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Introduction

Since economic reforms in China started in the late 1970s, China's overall economic growth rate has been very markable (Table 1). The replacement of collective farming system with a household-based farming system in 1978-84 improved farmer's incentives and made agricultre the leading sector of economic growth in that period. As the one-off efficiency gains from the farming institutional reform were essentially exhausted by the mid-1980's, agriculture's growth rate decelerated. However, the reforms in the urban area made the growth rates in other sectors continue to accelerate. Especially the industrial and service sectors' growth rates tripled from about 6 percent in the early period of the reform to about 16 percent by the early 1990's (Table 1).

Rapid economic development has also been accompanied by equally dramatic changes in the economic structure (Table 2). Because of a bold trade liberalization, China's foreign trade grew at a rate much higher than the growth rate of national income. The value of exports relative to national income rose from 3 percent in 1970, 7 percent in 1980, and up to 20 percent by 1992, a three-fold increase during the reform period. Judged by the trade dependence ratio, China has become the most open economy among the large economies in the world by the early 1990s. On the other hand, agriculture's share in the national economy has declined. For example, its share in the national income declined from 41 percent in 1970 to 29 percent in 1992. Meantime, agriculture's share in the total export declined from 37 percent to 12 percent, and in total employment from 81 percent to 59 percent in the same period. Within agriculture, the composition of gross domestic product also changed with the share of crops, specifically grains, oil crops, cotton, and other cash crops declining, in favor of livestock, fisheries, and other commodities. Among crops, the growth rate of grain production, after reaching its historical height in the early reform period, has suffered a rapid decline (Table 3). Partly due to the slow growth, severe grain price spikes were observed in the fall of 1993 and more recently from May 1994 to early 1995. The future of China's grain economy has been the subject of concern both within and withou China.

A number of grain predictors have claimed that China's grain imports will increase significantly in the near future. For example, Brown (1994) states that China's grain imports would exceed 200 MMT by 2030. These rapidly increasing grain imports will strain the world's productive capacity. However, most of China's own economists disagree. Researchers in the Chinese Academy of Agricultural Sciences have long predicted and still believe that the nation will remain a high level of self-sufficiency. The future's growth of grain production could be accelerated by the increase in grain yield through technological innovation, especially seed-improvement research (Lin, 1994, 1995; Mei, 1995). Whatever course China's grain economy takes, the stakes are high for China's own development and for the stability and health of the world's agricultural trade. The purpose of this paper is to assess the performance of China's agriculture in the past decades and to predict the future growth of China's food supply and demand balances. After the general introudtion, section II describes an overview of the growth of grain production and underline growth forces. The structural changes in food consumption are presented in the third section. Then, in fourth section food demand and supply projections are made using a model recently developed by Huang, Rozelle and Rosegrant (1995). In this model, a series of important structural factors and policy variables are accounted for explicitly, including urbanization and market development on the demand side, and technology, agricultural investment, environmental trends, and institutional innovations on the supply side. Finally, the conclusions and implications are made in the last section.

Agricultural Production Growth And Factors Underlined the Growth

The growth of agricultural production in China since the 1950s has been one of the main accomplishments of the nation's development policies. Except during the famine years of the late 1950s and early 1960s, the country has enjoyed rates of production growth that have outpaced the rise in population. Even between 1970 and 1978, when much of the economy was reeling from the effects of the Cultural Revolution, grain production grew at 2.8 percent per annum (Table 3).[1] Rice yields grew at 1.8 percent per year and those of other grain even faster (3.3 percent). These growth rates were further accelerated during the first period of rural reform (1978-84): Rice production increased by 4.5 percent per year, the output of other grains rose by 4.8 percent (Table 3). Yields of wheat and corn grew even faster. The most spectacular growth was enjoyed by cash crops which expanded in real value terms by 14.9 percent annually. However, these high growths were halted in the post reform period (Table 3). Declines in the growth of grain production after mid-1980s, especially since early 1990s have caused a national fear of future's grain deficit.

Past studies have already demonstrated that there are a number of factors which might have simultaneous contributed to the agricultural productivity growth during the reform period. The earliest empirical investigations by McMillan, Whalley and Zhu (1989), Fan (1991) and Lin (1992) centered around measuring the contribution of organizational reforms to agricultural growth in the early 1980s. They found that the introduction of the household responsibility system was major source of production growth of agriculture. While confirming the important impacts of the institutional and price and market reforms on the agricultural output growth in the early 1980s, Huang and Rozelle (forthcoming-b) and Huang, Rosegrant and Rozelle (1995) demonstrated that the technology adoption (change) was the most important determinant of agricultural growth in the whole reform period, especially in the late reform period (after 1984). The decline in the growth rate of agricultural production since mid-1980s has been associated with the completion of one-time impact of HRS, adverse impact of price policies, the slowdown of technological changes, and degradation of natural resources (Lin 1992; Sicular, 1995; Huang, Rosegrant, and Rozelle, 1995; Huang and Rozelle, forthcoming-a). Despite the relative high yield of grain in China, the return to agricultural research and potential grain yield are still high in China (Lin, 1995).

Growth in Pre-Reform Period. While there were some real gains from agricultural technology in the pre-reform era, the expansion of inputs generated much of the growth in production (Perkins and Yusuf, 1984). Irrigation expanded dramatically during the 1960s and 1970s, as did the use of chemical fertilizers (ZGTJNJ, 1994). Labor was pushed intensively onto the land (Weins, 1982). After accounting for the utilization of major inputs, the growth of total factor productivity is generally considered to have been relatively low if not zero (Wen, 1993; Tang, 1984). These low rates of productivity growth also dampened the real increases in rural incomes (Lardy, 1983).

