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Agricultural Development in China 1368-1968

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CHAPTER TWO

Six Centuries of Rising Grain Production

Between the late fourteenth and the early nineteenth centuries, China's population increased five- or six-fold. From the early nineteenth century to the 1950's it rose another 50 per cent. These people had to be fed, and food for such an increase in population in China could be obtained only by increasing grain production.

The central proposition of this book is that Chinese farmers were able to raise grain output and that they did so in more or less equal measure by expanding the cultivated acreage and by raising the yield per acre. The expansion in cultivated acreage requires little discussion beyond presenting the basic data and evaluating their quality. Demonstrating that grain yields per acre did in fact rise is much more difficult.

The first part of this chapter, therefore, is devoted to proving or, more accurately, establishing the plausibility of the existence of a rise in grain yields between the late fourteenth and nineteenth or twentieth centuries. The arguments in support of this proposition are long and rather technical. Only a summary version is presented in this chapter. The remaining arguments appear in Appendixes A, B, F, and G. The term *grain,* as used in this chapter, includes not only rice, millet, wheat, *kaoliang*, and all other cereals, but also potatoes and other tubers.

The latter half of the chapter includes an analysis of the pace of change in grain productivity during particular periods. Special emphasis is placed on developments since the middle of the eighteenth century. For the twentieth century, I have constructed a crude index of gross agricultural output (not just grain) for several years between 1914 and 1957. However, no such index has been attempted for earlier periods.

The chapter ends with a discussion of the level of Chinese output in the 1950's and 1960's. The implications of this level of output are explored by comparing Chinese yields per acre and per capita consumption with comparable data for other nations such as Japan and India.

The Rise in Grain Yields (1400–1957)

Two different approaches can be used to demonstrate that grain yields probably rose significantly between 1400 and the early nineteenth or twentieth centuries. The first starts with an argument to the effect that per capita grain output in China fluctuated, if at all, only within rather narrow limits. With this argument, together with estimates of the size of population and the amount of cultivated acreage, an average yield figure can be readily obtained from the following formula:

$$\frac{(\text{per capita grain output}) \times \text{population}}{\text{cultivated acreage in grain}} = \text{yield}$$

The resulting yield figure is the yield per unit of cultivated land, not per unit of sown acreage. An increase in double cropping would appear as a rise in yields in the former case but not in the latter.

The second approach involves an attempt to collect yield estimates for different periods and different regions in China. Yield figures in most countries today are obtained by sampling procedures. It is impossible to go into the countryside in China and ask a farmer what yields his ancestors were able to achieve several centuries earlier. But one can attempt to extract a sample from historical records. In this study, both the first and second approaches are used.

The three necessary ingredients of the first approach are assumptions about per capita grain output in earlier periods together with reasonably reliable population and cultivated acreage statistics. Grain imports (and exports) were too small to significantly affect these calculations and hence have been ignored. There is reason to believe that average per capita grain output in China was seldom, if ever, below 400 catties (200 kilograms) or above 700 catties (350 kilograms) of unhusked grain.

This range cannot be established for earlier periods directly. There are occasional references in historical records to per capita grain consumption levels. Even if the relationship between consumption and output could be established, however, these references are too few and scattered to be of much use. Instead it is necessary to use a more indirect approach. The full argument is presented in Appendix F.

The lower end of the range (400 catties) represents something like a minimum level of subsistence. "Minimum subsistence" is an imprecise term. To attach a precise number to such a concept, one should know the age, height, and weight distribution of the population; the nature of the climate; how hard the people

work; and the minimum health standard desired. All one can say here is that in no province of China in 1957 was per capita output as low as 400 catties and in over 130 villages surveyed by John Lossing Buck in the 1930's, fewer than ten fell below this level.[1] In addition, in over thirty countries listed in Table F.3 in Appendix F, only two, Peru and Colombia, had a per capita grain supply well below the 400 catties (200 kilograms) level.[2]

The upper end of the range (700 catties or 350 kilograms) has been surpassed in a number of countries, but in each case these nations were major producers and consumers of meat. Direct consumption of grain by people fluctuates within a rather narrow range. There is a limit to the amount of grain a person can eat in a year. All the evidence suggests that China has never been a major producer and consumer of meat and that the number of draft and meat-producing animals per capita has not changed much during the past several centuries.[3] Therefore, the upper limit on per capita grain output is determined by a generous estimate of direct consumption plus seed grain and a small amount of feed grain.

Actual per capita output in China in 1957 was 572 catties (286 kilograms). Provinces with levels of output significantly higher than this generally were major grain exporters. That is, farmers could not or at least did not consume all they produced.[4] Further, the national average was itself quite high. The figure of 286 kilograms was surpassed by very few underdeveloped nations and is just matched by the per capita supply (including imports) of Japan in 1934–1938 and 1957–1959.[5]

In most of the calculations in this chapter, I have used the narrower range of 500 to 600 catties (250 to 300 kilograms). It seems more likely that China's production in Ming and Ch'ing times fell below 500 catties per capita for long periods than that it rose above 600 catties for any sustained period. It is possible that consumption levels in China rose slowly (and unevenly) perhaps by as much as 20 to 30 per cent over the six centuries with which we are concerned. It may also have risen for a time and then fallen. Declining consumption over time appears less likely. To decline to the 1957 level of 572 catties over time would imply that levels in the past were extraordinarily high.

The population and cultivated acreage data used in the calculations in this chapter are presented in Table II.1. The key figures for estimating yields are those for the early Ming period (A.D. 1400), the mid Ch'ing (A.D. 1770–1850) and either 1933 or 1957. The issue is whether these statistics are "reliable" or fall within some usable margin of error.

1. The Buck data in Appendix F were originally given in terms of per capita consumption of grain in calories. I have converted these to kilograms (or catties) in the appendix. To convert the figures from per capita consumption to per capita output, one must also add grain used for seed, feed, and alcohol.

2. The grain supply per capita in Peru and Colombia was 328 catties (164 kilograms) and 294 catties (147 kilograms) respectively. Several other countries were at levels below 400 catties (200 kilograms) but just barely.

3. See discussion in Appendix F.

4. For data on grain surplus and deficit provinces, refer to Chapter VII.

5. See Table F.3.

TABLE II.1. POPULATION AND CULTIVATED ACREAGE ESTIMATES FOR CHINA—NATIONAL TOTALS (1400–1957)
(Constant Boundaries)

Year	Population (millions)	Cultivated Acreage (million shih mou)
1400	65–80	370 (±70)
1600	120–200	500 (±100)
1770	270 (±25)	950 (±100)
1850	410 (±25)	n.a.
1873	350 (±25)	1,210 (±50)
1893	385 (±25)	1,240 (±50)
1913	430 (±25)	1,360 (±50)
1933	500 (±25)	1,470 (±50)
1957	647 (±15)	1,678 (±25)

Cultivated acreage: Includes all land on which crops are grown, but excludes pasture land.
15 *mou* = 1 hectare = 2.5 acres.
SOURCES: See Appendixes A and B.

