Long-term Projections of China's Ability to Feed Itself: Technical and Policy Analysis

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China, with one-fifth of the world's population and rapidly rising incomes, is a country which has naturally been open to speculation about its ability to feed itself over the next several decades. Population will grow from 1.28 billion in 2000, to 1.46 billion in 2020, and 1.49 billion in 2030 (Table 1). Simultaneously, per capita income growth will lead to greater demand for animal and fish products, thus resulting in expanded feedstuffs requirements (Table 1).

The objective of the research reported on was to determine the extent to which China will be able to maintain its current level of being essentially self-sufficient in animal feedstuffs, animal and fish products, and other foods for humans. This article is divided into eight main parts; overall results, research method, consumption of animal and fish products, animal productivity improvement, animal inventory projections, feedstuffs utilization and production, nonconventional feed resources, and conclusions and policy implications. The research method used is to calculate all animal and fish requirements and availabilities on the basis of metabolizable energy (ME) and crude protein (CP).

Overall Results

It is concluded that ***technically***, despite human population growth and changes in diet, China can continue to meet its energy requirements for animal and fish feedstuffs. However, protein requirements are projected to exceed the base period of 1999-2001 domestically produced availabilities by 13 percent in 2010, 32 percent in 2020 and 37 percent in 2030 (Table 2). That gap will have to be met by expanded domestic production, or increased imports. Implications of the projected shortfalls on policy options are discussed later.

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The projections are based on conservative crop yield increases and per capita consumption projections derived from the economy growing at a moderately robust pace. Constraints on China's natural resources are taken into account, but the great potential biotechnology will probably have on crop production worldwide is not factored in. It can be expected there will be years in which imports will likely be needed and other years of surpluses due to climatic variations and other factors. Human consumption of food from sources other than livestock commodities is taken into consideration in the modeling.

Research Method

Most trade modelers use an econometric approach, such as the FAO World Food Model, the USDA model, the World Bank model or the IFPRI model. However, models of this nature are quite cumbersome to use, are restricted in use by the organizations, some only project out 10 years or so, and they are primarily based on price, a variable that loses meaning after a few years. As a result, virtually all projections have been misleading and erroneous about the potential for exports to China, as well as international agricultural trade in general (McCalla and Revoredo, 2001).

A major problem with trade models about China, and perhaps most important, is that they are quite simplistic from a technical viewpoint. The results provided in this article are based on a model especially developed for long-term projections of animal inventories, feedstuffs requirements and feedstuffs availabilities. Originally constructed by Simpson in the late 1980s and early 1990s, this non-deterministic simulation spreadsheet programmed model has been greatly revised and updated several times since then. Suffice it to say that the program is very large and complicated, with more than 5,000 lines of spreadsheet program, 800 variables and more than 2,200 parameters. The model is quite robust and, in fact, the original projections for 2000 (Simpson, Cheng and Miyazaki, 1994) using 1989-91 as the base period are quite close to

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what actually happened in 1999-2001 (the base period for the results reported in this article), thus lending credence to reliability of results. More information about the model is available online in Simpson and Li (2001).

The method used is to calculate all requirements and availabilities on the basis of metabolizable energy (ME) and crude protein (CP). There is a modest gap between requirements and availabilities due to lack of certain data, feedstuffs that cannot be measured such as water plants, roadside grazing, garbage feeding, misspecifications in the model, errors, etc Absolute size of the gap is not important. Rather, changes in the gap in projection years are the determinant of whether, and how much, imports of feedstuffs will be needed (Table 2).

The source of published data is FAO's on-line FAOSTATS service rather than directly from Chinese publications because FAO, in line with its international data standards, has a much wider availability of statistics. Unpublished parameters, like proportion of inventory in backyard versus commercial operations, use of crop residues, yield growth components, animal production parameters, etc., were ascertained by discussions with specialists, through publications of other authors, and personal survey data collection (e.g. Simpson, Shi, Li, Chen, and Liu, 2000).

Consumption of Animal and Fish Products

Per capita projections of meat, milk, fish and eggs were obtained from an unpublished cross-country consumption analysis by Simpson and Li (2000), building on the method of Simpson and Ward (1995). Beef is the largest growth meat commodity in China; per capita consumption (and production) doubles, from 4 kg in the base year, to 8 kg in 2030 (Table 3). Poultry doubles from 10 kg to 21 kg in that same period. Pork, already quite high, grows very little, from 33 kg to 38 kg.

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Total meat and fish consumption was 92 kg in 2000, and is projected to reach 118 kg in 2030. As a comparison, the totals in 2000 were 115 kg in Japan, 142 in the USA, 101 kg in Germany and 117 kg in Taiwan.

Total production of animal and fish products from 1985 to 2030 is provided in Table 4. Imports and exports were held constant at 2000 levels in projections to show the effect on domestic feedstuffs requirements and availabilities. Total production of meat and fish increases 49 percent in the 30 years from 2000 to 2030. Beef and veal production increases 127 percent, from 5 million tons to 11 million tons during the 30-year projection period.

Animal Productivity improvement

Remarkable growth has been recorded in China's livestock product production, and it is projected to continue for the foreseeable future, primarily because there is still great latitude for further progress in production efficiency and productivity. A multitude of technical aspects are taken into account in the modeling for cattle, pigs and poultry to explain and project animal numbers and feedstuffs requirements. Pigs, for example, are quite complicated, involving 65 variables in the program such as whether they are backyard or commercial, number born per litter, number of litters per year, weaning weights, time on feed by stage of feeding, and death loss, just to give a sampling of the information needed to explain and project technological changes in production. Poultry, in particular, are equally as complex.

Pigs also provide a good example of the impact technology adoption can have on production. In 1985 only 54 kg of pork was produced per pig in inventory (Table 5). By 2000 it had reached 95 kg, and is projected to reach 145 kg by 2030. In comparison, the average in 2000 was 150 kg in Germany, 136 kg in the United Kingdom and 138 kg in the USA. Offtake rates (the percent of pigs going to slaughter compared to inventory) in China are projected to increase from

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124 percent in 2000 to 170 percent in 2030. As a point of reference, rates for the above three other countries ranged from 144 to 195 percent in 2000 (FAO, FAOSTATS).

It is important to realize that productivity will continue to increase in other countries over the next three decades covered in the projections, and that with proper policy formulation focusing on industry and productivity stimulation, China will benefit from those changes as well as adoption of current technology, not to mention great structural changes that have been taking place (see for example Fang, Fuller, Lopez and Tuan, 2000). The point is that accuracy in projections about China's agriculture depends on a good understanding of its agricultural structure (including policy, research, education, etc.), knowledge about international agriculture and technology, recognition that agriculture is a dynamic industry and not a static one, and that in many respects it is more like European agriculture than that of its East Asian neighbors to which it is often, and misleadingly, compared (Simpson and Li, 2001).

