The Cultivated Land Change and Its Impacts on Grain Production in China

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I. INTRODUCTION

The pressure on cultivated land is unprecedented in China. On one hand, both Chinese economy and people's living standard are moving up rapidly in the recent two decades, which with the increase in population pushes up the demands for agricultural products at a record rate. On the other hand, cultivated land is ever shrinking drastically. Such crisis attracts many people's attention (OECF Discussion Papers No.6, 1995 ; Lester R. Brown, 1995 ; Chen Xikang and Guo Ju-e, 1996). The present paper tries to analyze the change of cultivated land and to estimate its impacts on grain production in China from 1949 to 1995.

II. HOW MUCH CULTIVATED LAND DOES CHINA HAVE?

For a long time people do not know the exact area of cultivated land in China because of the large disparity between statistical data and the real situation. According to the "1996 Chinese Statistical Yearbook" (National Statistical Bureau, 1996), China had 94,970.9 thousand ha cultivated land in 1995. But even in this book, the writers acknowledge this figure is not exact and must be verified. Table 1 gives several figures of cultivated land area in China estimated by different programs.

Although these programs were finished in different periods, and standards used are not the same, the final results are still similar, ranging within 130-140 million ha, which is much more than the area shown in the statistical yearbooks. At the beginning of eighties and nineties, two land use surveys were finished in China. One is called the General Land Use Survey (GLUS) and the other the Detailed Land Use Survey (DLUS). They make it possible to investigate the discrepancy between the data from land survey (SIGCLP, 1997) and those in the Statistical Yearbooks in corresponding years for these two sets of data have relatively consistent standards that made the comparison possible.

The figure from the GLUS is 136.6 million ha which can represent the situation in the early 1980 s. The figure in 1980 Statistical Yearbook is 99.3 million ha, which is 28.86% less than that from the GLUS. The datum from the DLUS is 133.8 million ha which can represent the situation from the end of 1980s to beginning of the 1990s, but the figure in 1990 statistical yearbook is 95.7 million ha, 28. 47% less than the former.

III. THE LOSS AND GAIN OF THE CULTIVATED LAND

Based on the data from the statistical yearbooks, Fig. 1 shows the change rates of sow area of grain crops (SAGC), cultivated land area and gross output of grains (GOG) in China from 1950 to

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Table 1. Different Estimations Cultivated Land in China Made by Different Programs

Area (billion ha)	Source	Representing Period
1.358	[1]	begining of eighties
1.433	[2]	begining of eighties
1.396	[3]	end of seventies to begining of eighties
1.325	[4]	end of seventies to begining of eighties
1.386	[5]	mid-eighties
1.338	[6]	middle and end of eighties begining of nineties
1.373	[7]	begining of nineties
1.311	[8]	1995

Not including Taiwan, Hongkong and Marco

[1] National Survey and Drawing Bureau and National Center of Remote Sensing (Kang Xiaoguang, 1994)

[2] National Agricultural Commision and National Planning Commission (Kang Xiaoguang, 1994)

[3] National Agricultural Depaetment General Survey of Land Use

[4] Second General Soil Survey (Institute of Agricultural Resources and Regional Planning, 1992)

[5] Commission for Integrated Survey of Natural Resouces, Chinese Acadomy of Sciences 1 : 1,000,000 Land Resouces Map

