



WHO WILL FEED CHINA? CONCERNS AND PROSPECTS FOR THE NEXT GENERATION



VACLAV SMIL
University of Manitoba

Fourth Annual Hopper Lecture, presented at the University of Guelph, Oct. 22, 1996, and at the University of Alberta, Edmonton, Oct. 23, 1996.

This lecture series and publication are carried out through the support of the International Development Research Centre, Ottawa, Canada.

This publication may be reproduced, stored in a retrieval system or transmitted in any form for research or educational purposes only. It may not be reproduced, stored in a retrieval system or transmitted in any form for commercial purposes without the permission of the Centre for International Programs, University of Guelph.

Published by the University of Guelph, Guelph, Ontario, Canada N1G 2W1

Who Will Feed China? Concerns and Prospects for the Next Generation

Foreword

The University of Guelph is once again pleased to share with a wide audience the Hopper Lecture in International Development. This annual lecture, funded by a generous endowment provided by the International Development Research Centre in Ottawa, brings distinguished speakers on international development each autumn to the University of Guelph and one other Canadian university. In 1996, the University of Alberta was the other venue for the lecture.

This year's distinguished lecturer, Professor Vaclav Smil, is a member of the Department of Geography at the University of Manitoba. He has published prolifically on matters related to energy, environment, food, population and public policy. He has been a consultant to IDRC, the Rockefeller Foundation, the World Bank, and the World Resources Institute, among others. Since the early 1970s, Professor Smil has been paying specific attention to the relationships among food, energy and the environment in China, the issues that he addresses in this lecture.

J.C.M. Shute, Director

Centre for International Programs

University of Guelph

Introduction

What do the Westerners in general -- and Canadians in particular -- know about China's food? I do not mean about Chinese food: on that score Canadians are much more knowledgeable than Europeans. Patrons of budget eateries cite their fondness for chow mein and beef and broccoli (and what does it matter that no classically trained Chinese chef ever heard of such dishes), while the connoisseurs frequent out-of-the-way Sichuanese or Hakka restaurants to burn their palates with mapo doufu or to order a properly salt-baked chicken.

But what do these avid consumers of Chinese food know about China's food, about the ways it is grown, stored, distributed, eaten and wasted, about its past and current supply and nutritional adequacy, about its effect on the country's welfare and politics, about its importance in the interconnected world -- and, above all, about the prospects of satisfying the country's expanding food needs as it changes its traditional dietary patterns while adding another quarter billion people during the next generation?

Here even reasonably well-informed Westerners tend to be apprehensive, if not outright pessimistic. Even when we set aside China's premodern history, developments of the 20th century justify such worries. When the American agricultural economist John Lossing Buck was doing his extensive surveys of Chinese farming during the 1920s and early 1930s, he found that peasants recalled an average of three famines during their lifetime (Buck, 1937). Those spells of hunger lasted an average of about 10 months, and forced a quarter of the affected population to eat bark and grasses.

Hunger affected tens of millions of rural and urban Chinese during the tumultuous years of Japanese occupation and civil war. Communist victory in the civil war did not bring plenty of food; the party took over in 1949, and just five years later it had to

impose strict rationing to assure adequate urban food supplies. But even that minimal security disappeared as the world's most destructive famine -- created not by natural catastrophes but by criminal mismanagement -- claimed at least 23 million, and possibly as many as 30 million lives, between 1959 and 1961 (Becker, 1996).

Agricultural output recovered between 1962 and 1964, but rationing continued and when Mao died in 1976, average per capita food supply was no higher than in the mid-1950s. Deng Xiaoping's post-1978 rural reforms were not undertaken because of his long-suppressed admiration for private farming, but in order to lift the nation from chronic food shortages and massive malnutrition. At that time, according to Deng's admissions, more than 100 million people suffered from recurrent food shortages expressed in moderate to severe stunting, diminished capacity for work and increased morbidity.

But why should we be apprehensive now when the record of the recent past -- resulting from the enormous change brought by the sudden privatization of the country's farming during the early 1980s -- has been quite impressive? The highlights of this period show a country rapidly improving its food supply, not one facing dismal food prospects.

