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LESTER BROWN'S CHINA: FACT OR FICTION

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China, with one-fifth of the world's population, rapidly rising incomes, and a long history of famines, is a country which has naturally been open to speculation of its ability to feed itself through the next several decades. Population is expected to grow from about 1.1 billion in 1990 to 1.5 or 1.6 billion in 2025. Simultaneously, per capita income growth will lead to greater demand for meat, thus resulting in larger feed requirements for animals. A number of projections have been made by both Chinese and foreign researchers about whether China will continue to be an agricultural exporter or will become an importer. The most extreme, and most pessimistic, of these projections are those of Lester Brown, President of World Watch, a nonprofit organization in Washington, D.C. His doomsday prophecies that Chinese feed imports will seriously disrupt world markets have received wide media attention. Will chaos erupt or is this fiction developed by a well-meaning but factually misguided public figure?

In sharp contrast to Brown and in radical disagreement with numerous analysts, the author of this paper argues that *technically* China can be self-sufficient in foodstuffs throughout the next few decades. One major exception to the rather naive or pessimistic projections, and one which generally supports the author's conclusions, is printed in a 1995 Japanese publication, "Modern Agriculture—We Now Want to Know About China." The term self-sufficient refers to the net trade balance in human and animal foods and feeds. In order to draw comparisons, most of the author's projections are based on protein and energy, units commonly used to determine demand and supply of feedstuffs. Protein is measured by weight, such as grams or tons, and energy is measured on a caloric basis. The term *technically* implies that the country can be self-

sufficient if China's decision makers adhere to their policy, which says the country *should* be self-sufficient. At some point the nation's leaders may view the goal of self-sufficiency as no longer paramount; for example, if the country develops an enormous balance of surplus payments, it would be deemed wise to import agricultural commodities to help reduce the surplus. It is also possible that net imports could result from inept macromanagement. Lets begin our evaluation with some general statistics on China's ability to feed itself.

In terms of livestock, China,

- ranks first in the world in pig, horse, chicken, and duck inventories.
- ranks second in numbers of goats, sheep, and buffalo; fourth in cattle numbers, tenth in camel numbers, and eighteenth in dairy cattle numbers.
- ranks first in production of pork, goat meat, sheep meat, and total meat and second in poultry meat.

On the crop side

- China is a major producer, if not the leading producer, of most of the world's principal crops.

China has ranked

- first in wheat, rice, cotton, and rapeseed production; second in maize production; and third in soybean production for most of this decade.
- as a major exporter of maize and oilseed meals over the past 10 years.

There are a number of misconceptions about China, derived from its chaotic past and the fact that it was only opened to the West relatively recently. Just two decades ago there was a major famine in the country, and the myth has been perpetuated that China is a country of

starving people. This is wrong. There are, of course, still a vast number of people with low incomes, who suffer from inadequate diets, particularly in the poorer rural areas, just as there are in Russia, Eastern Europe and even in some parts of the United States. China has an abundance and wide variety of foodstuffs spread virtually throughout the country, and hunger in the country is caused by a lack of income rather than a lack of supply.

Another misconception is that China is very densely populated. It is most unfortunate that some well-known public figures such as Brown, and even academics who specialize in the area, use other East Asian countries as points of reference for China's population and geography. The author of this paper can only deduce that these comparisons have evolved as a result of geographical proximity as well as some similarities in racial phenotype and writing systems.

On a persons per hectare basis, China shares more similarities with the United Kingdom and Germany than with other Far Eastern countries. For example, in terms of persons per hectare of arable land, while China has about 13 persons, Japan has 30; the Republic of Korea has 21; and Taiwan has 23 (Table 1). On the other hand, the United Kingdom has 9 persons, and Germany has 7. Care must be taken to use comparable data sources as this author has done with the Food and Agricultural Organization (FAO) *Production Yearbook*. Regrettably, some analysts have used cultivated land, which is different than arable land, when calculating figures for China.

The number of permanent meadows and pastures is especially important for cattle and small ruminant production. China has a density of four persons per hectare while Japan has 207 and the Republic of Korea has 442. Data are not available for Taiwan, but it is undoubtedly similar to Japan and Korea. In contrast, there are five persons per hectare of permanent meadows

and pastures in the United Kingdom and 18 in Germany. While China does have a substantial population density when compared to a country like the United States where there are just 1.3 persons per hectare of arable land, density in China is not as great a concern as many investigators would lead us to believe. This is especially true when it is recognized that, in contrast to the United Kingdom and Germany, a substantial portion of China's crop land is situated in warm areas and thus China's crop index, the measure of multiple cropping per year, is much higher than these temperate countries.

