R. E. Ford, University of Illinois, Urbana, with **H. L. Bissonnette, J. G. Horsfall, R. L. Millar, D. Schlegel, B. G. Tweedy, and L. G. Weathers**

Plant Pathology in China, 1980

Many teams of U.S. scientists (eg, experts on germ plasm, biocontrol, soybeans, and wheat) have gone to China and many from China have come to the United States (5). Kelman and Cook (4) published an assessment of plant pathology in China based on two separate trips. Our observations provide an update to these earlier accounts. Since others have published production figures for various crops, our group concentrated on the qualitative nature of weeds, diseases, and insects.

The Second Step

Our trip was the second step of an exchange between plant protection scientists in the United States and China. The first step was taken in 1979 when nine scientists were sent by the Chinese Plant Protection Society to the IXth International Congress of Plant Protection in Washington, DC. The delegation toured U.S. institutions for a month thereafter.

On our trip, we were the guests of the Chinese Plant Protection Society. The members of our team were weed scientists Fred Slife of the University of Illinois and David Bayer of the University of California at Davis; entomologists Ed Glass of Cornell University and the New York Agriculture Experiment Station, Geneva, and Keith Chapman of the University of Wisconsin; and plant pathologists Richard E. Ford of the University of Illinois, Howard Bissonnette of the University of Minnesota, Roy Millar of Cornell University, Ithaca, NY, David Schlegel of the University of California at Berkeley, Lewis G. Weathers of the University of California at Riverside, James G. Horsfall of the Connecticut Agricultural Experiment Station, and our team leader, Bill Tweedy of Ciba-Geigy Corporation, Greensboro, NC.

Our objectives were to: 1) give lectures to plant protection scientists in China, 2) hold discussions with plant protection specialists, 3) review agricultural research, education, and production practices as they relate to plant protection, and 4) define a proposed program for future cooperative activities with Chinese institutions concerning plant protection. When we met with Vice-Premier Wan Li at the People's Great Hall (Fig. 1), he added a fifth objective: to submit a report to the Ministry of Agriculture evaluating agricultural education, research, and production in China and making recommendations for improvements. This last objective is turning out to be a most difficult task.

One Month to Visit

Contrasted with the situation in China, each of us was an individual ambassador of his own state and university, not of the U.S. government, and each of us provided his own plane ticket to China. It was difficult for the Chinese to conceive of our scientific societies operating separately from the federal government. The Chinese Ministry of Agriculture, Academy of Science, and various provincial institutions provided our in-country expenses.

We visited communes, state farms, universities, research institutes, and other organizations located in or near Beijing, Nanjing, Shanghai, Hangzhou, and Guangzhou (Fig. 2). Each member of our delegation made presentations and led discussions at each location. The Chinese were very open with us, and our discussions were most productive.

We witnessed a society that long has been based on hard work, hand labor, and self-reliance. We were in a country just recovered from the catastrophe of the 10-year reign of terror by the "Gang of Four." This was part of the so-called cultural revolution. Many scientists openly discussed these times. These ingenious inventors of gunpowder, porcelain, movable type, cast iron, and the wheelbarrow have survived the cultural revolution and are working hard to regain the base of a decade of actions catastrophic to research and education.

We traveled a country that holds nearly 25% of the world's population, with over 80% living in rural areas. The amount of arable land is about the same as in the United States and seems to be sufficient to feed the people quite well.

Production could be increased through improved crop management and better pest control practices. Although this statement could apply to any country, in China we visited several areas where production had decreased during the past few decades. China clearly has the talent and structure for increasing agricultural production. We observed a vast array of crops and crop sequences in China—from the native soybean and rice to the recently (A.D. 1511) introduced maize (3)—growing in systems quite novel to Americans. Because one month was not long enough to view all of China's agriculture, we were unable to see the prime corn, wheat, and soybean production areas.

On the Commune or State Farm

Our travels were limited to the eastern seaboard of China (Fig. 2), from Beijing (Peking) to Guangzhou (Canton). We were most interested in crop productivity and the impact of pests and other practices on crop production. It was difficult to obtain kg/ha production figures because of the way the Chinese interplant and double- or triple-plant crops. We observed no starvation, only seeming health. Some analysts have calculated that per capita production remains at about 290 kg, compared with over 300 kg in the 1930s, even though the total annual grain harvest reportedly has increased by one-third since 1957.

Each commune or state farm has a

Part of the famous nine-dragon wall in the Forbidden City, now the Palace Museum in Beijing.

plant protection team as a part of a crop production brigade. One person in that unit is paid by the province, the others by the commune. One farmer in each brigade and production unit is responsible for crop protection. The farmers rely strongly on a nationwide pest and disease forecast system to warn of potential problems. The system's key function is to provide help and advice on all matters of crop protection, quarantines, cultural practices, crop rotations, and pesticides. The system advises about and may help breed and select crop varieties that will resist disease and pest attack and also suggests pesticides or pest control practices and appropriate timings. Communes request the purchase of specific pesticides from the Ministry of Agriculture, which pools all requests and decides which pesticides to purchase nationally.

The leader of the plant protection team on each commune has some formal university education, sometimes to the B.S. degree level in the Chinese educational system. The leader attends county meetings to receive information, training, and education from the provincial official responsible for pest control. Provincial officials obtain their information directly from university, academy, and research institute scientists during workshops and/or in-house training sessions. This approximates our extension system.

The plant protection department in universities, academies, and institutes in China traditionally is a single discipline that includes plant pathology and entomology. Weed science is traditionally studied in production (agronomy) departments, and thus weed control is often handled by teams separate from those for disease and insect control.