There are those who dispute the validity of the early Ming census data. The subject is discussed at length in Appendix A. Ping-ti Ho's work (1959) has already presented a case for a belief in the comparative reliability of the early Ming figures based on an analysis of the institutions concerned with carrying out the census. In Appendix A, I present the case for the internal consistency and historical plausibility of these data. In particular, the Ming statistics are consistent with estimates independently arrived at during the Sung (for A.D. 1080 and 1173) and Yuan (for A.D. 1270 or 1290) dynasties and with what we know of the various Mongol military campaigns. Although some underestimation seems likely, it is here argued that population in 1400 probably fell somewhere between 65 and 80 million persons (in contrast to the official census figure of 60.5 million).

The Ming acreage figures are less reliable, but still, as indicated in Appendix B, usable, but with major revisions. The official estimates are revised downward from a total of 851 million to 425 million Ming *mou*. Following the lead of the Japanese scholar, Hiroshi Fujii, these revisions are made primarily on the basis of textual analysis rather than from an analysis of internal consistency and plausibility. That is, the most frequently used figures were compared with those appearing in other sources, checks were made for recording errors such as the Chinese equivalent of a misplaced decimal point, and the like. Hence, the revisions could be and were checked for internal consistency without the reasoning becoming circular. In addition to establishing the consistency of the estimates, with each other and with data for the Han, Sung, and Yuan periods, reasoning similar to that used in setting limits on per capita grain consumption was used to set an upper limit on the amount of cultivated acreage in 1400. The result is a range centered on 370 million *shih mou* (± 70 million *mou*).

The institutional case (i.e., the case based on an analysis of the institutions

responsible for the censuses) for the comparative reliability of the mid-Ch'ing (1770–1850) population data is also taken from Ping-ti Ho and that of the 1953 census from John S. Aird (1968). The institutional case for the usefulness of the 1957 acreage data appears in Appendixes B and C.[6] The mid-Ch'ing acreage figures are of particularly low quality. Two independent approaches are used in a crude attempt to reconstruct an approximation to the true cultivated acreage in the mid-Ch'ing period. The individual estimates are then checked for consistency with each other and with historical events in the late nineteenth and early twentieth centuries. The case for the general reliability of the 1950's population and acreage data rests primarily on a belief in the effectiveness of the 1953 census and the statistical collection procedures of the State Statistical Bureau. The institutional case for the mid-Ch'ing figures is less convincing and hence the plausibility of the data depend rather heavily on the tests for consistency.

Given the three basic sets of data (per capita output, population, and acreage), together with an assumption that 80 per cent of the cultivated acreage was planted in grain, an estimate of yield per cultivated acre (or *mou*) can be readily obtained. To illustrate, I shall assume that per capita grain output was 570 catties in 1400, 1770, 1850, and 1933 as well as 1957. The results are as follows:

$$(1400)\quad \frac{570\times 72}{370\times 0.8}=139 \text{ catties per } \textit{shih mou}$$

$$(1770)\quad \frac{570\times 270}{950\times 0.8}=203 \text{ catties per } \textit{shih mou}$$

$$(1850)\quad \frac{570\times 410}{1{,}200\times 0.8}=243 \text{ catties per } \textit{shih mou}$$

$$(1933)\quad \frac{570\times 500}{1{,}470\times 0.8}=242 \text{ catties per } \textit{shih mou}$$

$$(1957)\quad \frac{570\times 650}{1{,}680\times 0.8}=276 \text{ catties per } \textit{shih mou}$$

These are, of course, not the only possibilities. For 1400, for example, one could obtain an estimate as high as 250 catties per *shih mou* if one assumed the population was 100 million, per capita output 600 catties, and grain acreage only 240 million *mou*. Such a result, however, is not very plausible. As argued in Appendixes A, B, and F, the "true" total acreage figure is more likely above 370 million *mou* than below, a figure of 100 million people is well above the most likely range, and 600 catties of grain output per capita is also a rather high figure.

These examples could be readily multiplied. If one were prepared to assume

6. The institutional case for the 1933 acreage data is made by Liu and Yeh, 1965, pp. 279–83.

that all the acreage estimates used here for the years prior to 1957 were biased upward (were higher than the true figures) or that population estimates had a substantial downward bias, one could raise the early yield estimates to something approximating the 1957 (or 1933) level. An assumption that per capita output was substantially higher in earlier periods than in 1957 would have much the same result. The reader must judge for himself how plausible these alternative formulations are.

National totals, however, obscure much that is relevant to the argument that yields increased. For example, could a shift in population onto high yielding land explain the rise in yields after 1400? The answer to this question is clearly no. Data in Table II.2 if anything suggest the opposite. The richest lands in China are the rice fields of the Yangtze River area in the south. The proportion of this

TABLE II.2. REGIONAL DISTRIBUTION OF CULTIVATED ACREAGE (PER CENT)

	1400		*1770*		*1873*		*1913*		*1957*	
Northeast	0		2		2		9		15	
Northwest	6	41	6	50	13	48	13	53	19	60
North	35		42		33		31		26	
East-Central	45	59	39	50	31	52	27	47	23	41
Southeast-Southwest	14		11		21		20		18	
Totals	100		100		100		100		100	

SOURCE: Tables B.8, B.12, and B.14.
Northeast: Heilungkiang, Kirin, and Liaoning.
Northwest: Shensi, Inner Mongolia, Sinkiang, Tsinghai, and Kansu.
North: Hopei, Shantung, Shansi, and Honan.
East: Kiangsu, Anhwei, and Chekiang.
Central: Kiangsi, Hunan, and Hupei.
Southeast: Fukien, Kwangsi, and Kwangtung.
Southwest: Kweichow, Yunnan, and Szechwan.

land to total cultivated acreage in China declined significantly between 1400 and the twentieth century. There was new settlement in the rich lands of the southwest, but this was more than matched by the resettlement of the dry lands of the northwest. The average quality of land declined over time. If the yield per unit area on any given quality of land had remained unchanged, the average on land of all types would have declined. Even a constant national average yield would imply that the yields on particular kinds of land were rising.

National totals can also obscure many errors in the underlying data. Major biases in the estimates of population and acreage in a small number of provinces could conceivably dominate the national totals, changing a picture of constant yields into one where yields appeared to rise or fall. It is desirable, therefore, to apply the method used in deriving yield estimates to the acreage and population figures for the individual provinces. This is done in Table II.3 for 1400, 1776, and

1851. The 1957 figures in Table II.3 were obtained by dividing State Statistical Bureau data on total grain output for each province by the cultivated acreage in grain.