Achievements of China's privatized farming

The quarter century of Maoist command farming brought rigid orders from the all-knowing centre, producing even in good years just enough food to provide barely adequate diets dominated by low-quality grain staples. Just five years after the beginning of privatization (with land still belonging to the state, but with peasants free to plant crops and to breed animals more or less as they wished), China's average per capita food availability of some 2700 kcal/day vaulted to within five percent of the Japanese mean food supply. Moreover, this quantitative rise was accompanied by impressive qualitative gains. Rice became whiter, a much preferred form at Chinese tables, as grain extraction fell to 70 percent, compared to the 85 percent typical of even good pre-1980 years.

Traditional non-staple favorites -- ranging from fat ducks to fragrant ginger, and from trays of firm beancurd to piles of long beans -- became readily available in revived rural and urban markets. The plant oil so essential for Chinese cooking ceased to be a strictly rationed rarity. During the 1970s the monthly allowance commonly prorated to no more than a single tablespoon a day per capita, but during the 1980s, harvests of oil crops (rapeseed, sunflowers, peanuts and soybeans) doubled, and imports of plants oils also increased.

Pork ceased to be a treat reserved for a few festive days (the national mean average of consumption per capita before 1980 was less than 5 kg a year in most rural areas) as the country doubled its meat output in a decade. Towards the end of the 1980s, per capita consumption of pork among higher income groups in coastal cities began to surpass the Japanese national mean. And newly dug ponds began filling with silvery carp as China's freshwater aquaculture registered even faster growth than pork production, nearly quintupling in a decade.

All food rationing was eventually abolished as Chinese media kept highlighting the contrast that -- although inaccurate -- is frequently repeated by not-so-well informed observers abroad: China feeds more than 20 percent of global population from just seven percent of the world's arable land. The highest grain harvest in China's history was recorded in 1984, and the next year the country actually became a net exporter of grain.

During the 1980s, unprecedented numbers of Westerners visited the country, and only those who strayed from the usual routine of big cities and famous scenic sights saw the misery and continuing malnutrition in deforested and heavily eroding hills of Gansu and Ningxia in the arid Northwest or in decrepit villages clinging to steep hillsides of subtropical, but often no less deforested and almost as badly eroding valleys in Guangxi and Yunnan in the Southwest.

But it could be easily argued that such inequities must be expected in any country of that size and at that stage of economic development. After all, even in the United States (as a Harvard Medical School study concluded), hunger -- defined as a chronic shortage of nutrients needed for growth and good health -- affected about 12 million children and eight million adults during the late 1980s (Brown, 1987).

And although grain harvests, always the greatest preoccupation of the Chinese rulers, stagnated after the 1984 record crop, average per capita food energy supply continued to increase slightly in quantity and appreciably in quality. And then a new record harvest in 1990 surpassed the 1984 yield by almost 10 percent, and yet another record was set in 1993. Quantities and varieties of food piled up in morning markets and were displayed in many new and modern urban food stores. A careful observer could not fail to notice a great deal of food waste in China's largest cities.

Brown's vintage performance

Why, then, is there so much recent anguish about China's food prospects? The phenomenon is easy to date: in the spring of 1994, Lester Brown, President of Washington's Worldwatch Institute, wrote an article arguing that China is rapidly losing the capacity to feed itself. According to Brown's interpretation, China's grain output had already reached its peak and would only go down, declining by at least 20 percent by the year 2030.

As China's economic growth moves the country up the food ladder, demand for more meat, requiring more feed grain, and also more plant oils and sugar rises while China's huge population keeps on increasing. Brown argued that as the country loses its arable land, running out of irrigation water and exhausting opportunities for further major yield increases, it will not be able to satisfy the resulting demand for food through domestic production.

Consequently, a richer China trying to make up its food deficit by rising imports will put an unbearable strain on the global food market. China's feed and food grain imports -- potentially much larger than today's global grain export capacity -- will push up worldwide prices of nearly all major food commodities and make food dear for everybody.

Given the limited prospects for the expansion of grain exports from North America, Australia and Europe, Brown argued that China's purchases would soon lead to such a tight seller's market for grain that major exporters could be forced to put limits on foreign sales in order to prevent skyrocketing domestic prices. On the other hand, if China cannot rely on the global grain market for the coming generation, where will it get its grain after losing half of its farmland and at least a fifth of its harvests?

In 1995 Brown amplified this dismal scenario in *Who Will Feed China?*, a slim volume subtitled "Wake-up Call for a Small Planet," that attracted suitably sensationalized and predictably superficial attention of mass media, always eager to report new bad news. It also caused deeper concerns among China watchers worried about the country's long-term prosperity and among policy-makers trying to discern future patterns in the global food market.