Another "plus" for China is that recent research using satellite imagery and ground surveys reveals much more cultivated (cropped) areas than previously believed to exist. Apparently, the discrepancy is quite large, perhaps 30 to 40 percent. If total production is approximately correct, then crop yields are substantially lower than reported. Regardless of the outcome, it is apparent that China has a much greater capacity for agricultural production increases than has been indicated by the statistical data.

One concern is the continued loss of cropland to nonagricultural uses. In all likelihood, cropland will continue to be used for other purposes. However, significant amounts of previously eroded, salinized land, as well as land classified as wasteland, are being converted to cropland, thus mitigating the loss. In addition, because the sown area has increased since the 1980s, the multiple crop index has remained stable (Table 2).

A key to making long term projections about China's ability to feed itself is the realization that, not withstanding remarkable economic growth, it is a developing country with very low income. Consequently, despite remarkable achievements by the rural labor force, China's agriculture is still in what is termed the era of horse power (Figure 1). Hand power is

also still prevalent in much of the country. In actuality, China is only now entering the era of mechanical power—the period which characterized the United States between World War I and II. The next era, referred to in Figure 1 as the science power era, lasted in the United States for about 40 years. It is now moving into a new era referred to by the author as the science and knowledge power era. China will progress through the eras much more rapidly than the United States did. Barring a severe political and/or economic setback, Chinese agriculture will be completely different in a few decades.

Paradoxically, China's recent history of communism will be an asset in moving the nation quickly toward the era of science and knowledge power. In bright contrast to virtually all other developing countries, China has substantial segments of large-scale crop and livestock agriculture. It is true that agriculture is very human labor-intensive, and particularly in the Southeast. Furthermore, in vegetable production, many individual plots are small. This is partly because of recent policies, which have led to the breaking up of a substantial number of areas that were communes and state farms. But, even the most cursory trip through major grain growing areas quickly convinces one that the economies of scale are large and can easily grow even larger, both from an institutional and land-base viewpoint. China has simply leaped across the smallholder restraint, which is a major problem, if not the major problem, of many developing countries. This historical legacy, coupled with rapid urbanization resulting from a policy of rural industry development which has opened the way for mechanization, provides an optimistic forecast for crop agriculture.

It is important to understand that, because much of China's farm work is carried out by hand labor and animal power, there is a *de facto* labor shortage during critical farming periods.

As urbanization continues, there will be expanded mechanization which will help alleviate this critical period labor shortage and will serve to both expand the multiple crop index and to increase yields. The author cannot stress too emphatically the importance of mechanization, capital development, and management improvement for long-term crop yield improvement, production sustainability, synergistic use of inputs, and reduction of crop losses.

Another source of optimism for long-term yield increases is ironically the variable quality and availability of inputs such as seeds, fertilizers, and chemicals. As the country develops, so will dependability of these inputs. One needs only look at the remarkable improvements of the past 10 years. It is true that processed feed production will double in the next 10 years, but quality of processed feed is low. As quality improves, processed feeds will be used more successfully and efficiently.

Transportation bottlenecks, although another serious problem, are being overcome as fast as is feasibly possible. Improved transportation will have an important impact on more rational uses of resources in agriculture. Transportation and marketing are crucial because of extreme climatological and geographical differences. On an optimistic note, observe that today's situation is nothing like that of a decade ago when the *de facto* provincial policies were designed to actually prevent exports to other provinces. Overcoming this provincial self-sufficiency mentality has been a vital first step to development of a national agricultural marketing system.

Storage of agricultural commodities is generally rudimentary, and large losses are the norm partly because of transportation problems and partly because of a lack of infrastructure. Huge investments by international lending agencies, China's agricultural bank, national agencies, provincial governments, county and city governments, not to mention farmer-owned

cooperatives are alleviating this massive problem, estimated at about 15 percent of crop production. If just a one/half percent reduction was made each year, it would be similar to a one-half percent increase in production. China is also aggressively seeking production and marketing technology for crops and animals.