Cattle are particularly important in determining whether China can feed itself because total beef production will have to double in order to meet increased demand. Most cattle in China are found in the cropping areas rather than on rangelands. Originally, they were mainly used for draft and transport, with milk and beef as by-products from aged animals that had to be culled. As the rural areas have begun to mechanize, and national per capita incomes have increased, demand for beef has also grown so that, although there is still a substantial portion of cattle used for work, a true beef industry is quickly emerging in which cows are kept primarily for calf production in both cropping and grassland areas (Longworth, Brown and Waldron, 2001; Simpson and Li, 1996). A variety of growing and fattening operations operations have sprung up. Most are small ones somewhat akin to those in the U.S. before and shortly after WWII. Some larger scale enterprises of several hundred head to several thousand head have developed, but U.S. style feedlots will not come into being in the foreseeable future.

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Productivity is increasing rapidly in China's cattle industry. In 1985 just 6 kg of beef was produced per head of cattle (including dairy cattle) in inventory (Table 5). By 2000 it had reached 47 kg. It is projected to reach 61 kg by 2010, then 77 kg in 2020 and 87 kg in 2030. These rates are not high for, by comparison, Germany recorded 91 kg in 2000, Japan 111 kg and the U.S. 124 kg.

Animal Inventory Projections

Historical data and projections on livestock are given in Table 6. Review of them is very instructive for they reveal the impact from technology adoption and structural change. As an example, despite total production continuing to grow, inventories of pigs and poultry are projected to grow moderately until 2010 and then decline slightly as the industry moves to large-scale technologically advanced enterprises that continue to increase their adoption of productivity enhancing technologies. Non-bovine work animal numbers are projected to decline from 24 million head in 2000, to 7 million head in 2030. There was an increase in their numbers until 1990 as farmer's income grew and animal power replaced human labor. The 1990s represented the beginning of the mechanization era, including contracting heavy farm work such as land preparation and harvesting. As a result, non-bovine animal numbers declined 13 percent in that decade. The same historical phenomena and projections apply to buffalo.

The 33 million head decline of non-bovine work animals and buffalo between 2000 and 2030 will free up considerable feedstuffs for other animals and farm raised fish. Draft/beef cattle numbers (termed beef cattle from now on) increased from 42 million head in 1985, to 99 million in 2000. They are projected to grow to 117 million in 2010 and then remain at that level through 2020, reaching 123 million in 2030. In brief, beef cattle inventory more than doubled in the 15-

year period to 2000, and is expected to grow 24 percent over the next 30 years. The big question is how to feed them.

Feedstuffs Utilization and Production

Beef cattle accounted for about 22 percent of all ME and CP requirements by animals and pond raised fish in 2000 (Table 7). That proportion is projected to increase to about 28 percent in 2030. Pigs have been, by far, the largest user of feedstuffs, accounting for 41 percent of ME and 40 percent of CP in 2000. Those proportions are projected to decline to 34 and 32 percent in 2030. Nutrition, including type of feedstuffs, is central to understanding the extent to which China can meet the great increases projected in livestock commodity and fish production to meet changes in demand for them.

Each country feeds its animals according to resource availabilities, tastes and preferences, food safety desires, and comparative advantage in production of feedstuffs. This is a key point to understand and project China's beef cattle structure. Americans, for example, have come to believe that large-scale feedlot type grain-fed beef is the standard for quality and production cost-effectiveness. Consequently, they believe that China will inexorably move toward such a system, and since China's grain production capacity is in doubt, substantial feedstuffs imports will thus be required. We believe, as do the Australians Longworth, Brown and Waldron (2001) that such a structure will not evolve. The issue is a very important one and should be a major focal point of agricultural policy planning.

Energy feedstuffs availabilities are calculated to have been 1.21 trillion Mcal of feedstuffs in 2000 (Table 8). Forty two percent of that was derived from principal crop sources, such as grains. That proportion will increase to 55 percent by 2030 as the industry and economy mature, still leaving 45 percent from other sources. Thirty nine percent of protein was produced from

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principal crop sources such as grains and oilseeds in 2000, and will only reach 42 percent in 2030 unless there is substantial reallocation in crop makeup. This finding also has substantial policy implications.

Crop yields and sown (harvested) area are inextricably bound together. A misspecification of one directly affects the other. Revision of sown area by crop was one of the major outcomes expected from the 1997 Census of Agriculture. Unfortunately, there were serious problems with that aspect and thus un-revised numbers continue to be reported. The magnitude of this problem can be appreciated by understanding that cultivated area was revised upward from 95 million hectares to 130 million hectares as a result of the census, a number that is now accepted nationally and internationally. However, due to enormous statistical difficulties, no revision has been made on historical data and no cultivated figures have been released since the census.

A very large increase in statistics on sown area should have accompanied the upward change in cultivated area. However, while the census results are generally considered quite reliable, there was great concern about reported sown area. Consequently, sown area census results were not used and all data series since the census have continued to use pre-census baselines. The upshot is that published crop yield data have also not been revised and thus are too high. The problem is a very serious one in making projections as a major issue is the extent to which yields can grow. All indications are that the yields should be much lower than in published numbers, and thus there is much more potential to grow than the data indicate. The modeling problem was then how to adjust sown areas and yields to reconcile them with the 37 percent higher cultivated area in order to be able to make comparisons with other countries and to be able to effectively communicate with Chinese crop specialists.

The Director General of the Rural Survey Office in the National Bureau of Statistics at that time reported at the final seminar on the census that yields based on published sown areas should

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be reduced by 20 percent overall to make them consistent with the actual situation (Zhu, 2000). No information has been made available on individual crops. Consequently, in the modeling for this article all crop yields were equally revised down 20 percent despite fully recognizing this was a second best solution since each crop should be different. Sown area of each crop was revised upward 25 percent to correct for the 20 percent revision down in crop yields.

Crops were divided into two types for projections, major and minor. Nine, chosen as major crops, account for about three quarters of sown area. Yield growth rates for the nine were ascertained by evaluating six factors that affect them; fertilizer, irrigation, land reclamation, seed variety, soil improvement, and "other" which includes management, mechanization, etc., as well taking into account international yields and natural resource conditions in China. Yield growth rates for the 20 minor crops for which published data are available were determined by evaluation of international yields, past growth rates, domestic and international demand and markets, and technology adoption by farmers. Sown areas for each were set by consideration of past growth rates, comparison of the impact on total production by yield increases and probable demand for them.