Accent on Applied

Research and education in plant pathology and other plant sciences have concentrated on applied aspects to help China recover from many years of war and meet food demands. Both before and after the cultural revolution, research has been published primarily in leaflets or pamphlets and rarely in journals. Such journals as *Acta Phytophysiologica Sinica*, *Acta Phytophylacica Sinica*, and *Acta Phytopathologica Sinica* are again being regularly published after a 10-year absence. Many scientists are "catching up" by publishing an accumulation (or synopses) of their research of the past 10–20 years. Tang (6) appropriately calls the period after the "Gang of Four" was thrown out in 1976 the "new long march."

The overall policy of science and technology is determined by the Science Commission, State Council, People's Republic of China. Agricultural research priorities are determined by the Bureau of Science and Technology under the Ministry of Agriculture, which consults with the Bureau of Plant Protection. Both bureaus have certain coordination with the Academy of Agricultural Sciences, universities and various research institutes, and the Chinese Plant Protection Society. The Chinese Phytopathological Society has been reorganized since the revolution and is now a member of the all-inclusive Association of Agriculture of the People's Republic of China. It is one of 20 scientific societies under the Chinese Association of Agricultural Sciences and associated with the Ministry of Agriculture.

An Educational Reawakening

When the cultural revolution began in 1966, most universities and many academies and research institutes were closed. Professors and scientists were sent directly to rural areas to do hand labor, and the research and technological system was destroyed. Our limited observations suggested that very few plant pathologists had an opportunity to be involved in disease control work. Scientists were deprived of their personal libraries and notes, and many of these materials were destroyed while the scientists were working on rural assignments. The institutional libraries that were not destroyed were hidden in homes, caves, and remote locations. Scientists quickly fell behind in their specialties.

Currently, most fundamental research is done in the academies of science and affiliated research institutes without a teaching dimension. There is evidence, however, of a gradual effort to link teaching with research and to develop an effective extension program.

The open scientific inquiry familiar to us is not customary in China. The steering committee of faculty and staff chosen by the Communist party makes it difficult to stray from the party line. This may change (many political changes have occurred in the year since we departed China), but the political system does not lend itself to rapid change.

We found a proud, uncomplaining people who openly admitted their need for help, sought our technological and scientific assistance and advice with eagerness, and were grateful for our willingness to spend time with them. The Chinese people are calm and patient and such things as traffic jams and complicated visit schedules, which would severely test our patience, found them even-tempered. They have a refreshing ability to seek consensus and compromise.

The Chinese people desire new knowledge, need current modern technology, and want open contact with the free world. A national plan for making China self-sufficient by the year 2000 includes four "modernizations": 1) agriculture, 2) industry, 3) national defense, and 4) science and technology. Despite a 30-year gap during the "dark ages" in higher education in China, a nucleus of Western-educated professors plus many of their own teachers and scientists are on hand to help guide the educational reawakening of China.

The government is anxious to send young scientists abroad to obtain additional training and advanced degrees. We observed a strong desire by many midcareer scientists to strengthen their scientific backgrounds by studying abroad. The policy of the Chinese government is to send midcareer people abroad for short-term upgrading and younger scientists abroad for postgraduate education.

Prior to 1949, Chinese universities were strongly influenced by Western universities. Following the "liberation," the higher education system of China was drastically altered under Russian influences during 1949–1956. (A Chinese professor who gave a seminar at the University of Illinois in 1980 said that during the 1950s and early 1960s he taught two courses in genetics simultaneously—the Russian-approved course embodying Lysenko's theories and the classical Mendelian course he had learned from Dr. Dobzhansky. He was able to do this because of his special personal acquaintanceship with Chairman Mao.) Teaching and research activities were separated, with teaching done in universities and research done in academies or institutes. Many institutes were established to serve a relatively narrow research need. Chinese authorities are moving away from the Soviet-type academic format. They now emphasize rigorous academic standards, morality, and physical training of students.

From our view, it is unfortunate that "traditional" degrees were not awarded during the cultural revolution and that Chinese agricultural universities were relocated to rural areas and separated from their larger counterparts in metropolitan areas. The broad fundamental training in the "hard" sciences of mathematics, physics, chemistry, and biology—which can be provided best by the liberal-arts-oriented university—is essential to the quality of China's future agricultural scientists. Although we did not examine curricula in all agricultural universities in detail, we saw deficiencies in these areas that preclude easy entry into graduate colleges in the United States.

Restoration and Expansion

At a national convention of science and technology in 1977, a decision was made to begin reassembling the universities and institutes into functional units. Some universities had begun classes in 1979 and some were scheduled to begin in 1980 and others in 1981. Many had to await the building of classrooms and libraries, because some of the previous classroom buildings are used for other purposes and the original libraries have been lost. The Beijing Agricultural University is still awaiting the return of many of its buildings and has lost its field research facilities.

The currently high 1:1 staff:student ratio in some universities, the result of earlier political appointments, will be reduced. All universities will again award academic degrees, which were abandoned during the cultural revolution. Many graduate students and specialists have already arrived in the United States to begin the long road to revitalization of their academia.

The government has ambitious plans to expand higher education. This was abundantly evident in the stacks of bricks everywhere awaiting arrangement into serviceable structures. During our visit with Vice-Premier Fang Yi, president of the Chinese Academy of Sciences, he emphasized quality higher education as the principal means of building China into a modern economic power. Only 1% of the college-age population (about 1 million students) is enrolled in higher education. The intent is to triple enrollment by 1990 and to start 2-year community colleges. This should be easily attainable because even the largest universities we visited were moderate in size according to our standards. The Ministry of Education, however, will limit most campuses to approximately 15,000 students.

