Academy joint project: desertification control and integrated agricultural development in Shigase, south of Tibet.

- **International activities: 10 years experiences since 1992,** I have been invited 12 times by other countries and organizations to attend international conferences and workshops to give lectures.

Selected publications:

1). **J. Liu,** Science, the Environment and Agriculture, pp 118—121, Vol. 16, No. 2, 2002, Bulletin of the Chinese Academy of Sciences(English).

2). **J. Liu** & Q. Lu (eds), Integrated Resource Management and Sustainable Agricultural Development in the Red Soil Hilly Area of South China, Proceedings of Annual International Workshop, Sustainable Agriculture Working Group, China Council for International Cooperation on Environment and Development, China Environmental Science Press, 2000 (English)

3). **J. Liu** & Q. Lu (eds), Land Use and Sustainable Development in Loess Plateau, Northwest China, Proceedings of Annual International Workshop, Sustainable Agriculture Working Group, China Council for International Cooperation on Environment and Development, China Environmental Science Press, 1999 (English)

4). **J. Liu** & Q. Lu (eds), Grassland Management and Sustainable Development in China, Proceedings of Annual International Workshop, Sustainable Agriculture Working Group, China Council for International Cooperation on Environment and Development, China Environmental Science

Press, 1998 (English)
5). **J. Liu** & Q. Lu (eds), Challenges and Opportunities on Sustainable Agriculture in China, Proceedings of Annual International Workshop, Sustainable Agriculture Working Group, China Council for International Cooperation on Environment and Development, China Environmental Science Press, 1997. (English)
6). M. Huo, **J. Liu** et al, "Strategies for Regional Development of China's Inland Areas with Rich Natural Resources," Science Press, 1995 (Chinese)
7). **J. Liu,** China's Modernization Process, the Environmental Cost of Development. EED working paper, 1994/3, ISSN0804-364, 1994 (English)
8). **J. Liu,** the Efficiency of Nutrient Cycling and Energy Transformation of Three Typical Land Ecosystems in the Loess Plateau, Northwest China. China Arid Land Research No.1, Vol.5, 1992, Published in New York (English)
9). **J. Liu,** "Population Carrying Capacity of the Loess Plateau", People's University Press, 1991 (Chinese)
10). C. Zhao & **J. Liu** et al, "Land Resources of the Loess Plateau", Science and Technology Press, 1991 (Chinese)