Reforms in the past decade. To overcome some of the above problems, a series of reforms were launched in the late 1970s. For example, a household responsibility system (HRS), which restored the primacy of the individual household in place of the collective production team system as the basic unit of production and management in rural China, has been implemented since late 1970s (Lin, 1988). Under HRS, collectively-own land was assigned to individual household with a contract for up to 15 years and recently extended to 50 years. The HRS have impacts not only on incentive system, but also on the adoption of new technologies (Lin, 1991; Huang and Rozelle, Forthcoming-b). On the other hand, China's policy-makers recognize the role of prices and market competition in determining production and efficient allocation of resources. Price and market reforms, therefore, have been key components of the country's development thrust as it gradually shifts from a socialist to a market-oriented economy. While the institutional transformation from a collective to a household responsibility system of farm management was essentially completed by the early 1980s, the process of price and market reform has not been completed after one-and-a-half decades. Although there has been definitely a decisive trend towards liberalization, the process has been characterized by cycles of deregulations and reinstatement of controls (Findlay et al., 1993; Lin, 1994; Huang and David, 1995; Rozelle, Park and Huang, 1995).

Recent Price and Market Reforms. Although both the state distribution and procurement systems were liberalized in early 1990s, the price and marketing reform process was quickly slowdown since early 1994 and even moved backwards as a result of a severe grain price spike in November and December 1993, and more recently since May 1994 to early 1995. Some claim that the grain price inflation is mainly a result of state Grain Bureau-"mis-operation" after they were fully committed to profit maximization but retaining their monopsony and monopoly power in the grain market, therefore they favor the options of either closing the grain market and forcing the trade into the former centralized "main" channels", or complete liberalizing the grain market. Some believe that rising stocks by both government and farmers caused the grain price to increase in early 1990s. While the others claim that the grain price was mainly driven up by the demand and supply forces and free market. By end of 1994, China found itself either pushing toward, or being pushed into, a new phase where the market was expected to play a bigger role in sectoral resource allocation and distribution of income.

Moreover, as a results of continued declining growth of grain production recently (Table 3), a national-wide fear of the shortage of grain supply in the coming years began to grow. In response, several new policies have been implemented since late 1994. Grain exports were banned. Government grain procurement once again became compulsory. The procurement decisions are strictly and directly determined by the government at central and provincial levels; procurement prices are strictly determined by the central government. The market procurement of grain by non-grain bureau was blockaded until the targeted 90 million tons of state grain procurement are met. Moreover, regional (provincial) grain self-sufficiency policy is reintroduced.

Technology Changes. Beside the institutional and price and market reforms, many other sharp transitions are also underway. Above all, technological change has been the engine of China's agricultural economy growth (Stone, 1988), and will continue to be the main sources of grain yield growth in the future (Lin et al, 1995; Huang, Rosegrant, and Rozelle, 1995). China's technological base grew rapidly during both the pre-reform and reform periods. For example, hybrid rice, a breakthrough pioneered by Chinese rice scientists in the 1970s, increased yields significantly in many parts of the country, and rapidly spread to nearly one-half of China's rice area by 1990 (Lin, 1991; Huang and Rozelle, forthcoming-b). Other grains enjoyed similar technological transformations (Stone, 1988). China's robust growth in the stock of research capital has in significant part been responsible for these dramatic changes (Fan and Pardey, 1992; Huang, Rosegrant and Rozelle, 1995). There is concern, however, that China's system maybe suffering from neglect after more than a decade of reform (Conroy, 1987; Lin, 1995 ?; Pray, Rozelle, and Huang, 1995). Real annual expenditures on agricultural research fell between 1985 and 1990, before resuming real growth in 1990 (SSTC). The slowdown in growth in annual investments in the late 1980s will result in slower growth in the overall stock of research in the 1990s. The ability of China's research system to maintain a stream of technical innovations will critically affect the growth of grain supply and the nation's grain balance. However, the reforms in the rest of the economy, which had resulted in more competition and shrinking fiscal revenues of central government, have put pressure on national leaders to search for ways to encourage the investment in the agricultural research and infrastructure.

Investment Policy. Investment in agricultural infrastructure, especially irrigation, is another important determinant of China's agricultural growth in recent decades (Nickum). Irrigation investment and the stock of facilities have followed patterns similar to those for research (Huang and David, 1995). Since the early 1950s, China has invested heavily in irrigation, raising irrigated area from 18 percent of cultivated area to nearly one half (ZGTJNJ, 1993). Real annual expenditures on irrigation rose rapidly until 1975, before beginning a ten-year decline. However, in 1985, annual expenditures began to grow again, and were at an all time high in 1992 (Huang and David, 1995).

Natural Resources. Trends in environmental degradation, including erosion, salinization, and loss of cultivated land show that there may be considerable stress being put on the agricultural land base: erosion and salinization have increased since the 1970s, although in a somewhat erratic pattern (Huang and Rozelle, forthcoming-a). These factors have been shown to affect output of grain, rice, and other agricultural products in a number of recent studies (Huang and Rozelle, forthcoming-a;b; Rozelle, Huang, and Veeck; Huang, Rosegrant, and Rozelle, 1995).

Structural Changes in Food Consumption Patterns

Per capita aggregate (national level) direct cereal consumption as food in recent years has not increased as much as the past decade in the rapidly growing economy of China, while meat, fish, and dairy consumption have increased dramatically. Typically economists have tried to explain such changes in food consumption patterns primarily by increases in disposable income and changes in food prices. There is no doubt that household income and food prices strongly influence food consumption patterns. This fact is perhaps as well substantiated empirically as any relationship in the economics literature. Nevertheless, in examining and projecting food demand patterns over the long-run, particularly in economies undergoing rapid structural transformation and urbanization such as that expected to occur in China in the past decade and over the next twenty-five years (the urban population has grown from 19 percent of total population in 1980 to 28 percent in 1992, and expected to reach 50% in 2020), changes in tastes and lifestyles also have been important influences on food demand.

There are a number of reasons to think that there are structural shifts (as distinguished from income and price effects) in food demand patterns as populations move from rural to urban areas (Huang and Bouis, 1995): 1) There is a wider choice of available foods in urban markets; 2) Urban residents are more exposed to the rich variety of dietary patterns of foreign cultures; 3) Urban lifestyles may place a premium on foods which require less time to prepare; 4) Urban occupations tend to be more sedentary and consumer require a lower energy expenditure and so a lower calorie intake; 5) Urban residents typically do not grow their own food, thus, their consumption choices are not constrained by the potentially high-cost alternative of selling one food at farmgate prices (say rice) to buy another food (say bread) at retail prices (a choice faced by semi-subsistence producers).