Brown argues that at the world level, crop yields are reaching maximum levels, and marginal returns to fertilizer use are leveling off. But China is different, and, despite a relatively high use of plant nutrients per ha of arable land, this statistic hides some realities. For one, improved efficiency of fertilization could provide gains of 25 to 30 percent from this input alone. One reason is that current recovery rates for nitrogenous fertilizers are only about 40 percent for dryland crops and usually just 20 to 30 percent for rice. Additional gains can be obtained from improved quality of fertilizer by gradually shifting production from the many small- and medium-sized fertilizer plants that produce ammonium bicarbonate to modern urea and compound plants. At least a third of fertilizer used today is ammonium bicarbonate, a compound that is highly volatile and results in large losses even before application. Statistics also conceal an improper use of fertilizers. At a time when advanced farmers in developed countries are adopting use of satellite-controlled fertilizer application systems, the Chinese are at a very rudimentary stage, which does not even include soil testing.

The elementary level of farming will lead to greater—and more sustainable—production as time elapses. Consider this. As of 1990, China's maize yield was 4.4 tons per ha compared with 7.9 tons in the United States. As discussed, even at that level the calculated yields in China are apparently too high based on the underreporting of cropland. Even taking into consideration differences in natural resource endowments between the two countries, yield could grow

substantially. In stark contrast to Brown's projections, the Office of Technology Assessment of the United States Congress, a major source apparently overlooked by Brown in his rather one-sided selection of references, forecasts a maize-yield growth rate of 1.01 percent annually for the United States between 1990 and 2000. They also project for the same period that cotton yield in the United States will increase by 1.67 percent annually; soybean yield will increase by 0.39 percent per year; and wheat yield will increase by 2.04 percent annually.

Let us turn to the animal side of the equation. The author submits that efficiency in animal production is a crucial subject overlooked by Brown and others, who have made projections about China's ability to feed itself. As of 1990, China produced 12 Kg of beef per head, in pointed comparison with the United States, which produced 107 Kg (Table 3). It is of paramount importance to realize that China has vast grazing areas, a substantial portion of which produce at much less than their potential, partly as a result of management problems. Another reason is lack of incentive caused by remoteness, prohibitive transportation costs, and institutional legacies, which inhibit structural and production system adjustments.

As the country develops and becomes mechanized, the grazing lands will gradually shift to production of feeder cattle, and rather than being grass fattened, will be followed by minimal feedlot fattening in grain producing areas. In all likelihood, because of economic and institutional considerations, a hybrid of the Australian and U.S. systems will evolve. Regardless, production per head of inventory will increase which means that fewer cattle will be required to produce the same, or even expanded, amounts of beef. Perhaps most important is the realization of the error in simply applying a feed conversion coefficient, such as eight to one for beef, based on production feedlot- type fattening systems in the United States. In fact, if there is one thing

which distresses the author of this paper greatly about other analysts' work, it is the lack of attention that they give to production complexities. Finally, China has a huge amount of by-product and nonconventional feed resources, such as straw.

Pork production per head of inventory in China is about one-half of that of the United States, 66 Kg versus 128 Kg (according to FAO data in Table 3). As economic development takes place in China, an increasing proportion of swine will be raised in commercial operations, which will vary from small operations of 20-40 head to 2,000 or more animals per unit as opposed to the typical one to two-head backyard operations. Vast improvement will take place in genetics and management, paralleled by phenomenal changes in quality and availability of feedstuffs. As a result, even though human per capita consumption of pork will increase and population will grow, swine inventory will grow proportionally less and feed per Kg of pork produced will decline.

Poultry for meat are largely raised in confinement, meaning that they must be fed grain or other feedstuffs. However, as a result of rudimentary procedures, only about 2 Kg of meat are produced per head of inventory, compared with 7 Kg in the United States. Similar to swine, vast improvements will take place in productivity and more efficient use will be made of feedstuffs, resulting in a substantial reduction in feed per Kg of meat produced. The same situation holds true for eggs.

Production of pigs, poultry, and milk lends itself to a "factory" type system of very large-scale production. China's cities, counties, and provinces have abundant cash resources and are aggressively moving into these operations. Numerous joint ventures are being consummated, both between Chinese firms and foreign ones. Although about 70 to 75 percent of pig inventory,

60 to 65 percent of chickens for layers and 30-35 percent of chickens for meat are still raised in backyard operations, the percentage is falling. Furthermore, as a result of technological efficiencies, the bulk of production is from commercial operations.

Let us now turn to the author's projections. As an agricultural economist, he knows that results of various political and sociological changes can be captured in economic models. If there is political stability, a desire for cultural change, and proper economic policies, Gross National Product (GNP) will grow rapidly. This is the case of China. Their economy has grown at an average annual rate of 9 percent since 1978. In the past few years GNP has grown at well over 10 percent annually.