[6] National I and Management Administration Detail Survey of Land Use

[7] Institute of Applied Remote Sensing, Chinese Acadey of Sciences#

[8] National Land Management Adiministration 1995

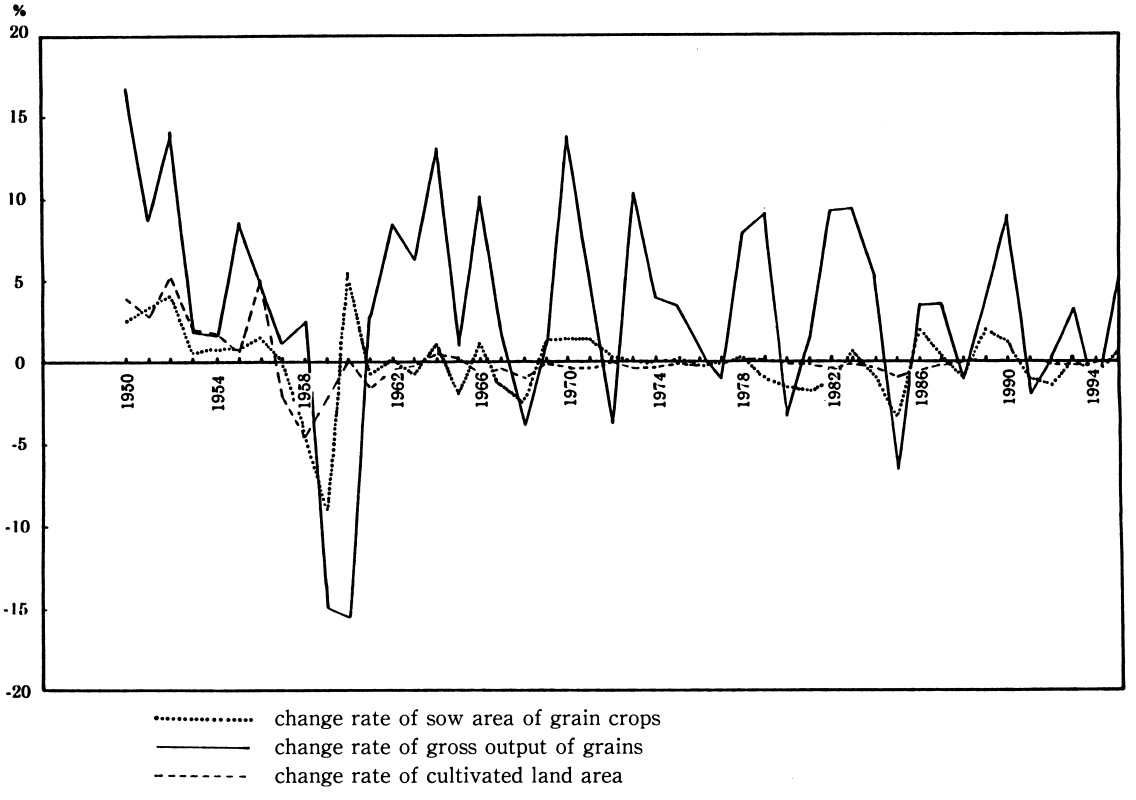

Fig. 1 change rates of sow area of grain crops, cultivated land area and gross output of grains (%)

1995. The change characteristics of cultivated land area are as follows :

1. Before 1961, the change rate of cultivated land area rose or dropped drastically. Peaked in 1958 and bottomed in 1959, the range of change is over 8%, from +4.09% to −4.4%.
2. Since 1962, the change rate has shown a drop tendency, but the fluctuation tends to be smoother, within the range of −1% to +0.6%.
3. There are three major phases of drops between 1969 and 1975, 1980 and 1986, 1990 and 1994.

Since 1987, however, the National Land Management Administration (NLMA) has had the uninterrupted data of land use which are considered closer to the real situation than the Statistical Yearbooks (Chen Baiming, 1996). It is possible to analyze the cultivated land losses caused by different reasons in the recent nine years.

In the "Yearbook of land of China 1995" (NLMA, 1995), the reasons for the loss of cultivated land are classified into the following six types :

1. Capital construction including extension of urban built-up area, construction of large factories and mines, projects of large irrigation and water and soil conservation and hydroelectric stations, extension of national highways and railways.
2. Collective or village-level construction including building of rural roads, small irrigation and water and soil conservation facilities, and development of township industries.
3. Rural (peasant) settlement
4. Readjustments of agricultural land use including the cultivated land converted to orchard, fish ponds, forests or grasslands.
5. Natural hazards
6. Other

This classification does not fully consider the influences of urbanization on cultivated land. For example, according to this classification, only the capital construction belongs to urbanization. But it only occupies 13.8% in total loss of cultivated land which is much less than the loss caused by readjustments of agricultural land use in the recent nine years (61.9%). In fact, some parts of collective construction and readjustments of agricultural land uses are also caused by urbanization. They include the development of township industries, the increase of orchard and fish ponds. Therefore, a new classification should be proposed. This is the table 2 and Table 3.