As is always the case with Brown's wake-up calls, they cannot be dismissed outright, but they also cannot be taken altogether seriously, as they are an infuriating mixture of informed understanding and measured analyses on the one hand, and of a slantingly selective use of facts and utterly indefensible interpretations on the other.

I have been taking issue with Brown's interpretations of energy, environmental and food matters for more than two decades, and I must concede that his China scare is a vintage performance. An uninitiated reader will be swept along by Brown's apparently seamless arguments and could easily believe that the author merely follows an inexorable flow of history. This is not, fortunately, the case, and I will deconstruct Brown's scenario by reviewing first the reasons for concern and then by outlining a number of realistic options and opportunities which may lead to much more satisfactory outcomes.

Why worry?

The answer lies in a combination of several major concerns. Certainly the most important ones are: the continuing increase of China's population accompanied not just by a relative decrease of arable land but by major absolute losses of farmland; the country's rapid dietary transition driven by very high rates of economic growth; widespread environmental pollution and ecosystemic degradation; and declining productivity of farming inputs; and above all, falling yield response to intensifying applications of synthetic fertilizers.

I will note just a few key relevant facts illustrating these trends. In spite of its relatively highly effective population controls -- some countries would view them enviously and many observers would remark on their coercive components -- the absolute rate of annual population increase is at historically high levels, and will not decline appreciably at least for another decade. With an annual growth rate of just 1.1 percent, China is well below the Indian level (now at about 1.9 percent), but that rate translates to almost 25 million new births a year, and to the net increment of more than 13 million people. Continuation of these annual increments will add more than 300 million people in a single generation, more than the combined populations of the United States and Canada today.

Obviously, merely maintaining the existing food consumption rates will call for at least 1.1 percent increase in annual grain harvests (or currently close to 5 million tonnes (Mt) a year), but if the food supply is to keep up with rising expectations, the actual rates will have to be much higher. Moving up the food chain -- that is eating directly less staple grain, but more meat, fish, eggs, and dairy products, and also more plant oils, fruits and vegetables, and drinking more alcoholic beverages -- has been a universal trend clearly discernible in all modernizing countries with rising personal incomes.

China is no exception. As already noted, major per capita consumption increases since the early 1980s have already brought its dietary pattern much closer to East Asia's three richest economies -- Japan, South Korea and Taiwan. Potentially, there is still quite a distance to go.

Consumption surveys show that the expenditure elasticities for rice and coarse grains are declining throughout China, but those for wheat, meat, alcohol and vegetables are increasing. And then there is the matter of large regional disparities: national means are impressively high because coastal provinces in general, and their large cities and periurban areas in particular, may be at par with Taiwan, but average diets are still barely adequate in at least half a dozen inland provinces.

Rising demand for meat and alcoholic beverages easily allows us to foresee a doubling of grain needed for feed and fermentation during the next 10 to 15 years. More specifically, advancing Westernization of urban diets will push up the demand for wheat, sugar and oils. At the same time, increased production will have to come from a shrinking amount of farmland.

Much like the dietary transitions, losses of farmland are a global phenomenon, and a long-standing Chinese problem. Official statistics show the country's farmland peaking in 1957 at 111.83 million hectares (Mha), and then declining to just above 95 Mha by the late 1980s. Given the country's intervening population increase, the average farmland availability was more than halved, from about 0.18 to just 0.08 ha/person (for comparison, Canada's mean is about 1.7 ha/capita).

Rapid post-1980 modernization brought a spate of new rural and urban housing construction, unprecedented expansion of export-oriented manufacturing and transportation links. New peasant houses are rarely built on sites of old structures; new factories usually take over highly productive alluvial land; and government policies promote an American rather than Japanese approach to intercity transport: freeways instead of rapid trains. Not surprisingly, annual farmland losses have averaged at least half a million ha since 1980, mostly concentrated in rapidly developing coastal provinces.

Environmental pollution accompanying China's industrial and urban expansion is both widespread and severe. China is now the world's largest consumer of coal, producing more SO₂ and particulate matter than all of Europe outside Russia. More than 80 percent of its waste water is discharged without treatment. Inevitably, this air and water pollution affects soil quality and crop yields in most periurban areas.

Degradation of ecosystems has an even greater impact, with damage including extensive soil erosion, silting of reservoirs and irrigation canals, and aggravated flooding due to reckless reclamation of wetlands and filling of lakes. My systematic, and necessarily incomplete, survey of the economic costs of China's environmental pollution and ecosystemic degradation shows that they are equivalent to about one-tenth of the country's annual GDP.