TABLE II.3. APPROXIMATIONS TO GRAIN YIELDS (ALL GRAINS)
(*shih* catties/*shih mou* of cultivated area)

Province	YEAR *1400*[a]	*1776*[a]	*1851*[a]	*1957*[b]
Northwest				
Shensi	57–68	77–93	113–136	133
North				
Hopei	45–55	95–114 (−)	109–130 (−)	171
Shansi	48–57	136–163	171–205	144
Shantung	86–103	99–118	152–174	193
Honan	44–53	103–124	124–150	296
East				
Anhwei	105–125	209–251	285–342 (+)	327
Kiangsu		244–293	375–451 (−)	414
Chekiang	182–218	329–395 (−)	532–614 (−)	674
Central				
Hupei	146–175	206–247	469–563 (−)	482
Hunan		188–225 (+)	195–234 (+)	485
Kiangsi	183–220	255–306 (+)	371–446 (+)	465
SE				
Fukien	185–222	432–518	385–464	442
Kwangtung	81–97	265–315 (−)	278–334 (−)	467
Kwangsi	88–106	336–404	122–147 (?)	316
SW				
Yunnan	——	258–291	272–326	381
Kweichow	——	104–125	309–370	424
Szechwan	98–117	118–151	265–320	495

Underscore indicates figures more or less unchanged over time.
(+) Provinces which were major exporters of grain (hence their yield estimates should be raised slightly).
(−) Provinces which were major importers of grain (hence their estimates should be lowered slightly).
(?) Implausible approximation.
—— Indicates data were not available.
[a] The assumptions used in constructing the figures for these three periods were as follows:
(1) Per capita grain output was either 500 catties or 600 catties (250 to 300 kilograms).
(2) Population per province was as indicated in Table A.4.
(3) Cultivated acreage per province was as indicated in Tables B.8 and B.12. The year 1766 was used instead of 1776 and 1873 instead of 1851.
(4) The percentage of the cultivated area sown to grain was the same as the percentage of the sown area planted in grain in 1957. For Kiangsu, Chekiang, Hupei and Kiangsi a figure of 70 per cent was used; for Anhwei, Hunan, and the southwest a figure of 80 per cent was used; and for the remaining provinces, 90 per cent was used.
[b] These figures were derived from official grain output and cultivated acreage data in Tables B.14 and F.2 together with assumption (4) under footnote a.

If the pre-modern estimates of provincial population and acreage had been arrived at by arbitrary methods, one would expect yield data derived from such figures to rise in certain periods and fall in others with no apparent pattern. The estimates would also probably bear little relation to the 1957 figures. But most of the estimates in Table II.3 for 1850 bear a close relation to the 1957 figures. Furthermore, the changes in yields over time are almost all in one direction: rising. Only the estimates for Kwangsi (SE) and Yunnan (SW) behave in a completely implausible way. Thus the provincial yield estimates tend to support the contention that grain yields per unit of cultivated area rose between 1400 and the nineteenth or twentieth centuries.

With these provincial estimates in mind, it is useful to turn to the second approach to establish the plausibility of this increase in yields—that of use of direct yield data for different periods and different regions in China.

In local histories of Chinese *hsien* (counties) and provinces various kinds of yield and rent data occasionally appear. Rent data can be used to estimate yields because rents were generally about half of the main crop and seldom were less than 40 or more than 60 per cent of that crop.[7] In converting these yield and rent figures into common units one is faced with major problems due to lack of comparability of grain capacity and land measures over time and among regions. Perhaps even more serious is that yields within any given region and period differ greatly even when properly measured in comparable units. These difficulties are discussed at greater length in Appendix G.

The greatest supply of rent and yield data is for the rice crop in the east, central, and southern provinces. Averages derived from nearly 900 individual observations in over 100 different sources are presented in Table II.4. With the possible exception of Kwangsi (SE), the data from the local histories for all nine provinces in the table indicate some rise in yields over time. The figures for Kwangsi in the eighteenth century are difficult to interpret (see Appendix G) and there is only one Kwangsi (SE) observation for an earlier period. The Szechwan (SW) data for the nineteenth century are also of low quality. I have used only a single observation for seventeenth century Chekiang (E), but this figure is from a particularly reliable seventeenth-century agricultural handbook and is meant to be representative of a rather large area.[8]

If one averages the earliest figures available for each of the provinces, and compares this average with that for nineteenth-century data [1957 figures are used for Chekiang (E) and Yunnan (SW)], the rise is almost 70 per cent whether or not Kwangsi (SE) and Szechwan (SW) are included.[9] The figures are also broadly consistent with the estimates in Table II.3. In both tables, for example,

7. One can, of course, find a few examples of higher and lower rents, but too few to be a major source of bias. "Main crop" as used here refers to the crops harvested in the summer and fall. In the south, this crop is most generally rice (if there are two rice crops a year, both would be included in this concept), while in the north the crop is millet or *kaoliang*.

8. This figure is from the *Fu nung shu* as reported in Ch'en Heng-li, 1958, pp. 26–28. The figure is a rounded average of the yields on four different kinds of land.

9. The figure 70 per cent is derived from a simple unweighted average of the average yield of each province.

TABLE II.4. ESTIMATED RICE YIELDS (*shih* catties per *shih mou*—unhusked)

	PERIOD							
Province	*Sung* *960–1279*	*Yuan* *1280–1367*	*1368–1499*	*Ming* *1500–1599*	*1600–1699*	*Ch'ing* *1700–1799*	*1800–1899*	*1957*
East								
Chekiang	402 (115)	473 (28)	—	—	600	—	—	685
Kiangsu	326 (143)	347 (3)	—	450 (11)		550 (6)	501 (8)	433
Central								
Kiangsi North	—	—	—	400 (13)		423 (22)	423 (64)	400
Kiangsi Entire	—	—	—			—	—	343
Hunan	—	—	—	288 (7)		321 (16)	467 (50)	426
Hupei	255 (2)	—	—	250 (5)	249 (10)	267 (41)	555 (2)	517
SE								
Kwangtung-Swatow	—	—	—	512 (3)	484 (8)	486 (12)	1,299 (6)	900
Kwangtung-Entire	—	—	—	416 (14)	512 (11)	447 (37)	1,037 (19)	455
Kwangsi	—	—	300 (1)	—	—	438 (73)	—	400
SW								
Szechwan	178 (1)	—	—	—	—	—	263 (15)	641
Yunnan	—	—	—	—	380 (130)	—	—	447

( ) The figure in parentheses is the number of observations used in obtaining the average figure in the table.
— Indicates data not available.
SOURCE: See Appendix G. As indicated there, these figures were culled from local histories and from works by several Japanese scholars by Yeh-chien Wang in the case of Hunan and Kiangsu, and Mrs. Kuo-ying Wang Hsiao in the remainder. Many of these rice yield figures have been estimated from rent data.

there is a sharp rise in the yields of Hunan (C) and Hupei (C) in the nineteenth or twentieth centuries. The increases in Kiangsu (E), Chekiang (E), and Kiangsi (C) are much less dramatic in both tables. The figures for these three provinces in Table II.3, however, do indicate more of a rise than the estimates of Table II.4. The two tables, of course, are not precisely comparable in two respects, which may explain this difference. First Table II.4 gives figures for rice yields only, whereas the figures in Table II.3 are for all grains. Second, the data for these three provinces in Table II.4 are from the richest area in each province, areas that were heavily settled at an early date.

An additional problem with the averages in Table II.4 requires explanation—the indicated decline from the nineteenth century to 1957. This decline also results primarily from the fact that the data for the nineteenth century and earlier are biased toward high yield regions. The Kiangsu (E) figures are mostly from the rich regions of Soochow and Sung-chiang in the Yangtze delta, the Chekiang (E) data are almost all from three prefectures around the Gulf of Hangchow which were highly developed as early as the Sung; the Kwangtung (SE) statistics are from Swatow and other above average areas; and the Kiangsi (C) data are from the rich northern half of the province around Poyang Lake. Only the Hupei (C), Kwangsi (SE), Yunnan (SW), and, to a lesser degree, the Hunan (C) observations could be considered to be reasonably representative of their entire provinces. The Hunan (C) figures, however, tend to be dominated by data from the rich Ch'ang-sha and Heng-chou prefectures. The 1957 estimates, in contrast, are the average rice yield (per cultivated *mou*) on *all* the land in the province. Thus the indicated decline from the nineteenth century to 1957 is a reflection of the degree of upward bias in the earlier rent and yield data.

