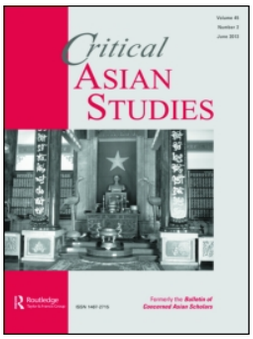


Bulletin of Concerned Asian Scholars

ISSN: 0007-4810 (Print) (Online) Journal homepage: www.tandfonline.com/journals/rcra19

How China is solving its food problem

Benedict Stavis

To cite this article: Benedict Stavis (1975) How China is solving its food problem, Bulletin of Concerned Asian Scholars, 7:3, 22-38, DOI: 10.1080/14672715.1975.10406379

To link to this article: https://doi.org/10.1080/14672715.1975.10406379

How China is Solving its Food Problem

by Benedict Stavis

Introduction

The world food crisis of 1974 has brought into sharper focus the whole range of questions involving food, including production and distribution. In widespread regions of South and Southeast Asia, as well as Africa and South America, hunger and malnutrition are the *normal* situation for large segments of the population; in years of poor harvests, famine and death are widespread.

China is almost unique in Asia as a land free of widespread hunger, malnutrition, and famine. Virtually every group of visitors, whether reporters, medical specialists, or agricultural scientists, has been stunned by the nutrition and health of the Chinese population.[1] How has China managed to do this? What policies have been adopted to solve the food problem? The Chinese explanation for their success is that the crucial factor is politics, "politics in command." There is much truth in this interpretation. Although people cannot eat ideological and political books or organization, the patterns of political organization do affect the ability of a country to generate, diffuse, and adopt modern technology, and to distribute the fruits of modern productivity.

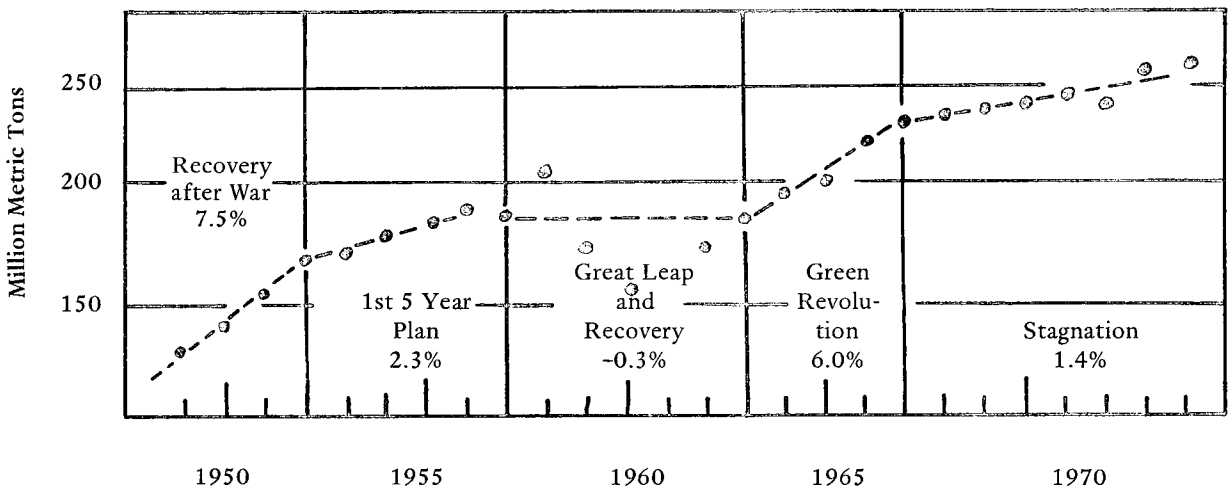
Section I of this paper will specify the extent to which agricultural technology has changed in China. In a word, large regions now have modernized agriculture. The green revolution is spreading rapidly; serious problems loom ahead, but they can be managed. Section II compares the extent of change in China with that in other countries, and concludes that agricultural development is progressing as or more rapidly in China as in many other Asian countries. China is especially successful in distributing food fairly over time, space, and social standing. Section III looks at some of the political decisions and organizational devices which have contributed to rapid agro-technical development in China.

I
CHANGES IN CHINA'S AGRICULTURAL TECHNOLOGY

Although the social and political aspects of rural policy in China have received most attention, these changes are in fact closely intertwined with the technological transformation of agriculture—China's green revolution. The importance, timing and relation to social changes of China's green revolution were suggested by Mao Tse-tung almost twenty years ago:

> *We are carrying out a revolution not only in the social system, changing from private ownership to common ownership, but also in technology, changing from handicraft production to mass production with up-to-date machinery. These two revolutions interlink.*
>
> *. . . The economic conditions of our country being what they are, technical reform will take longer than social reform. It is estimated that it will take roughly four or five five-year plans, that is, twenty to twenty-five years [i.e., until 1975-80], to accomplish, in the main, the technical reform of agriculture on a national scale.*[2]

Figure 1. Trends in Grain Production, 1949-73



Source: Benedict Stavis, Making Green Revolution: The Politics of Agricultural Development in China *(Ithaca: Cornell Center for International Studies, 1975), pp. 12-15.*

To some extent Mao underestimated the difficulty and magnitude of the task of transforming agricultural technology. Mao also overemphasized the importance of mechanization and gave inadequate attention to biological and chemical transformations in agriculture. Nevertheless, Mao's prediction of the phases through which agriculture would pass was remarkably accurate. Before 1962 overall rural policy emphasized social transformation, namely the establishment and consolidation of a collective agricultural system. Since then rural policy has put equal attention or even priority on technical transformation. This new thrust in policy was announced at the Tenth Plenum of the Eighth Central Committee, meeting in September 1962. A Chinese economist interpreted the new policy as follows:

> *The decision of the Tenth Plenum means that in the field of agriculture the main emphasis has been shifted from social transformation to technical transformation.*[3]

A. Trends in Grain Production Over Time and Space

This discussion refers to grain production, which includes cereals (rice, wheat, sorghum, millet, maize, etc.) and potatoes. Other agricultural products, such as pulses (various types of beans), oil-bearing crops (peanuts, soy beans), vegetables, fruits, animal and fish products, dairy products, industrial crops such as cotton and other fibers, tobacco, tea, medicinal herbs, sericulture and many other products are not included in grain production. In China, as in other countries, these subsidiary crops have much higher profits and provide a major part of rural cash income because government policy keeps the price of food grains low. In part C below, the significance of agricultural diversification and its impact on family income will be discussed.

In Figure 1 statistics for food grain production in China are offered. For the period before 1958, these are based on

Note: This paper is an updating, summary, and extension of two monographs, *Making Green Revolution, the Politics of Agricultural Development in China* and *People's Communes and Rural Development in China.* Both are published by the Rural Development Committee, Center for International Studies, Cornell University, 1974.

estimates developed by Kang Chao, which are somewhat higher than official statistics, on the presumption that the Chinese underestimated sown area.[4] For the years after 1958, sources are whatever official or unofficial reports the Chinese have made on their food grain production.

During the 22 years from 1952 (after recovery from chaos and war) until 1974, grain production rose from about 166 million tons to about 257 million tons—an annual compound growth rate of 2 percent. The growth has been concentrated in certain years and in certain regions.

Mobilization of Traditional Resources

For the first years after the victory of the revolution, grain production grew very rapidly at 7.5 percent. I believe this reflects the termination of disruptions associated with over a decade of international and civil war more than it reflects energies released by land reform.

From about 1952 to 1957, during the First Five Year Plan, grain production increased at an average rate of growth of 2.3 percent. This growth was associated with an increased utilization of traditional resources, especially labor, and the repairing of irrigation systems, so that the prewar system could be brought back into full use. I do not believe that much of the growth of grain production is explained by institutional reforms, i.e., the establishment of cooperatives. Evidence for this view is presented below, in the context of a discussion of incentives. By 1957, the traditional resources were again fully utilized, and agriculture could not grow above this plateau of 185 million metric tons without technological change.

Transition

From 1958 to 1963, grain production first went up sharply, then dropped into a deep depression and recovered. While bad weather was one of the reasons for the sharp decline, a more important factor was an attempt to increase agricultural production beyond the limits of traditional agriculture without supplying enough modern inputs, and by popularizing techniques that were inappropriate to many regions. The Great Leap Forward could not speed up the agricultural growth rate simply with organizational transformation and ideological pressure. The agricultural balance was upset, and it took until 1963 to recover fully.

Technical Transformation

From 1964 to 1967, grain production rose very rapidly above the 1957 plateau, at an average of 6.0 percent each year. This is the period in which China rapidly adopted modern agricultural inputs, following the decisions of the Tenth Plenum.

Since 1968, grain production has grown at only 1.4 percent annually. The stagnation after 1968 has several causes which will be considered later.

Distribution of Agricultural Development over Space

Agricultural development proceeds on a region-by-region basis because the technical inputs for modern agriculture must be used together. High-yielding varieties of seeds require improved irrigation systems, more fertilizers, and improved patterns of pest control. New cropping patterns are possible if mechanization can be supplied. Economic theory calls this the principle of *complementarity;* Mao Tsetung thought calls this the principle of "concentrating forces and winning battles of annihilation." Because China cannot produce these inputs in quantities for application everywhere, they developed "high and stable yield areas" (*kao-ch'an wen-ch'an ch'ü*) with modern agriculture.

In addition to these highly productive areas, there are large regions of China which have partially modern agriculture. These areas are marked by substantial improvements in water control, so that production is stabilized; however, high-yielding varieties and large amounts of fertilizer are not available. Regions with mechanical tillage but without assured irrigation or without high-yielding varieties would also be in this category.

