Presidential Address

Whither Plant Pathology? Whither Plant Health?

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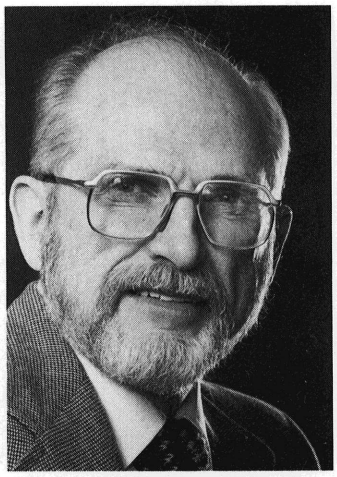

When President-Elect and Program Chairman Dick Ford asked if I wanted a presidential address this year, I gave him a resounding "yes"! I value very highly the tradition of the presidential address, had long envied the practice in other societies, and had wondered why APS never had one. Finally, in 1975, then-President James Tammen initiated it. I am pleased to help perpetuate this highly desirable young tradition and I commend it to my successors.

It has been a great and rare privilege for me to serve as your president this year. When representing you before Council, at division meetings, and at other organizations at home or overseas, I have tried to impart my enthusiasm for our science and for the great organization that we are.

We are now over 4,000 strong and the largest, most influential phytopathological society in the world. Not surprisingly, with this extra strength come extra opportunity and extra responsibility.

Next year [1983] our Society will be 75 years old, about one-half the age of our science as a recognizable science. It is very timely and natural to reflect on our past, but probably it is more important to consider where we are—or should be—going and how to get there.

I have commended Dean Sam Smith's Diamond Jubilee Celebration Committee for the genius they showed in generating the theme "Challenging Problems in Plant Health" for the Diamond Jubilee volume now in press.

To help prepare for this historical celebration *and for moving beyond it,* I would like us to consider where plant pathology and plant health should be going.

Probably I should define my concept of plant health. Plant health is far more than the freedom from infectious disease as used in phytopathology. Plant health describes the relative freedom from biotic and abiotic stresses of the green plant and its ecosystem that limit their producing to the maximum of their genetic potential over time. Thus, many disciplines contribute to plant health and can justifiably claim a piece of the action relative to it. It is very important, however, that *the philosophical home of the plant health concept resides in the discipline of phytopathology.*

Before we can consider whither plant pathology and whither plant health, we must consider whither the world, for that is the challenge all of us in agriculture face. Then, we must consider our minimal response to that challenge as concerned, knowledgeable scientists and human beings. I am going to present this in a personal way to emphasize the dramatically deceptive nature of exponential growth or growth by doubling.

When my wife Arra and I were born, we were among only about 1.9 billion people in the world. As we started school, the world population reached 2 billion. When our daughter Gayle was born in 1950, she was one of only 2+ billion. Yet when *her* daughter, our granddaughter Arra Christina, was born in 1980, she shared the planet Earth and its resources with about 4.5 billion people! Worse, by the time Arra Christina is recognized as a Phi Beta Kappa in about A.D. 2000, she will share Earth's resources with about 6.3 billion others.

Does this timing have any special relevance to any of us today? If you graduate students go from your university to a position that involves, say, breeding for disease resistance, and if you make a new, conventional cross and spend the usual time developing and testing the progeny, releasing the new variety, and getting it accepted, about 6.3 billion people will be demanding food from that and other cultivars. When you release the variety, there will be 40% more mouths to feed than when you are still preparing to go and make the cross. Such is the deceptive nature of growth by doubling! The final increase is so rapid that it almost literally has happened before anyone realizes that it is even going to happen!

But back to our granddaughter Arra Christina. Born one of 4.5 billion people, before she is my age she will be one of 10 billion. And if this growth trend continues, the Earth could approach its estimated carrying capacity of 30 billion by the end of the next century, in just 118 years! Let me emphasize the consequences of this by quoting a few passages from the summary of the "Global 2000 Report to the President" (3):

> If present trends continue, the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now. . . . For hundreds of millions of the desperately poor, the outlook for food and other necessities of life will be no better. For many it will be worse. . . . Rapid growth in world population will hardly have altered by 2000. The world's population will grow from 4 billion in 1979 to 6.35 billion in 2000, an increase of more than 50 percent. The *rate* of growth will slow only marginally. . . . In terms of sheer numbers, population will be growing faster in 2000 than it is today, with 100 million people added each year compared with 75 million in 1975. Ninety percent of this growth will occur in the poorest countries. . . . Arable land will increase only 4 percent by 2000, so that most of the increased output of food will have to come from higher yields. Most of the elements that now contribute to higher yields—fertilizer, pesticides, power for irrigation, and fuel for machinery—depend heavily on oil and gas. . . . For the one-quarter of humankind that depends primarily on wood for fuel, the outlook is bleak. Needs for fuelwood will exceed available supplies by about 25 percent before the turn of the century. . . . Significant losses of the world's forests will continue over the next 20 years as demand for forest products and fuelwood increases. . . . Serious deterioration of agricultural soils will occur worldwide, due to erosion, loss of organic matter, desertification, salinization, alkalinization, and waterlogging. . . . At present and projected growth rates, the world's population would reach 10 billion by 2030 and would approach 30 billion by the end of the twenty-first century. These levels correspond closely to estimates by the U.S. National Academy of Sciences of the *maximum carrying capacity of the entire earth* [emphasis added].