And, as anywhere else, rising rates of fertilization bring lower yield responses. This is particularly obvious in coastal provinces, where nitrogen applications in triple-cropped fields average 300 kg N/ha and in many localities surpass 500 kg N/ha, levels comparable only to those in the Netherlands.

Reasons for better prospects

A closer look at this combination of negative factors reveals a number of reasons for much more hopeful scenarios. Surely the most obvious one is that Brown got some basic facts (not interpretations, just facts) quite wrong. Just as he was saturating the media with his catastrophic tales predicated on the conclusion that China is losing its capacity for higher food production and that its grain harvest will never surpass the 1993 level, China announced a new record yield of 466 Mt of grain in 1995, 10 Mt higher than the previous high in 1993. And before the severe flooding in the Yangzi basin, the Ministry of Agriculture expected another record harvest of summer grains in 1996, and a new record of about 471 Mt for the whole year. Unfortunately, I have not heard Brown pointing out these facts!

No less important is the fact that China's farmland scarcity is nowhere near the level observed in neighbouring South Korea, Taiwan and Japan (according to Brown, China is destined to follow its neighbours= increasing dependence on food imports). The 95 Mha official total of China's farmland, proffered by the State Statistical Bureau, puts China's per capita mean of arable land below the Bangladeshi average. But this figure is wrong. Estimates as high as 150 Mha were offered on the basis of LANDSAT images, and detailed sample surveys of the late 1980s came up with the range of 133-140 Mha.

Disputes among various Beijing bureaucrats have so far prevented the adoption of a new official total, but two totals have come up most frequently during the past two years: 133.4 Mha and 122.2 Mha. Even the lower total would prorate to about 0.1 ha per capita, more than twice that of South Korea and Taiwan and three times as high as the Japanese mean. Again, Brown could not spare even a small note to acknowledge this reality and stuck to the official figure of 95 Mha although anybody following Chinese affairs closely has known for more than a decade that this total is wrong.

Not surprisingly, provincial differences in the land undercount are considerable, with the poorest interior provinces reporting less than a third of actually farmed land, and with provincial totals as high as 2 Mha in Heilongjiang, a major wheat and soybean area, and in Sichuan, China's most populous province. Naturally, substantial underestimates of cultivated land combined with much less inaccurate harvest figures mean general overestimates of crop yields.

The difference is smallest for rice, (between 5-10 percent), and largest (about 40 percent) for corn. This means that China's average grain yields are still much lower than the Korean and Japanese means, and that the country has even more room to improve crop productivity by using additional inputs, better agronomic practices and prices reflecting better real costs of production.

One does not have to be an economist or an agronomist to be struck by the absence of any price considerations in Brown's analysis and by his unwillingness to acknowledge the often surprisingly large impact of relatively simple technical fixes. For example, when he notes that the supply of irrigation water is tight in many places, his conclusion is that it must inevitably get worse in the future.

But Chinese farmers, much like their California counterparts, have been enjoying enormous irrigation subsidies, paying less than a tenth of the real cost of delivered water and on average wasting more than 60 percent of it! Could Brown not at least acknowledge that higher prices might do something for the field efficiency of irrigation?

A single example illustrates the potential of simple technical fixes. A near-perfect scheduling of irrigation can be done by burying gypsum blocks containing two electrodes at a few places in the root zone. As the blocks absorb and lose moisture at a rate very similar to that of the surrounding soil, regular measurements of changing current flow give reliable indications of soil moisture.

Benefits include not only considerable water savings but also higher crop yields as plants avoid being stressed by either too much or too little moisture. There is no insurmountable obstacle that prevents China's average irrigation efficiency from increasing by 40 to 50 percent; even then it would be just above 50 percent, well below realistically achievable performance.

Fertilizer applications offer equally impressive examples for great efficiency opportunities. Major gains in fertilizer efficiency would result from gradual dismantling of small fertilizer factories that make ammonium bicarbonate. This compound still accounts for about a third of China's total output of synthetic nitrogenous fertilizer, but high volatility combined with shoddy packaging means that a large amount of the nutrient is lost before it is applied to the fields. This, and the underestimated farmland, mean that actual applications of nitrogen are much lower than implied by official statistics. Hence the potential to raise yields by higher fertilization is commensurably higher.