Each province has at least one agricultural college and some of the heavily populated ones have more. The seven key agricultural universities or colleges that train and educate plant protection scientists are: Beijing Agricultural University, Nanjing College of Agriculture, Northwest College of Agriculture at Shaanxi, South China College of Agriculture at Guangzhou, Central China College of Agriculture, Shen Yang College of Agriculture, and Zhejiang Agricultural University at Hangzhou.

Beijing Agricultural University opened for its first classes in the fall of 1979. The over 700 faculty include 130 professors and associate professors in 8 departments with 17 specialties. The faculty of plant pathology consists of 4 professors, 4 associate professors, 12 lecturers and instructors, and 3 assistants. The university plans an advanced-level enrollment of 500 M.S. and Ph.D. candidates by 1985. Other major colleges have similar plans. Significant assistance in training and educating Chinese scientists has been offered by the Food and Agriculture Organization (FAO) and the United Nations Development Program (UNDP).

Comparison of Plant Diseases

Crop for crop, most plant diseases that predominate in the United States are also common in China (Table 1). Wilts, root rots, mosaics, and blights were on most of the farms and research stations we visited. Major differences between the two countries in occurrence and intensity were due to cropping and cultural practices unique to China.

Crops and major diseases needing attention in China are, to name a few, wheat rusts, scab, and viruses; rice blight and blast; corn blights and viruses; soybean cyst nematode and viruses; early and late blights and viruses of tomato; cucumber viruses; bean viruses; Valsa canker of apple and peach; apple scab;

Fig. 1. The American Plant Protection delegation in the People's Great Hall, Beijing. Front row (L to R): Howard Bissonnette, University of Minnesota; James Horsfall, Connecticut Agricultural Experiment Station; Vice-Minister of Agriculture Yang; Bill Tweedy (leader), Ciba-Geigy Corporation; Vice-Premier Wan Li; David Schlegel, University of California, Berkeley; Chi-yi Shen; Roy Millar, Cornell University; Lewis Weathers, University of California, Riverside. Back row (L to R): Richard Ford, University of Illinois; C.-S. Tsi; Keith Chapman, University of Wisconsin; Fred Slife, University of Illinois; David Bayer, University of California, Davis; Lian Wang, translator; Ed Glass, New York Agricultural Experiment Station, Geneva; Quang-you Chen, organizer for general arrangements; Wei-fan Chiu; two staff personnel.

citrus viruses; and cotton wilt and angular leaf spot. Wheat scab, for example, is a severe problem because a wheat crop was grown immediately after two crops of rice. We observed tobacco mosaic virus (TMV) so severe in some fields that tomato fruit deformation and yield losses were apparent, whereas little or no TMV symptoms were observed in other fields. Hand-labor operations from transplant to harvest of tomatoes is responsible for all mechanical transmission of TMV to plants.

The soybean mosaic problem is more severe in China than in the United States, whereas the soybean cyst nematode seems to be equally troublesome in both countries. Leaf blights of corn, rice, and wheat are similar; the only difference seems to be fewer genetically resistant varieties in China.

Our general conclusion is that virus diseases cause some of China's most severe problems in vegetable, fruit, and field crops. Rice black-streaked dwarf virus, transmitted by *Laodelphax striatellus* and causing a serious dwarfing disease in rice, was formerly present in epidemic proportions in some provinces, then disappeared, leaving no infected plants even for classroom demonstrations. We are as puzzled as the Chinese scientists about the factors causing its disappearance.

A sample of diseases reported from China and not found in the United States is: late wilt of corn caused by *Cephalosporium maydis,* rust of soybean caused by *Phakopsora pachyrhizi,* scab of soybean caused by *Sphaceloma glycines,* sleeping leaf (brown stripe) of soybean caused by *Septogloeum sojae,* and pod rot or blight of soybean caused by *Macrophoma mame.* A sample of diseases reported from the United States and not found in China is: fire blight of apple or pear caused by *Erwinia amylovora* and Stewart's wilt of corn caused by *Erwinia stewartii.*

The Overall IPM Strategy

Development of effective quarantines is an integral part of an overall integrated pest management (IPM) strategy for both countries (1). The Chinese recognize the importance of controlling pests through quarantine, and China sent a team of specialists to the United States in 1979 to study our practices.

Control programs are more easily integrated in China than in the United States because of the way the principles of pest control are taught to the specialists and because of the way pest control is organized on the communes and state farms. China has an advantage over most countries in integrating pest control because a large work force is already in place making assessments and measurements. We saw some evidence that IPM is effective in many areas.

As a part of the overall IPM program, China recognizes the need for incorporating genetic resistance into commonly grown crops. In fact, China is in a unique position to broaden the germ plasm base in soybean (2) and many other crops. The C-103 inbred is being used to give maize resistance to stalk rot. China does not seem to have a strong, progressive crop variety seed program but is striving to develop one. Although some coordination at a national level exists, each province collects and stores its own germ plasm. Some germ plasm was maintained at personal sacrifice during the cultural revolution (T. Hymowitz, *personal communication*).

Preliminary efforts are under way in disease diagnosis and forecasting. Only an occasional institute has up-to-date scientific equipment for modern research. China appears to use more biological control practices than any other country. Whether such practices are successful is yet to be determined. China has the largest work force of plant protectionists. Specifically, great effort is being expanded to develop efficient biological controls for take-all and scab of wheat, Fusarium wilt of cotton, and anthracnose of apple. The disease information being used as a basis for control tactics and strategies has been available for a decade or longer.