It would be desirable to derive a comparable table for the major grain crops of north China as well. Unfortunately, the historical records of the northern provinces are much less complete, the number of grain crops large (e.g., wheat, millet, corn, *kaoliang*, barley, oats, and potatoes), and land and capacity measures probably subject to greater differences and error than those in the south. Some data for Shantung (N), Shensi (NW), Honan (N), and Liaoning (NE) are presented in Appendix G. The Shensi (NW) figures are the most numerous (fifty observations), but too varied to admit firm conclusions, although it seems likely that yields in the seventeenth and eighteenth centuries were well under 100 catties per *mou*. The Liaoning (NE) figure is for a period (1640's) when that province was virtually unsettled, and hence not very meaningful. The Honan (N) figure for all grains of about 100 catties per *mou* in A.D. 1262 (as compared to 180 catties in the 1930's) is interesting because it is said to be the average on 96 million *mou* of land. One can surmise that the depopulation that followed immediately after this date (due to the Mongols) reduced available labor and hence yields, and that they then rose slowly again once peace was restored—but this is only surmise. In any case, it seems likely that grain yields in the north rose more or less as indicated in Table II.3, but the direct evidence is much less conclusive than that for southern rice.

The case for a rise in yields in China during the past six centuries, therefore, is not airtight. Most of the evidence available, however, tends to support the proposition that grain yields did, in fact, increase.

The Pace of Change (Late Fourteenth–Late Eighteenth Centuries)

The major engine generating this rise in yields was population growth. The pace of change tended to be dominated by the rate of growth in the number of people. The methods by which this growth raised farm output and yields are discussed in Chapters III and IV. Here the task is to examine the pace of change and see how much of the increased output can be accounted for by an expansion of the cultivated acreage and how much by a rise in yields.

To state that population growth largely determined the rate of growth in farm output is to reverse the usual Malthusian direction of causality, which has the pace of agricultural development determining the level of population. Increasingly, in recent years, scholars have questioned the validity of Malthusian analysis as an explanation of the rise in population in different parts of the globe (Boserup, 1965). The case for China can suitably be made in the context of our discussion of agricultural productivity.

China's population in the late fourteenth century was not much higher than the level achieved during the Han dynasty (206 B.C.–A.D. 220).[10] But the numbers did not remain constant at this level over the intervening fourteen-century period. During the eleventh century China's population most likely surpassed the 100 million mark for a time.[11] This eleventh-century rise may have fit the Malthusian pattern to a limited degree. By this period, a significant portion of China's population[12] was living in the southern rice regions where harvest fluctuations were much less severe than on the parched northern plains. Thus, famine may not have played such a large role in keeping the number of people in check. But the principal cause of the increase was probably the relative peace and stability achieved by the early Sung government.

The subsequent two centuries, however, were anything but tranquil. Most of the turmoil was connected with the rise and fall of the Mongols in China. Initially the Mongol armies sacked almost all of north China, as well as selected regions of the south.[13] Not only were large numbers of people put to the sword, but crops and grain stores were systematically destroyed so that vast numbers starved to death. Those who escaped starvation were felled by the increase in

10. Han population data are presented in Table B.7 and range from 48 million persons (in A.D. 146) to 60 million (in A.D. 2).

11. The number of families registered in the Sung censuses surpassed 20 million in the eleventh century, but there were, according to Sung records, fewer than three persons per family. If one assumes that most women and children were not registered and hence that the average family size was over five persons, then eleventh-century population surpassed 100 million. See Appendix A for a further discussion of Sung population statistics.

12. If Sung census data can be believed, over 60 per cent of China's population in A.D. 1080 lived in rice-growing areas (see Table A.1).

13. The Mongol campaigns and their relationship to population decline are discussed in detail in Appendix A.

disease that usually accompanies so much disruption.[14] Hence lack of food helped bring about a decline in population, but the lack of food resulted from political-military action—not from inadequate capacity of the economy to produce food under stable conditions.

The formal inauguration date for the Ming dynasty is A.D. 1368. From that year until the middle of the nineteenth century, the people of China lived in what for them was comparative peace and security. As a result, between 1400 and 1800 China's population rose six-fold from over 65 million persons to about 400 million. These increases, however, were not spread evenly over the entire period. The most rapid rise in population probably took place during the almost unprecedented peace and prosperity of the eighteenth century. The fifteen century may also have been a period of above average growth.[15]

Population growth in this period, it must be stressed, was rapid only by pre-modern standards. The average rate of increase over the four centuries was 0.4–0.5 per cent per annum and it is unlikely that even in the eighteenth century the rate rose as high as 1 per cent for any sustained period.[16] This compares with a rate of more than 2 per cent in China in the 1950's,[17] and rates of 3 per cent and more in many areas of the globe since World War II. Disease and famine took a heavy toll of lives in China between 1400 and 1800, but not so heavy as to offset completely the effects of a high birth rate.

Only during a decade or two of the seventeenth century was there apparently any sharp decline in the total number of people. In the first half of that century, battles between the Ming and the Manchu took a toll. Most important, Chang Hsien-chung with his army set out to murder virtually everyone in Szechwan and neighboring areas and may have come close to success.[18] Again, therefore, the cause of the decline in population was political-military in origin.

As in many other countries, the people of China did not spread themselves evenly across the available cultivable land. Prior to the T'ang period, they concentrated on the North China Plain. In the early Ming, they gathered in five east-central provinces mainly along the lower Yangtze River. There was almost

14. See, for example, the discussion of disease in the city of K'aifeng at this time in Hartwell (1967).

15. There is every reason to believe that population rose slowly during the Ming period, and some reasons for believing that the rise may have been more rapid in the fifteenth than the sixteenth century. There is, for example, some inconclusive evidence that floods and drought were more severe in the latter century (see Appendix A, nn. 27–29).

16. This conclusion is based on the data in Table II.1, on other official Ch'ing population data some of which are in tables in Appendix A, and on what we know of the performance of Chinese population under varying circumstances in the twentieth century prior to 1949.

17. Official Chinese estimates place the rate of growth of China's population in the 1950's at a little over 2 per cent. Some analysts in China and elsewhere, such as Ma Yin-ch'u, believe that the rate may have been a bit higher than that indicated by the official estimates.

18. James Parsons (1956, p. 92) quotes Li Wen-chih to the effect that about one million people were killed in the terror unleashed by Chang Hsien-chung, but any estimate has to be arbitrary because of the lack of meaningful population data for China in the sixteenth and early seventeenth centuries. The actual number of people put to the sword may have been well under one million, but disease, lowered birth rates, etc. may have reduced Szechwan's population by several times one million.

continuous migration out of these highly populated areas, but not at such a rate during these four centuries that the remaining total failed to rise.[19]

The migrations themselves were largely to a few areas in any single period. Parts of southwest China (Yunnan and Kweichow) were probably not heavily settled until the nineteenth century, and Manchuria was virtually empty until the late nineteenth and twentieth centuries. The resettlement of most of north China during either Ming or early Ch'ing times proceeded very rapidly, and then slowed markedly in the late eighteenth and nineteenth centuries with rapid rise renewed only with the advent of industrialization in the twentieth century.[20] The pace of settlement in southeast China was probably similar to that of the north.[21] Szechwan (SW) was resettled in Ming, laid waste by Chang Hsien-chung, and resettled again in the eighteenth century.