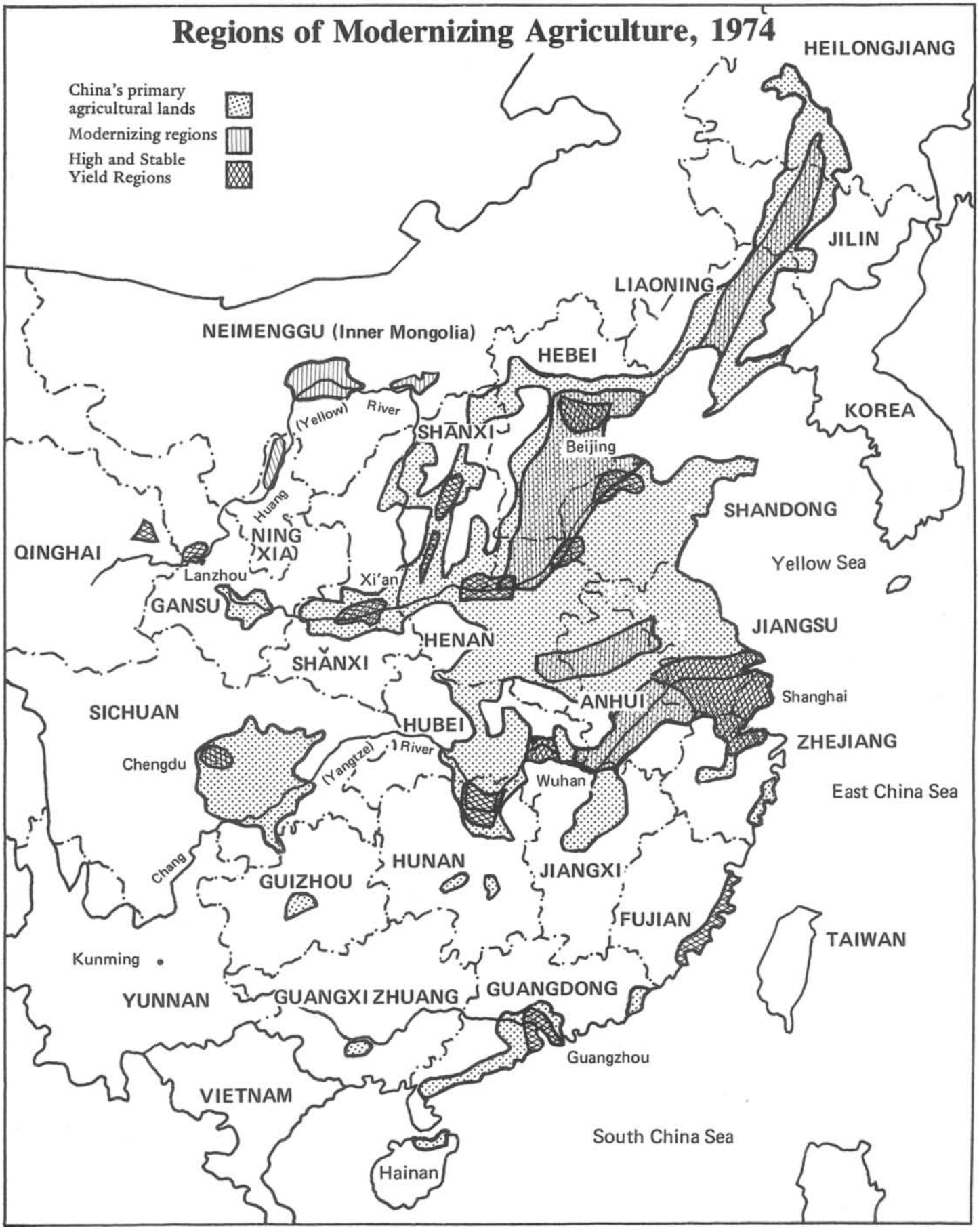
The high and stable yield areas were first established in major river and lake basins, generally near major urban centers in the early 1960s. By 1965, 6.6 million hectares of land were securely irrigated by mechanical power (8.6 million horsepower). The regions near Peking, Shanghai and Canton and the inland areas of Tungting Lake and Szechuan accounted for about 88 percent of the mechanically irrigated areas.

By the late 1960s and early 1970s, when the low-land irrigation schemes were substantially completed, the focus of

Table 1. Summary of the Spread of Modern Grain Production in China, 1974

		Area Sown to Grain Million HA[a]		*Total Cultivated Area Million HA*[b]	
1. Modernizing Regions:					
A. High and Stable Yield Areas	11	43	(31%)	29	(24%)
B. Improved Regions	32				
2. Traditional Regions, Some Marginal Change		94	(69%)	91	(76%)
TOTAL		137	(100%)	120	(100%)

Source: Benedict Stavis, "A Preliminary Model for Grain Production in China, 1974," China Quarterly, *No. 65 (March 1976).*


Regions of Modernizing Agriculture, 1974
China's primary agricultural lands
Modernizing regions
High and Stable Yield Regions
HEILONGJIANG
JILIN
LIAONING
NEIMENGGU (Inner Mongolia)
HEBEI
KOREA
(Yellow) River
SHĀNXI
Beijing
SHANDONG
Huang
NING XIA)
QINGHAI
Yellow Sea
Lanzhou
Xi'an
GANSU
JIANGSU
HENAN
SHĂNXI
ANHUI
Shanghai
SICHUAN
HUBEI
ZHEJIANG
Chengdu
(Yangtze) River
Wuhan
East China Sea
Chang
HUNAN
JIANGXI
GUIZHOU
FUJIAN
TAIWAN
Kunming
YUNNAN
GUANGXI ZHUANG
GUANGDONG
Guangzhou
VIETNAM
South China Sea
Hainan

attention shifted to the North China Plain, and the technology shifted to deep pump wells (tube wells). By 1974 roughly 1.3 million mechanical pump wells had been developed, servicing 7.3 million hectares.[5] The horsepower of mechanical irrigation equipment expanded rapidly, to 12 million horsepower in 1971[6] and 30 million in 1974.[7]

At the same time throughout the 1960s, massive programs were developed for water conservancy, especially along the Yangtze River and on the North China Plain, involving the Huai and Hai River basins. Dams, irrigation canals, and huge drainage systems were constructed to mitigate against flood and drought. Low lift and deep well pumps supplemented the massive earth work in these systems. By 1974 roughly 29 million hectares of cultivated land and about 42 million hectares of sown land (i.e., counting double cropping) had significant improvements in agricultural technology (see Table 1). The localities of these improvements are crudely indicated in the Map.

B. Changes in Production Technology of Food Grains

The individual components of China's agro-technical transformation are pretty much the same as used everywhere. Specific Chinese slogans summarize the elements of modern agriculture: "the four changes": (1) electrification, (2) chemicalization, (3) irrigation, and (4) mechanization. In addition there is the "Eight Character Charter": (1) land construction and rearrangement, (2) water control and irrigation, (3) fertilizer, (4) improved varieties of seeds, (5) pest control, (6) improved field management, (7) better farm tools, and (8) suitable spacing of plants.

Irrigation

The Chinese slogan "water conservation is the lifeline of agriculture" is well justified. Expansion of irrigated area and improvement in the quality of water control (i.e., in the ability to supply and drain water at different times) underlie both the improvement in yields and the expansion of multiple cropping. During the 1950s irrigated area expanded slowly to about 32.1 million hectares in 1955. This included 26.5 million hectares of irrigated paddy fields and 5.6 million hectares of irrigated dry fields.[8] Probably this expansion of irrigated area reflected repairing and bringing into full use the pre-existing irrigation system.[9] From 1956 through the Great Leap, tremendous amounts of labor were mobilized to expand the irrigation network, but it appears that the newly created irrigation systems could not work well. They lacked mechanical energy to move water, and thus were sometimes ineffective. In many cases, drainage systems were not built to complement the irrigation systems, so new irrigation simply raised the water table and contributed to soil salinity. Statistics for irrigated area in the early 1960s suggest that only a modest addition was made to the irrigated area. Estimates for the early 1960s range from 32 to 37 million HA.[10] China has not released official statistics for irrigation in area in the 1970s, but various visitors to Peking have been given figures for irrigated area ranging from 40 to 44 million HA. Not all of this is irrigated with complete assurance. In 1974, China claimed that 33 million HA of farmland had "harvests guaranteed in spite of drought or flood."[11]

The gradual expansion of the irrigated area and the improvement of quality of irrigation rest on two complementary factors. First, enormous amounts of labor have been mobilized every winter for capital construction projects.[12] Particularly on the North China Plain, where the Yellow River, Huai River, and Hai River have finally been effectively harnessed through construction of dikes, drainage canals, and irrigation systems. In addition, much land has been levelled so it can be irrigated more easily. (Incentives for getting the labor participation in these projects will be considered later.) These labor-intensive construction projects have been complemented by tremendous expansion of mechanical pumping equipment since 1960, statistics for which are given above. This mechanical equipment has assured that the problems in irrigation work which were encountered during the Great Leap will not be repeated.

Chemical Fertilizer

The growth rate in China's chemical fertilizer industry has been nothing less than phenomenal. From 1960 to 1966 production quadrupled. From 1966 to 1973 it doubled again. The chemical fertilizer industry now supplies roughly 4 million tons of crop nutrients and another 1 million tons is imported. Altogether China uses more chemical fertilizer than any other country in Asia. Japan and India each use roughly half the amount of chemical fertilizer that is used in China. Despite this tremendous chemical fertilizer industry, China uses natural fertilizers very extensively, so that chemical fertilizer supplies roughly one-third of the available crop nutrients, on a national basis. Even this massive amount of chemical fertilizer is not enough. China is currently purchasing large amounts of chemical fertilizer on the international market and has recently purchased eight huge ammonia factories from the U.S. and Japan, which will expand their already large production by about 65 percent.[13]

Improved Seeds

Soon after the Tenth Plenum of 1962, the central authorities expanded research and development on improved seeds.[14] Research was carried out by the Chinese Academy of Sciences, the Chinese Academy of Agricultural Sciences, and various provincial level research institutes. Commune-level research units provided a good mechanism for drawing on the experience of peasants and for local testing. Progress came quickly. (Actually, much of the research on rice had been done already from 1930 to 1960.)