Nematology as a science is in its infancy in China, ie, fewer than 20 nematologists, according to estimates. We were told of plans to increase the number of scientists studying and teaching nematology. Plant protection scientists in China understand the potential damage nematodes cause, but little active research has been done except on *Heterodera glycines.* Even that species has not been characterized as to race composition according to soybean-growing districts. Until that is done, little progress will be made in identifying resistance genes specific to each race and incorporating them into the most productive varieties. China has farmed its

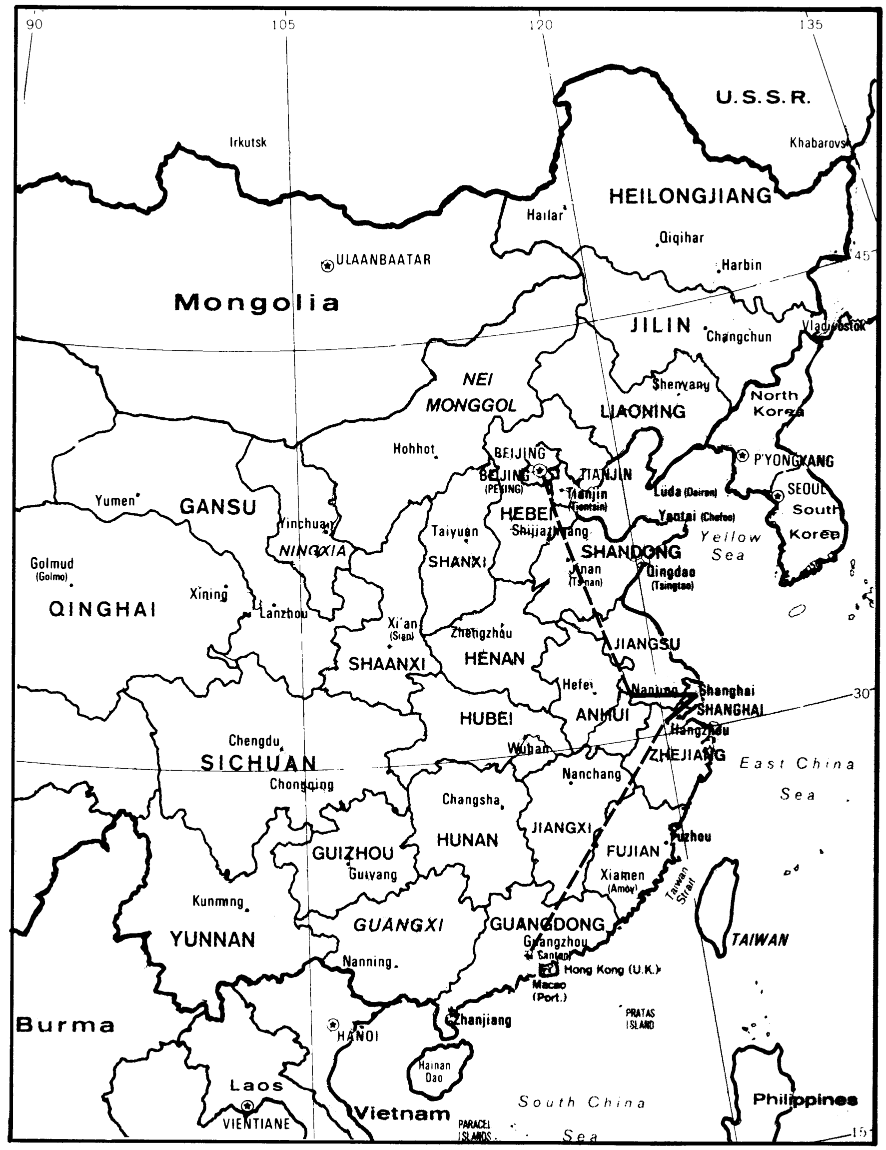

Fig. 2. Travel routes by air (-----) and by rail (——) for the American Plant Protection delegation after their arrival in Beijing.

Some Scenes and Experiences in China

Vegetables are produced intensively year-round on the same land on the Evergreen Commune near Beijing, in the open during the summer and under a plastic greenhouse system in the winter. One-fourth of all the vegetables for the 8 million people in the city of Beijing are grown here.

Under the supervision of a Chinese technician, James Horsfall mixes Bordeaux for control of vegetable diseases on the Evergreen Commune.

Cowpea mosaic virus on beans grown on a trellis over an irrigation ditch to make maximum use of field space on the Evergreen Commune.

Bill Tweedy, leader of the American delegation, at the San Ling Commune near Shanghai, maneuvers the type of machine and trailer used in eastern China to move the majority of produce from farm to market.

Sheath blight of rice on the Jiangning Commune. (Courtesy J. Froyd)

The traditional plowing and cultivating power for preparing rice paddies for another crop on the Jiangning Commune. (Courtesy J. Froyd)

Rice farming near Ding Wu mountain at Guangzhou (formerly Canton). We observed all stages of growth—from paddy preparation and seeding to harvest—on one day.

This aquaduct traversing citrus orchards near Guangzhou supplies irrigation water to both the young, recently planted orchard on the hill in the background and the productive orchard in the foreground.