The revised yields are generally lower than in most economically developed countries, with the exception of cotton and wheat. For example, maize yield in the United States averaged 8,554 kg for the period 1999-2001 while the revised yield in China was 3,861 kg (Table 9). The yield for China grew at 0.9 percent annually in the 1990s and is projected to grow 2.1 percent annually over the next 30 years. However, even at that rate the yield only reaches 7,237 kg, considerably below the US yield in 2000. The point is that the yield projections for 2030 are very conservative considering that few of them in 2030 projections reach the levels of economically developed countries in 2000. From a strictly international point of view considerable latitude

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exists for yield enhancement in China, a point that is elaborated on in the policy implications section.

Land reclamation and structural production improvement led to sown area increasing 0.5 percent annually during the 1990s despite considerable crop (cultivated) land being converted to non-agricultural uses. The projections continue the trend of sown area increases (0.4 percent annually) until 2010 at which time there is enough cultivated land being converted to non-agricultural use that, despite more intensive use of land, the sown area will also begin to decline. The projection is for a long-term total decline of 1.1 percent from 2000 to 2030 (Table 10). Sown area of the nine major crops is projected to decline 0.1 percent and minor crops 3.7 percent, over that period. The implication is that as irrigation water becomes scarcer, placing greater constraints on crop yield growth, it will be imperative that crop research be expanded, and technology adoption accelerated, if China is to meet increased demand for food and animal feedstuffs. In particular, as will be shown in the next section, given the projected shortfall in protein, research should be focused on oilseed crops and adjustments in planting them, and expanded use of crop residues rather than energy oriented grain crops

Projections are that total production of cereal crops will expand by about an additional 30 million tons every decade, from 422 million tons in 2000 to 534 million tons in 2030, up from 390 million tons in 1990 (Table 11). Oilseed crops are projected to grow from 28 million tons in 2000, to 53 million tons in 2030 unless there is some policy to shift more resources into additional oilseed crop production to meet projected protein shortfalls. The government is cognizant of the problem as evidenced by production from oilseed crops having increased much more rapidly than cereal crops, about 6 percent annually from 1990 to 2000 versus about 1 percent by cereal crops.

Nonconventional Feed Resources

Nonconventional feed resources (NCFR) are a major source of both energy and protein (36 and 26 percent of ME and CP production, respectively, in 2000) for animal feeds, and are nearly as important as principal crops from which 42 and 39 percent of total energy and protein were derived in 2000 (Table 8). Crop residues and silage are really the focal point to understand Chi9na's potential to meet its growth in animal and fish production as they will continue to be an important source of animal feedstuffs for the next 2 decades although the percentages of total ME and CP will decline to 26 and 22 percent while principal crops increase to 55 and 42 percent as crop breeding improvements lead to a higher proportion of grain within the plant.

It is estimated that 795 million tons of crop residues and silage, the major source of NCFR, were produced in 2000 (Table 12). Relatively small amounts of NCFR are fed to backyard poultry and pigs, and that proportion will decline in importance as these industries commercialize. Draft and beef cattle consume most of the NCFR, and this feedstuffs category is the explanation of why China will be able to feed its rapidly growing cattle numbers without resorting to substantial grain imports. It is also a very important feedstuff for other ruminants and non-bovine work animals. However, as pointed out in the section on livestock inventory projections, buffalo and non-bovine work animal numbers will decline substantially, thus freeing up these resources for beef production oriented cattle.

Crop residues include vines, straw and stover of which a part is simply waste that is burned in the field after harvest, plowed back into the ground, used in other activities such as paper making, or used for cooking and heating by farmers. The rest is fed to animals, primarily ruminants. Thirty four percent of all residues were fed to animals in 2000, and estimates are that it will reach 38 percent by 2010 (Table 12), primarily as a result of government programs (calculations in modeling taking into account data inTingshuang, Sanchez and Peiyu, 2002) Silage, mainly from maize, is an important feedstuff, accounting for 34 percent of total residues and silage

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fed in 2000. An increasing amount of maize production will be shifted from grain to silage as cattle fattening expands leading to silage accounting for 50 percent of the total fed in 2030.

Stover is the preferred crop residue to feed animals because it has a higher feeding value than straw (e.g., 1.87 Mcal/kg and 5.4 percent CP for maize stover compared with 1.43 Mcal/kg and 2.9 percent CP for rice straw. One mega-calorie or Mcal is equivalent to 1,000 Kcal. One Kcal is the unit commonly known as the calorie in human nutrition). Total residues and silage fed is projected to grow from 473 million tons in 2010, to 503 million tons in 2020 and 522 million tons in 2030 (Table 12).

An important part of China's animal policy has been to increase use of both untreated and treated residues (Tingshuang, Sanchez and Peiyu, 2002). China embarked on a crop residue improvement program in the mid 1980s, and FAO and UNDP provided considerable financial and technical assistance from 1987. By 2000, 13 prefectures and 380 counties had programs, including demonstration sites. The projections of total tonnage fed reveal the emphasis which continues to be placed on the program, one of the most important in rural China.

There are a number of ways to treat residues (and silage), with ammonia having become the most common in China. The cost is modest, the technology relatively simple, and the payback substantial. One benefit is that the lignin is broken down, thus improving digestibility. Another is that the ME and CP content are increased. As an example, ME in maize stover will nearly double from 1.87 Mcal/kg to 2.50, and CP from 5.4 to 8.0 percent. In contrast, there is relatively little increase in ME when straw is treated although CP increases from 2.9 to 4.3 percent, a modest gain. It is estimated that about 45 percent of all crop residues fed to animals in 2000 were treated.including 49 percent of straw fed and 51 percent of stover fed (Table 12). The amounts fed and treated will both increase—and for very good reasons.

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Conclusions and Policy Implications

The foremost conclusions are that China will be able to meet its energy related feedstuffs requirements over the next several decades, but there will be an increasing shortfall in protein if action is not taken. There are ways in which China can avoid large increases in feedstuffs imports, but they will require appropriate and sometimes onerous policy decisions. This article is mainly about feedstuffs, so a handy way to tie conclusions with policy recommendations is to start with the four feedstuffs categories provided in Table 8.

Grasslands are the most difficult feedstuffs supply categories to develop policies for because only a relatively modest amount of total energy and protein availabilities are derived from them, and only a small proportion of livestock are raised on them.. Most problematic is that they are first and foremost a people problem. Most areas are heavily overpopulated by humans as well as livestock, at least from a long-term sustainability perspective. Unfortunately, failure to control grazing is having a well-publicized, long-term detrimental impact on China's vast grasslands and pastoral areas. That demands national level response. It is really a tough social problem that must be dealt with by encouraging migration and giving up or selling land use rights (c.f. Simpson, Li and Li, 2003) and we agree with government efforts to relocate rural poor in those areas (*China Daily,* march 11, 2003). Government is also experimenting with large-scale grazing land deferment programs, and these should be strongly encouraged and supported.