During the early 1960s, very high-yielding varieties (HYV) of rice and wheat were developed and popularized,

especially in the "high and stable yield" areas which had good, mechanized irrigation. By 1965 about 3.3 million hectares of high-yielding rice and about 2.5 million hectares of high-yielding wheat were planted.[15] The Chinese HYV are definitely not simple copies of varieties from the International Rice Research Institute (IRRI). The Chinese HYV were, in fact, distributed before the first IRRI varieties were. IRRI varieties take too long to mature for China's multiple cropping systems. However, they may have been used in some of the breeding programs in China recently. By 1973, 6.7 million hectares were sown to improved rice varieties. Another report stated that 80 percent of rice paddy and 70 percent of wheat were sown with "improved" strains.[16] Notwithstanding apparent success with their own HYV of wheat, China imported 16 tons of Mexican HYV seeds in 1974-1975.[17] Significant success has also been reported in high-yielding hybrid varieties of maize and sorghum.[18] With regard to vegetables, which contribute crucial elements to China's diet, available reports suggest that not very much research effort has gone into improving varieties of vegetables, from the point of view of yield, pest resistance, quality or uniformity of maturity.[19]

Mechanization

Another dimension of technical change in China's agriculture is mechanization. By 1974, tractors were used to plow roughly 20 million hectares, representing about 18 percent of the total cultivated area.[20]

Tractors are generally concentrated in the northeast sections of China and the North China plain. By 1965, about one-third of the land in the Northeast was machine cultivated. The Peking suburbs were also mechanized during the 1960s; by 1966, 60 percent of the suitable land around Peking was machine plowed. Other areas on the North China Plain also developed mechanization. Many tractors were reported in Shantung, Shansi, and Hopei. Mechanization speeded up in the late 1960s, and by 1970, 60 percent of the farm land was cultivated by machine in a number of provinces. In 1971, 40 percent of the land in Honan was mechanically tilled.[21]

In the southern rice paddy areas, mechanization based on small garden tractors is not known, but they are in widespread use in suburban communes in southern China, according to many visitors.

Mechanization of harvesting in China is almost unknown, with the exception of harvesting of wheat on mechanized state farms, mostly in the northeast. Mechanization of grain processing—threshing and milling, for example—is widespread, but again statistics are lacking. In the Pearl River Delta, foot-operated threshing machines are quite widespread.[22] In 1972, China vaguely reported: "In many places more than half the rice harvested is machine-threshed."[23] In Hunan, 80 percent of the rice threshing was mechanized or semi-mechanized by 1973.[24]

For more than fifteen years, China has been trying to develop machinery that could transplant rice shoots. Engine-driven rice transplanters are used in the Peking suburbs, but it is not known whether they are used for all the rice or only experimentally.[25] In Hunan around 1970, over 13,000 mechanical transplanters were used. (Chuchou County of Hunan had 3,700 for 4,300 hectares.)[26] In Kwangsi, 30,000 transplanters served 53,000 hectares.[27] In Shanghai in 1974, about 20 percent of the rice was mechanically transplanted; in the Pearl River Delta most of the rice is still transplanted by the traditional hand method.[28] Machine sowing of wheat is developing. In 1974, 80 percent of the wheat around Peking was sown by mechanical devices.[29]

Generally speaking, mechanization does not have much effect on yields in a densely populated country such as China, because enough labor is available to assure intensive cultivation and maximum utilization of available resources. However, mechanization can help improve yields in certain regions. During the 1950s, surveys of mechanized areas of Heilungkiang, a northeastern province, showed increases in yields of roughly 0.4 tons per hectare due to deeper plowing and more careful cultivation.[30] In addition, mechanization has permitted expansion of cultivation in underpopulated sections of China's vast northeast and northwest regions. Equally important, mechanization of both cultivation and grain processing can contribute to increases in production in the densely-populated southern and central regions by saving time and thus permitting increases in multiple cropping.[31] (Of course adequate water control, fertilizer, and suitable seeds are also needed to do this.) Aside from its contribution to production, mechanization has been encouraged as a way of expanding the scale of profitable operations, to make the collective system more sensible and as a way of encouraging rural industrial development.[32]

Pest, Disease, and Weed Control

Chemical pesticides are widely used in China. The types of chemicals in use, however, are not especially modern. Application rates are fairly low, generally chemicals are applied to control outbreaks, and are not used prophylactically. Chemical pesticides are supplemented by a variety of natural control systems, including other insects and complex intercropping systems.[33] With regard to plant disease control, some effort has gone into breeding disease-resistant varieties of cereals. Herbicides are used for chemical control of weeds at least on an experimental basis. In Yunnan, over one-third of the rice crop was treated with chemical herbicides in 1974.[34] Often, however, weeds are pulled by hand and fed to pigs.

Cropping Systems

The one aspect of China's agricultural techniques which is distinctive in comparison with other places is the way China emphasizes complex, intensive multiple cropping and intercropping systems. Often yield of an individual crop is sacrificed to get higher production, more stability, better natural crop production, and more varied diet over a one- or two-year cropping cycle. It is for this reason that in some cases the yields for each crop are not tremendously impressive. Some American agricultural scientists who have visited China suspect that in some cases multiple cropping has been carried too far; however there is little argument with the overall

approach. It is interesting to note that the International Rice Research Institute has recently increased its research efforts in developing intensive multiple cropping systems as a way of getting high production with a minimum of chemical inputs for fertilizer and pest control. Also such a system of cultivation is highly labor intensive, and this may be beneficial in densely populated areas where unemployment can emerge as a serious problem.

C. Rural Income

While food grain production is one crucial dimension of rural development, it is not the only one. Another important factor is the income of people in rural areas. The level and trend of income are somewhat different from those of food grain production. From the early 1950s to the late 1960s, net rural income per capita has roughly doubled, from 70 Yuan to about 150 Yuan.

Three factors make the trends in rural income different from the trends in food grain production. First, there is the issue of costs of production of food grains. If taxes and increased production costs absorbed all the increments in income resulting from higher production, then the rural people would experience no increase in income. Data from a few communes, however, indicate that this is not happening. Production costs seem to be mostly between 15 and 30 percent of total production and there is no clear indication that communes with higher incomes spend more for production expenses. Agricultural taxes are generally fixed.

Family income is also generated by the private family garden plots and family handicrafts which together contribute around 20 percent of total rural income. Scant data available suggest that the private sector may be more important in wealthier localities,[35] i.e., localities with better natural conditions and near urban markets.

The third and most important factor influencing rural income is the extent of diversification of the rural economy. Government policy has been to keep the price of food grains low (now roughly 14 Yuan per 100 catties). At official exchange rates this is about $0.07 per pound. Rice at the supermarket in the U.S. today is about $0.50, or seven times as much. The agricultural planning system strongly encourages the communes to emphasize food production until self-sufficiency is reached. Once a locality can divert resources (land and labor) to higher-priced subsidiary crops such as fruits, vegetables, oil and fiber crops, animal husbandry, sericulture, beekeeping, or local handicrafts and industry, the cash income of the farmers goes up rapidly.

The significance of diversification can be shown with available data from a few locations. In Lienchiang County, Fukien, income in 1962 was low, averaging 66 Yuan per capita from collective sources. In this area, agriculture was not very diversified. Food grains supplied from 60 percent to 75 percent of the income of the production teams. Differences in income between teams were explained largely (over 75 percent) by differences in food grain productivity.[36]

In contrast, in Liuling brigade, Shensi, where agricultural techniques had begun to change by 1961 (there was mechanical irrigation for a collective vegetable plot and there was machine plowing), average collective income was about 127 Yuan per capita; food grains supplied only about 36 percent of the total collective income. Other plant products (fruits, vegetables, and tobacco) supplied 32 percent and animal husbandry supplied 9 percent.[37]

In one commune in Tungkuan County, Kwangtung, where there was extensive mechanization of irrigation and other processes, diversified activities provided the key to rapid growth. From 1957 to 1964, total collective income went up 2.2 times, with three-quarters of this accounted for by increases in diversified activities. These activities included animal husbandry (pigs, beekeeping, sericulture, fish farming), increased cultivation of non-grain crops (such as peanuts, sugar cane, jute, soya, sesame, bamboo, medicinal herbs, and fruit), some manufacturing (of bamboo farm implements, charcoal, bricks, and tile), and increases in local food processing. In 1957, grain supplied 55 percent of commune income.[38]

In Tachai, the national model for agriculture, economic diversification (fresh and dried fruit, fish ponds, pig raising, forestry products, and small factories) contributed only 27 percent to total collective income in 1967. This went up to 53 percent by 1973.[39] In a rapidly developing area near Tungting Lake, a team's grain production doubled from 1962 to 1972. In 1972, its income from diversified products doubled compared to 1971.[40]

No national data are available to prove conclusively that agriculture has diversified significantly during the period that grain production went up; or to demonstrate that diversification occurred in localities where grain production reached "high and stable" yields. However, there are strong tendencies making it easier for a locality to switch land to high-value crops if food grain yields have increased enough to reduce the area sown to food grains.

It might be noted that there appear to be new programs to encourage diversification into poultry and fish culture. Surveys on poultry were made in 1966-68 (during which time the number of eating chickens declined from 462 million to 397 million, and then came up to 410 million). Consumption ranged from 1.4 kg per capita per year in North China to 4.9 kg. in the richer southern China provinces. The average was 3.1 kg., up somewhat from an estimated 2.3 kg. in the 1930s.[41] Fresh-water fish cultivation increased 11.1 percent in 1973 over 1972. Production was 1.4 times the total of 1965. The government has organized exchanges of information to encourage the rapid diffusion of fish culture.[42] Poultry and fish are, of course, the most efficient converters of plant food into animal protein, so there is much logic in programs directed at expanding production of these products.