Table 1. Diseases[a] observed by our group, published by Chinese scientists, or reported by other scientists who traveled in China

Crop	Disease	Pathogen	Province[b]
Adzuki or urd bean (*Phaseolus mungo*)	Mosaic	Cowpea mosaic virus	10
	Rust	*Uromyces* sp.	17
Apple (*Malus sylvestris*)	Mosaic	Apple mosaic virus	12
	Crown gall	*Agrobacterium tumefaciens*	12
	Powdery mildew	*Podosphaera leucotricha*	12,13
	Leaf spot	*Marssonina mali*	7,12,13
		Phyllosticta pirina	12
	Canker	*Valsa mali*	10,12,13
	Rust	*Gymnosporangium yamatae*	12
	Ring rot	*Physalospora piricola*	5,7,12,13
	Bitter rot	?	10
	Fruit rot	*Sclerotinia fructigena*	12,13
		Glomerella sp.	5,7,12,13
	Anthracnose	*Neofabraea malicortis*	10
	Rough skin	?	10
Asparagus bean (*Vigna sesquipedalis*)	Mosaic	Cucumber mosaic or cowpea mosaic virus	10,12
	Rust	*Uromyces appendiculatus*	12
Banana (*Musa cavendishii*)	Bunchy top	Mycoplasmalike organism	1
	Mosaic	Cucumber mosaic virus	1
Barley (*Hordeum vulgare*)	Covered smut	*Ustilago hordei*	16
	Loose smut	*Ustilago tritici*	16
	Barley stripe	*Helminthosporium gramineum*	16
	Scab	*Gibberella zeae*	16
	Yellow mosaic	Barley yellow mosaic virus (soilborne)	16
Bean (*Phaseolus vulgaris*)	Rust	*Uromyces phaseoli*	1
	Mosaic	Bean common mosaic virus	10,12
		Cucumber mosaic virus	12
Broad bean (*Vicia faba*)	Mosaic	Broad bean mosaic virus	16
	True mosaic	Broad bean true mosaic virus	16
	Common mosaic	Broad bean common mosaic virus	16
	Mottle	Broad bean mottle virus	16
Chestnut (*Castanea mollissima*)	Blight	*Endothia parasitica*	7
Chinese cabbage (*Brassica chinensis*)	Ringspot	Tomato ringspot virus	16
	Mosaic	Tobacco mosaic virus Holmes, Ribgrass strain	7,16
		Raphanus mosaic virus	1,12
		Cucumber mosaic virus	10,12
		Tobacco mosaic virus	1,3,10,15
	Kwuting	Turnip mosaic virus	1,10,12
	Downy mildew	*Peronospora parasitica*	7,10,12**,18
	Soft rot (bacterial wilt)	*Erwinia carotovora* var. *carotovora*	7,10,12**,18
	Black rot	*Xanthomonas campestris*	10**
Chinese date (*Ziziphus jujuba*)	Witches' broom	Mycoplasmalike organism	12
Citrus (*Citrus reticulata*)	Anthracnose	*Colletotrichum gloeosporioides*	7,12,16
	Greening/ yellowing or yellow shoot	Mycoplasmalike or rickettsialike organism	1
	Canker	*Xanthomonas citri*	12,16
		Valsa sp.?	7
	?	Viruses	1
	Gummosis	*Phomopsis* sp.	7
	Scab	*Sphaceloma* sp.	7,16
	Root problems	Nematodes (sp.?)	1
Corn (maize) (*Zea mays*)	Head smut	*Sphacelotheca reiliana*	4,8,13,17
	Northern leaf blight	*Helminthosporium turcicum*	4,5,6,7,8,10,14, 16,17
	Southern leaf blight	*Helminthosporium maydis*	4,5,6,7,10, 14,16
	Chlorotic fleck	Virus?	17
	Common smut	*Ustilago maydis*	8,14,16,17
	Late wilt	*Cephalosporium maydis*	14,17
	Rust	*Puccinia sorghi*	17
	?	*Holotrychia morosa*	14
	Mosaic	Maize mosaic virus	12
	Dwarf mosaic	Maize dwarf mosaic or sugarcane mosaic virus	2,5,7,9,10,12, 16,17
	Streaked dwarf	Rhabdovirus	19
	Rough dwarf*	Maize rough dwarf virus	7,16
	Rots	*Fusarium* sp.	6,8,14
	Anthracnose	*Colletotrichum graminicola*	7
	Stalk rot	*Colletotrichum graminicola*	7
	Eyespot or brown spot	*Kabatiella zeae*	8
Cotton (*Gossypium hirsutum*)	Wilt	*Verticillium albo-atrum*	7,10
		Fusarium sp.	7**,10
	Seedling blight	*Phytophthora* sp.	7,10
		Rhizoctonia solani = *Pellicularia filamentosa*	7,16
	Anthracnose	*Colletotrichum gossypii* = *Glomerella gossypii*	7,16
	Boll rot	*Phytophthora bohemia*, *Ascochyta gossypii*	7,16
		Rhizopus sp., *Diplodia* sp.	16
	Angular leaf spot	*Xanthomonas malvacearum*	16
Cucumber (*Cucumis sativus*)	Fruit rot	*Phytophthora* sp.	7
	Blight	*Phytophthora* sp.	7,10**
	Powdery mildew	*Erysiphe* sp.	4**
	Downy mildew	*Pseudoperonospora cubensis*	7,12,14,16,17
	Wilt	*Verticillium albo-atrum*	17
		Fusarium sp.	7,10,12**
	Lesions	Bacterium	12
	Root knot	*Meloidogyne* sp.	10
	Mosaic	Cucumber mosaic virus	7
Date (*Phoenix dactylifera*)	?	Virus	12
Eggplant (*Solanum melongena* var. *esculentum*)	Mosaic	Cucumber mosaic virus	12,21
	Blight	*Phomopsis vexans*	7
	Wilt	*Fusarium* sp.	4**
		Verticillium sp.	7,17
Grape (*Vitis vinifera*)	Anthracnose/ black rot	*Elsinoë ampelina*	5,12
	Downy mildew	*Plasmopara viticola*	5
	Rot	*Glomerella cingulata*	5
	Spot	*Cercospora vitis*	5
	White rot	*Coniothyrium diplodiella*	5,12
Jute (*Corchorus capsularis*)	Anthracnose	?	16
	Root knot	*Meloidogyne* sp.	16
Lettuce (*Lactuca sativa*)	Mosaic	Lettuce mosaic virus	12
Millet, foxtail (*Setaria italica*)	Blast	*Pyricularia grisea*	14,17
	Downy mildew	*Sclerospora graminicola*	14,17