One of the two projection alternatives from the author's book, co-authored by Cheng Xu and Miyazaki Akira, referred to as "robust," is based on continued strong economic growth. When an economy is robust, demand and per capita consumption of higher-valued foods, such as animal products, increase. However, this is offset by the government spending more money on agricultural research and extension. Furthermore, there is expanded migration to urban areas leaving the better producers on farms. In addition, farm size increases, enabling greater use of scale-dependent technologies. The result of these changes is that agricultural technology is adopted at a rapid rate, and input use is vigorously expanded. In a developing country like China, one consequence is that draft animals are rapidly replaced by machines, not only increasing economic efficiency and crop productivity but also freeing up feedstuffs for use by livestock raised specifically for human food consumption.

When an economy is besieged by political instability, inappropriate economic policies, etc., GNP growth is relatively low. Likewise, growth in per capita consumption of what

economists term "luxury or superior goods" like animal products, as opposed to the so-called "inferior goods" like grains, increases relatively slowly. Minimal growth in agricultural research, technology transfer, and adoption are associated with reduced government revenue. Slow growth in the economy, coupled with modest growth in per capita consumption of food products, is the basis for my second alternative which is the "economy sluggish" projections.

China is potentially a politically volatile country. In addition, if analyses of long-term economic growth in other countries are any indication, there will be fluctuations in China's economy and growth rate. The author is fairly confident that economic growth will fall somewhere between his projections of robust and sluggish.

Feedstuffs vary greatly in their nutrient composition. Likewise, there is a tremendous difference in nutrient requirements between animals. Cropping patterns and cultivation methods, as well as species composition, also change over time. The approach used in the following projections about China's feed situation was to base calculations on protein and energy requirements, and protein and energy availabilities. A base year, in this case the average of 1989-1991, was selected; the models were validated; and projections were developed for the years 2000, 2010 and 2025. The requirements and availabilities models have about 300 variables and 1,000 parameters each. Evaluation of data and analysis is so complex that full documentation takes up several hundred pages in the author's book *China's Livestock and Related Agriculture: Projections to 2025*.

The method used to estimate feed requirements of animals was to first project per capita human consumption of animal products and multiply this by population to determine total consumption. For most livestock commodities, consumption has equaled production in China.

Animal inventory was then calculated for food-oriented animals from production. Separate projections were made for animals used for draft or transport. Inventories of all animals were then multiplied by metabolizable energy (ME) and crude protein (CP) daily requirements to obtain totals.

Per capita consumption projections were prepared using standard statistical techniques, which relate per capita income and per capita consumption for each commodity to derive income elasticities. A cross section of eight East Asian countries was used. China's per capita income was then projected for the economy sluggish and economy robust alternatives, and per capita consumptions were derived for the years 2000, 2010, and 2025. Pork, for example, is projected to increase from the 20.1 Kg of 1989-91 to 28.4 Kg in 2025 under the economy sluggish projection and to 35.3 Kg under the economy robust alternative (Table 4).

The remaining discussion relates to the year 2025—30 years from now. Please take a moment to consider the length of time this signifies. The author spent some time in Japan from 1958 to 1961, and he can attest that its agriculture and animal husbandry was much different then it is today. If you can visualize what 30 years signifies, it will not be difficult to place the author's projections of China's agriculture into perspective.

The projections reveal that China's animal inventories will not be much larger in 2025 than they were in 1990, despite large increases in human population and per capita consumption, because of the changes in industry structure and management mentioned earlier. The parameters chosen for the models are quite conservative as you can easily determine by examination of *China's Livestock and Related Agriculture: Projections to 2025*. The benefits from improved efficiency and mechanization are such that total cattle numbers are only about 85 percent higher

for the sluggish projection in 2025 compared to 1990, and 60 percent more in the robust alternative (Table 5). Total pig numbers are just 17 percent and 25 percent greater for the two economic alternatives. Poultry numbers are almost double.

For the base period, which is the average of 1989 through 1991, metabolizable energy requirements by animals were 1.46 times 10 to the 12th power megacalories, i.e., 1.46 trillion megacalories. As a point of reference, one megacalorie is equal to one million calories.