This uneven pace of settlement was not simply the result of peasant conservatism and reluctance to leave the home of their ancestors—although such influences undoubtedly played some role. In many instances, these areas were frontier regions in every sense, populated, however sparsely by hostile and warlike non-Han peoples.[22] Perhaps equally important, during the early development of several of these regions, crop fluctuations due to weather could be particularly severe, because of lack of adequate water control facilities. Furthermore, with the underdeveloped state of the commercial network, discussed in more detail in Chapter VII, a crop failure of a given magnitude undoubtedly took a heavier toll of human life in the outlying than in the more developed areas. Over the long run a farm family might be more prosperous in Yunnan (SW), but in the short run half its members might die.

Whatever the constraints on migration, there is little reason to believe that prior to 1800 people in China were so concentrated into a few areas that they were pressing at the upper limit of the potential food supply in those areas. Many died of starvation, but in particularly bad years and not because long-run

19. For a discussion of several of the major migrations in this period see P. T. Ho, 1959, pp. 136–68.

20. These conclusions are based on population data in Appendix A, but most can be verified by qualitative evidence as well. The hardest to verify is the resettlement of the north China plain, probably because of the poor quality of the records for the area. One can, however, find evidence that Hopei (N) was resettled by people from Shansi (N) and northern Kiangsu (E) during Ming times (e.g., in Gamble [1963], Village C was founded by migrants from Shansi in the late fifteenth century and Village A by a Ming eunuch in 1440). The principal basis for believing that there must have been northward migration is the fact that the population of the four northern provinces rose from something over 13 million in 1393 to 75 million in 1776, an increase of 480 per cent as compared to a rise of 300 per cent for the country as a whole.

21. Memorials written in the fifteenth century indicate that there was large-scale migration into Hu-kwang (C), the southeast, and southwest at that time. In the fifteenth century there may still have been some migration out of the north, but this latter trend must have been reversed later. See memorials of Sun Yuan-chen (1454), Ma Wen-sheng (1426–1510) and others in Ch'en Tzu-lung, Hsü Fu-yuan, and Sung Hui-pi (1964), 3/715–16 and 5/429–30.

22. Anyone who doubts this statement should read the accounts of European travellers to Manchuria in the late nineteenth century and Yunnan somewhat earlier (e.g., James, 1888, and Margary, 1876).

average grain output was inadequate. Only in periods of civil war does the death rate appear to have exceeded the birth rate for any sustained period.

From the data in Table II.3 and A.4, and from national average yield calculations, it would appear that yields began to rise soon after an area was settled. People did not first spread evenly over the land in any given province. Instead, extending the cultivated acreage and raising yields proceeded together.

Because population data of sufficient quality are not available for the period between 1400 and the 1770's, it is not possible to differentiate the periods in which the principal cause of increased grain output was a rise in yields from those in which it was an extension of the cultivated acreage. One can, however, estimate the share of each in rising output over the entire period. One way of doing this is to ask what grain output in the 1770's would have been if yields had remained at the 1400 level and only the cultivated acreage had been expanded. Using the acreage data in Table II.1 and a yield figure of 139 catties per *mou* for 1400 and for 1770, grain output would have risen from about 20 million tons to about 50 million tons. If yields were to have risen enough to maintain per capita grain output at the 1400 level, output in 1770 would be approximately 75 million tons. Hence of a total increase in output of 55 million tons, 30 million tons (55 per cent) was accounted for by increased acreage, and 25 million tons (45 per cent) by a rise in yields.[23] Alternate assumptions would give rise to slightly different figures, but the result of most such calculations is that rising yields and expanded acreage share more or less equal credit for the increase in total grain output in this period.

A Declining Growth Rate, 1800–1900

From the calculations of an estimated national average yield earlier in this chapter, and assuming constant per capita consumption, one would have to infer that yields rose about 46 per cent between 1400 and 1770 and another 17 per cent in the short span of the next eighty years. This would be an acceleration in growth in yields, even allowing for the fact that these eighty years were the one period when the increase in acreage in the south was greater than in the north. It would appear more reasonable to assume that per capita output was declining slightly in this latter period as a result of increased population pressure on the land (and perhaps that it was rising prior to 1770).[24] If per capita output did not decline between 1770 and 1850, then the credit for the rise in total grain output was shared more or less equally by increased yields and expanded acreage. If per capita output was declining, the share of yield increases would correspondingly be reduced.[25]

23. See calculations and discussion of alternative methods of arriving at the share of yields and acreage in rising output in the notes to Table II.10.

24. All statements about trends in per capita output and consumption refer to long-run trends. Within any long-term movement, of course, there will be considerable short-run fluctuation.

25. See Table II.10.

By the nineteenth century, China had begun to run out of readily cultivable land. To be sure, the amount of cultivated land increased about 40 per cent in the hundred years prior to 1957, but about 80 per cent of this increase was onto low quality land in Manchuria, Inner Mongolia, and elsewhere in the northwest.

This pressure on available land was accompanied by the decline in power and vitality of the Ch'ing dynasty. An argument frequently made is that dynastic decline was generally accompanied by a failure to tend the dikes and irrigation works, which in turn led to crop failures and general economic decline. Whatever the explanation, it would appear that economic conditions in the nineteenth century, particularly the latter half, had worsened. There are numerous observations by individuals living in China to this effect, but such statements are notoriously unreliable indicators of real economic performance. Tables II.5 and II.6 contain information culled by mainland Chinese historians from official

TABLE II.5. IMPLIED INDEX OF FARM YIELDS (1821–1911)

Year	*Summer Harvest*	*Fall Harvest*	*Average*	*Implied Index*
	(per cent of standard yield)			
1821–1830	71.0	74.0	72.5	100
1831–1840	66.8	66.6	66.7	92
1841–1850	66.7	66.0	66.4	92
1851–1860	63.0	63.5	63.3	87
1861–1870	58.5	60.0	59.3	82
1871–1880	57.5	58.8	58.2	80
1881–1890	58.8	57.0	57.9	80
1891–1900	57.5	55.0	56.8	78
1901–1911	57.5	55.0	56.8	78

SOURCE: *CKNY*, Vol. I, pp. 755–760. These figures are simple arithmetic averages of the percentage yields of nine provinces in the case of the summer harvest and ten provinces for the fall harvest. The original figures were expressed in terms of tenths and not carried to any further decimal place. The trends in each province were similar enough so that an average weighted by some other means would not have changed the results significantly. The provinces included in these indexes are: Hopei (N), Honan (N), Shansi (N), Shensi (NW), Anhwei (E), Kiangsi (C), Hunan (C), Hupei (C), and Fukien (SE). Chekiang (E) is included in the fall harvest index, but not that for the summer harvest.

reports of the period. Needless to say, estimates by officials of the quality of the harvest in their region expressed as a percentage of some ill-defined ideal level are not reliable. The figures used to construct Table II.5, however, all point in the same direction. If the percentages are not precise, at least the official reporters were in near unanimous agreement that the harvests were poorer than previously. There is, however, a certain lack of consistency between the yield estimates and the figures for the number of *hsien* effected by natural disasters (Table II.6). The latter indicate considerable improvement during the T'ung Chih restoration period (1862–1874), as one might expect given the political stability of that period, but the former data indicate steady decline. Both sets of figures indicate very poor conditions during the last three decades of Ch'ing rule (1881–1911).