Within urban sector, recent changes in the urban economy have made urban consumers almost entirely dependent on markets for their consumption needs. In this sector, prices and income changes most likely will be the fundamental force driving consumption pattern changes. Urban incomes rose at a steady rate of nearly 8 percent per year in the early years of reform (ZGTJNJ). In the early reform era, rising incomes meant an increasing demand for most all food products, including fine grains like wheat and rice.

Real income per capita for urban residents continued to rise in recent years, jumping an average of 5-7 percent between 1985 and 1992. At the current average level of income for most urban residents food grain consumption rises very little with new increments in income; meat consumption, on the other hand, is still very much influenced by income changes (Carter and Zhong, 1991; Huang and Bouis, 1995).

Rural residents live in a very different environment than their urban counterparts, and exhibit different demand behavior. While rural incomes have grown much more slowly since the mid-1980s, demand for food grains and meat products have still increased as incomes have risen (Huang and Rozelle, 1994; 1995; Fan, Cramer and Wailes, 1995). Rural consumption markets also are less complete. Farmers in many areas face limited choices in their consumption decisions since many of the products they desire on a daily basis, such as meat and fresh fruit, are not always available, even as their incomes rise (Huang and Rozelle, 1995). Discontinuous free markets, lack of refrigeration, and generally high transaction costs for procuring food in rural areas have been shown to fundamentally affect the consumption patterns of rural consumers in China. While changes in the rural market have been rapid, in 1992 Chinese farmers still purchased only 46 percent of the food they consumed (ZGTJNJ). As markets develop, and activity on rural consumption markets increases, apart from changes in income and prices, consumption patterns will be affected.

Results of Food Demand and Supply Projections

Various attempts have been made in projecting future trends in China's grain imports and exports. The most striking feature of the projections of grain surpluses and deficits is their wide range. At one extreme, China is predicted to become a net exporter of grain. CAAS (1985) forecasts that China will have the capacity to export 47 MMT in the year 2000. Other analysts believe China will eventually become a net importer of grain. Brown who forecasts that a rapidly modernizing China will import at least 216 MMT by 2030 even if per capita consumption of grain does not increase. Other analysts also predict China's grain imports will increase significantly.

However, almost all of the changes in the future growth of supply in the previous studies are dependent on assumed changes in technology (even though this process of technical change is not always explicitly recognized). Demand growth mostly depends on changes in income (and somewhat on the impact of price changes). Fundamental forces in the economy, such as urbanization and market development as mentioned above, are ignored in most studies. Given the rapid structural change in China's economy-in-transition, this omission is most likely a reflection of the poorly developed empirical literature on China's food economy. There also is little scope for assessing the impact of policy variables. With the exception of the World Bank's model, no other model can be used to systematically assess the effect of policy tools that are under the control of government.

In this study, we apply a food demand and supply projection model developed by Huang, Rozelle and Rosegrant (1995). The explanation of the model and assumptions are reported in Appendix I and Appendix Tables 1-3.

Results of Baseline Projections

According to our projection, per capita food grain consumption in China hit its zenith in the late 1980s and early 1990s. From a baseline high of 225 kilograms, food grain consumption per capita falls over the forecast period (Table 4). The average rural resident will consume greater amounts through the year 2000, before reducing food grain demand in the first decade of the next century. This decline in the rural area occurs at a time when income elasticities, although lower than the late 1990s, are still positive. As markets develop, rural consumers have more choice, and will move away from food grains. Urban foodgrain consumption per capita declines over the entire projections period.

In contrast, per capita demand for red meat is forecast to rise sharply throughout the projection period (Table 4). China's consumers will more than double their consumption by 2020, from 17 to 43 kilograms per capita. Rural demand will grow more slowly than overall demand, but urbanization trends will shift more people into the higher-consuming urban areas (in 1991 an urban resident consumed about 60 percent more red meat than his/her rural counterpart). While starting from a lower level, per capita demand for poultry and fish rise proportionally more.

The projected rise in meat, poultry, fish, and other animal product demand will put pressure on aggregate feed grain demand (Table 4). In the baseline scenario, demand for feed grain will increase to 109 MMT by the year 2000. Although China does not publish aggregate feed grain statistics, by the authors' calculations this represents an increase of 30 percent during the 1990s (up from 76 MMT in 1991). By the year 2020, the projected grain needed for feed will reach 232 MMT. At this rate of growth, feed grain as a proportion of total grain utilization will move from 20 percent in 1991 to 38 percent in 2020. This process of moving from an agricultural economy which produces grain primarily for food to one which is becoming increasingly animal feed-oriented is typical of rapidly developing economies elsewhere in the world, and also has been predicted to occur in China by others (Carter and Zhong, 1991).

When considered with the projected population rates, the projected per capita demands for food and feed grain imply that aggregate grain demand in China will reach 450 MMT by the year 2000 (Table 4), an increase of 17 percent over the level of the early 1990s (386 MMT).[2]

Although per capita food demand is falling in the later projection period, total grain demand continues to increase through 2020 mainly because of population growth and the increasing importance of meat, poultry, and fish in the average diet. By the end of the forecast period, aggregate grain demand will reach 594 MMT, over 50 percent higher than the initial baseline demand (Table 4).

Baseline projections of the supply of grain shows that China's producing sector gradually falls behind the increases in demand (Table 4). Aggregate grain supply is predicted to reach 410 MMT (in trade weight) by the year 2000. This projection implies a rise in grain output of only about 6.5 percent over the early 1990s, a figure far below the more optimistic estimates given in recent years by MOA officials who had hoped to meet its target of 455 MMT by 2000 (or 500 MMT in nontrade weight figures).

On the other hand, production is expected to rise somewhat faster in the second and third decades of the forecast period. Mostly as a result of the resumption of investment in agricultural research during the forecast period, aggregate grain production is expected to reach 469 MMT in 2010, an increase of 14 percent during the preceding 10 years; production will reach 552 by 2020, an even higher percentage increase for the decade (18 percent over the 2010 level).

