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Sustainable Agriculture in China

The original Green Revolution started more than 50 years ago, and has saved over 1 billion lives around the world. Norman Borlaug used his experience in biology and plant pathology to develop ways to breed high-yield seeds and isolate particular traits in a short period of time. The resulting movement, widely called the Green revolution after the 1960's, incorporated breeding, chemicals, and irrigation to double world food production. Since this accomplishment, the world population has risen past six billion, possibly reaching nine billion within a few generations. China currently holds over one billion of the world's population, yet has limited land and resources; future food security is jeopardized without a change being made to the system used today. Water shortages in the North force farmers to draw groundwater, something replenished only by the already low levels of rain. The increased strain on the existing food infrastructure and environmental limitations now calls for a second Green Revolution lead by the best international research. The new wave of agricultural research will allow poor rural areas in countries like China experience better health and efficient use of natural resources. As many development projects in developing countries rely to some extent on the support of developed countries, any changes must appeal to powers inside and outside of the country. North America and Europe have active trade with China, and influence the country. Recent trends in the attitude towards genetically modified crops might hinder the spread of this valuable resource to developing countries, particularly if they want to export crops to North America or Europe, or receive funding for related projects. Changes in the crops used, through breeding or gene-splicing, are necessary to increase yields in conditions of threats from insects, weeds, and a changing climate. Global warming, as a result of increased carbon dioxide levels, will create lower yields unless both carbon output and crop traits are corrected. To insure practical and efficient use of farmland, laboratories around the world must work on increasing net yields of all crops in all regions without use of toxins or limited resources. With research and action, the food security of the world will be strengthened.

The large size of China creates a problem, as small family farmers in mountainous and Midwestern areas are currently in need of resources, mainly for accessibility and irrgiation. Most of the impoverished people in China live outside the cities, and sparsely populated areas limit access to resources. China's low income families are important when considering food security, as many of the rural farm families are in danger of extreme poverty. About 30 million people are considered extremely poor, but 80-160 million people now face the risk of slipping from the low-income category to the extremely poor category. 100 million of the rural farm workers are currently unemployed, and the government is working to fight further degradation of their status. Many family farms in China are smaller than the small American farms, and farmers are now under increasing tension with a growing population in the cities and the entire country.

The agricultural situation has improved dramatically over the last ten years in China. Today, China has a sufficient food supply, with a higher meat and grain output per capita than most developing countries. China uses a system of grain reserves to buffer low harvest levels, yet grain consumption has outpaced domestic grain production, according to the Chinese Ministry of Agriculture. The production/consumption gap now averages around 2.5-3.5 tons per year, with a total demand of around 500 million tons pre year. If China's population increases by 500 million, and soil erosion continues at the current rate, China will need to import an additional 200-400 million tons of grain a year by 2050. China has experience with food security, and both farmers and the government have kept respective food stockpiles to offset production trends. This dependable method may become insufficient in the near future: China faces distribution problems, grain quality issues, and aging warehouses.

Chinese farmers currently produce almost all of the county's grain. The average nutritional Calorie intake for a Chinese citizen is 2,766, with 1,646 of these Calories coming from grains, or 60%. The Chinese farmer is clearly important to the nutritional health of the citizens. With millions of tons of maize and rice diverted to animal feed, the output of grains must either be increased or diverted to continue to supply over half of China's diet. Because energy, as Calories, is lost from the grain when it is fed to animals, direct human consumption is a more efficient use of a food crop. For example, a bushel of grain could either go to bread or meat. The transition to bread would lose few Calories and would provide nutritional fiber and complex carbohydrates, as opposed to sugars. Meat needs more energy to form, and only provides protein and fats, substances that can also come from grains and vegetables. With limited crop and farmland, the most efficient paths to nutritional consumables must be used.

China may have a satisfactory supply of food now, but the population will increase by more than half a percent this year, with an overall upward trend. The current population is around 1.323 billion (as of 1 August, 2006) with over 30 million more men than women. This constant growth on a limited amount of usable farmland will increase China's reliance on foreign imports of grain. This reliance on imports is expected to grow- from 1994-1996, the net imports of grain alone increased by 3.5 tons per year. The increased use of grain as food for livestock also reduces the supply. For the same period of 1994-1996, 4.6 million tons of rice were used to feed livestock. 80% of the maize crop, or 91 million tons, now feeds livestock in China. These figures came from a Food and Agricultural Organization report comparing China's agriculture from 1964-66 to the contemporary period of 1994-1996, as the government changed the agricultural policy in 1978 to favor farmers.