On the availabilities side, production of each crop for 1989-91 was multiplied by the amount of ME and CP to determine totals. Many crops have multiple outputs which really make a computer indispensable. For example, barley grain is used for human food, beer, and animal feed. The straw can be used for animal feed with the challenge being determination of the proportion fed. An added complexity is that barley straw, like many other crop residues, can be treated with chemicals to improve its digestibility and protein content, and the spent grains can be fed to animals after the brewing process.

Feed availabilities, which are based on published data or for sources which could be estimated with some degree of confidence, such as pasture lands, are 0.93 times 10 to the 12th power megacalories for the base year of 1989-91 (Figure 2). The difference between requirements and availabilities is 0.53 times 10 to the 12th power, or 36 percent. This gap is met by feeding garbage, roadside grazing, and widespread use of nonconventional feed resources such as water plants like hyacinth for which there is no published data. Please remember this 36 percent as it is crucial to the analysis about the extent to which China can feed itself.

Results from the robust and sluggish projections indicate that the calculated gap between ME requirements and availabilities will continue to be 37-38 percent in the years 2000, 2010 and

2025. Because the gap, caused by lack of published data between feed availability and requirements, will remain essentially the same for the next 30 years, the conclusion is that China will essentially have a balance between metabolizable energy needs and domestic production.

The gap between protein requirements and availabilities increases slightly during the period 1990 to 2000, from 48 percent to 50 percent. This should be no problem for China, which is a major world exporter of oilseed products. In fact, in addition to having exported over one-half a million tons of rice and 6 million tons of maize annually during the early 1990s, China accounts for about one-half of the world's cottonseed meal exports and 8 to 17 percent of other oilseed meals. China does, however, import about 10 million tons of wheat annually. In summary, on the crop side, by 2010 the gap caused by a lack of data is projected to decline to 42 percent and remain about there in both the sluggish and robust projections. This 42 percent is well below the 48 percent gap calculated for 1990.

The concern of whether there is sufficient production capacity in China to meet human food consumption needs of nonanimal products as well as feeding animals was evaluated by focusing on total caloric intake by humans. Part of the modeling process included estimating the percentage of use by animals for each crop. The remainder for each crop is the amount used by humans, wasted, lost in storage, etc. Calculations for 1990, in the model for the commodities consumed by humans, indicated there were 74 percent more calories than needed. The amount consumed, according to FAO, is 2,356 calories per day per person. The overconsumption includes harvest and postharvest losses, cooking losses, etc. In brief, the calculations in the model for human use are reasonable. With the preliminary work done, the final calculations are the ratios between the animal and human use of crops. They were about the same in all

projection years as in the base year. Thus it was concluded that even if human caloric levels were to increase and the required composition of carbohydrates, fat, and protein were to change, the effects on animal feedstuffs projections would be negligible.

The authors of *China's Livestock and Related Agriculture: Projections to 2025* concluded that, on balance for the next few decades, *technically* China can be self-sufficient not only in animal feedstuffs but also in human foodstuffs, apart from wheat. In years of abundant harvests, it will be a net exporter of maize and oilseed meals. In years of poor harvests, such as those of the past two years, the country will import feedstuffs (Figures 3 and 4). These fluctuations, normal in a climate-influenced production process, will affect world trade to some extent but, contrary to Brown's assertions, relatively little. Much of the effect will depend on how government develops storage facilities and other policies to account for the vagaries of nature. Let me assure you that, with the assistance of massive international loans, impressive efforts are underway to improve storage and transportation of grain.

Paradoxically, China's current relatively low level of crop yield and very low level of animal productivity is one major reason why *technically* it will be able to be self-sufficient in food in the foreseeable future. On the animal side, as the economy matures there will be a continued shift from backyard to commercial operations, and from draft power to mechanization. As a result of improved management, increased infrastructure like transportation and communication, a wider array of quality, imported and improved breeds, and a host of technologies, the amount of feedstuffs required per kilo of animal product will decrease.

What if China really got busy and strongly embraced the emerging benefits of research such as those from biotechnology? Our rather conservative projections indicate that livestock

inventory would be 15 to 35 percent lower than in the robust projection. In fact, by 2025, the national inventory of some animal species would be lower than it was in 1990. Greater production with fewer animals means less feedstuffs requirements.