(continued on next page)

[a]* = no longer found; ** = most damaging economically.

[b]Province (city) [former spelling]: 1 = Guangdong (Guangzhou) [Kwangtung (Canton)]; 2 = Gansu [Kansu]; 3 = Hangzhou [Hangchou]; 4 = Heilongjiang [Heilungkiang]; 5 = Henan [Honan]; 6 = Hubei [Hopei or Hupei]; 7 = Jiangsu (Nanjing, Shanghai) [Kiangsu (Nanking)]; 8 = Jilin [Kirin]; 9 = Hebei [Hepei]; 10 = (Beijing) (Peking); 11 = Inner Mongolia; 12 = Shaanxi [Shensi]; 13 = Shanxi [Shansi]; 14 = Shandong [Shantung]; 15 = Tientsin; 16 = Zhejiang (Hangzhou) [Chekiang (Hangchow)]; 17 = Liaoning; 18 = North China; 19 = West China; 20 = Fujian [Fukien]; 21 = Ningxia [Ningsia].

Table 1. *(continued from preceding page)*

Crop	Disease	Pathogen	Province[b]
	Rust	*Puccinia* sp.	5,14,17
	Smut	*Ustilago crameri*	17
	Red leaf	Sugarcane mosaic virus	5,11,14
Mulberry (*Morus nigra*)	Wilt	*Pseudomonas solanacearum*	1,10
	Yellow dwarf	Mycoplasmalike organism	16
	Common dwarf	Mycoplasmalike organism	16
	Mosaic	Mulberry mosaic virus	16
	Root knot	*Meloidogyne* sp.	1
Papaya (*Carica papaya*)	Ringspot	Papaya ringspot virus	1
Peach (*Prunus persica*)	Anthracnose	*Gloeosporium lacticolor*	10,14,16
	Brown rot	*Monilinia fructicola, Sclerotinia laxa*	7,10,16
	Shot hole	Bacterium	10,14
	Canker	*Valsa mali*	10**
	Leaf curl	*Taphrina deformans*	7
	Scab	*Closterosporium carpophilum*	7
Peanut (*Arachis hypogaea*)	Wilt	Bacterium	1
	Leaf spot	*Cercospora* sp.	14
	Rust	*Puccinia arachidis*	14**
	Root knot	*Meloidogyne hapla* and *M. chitwoodii*?	10,14
Pear (*Pyrus communis*)	Valsa canker	*Valsa mali*	13**
	Scab	*Venturia pirina*	7,13
	Fruit rot (black rot)	*Sclerotinia fructigena*	4**
	Rust	*Gymnosporangium yamatae*	7,13
		Gymnosporangium haraeanum	16
Pepper (*Capsicum* spp.)	Mosaic	Cucumber mosaic virus	7,10**,12,17,21
		Potato virus Y	10,13,21
	Streak, mosaic	Tobacco mosaic virus	7,10,12,16
	Spot	*Pseudomonas solanacearum*	10
	Mottle	Potato virus X or Y	5,21
	Leaf roll	Potato leaf roll virus	5
	Bacterial wilt	*Pseudomonas solanacearum*	10
Potato (*Solanum tuberosum*)	Late blight	*Phytophthora infestans*	4,7,10,16
	Wilt	*Pseudomonas solanacearum*	10
	Mosaic	Potato virus X, Y, M, or S	10,12
	Early blight	*Alternaria solani*	7
	Spindle tuber	Viroid	7,10
Prunus (*Prunus* sp.)	Bacterial leaf spot	*Xanthomonas pruni*	12
Rape (*Brassica napus*)	Sclerotinia wilt	*Sclerotinia sclerotiorum*	16
	Mosaic	Tobacco, cucumber, or turnip mosaic virus	3,16
Rice (*Oryza sativa*)	White sheath (rare)	Nematode (sp.?)	16
	Bacterial leaf blight	*Xanthomonas oryzae*	1,7,10,16,17
	Brown spot	*Helminthosporium oryzae* = *Cochliobolus miyabeanus*	7,16
	Sheath blight	*Rhizoctonia* sp.	1**
	Blast	*Pyricularia oryzae*	1**,7,16,17
	Nematode	*Aphelenchoides* sp.	1,10
	Black streak	Rice black-streaked dwarf virus	7,16
	Dwarf	Rice dwarf virus	1,16**
	Yellow dwarf	Mycoplasmalike organism	16
	Transitory yellowing	Rice transitory yellowing virus	1,16**
	Stripe	Rice stripe virus	16
	?	RTyV, RGSV, RDLV	16
Sesame (*Sesamum orientale*)	Wilt	*Pseudomonas solanacearum*	10
	Sclerotinia wilt	*Sclerotinia sclerotiorum*	10
Sorghum (*Sorghum bicolor*)	Anthracnose	*Colletotrichum graminicola*	14,17
	Charcoal rot	*Macrophomina phaseoli*	4