All of these factors mean that rural income is going up faster than the growth rate of grain production of two percent per year. Using survey data, it is possible to compare rural income in the 1950s with the 1960s. For the 1952-55 period, average peasant (per capita) consumption has been estimated at 68 Yuan. (This was 49 Yuan worth of crops and 19 Yuan in cash.)[43]

For a comparison, data from 21 localities in China, generally from the mid- to late 1960s, are examined. (In some cases the data refer to communes, in others to brigades or teams.) The median income (personal disposable income including cash and rations) from collective sources is about

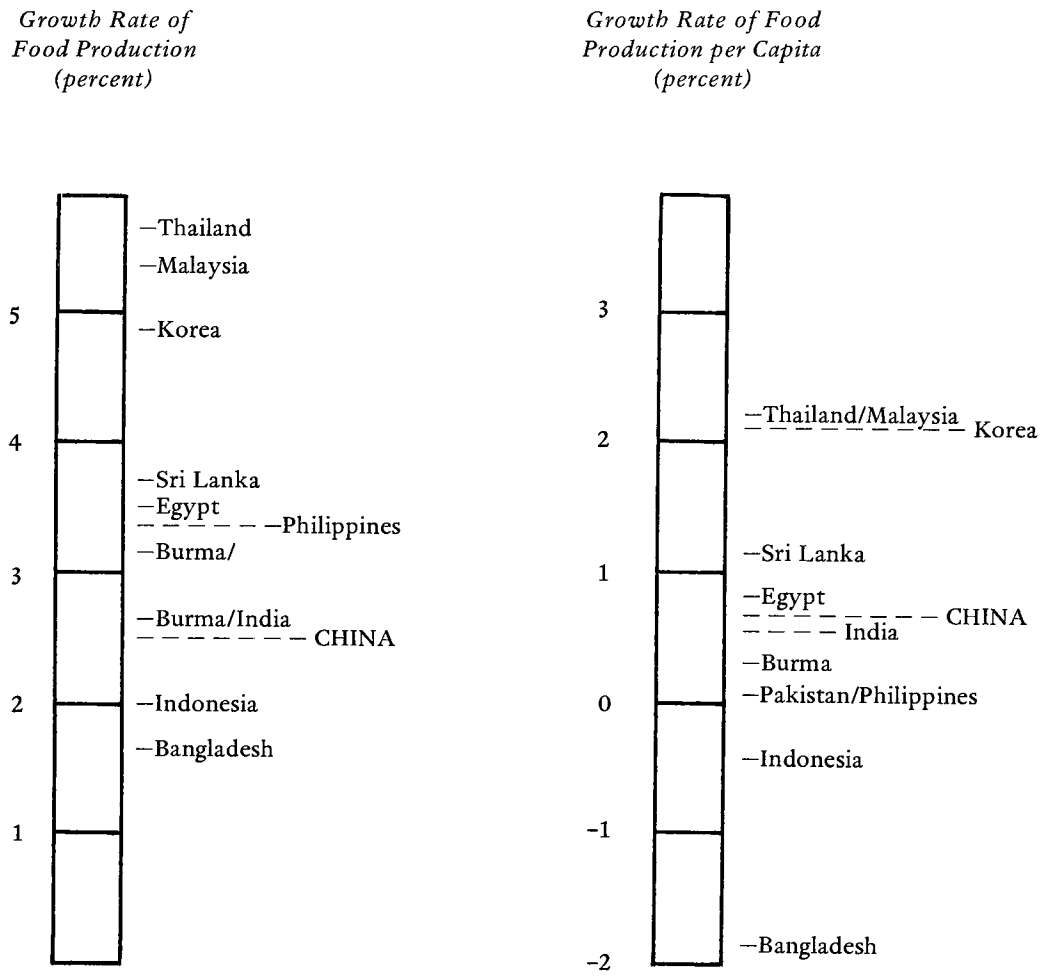
110 Yuan per capita. The most frequently encountered level of income was 80-100 Yuan per capita. A few wealthy localities brought the average up to 126 Yuan. We estimate that income from private plots is about 20 percent of total income, so that the median total net income in rural areas would be about 137 Yuan and the average would be 158 Yuan.[44]

These data indicate that rural income roughly doubled in 15 years. This is an average compound growth rate of 5 percent. Prices of consumer goods have been roughly constant, or have declined somewhat, so no correction need be made for inflation. In fact, it is possible that a correction should be made for deflation.[45]

D. Future Trends

As noted above in Figure 1, there appears to have been a slackening in the rate of growth in grain production after 1968. Several reasons can be advanced for this. The rapid growth of the early and mid-1960s was associated with improving irrigation in regions where it was relatively inexpensive to do so, namely in river valleys and lake basins. By the late 1960s the opportunities for inexpensive expansion and improvement of irrigation had been exhausted; development of tubewells for the North China Plain was more expensive. Moreover, in the late 1960s the Chinese leadership perceived the Soviet Union as a major military threat and

Table 2. Growth Rates of Food Production, 1952-72



Source: "Assessment of the World Food Situation, Present and Future," U.N. World Food Conference Report, Rome, November 5-16, 1974, pp. 51-54.

Note: Bangladesh data are for 1962-72.

increasingly diverted resources to defense industries, leaving less funds available for agricultural investment. Another possible explanation for the slackening in growth may have to do with agricultural research. The Cultural Revolution and extended "criticism, struggle, transformation" process in agricultural scientific research may have delayed research for several years. The final decision to disperse research institutes and agricultural colleges to the countryside and to require scientists to spend one-third of their time living on communes and one-third of their time travelling (sort of as trouble shooters) will have many consequences. The new system will assure that scientific research is based on a sound understanding of production problems and will assure that scientists do not ignore the accumulated wisdom of the peasants. It will be good for testing and spreading innovations. It is possible that the new system may generate problems in achieving highly specialized research with close integration with other natural sciences based in urban institutes.[46] At this time in China's agro-technical transformation, scientific research will play an increasingly important role; the high and stable yield areas will undoubtedly develop problems of pest and disease control as new strains of diseases and pests emerge to which the new varieties are susceptible. Moreover, the problems of developing high-yielding upland crops and new patterns of crop rotation are very great.

While these factors suggest difficulties in the future, there are other factors which suggest that grain production can continue to rise for many years. Perhaps most important is the tremendous improvement of irrigation in the North China Plain in the early 1970s. This opens up a tremendous potential for improvement of wheat and maize in the next decade. With regard to the problem of defense spending, recent estimates prepared by the U.S. Government suggest that military procurement in China has declined sharply since 1971, after a rapid rise in 1968-70. Military spending is above the levels of the mid-1960s but now seems controlled, and more resources will be available for agricultural and industrial investment.[47] In the field of agro-science research, an important step was taken in September 1974 when Chinese agricultural scientists visited the U.S. and a group of American agricultural scientists visited China. International transfer of agricultural technology can be very useful, especially when there are a strong domestic research system capable of good adaptive research and a system for diffusing innovations, such as China has. In addition, new supplies of petroleum can assure supplies of fertilizer and energy for moving water.

For these reasons I believe optimism is justified in estimating China's ability to expand food production to meet increased demands in the next decade or two.

II. China's Agricultural Success Compared to Other Places

Compared to other places, China's agricultural development has been very successful, especially with regard to maintaining high levels of production and achieving equitable distribution. China's average rate of growth is roughly comparable to those of other Asian countries.[48]

A. Growth Rates

We have estimated that grain production in China grew at an average annual rate of 2.0 percent, while total agricultural production probably grew at a faster rate to account for the 5 percent annual increase in rural income. Using slightly different data, the U.N. Food and Agricultural Organization estimates the annual growth rate of food production from 1952 to 1972 was 2.3 percent; total agricultural production went up 24 percent from the early 1960s to 1972. In Table 2 the growth rates for China are compared with those of other countries in Asia. In terms of gross growth rate of food production, China's performance is a little low. For the 1952-72 period, China seems to be expanding food production more rapidly than the populous South Asian countries, especially Bangladesh and Indonesia. China's growth rate is roughly similar to that of India and Burma. It is lower than that of Pakistan, Sri Lanka, and Thailand. Because of lower population growth, China is doing quite well in terms of growth of per capita food production. Few other Asian countries exceeded China's growth rate. These comparisons suggest that China's growth rate in food and agricultural production is substantial but not far superior to those in other Asian countries.

Table 3. Food Staple Production Per Capita, 1972-73

	Production of Food Staple Equivalent (Million Tons)	*Population (Million)*	*Food Staple Production Per Capita (kg)*	*Index*
Thailand	12.4	39.3	315	144
China	198.0	807.0	245	112
		900.0	219	100
Taiwan Province	3.5	15.0	231	105
Nepal	2.6	11.9	220	100
Burma	6.0	29.4	203	93
South Korea	6.6	34.1	194	88
India	99.0	569.2	174	79
Pakistan	10.7	67.3	158	72
Bangladesh	12.5	81.8	151	68
Indonesia	19.2	131.6	146	67
Philippines	5.7	41.5	137	63
Malaysia (West)	1.2	9.8	122	56
Japan	13.0	107.7	121	55
Sri Lanka	1.0	13.4	74	34

Source: The figures represent the sum of averages of estimates of individual crops for 1972 and 1973 by FAO (in Production Yearbook 1973) *and USDA* (Agricultural Statistics, 1974). *The only exception is Taiwan Province, for which data come from* Population Yearbook 1971.

The population of China is very much a question mark in this type of analysis. I have done computations using alternative population estimates and base the index on the high population estimates—an estimate I consider unrealistically high.