TABLE II.6. AREA AFFECTED BY NATURAL AND MANMADE DISASTERS (1846–1910)
(No. of *hsien* and *chou*; annual averages)

Year	Yangtze Area	Yellow River Area	Total
1846–1850	129	116	245
1851–1860	116+	54	170
1861–1870	59	66	125
1871–1880	73	145	218
1881–1890	183	256	439
1891–1900	186	217	403
1901–1910	167	200	367

SOURCE: *CKNY*, Vol. I, pp. 720–22, 733–35. The 1851–60 figures for the Yangtze area are incomplete because of the Taiping rebellion.

[a] The original source lumps *hsien* (counties) and *chou* (districts) together. There is thus no way of separating one from the other.

The most important effect of political decline on the economy in this period operated not so much through the failure to maintain irrigation and flood control works, however. In the 1850's China was again visited by that most effective of checks on population growth, civil war. The largest rebellion, that of the Taipings, was probably directly responsible for the deaths of over 20 million people.[26] The Moslem rebellions in the northwest in the 1860's and 1870's also wreaked their share of havoc on the population, making up by viciousness for their failure to be located in the most densely populated regions. Altogether these midcentury conditions probably accounted for a decline in population of over 50 million, due partly to war casualties and famine and partly to lowered birth rates and higher death rates indirectly attributable to the fighting. For those who find such a large decline difficult to accept, the issue is argued at greater length in Appendix A.

TABLE II.7. STAGNATION IN THE TAIPING PROVINCES

	POPULATION (*millions*)		CULTIVATED ACREAGE (*million* mou)	
	1861	*1953*	*1873*	*1957*
East				
Kiangsu	44.3	47.5	84	93
Anhwei	37.6	30.3	82	88
Chekiang	30.1	22.9	42	33
Central				
Kiangsi	24.5	16.8	47	42
Hupei	33.8	27.8	51	65
Total	170.3	145.3	306	321
All China	405.1	581.3	1,210	1,678

SOURCES: See Appendixes A and B.

26. See discussion in Appendix A.

It is interesting to speculate on the extent to which the Taiping rebellion was the result as well as the cause of economic decline. In four of the five provinces most affected by the rebellion, population by 1957 had not recovered to the reported levels of 1851 and the same would be true of the fifth if it weren't for the rise of Shanghai (Table II.7). This lack of full recovery may simply reflect the impact of the rebellion, but it is more likely to indicate that these provinces were badly overpopulated in the early nineteenth century.

In one sense, therefore, it may be argued that the Taiping rebellion, by alleviating population pressure, helped delay a Malthusian day of reckoning for Chinese agriculture, but this is getting ahead of the story. What is relevant here is that by the nineteenth century the share of increase in output that could come from extending cultivated acreage had declined sharply. Were it not for the Taiping rebellion, rising population in the late nineteenth and early twentieth centuries might have outstripped the ability of Chinese agriculture to provide adequate food supplies.

AGRICULTURAL GROWTH IN THE TWENTIETH CENTURY

If the declining availability of rich uncultivated land began to put pressure on consumption standards in the nineteenth and twentieth centuries, China's traditional agriculture had not completely run out of growth potential. From 1911 through 1957, farm output was probably able to nearly keep pace with a population that rose 50 to 60 per cent or a little less than an average of 1 per cent per year.[27] It was not until population growth accelerated to over two per cent per year in the 1950's and 1960's that, as is argued in subsequent chapters, an approach was required that did not rely on traditional methods of raising productivity.

If output kept up with population growth in the first half of the twentieth century, it did so with little margin to spare. In Tables II.8 and II.9, the results of an attempt to measure agricultural output during the period 1914–1957 are presented. The 1957 data are generally viewed as the most reliable of those published by the State Statistical Bureau, the 1931–1937 figures are full of problems, and many would argue that the 1914–1918 statistics cannot be used at all. Unlike the estimates for the period prior to 1914, data cover crops other than grain for the post 1914 period at least well enough to warrant an attempt to calculate the gross value of all agricultural output, not just of grain.

In constructing these estimates I have started from the insight of Ta-chung Liu and Kung-chia Yeh that the Nationalist estimates for 1931–1937 (or 1933) for the acreage sown to rice result from the application of an essentially correct percentage (for a given province) to an incorrect total acreage figure (for that province) (Liu and Yeh, 1965, p. 284). The same assumption was applied to all other crops not only for 1931–1937 but for those provinces that were effectively

27. The case for believing that population growth in the first half of the twentieth century must have approached 1 per cent a year is made in Appendix A. There is direct as well as indirect evidence suggesting that such a rate must have prevailed.

TABLE II.8. GROSS VALUE OF FARM OUTPUT (1914–1957)
(billions of 1933 *yuan*)

	1914–1918[a]	1931–1937		1957	
		This study[a]	*Liu-Yeh*[b]	*This Study*[a]	*Liu-Yeh*[b]
Grain	9.15[c]–10.17	10.31[c]–10.96	12.64	12.32	13.58
Soybeans	0.43	0.66	0.92	0.78	0.78
Oil-bearing crops	0.51	1.13	0.75	0.77	0.42
Cotton and other fibers	0.78	0.86	0.74	1.28	1.32
Tobacco, tea, and silk	0.49	0.52	0.59	0.32	0.34
Sugar cane and beets	0.11	0.11	0.05	0.14	0.14
Animals	1.14	1.40	1.34	2.74	1.70
Subtotal	13.63	15.65	17.03	19.36	18.19
Other Products	[3.40][d]	[4.14][e]	4.14	[4.91][e]	4.91
Total Gross Value	16.01–17.03	19.14–19.79	21.17	24.27	23.10
Per capita[f] (*yuan*)	36.1 –38.4	38.1 –39.4	42.2	37.5	35.7

Exchange Rate: one 1933 *yuan* = 1933 U.S. $0.26 = 1957 U.S. $0.655.

[a] For the methods used in arriving at these estimates, refer to Appendixes C and D.

[b] Liu and Yeh, 1965, pp. 397–400. The Liu-Yeh estimates are for 1933, not 1931–1937.

[c] The lower ends of these ranges were arrived at by assuming that the value of grain output in 1914–1918 was 10 per cent below the higher figure for 1914–1918 and in 1931–1937 was 5 per cent below the higher figure for 1931–1937. The lower figures, in effect involve the assumption that yields rose by slightly more than 5 per cent between 1914–1918 and 1931–1937 and between 1931–1937 and 1957 over and above any increase in yields due to changing the mix of grain crops or an increase in double cropping.

[d] This figure was obtained by taking 25 per cent of the subtotal (approximately the same percentage (24.7) as in 1931–1937).

[e] I have used the Liu-Yeh estimates to fill the gap in my data. These figures have almost no effect on the percentage increase in my estimates.

[f] Population data used in this calculation were taken from Table II.1.

TABLE II.9. INDEXES OF PER CAPITA FARM OUTPUT

	1914–1918	*1931–1937*	*1957*
Grain	100	89–106[a]	90–100[a]
Other Crops	100	163	97
Animals	100	109	165
Total	100	99–109[a]	98–104[a]

SOURCES: Table II.1 and II.8.