The other rewarding path to higher fertilizer efficiency is to get the N:P:K ratios right. While the worldwide mean is now about 100:44:28 (and the Canadian average is roughly 100:47:24), Chinese applications have been chronically deficient in both P and K. The nation-wide ratio is 100:33:10 with much higher imbalances in many intensively cultivated regions. Needless to say, this chronic excess of nitrogen diminishes the efficiency of nitrogen applications and promotes unnecessarily high losses of the nutrient with a resulting high nitrate burden in China's streams, lakes and ponds and high denitrification rates producing even more N₂O (China is already the world's largest emitter of this greenhouse gas from farming).

Considerations of food prospects have been excessively tilted toward exploring the possibilities of increased supply, with too little attention given to the great opportunities for reducing waste along the whole food chain. China's performance has been particularly poor in this respect. A recent five-year survey of grain losses in leading cereal-producing provinces found that about 15 percent of the crop is lost annually during harvesting, threshing, drying, storage, transport and processing.

Better storage could make a huge difference because China holds extraordinarily large amounts of grain in state and private reserves. The total, long considered a state secret, was claimed to be 490 Mt in 1990 -- more than the combined harvest of all cereals and tubers -- and about six times as high as the U.S. Department of Agriculture estimate (82 Mt), which was in line with standard expectations of setting aside slightly less than a fifth of annual grain consumption.

Table waste in hundreds of thousands of labor-unit mess halls and losses during inefficient animal feeding and wasteful fermentation to alcohol almost double the total of grain losses to more than 50 million tonnes of staple grain equivalent a year. Production of alcoholic beverages is a particularly fine example of waste that could be sharply reduced by relatively simple

technical improvements. Beer brewing and fermentation of a variety of Chinese liquors (usually rice- or sorghum-based) now consume almost 20 Mt of grain a year, and the demand has been going up by about 20 percent a year. But increased alcohol consumption is only a partial explanation for this huge total: most of China's 40,000 distilleries and breweries are small inefficient enterprises where grain consumption is typically 40 percent higher than in state-of-the-art factories.

Raising the efficiency of meat production is another area of potentially large rewards. The overwhelming majority of China's pigs are still not fed well-balanced mixtures. Their diet consists of just about any available edible matter, feed that is often deficient in protein. Not surprisingly, an average Chinese pig takes at least twice as long to reach slaughter weight as a typical North American animal (a year rather than six months) and even then its carcass is about 40 percent lighter. Likewise, the hundreds of millions of chickens roaming the country's farmyards take three times as long to reach a lower slaughter weight than our broilers. Widespread availability of proper mixed feeds and better breeds could lower today's feed/meat ratios from well over four to just over three for pigs, and from much above three to just over two for chickens.

I do not want to offer any detailed quantitative forecasts spanning the next generation. Such figures are easy to generate, but even if they come from simplistic linear regressions of complicated feedback models, they inevitably turn out to be wrong. But it is easy to do a series of calculations showing that a combination of very modest improvements in potential yields of new cultivars (particularly rice and corn), improvements in the efficiency of basic agricultural production inputs, and improvements in investments designed to eliminate and moderate the worst forms of environmental degradation could keep the country basically self-sufficient in food supply for at least another generation.

Obviously there is no room for complacency and for simplistic faith in the automatic efficacy of technical fixes. Fortunately many Chinese agricultural scientists and some decision-makers are well aware that keeping China well fed largely through domestic efforts will require a continuing commitment to specialized education and scientific research, to sensible pricing, to higher quality of basic inputs, and to effective environmental protection, and that only a combination of such measures will bring long-lasting benefits.

That such basic self-sufficiency might also go along with increased purchases of feed grain, meat and edible oils on the world market is surely no reason for concern. A China that imports twice as much food as it does today will not destabilize the global agricultural trade. In fact, its long-term commitment to substantial imports may be welcomed by North American farmers, economists and politicians concerned about China's large and rising trade surplus with both the U.S. and Canada.

The global grain market, now moving about 200 Mt a year (mostly as corn, wheat, barley and rice) should have no great difficulty accommodating orderly increases in China's imports. Canadian producers should be major beneficiaries of this trend, and not only in terms of grain exports. As the combination of China's rising affluence and growing urbanization increases the demand for baked goods, alcoholic beverages, lean meat and dairy products, Canadian farmers and agribusinesses could supply high quality bread wheat and malting barley and better cereal, legume and oil cultivars, better breeds of broilers, pigs and dairy cows, and better know-how for more efficient field farming and animal husbandry, as well as for food processing, storage and distribution.