	Head smut	*Sphacelotheca reiliana*	4,14**,17
	Loose (kernel) smut	*Sphacelotheca cruenta*	14,17
	Rust	*Puccina purpurea*	17
	Mosaic	Maize dwarf mosaic virus	5,12
	Small seed	?	17
	Wen Ky	?	17
	Gray leaf spot	*Cercospora sorghi*	14
Soybean (*Glycine max*)	Septoria leaf spot	*Septoria* sp.	10
	Pod blight/rot	*Macrophoma mame*	5
	Brown leaf blotch	*Mycosphaerella sojae*	5
	Bacterial pustule	*Xanthomonas phaseoli*	5
	Anthracnose	*Colletotrichum dematium* or *Glomerella glycines*	4,10
	Bacterial blight	*Pseudomonas glycinea*	4**,5,12,14**,17
	Brown spot	*Alternaria* sp.	4,5,17
	Cyst nematode	*Heterodera glycines*	4**,5,6,7,10,17
	Downy mildew	*Peronospora manshurica*	4,14,17
	Wilt/blight	*Fusarium oxysporum*	4
	Top necrosis, leaf curl, yellow mottle	Soybean mosaic virus	4,7
	Mosaic	Soybean mosaic virus	4,5,6,10,13,14,17
		Bean common mosaic virus	13
	Seed mottle	Soybean mosaic virus	4
	Pod and stem blight	*Diaporthe phaseolorum* var. *sojae*	4,5
	Brown stripe	*Septogloeum sojae*	5
	Purple seed stain	*Cercospora kikuchii*	5,17
	Gray leaf spot	*Cercospora sojina*	17
	Scab	*Sphaceloma glycines*	5,17
	Rust	*Phakopsora pachyrhizi*	14,17
	Bud blight	Tobacco ringspot or streak virus	5**,10
	Ring leaf spot	*Ascochyta sojaeicola*	5
Spinach (*Spinacia oleracea*)	Mosaic	Turnip mosaic or cucumber mosaic virus	12
Squash (*Cucurbita pepo*)	Mosaic	Squash mosaic virus	10
Sugar beet (*Beta vulgaris*)	Leaf spot	*Cercospora beticola*	13,21
	Yellows	Turnip yellow mosaic virus	10,11,12,21
		Phoma lignicola	12,21
	Root knot	*Meloidogyne* sp.	10
Sugarcane (*Saccharum officinarum*)	Mosaic	Sugarcane mosaic virus	1,16
	Red rot	*Colletotrichum falcatum*	1
	Leaf spot	*Cercospora* sp.	1**
	Ratoon stunt	Mycoplasmalike organism	1
Sunflower (*Helianthus annuus*)	Wilt	*Pseudomonas solanacearum*	10
Sweet potato (*Ipomoea batatas*)	Black rot (spot)	*Ceratocystis fimbriata*	14,16
	Root knot	*Meloidogyne* sp. (*M. chitwoodii*?)	10,14
	Root rot	? plus *Ditylenchus* sp.	10,14
	?	*Fusarium* sp.	5
Tea (*Thea sinensis*) (over 100 diseases have been described)	Dead root	*Ganoderma* sp.	16
	Brown root	*Ganoderma* sp.	16
	Red root	*Ganoderma* sp., *Gloeosporium theaesinensis*	16

(continued on next page)

Table 1. *(continued from preceding page)*

Crop	Disease	Pathogen	Province[b]
	Anthracnose	?	16
	Leaf blister spot	*Exobasidium vexans* or *E. reticulatum*	3**,16**
	Root knot	*Meloidogyne* sp.	1,16
	Brown blight	*Colletotrichum (Guignardia) camelliae*	16
	Canker	*Nectria cinnabarina, Pestalotia theae, Agrobacterium tumefaciens, Pellicularia rolfsii*	16
	Bud blight	*Phyllosticta theicola* and *P. theaefila*	16
Tobacco (*Nicotiana tabacum*)	Mosaic	Tobacco mosaic or cucumber mosaic virus	Widespread
	Wilt	?	1
	Black shank	*Phytophthora parasitica* var. *nicotianae*	1
Tomato (*Lycopersicon esculentum*)	Bacterial wilt	*Pseudomonas solanacearum*	1,10
	Late blight	*Phytophthora infestans*	10**,17
	Streak (black heart)	Tobacco mosaic virus plus potato virus Y	10,16
	Streak	Tobacco mosaic virus	12
	Wilt	*Verticillium albo-atrum*	10
	Mosaic	Tobacco mosaic virus	1,4**,7**,10**,12**,16**,17
		Cucumber mosaic virus	7,10,12,16
	Early blight	*Alternaria solani*	4**,10,12**,17