An idea of the impact that greater productivity could have is obtained by considering pigs. In 1980, China's pigs produced about 36 kilograms of pork per head of inventory. This number is derived by dividing total pork production in the country by the total number of pigs. By 1990, productivity had reached 62 kilograms (using Chinese data). By use of considerable new technology and more rapid improvement in management than in the sluggish and robust projections it's estimated that 128 Kg could be produced per head of inventory. The level is calculated to be 121 kilograms in 2025 for the robust projection. These numbers are placed in perspective by recognition that the greater use of technology projection of 128 kilograms thirty years hence is the same as the average production per pig in the United States back in 1990. The average was 121 kilograms in Europe in 1990 and 132 kilograms in Japan. In brief, the author's basic, robust and sluggish projections are not out-of-bounds scenario building but rather may be even too conservative, especially when related to recent results for other countries.

The reference to the impact from technology development and adoption on the requirements side holds true for the feedstuffs availabilities side as well. During the period from the establishment of New China in 1949 until about 10 years ago, little attention was paid to land conservation. Today, environmental issues are a hot topic receiving not only national and local attention but also international aid. Desert protection, a very long-term and high-cost problem area, is an example of the great strides being made. Great efforts are being made in flood control, irrigation improvement, and waste land reclamation. Major attention is being given to

sustainable agriculture. Clearly, much more needs to be done especially in ground and surface water quality control and acid rainfall. But compared with other developing countries, China is way ahead.

In summary, we will revisit a few major points. First, there are self-correcting mechanisms in a market economy, ones to which Brown apparently believes China's policymakers cannot or will not respond. I believe they will respond. But, as shown in the economy sluggish projection, even if they do not respond although supply does not increase rapidly, neither does demand.

A second major point is that because China underreported its cropland areas by an estimated 30-40 percent in the past, Chinese yield statistics have been greatly exaggerated. The actual yields leave much room for improvement. In addition, there is much more arable land than has been recognized. Fertilizer use is much less than satisfactory, yet China only needs capital investment for significant fertilizer output expansion and quality improvement, as the country has abundant natural resources for fertilizer production.

A third reason that China will be able to feed itself is the rapid shift to non-agricultural employment. Finally, meat demand will not rise as fast as Brown predicts. Even today per capita meat consumption is roughly on par with South Korea and only 10 kg below Japan.

What does all this mean for those of us in this room? One major message is the need to be more aware of the impact from agricultural technology—and technology in general as well as management. Through careful research, we can avoid mistakes about markets and trade—and search for the real and profitable opportunities.

China cannot fail in its quest for self-sufficiency in food and feedstuffs production. It is

the duty of the United States to help China in its quest for agricultural improvement.

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Table 1. Population density in China compared with selected other countries and regions, 1992

Country or region	Total land area	Arable land	Permanent meadows and pastures	Arable land, permanent crops and meadows
	----------Persons per ha----------			
World	0.4	4.1	1.7	1.2
China	1.3	12.8	3.7	2.9
Japan	3.3	30.3	207.2	23.9
Korea, Republic of	4.5	21.0	441.6	18.4
Taiwan	5.8	23.1	N/A	10.9
United Kingdom	2.4	8.9	5.2	3.3
Germany	2.3	7.0	18.3	5.0
China, 2025	1.7	17.1	3.9	3.2

Source: FAO, *Production Yearbook* (1993)

Table 2. Cultivated and sown area and crop yields in China

	1989-91	1992	1993	1994
	----------Million ha----------			
Total cultivated area	95.7	95.4	95.1	94.9
Total sown area	146.7	149.0	147.7	148.2
Multiple crop index	155	156	155	156
Sown area				
Oilseeds USDA	22.5	23.8	24.1	25.9
Oilseeds PRC*	10.7	11.5	11.1	12.1
Grain	112.7	110.6	110.5	109.5
	----------Million tons----------			
Production				
Grain	429.7	442.7	456.4	445.1
Maize	91.5	95.4	102.7	99.3
Wheat	95.0	101.6	106.4	99.3
Oilseeds, USDA	32.1	33.0	38.3	42.4
Oilseeds, PRC	15.1	16.4	18.0	- -
	----------Tons/ha----------			
Grain yield	3.7	4.0	4.1	4.1
Maize yield	4.3	4.5	5.0	4.7
Wheat yield	3.1	3.3	3.5	3.4
Oilseeds yield, USDA	1.3	1.4	1.6	1.6
Oilseeds yield, PRC	1.3	1.4	1.6	1.6

* Does not include cotton and a few other oilseeds.