[a] These ranges are the highest and lowest figures that can be derived from the ranges in Table II.8.

controlled by the Peking government in 1914–1918 as well. For provinces not controlled by the Peking government, or where other factors make the data clearly unreliable, I have projected the 1931–1937 figures backward. In effect, in order to obtain the acreage sown to each crop, the percentage sown to each crop in each province in every year has been calculated and then applied to provincial sown acreage figures independently arrived at (see Appendix C).

Output figures were arrived at first by applying 1957 yields to the other two periods, with a few exceptions where there is clear evidence of change. A second calculation was then made, using the assumption that individual grain crop yields rose 5 per cent between 1914–1918 and 1931–1937 and another 5 per cent from 1931–1937 to 1957. This procedure differs from that of Liu and Yeh, who for their 1933 estimates averaged the yield estimates of John Lossing Buck and the National Agricultural Research Bureau. Their procedure leaves one with the problem of explaining a sharp drop in yields for several grain crops from 1933 to the 1950's—an event not likely to have occurred. The Buck grain yield figures, in particular, are in several important instances as high as the admittedly falsified Communist estimates of 1958, while those of the NARB are only a little below or roughly the same, as far as national averages are concerned, as those of the Communists.[28] The prices used are those of Liu and Yeh for 1933, the year for which the most complete price data are available.

Some may argue that the use of the 1914–1918 figures, even only to calculate the percentage share of each crop in the total acreage, is unwise. A survey of the tables in Appendix C, in my opinion, shows a high degree of consistency among the data for the various periods including 1914–1918. The trends shown also are roughly consistent with independent estimates of Buck, although the trends in my figures are considerably more pronounced.

The principal trends involved are major increases in acreage sown to corn and potatoes and more modest increases in the acreage sown to wheat and rice. At the same time, the importance of barley and *kaoliang* declined. Accompanying these trends was a net increase in total acreage sown to grain of almost 400 million *mou*, over half of which was in corn and potatoes.[29]

The performance of cash crops will be analyzed in more detail in the chapters on marketing. Here it should simply be pointed out that several of these crops grew substantially in the decades prior to 1937, particularly soybeans and other oil-bearing seeds, and then fell off markedly by the 1950's. These trends are quite clear and readily documented. The high figure for animals in 1957 is less easily supported. Liu and Yeh reject the figure and substitute a lower estimate of their own. On the other hand, this high figure, due primarily to hogs, may simply reflect distortions resulting from collectivized agriculture. Hogs were privately raised and could be sold on a free market in 1957, but this was not the case for grain. The 1914 to 1931 rise in oxen, water buffaloes, sheep, and donkeys may also be a statistical illusion.

Whatever assumptions one makes about hogs, it is reasonably clear from data in Tables II.8 and II.9 that agricultural output in the first six decades of the twentieth century could not, over the whole period, have done much more than

28. See Appendix D.

29. See Tables C.5–C.12. Acreage of expanding grain crops increased by just under 500 million *mou* and that of *kaoliang* declined by about 80 million *mou*.

keep up with population growth. Unless one is prepared to argue that yields rose much more rapidly than suggested by these estimates or that population growth was significantly lower, it is difficult to see how per capita consumption of grain or of total farm produce could rise. This conclusion seems inescapable, however one stands on the rate of growth in agriculture between 1952 and 1957[30] or the magnitude of the difficulties since 1957.[31]

If a rate of growth of one per cent a year or less represents the long-term potential of Chinese agriculture within the context of a traditional technology, then the implications of the sharp decline in death rates in the 1950's are dramatic. In effect, the Chinese Communists must at least triple the long-run average rate of growth in Chinese agriculture if they are to break out of poverty into sustained increases in their standard of living. Such increases will have to be achieved without much expansion in cultivated acreage. Easily usable land has mostly been exploited and new land can be made suitable for crops only with large expenditures on irrigation works and the like. In 1958, the government even experimented with a reduction in total acreage in order to try to raise output by concentrating non-land inputs.

If China had run out of easily cultivated new land by 1957, however, this was not the case during the first half of the twentieth century. The opening up of Manchuria was the principal source of new land, but there was also an extension of cultivation in the northwest. In fact, the expansion of cultivated acreage in the twentieth century may have accounted for a greater share of the rise in grain output (*vis-à-vis* a rise in yields) than in previous periods. The likely range of possibilities for the twentieth century together with the estimates for the earlier periods are presented in Table II.10. The numbers in the table are, of course, subject to a wide margin of error.

Chinese Agriculture in the Mid-Twentieth Century

For six centuries China's population grew and somehow Chinese agriculture managed to keep pace. This growth was anything but even. Population stagnated or fell at times as a result of civil war and accompanying disasters, and agricultural output probably stagnated or fell along with it. Nor did the productive capacity of the farm always keep up with the increased number of people during periods of comparative stability. The early nineteenth century, for example, may have been a time when the rate of population growth began to creep ahead of the rise in grain production. The first half of the twentieth century, on the other hand, may have witnessed a more or less equal match between a rising population and increased output.

30. The official rate of growth in agricultural output for the 1952–1957 period is over 4 per cent per year, but many Western analysts feel this figure is too high.

31. Probably the best guess for the 1957–1966 period would be a sharp drop in grain output in 1959–1961 of about 15 to 20 per cent in *absolute* terms and a recovery by 1964 or 1965 to something approaching the *per capita* levels of 1957. The average rate of increase in total grain output over the 1957–1966 period, therefore, would be perhaps one per cent per year or slightly less. See discussion in Perkins, 1967, pp. 35–39.

TABLE II.10. SHARE OF YIELDS AND ACREAGE IN INCREASED GRAIN OUTPUT
(Percentage shares)

	1400–1770	*1770–1850*	*1914–1957*
Increases in yield	42[a]	47[b]	24–45[c]
Extensions of cultivated acreage	58	53	76–55
Total	100	100	100

Explanation of Table: The figures in this table are suggestive only. By changing the numbers around one can get percentages different from those in this table. It should also be pointed out that to say that 50 per cent of the increase in output was accounted for by a rise in acreage, in this context, does not mean that land alone was responsible. This increase in output would not have been possible without a commensurate increase in capital and labor inputs sufficient to maintain yields at a constant level. Some idea of the share of the factor land alone can be obtained from the calculations in the mathematical supplement to Chapter IV.

[a] The percentage shares for the 1400–1770 period were calculated according to the formula:

$$\frac{(1770 \text{ population} \times 570 \text{ catties} - 1770 \text{ grain acreage} \times 1400 \text{ yield})}{(1770 \text{ population} \times 570 \text{ catties} - 1400 \text{ population} \times 570 \text{ catties})}$$
= the share of yields in the rise in output.

The actual numbers used are

$$\frac{270 \times 570 - 950 \times 0.8 \times 139}{570\,(270-72)} = 0.42$$

The 1400 yield figure is that derived in the text at the beginning of this chapter. Clearly the use of a different level of per capita output, a different 1400 yield figure, etc., would lead to somewhat different results.

[b] The formula used in deriving this percentage was,

$$\frac{410 \times 570 - 1210 \times 0.8 \times 203}{570\,(410-270)} = 0.47$$

The yield figure of 203 catties is that derived by assuming per capita output in 1770 was 570 catties and using the acreage and population data in Table II.1.