Under the projected baseline scenario, the gap between the forecast annual growth rate of production and demand implies a rising deficit. Total grain consumption rises at 1.72 percent per year, 1.28 percent from the rise in population and 0.44 percent due to rising per capita grain demand. Nearly all of this increased per capita grain demand is from the higher demand for feed grain (it rises by 2.71 percent while aggregate demand for food is stagnant). Grain production during this period grows only 0.64 percent annually. Imports surge in the late 1990s to 40 MMT (Table 4). After peaking in 2010 at 43 MMT, grain imports remain at that level through 2020.

Alternative Projections

To test the sensitivity of the baseline results to changes in the underlying forces driving the supply and demand balances, a number of alternative scenarios are run, altering the baseline growth rates of the key variables, including population, income, feeding efficiency, non-staple food trade policy in the demand side, and investments in technology and irrigation, price policy, natural resource, and opportunity costs of labor and land in the supply side. The results, shown in Table 5, indicate that low population growth rates would reduce grain demand by 5 MMT in 2000 and 33 MMT in 2020 compared to the baseline. With high population growth, demand for grain increase to 621 MMT. Low income growth causes a decline in projected total grain demand from 594 MMT to 549 MMT, resulting in slight exports of grain in 2020. With rapid income growth, projected demand would increase by 53 MMT. Changes in the feeding efficiency of livestock and fish production, compared to the baseline projection, would increase or decrease the demand for grain by only about 2-3 MMT in 2000, by 7-8 MMT in 2010 and 16-17 MMT in 2020.

Perhaps the most important result shown in Table 5 is the very large impact of income growth on demand for feed grain. This is expected as the income elasticities of demand for meat and fish products are high.

Table 6 shows the projections of grain production under alternative assumptions of investment in research and irrigation, grain price, natural resource changes and the opportunity costs of labor and land. The most important result of these excises is the very large impacts of investment in agricultural research and irrigation on grain production. This is hardly surprising given the large contribution that agricultural research--and the technology it has produced--has made to agricultural productivity in recent years. Increases in the rate of growth in investment in agricultural research and irrigation from 3 percent to 4 percent per year are projected to shift China from an import to an export position by 2020. If, instead, growth in annual investment in the agricultural research system and irrigation fell only moderately, from 3 percent per year (as forecast under the baseline projections) to 2 percent, by 2020 total production would only be 486 MMT, a far below the baseline projections of grain demand and production. Table 6 also shows that grain production is insensitive to small changes in price trends. Output price trends do affect China's grain balances, but the effects are small. At the baseline level, for every 0.5 percent increase (decline) in the annual projected grain price trend, imports fall (rise) by 2 MMT.[3] In the total, altering the assumptions on the output prices would only change the grain production from the baseline's projection by 7-8 MMT in 2020 because the increase in the one grain production resulted from the own price impact would be partially offset by the cross-price effects of the other grain.

Finally, while the production projections are sensitive to the alternative assumptions of natural resource and opportunity costs of labor and agricultural land, the different between these projections and baseline projections is still lower than the grain net import implied by the baseline projection (Table 4), ranging from 22 MMT to 29 MMT.

Table 7 shows grain net import requirements implied by the above various scenarios. Most of projections shows that China's grain production will gradually fall behind the increases in demand. Imports will raise significant before the year of 2000. Low population growth would reduce the grain demand with total grain imports falling to only 9 MMT. With high population growth, imports increase to 70 MMT. Low income growth leads a decline in projected grain demand and results in slight exports of grain in 2020. With rapid income growth, projected imports would more than double, to 96 MMT. While grain net imports are less sensitive to the assumptions on the feeding efficiency, prices, salinity, erosion and opportunity costs of labor and land, they are highly sensitive to the changes in the government investment in research and irrigation. With no change in the assumption regarding the level of food demand, China could become grain net export after 2010 if the growth rate of investment in the research and irrigation reaches 4 percent per year. On the other hand, if the growth in annual investment in the agricultural research and irrigation fell from the baseline of 3 percent per year, by 2020 imports under such a scenario would reach a level of 106 MMT.

This level of grain imports could be expected only if there was continued decline in the growth of agricultural investment, and if the government did not respond with countervailing policy measures as import levels rose. Such a scenario could unfold only if the government was unwilling or unable to undertake policies to stimulate food production growth. However, agricultural research and irrigation investments have already recovered in recent years, and in recent months, as grain prices have risen in response to short term tightening of grain supplies, government policy makers have responded with promises of greater investments in agriculture. While most of the investments have been targeted at irrigation, improvements in the operations of research institutes have also been announced.

The projections of impacts of China's grain trade on the world market are also simulated using IFPRI's IFPTSIM model. The results show that China will have strong impact on the world grain market and price. The annual grain net imports raised from 20-

30 MMT as projected by IFPRI to 40-43 MMT as implied by our baseline projection would lead world grain price to decline by about 0.2 percent annually in 2000-2020. At one extreme, If China would be able to achieve her grain self-sufficiency, world grain price could decline by as much as 0.50 percent per year more that those projected by IFPRI in early 2020. On the other hand, if the government would not be able to stimulate food production by revising its investment policy, price and market reform, and improve the natural resource, China's grain net import could reach about 100 MMT by 2020. This would place further pressure on world grain market and cause an even no decline trend of world grain price in the early 21th century if demand and supply of other countries remained the same as those projected by IFPRI.

Conclusions Remarks

The purpose of this paper was to assess the performance of China's agriculture in the past and the future supply and demand balance, and then explore the factors that may be behind the past growth and those alternative predictions. In the projections of China's future grain demand, supply and trade, the authors' framework includes a demand-side model that, in addition to the impacts of income and population trends (as well as income response parameters that vary as income levels rise), accounts for the effects of urbanization and the changing level of the development of rural consumption markets. The supply response model considers the impact of prices, public investment in research and irrigation, institutional change, and environmental factors.

The projections show that under the most plausible expected growth rates in the important factors, China's imports will rise steadily throughout the next decade. By 2000, imports are expected to reach 40 MMT, a level nearly 3 times higher than their historic high. Increasing imports arise mainly from the accelerating demand for meat and feed grains, as well as by the continued slowing of supply due to reduced investment in agricultural research in the late 1980s. However, after 2000, grain imports are expected to stabilize, as demand growth slows due to increasing urbanization and declining population growth rates; and supply growth is sustained with the on-going recovery of investment in agricultural research and irrigation.