Table 3. Production per head of inventory, 1990

	China	USA
	----------kg----------	
Beef	12	107
Pork	66	128
Cow milk	1,632	6,711
Poultry	2	7

Source: Derived from FAO *Production Yearbook* (1992)

Table 4. Meat consumption per capita in China, 1990 and 2025

Commodity	1989-91	2025	
		Sluggish economy	Robust economy
Beef	1.0	2.1	3.2
Pork	20.1	28.4	35.3
Mutton & lamb	0.5	0.8	1.0
Poultry meat	2.9	9.4	18.2
Total meat	25.1	41.2	58.1
Eggs	7.1	10.1	12.6
Cow milk	3.7	12.5	24.7

Source: Simpson, Cheng and Miyazaki (1994)

Table 5. Livestock inventory in China, 1990 and 2025

Species	1979-81	1989-91	2025 Economy sluggish	2025 Economy robust
	----------Million head----------			
Asses	7.9	11.2	12.7	8.0
Horses	11.0	10.2	8.2	5.9
Mules	4.2	5.5	5.8	5.2
Sheep	106.2	112.4	210.5	242.9
Goats	79.8	96.9	141.3	92.8
Milk cows	0.6	2.7	4.7	6.9
Draft/beef	52.9	78.3	146.4	121.4
Total cattle	53.6	81.0	151.1	128.2
Buffalo	18.6	21.7	21.7	19.0
Pigs				
Commercial	-	99.0	287.7	386.2
Backyard	-	271.6	145.4	78.7
Total	306.3	370.6	433.2	464.9
Poultry				
Chicken	860	1,996	3,517	4,991
Other	251	361	480	581
Total	1,111	2,358	3,996	5,573

Source: Simpson, Cheng and Miyazaki (1994)

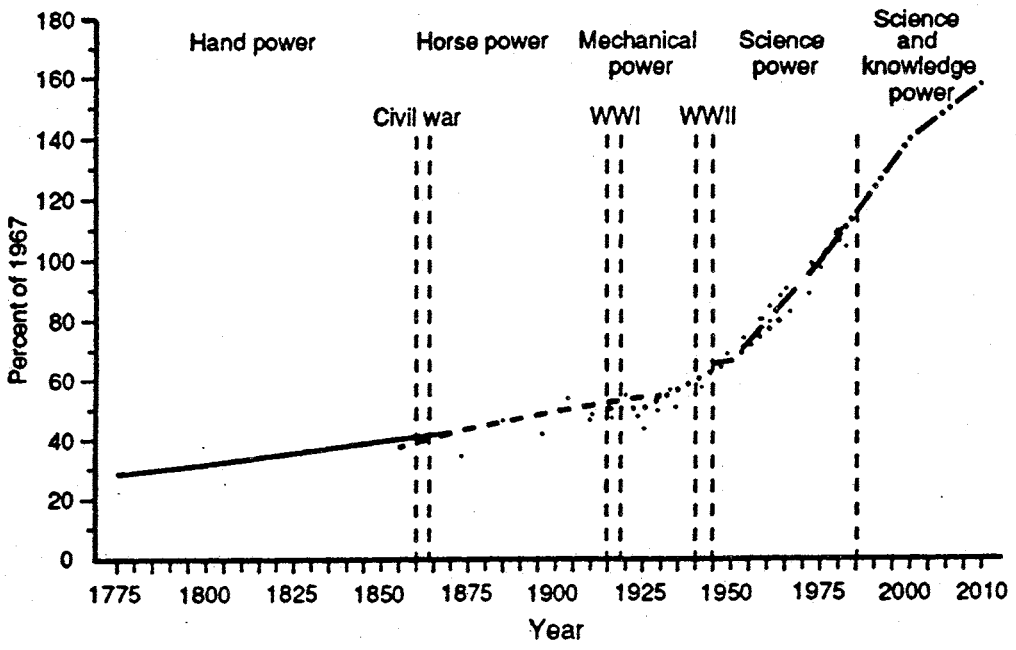
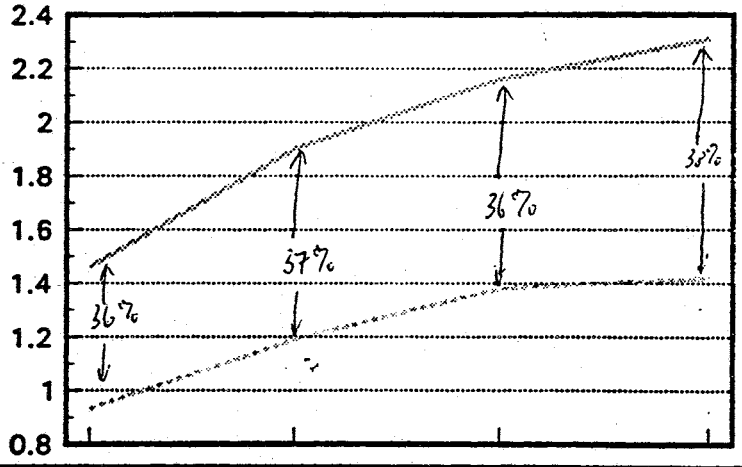


Fig. 1. United States agricultural productivity growth - era of science and knowledge power. Source: Adapted from Lu *et al.* (1979).