B. Level of Production

The actual level of food production per capita is very high in China when compared to other places in Asia. This is shown in Table 3, which compares production of food staples (comprising processed cereals, tubers at one-fourth their weight, and pulses at full weight) in several Asian countries and in the province of Taiwan. (Note that this computation does not include animal products, fruits, vegetables, etc.)

The level of food production is of course not identical with the level of food consumption, especially for countries such as Japan and Sri Lanka, which have consciously chosen to specialize in some particular commodity for export and to import food. Nevertheless, for populous countries such as India, Indonesia, and Bangladesh, food consumption in rural areas must be strongly related to levels of production, and in comparison with these countries, China is doing very well. These countries produce only three-fifths to four-fifths of the food staples per capita as China does, even assuming a high population estimate for China.[49]

The relatively high level of food production in China is due, in large part, to high yields per hectare. The average rice yield is double that of India, and there is more multiple cropping in China. Probably the most important reason for high yields in China is extensive irrigation. Careful field management and full utilization of all sources of natural fertilizer (animal manures, human feces, mud, etc.), improved varieties, and other improved techniques are all important also. The high and stable yield regions in China have yields almost as high as the most modern areas of the world, and the average yields in China are well above the yields of traditional cultivation methods. This is shown in Table 4. The adoption of modern techniques (fertilizer, high-yield varieties, machinery, etc.) is as rapid in China as elsewhere in Asia.[50]

C. Distribution

The high levels of food production are, of course, the *sine qua non* for the healthy, well-fed appearance of people in China. However, the system of distribution of food is also exceedingly important. China has developed mechanisms for substantially equalizing distribution of food over time, space, and social standing.

Table 4. Yields of Different Crops in Different Places, 1972
(tons/HA)

	Rice	*Wheat*	*Maize*
China Mainland average	3.1	1.6	2.7
Japan	5.8	2.3	
Taiwan Province	3.4		
India	1.6	1.4	0.9
United States	5.3	2.2	6.1
Indonesia	2.4		
Bangladesh	1.5		
Soviet Union		1.5	2.5

Source: China rice and wheat, Benedict Stavis, "A Preliminary Model for Grain Production in China, 1974," China Quarterly *No. 65 (March 1976). All other data:* Production Yearbook 1972 *and* 1971, *FAO.*

Distribution over Time and Space

Redistribution of food over time and space is crucial in any agricultural economy because food production in any locality in any year is so greatly affected by the vagaries of weather. Fortunately, smoothing out the peaks and slumps in agricultural production caused by the vagaries of nature is not quite as difficult in China as in other parts of Asia. China stretches from the tropics to the temperate zones and includes several climatic regions. It is unlikely for the weather to be bad everywhere in one year. This contrasts with the situation in India, where a late monsoon drastically affects total production, or in Bangladesh, where a single typhoon can wipe out most of a crop.

In China the state has the political legitimacy and administrative power needed to procure substantial amounts of food. While at first glance this may not seem new or important, since the traditional Chinese state also procured food, the difficulties of the Indian government in managing a state-run procurement system in 1973 indicate that state procurement of food grains is not a simple task. The state procures food in several ways: tax is paid in kind; compulsory sales of grains are required by economic plans; additional grain may be sold to the state at bonus prices;[51] the state may import grain; and the state controls the production of state farms. While most of the procured grain is for feeding cities and the military, some of it is available for inter-regional transfers to meet needs generated by bad weather and crop failures. Some of the grain is put in reserve to guard against bad weather in the future. Chinese policy is not designed to equalize food consumption in every place in every year; in general it is based on the idea of "self-reliance," i.e. each region and locality should feed itself.[52] However, the state can meet emergency needs and prevent famine.[53]

Distribution within the Village

The most important factor in the distribution of food is the substantial equalization of food distribution within the village. Because of collective ownership of means of production, everyone in a village has a claim to the production of that village. Different villages develop different methods and criteria for distribution of food. In some cases food is distributed principally according to need; in other cases food is distributed according to the amount of labor a worker does in the collective economy. Whatever the method, the village (actually the production team) accepts the responsibility for feeding everyone.

Precise comparison with other countries is difficult because statistics on income distribution are scarce for China and often inaccurate for other countries. In one village for which we have data, Liuling in 1961, the top 20 percent of the families had incomes 4.6 times the bottom 20 percent. This is about the smallest difference between high and low income in Asia; typical ratios run from 5 to 10 times and up to 20.[54]

These ratios for income distribution reflect the fact that in many Asian countries (such as India and Indonesia) a very significant portion of the rural population (often around 30 percent) are landless laborers, owning no resources and having no assured claim to food. If such a person cannot find employment and earn money, he has no food. Sometimes there may be a relief system which offers a bowl of gruel, but his life is marked by insecurity and fear.

The importance of the distribution system in China today cannot be over-emphasized. A survey of 136 localities in China in 1929-33 showed that in 29 percent the caloric intake was below what was considered necessary (2,800 calories per adult), even though the overall average availability of calories was sufficient. Since the selection of localities excluded regions with serious famine, in reality a higher percentage of localities had inadequate food. We cannot compute distribution of food within villages for this period, but undoubtedly there were under-fed people even in villages with a high average caloric intake.[55] Thus it is possible that half the people were inadequately fed in any one (even good) year. When we recall that peasants put great emphasis on security, on assurance that they can get food even in a bad year, the importance of a state system that can spread out food over time, space and social groupings within the village becomes enormous. A famine once in 10 years in China before liberation or in other Asian countries today does not suggest a 10 percent problem; it means massive social disruption and death.[56]

III. Political Leadership for Agricultural Growth

In the Chinese view, political factors are the most important elements of agricultural development. Increasingly, observers of food problems and agricultural scientists in other countries, if not agreeing completely, now see political factors as very important. There is no one single political choice which explains China's success; I list eleven important policies in *Making Green Revolution.* Since writing that monograph, I have come to consider three basic political decisions which shape material incentives for the peasant to be especially important. First, the state fully supports the expansion of agricultural production. Second, the bulk of benefits of modern agriculture remain in the rural sector. Third, the benefits are shared evenly by everyone in the rural sector.

When this strategy was established in 1960-62, it was a departure from the policy of the mid-1950s, when the Soviet strategy of exploiting the rural sector to provide resources for urban-industrial development had been followed. The process by which China came to this decision is beyond the scope of this paper, but it clearly involved many factors, including the leadership of the Chinese Communist Party, which came substantially from the countryside. It also reflected the ability of the peasantry to cripple economic development plans. If not given adequate incentives they could refuse to work either on regular agricultural production or on the labor-intensive construction projects. To some extent this happened in 1959-61 and precipitated the crisis of those years which led to the policy shift.

The policy of giving priority to agriculture shows up in increasing direct investments in agriculture. State investments in agriculture in 1973 were nearly double those of 1958.[57] In the North China Plain, the great increase in state investment came in the early 1970s. Investments in 1973 were double those of 1970.[58] Informed estimates (not yet available for public attribution) are that agricultural investment represented 8 percent of the central budget in the First Five Year Plan; it rose to 27 percent during the Second Five Year Plan and dropped to 18 percent during the Third Five Year Plan (1966-70). These figures include investments for industries directly serving agriculture (i.e., tractor and fertilizer factories) as well as subsidies for labor and material in irrigation construction projects and other expenses. Dwight Perkins estimates that state investment in agriculture has roughly quintupled, from about 1 billion Yuan annually in the 1950s to around 5 billion Yuan annually in the 1960s and early 1970s.[59] This policy of taking agriculture as the base underlies the availability of modern inputs in agriculture and the rapid improvement on China's irrigation system.

The second major policy is to permit a major portion of benefits from agricultural progress to remain in the rural sector. The fruits of agricultural modernization are not siphoned off mostly for urban dwellers and urban-centered industrial development.[60] Thus agricultural taxes have basically remained at a fixed amount (and therefore declining rate).[61] The price the government pays for agricultural products has roughly doubled in the past 20 years. The base procurement price for grain has gone up from roughly 7 Yuan per 100 catties (50 kg) in the early 1950s to about 14 Yuan per 100 catties in the mid-1970s.[62] At the same time, the prices of industrially produced means of production have been declining, and the prices of consumer goods have been stable.[63] In addition, efforts are increasingly focused on improving the life of people in rural areas. Health, education, recreation and entertainment are provided to people in the countryside, often with partial state subsidies. Peasants do not have to move to the cities to get these benefits of modernization.[64]

Relatively equal distribution of income and assured access to food are the third major policy for distribution. The distribution is based on the principle of collective ownership, as described above. The Chinese leadership has been extremely sensitive to the possibility that a new rural elite could emerge through a variety of mechanisms—through manipulation of political power, through control over high-priced subsidiary crops, or through traditional corruption. Perhaps more than any other government, China's has been very much aware of the direct distributional effects and the long-term incentive effects of corruption, and has taken extraordinary measures to curb it.