There is considerable range in the projections, however, when baseline assumptions are varied in both the short- and long-run. Different rates of agricultural investment create some of the largest differences in expected imports, but this is what should be expected from the factor that has the largest marginal output response. While there are a few scenarios where projected levels of imports are somewhat large, from both the view point of China's own domestic needs, and relative to the size of current world market trade, there are factors which may keep China from becoming too large of the player in the world market. First, world grain prices would certainly rise in the face of large Chinese imports, a tendency which would dampen Chinese grain demand and stimulate domestic supply. Second, there may be major foreign exchange constraints to importing such large volumes of grain--either government policy makers will not allocate foreign exchange for additional grain imports, or exchange rate movements will discourage imports. Third, limitations on the ability of China's ports and other parts of the nation's transportation and marketing infrastructure to handle large quantities of grains may constrain import levels. Finally, there are many political economy factors that will make China's leaders react to increasing grain shortages. Regardless of China's comparative advantage, government leaders have historically, and continue to be, concerned with maintaining near self-sufficient domestic agricultural production capacity. National defense, pride, and ideology will necessarily put a premium on maintaining a rough balance between domestic demand and supply.

On the basis of the results presented in this paper, it appears that China will neither empty the world grain markets, nor become a major grain exporter. It does seem likely, however, that China will become a more important player in world grain markets as an importer in the coming decades. Both potential exporters outside of China and those charged with managing China's food needs through domestic production and imports need to be ready. Exporting nations--especially those dealing with wheat and maize--will undoubtedly be the beneficiaries of these trends in the short run. If China's policy makers believe the projected level of imports are too high (either politically or because they see some other physical or economic constraint), investment strategies need to be devised in the near future because of the long lags between the period of expenditure and the time when such investments can affect production. Investment in facilities and institutions needed to handle the increased volume of incoming grain will smooth the shock of production shortfalls, and reduce the time and expense of importing grain. China's foresight in dealing with the upcoming challenge will most likely determine whether the production-demand gap turns into a major agricultural crisis, or whether it will become an opportunity to more effectively develop the nation's food economy.

Appendix I

A Framework for Forecasting China's Grain Supply, Demand and Trade

The major components of this paper's forecasting framework include a supply model for the rice, other grain, and cash cropping sectors of the agricultural economy, and demand models specified separately for rural and urban consumers for rice, grain, meat, and 6 other animal products. Real world price projections are generated by IFPTSIM, a partial equilibrium global trade model developed at IFPRI (Rosegrant, Agcaoili, and Perez, 1995). In addition to income and prices, the modeling framework for China includes a number of structural and policy variables to account for fundamental forces of transformation in China's rapidly reforming and modernizing economy.

Grain Production and Supply Elasticities

The supply model forecasts future trends in China's grain output utilizing separate equations for rice and for other grains (total grain minus rice). The parameters used in the supply forecasting model are from Huang, Rosegrant and Rozelle (1995), which are estimated using the normalized quadratic form of the dynamic dual value function approach developed by Epstein (1981). Simultaneous with the two grain supply equations, four other equations--cash crop supply, two quasi-fixed inputs (labor and sown area), and fertilizer--were estimated using a non-linear solution algorithm. Grain output and other explanatory variables are assumed to respond to the crop's own-price, prices of other crops, quasi-fixed and variable inputs, and the off-farm wage. Output also is a function of the stock of agricultural research, the stock of irrigation infrastructure, and three environmental factors--erosion (in the other grain equation), salinization, and the breakdown of the local environment.[4] The full set of results and detailed discussion of the model can be found in Huang, Rosegrant, and Rozelle (1995).

Grain Consumption and Demand Elasticities

Grain consumption is divided into two parts: grain that is directly consumed for food, and that which is fed to animals and consumed indirectly. Direct food equations are divided into rice and other grains. Indirect grain consumption is imputed from the underlying demand equations for pork, beef and mutton, chicken, fish, eggs, and milk. The demand equations for all crops are specified separately for rural and urban consumers for all products. Different demand parameters are used for each projection period: the 1990s; 2000-2010; and 2010-2020. Demand is specified as responding to own-price, the price of other major commodities, income, and a variable representing the level of development of rural consumption markets (in the rural demand equations). The effect of urbanization is accounted for by multiplying per capita grain projections for each sector by the projected changes in rural and urban populations, including the anticipated flows of rural residents into the cities.

Income elasticities of demand for rice, other grain, and meat are from Huang and Rozelle (1994), Huang and Rozelle (1995), and Huang and Bouis(1995). Parameters used to account for the impact of urbanization and rural food consumption market development are reported in Appendix Table 1. All simulations begin from the early 1990s, the base period. Base period data on production and utilization (discussed above) are three year averages centered on 1991. Supply side factors include changes in factor prices, variations in the pattern of government investment in agricultural research and irrigation investment policy, as well as changes in the state of the environment. Summaries of the assumptions for the major factors affecting future demand and supply growth are in Appendix Tables 2 and 3.

Endnotes

1. Grain in China includes rice, wheat, maize, barley, sorghum, millet, and other coarse grains, as well as soybeans. Sweet and white potatoes are also included but their actual weight is divided by five to turn them into grain equivalents.

2. In addition to projected food and feed demand, total grain demand also includes use of grain for seed, nonfood manufacturing, and waste. Projected values of these uses are calculated by roughly maintaining the same ratios as found in the initial year of the baseline.

3. Import projections are not very sensitive to changes in prices for two reasons. First, our estimated supply own-price response elasticities are small, a characteristic that is commonly found in other Asian countries where the government frequently intervenes into the agricultural decision making process. Second, on the demand side, although there are fairly large negative own-price elasticities, positive cross price elasticities dampen the reduction (increase) in demand when prices rise (fall).

4. Technology was measured in stock form, and was built by aggregating past government expenditures on research according to a weighting criteria suggested by Pardey et al. (1992). Irrigation stock was constructed by aggregating public expenditures on irrigation, subject to a depreciation rate of 4 percent per year. The environmental variables have been described and analyzed in Huang and Rozelle (forthcoming-a). The severity of erosion is measured as a ratio of eroded area to cultivated area (which can exceed one since eroded area includes both cultivated and non-cultivated area). Salinization is the proportion of total sown area where salinity levels are high enough to affect yields.