Crop residues and silage do not convey the aura of excitement associated with biotechnology and other high-tech solutions associated with principal crop outputs, yet they are one of the main policy alternatives available to policymakers, for several very good reasons. One is very modest cost as little new research is needed to improve their use. Second is that the technology is relatively simple and fits China's agricultural structure. Third is that expansion of the program to expand their use in beef production can prevent China from having to import large

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amounts of grain required by large-scale U.S. style cattle feedlots. The biggest reason is that the impacts on protein deficits from promoting its use are substantial, especially considering that beef production is the least amenable of all livestock and fish to technological change and productivity increases through scale economies. Following is a simple example using data presented in this article that demonstrates why considerable attention should be given by policy makers to crop residues.

Consider the projections that beef production (consumption) will grow from 3.9 kg in 2000, to 5.5 kg in 2010. Using those figures, as well as the other data presented in previous tables, the result would be a CP shortfall of 2.2 million MT in 2010 (Table 2). ME and CP are a useful way to quantify very different feedstuffs, but they're also an abstract measure. Consequently, the additional requirements over the base period (1999-2001) have been converted to a soybean equivalent (SBE) basis using a 40% crush rate, and resultant meal set at 43 percent CP. That converts to an equivalent of 12.9 million MT of additional soybean imports in 2010 as shown in the projected (first and base) scenario of Table 13. To place these results in perspective the USDA baseline import projection for China in 2007 is 5.3 million MT of soybeans, which is an additional 1.5 million MT over imports in 2000.

Clearly, there are other sources of protein based feeds such as oilseeds and by-products like oilseed and fish meals. (China averaged 14 million tons of all net oilseed imports in 1999-2001, up substantially from less than 1 million tons in 1989-91 and 2 million tons in 1994-96). The soybean example is used because it is easy to visualize. Continuing the base (projected) scenario, consider the year 2030. If projections for that year of 36.1 million MT of SBE were realized, and all imports were soybeans, that amount would nearly reach the equivalent of total world soybean imports in 2000 (40 million MT

A natural question is about sensitivity of the projections. It turns out that changes in crop yields and sown area do have an impact, and since the projections are based on moderate yield increases, additional response rates from further development and adoption of research results would have a mitigating impact on the shortfalls. Also, as pointed out, beef is the principal commodity of concern in projections since cattle production utilizes such a large amount of feedstuffs. The government program to foster feeding and

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treatment of crop residues is very important because only modest increases in feeding residues, particularly treated ones, do have a major impact on CP shortfalls. Consider, for example, just one feedstuff, maize stover as shown in scenario 2. If the proportion of maize stover production in the base scenario that is treated and fed were increased from the projected 25 percent in 2010 to 35 percent, just 4.9 million tons of additional SBEs (rather than 12.9 million MT) would be needed to cover the shortfall in 2010(Table 13). An increase to 60 percent in 2030 from the projected 35 percent (while simultaneously untreated residues fed falls from 20 percent in 2010 to 5 percent in 2030) means just 13.6 million tons of additional SBE (a reasonable amount) would have to be imported rather than 36.1 million MT.

What about beef consumption increasing at a much faster rate than projected, say from 7.5 to 10.0 Kg in 2030? The answer (scenario 3) is that, with the base scenario of 35 percent of maize stover being treated and untreated falling to 5 percent of residues produced, the SBE increases to an almost unimaginable 82 million MT. If the treatment percent were to increase to 60 percent (scenario 4), the SBE would still be an inconceivable 60 million MT.

On the positive side, maize residue is just one of many residues covered by the government program. If feeding levels of many or most of residues and treatment of them were to expand in line with government programs, it is likely that protein shortfalls, or at least most of them, could be met with reasonable levels of protein oriented imports. The point is that relatively simple solutions are available to meet projected shortfalls in protein requirements, they are in place, and they are an important component to meet feedstuffs requirements.

In brief terms, trade data reveal that China has shifted dramatically from being a net protein exporter to being a substantial importer during the 1990s. The very conservative projections reported on in this article amplify that trend as the decades roll by. Many pundits, particularly those who would benefit by China increasing agricultural imports, paint dismal pictures of the future. In contrast, we firmly believe that while the nation has formidable obstacles facing it such as water shortages reversal of land degradation, redundancy of rural workers and rapid change in diet to greater consumption of livestock and fish products, there is considerable room for optimism provided appropriate agricultural and other rural policies are enacted and effectively carried out. There is substantial potential to increase oilseed production, and biotechnology offers great potential for development of drought resistant and dryland agriculture varieties, reduced use of chemicals, and yield enhancement far beyond those used in the projections (Gianessi, Sankula and Reigner, 2003; Huang, Rozell, Pray and Wang, 2002; Huang, Hu, Wang, Keeley and Zepeda, n.d..

It is not possible to provide policy prescriptions due to space limitations. Rather, the purpose has been to highlight a method that can complement and enhance econometric trade models. Few economists in China are greatly concerned with agriculture per se, but all are at least mildly interested in how to measure productivity and efficiency for they are major determinants in reducing production cost, lowering food costs to consumers, and increasing income to farmers and the wide array of agro-businesses associated with the entire food chain. Economists by nature are long-term oriented, are concerned with optimal allocation of scarce resources, and with the most effective use of land, labor and capital. The projections presented in this article dramatically show the need to take a long-term approach in agricultural policy and planning, and they demonstrate know that sound economic planning is based on sound technical analysis.

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TABLE 1. POPULATION AND GROSS DOMESTIC INCOME PER CAPITA, CHINA, ECONOMY ROBUST, 1984-86 TO 2030

ITEM	1984-1986	1989-1991	1994-1996	1999-2001	2010	2020	2030
				POPULATION			
			MILLIONS				
POPULATION	1,075.9	1,161.4	1,226.0	1,282.4	1,374.4	1,455.0	1,494.1
				GROSS DOMESTIC INCOME (GDI) PER CAPITA			
	COMPOUND ANNUAL GROWTH RATE			BASE YEAR	PROJECTION YEARS		
	2000-2010	2010-2020	2020-2030	2000	2010	2020	2030
	PERCENT			$ US			
PPP BASIS	7.0	5.5	4.5	3,940	7,751	13,239	20,560
	0.0						
EXCHANGE RATE BASIS	7.0	5.5	4.5	840	1,652	2,823	4,383
				YUAN			
EXCHANGE RATE TO DOLLARS				8.28	8.28	8.28	8.28
PPP BASIS				32,623	64,175	109,620	170,236
EXCHANGE RATE BASIS				6,955	13,682	23,371	36,294

SOURCE: BASE YEAR PPP AND EXCHANGE RATE BASIS FROM WWW.rieti.go.jp/en/China/02080901.html
POPULATION FROM FAO DATASTATS.