According to the Table 2, from 1987 to 1995, the total loss of cultivated land is 5681.31 thousand ha, average 631.25 thousand ha per year. Among these, the loss owing to urbanization is 2,427.21 thousand ha, average 269.69 thousand ha per year, and shows a rising tendency. Returning cultivated land to forests and rangelands (grasslands) contributes 33.15% (1,884.44 thousand ha) to the total loss, average 209.38 thousand ha per year. Rural settlement encroaches 107.27 thousand ha (2.776%). Natural hazard damages 965.46 thousand ha (16.99%), average 107.27 thousand ha per year. Infrastructure construction for agriculture (including rural roads, small irrigation and water conservation projects) occupies 71.45 thousand ha (1.25%).

1. The loss owing to urbanization

Table 2. Different Fractions in Decrease of Cultivated Land Arrea (thousand ha)

year	Total Loss of Cultivalted	Area Loss caused by Urbanization		Area Damaged by Natural Hazards		Area Returning to Forests and range Land		Area Loss Caused by Construction of agricultural Infrastructure		Rural Settlement		Others	
		thousand ha	%	thousand ha	%	thousand ha	%	thousand ha	%	thousand ha	%	thousand ha	%
1987	877.22	305.17	34.78	126.72	14.44	365.99	41.72	14.08	2.95	45.01	5.13	104.30	11.88
1988	676.29	219.71	32.48	159.36	23.56	254.83	37.68	7.59	2.46	21.97	3.25	3.73	0.55
1989	417.31	131.95	31.61	96.97	23.23	153.41	36.76	4.87	4.33	15.34	3.68	1.56	0.37
1990	346.36	107.31	30.98	56.05	16.18	147.95	42.71	5.77	6.25	12.06	3.48	1.34	0.39
1991	448.34	177.75	39.64	144.01	24.76	119.35	26.62	8.29	6.18	10.37	2.31	2.14	0.48
1992	707.25	331.97	46.93	98.91	13.98	237.93	33.64	8.55	3.42	11.38	1.61	2.82	0.40
1993	625.26	363.81	58.18	67.36	10.77	154.62	24.72	5.52	2.77	10.77	1.72	2.92	0.47
1994	785.23	347.30	44.22	123.33	17.26	263.97	33.61	7.45	2.37	12.60	1.60	2.61	0.33
1995	798.05	442.23	55.41	125.74	15.75	186.37	23.35	9.33	2.36	17.60	2.21	7.23	0.91
total	5,681.31	2,427.21	42.72	965.46	16.99	1,884.44	33.17	71.45	1.26	157.10	2.77	128.64	2.26
average	631.25	269.69	41.58	107.27	17.77	209.38	33.42	7.94	3.68	17.46	2.77	14.29	1.75

Source : National Land Management Administration, 1995
National Land Management Administration, 1996
Chen Baiming, 1996

Table 3. Area Loss caused by Urbanizatio (1 thousand ha)

year	Direct Loss					Indirect Loss			
	Capital Construction	Township Indusfres	Iudividual Factory	Total	%	Orchard	to Fish Ponds	Total	%
1987	98.30	16.41		114.71	37.58	16.41	26.29	190.47	62.41
1988	71.16	7.74	0.88	79.78	36.31	119.35	20.58	139.93	63.68
1989	51.21	2.88	0.17	54.25	41.11	69.17	8.53	77.69	58.88
1990	45.42	2.05	0.15	47.61	44.36	53.63	6.07	59.70	55.63
1991	58.51	3.44	0.31	62.26	35.02	103.23	12.27	115.50	64.97
1992	103.62	12.83	0.65	117.10	35.27	171.86	43.01	214.87	64.72
1993	90.12	4.21	0.67	95.00	26.11	202.49	66.31	268.81	73.88
1994	89.79	9.71	0.65	100.15	28.83	205.65	41.50	247.15	71.16
1995	99.72	16.32	0.75	116.79	26.40	297.84	27.61	325.45	73.59
total	707.85	75.56	4.22	787.64	32.45	1,239.64	252.16	1639.56	67.55
average	78.65	8.40	0.47	87.52	34.55	137.74	28.02	182.17	65.43

Source : See table 2

The influence of urbanization on cultivated land may be classified into two types. One is encroachment (direct loss) that includes the development of capital construction, township industries and any kinds of large individual factory. Another is that cultivated land is changed to orchard or fish ponds driven by the increasing demand of urbanization (indirect loss). This kind of loss is more serious than the encroachment. Table 3 shows that the area of cultivated land transformed to orchard and fish ponds is 1,639.56 thousand ha (67.55%), average 182.17 thousand ha per year, which is more than the encroachment in all nine years. Among the encroachments, the major loss is the capital construction, which is 707.85 thousand ha, average 78.65 thousand ha per year. However, the tendency is basically stable. Township industries and individual large factories increase fast in the recent years though its contribution to the total loss is small.