FIGURE 2. METABOLIZABLE ENERGY

REQUIRMENTS AND AVAILABILITIES,

10 TO THE 12TH POWER MEGACALORIES



YEAR	1989-91	2000	2010	2025
REQUIR ———	1.46	1.90	2.16	2.31
AVAILABILITIES — -	0.93	1.19	1.38	1.42

SOURCE: SIMPSON, CHENG AND MIYAZAKI, 1994.

Figure 3. CORN PRODUCTION AND IMPORTS

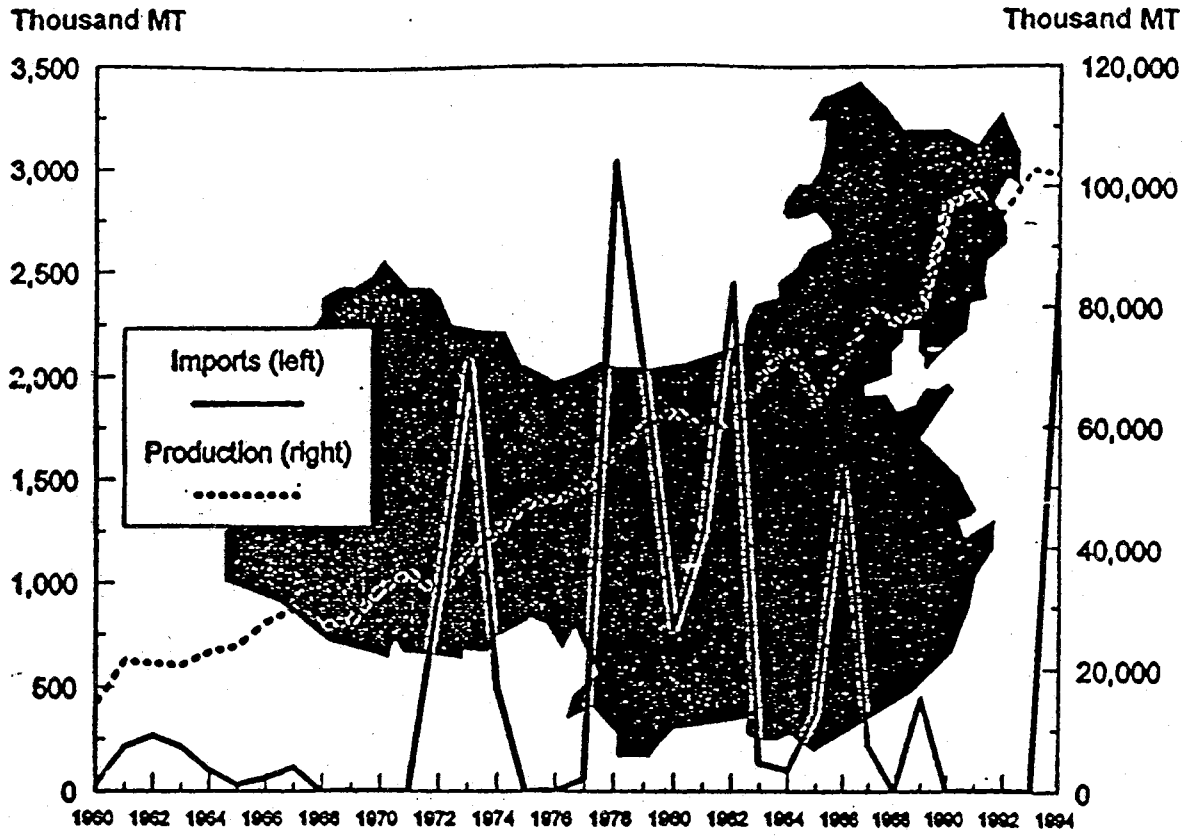


Figure 4. CHINA: CORN IMPORTS AND EXPORTS