Crop	Disease	Pathogen	Province[b]
	Leaf roll	Physiological?	10
	Root knot	*Meloidogyne* sp.	10
	Curly top	Tomato curly top virus	1
Watermelon (*Citrullus vulgaris*)	Mosaic	Cucumber mosaic or watermelon mosaic virus	12
	Leaf spot	Bacterium?	7
Wheat (*Triticum aestivum*)	Spindle streak	Wheat spindle-streak mosaic virus	
	Bunt	*Tilletia foetida* and *T. caries*	7,16
	Loose smut	*Ustilago tritici*	7,16
	Red dwarf	Barley yellow dwarf virus?	7,12
	Scab	*Fusarium graminearum*	7**,10
		F. avenaceum var. *herbarum* and var. *anguoides, F. moniliforme*	16**
	Yellow dwarf mosaic	Barley yellow dwarf virus	5,7,10,11,12**,16
	Mosaic	Wheat mosaic virus (yellow and green strains, soilborne)	5,12
	Rosette (stunt)	Rhabdovirus	5,6,10,12
	Stunt	Wheat stunt virus	16
	Take-all	*Ophiobolus graminis*	10,14,16
	Stripe rust	*Puccinia striiformis*	4,5,7,10,12,14,16
		Puccinia glumarum	7,16
	Leaf rust	*Puccinia recondita*	4,5,7,14,16
	Stem rust	*Puccinia graminis* var. *tritici*	4,7,10,16
	Powdery mildew	*Erysiphe graminis*	5,7,10
	Nematode*	*Anguina tritici*	7,10,16

land for many centuries, and a Greek consultant in soil physics, with whom we met on several occasions, said the soils are now considered man-made. Thus, the nematode-crop interrelationships that may be occurring in China may not exist anywhere else in the world.

Entomology seems quite well developed, especially with regard to taxonomy and systematics. Emphasis is placed on biological control mechanisms and on developing methods to deploy the mechanisms within the agroecosystem. We could not determine that these biocontrol systems worked in the field, however. Plant resistance studies are under way for major insect pests of rice and wheat. Insecticides are used liberally and under less strict protective standards than in the United States. There is ample room for improving spray application technology and for determining damage thresholds under field conditions.

Weed science is the most "primitive" crop protection component. Mostly manual labor tactics are involved with weed control. Annual weeds are abundant and allowed to attain significant growth before being removed and fed to farm animals. Intense interest in herbicides exists within the scientific community, but few herbicides are used in farming practice. Because interplanting of two or three different species is practiced (especially in southern China, where two or more crops per year are grown), more selective chemicals than those used by U.S. farmers may be required.

Pesticide Production and Use

The Chinese place great emphasis on formulating and manufacturing their own pesticides to aid agricultural productivity. China does not subscribe to the International Patent Convention, and several pesticides manufactured there are still under patent protection in the United States and other countries. China is unable to find the foreign exchange to import all the chemicals needed. The National Council for U.S. Trade, which was a guest in China in 1979, believes, as do others, that the Chinese will have to abide by international patent laws if they are to have free and open access to world trade (J. Froyd, *personal communication*).

Currently, China uses insecticides, fungicides, and herbicides, in that order. Collective estimates by Chinese scientists at several locations suggest that usage breaks down to about 80% insecticides, 15% fungicides, and 5% herbicides. Most pesticide applications are made after the problem appears rather than before, ie, as a protectant. High chemical costs is one reason protectant measures are not used more. The primary fungicides used are lime sulfur, Bordeaux mixture, maneb, and carbendazim (MBC). The Chinese want to increase the use of chemicals to control pests, and at each location they inquired about any new pesticide that was "cheap" and environmentally sound. Resistance is a bigger problem with insecticides than with fungicides.

The Chinese manufacture most of the pesticides used on their farms. In Shanghai we learned that the following are produced in Jiangsu Province: 1) the insecticides acephate, aluminum phosphide, BHC, carbaryl, chlordimeform, DDT, dichlorvos, dimethoate, meobal, methyl bromide, methyl parathion, parathion, phoxim, sulfotepp, and trichlorfon; 2) the fungicides copper sulfate, IBP, lime sulfur, MBC (carbendazim), sodium *p*-aminobenzene sulfonate, and validamycin; 3) the herbicides chlorotoluron, CNP, MCPA, and nitrofen; and 4) the plant growth regulators ethephon and gibberellic acid. Maneb, MBC, and many others are produced in the northern provinces.

The application of pesticides needs improvement, ie, sprayers. Most pesticides, regardless of toxicity, are applied by hand, which presents a real safety problem. Also, because there is no way to determine accuracy of delivery, coverage varies from none to several times the quantity needed.

A Tremendous Potential

Our trip was most educational. The people were warm and communicated openly. We saw areas in need of improvement, which the Chinese recognize and acknowledge. A trip across any country would reveal areas where cropping practices could be improved, and in China several simple changes could markedly improve crop production. The lack of trained agricultural professionals is a serious detriment to implementation of plant pest control programs. About 82% of China's productive land is already growing crops. Increased productivity will depend partly on better use of plant pest control on communes, a farming system that does not lend itself to rapid changes but one that feeds 1 billion people from no more arable land than that in the United States. The Chinese have adequate food and appear healthy. This accomplishment commands our deep respect and is evidence that the Chinese are doing many things right. With the application of modern agricultural and pest control practices, China has a tremendous potential to increase its crop production.

R. E. Ford

Dr. Ford has been professor and head of the Department of Plant Pathology at the University of Illinois since 1972. He majored in botany at Iowa State University and then obtained advanced degrees in plant pathology at Cornell University. His professional career in the USDA began at Oregon State University in 1961, researching legume viruses. The corn virus outbreak drew him back in 1965 to Iowa State University, where he also taught several graduate courses. His research has concentrated on virus characterizations, physiological and cytological studies, and pathogen-host interactions, especially with maize dwarf mosaic virus. He has consulted and lectured internationally, including on a Fulbright grant, and currently serves as President-elect of The American Phytopathological Society.

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