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TABLE 2. METABOLIZABLE ENERGY AND CRUDE PROTEIN REQUIREMENTS AND AVAILABILITIES, ANIMALS AND FISH, CHINA, ECONOMY ROBUST, NO CHANGE IN TRADE FROM BASE LEVEL, 1999-2001 TO 2030

Item	AVG 99-2001	2010	2020	2030
		METABOLIZABLE ENERGY		
		MILLION Mcal		
ANIMALS AND FISH				
REQUIREMENTS	1,595,970	1,896,705	2,124,963	2,272,334
AVAILABILITIES	1,211,936	1,517,321	1,756,966	1,967,125
REQUIREMENTS OVER AVAILABILITIES	384,034	379,384	367,997	305,209
ADDITIONAL REQUIREMENTS OVER BASE YEAR	--	-4,650	-16,037	-78,825
		Percent		
REQUIREMENTS OVER AVAILABILITIES	24	20	17	13
DIFFERENCE FROM BASE PERIOD (PERCENT)	--	-1	-4	-21
DIFFERENCE FROM PREVIOUS PERIOD (PERCENT)	--	-1	-3	-17
ANIMALS AND FISH INCREASE OVER BASE YEAR				
INCREASE OVER BASE YEAR				
REQUIREMENTS	--	19	33	42
AVAILABILITIES	--	25	45	62
		CRUDE PROTEIN		
		1,000 MT		
ANIMALS AND FISH				
REQUIREMENTS	69,742	83,576	96,155	106,145
AVAILABILITIES	52,961	64,576	73,972	83,150
REQUIREMENTS OVER AVAILABILITIES	16,782	19,000	22,183	22,995
ADDITIONAL REQUIREMENTS OVER BASE YEAR	--	2,218	5,401	6,213
		Percent		
REQUIREMENTS OVER AVAILABILITIES	24	23	23	22
DIFFERENCE FROM BASE PERIOD (PERCENT)	--	13	32	37
DIFFERENCE FROM PREVIOUS PERIOD (PERCENT)	--	13	17	4
ANIMALS AND FISH OVER THE BASE YEAR				
INCREASE OVER BASE YEAR				
REQUIREMENTS	--	20	38	52
AVAILABILITIES	--	22	40	57

SOURCE: SIMPSON, MODELING RESULTS.

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TABLE 3. PROJECTIONS OF PER CAPITA MEAT AND FISH SUPPLY, CHINA, ECONOMY ROBUST, 1999-2000 TO 2030

	COMPOUND ANNUAL GROWTH RATE CALCULATED			PROJECTION PER CAPITA ENTERED			
	2000-2010	2010-2020	2020-2030	1999-2001	2010	2020	2030
	PERCENT			KG			
BEEF AND VEAL	3.6	1.7	1.4	3.9	5.5	6.5	7.5
PORK	0.4	0.6	0.5	32.6	34.0	36.0	38.0
MUTTON AND GOAT	0.8	0.2	0.0	2.1	2.3	2.4	2.4
MUTTON AND LAMB	0.7	0.4	0.0	1.1	1.2	1.3	1.3
GOAT	0.9	0.0	0.0	1.0	1.1	1.1	1.1
BUFFALO MEAT	-2.2	-2.7	-6.7	0.3	0.2	0.2	0.1
TOTAL, RED MEAT	0.8	0.7	0.6	38.9	42.0	45.0	47.9
POULTRY	3.5	2.5	1.6	9.9	14.0	18.0	21.0
TOTAL MEAT	1.4	1.2	0.9	48.8	56.0	63.0	68.9
FISH,FRESH	1.3	0.4	0.7	11.8	13.5	14.0	15.0
TOTAL MEAT & FISH	0.8	0.9	0.8	92.1	99.5	109.0	117.9
MILK							
COW	1.4	4.1	5.2	7.0	8.0	12.0	20.0
GOAT	-0.1	0.0	0.0	0.2	0.2	0.2	0.2
BUFFALO	-1.7	-3.4	-7.3	2.1	1.7	1.2	0.6
EGGS, HEN	0.8	0.1	0.0	15.1	16.3	16.5	16.5
				PERCENT			
BEEF AND VEAL				4	6	6	6
PORK				35	34	33	32
MUTTON AND GOAT				2	2	2	2
MUTTON AND LAMB				1	1	1	1
GOAT				1	1	1	1
BUFFALO MEAT				0	0	0	0
TOTAL, RED MEAT				42	42	41	41
POULTRY				11	14	17	18
TOTAL MEAT				53	56	58	58
FISH,FRESH				13	14	13	13
TOTAL MEAT & FISH				100	100	100	100

SOURCE: SIMPSON, MODELING RESULTS.

TABLE 4. TOTAL PRODUCTION OF MEAT AND FISH, CHINA, ECONOMY ROBUST, 1984-86 TO 2030

SPECIES	1984-1986	1989-1991	1994-1996	AVG 99-2001	2010	2020	2030
	1,000 MT						
BEEF AND VEAL	406	1,168	3,054	4,944	7,559	9,458	11,206
PORK	17,322	24,062	33,010	41,811	46,730	52,380	56,776
MUTTON AND GOAT	601	1,071	1,682	2,731	3,161	3,419	3,511
MUTTON AND LAMB	307	551	893	1,438	1,649	1,819	1,868
GOAT	294	520	789	1,292	1,512	1,601	1,644
BUFFALO MEAT	127	165	275	369	317	256	131
TOTAL, RED MEAT	18,456	26,465	38,021	49,855	57,767	65,513	71,624
POULTRY	2,092	3,855	8,279	12,671	19,242	26,190	31,376
TOTAL MEAT	20,548	30,321	46,300	62,526	77,009	91,703	103,000
FISH,FRESH		5,263	10,475	15,175	18,554	20,370	22,412
TOTAL MEAT & FISH		50,337	86,083	118,069	136,795	158,633	176,211
MILK							
COW	2,619	4,411	6,090	8,916	10,995	17,460	29,882
GOAT	144	163	194	234	247	262	269
BUFFALO	1,627	1,907	2,200	2,633	2,377	1,787	859
EGGS, HEN	4,225	6,701	13,912	19,390	22,403	23,935	24,653

SOURCE: HISTORICAL DATA FROM FAO DATASTATS. PROJECTIONS FROM SIMPSON, MODELING RESULTS.