In 2005, a team of MIT scientists, backed by the Alliance for Global Sustainability (AGS), decided to calculate the possible production capacity for China as it is now and with a system of sustainable irrigation. With all farmland values constant (no increase or decrease in acreage), and farmers pumping groundwater in dry regions, it was projected that China could feed between 1.1 and 1.7 billion people (1.3 billion is the current population). The lack of water in northern regions forces farmers to pump groundwater, which depletes the groundwater over time, jeopardizing the environment. With a sustainable irrigation plan, China's production could increase with a higher number of planting cycles, and feed 1.3 to 2.0 billion people. The wide range of .7 billion represents the uncertainty of the cropland area, something the AGS team is working on. With the United Nations 2030 Chinese population estimate of 1.6 billion, these scenarios demonstrate the potential conflict of China's current farming methods and the population the farmers must feed.

As global warming becomes a significant factor in Earth's future, the addition of carbon dioxide and related factors may prove hazardous to China's future. Although CO2 will raise the temperature of the atmosphere, some scientists believe it will also add to the photosynthesis of plants, thus reducing the loss of fertility. The increase in CO2 in the air is tested in carefully controlled greenhouses, but some scientists consider these tests inaccurate because of the environmental variables of a field. The Free-Air Concentration Enrichment project used large fields to conduct open-air testing. The results were not encouraging: real-world testing showed a halving of the fertility rates derived from greenhouse testing. Along with increased levels of CO2, scientists believe ozone (O3) will also increase at ground level with the rise in temperature. As ozone is a poisonous gas at ground level, a 10% increase in O3 levels decreases yield by 10%, making it clear that global warming and increased carbon dioxide levels will not help world food production.

The scientific methods of the 1950's and 1960's introduced widespread use of chemical fertilizers, herbicides, insecticides, and fungicides, along with highly specialized fertile seed varieties, all allowing farmers to increase yields and cut damages. At the same time of these agricultural developments, the significance of genetics emerged. Researchers found how enzymes, genes, and replication changed deoxyribonucleic acid in heredity, cloning, and various anomalies such as cancer. By the 1980's, scientists had a clear view of how changes to genes produced changes in organisms, popularizing a public view of cloning, DNA research, and modified organisms. With the recent development of Genetically Modified (GM) crops, the revolutions in agriculture and genetics have merged to create higher yields, efficiency, and damage resistance. By suppressing, splicing, and replicating genes, scientists can introduce traits in crops like increased resistance to pests, herbicides, and climate and soil factors.

An example of the merging fields is the development of Newleaf, a GM potato produced by Monsanto of St. Louis. This potato controls Colorado potato beetles and aphids with encoded toxins from *B. thuringiensis*, a bacteria. This toxin was chosen because it affects plant pests without harming birds, mammals, and fish- a unique opportunity to control insects while ensuring the safety of the product and the environment. In addition, ORF-1 (open reading frame 1) and ORF-2 regions from potato *leafroll luteovirus* (PLRV) were later added to increase resistance to PLRV infection spread by the aphids, strengthening the plant's characteristics. This new potato plant (now Newleaf-Plus) was approved for use in food and animal feed in 1998, and has shown a reduction in farm chemical use, while increasing yields. Farmers noted the product seemed safer because of low chemical use and the reduced levels of toxins in the soil. Technologies like Newleaf holds a promising future both on the farm and downstream. Economically, the product gave farmers higher yields for the money spent on the crop. To grow a crop without chemicals shows the large amount of damage faced by the plants. Organic farming, without synthetic pesticides, yields around half as much yeild as conventional (chemical) methods.