The reasons are obvious. Driven by relatively high earnings, people always transform cultivated land to non-agricultural use in order to make more profit. In 1992, different economic developmental zones throughout the country reached more than two thousands and seven hundreds.

Even many local villages and townships had their own developmental zones (Kang Xiaogang, 1994). The loss of cultivated land caused by the capital construction reached the climax in that year. With the urbanization accelerated, this loss will continue. People have noticed the seriousness of the direct loss, and try to control it. In the recent years, a set of law and regulation were enacted to avoid massive loss of cultivated land. In some regions, the cultivated land protected areas have been built. The local governments stipulate that the cultivated land in the protected areas are forbidden to be used for non-agricultural purposes. However, the indirect loss of cultivated land was not easily noticed by some people. Because of the "production responsibility system"[1], it is very difficult for governments to control this kind of transformation. Some people think this change is congruent with the national economic policy (market economic policy). So, this loss is continuing at an accelerated rate in the recent years and in the near future.

2. Returning cultivated land to forests and rangelands (grasslands)

The loss of cultivated land caused by returning to forests and rangelands is second to urbanization. Table 2 demonstrates that the loss caused by returning to forests and rangelands is about 1,884.44 thousand ha. In the sixties and seventies, under the policy "Grain Production is the Key Link", a lot of marginal land was cultivated for grain production. According to Zhang Fongrong' s estimation, the area of this kind of "illegal cultivated land" is about 10% of the area of total cultivated land in the Detailed Land Survey (Zhang Fongrong, 1996). In effect, most of them are unsuitable for crop production because of various physical constraints.

3. The area damaged by natural hazards

Although the percentage of the loss caused by natural hazards is the third in total loss (16.99%), the damage on cultivated land is most serious because natural hazards degrade the cultivated land and make it badlands. The magnitude of this loss varies greatly in different years.

4. The gain in cultivated land and potential reserves

In the recent nine years, the total increase of cultivated land is 4,442.62 thousand ha according to every statistical yearbook. It has been mainly gained through reclaiming the wilds or wasteland.

China has 13.3 million ha uncultivated land considered suitable for agricultural use (Zhang Fongrong, 1996). Of this total area of uncultivated land only a small fraction is ideally suitable for crop production. The rest is less or marginal suitable due to one or more constraints, i.e. steep slopes, poor or contaminated soil, poor drainage, and variable precipitation. Significant potential reserves exist only in remote northwest and northeast China (CISNAR, 1991). As mentioned above, so much illegal cultivated land needs to be returned to their original landscape. It is impossible for Chinese people to depend on this reserves to mitigate the shortage of cultivated land.

IV. THE RELATIONSHIP BETWEEN GRAIN PRODUCTION AND THE CHANGE OF CULTIVATED LAND AREA

Apart from the cultivated land lost by returning to forests and rangelands or being damaged by natural hazards, most of the lost cultivated land is located around cities or along the main roads which was ideally suitable for grain production. In contrast with it, most of the cultivated land which has been gained in the recent years is marginally suitable for crop's production. On the aspect

of potential production, it is obvious that the gain can not compensate the loss. This point also can be shown in the regional differences of the gain and loss of the cultivated land . From 1980 to 1990, only in five provinces……Heilongjiang, Inter Mongolia, Liaoling, Xingjiang and Jiling……did the area of cultivated land increase significantly, occupying 86.1% (6,379.3 thousand ha) in total gain. They are located at remote northwest and northeast China which have critical environment. The first five provinces losing cultivated land are Guangdong, Shandong, Hebei, Henan and Hunan which together made up 46.5% (6,736 thousad ha) of the total loss[2]. They are located in coastal and central regions and are traditionally grain production provinces. Losing these mean losing some of the world's most productive cropland (Lester R. Brown, 1995).

Grain production is influenced greatly by the sow area of grain crops (SAGC). From the long -term perspective, the SAGC depends on the area of cultivated land (see Fig.1). From 1958 to 1995, the area of cultivated land and the SAGC decreased 12,195.3 thousand ha and 24,103.8 thousand ha, respectively (according to the statistical yearbooks).