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TABLE 5. PRODUCTION PER HEAD OF INVENTORY, CHINA, ECONOMY ROBUST, 1984-86 TO 2030

SPECIES	1984-1986	1989-1991	1994-1996	AVG 99-2001	2010	2020	2030
	KG OF MEAT PER HEAD OF INVENTORY						
SHEEP	3	5	8	11	11	12	13
GOATS	5	5	6	9	9	9	10
CATTLE	6	15	31	47	61	77	87
BUFFALO	6	8	12	16	16	18	19
PIGS	54	67	81	95	103	130	145
POULTRY (JAN 1 INV)	1	2	2	3	4	6	7
	KG OF MILK PER HEAD OF INVENTORY						
GOATS	1	1	1	1	1	1	1
MILK COWS	1,475	1,453	1,436	1,680	2,046	3,255	5,580
BUFFALO	83	89	96	116	121	123	128

SOURCE: SIMPSON, MODELING RESULTS.

TABLE 6. LIVESTOCK INVENTORY, CHINA, ECONOMY ROBUST, 1984-86 TO 2030

SPECIES	1984-1986	1989-1991	1994-1996	AVG 99-2001	2010	2020	2030
	1,000 HEAD						
NON-BOVINE WORK ANIMALS							
ASSES	9,942	11,128	10,853	9,906	7,466	4,021	1,151
CAMELS	542	470	360	330	242	197	157
HORSES	10,956	10,338	10,025	8,889	6,236	5,095	4,382
MULES	4,785	5,417	5,480	4,647	2,822	1,876	1,017
TOTAL, NON-BOVINE	26,225	27,353	26,718	23,772	16,765	11,190	6,708
CATTLE							
MILK COWS	1,776	3,037	4,241	5,308	5,374	5,364	5,355
DRAFT/BEEF	41,563	54,835	68,803	98,869	117,813	116,759	123,455
TOTAL CATTLE	43,339	57,872	73,044	104,177	123,187	122,123	128,810
BUFFALO	19,571	21,412	23,030	22,681	19,704	14,530	6,732
TOTAL,CATTLE,BUFFALO	62,910	79,284	96,074	126,858	142,891	136,654	135,542
TOTAL LARGE ANIMALS	89,135	106,637	122,792	150,630	159,657	147,844	142,250
SHEEP	96,108	112,299	118,919	130,539	146,135	151,942	147,592
GOATS	64,521	95,615	126,431	149,245	166,649	170,121	168,669
TOTAL SMALL RUMINANTS	160,629	207,914	245,350	279,784	312,784	322,064	316,261
PIGS							
COMMERCIAL				154,134	204,594	302,370	356,833
BACKYARD				286,248	250,060	100,790	35,291
TOTAL	319,078	360,543	408,782	440,382	454,654	403,160	392,124
	MILLION BIRDS						
TOTAL POULTRY	1,586	2,558	3,914	4,410	4,775	4,599	4,298

SOURCE: HISTORICAL DATA FROM FAO DATASTATS. PROJECTIONS FROM SIMPSON, MODELING.

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TABLE 7. METABOLIZABLE ENERGY AND CRUDE PROTEIN REQUIREMENTS BY SPECIES GROUPS, CHINA, ECONOMY ROBUST, 1999-2001 TO 2030

SPECIES	TOTAL REQUIREMENTS ME	TOTAL REQUIREMENTS CP	SPECIES PROPORTION ME	SPECIES PROPORTION CP
	-Million Mcal-	-1000 MT-	--------PERCENT---------	
AVG 99-2001				
DRAFT/BEEF CATTLE	352,933	14,074	22.1	20.2
OTHER LARGE ANIMALS	134,344	5,407	8.4	7.8
TOTAL LARGE ANIMALS	487,277	19,481	30.5	27.9
SMALL RUMINANTS	124,315	5,678	7.8	8.1
PIGS	660,159	23,534	41.4	33.7
POULTRY	154,003	8,182	9.6	11.7
FISH, FRESH WATER	170,217	12,868	10.7	18.5
TOTAL	1,595,970	69,742	100.0	100.0
2030				
DRAFT/BEEF CATTLE	627,249	23,837	27.6	22.5
OTHER LARGE ANIMALS	90,029	4,262	4.0	4.0
TOTAL LARGE ANIMALS	717,278	28,100	31.6	26.5
SMALL RUMINANTS	154,837	7,103	6.8	6.7
PIGS	909,159	33,781	40.0	31.8
POULTRY	311,544	20,576	13.7	19.4
FISH, FRESH WATER	179,516	16,585	7.9	15.6
TOTAL	2,272,334	106,145	100.0	100.0

SOURCE: SIMPSON MODELING.

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TABLE 8. TOTAL METABOLIZABLE ENERGY AND CRUDE PROTEIN PRODUCED BY SOURCE TYPE, CHINA, ECONOMY ROBUST, 1999-2001 TO 2030 (1)

ITEM	AVG 99-2001	2010	2020	2030
	METABOLIZABLE ENERGY			
	MILLION Mcal			
BY-PRODUCTS	110,684	135,808	164,850	195,403
NONCONVENTIONAL	441,711	528,720	524,847	516,587
GRASSLAND	156,511	167,712	171,153	174,435
PRINCIPAL CROP(2)	503,031	685,080	896,117	1,080,700
TOTAL	1,211,936	1,517,321	1,756,966	1,967,125
	PERCENT			
BY-PRODUCTS	9	9	9	10
NONCONVENTIONAL	36	35	30	26
GRASSLAND	13	11	10	9
PRINCIPAL CROP(2)	42	45	51	55
TOTAL	100	100	100	100
	CRUDE PROTEIN			
	1,000 TONS			
BY-PRODUCTS	13,026	16,346	20,177	23,771
NONCONVENTIONAL	13,641	17,247	17,761	18,399
GRASSLAND	5,529	5,931	6,120	6,277
PRINCIPAL CROP(2)	20,764	25,051	29,914	34,702
TOTAL	52,961	64,576	73,972	83,150
	PERCENT			
BY-PRODUCTS	25	25	27	29
NONCONVENTIONAL	26	27	24	22
GRASSLAND	10	9	8	8
PRINCIPAL CROP(2)	39	39	40	42
TOTAL	100	100	100	100

SOURCE:SIMPSON MODELING.

(1) THE ACTUAL ME IS HIGHER, BUT CANNOT BE CALCULATED DUE TO PROBLEMS IN ESTIMATION OF NONPUBLISHED NUMBERS SUCH AS GARBAGE FEEDING, WATER PLANTS, NON-SPECIFIED FORAGES, STATISTICAL ERRORS IN REPORTED DATA, ETC.

(2) INCLUDES SILAGE.