[c] Using the grain output data in Table D.14 and the acreage data in Table II.1, one can derive a 1914–1918 yield figure of 208 catties per *mou*. If the yield in 1957 had only been 208 catties, output would have risen from 142 million tons to 174.5 million tons instead of 185 million tons. Under these conditions, 24 per cent of the rise in output would be accounted for by a rise in yields. These yields are sown acreage yields whereas those in footnotes a and b are cultivated acreage yields.

If instead one assumed that the per capita consumption of grain in 1914–1918 was 570 catties and derived a yield figure from that (180 catties), the share of yields would be 54 per cent. But this would imply an improbably high increase in yields (over 20 per cent). I rather arbitrarily lowered the maximum possible share of yields to 45 per cent.

Whatever the precise pace of development in per capita grain output in any given century, the level of per capita grain output in 1957 was quite high by world standards. Some comparisons with other nations are presented in Table II.11. From these it is apparent that China in the 1950's was further removed from a level of "minimum subsistence" than is commonly supposed. "Minimum subsistence" is, of course, a vague term, and there may have been a number of reasons why Chinese required higher ratios for survival than either Indians or Japanese. But the differences among these three countries are, in any case, quite striking. Only in recent years has the per capita availability of grain in Japan matched or surpassed the level of China in 1957 and per capita supplies in India in the late 1950's were only two-thirds of those in China. Japan in the early Meiji period at the beginning of her century of growth was able to feed itself only at a level comparable to that in India today.

TABLE II.11. PER CAPITA GRAIN OUTPUT AND SUPPLY

Country	*Year*	*Per Capita Output* (*kilograms of unhusked grain*)	*Per Capita Supply*
China	1953	269[a]	267[a]
China	1957	286	285
Japan	1878–1882	—	230[b]
Japan	1934–1938	246	286
Japan	1947–1948	213	230
Japan	1957–1959	246	289
India-Pakistan	1934–1938	202	208
India	1957–1959	183	191
Pakistan	1957–1959	215	230

SOURCE: Except where otherwise noted, these data are from Table F.3.

[a] These figures were all derived from official Chinese estimates. The population figure is that obtained in the 1953 census, the production figure is from *Ten Great Years* (*TGY*) p. 119, and the grain export figure is from *T'ung-chi kung-tso* data office, "The Basic Situation With Respect to Our Country's Unified Purchase and Sale of Grain," *Hsin-hua pan-yueh-k'an*, Nov. 25, 1957, pp. 171–172. The export figure excludes soybeans.

[b] According to Y. Hayami and S. Yamada, between 1878–1882 and 1918–1922, Japanese per capita calorie intake (from grains and potatoes) rose 24 per cent from 1,664 to 2,059 calories per day (Rosovsky, 1968). Per capita consumption changed little in the 1920's and 1930's so I applied this percentage to the FAO figure for 1934–1938 to obtain the figure in the table.

The low levels of output in India in the 1950's or Japan in the late nineteenth century were not compensated by greater production of other farm products. Even in 1952, the gross value of all farm output (per capita) in China was 25 to 29 per cent higher than in India at roughly the same time (14 to 22 per cent if livestock are included).[32] If 1957 gross value figures for China are used, the difference in per capita farm output is about 40 per cent.[33] In Japan in 1878–1882, some 72 per cent of the nation's gross agricultural product came from grain, as contrasted to 55 per cent in China in 1957.[34] Therefore, differences between

32. Eckstein, 1961, p. 67. The lower figure is that obtained by using Chinese prices, the higher figure by using Indian prices. I have stressed the figure exclusive of livestock because India's livestock population is hardly an unqualified asset.

33. Official Communist figures show a rise of 11 per cent in per capita gross agricultural output between 1952 and 1957. The Eckstein estimates are in essence based on disaggregated official data so application of this 11 per cent figure to his estimates is proper as long as not too much precision is claimed.

34. The Japanese percentage was derived from data in Ohkawa, 1957, pp. 57–58. The Chinese figure was derived from data in Table II.8.

Chinese and Japanese per capita levels of total farm output would be even greater than for grain alone.

Chinese agriculture thus managed not only to keep the people of China alive, it even was able to produce a small "surplus" above survival. This surplus allowed China to raise the rate of investment in industry in the 1950's to a level comparable to that in a number of industrial nations[35] and to survive a sharp drop in farm output in 1959–1961—a decline of perhaps 20 per cent—apparently without widespread starvation (Perkins, 1967).

Perhaps half of the increase in grain output over this six-century period was accounted for by the expansion of the cultivated acreage. But if expanding acreage had been the only way of raising output, China's population would long ago have begun to feel the pressure of inadequate food supplies. As it was, yields rose rapidly enough to assure not only survival but, as already mentioned, a small surplus.

By 1957, Chinese yields were equal to or slightly above those of early Meiji Japan and double or triple those of India and Thailand (see Table II.12). In the case of India, different weather and soil conditions account for part of the gap, but Thai rice is grown on a rich semitropical river delta. Interestingly, present

TABLE II.12. RICE YIELDS
(catties/*mou*)

Country	*Year*	YIELD (UNHUSKED RICE) *per sown* mou	*per cultivated* mou
China	1957	359	457
Chekiang	,,	489	685
Szechwan	,,	440	641
Hunan	,,	341	426
Japan	1878–1882	337	—
Japan	1953–1962	631	—
Taiwan	1953–1962	391	—
India	1953–1962	181	—
Thailand	1953–1962	184	—
Indonesia	1953–1962	232	—
Korea	1953–1967	367	—

SOURCES: The Chinese sown acreage yields are from Chen, 1967, pp. 318–35. The cultivated acreage yields are from Table II.4. The other sown acreage yields are from Rosovsky (1958), whose data in turn are based on the estimates of Y. Hayami and S. Yamada. For a different view of the level of rice yields in Japan in 1878–1882, see Nakamura (1966).

35. The Chinese rate of investment (GDI/GDP) was about 20 per cent in the late 1950's.

CHAPTER THREE

Improved Seeds, Changing Cropping Patterns, and New Crops

"Traditional agriculture" can be defined as a system possessing certain cultural values, patterns of personal relationships, or any number of other characteristics. For the economist, the most useful definitions involve differentiating between a "modern" technology and a "traditional" technology. A traditional technology may stagnate and remain unchanged for centuries, or there may be gradual improvements introduced into it. If there are improvements, however, they are generally discovered by the farmer himself or adopted from other farmers. Sometimes the spread of new techniques is aided by government officials and merchants, but the original source is usually an individual peasant's tinkering with the methods available to him. Modern technology, in contrast, involves the application of the scientific method to the problems of agriculture and is generally done by trained specialists, not the farmers themselves. When new equipment or other materials are involved, they often, but not always, are produced outside of the agricultural sector in modern industrial enterprises.

In some rural societies the traditional methods have been known for so long that production has gradually approached an equilibrium where further increases in output are not possible (see, e.g., Schultz, 1964). But in China population and presumably output rose about six times between the fourteenth and nineteenth centuries and then by another 50 per cent by the middle of the twentieth century. As indicated in the previous chapter, only about half of this rise can be accounted for by an extension of cultivated acreage. The remainder was brought about by a doubling of the yields of the major grain crops.

If there was something like a doubling of grain yields, how did it happen? The