The correlation coefficient R between the change rates of the CAGC and the gross output of grain (GOG), during 1950-1995, is 0.4796. However, if the whole time period is divided into five segments, then the degree of correlation is different. Here are the different correlation coefficients R in different periods :

1950-1959 : R = 0.8266
1961-1970 : R = 0.7776
1971-1980 : R = 0.1729
1981-1990 : R = 0.5778
1986-1995 : R = 0.7333

(The datum in 1960 is omitted because it is unreasonable owing to the Great Leap Forward)

The scatter diagram of change rates of the SAGC and the GOG also shows a kind of linear relationship on the whole, especially during the periods 1950-1959, 1961-1970 and 1990-1995 (see Fig. 2). This relationship is not obvious in the period of 1971-1980. Maybe, the rapid increase of the use of chemical fertilizers and expansion of effective irrigated area in the 4th and 5th Five Year Plans masked the role of the SAGC in raising the GOG. Both Ke and Kang pointed out that the increase of agricultural investment in that period (from 1971 to 1980) was very fast (Ke Binsheng, 1995 ; Kang Xiaoguang, 1994).

In the past 46 years, the SAGC shows increases in 23 years and decreases in other 23 years. Only in 1959, 1968, 1980, 1985, 1988, 1991 and 1994, the GOG decreased dramatically because both SAGC and average per ha yield of grain crops decreased. In order to estimate the extent of the influence of SAGC on GOG, the data in 8 years are taken to be analyzed. They are 1957, 1958, 1959, 1965, 1968, 1980, 1981 and 1985. In each of these years, the SAGC decreased at least 2 million ha. The result of analysis shows that the total loss of the SAGC is 34.2 million ha in these 8 years, occupying 3.6% of total SAGC in the same period. The net loss of GOG is 59,750 million kg, occupying 3% of gross output of grain crops. Among these 8 years, there are 4 years in which the GOG increased slightly or did not decrease because of the increase of average per ha yield of grain crops. In the rest of years, the GOG decreased sharply because of the decrease of both. From the above data, it can be estimated that the GOG decreased at least 16875 million kg when the SAGC dropped 1%.

The only period when the SAGC was in an four year's uninterrupted shrinkage is from 1990 to