References

Brown, Lester. "How Could China Starve the World: Its Boom is Consuming Global Food Supplies." *Outlook Section, Washington Post*, August 28, 1994.

CAAS [Chinese Academy of Agricultural Sciences]. "Abstract of the Comprehensive Report on Study of the Development of Grain and Cash Crops Production in China." *Study of the Development of Grain and Cash Crop Development in China--Volume 4*. CAAS, eds. Beijing, China: Chinese Academy of Agricultural Sciences, 1985.

Carter, Colin and Zhong Funing. "China"s Past and Future Role in the Grain Trade." *Economic Development and Cultural Change* 39(July 1991):791-814.

Conroy, Richard. "The Disintegration and Reconstruction of the Rural Science and Technology System." *The Reemergence of the Chinese Peasantry*. A. Saith, ed. London: Croom Helm Press, 1987.

Epstein, Larry. "Duality Theory and Functional Forms for Dynamic Factor Demands." *Review of Economics and Studies* 48(January 1981):81-95.

Fan, S. "Effects of Technological Change and Institutional Reform on production growth in Chinese Agriculture," *American Journal of Agricultural Economics* 73(1991):266-275.

Fan, S. and P. Pardey. *Agricultural Research in China: Its Institutional Development and Impact*. The Hague, Netherlands: International Service for National Agricultural Research, 1992.

Fan, S., E.J. Wailes, and G.L. Cramer. "Household Demand in Rural China: A Two-Stage LES-AIDS Model," *American Journal of Agricultural Economics* 77(Feb.1995):54-62.

FAO (Food and Agricultural Organization). "Demand Prospects for Rice and Other Foodgrains in Selected Asian Countries." Food and Agricultural Organization Economic and Social Development Paper No. 97, Rome, Italy, 1991.

Huang, Jikun and Howarth Bouis. "Structural Changes in Demand for Food in Asia." IFPRI 2020 Discussion Paper, International Food Policy Research Institute, Washington D.C, 1995.

Huang, Jikun and Cristina C. David. "Policy Reform and Agricultural Incentives in China," Working Paper, International Food Policy Research Institute, Washington, DC. 1995.

Huang, Jikun, Mark Rosegrant, and Scott Rozelle. "Public Investment, Technological Change and Agricultural Growth in China." Paper Presented in the Final Conference on the Medium- and Long-Term Projections of World Rice Supply and Demand, Sponsored by the International Food Policy Research Institute and the International Rice Research Institute, Beijing, China, April 23-26, 1995.

Huang, Jikun and Scott Rozelle. "Environmental Stress and Grain Yields in China." *American Journal of Agricultural Economics*. forthcoming-a.

________. "Income, Quality, and the Demand for Food in Rural China," Working Paper, Food Research Institute, Stanford University, 1994.

________. "Market Development and Food Demand in Rural China." FCND Discussion Paper No.5, International Food Policy Research Institute, Washington D.C., 1995.

________. "Technological Change: Rediscovering the Engine of Productivity Growth in China"s Agricultural Economy." *Journal of Development Economics*. forthcoming-b.

Huang, Rozelle and Rosegrant. "China's Food Economy to the 21th Century: Supply, Demand and Trade," IFPRI's 2020 Discussion Paper, International Food Policy Research Institute, Washington D.C., 1995.

Lardy, N. *Agriculture in China's Modern Economic Development*. Cambridge: Cambridge University Press, 1983.

Lin, Justin Yifu. "Rural Reforms and Agricultural Growth in China." *American Economic Review*, 82(1992):34-51.

Lin, Justin Yifu. "Rural Reforms and Policy Changes in China's Grain Economy," Prepared for the Third Workshop on "Projections and Policy Implications of Medium and Long-term Rice Supply Demand," IRRI and IFPRI, Bangkok, January 24-26, 1994.

Lin, Justin Yifu. "The Household Responsibility System Reform and the Adoption of Hybrid Rice in China." *Journal of Development Economics*. 36(1991):353-373.

Lin, Justin Yifu. 1995 "A Study of Grain Yield Potential and Research Priority" *Zhongguo Nonch Guancha* (China Rural Observation) No. 2 (March 1995).

Liu, Jiang. *Quanguo nongcun jingji fazhan: Shinian guihua he dibage wunian jihua* [Rural economic development of China: Ten year plan and the eighth five-year plan]. Beijing, China: Ministry of Agriculture Press, 1991.

McMillan, J. J. Walley and L. Zhu. "The Impact of China"s Economic Reforms on Agricultural Productivity Growth." *Journal of Political Economy*. 97(1989):781-807.

Mei, Fangquan. "China Can Feed Its Population." *China Daily*. April 29, 1995.

Pardey, Phil, R. Lindner, E. Abdurachman, S. Wood, S. Fan, W. Eveleens, B. Zhang, J. Alston. "The Economic Returns to Indonesian Rice and Soybean Research." Report Prepared by the Agency for Agricultural Research and Development (AARD) and the International Service for National Agricultural Research (ISNAR), November 1992.

Perkins D. and S. Yusuf. *Rural Development in China.* Baltmore, MD: The Johns Hopkins University Press, 1984.

Pray, Carl, Scott Rozelle, and Jikun Huang. "Agricultural Research in China: Growth and Reforms." Working Paper, Dept. of Agricultural Economics, Rutgers University. 1995.

Rosegrant, Mark, Mercedita Agcaoili-Sombilla, and Nicostrato Perez. "Rice and the Global Food Economy: Projections and Policy Implications of Future Food Balances." Presented in the Final Conference on the Medium- and Long-Term Projections of World Rice Supply and Demand, Sponsored by the International Food Policy Research Institute and the International Rice Research Institute, Beijing, China, April 23-26, 1995.

Rozelle, Scott, Albert Park and Jikun Huang. "Dilemmas in Reforming State-Market Relations in Rural China." Working Paper, Food Research Institute, Stanford University, 1995.