The current trend in developed nations, particularly North America and Europe, is to limit the use of genetically modified consumable products. The negative attitude faced by Genetically Modified organisms has caused global companies as Gerber and McDonald's to remove these products from their food. To do this, major distributors, like J.R. Simplot in the case of Newleaf, inform farmers they will no longer accept GM crops or animals fed with GM crops. Farmers are forced to switch seed or find a new distributor. Crops like Newleaf were not distributed, and many have been discontinued. Newleaf is no longer grown commercially. This trend is dangerous to developing countries. Many products imported into North America, like coffee, tea, and other foods are cash crops in developing countries. To increase yields on shrinking farmland, new high-yield crops, possibly genetically modified crops, should be planted. If the same distrust s put into GM coffee as GM potatoes, developing countries across the world would have to switch to un-altered crops or find new buyers. The reduced use of pesticides is critical to the health of China's farm workers and consumers. According to the United Nation's Food and Agriculture Organization, "normal" use of the pesticides parathion and methamidophos is responsible for some 7,500 pesticide poisoning cases in China each year. Reduction or elimination of these chemicals is critical to the continuation of China's strained food production.

The distrust in genetically modified crops is becoming dangerous to farmers and consumers. In the specific case of Newleaf, farmers noted how safe growing the plants was for them and the environment. Farmers now must use chemicals like methamidophos, an organophosphate nerve poison for aphids. This product is currently considered safe, but there is a strong chance the EPA may repeal this status. If this product spread over to farm workers, they could legally sue for personal damages. If the product leaked into bodies of water, state agencies could bring an administrative action to cover the loss from a fish kill. Fish kills from potato fields are common in potato growing areas, sometimes over a dozen cases a year. Consumers are put under a risk because of the potential safety of their food. GM crops may fight off specific threats such as fungus, and reduce the chance of exposure to toxin. Many of these threats are undetectable, and food companies put themselves at risk by not allowing the improved version of their product, along with its reduced risk. If a consumer of Gerber products develops a neural tube defect such as spina bifida, from the use of neurotoxin pesticides, the company may face legal action, lost cash from settlements, lost revenue, and diminished public image. This risk is not limited to North American companies; Bayer of Germany is currently handling mysterious traces of GM rice, tested only in America, found in European distribution centers and German stores (Aldi). The mistrust is often called the Frankenfood myth, or Xenogenophobia. The public conception of ‘bad’ GM products does not reflect the reality; bacterial outbreaks of *E. coli* and *Salmonella* kill people, yet consumers still put themselves at risk with improperly cooked and cleaned foods. Consumers would be alarmed at the amount of product recalls a year from something natural, like insect parts detected by microscopic examination; and fungus-bacteria and fungi can introduce toxins that are not denatured or removed with cleaning or cooking.

The Green Revolution has saved over a billion lives. Proper maintenance of both population and food production will insure that people also live better, with the higher incomes, life expectancies, and overall quality experienced by such a small part of the world today. China’s food production relies largely on limited farmland and limited production capacity under the current methods. The strain of food production for the country is placed on farmers with a status so low they are on the verge of poverty or extreme poverty. These farmers try their best to support the country with grain stockpiles, but China still consumes slightly more grain than it produces. With China’s population on the rise, grain imports will increase without a change to yields or consumption. With 60% of an average citizen’s diet coming from grains, this area is worth targeting with efforts to increase yields. By diverting crop yields away from animal feed and towards direct human consumption, China will get more out of its current and future grain production. China is working on slowing the rate of its population increase, but in the near future it will still increase by more than 1% a year. China will need to feed this additional population even more per person to sustain or increase the quality of life. The low status of farmers around the world suggests a discrepancy between the true value of food and the amount paid to the producers. With the growing energy consumption, unusually high levels carbon dioxide, carbon monoxide, and sulfur effect our environment. Global warming trends from this production will limit change the climate and atmosphere, reducing yields. Toxins like chemicals and heavy metals effect the soil and water, upsetting the environment and the production of crops. To reach higher yields, the world must reduce things that effect it negatively and increase positive trends. Genetic manipulation increases yields by targeting positive and negative traits of a crop to achieve higher efficiency from each seed and each acre. Genetic manipulation reduces the amount of chemicals introduced into our food and environment- many of these chemicals harm both plants and animals. The distrust in this new science has caused consumers in developed countries to fight the spread of GMO’s into their food. The distrust in GM products has the negative effects of improper chemical use throughout the world and limits the ability of a developing country to expand possibilities and yields with this useful technology. To insure the continued increase in yields, well-funded and careful research must continue into modified and non-modified crops, and through methods safe to consumers, researchers, farmers, and the environment.

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