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TABLE 9. YIELD PER HECTARE AND SOWN AREA CHANGE OF CROPS, CHINA, ECONOMY ROBU AVG 1999-2001 TO 2030

YEAR	COTTON(1)	MAIZE	RAPE SEED	RICE	SORGHUM	SOYBEANS	WHEAT	BARLEY	GROUND NUTS (PEANUTS)
	GROWTH RATE IN TECHNOLOGY & ADOPTION								
	COMPOUND ANNUAL GROWTH RATE (PERCENT)								
AVG 1999-2001 TO 2010	1.00	2.05	1.50	1.50	1.50	2.30	1.50	1.60	1.50
2010 TO 2020	0.90	2.05	1.40	1.20	1.00	2.10	1.20	1.50	0.90
2020 TO 2030	0.50	2.25	1.00	0.30	1.00	1.85	0.30	1.00	0.20
	YIELD PER HECTARE (PUBLISHED DATA SERIES THAT OVER ESTIMATES)								
	KG								
AVG 99-2001	3,229	4,826	1,467	6,316	3,124	1,740	3,839	2,415	3,024
	YIELD PER HECTARE (REVISED DOWN TO ADJUST FOR SOWN (HARVESTED) AREA INACCURACIES								
	PERCENT								
ADJUSTMENT	20	20	20	20	20	20	20	20	20
	KG								
AVG 99-2001	2,583	3,861	1,174	5,053	2,499	1,392	3,071	1,932	2,419
2010	2,853	4,729	1,362	5,864	2,900	1,747	3,564	2,264	2,808
2020	3,121	5,793	1,565	6,607	3,204	2,151	4,016	2,628	3,071
2030	3,281	7,237	1,729	6,808	3,539	2,584	4,138	2,903	3,133
	PERCENT								
INCREASE 2000-2030									
TOTAL	27.0	87.5	47.3	34.7	41.6	85.6	34.7	50.2	29.5
COMPOUND ANNUAL	0.8	2.1	1.3	1.0	1.2	2.1	1.0	1.4	0.9
ANNUAL RATE 1989-91 TO 1999-2001									
CHINA	3.0	0.9	2.5	1.1	-0.3	2.3	2.1	-1.0	3.6
UNITED STATES	0.0	1.8	-0.5	0.9	0.7	1.3	1.6	1.1	1.7
	KG								
YIELD PER HA, 1999-2001									
UNITED STATES	1,851	8,554	1,499	6,940	3,986	2,563	2,801	3,201	3,041

(1) LINT BASIS
(2) E.G. SHIFT TO MECHANIZATION, TECHNOLOGY ADOPTION, MANAGEMENT IMPROVEMENT.

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TABLE 10. SOWN (HARVESTED AREA) CHANGE, MAJOR CROPS AVG 1999-2001 TO 2030, AND COMPARISON OF MAJOR AND MINOR CROPS 1980-2000 AND AVG 1999-2001, CHINA, ECONOMY ROBUST

YEAR	COTTON(1)	MAIZE	RAPE SEED	RICE	SORGHUM	SOYBEANS	WHEAT	BARLEY	GROUND NUTS (PEANUTS)
	SOWN (HARVESTED AREA CHANGE, MAJOR CROPS								
	COMPOUND ANNUAL GROWTH RATE (PERCENT)								
AVG 1999-2001 TO 2010	-2.00	0.20	2.80	-1.00	-0.50	2.30	-0.80	0.00	1.20
2010 TO 2020	-1.50	-0.40	1.50	-0.90	0.00	2.50	-0.50	0.30	0.50
2020 TO 2030	-1.00	-1.00	0.50	-0.20	0.00	1.80	-0.10	0.30	0.00

SOWN (HARVESTED) AREA CHANGE, ALL CROPS

	CHANGE FROM BASE YEAR			PROPORTION OF ALL AREA		
	MAJOR CROPS	MINOR CROPS	TOTAL CROPS	MAJOR CROPS	MINOR CROPS	TOTAL CROPS
	PERCENT					
1980-1990			0.1			
1980-2000			0.3			
1990-2000			0.5			
AVG 99-2001	-	-	-	73.0	27.0	100.0
2010	-0.1	1.7	0.4	72.7	27.3	100.0
2020	-0.2	-0.8	-0.3	73.2	26.8	100.0
2030	-0.1	-3.7	-1.1	73.7	26.3	100.0

SOURCE:SIMPSON MODELING.

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TABLE 11. PRODUCTION OF CEREAL AND OILSEED CROPS, CHINA, ECONOMY ROBUST, 1999-2001 TO 2030

CROP	PUBLISHED AVG 89-91	PUBLISHED AVG 94-96	PUBLISHED AVG 99-2001	MODEL BASE AND PROJECTIONS 2010	2020	2030
	---1,000 MT---					
	PRODUCTION OF CEREAL CROPS (PRC DEFINITION)					
RICE	186,598	187,442	190,577	200,033	205,894	207,950
WHEAT	94,999	104,027	102,339	109,513	117,355	119,719
MAIZE	91,891	113,300	116,757	145,747	171,523	193,780
MILLET	3,918	3,430	2,297	1,870	1,493	1,419
SORGHUM	5,135	5,678	2,948	3,245	3,584	3,959
OTHER GRAINS	7,630	9,053	7,300	7,000	7,500	8,000
TOTAL	390,171	422,930	422,218	467,407	507,349	534,827
	PRODUCTION OF COARSE GRAINS, INTERNATIONAL AND USDA DEFINITION					
BARLEY	3,400	4,401	3,299	3,869	4,627	5,266
MAIZE	91,891	113,300	116,757	145,747	171,523	193,780
MILLET	3,918	3,430	2,297	1,870	1,493	1,419
OATS	733	850	650	574	529	528
SORGHUM	5,135	5,678	2,948	3,245	3,584	3,959
OTHER GRAINS	0	0	0	0	0	0
TOTAL	105,077	127,659	125,951	155,305	181,756	204,953
	PRODUCTION OF OILSEED CROPS (PRC DEFINITION)					
GROUNDNUTS	6,082	10,103	13,925	18,201	20,925	21,347
RAPESEED	6,610	8,823	10,944	16,749	22,337	25,936
SESAME	415	569	782	1,218	1,686	1,863
SUNFLOWER	1,275	1,320	1,906	2,600	3,236	3,435
OTHER OILSEEDS	0	0	0	0	0	0
TOTAL	14,382	20,815	27,557	38,767	48,184	52,581
	---PERCENT---					
	ANNUAL INCREASES FROM PREVIOUS PERIOD					
CEREAL CROPS	-	1.6	0.0	1.0	0.8	0.5
COARSE GRAINS	-	4.0	-0.3	2.1	1.6	1.2
OILSEED CROPS	-	7.7	5.8	3.5	2.2	0.9

SOURCE: HISTORICAL FROM FAO DATASTATS. PROJECTIONS FROM SIMPSON MODELING.