Rozelle, Scott, Jikun Huang and Gregory Veeck. "The Impact of Environmental Degradation on Grain Production in China." *Economic Geography*. forthcoming.

Sicular, Terry. "China"s Agricultural Policy During the Reform Period," *China"s Economic Dilemmas in the 1990s: The Problems of Reforms, Modernization, and Interdependence*. Joint Economic Committee Congress of the United States, ed. Armonk, NY: M.E. Sharpe, pp. 340-64, 1995.

SPB [State Price Bureau]. *Quanguo nongchanpin chengben shouyi ziliao huibian* [National Agricultural Production Cost and Revenue Information Summary--in Chinese]. China Price Bureau Press: Beijing, China, 1988-92.

SSTC [State Science and Technology Commission]. *Zhongguo Kexue Jishu Ziliao Ku, 1985-90; 93* [China Science and Technology Statistical Yearbook, 1985-90; 93--in Chinese].

Tang, Anthony. "An Analytical and Empirical Investigation of Agriculture in Mainland China, 1952-80," Taipei, Taiwan: Chung-hwa Institute of Economic Research, 1984.

Stone, Bruce. "Developments in Agricultural Technology," *China Quarterly* 116(December 1988).

UN [United Nations]. "World Population Prospects, 1992 Revisions." Report from the United Nations, Department of Economic, Social Information, and Policy Analysis. New York, NY: United Nations, 1993.

Weins, T. "The Limits to Agricultural Intensification: The Suzhou Experience," *China under the Four Modernization, Part I*, US Government Printing Office, pp462-474, 1982.

Wen, J.G. "Total Factor Productivity Change In China's Farming Sector: 1952-89," *Economic Development and Cultural Change* 42:1-42.

World Bank. *Agriculture to the Year 2000*. A World Bank Country Study (Annex 2 to China: Long-term Development Issues and Options), Washington, DC: The World Bank, 1990.

ZGTJNJ. *Zhongguo Tongji Nianjian [China Statistical Yearbook]*. Beijing, China: China Statistical Press, 1980-93.

Table 1. Growth Rates (%) of National Income by Sector.[a]

	Pre-reform	Reform period			
	1970-78	1978-84	1984-90	1990-92	1978-92
National income	4.9	7.9	8.6	11.0	9.0
Agriculture	2.7	11.5	6.0	1.7	7.6
Industry	6.8	5.9	9.4	15.1	8.9
Others	4.6	5.8	11.8	16.9	12.3
Population	1.9	1.2	1.7	1.2	1.4
Per capita national income	3.0	6.7	6.8	9.7	7.5

[a] Growth rates are computed using regression method.

Source: ZGTJNJ [Statistical Yearbook of China], 1993.

Table 2. Changes in the Structure of China's Economy (%).

	1970[a]	1980	1985	1990	1992
Rural share in total population	83	81	76	74	72
Share in national income					
Agriculture	41	37	37	33	29
Crops		73	64	57	56
Livestock		18	21	27	27
Fishery		2	4	6	7
Forestry		4	5	4	5
Sideline		4	6	6	6
Industry	46	53	51	53	56
Services	13	10	14	15	15
Share in employment					
Agriculture	81	69	62	60	59
Industry	10	18	21	21	22
Services	9	13	17	19	20
Share in exports					
Agriculture	37	19	18	13	12
Processed agriculture	38	29	29	29	na
Industry and others	25	52	53	58	na
Share in imports					
Agriculture	na	34	14	16	11
Manufacture and others	na	66	86	84	89
Export ratio to national income	3	7	11	16	20

[a] These are 3-year averages centered at year shown.
Source: Huang and David, 1995.

Table 3. Growth Rates (%) of Crop Production, Sown Area and Yields in China, 1970-92

Commodity	Pre-reform	Reform period		
	1970-78	1978-84	1984-92	1978-92
Grain				
-- Production	2.8	4.7	1.8	2.7
-- Sown area	0.0	-1.1	0.1	-0.5
-- Yield	2.8	5.8	1.7	3.2
Rice				
-- Production	2.5	4.5	1.3	2.3
-- Sown area	0.7	-0.6	-0.0	-0.4
-- Yield	1.8	5.1	1.3	2.7
Other Grain				
-- Production	3.1	4.8	2.2	2.9
-- Sown area	-0.2	-1.3	0.2	-0.5
-- Yield	3.3	6.1	2.0	3.4
Cash crops:				
-- Real output	2.1	14.9	2.3	6.3
-- Sown area	2.4	5.1	2.0	3.4

Notes: Growth rates are computed using regression method. See data section for computation of real output value for cash crops.
Sources: ZGTJNJ (1980-93).

Table 4. Baseline Projection of Demand, Supply and Net Import in China, 1991-2020.

Commodity	1991	2000	2010	2020
	Per Capita Food Consumption (kg)			
Grain	225	223	214	203
-- Rural	242	246	243	239
-- Urban	178	177	174	168
Red Meat	17	23	32	43
-- Rural	15	20	26	33
-- Urban	24	30	40	52
Poultry	2	3	5	8
-- Rural	1	2	3	4
-- Urban	4	6	8	12
Fish	6	10	17	28
-- Rural	4	6	9	14
-- Urban	12	18	28	43
	Grain Demand, Production and Net Import (MMT)			
Total Grain Demand	386	450	513	594
-- Feed Demand	76	109	158	232
Domestic Production	385	410	469	552
Net Import	3	40	43	43

Note: net import differs from the gap between demand and production because of the changes in stock.

Table 5. Projections of Demand for Total and Feed Grains (MMT) under Alternative Scenarios in China, 1991-2020.

Alternative Scenario	1991	2000	2010	2020
Baseline				
Total Grain	386	450	513	594
-- Feed	76	109	158	232
Low Population Growth				
Total Grain	386	445	496	561
-- Feed	76	108	153	218
High Population Growth				
Total Grain	386	454	527	621
-- Feed	76	110	163	242
Low Income Growth				
Total Grain	386	440	489	549
-- Feed	76	103	139	189
High Income Growth				
Total Grain	386	459	537	647
-- Feed	76	116	181	286
Low Feeding Efficiency				
Total Grain	386	452	520	610
-- Feed	76	111	165	248
High Feeding Efficiency				
Total Grain	386	448	505	577
-- Feed	76	107	150	215
Import Meat/Feed by 10%				
Total Grain	386	439	497	571
-- Feed	76	98	142	209

See Appendix Table 2 for assumptions on growth rates of income and population. High (low) feeding efficient scenario assumes that the annual growth of feeding efficiency is 0.25% higher (lower) than the baseline assumptions.