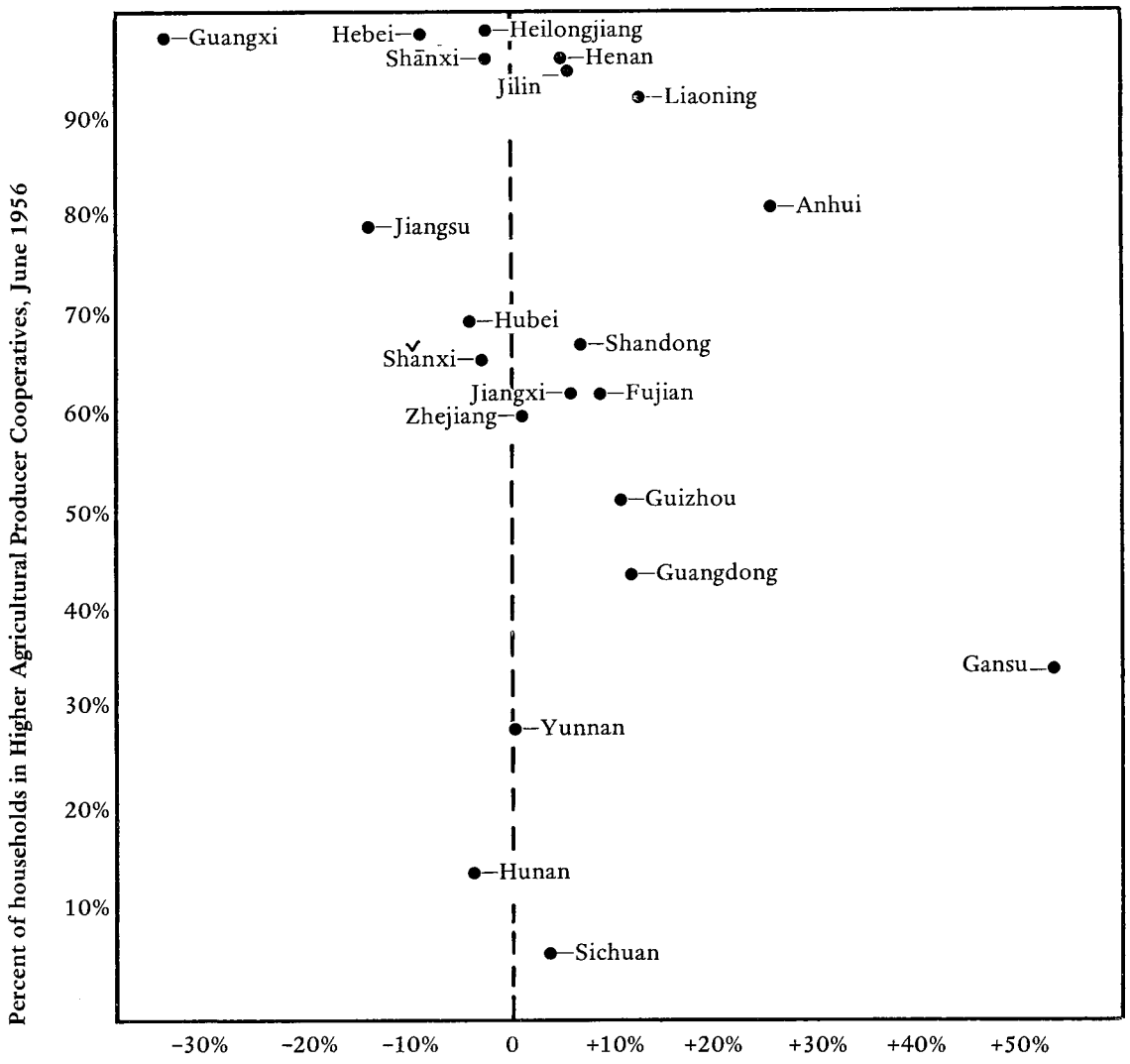
It is commonly thought that an elite is necessary for agricultural development—it provides savings and investments as well as entrepreneurial skills. It is presumed *a priori* that collective agriculture will be inefficient; and problems in agricultural production in the Soviet Union are sometimes assumed to confirm this hypothesis. A careful analysis of China's experience, however, shows that collective agriculture has both potential advantages and disadvantages, and the advantages generally outweigh the disadvantages.[65]

First, the romantic idea that collective agriculture immediately increases production because of more effective labor organization and greater labor enthusiasm should be

discarded. When changes in food grain productivity are compared with the rate of adoption of collective agriculture in 1956, there appears to be no significant correlation, suggesting that there are not necessarily any immediate major productivity gains resulting from new labor organization. This is shown in Figure 2. (Of course there may be some places where there are such short-term gains.) The Figure uses the percentage of households in Higher Agricultural Producers Cooperatives in June 1956 as an indication of the rate of social transformation in each province, and uses the percentage change in per capita grain production 1954-56 as an indicator of productivity.

The benefits of collective agriculture should be sought in longer-term effects. Rural local organizations simplify mobilizing labor for rural construction projects, such as water conservancy and land construction projects, which have been so important to agricultural production. Because there are several levels of rural institutions (team, brigade, commune, county, river basin authority), interests can be identified, expressed and articulated for projects of almost any scale. In

Figure 2. Relation Between Agricultural Cooperation and Grain Production



Sources: Percent of Households in HAPC, 1956: Thomas Bernstein, Leadership and Mobilization in the Collectivization of Agriculture in China and Russia: A Comparison *(Columbia University dissertation, 1970), chapter II, p. 30.*

Grain Production in each Province: Computed from Kang Chao, Agricultural Production in Communist China, 1949-65 *(Madison: University of Wisconsin, 1970), pp. 304-305. These figures are Chao's estimate, not official figures.*

Population in each Province: Computed from Robert Michael Field, "A Note on the Population of Communist China," China Quarterly, *No. 38 (April-June 1969), p. 162.*

addition, there is the capacity to construct projects on any scale. Virtually no project is too small to be worthwhile to some institution, or too large to mobilize funds and labor.

The collective ownership system has a strong incentive for labor-intensive construction projects, namely the collective units have a fundamental obligation to provide work, food, and income to all members; a team leader cannot dismiss the members of the team when labor begins to have a declining marginal profit. As long as increments in labor have positive productivity, no matter how small, it makes sense to use that labor. Thus the collective system of ownership makes it sensible to utilize more labor than would be used under private ownership, where workers could be dismissed and would have to seek new employment.

Moreover, the peasants have good incentives for participating in improvement efforts; everyone receives some of the benefits of increased productivity. If a construction project is sensible, it will improve the income of everyone and everyone's descendants. No one has the feeling of working on a project which will benefit only a few people. This feeling of shared interests is reinforced when leaders of the managing organizations participate in physical labor with the other farmers.

A second advantage of the organizational system in China is that certain socio-political impediments to efficient economic allocation of resources are removed. Two examples will explain this. Under private subsistence farming, peasants have a strong tendency to grow enough food grains to ensure family survival, even though their land might not be optimal for growing food grains and might be optimal for growing some other crop. Few peasants are willing to trust family survival to market conditions and specialize in cash crops, unless the marketing system is unusually stable and well developed and income is well above subsistence levels. In collective agriculture the production unit can use land in a more optimal fashion, inasmuch as no family's survival is dependent on the food grain production of any particular piece of land.[66]

This advantage of collective agriculture also shows up clearly in allocation of water. Studies in the Philippines have shown that good irrigation is crucial to the adoption of high-yielding rice production techniques. In rainfed regions, rice yields are only about 1.8 tons per hectare, while in effectively irrigated localities yields are 2.8 tons per hectare.[67] In many localities the constraint for expansion of irrigated area is *not* lack of water; water at the head of an irrigation system is wasted so that it is insufficient at the lower reaches. Very often the people who own land at the head of the irrigation system have social and political power and block changes in irrigation practices which would result in more sharing of water (hence income and power) with people lower down in the system. Analagous circumstances frequently explain suboptimal distribution of other inputs, such as fertilizer and credit. In contrast, the collective system in China offers incentives for maximizing total production.

There are several other features of the rural local institutions in China which are highly conducive to rapid agricultural development. They have the ability to enforce a fairly high degree of savings and a commensurate high level of investment. The level of savings and investment is discussed at a public meeting at each level and is a collective decision which is influenced by Party policy. The collective ownership system permits the use of powerful collective economic incentives, including a regressive tax structure, without aggravating income differences within the village.[68]

Another strength of collective agriculture is its ability to spread out the risks of agricultural innovation. Very often, poor peasants in a system of private ownership have so few resources that they cannot risk an innovation. Should it fail at all, their families might starve. In contrast, in collective ownership a small piece of land can be set aside for experimentation. If the experiment is successful, the new technique can be adopted; if it fails the consequences are not catastrophic. No one starves, because no one is entirely dependent on the outcome of the experiment for food. When I visited China in 1972, I was very much impressed by the careful local testing of seeds, fertilizers, and cultivation techniques.

Yet another advantage is that under the collective system, transfer of technology is very rapid. All agricultural techniques are public information; there are no secrets. Government often organizes meetings to demonstrate successes of a region and to exchange experiences.

Another advantage of the collective system includes the enlargement of the size of plots and reduction in parcelization. This simplifies mechanization of cultivation and reduces time wasted by private farmers in going from plot to plot, often quite far apart. Collective ownership reduces the expenditures needed to prevent thievery of both crops and water. It eliminates waste of land used for boundaries. It also simplifies the staggering of peak labor times by rationalizing the planting time.

From a broad cultural point of view, collective agriculture has another potential advantage. Because everyone can benefit from agricultural development, there are no people in a village who need to oppose development to protect their livelihoods or their privileges. There are no tenants who fear losing their lands if mechanization comes, or who will have to turn over the bulk of increments as rent. There are no small farmers who get pushed out of the rice market when new seeds increase productivity and push prices down. For these reasons superstitions may be dropped and scientific values adopted more quickly.[69]

There is no need to argue that these advantages are unique to the collective system in China. There are a variety of ways that these features can emerge from a system of private ownership. Generally, however, such a system has important distributional effects. Only the wealthy, progressive farmer (if he exists) has a high enough income to invest his savings, to experiment with new techniques, and to get information rapidly about new techniques. So, generally he can monopolize the benefits of agricultural development. The important fact about China for this analysis is that these features of incentives, savings, risk taking, and information are not, by any means, eliminated under collective agriculture.

Collective agriculture can, under certain circumstances, generate serious disadvantages for production. When the collective system was first implemented, labor incentives were not rational; peasants sometimes went on informal sit-down strikes. Rigid government leadership sometimes encouraged the adoption of inappropriate agricultural techniques. Also, when collective agriculture was first introduced, there was a serious shortage of qualified agricultural managers to assist at all levels and in all areas. No one knew how to assign labor on

the scale of the whole village; nor were there adequate personnel to do the accounting. Several years were required before rural China had the management skills needed to make the collective system work efficiently.[70]

Yet another potential problem with collective agriculture is the problem of entrepreneurship. Since there is no individual who will make a lot of money by investing or adopting a new technique, what alternative incentive system can get people interested in taking risks and in making changes? There are, in fact, many alternative reasons for people to desire change other than profit; these include patriotism, ideology, social pressure, and desire to help everyone. The transition from one pattern of incentives and entrepreneurship to another is not simple, however.