LI OU. CHECK OILSEEDS, OTHER, AND TOTAL FOR OILSEEDS. I CANNOT GET A CONSISTANT TOTAL

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TABLE 12. TOTAL RESIDUES AND SILAGE PRODUCED AND TREATED IN CHINA,
ECONOMY ROBUST, 2000 AND 2010

ITEM	AVG 99-2001	2010	2020	2030	AVG 99-2001	2010	2020	2030
	1,000 TONS				PERCENT			
	RESIDUES AND SILAGE PRODUCED							
VINES	130,113	157,218	179,784	201,060	16	17	18	19
STRAW	380,303	380,550	381,106	368,439	48	41	38	36
STOVER	165,887	182,669	197,798	206,022	21	20	20	20
RESIDUES	676,303	720,437	758,688	775,521	85	79	77	75
SILAGE	119,163	197,018	231,879	261,998	15	21	23	25
TOTAL	795,466	917,455	990,567	1,037,519	100	100	100	100
	RESIDUES AND SILAGE FED AND PROPORTION OF TOTAL							
VINES	30,100	41,262	45,391	50,780	9	9	9	10
STRAW	130,495	151,689	145,706	126,377	38	32	29	24
STOVER	66,311	82,715	80,228	83,324	19	17	16	16
RESIDUES	226,906	275,666	271,325	260,481	66	58	54	50
SILAGE	119,163	197,018	231,879	261,998	34	42	46	50
TOTAL	346,069	472,684	503,204	522,479	100	100	100	100
	PERCENT OF EACH RESIDUE AND SILAGE PRODUCED FED							
VINES	30,100	41,262	45,391	50,780	23	26	25	25
STRAW	130,495	151,689	145,706	126,377	34	40	38	34
STOVER	66,311	82,715	80,228	83,324	40	45	41	40
RESIDUES	226,906	275,666	271,325	260,481	34	38	36	34
SILAGE	119,163	197,018	231,879	261,998	100	100	100	100
TOTAL	346,069	472,684	503,204	522,479	44	52	51	50
	INCREASE IN TOTAL FED FROM BASE PERIOD							
VINES					--	37	51	69
STRAW					--	16	12	-3
STOVER					--	25	21	26
RESIDUES					--	21	20	15
SILAGE					--	65	95	120
TOTAL					--	37	45	51
	RESIDUES AND SILAGE TREATED, AND AS A PROPORTION OF THE AMOUNT OF PRODUCTION							
VINES	4,077	8,186	9,434	10,568	3	5	5	5
STRAW	64,437	80,566	83,384	84,440	17	21	22	23
STOVER	33,699	46,181	59,250	71,392	20	25	30	35
RESIDUES	102,212	134,932	152,068	166,401	15	19	20	21
SILAGE	0	0	0	0	0	0	0	0
TOTAL	102,212	134,932	152,068	166,401	13	15	15	16
	RESIDUES AND SILAGE TREATED, AND AS A PROPORTION OF THE AMOUNT FED TO ANIMALS							
VINES	4,077	8,186	9,434	10,568	14	20	21	21
STRAW	64,437	80,566	83,384	84,440	49	53	57	67
STOVER	33,699	46,181	59,250	71,392	51	56	74	86
RESIDUES	102,212	134,932	152,068	166,401	45	49	56	64
SILAGE	0	0	0	0	0	0	0	0
TOTAL	102,212	134,932	152,068	166,401	30	29	30	32

SOURCES: SIMPSON MODELING WITH RECOGNITION OF TINGSHUANG, SANCHEZ AND PEIYU, 2002,
FOR MUCH OF THE BASIC DATA FOR 2000 AND 2010.

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TABLE 13. SCENARIOS ABOUT THE IMPACT OF CROP RESIDUES ON SOYBEAN IMPORTS, CHINA, ECONOMY ROBUST, 1999-2001 TO 2030

ITEM	AVG 99-2001	2010	2020	2030
	BEEF CONSUMPTION AT PROJECTED LEVEL			
PER CAPITA BEEF CONSUMPTION (KG)	3.9	5.5	6.5	7.5
SCENARIO 1 (BASE)				
PROPORTION OF MAIZE STOVER PRODUCTION				
UNTREATED AND FED TO ANIMALS (PERCENT)	20	20	10	5
TREATED AND FED TO ANIMALS (PERCENT)	20	25	30	35
SHORTFALL IN CP OVER BASE (1,000 MT)	--	2,218	5,401	6,213
ADDITIONAL SOYBEAN IMPORTS (MILLION MT) (1)	--	12,897	31,402	36,122
SCENARIO 2				
PROPORTION OF MAIZE STOVER PRODUCTION				
UNTREATED AND FED TO ANIMALS (PERCENT)	20	20	10	5
TREATED AND FED TO ANIMALS (PERCENT)	20	35	50	60
SHORTFALL IN CP OVER BASE (1,000 MT)	--	850	2,428	2,337
ADDITIONAL SOYBEAN IMPORTS (MILLION MT) (1)	--	4,939	14,117	13,590
	BEEF CONSUMPTION AT HIGHER LEVELS			
PER CAPITA BEEF CONSUMPTION (KG)	3.9	6.0	9.0	10.0
SCENARIO 3				
PROPORTION OF MAIZE STOVER PRODUCTION				
UNTREATED AND FED TO ANIMALS (PERCENT)	20	20	10	5
TREATED AND FED TO ANIMALS (PERCENT)	20	25	30	35
SHORTFALL IN CP OVER BASE (1,000 MT)	--	3,973	13,699	14,156
ADDITIONAL SOYBEAN IMPORTS (MILLION MT) (1)	--	23,100	79,644	82,301
SCENARIO 4				
PROPORTION OF MAIZE STOVER PRODUCTION				
UNTREATED AND FED TO ANIMALS (PERCENT)	20	20	10	5
TREATED AND FED TO ANIMALS (PERCENT)	20	35	50	60
SHORTFALL IN CP OVER BASE (1,000 MT)	--	2,604	10,726	10,280
ADDITIONAL SOYBEAN IMPORTS (MILLION MT) (1)	--	15,142	62,359	59,768

SOURCE:SIMPSON MODELING.

(1) THE AMOUNT ON A SOYBEAN EQUIVALENT BASIS NEEDED TO COVER THE SHORTFALL IN DOMESTICALLY PRODUCED CRUDE PROTEIN AVAILABILITIES. THE FIRST SCENARIO IS SHOWN IN TABLE 2. THE CRUSH RATE IS 40 PERCENT AND THE CP CONTENT OF THE RESULTANT SOYBEAN MEAL IS 43 PERCENT.

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