In the Chinese language the word crisis, weiji, is made up of two characters -- the first meaning danger and the second meaning opportunity. Few great challenges facing modern civilization embody better this dynamic unity than China's continuing quest for an expanded food supply.

Catastrophists dwell, not without a great deal of justification, on the first half of the whole -- on the dangers weakening China's capacity to feed itself. But by largely neglecting the second half, opportunity, they offer a distortion of a much more complex reality. They leave out the dimension that completes the image by going beyond apprehension and scare tactics and reveals the opportunities renewing realistic hope. China in the early 21st century may find it very difficult to meet these expectations, but there appear be no insurmountable biophysical, agronomic or technical limits preventing it from doing so.

REFERENCES

- Becker, J. 1996. *Hungry Ghosts: China's Secret Famine*. John Murray, London.
- Brown, J.L. 1987. Hunger in the U.S. *Scientific American* 256 (2): 37-41.
- Brown, J.L. 1994. Who Will Feed China? *World Watch* (newsletter of the Worldwatch Institute), also *Washington Post*, Aug. 24, 1994.
- Brown, J.L. 1995. *Who Will Feed China? Wake-up Call for a Small Planet*. W.W. Norton & Company, New York.
- Buck, J.L. 1937. *Land Utilization in China*. University of Nanking Press, Nanking.
- Chan, L.Y. 1994. China: rice market reforms. *Food Policy* 19: 367-379.
- Crook, F.W. 1995. 1995 China Trip Report. USDA, Washington, DC.
- Edmonds, R.L. 1994. *Patterns of China's Lost Harmony*. Routledge, London.
- Fan, S., G. Cramer and E. Wailes. 1994. Food demand in rural China: evidence from rural household surveys. *Agricultural Economics* 11: 61-69.
- Huang, J., S. Rozelle. 1995. Environmental Stress and Grain Yields in China. *American Journal of Agricultural Economics* 77: 853-864.
- Ke, B. 1996. Grain Production in China. Paper presented at Harvard University Conference, Cambridge, MA, March 1, 1996.

- Kung, J. K. 1992. Food and Agriculture in Post-Reform China: The Marketed Surplus Problem Revisited. *Modern China* 18: 138-149.
- Livernash, R. 1995. China and India Shape Their Destinies. *Environment* 37(6): 6-11, 25-34.
- Paarlberg, R.L. 1996. Rice bowls and dust bowls. *Foreign Affairs* 75 (3): 127-132.
- Prosterman, R.L., T. Hanstad and Li Ping. 1994. Reforming China's Rural Land System: A Field Report. Rural Development Institute, Seattle, WA.
- Prosterman, R., T. Hanstad and Li Ping. 1996. Large-scale Farming in China: An Appropriate Policy? Rural Development Institute, Seattle, WA.
- Riskin, C. 1995. Feeding China: the experience since 1949. In: J. Dreze, A. Sen and A. Hussain, eds. *The Political Economy of Hunger*, Clarendon Press, Oxford, pp. 401-444.
- Rozelle, S., Huang, J. and M. Rosegrant. 1996. Why China will not starve the world. *Choices* 11: 18-22.
- Smil, V. 1993. *China's Environmental Crisis*. M.E. Sharpe, Armonk, NY.
- Smil, V. 1995. Who will feed China? *The China Quarterly* 143: 801-813.
- Smil, V. 1996. Barriers to a sustainable China. In: D.C. Pirages, ed. *Building Sustainable Societies*, M.E. Sharpe, Armonk, NY, pp. 175-187.
- Smil, V. 1996. *Environmental Problems in China: Estimates of Economic Costs*. East-West Center, Honolulu, Hawaii.
- Tyson, A. and J. Tyson. 1996. China's human avalanche. *Current History* 95: 277-283.
- U.S. Department of Agriculture. 1996. *China Situation and Outlook Series*. USDA, Washington, DC.
- Webb, S.H., A.J. Webb and W.T. Coyle. 1992. China's food consumption and production patterns in the year 2000: Implications for trade. In: *China Agriculture and Trade, July 1992*, USDA, Washington, DC, pp. 38-45.

Centre for International Programs
Guelph, Ontario, Canada
N1G 2W1
(519) 824-4120 ext. 4876
© 2000 University of Guelph