For these reasons, it is quite possible for the establishment of collective agriculture to disrupt production severely. These kinds of disruptions magnified problems caused by bad weather in 1959-60, and the results were quite serious because China's agricultural system is so delicately balanced and had so little slack. These dangers still exist, but since 1962 the Chinese have been very careful to see that they do not again disrupt agriculture.

It must be emphasized that these policies of expanding investments in agriculture, of leaving benefits of modernization in the countryside, and of relatively equal sharing of the benefits are not simple economc/administrative allocations made on the basis of mathematical analysis. These are highly controversial political policies, involving fundamental questions of who benefits from modernization.

Revolution was needed to establish the political climate in which these policies would be adopted. The Communist-led, peasant-based revolution broke the stranglehold of urban interests over the political system. It could not guarantee that rural interests would receive priority, and in fact they did not during the 1950s when the Soviet model was being followed. But revolution was a precondition for adopting policies with rural emphasis. To assure reasonably equal distribution of the fruits of agricultural modernization within the rural sector required the elimination of the traditional rural elite as a ruling class. This was achieved during the land reform campaign, in which transfer of land was a minor part of a process to destroy the political power of the traditional elite. Mass participation in criticism meetings coupled with occasional violence tremendously weakened the traditional elite.

After revolution, continued strong government committed to these policies has been needed to assure the maintenance of these policies. Some urban interests undoubtedly would prefer a policy that extracted more from the rural areas for urban consumption, that stressed the development of cash crops for export, that did not emphasize the expansion of health and education services to the rural areas, and that did not orient China's culture to rural tastes. Many urban youth are not happy with programs that require them to settle in rural areas.

In the countryside there are numerous people, including former landlords and merchants as well as former poor peasants and some government officials, who feel they could do better under a private economic system. They frequently try to split off the profitable activities from the collective sector and place them in the private sector, or otherwise increase the individual family's control over resources. Some would prefer to move to the cities, if they could. Constant leadership of the Communist Party and mass mobilization are needed to protect the collective economy from "spontaneous capitalism." This necessity for constant political leadership on these issues is summarized in the slogans "never forget class struggle" and "strengthen the dictatorship of the proletariat."

The Chinese policies have also been based on an unusual independence in international relations. China's strategies, certainly since 1956, have not been inspired by foreign models, experiences, and experts. The political power of urban interests and rural elites has not been propped up by the political, economic, and military support of foreign aid programs. The character of the industrial sector has not been shaped by multinational corporations. The pattern of foreign trade has not been influenced by international agencies such as the World Bank or by foreign-dominated plantations.

At the same time, it should be noted that China's agricultural development has not been carried out in isolation from other countries. Many of China's leading agricultural scientists were trained abroad. Certain technologies are imported (some varieties of seeds, fertilizer factories, some machinery) to supplement China's own capabilities in these fields. China also has a modest international trade in agricultural commodities, which includes the import of wheat and the export of rice and various vegetables, meats, dairy products, etc. While China imports calories in its grain trade (probably to feed some major cities in the north and reduce the political and logistic problems of procurement) it makes money in other commodities to pay for some industrial imports.

The comparisons with other places do not show that revolution and dictatorship are preconditions for rapid

agricultural growth, but it is clear that coordinated political policies are required to achieve equity and stable food supply. Moreover, revolution and equity are not necessarily obstacles to growth. Indeed, they can establish the broad incentives necessary for development.

While there is much suffering inherent in revolution and dictatorship for some people, is it worse than the suffering that comes along with the failure to solve the most basic need of people, namely food? More and more people whose lives are perched on the brink of disaster may conclude that the risks and sufferings of revolution and dictatorship are less than the tragedy of the present. They may see no other way to convince the rural elite and the urban classes to relinquish control over the benefits of agricultural modernization. To solve the food question in many impoverished nations without force and violence requires the willingness of privileged groups to sacrifice short-term interests and to create new solutions for the whole society. Such far-sighted, enlightened policies are tragically rare.

Notes

1. One-month-old infants now average 3.25 kg., compared with less than 3.0 kg. before 1949. In Wuhan, surveys showed that 10-year-old children averaged 5 cm. taller in 1973 than in 1956; boys averaged 2.5 kg. heavier. In one locality populated by national minorities, seven-year-olds averaged 3 to 5 kg. heavier and 10 cm. taller than before 1949. "Healthy Children," *Peking Review* No. 24 (June 14, 1974), p. 22. See also the detailed article by Janet Salaff, "Mortality Decline in the People's Republic of China and the United States," *Population Studies* 27:3 (November 1973), pp. 551-76. At page 575 Salaff offers data on the increase in size of children from the 1930s to the 1950s.

2. Mao Tse-tung, *The Question of Agricultural Cooperation* (Peking: Foreign Languages Press, 1956). Available in Robert Bowie and John Fairbank, *Communist China, 1955-1959* (Cambridge: Harvard University Press, 1965), p. 101, 104.

3. Wang Kuang-wei, "Actively and Steadily Carry Out the Technical Transformation of Agriculture," *Ching-chi Yen-chiu* No. 3, March 1963, SCMM 361 p. 34.

4. Kang Chao, *Agricultural Production in Communist China, 1949-65* (Madison: University of Wisconsin Press, 1970), p. 227.

5. "How Chinese People Control Rivers (three)," NCNA Peking, November 1, 1974.

6. "Agricultural Development," *Peking Review* No. 45 (November 10, 1972), p. 45.

7. "Full-Scale Water Conservancy Improves Farming Conditions in China," NCNA Peking, September 16, 1974.

8. *Economic Statistical Abstract,* State Statistical Bureau, Feb. 1960, p. 120. Cited in Buck, Dawson, and Wu, *Food and Agriculture in Communist China* (New York: Praeger, 1966), p. 156.

9. Benedict Stavis, *Political Dimensions of the Technical Transformation of Agriculture in China* (Columbia University Ph.D. dissertation, 1973), p. 24.

10. Dwight Perkins, *Agricultural Development in China, 1968-1969* (Chicago: Aldine, 1969), p. 64; Kang Chao, *Agricultural Production in Communist China, 1949-1965* (Madison: University of Wisconsin, 1970), p. 121.

11. "Sharp Rise of Farm Machinery," *Peking Review* No. 6, February 7, 1975, p. 23.

12. Jim Nickum, *A Collective Approach to Water Resource Development; The Chinese Commune System,* 1962-72 (University of California Berkeley Ph.D. dissertation, 1974).

13. Benedict Stavis, *Making Green Revolution, the Politics of Agricultural Development in China* (Cornell University, Center for International Studies, Rural Development Committee, 1974), pp. 40-47, 70.

14. *Making Green Revolution,* pp. 26-40. A recent report by U.S. plant scientists who visited China in 1974 offers much detail on China's plant varieties. *Plant Studies in the People's Republic of China* (Washington: National Academy of Sciences, 1975).

15. Ibid.

16. "China Develops Science and Technology Independently and Self-Reliantly," *Peking Review* (November 15, 1974), pp. 14-15.

17. Plant Studies, pp. 56-57.

18. In 1965 over 66,000 HA planted to maize yielded 3.7-4.5 tons per hectare. In some localities yields were as high as 6.7 tons per hectare. In 210 counties yields were over 2.25 tons per hectare. The Scientific and Technical Group of Maize of the Chinese Academy of Agricultural Sciences, "A Summing-Up of the Experiences on Obtaining a Stable and High Yield Maize in 1965," *Chung-kuo Nung-yeh, K'o-hsüeh* 1966, No. 3, p. 3. See also *Making Green Revolution,* pp. 38-40.

By 1972 the area sown to hybrid maize had gone up to 1.73 million hectares. Science for the People, *China: Science Walks on Two Legs* (N.Y.: Avon, 1974), p. 130.

19. Plant Studies, pp. 81-87.

20. The tractor-plowed area nearly doubled from 1965 to 1974. (Chi Feng, "Thirteen Consecutive Years of Rich Harvests," *Peking Review* No. 1, January 3, 1975, p. 12) In 1964 it was reported that tractors cultivated about 10.7 million hectares (Kang Chao, p. 115). Presumably tractors cultivated a bit more in 1965, so the area plowed by tractors in 1974 would be about 20 million hectares.

A document for study groups in the Chinese military reports that for 1973, "the degree of agricultural mechanization . . . is now about 27 percent. Efforts will be made to raise it to 40 percent by 1975." The document failed to specify how the degree of agricultural mechanization was defined; but it may simply be the percent of land plowed by tractor. This would seem to imply over 30 million hectares machine-plowed. This figure is much larger than the other one; perhaps it counts double-cropped land as being plowed twice. *Reference Materials Concering Education on Situation,* No. 45. Kungming: Political Department, Kunming Military Region, April 6, 1973. Available in *Issues and Studies* X:10 (July 1974), p. 101.

21. *Making Green Revolution,* pp. 47-51.

22. Interviews by author, 1972.

23. "Mechanizing Paddy-Rice Cultivation," *Peking Review,* No. 42 (October 20, 1972), p. 23.

24. "Machine-Building Industry," *Peking Review,* No. 44 (November 2, 1973), p. 22.

25. Observed by author when he visited China in Spring 1972.

26. Radio Hunan, July 24, 1970. Also, "Central South China Hsien Makes New Rice Transplanter," NCNA Changsha, October 21, 1968. SCMP 4286, p. 22.