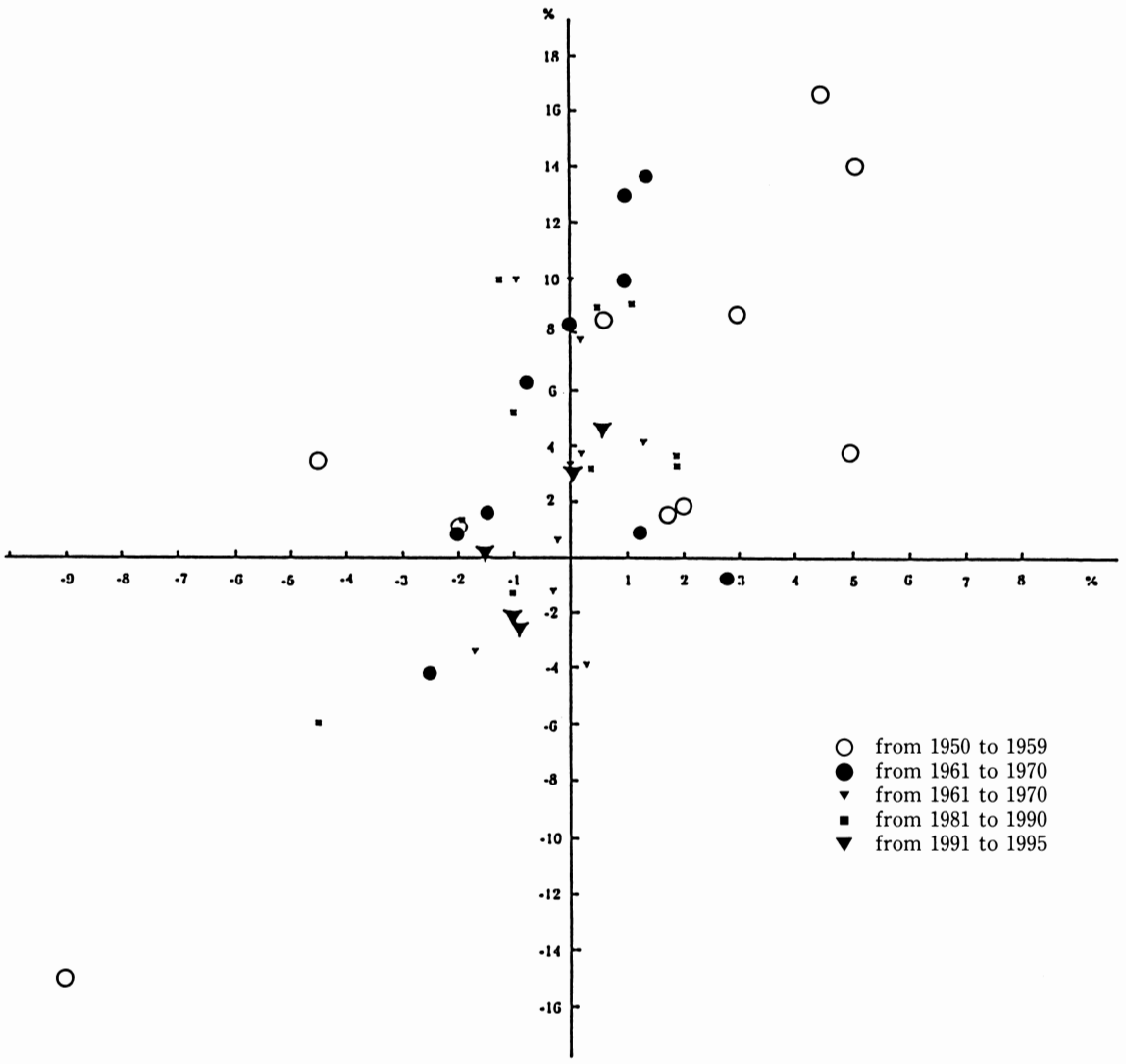

Fig. 2 scatter diagram of the change of the SAGC (sow area of grain crops) and the GOG (gross output of grains) (%)

1994 in the past 46 years. The total area of decrease is 3,923 thousand ha. The SAGC in 1994 is only 109,543 thousand ha (below the "warning line"-11,000 thousand ha), which is 965.7 thousand ha less than in 1993, occupying 0.88% of the SAGC. However, the decrease of GOG caused by it is 4,500 million kg in 1994 (People's Daily, 4/2/1995), occupying 1% of the GOG.

V. CONCLUSION

1) China has at least 133 million ha cultivated land now. This figure is 40% more than that from the "1996 Chinese Statistical Yearbook".

2) In the recent 9 years, the loss caused by urbanization is the most important part in the total loss of cultivated land area.

3) The impacts of the change of cultivated land on grain productions depend upon the changes of

SAGC. Generally, the decreases of SAGC can make the GOG decrease drastically if it coincide with the decreases of per ha yield of grain crops.

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NOTES

1), 2) COMES FROM THE RESEARCH REPORT "THE DYNAMIC RESEARCH AND LARGE-SCALE INVESTIGATION USING THE REMOTE SENSING ON NATIONAL RESOURCES AND ENVIRONMENT".

1) In 1979, Chinese agricultural policy began to change from 'commune system' to production responsibility system. Farmers were allocated land in their local villages, allowed to arrange production by themselves. They took out contrasts with the government to deliver a certain amount of agricultural production and can sell surplus goods in 'free markets'.

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中国における耕地面積の変化とその食糧生産に対する影響

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本稿は，1949年から1995年にかけての中国における耕地面積の変化を分析し，それが食糧生産に及ぼした影響を評価することを目的とする。本稿は3つの部分で構成されている。はじめに，中国全国の耕地面積値が出典によって異なっていることを討論した。そして，1980年代初めと1990年代初めにそれぞれ実施された土地利用調査データと同時期の統計年鑑のそれを比較した。

次に，統計年鑑に基づき，耕地面積の変化率に関して3つの特徴を示した。最近の9年間における耕地面積減少の要因を分析する過程で，都市化の耕地面積に及ぼす影響を充分考慮に入れた要因分類法を提示した。

要因としては都市化，農村集落の拡大，林地と草地への転用，自然災害，農業その他のためのインフラの整備などがあげられるが，都市化の影響が最も大きい。最後に，耕地面積の減少による食糧生産への影響は食糧作付け面積に依存すると指摘した。作付け面積の減少は単位面積当たり収穫量の減少を伴う場合，食糧総産出量を著しく減少させる。

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