Table 6. Projections of Grain Production (MMT) under Alternative Scenarios in China, 1991-2020.

Alternative Scenario	1991	2000	2010	2020
Baseline	385	410	469	552
Investment in Research and Irrigation				
-- Low (2% per year)	385	408	441	486
-- High (4% per year)	385	412	500	627
World Price Impact				
-- Large (0% per year)	385	411	474	559
-- Small (-1% per year)	385	408	465	544
Salinity and Erosion				
-- Improve (-0.5% per year)	385	415	481	574
-- Degradation (1.0% per year)	385	404	456	527
Opportunity Costs of Labor and Land				
-- No Change (0% per year)	385	416	486	580
-- High (2% per year)	385	403	454	523

See Appendix Table 3 for assumptions on growth rates.

Table 7. Projections of Grain Net Import (MMT) under Alternative Scenarios in China, 1991-2020.

Alternative Scenario	1991	2000	2010	2020
Baseline	3	40	43	43
Population Growth				
-- Low Growth	3	35	26	9
-- High Growth	3	45	57	70
Income Growth				
-- Low Growth	3	30	20	-2
-- High Growth	3	49	67	96
Feeding Efficiency				
-- Low (-0.25% per year)	3	42	51	58
-- High (0.25% per year)	3	38	36	25
Meat or Feeds Import 10%	3	29	27	20
Investment in Research and Irrigation				
-- Low (2% per year)	3	42	70	106
-- High (4% per year)	3	38	14	-30
World Price Impact				
-- Large (0% per year)	3	38	39	37
-- Small (-1% per year)	3	42	48	48
Salinity and Erosion				
-- Improve (-0.5% per year)	3	35	32	21
-- Degradation (1.0% per year)	3	45	56	66
Opportunity Cost of Labor and Land				
-- No Change (0% per year)	3	34	28	15
-- High (2% per year)	3	47	59	71

Appendix Table 1. Urbanization and Food Market Development in China, 1990-2020.

Year	Share of Population		Food Market Development			
				Demand Elasticity[a]		
	Rural	Urban	Index[b]	Rice	Other Grain	Meat
1990	74	26	45	-0.11	-0.11	0.32
2000	66	34	60	-0.08	-0.08	0.20
2010	58	42	70	-0.06	-0.06	0.10
2020	50	50	80	-0.02	-0.02	0.05

[a] Demand elasticities of rice, other grain, and meat with respect to food market development measures the impact on consumption of the expansion and modernization of rural food consumption markets, holding everything else constant (e.g., income and prices). See Huang and Rozelle (1995) for details.

[b] Food market development index measures the proportion of food bought by rural residents in local food markets. The rest of food is own-produced.

Sources: Population data are from UN. The other data and parameters are from Huang and Rozelle (1995) and Huang and Bouis (1995).

Appendix Table 2. Assumptions on the Growth of Factors Affecting Grain Demand in China, 1991-2020.

Factors	Annual Growth Rate (%)		
	Low	Baseline	High
Total Population			
1990-2000	1.142	1.283	1.410
2000-2010	0.491	0.740	0.932
2010-2020	0.374	0.649	0.844
-- Rural			
1990-2000	0.029	0.158	0.284
2000-2010	-0.844	-0.603	-0.413
2010-2020	-1.030	-0.764	-0.572
-- Urban			
1990-2000	3.827	3.993	4.124
2000-2010	2.729	2.983	3.180
2010-2020	2.062	2.341	2.539
Per Capita Real Income			
-- Rural	2.0	3.0	4.0
-- Urban	2.5	3.5	4.5
Prices			
-- Rice	0	-0.5	-1.0
-- Other Grain	0	-0.5	-1.0
-- Meat	-0.5	-0.5	-0.5
Rural Market Development			
-- 2000	0.60	0.60	0.60
-- 2010	0.70	0.70	0.70
-- 2020	0.80	0.80	0.80

Note: Population estimates are based on UN. Per capita rural income growth figures are similar to those used in World Bank, FAO, and Rosegrant, Agcaoili, and Perez. Output prices are based on simulation analysis performed in collaboration with a model developed by the International Food Policy Research Institute--see Rosegrant, Agcaoili, and Perez (1995). Figures for the rural market development are index numbers for the year indicated (Huang and Rozelle, 1995).

Appendix Table 3. Assumptions on the Growth of Factors Affecting Grain Supply in China, 1991-2020.

Factors	Annual Growth Rate (%)		
	Low	Baseline	High
Output and Input Prices			
-- Rice	0	-0.5	-1.0
-- Other Grain	0	-0.5	-1.0
-- Fertilizer	1.0	1.0	1.0
Land and Labor			
-- Land opportunity cost	0	1.0	2.0
-- Wage	0	1.0	2.0
Agricultural Research Expenditure	2.0	3.0	4.0
Irrigation Expenditure	2.0	3.0	4.0
Environmental Factors			
-- Salinity	-0.5	0.2	1.0
-- Erosion	-0.5	0.2	1.0

Notes: Agricultural research and irrigation expenditures are extrapolated from recent trends and are adjusted based on recent Ministry of Agricultural (MOA) plans (Liu), pronouncements in newspapers, and interviews with MOA and provincial officials. The "Land opportunity cost" growth rate is an extrapolations from trends from SPB (1988-92). Land opportunity cost is assumed to be the return to grain cropping (total revenues) net of expenditures for labor (including own labor valued at the market wage), farm chemicals, and other cash expenses. Output price trends are based on simulation analysis performed in collaboration with the IMPACT model developed by the International Food Policy Research Institute--see Rosegrant, Agcaoili, and Perez. Fertilizer price trends are similar to those used by the World Bank. The trends in the deterioration of the environment are based on extrapolations of past trends (Huang and Rozelle, 1994).

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