27. National Conference on Rice Transplanter Held in Nanning," NCNA Nanning, April 27, 1969. SCMP 4407, p. 21.

28. Interviews by author, 1972. Report of Nyle Bradey, November 1974.

29. Diversified Economy Thrives on Peking's Outskirts," NCNA October 18, 1974.

30. Wang Kuang-wei, "On the Modernization of China's Agriculture," *Hsüeh-hsi* (Study) No. 1 (January 1958).

31. For example, if rice takes over 100 days to mature, and if the growing season is 210-220 days, mechanization may alleviate the otherwise extreme time pressures in planting the second crop.

32. This theme is explored in detail in my Ph.D. dissertation.

33. An excellent summary is Tien-hsi Cheng, "Insect Control in Mainland China," *Science* Vol. 140, No. 3564 (April 19, 1963), pp. 269-77. See also: Science for the People, *China: Science Walks on Two Legs* (New York: Avon, 1974), pp. 151-64.

34. "Extensive Use of Herbicides," *Peking Review* No. 42 (October 18, 1974), p. 23.

35. Shahid Javed Burki, *A Study of Chinese Communes, 1965* (Cambridge: Harvard University Press, 1969), pp. 40-41.

36. "Statistical Tables Relating to the Hu-Li Brigade of the P'u-k'ou Commune," C. S. Chen and C. P. Ridley, *Rural People's Communes in Lien-chiang* (Stanford: Hoover Institution Press, 1965), p. 198.

37. Jan Myrdal, *Report from a Chinese Village* (New York: Pantheon, 1965), p. 198.

38. Wang Chen-hua, "Diversified Undertakings Promote Development of Grain Production," JMJP, October 21, 1965. SCMP 3577, p. 15.

39. Kuo Feng-lien, "The Tachai Road," *Peking Review* No. 40 (October 4, 1974), p. 25. For slightly different figures based on different years see "Tachai Year-end Report, Yields High Despite Drought," *Peking Review* No. 52 (December 29, 1972), p. 14.

40. "A Visit to the Tungting People's Commune (IV)," *Peking Review,* No. 16 (April 20, 1973), p. 27.

41. "I Polli di Mao," *Avi-Corriere* (Italy), February 1970, p. 6. I wish to thank Mr. N. Erus of the Food and Agriculture Organization for supplying this reference. Estimates for the 1930s were derived from John Buck, *Land Utilization,* p. 413.

42. "Breeding Freshwater Fish," *Peking Review* No. 28 (July 12, 1974), pp. 22-23.

43. This is the conclusion of Peter Schran after intricate manipulations of a variety of survey data. Peter Schran, *The Development of Chinese Agriculture, 1950-1959* (Urbana: University of Illinois Press, 1969), p. 134.

Unfortunately the surveys that were done in the 1950s have not been published in a manner that would permit analysis of the distribution of income within or between different localities. However, the median income was a little lower than the average.

44. *Making Green Revolution,* p. 59. Alexander Eckstein has estimated that the Chinese gross national product per capita was 189 yuan in 1966 and 228 yuan in 1970. If we assume that 30 percent of the GNP is used in investment and depreciation, then 133 yuan in 1966 and 160 yuan in 1970 would be available for consumption. Rural incomes should be expected to be lower than urban incomes, so these aggregate computations are very close to the results from the analysis of the sample. This suggests that the sample is reasonably representative. See Alexander Eckstein, "Economic Growth and Change in China: A Twenty-Year Perspective," *China Quarterly* No. 54 (April/June 1973), p. 232.

45. The meaning of this growth is not clear because of price ratios in China. The first things people buy—food and clothing—are priced very low, but other commodities (e.g., radios, bicycles) are priced high, so even with a growth in cash income the amount of non-essential goods that can be purchased does not go up very much.

46. Observation of Henry Munger.

47. Testimony of William Colby, Director of CIA, in *Hearings,* U.S. Congress Joint Economic Committee, April 12, 1974, p. 77.

48. These international comparisons rely on data collected by the United Nations Food and Agriculture Organization. FAO makes a major effort to gather comparable statistics. There are problems with the data for China for the mid-1960s, but the FAO estimates for the early 1960s and the 1970s seem acceptable. I discuss this problem in *Making Green Revolution,* pp. 62-63.

49. Differences in body size and climate should be considered in interpreting these statistics. "Because healthy adult Bengalis are much smaller than average American men and women, they require only about 75 percent as many kilocalories per day." Roger Revelle, "Food and Population," *Scientific American* 231:3 (September 1974), p. 162.

50. *Making Green Revolution,* pp. 68-74.

51. Roland Berger, "Financial Aspects of Chinese Planning," *Bulletin of Concerned Asian Scholars* VI:2 (April-August 1974), pp. 16-17.

52. Certainly some migrants to Hong Kong report some problems in food supply in some places in some years.

53. From 1953 to 1957 the state supplied deficit areas with 15 million tons of grain. In the twenty years 1952-72, Hopei received over 10 million tons. "Rational Distribution of Food Grain," *Peking Review,* No. 1, January 3, 1975, p. 13.

54. For China, see *Making Green Revolution,* p. 260. The computations are made on the basis of income from collective sources; it is not known how private income would affect the distribution. Also, the computations do not include services, the inclusion of which would reduce inequality. For comparisons with other places in Asia, see Norman Uphoff and Milton Esman, *Local Organization for Rural Development* (Ithaca: Cornell Center for International Studies, 1974), p. 50.

55. John Buck, *Land Utilization,* p. 407.

56. For frequency and severity of famines in China, a convenient summary is in Buck, pp. 125-28.

57. "How China Achieves Self-Sufficiency in Grain," NCNA Peking, September 25, 1974.

58. "Grain Deficient Provinces in Northern China Have Enough and to Spare," NCNA Peking, October 14, 1974.

59. Dwight Perkins, "China's Fourth Five-Year Plan," *Current Scene* 12:9 (September 1974), p. 2.

60. Detailed studies show extraction from the rural sector during the early 1950s. John Macrae, "Mobilization of the Agricultural Surplus in China for Rapid Economic Development, 1952-57," *The Developing Economies,* 8:1 (March 1970), and Shigeru Ishikawa, "Resource Flow between Agriculture and Industry, the Chinese Experience," *The Developing Economies* 5:1 (March 1967). Because of the lack of statistical data, there are no detailed analogous studies for the 1960s, when policy was different.

61. There are, however, a few reports that the agricultural tax has been raised in some (presumably wealthy) localities and perhaps redistributed within counties, pursuant to a 1971 directive. Joan Robinson, "For Use, Not for Profit: A Report on a Recent Visit to China," *Eastern Horizon,* Vol. XI, No. 4 (1972), pp. 6-15; available in Milton, Milton and Schurmann, *People's China* (New York: Vintage, 1974), p. 56.

62. Actually, there are surprisingly few data on the actual prices paid; most reports are in terms of ratios. Another source suggests prices went up from 5.5 yuan to 10.8 yuan per 100 catties, perhaps limited to Peking or Hopei. (Jan Prybyla, "Income and Prices in China," *Asian Survey* 15:3, March 1975, p. 272.) Confusion can be introduced by the fact that prices may be the base procurement price, the marginal price (i.e., with the 30 percent bonus), or an average. Also, prices refer to different grain commodities.

63. Roland Berger, p. 16-17; "China Rationally Distributes Her Food Grain," NCNA Peking, November 8, 1974. "Rational Distribution of Food Grain," *Peking Review* No. 1 (January 3, 1975), p. 13. For other information on prices and price ratios see Jim Nickum, p. 103; Ernest Young, "Development, Chinese Style," *Understanding China Newsletter* 11:2 (March-April 1975), p. 3.

64. The policy of leaving benefits of modernization where they are produced leads to the problem of regional inequalities, because some regions expand production more rapidly than others. To reduce (or control) regional inequalities the state can make loans and grants to poor regions for welfare services and construction projects, send political and technical cadres, and assure purchase of profitable specialized commodities. Also, the tax and profits incorporated in the price of many consumer goods fall more heavily on wealthy regions. Data are not available to permit a conclusion about whether regional inequality is increasing or decreasing.

A very recent report in *Peking Review* implies that tax rates are being systematically reviewed and that increases in about five years are possible. "Rational Distribution of Food Grain," *Peking Review* No. 1 (January 3, 1975), p. 13.

These shreds of data raise the possibility that a major revision in the agricultural tax system is emerging; perhaps experiments with new principles of taxation are being carried out so that the agricultural tax can contribute to a regional redistribution of the benefits of agricultural modernization.

65. This discussion focuses on material incentives at the collective level. Also relevant are ideological and material incentives at the personal level, which have attracted much deserved attention elsewhere.

66. Ramon Myers argues that agriculture was commercializing in China before liberation, and this is undoubtedly true for some regions. But there were impediments to this process and limitations on the ability of the majority of the peasants to get the full benefits from crop diversification. See Ramon Myers, "The Commercialization of Agriculture in Modern China," in W. E. Willmott, *Economic Organization in Chinese Society* (Stanford: Stanford University Press, 1972), pp. 171-191.

67. Randolph Barker, "The Evolutionary Nature of the New Rice Technology," *Food Research Institute Studies in Agricultural Economics, Trade, and Development* (Stanford), Vol. X, No. 2, 1971, p. 118.

68. I am grateful to Professor John Mellor for pointing this out to me.

69. The diffusion of scientific values is described by Silas H. L. Wu, "The Changing Peasant Mentality on China, Some Personal Reflections After 27 Years," *Understanding China Newsletter* X:6 (November-December 1974), p. 6, 8.

70. Some of the problems were aggravated by the tendency of administrative boundaries for the communes and sub-units to disregard the realities of social organization when the communes were first established. After 1961 administrative boundaries were substantially redrawn to reflect traditional marketing patterns and social organization. I discuss this in my monograph *People's Communes and Rural Development in China,* pp. 46-48. The analysis is based on the work of William Skinner.