This report, of course, was to President Jimmy Carter, and to my knowledge it is the closest approach any government has made toward coming to grips with this overriding issue. To my knowledge, the Reagan administration is choosing to ignore it.

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This phenomenal rate of population growth and the resultant endangering of our resource base have very special significance for all plant scientists, for they pushed the world unknowingly and unwittingly into what I call the "Age of Plants." The onset of the Age of Plants was in the mid-1970s, with no more fanfare than depleted grain stocks, rising food prices, rising energy costs, and mountainsides depleted of firewood. The cause and significance of these signals were missed by the vast majority of the population, but the onset of the Age of Plants was very real, nonetheless.

Man has known many ages—the Stone Age, the Bronze Age, the Atomic Age, the Space Age—but now man may have moved into the most important age of all, the Age of Plants. Before the Age of Plants, man had plants in ridiculous excess and could abuse them, waste them, take them for granted. But no more. He must finally give plants their due! Plants are the primary photosynthetic factory, and in the Age of Plants, for the first time in history, virtually every plant has actual or potential value for food, feed, fiber, firewood, or aesthetic purposes.

Obviously, this has tremendous relevance for all of us! The greatest experiment of all time will be whether the world can feed, clothe, and shelter its burgeoning population with the primary photosynthetic factory the major limiting factor.

What should be *our* response in this great experiment? The obvious solution is to decrease rapidly the rate of population growth. You see, there is no shortage of food or land or water or energy *yet. There is no shortage of these things; there is a longage of people*, as phytopathologist Bill Paddock (5) has reminded us. But the world, including the world of plant pathology, is not yet ready and willing to take a stand—much less propose action—on population. What, then, can we do as plant scientists? *What can we do that is within our expertise and our prerogative to do?*

The bottom line is that we can and we must secure and stabilize the primary photosynthetic factory and its ecosystem!

How do we go about this?

First, we phytopathologists and other agricultural leaders must recognize that the basis of *any* successful agriculture is the healthy, productive green plant, and we must develop cultivars and cultural systems so that each cultivar can yield to the maximum of its agronomic, horticultural, or silvicultural potential *over time. This can be achieved ONLY if the protection a given cultivar enjoys does not just rest on each individual plant in the population but is characteristic of the whole population, ecosystem, and cultural system.*

Second, we plant scientists must rediscover the important ecological concept of "carrying capacity" and apply it to agriculture. The National Academy of Sciences estimates that the carrying capacity of the planet is 30 billion and that the time is in sight, within only five generations, when this population may be reached. But we haven't the foggiest idea whether this figure is correct. It may be way too high! So, as responsible scientists, we must determine the agricultural carrying capacity of the land. Then, we must say to decision makers with kindness but firmness and confidence, "This population and no more can be sustained over time, at a given standard of living, on this land." Science, of course, cannot specify the standard of living.

This concept of *agricultural* carrying capacity is the same as that of the sustained-yield agroecosystem (SYAE). For an SYAE, Greenland (4) said, "It is necessary 1) that the chemical nutrients removed by crops are replenished in the soil, 2) that the physical condition of the soil suited to land utilization type is maintained, which means that the humus level of the soil is constant or increasing, 3) that there is no buildup of weeds, insects, and pathogens, 4) that there is no increase in soil acidity or toxic elements, and 5) that soil erosion is controlled. All of these are essential."

Some of you will recognize that this is essentially the same as the population biology concept of an evolutionarily stable strategy (ESS). An evolutionarily stable strategy is defined as a strategy that, if most members of a population adopt it, cannot be bettered by an alternate strategy. This is a strategy evolved in nature. Its agricultural counterpart is an agriculturally stable strategy or stable agricultural strategy, which must be developed by man, and only the research scientists can do it! The farmer does not have the research philosophy, the statistical tools, etc., for this advanced agricultural research, but it *is* incumbent on us plant scientists to develop the strategy.

Of the five points Greenland mentioned as being necessary for an SYAE, it is appropriate that we concentrate on preventing the buildup of weeds, insects, and pathogens, because some of these can change genetically and increase rapidly to cause major instability in crop yields. But it would be foolish to concentrate just on pathogens, say, and have soil erode from under us, which was Greenland's fifth point. This *is* a real danger. For instance, Brink et al (1) emphasized that 70 of 93 quarter sections of corn land studied in Wisconsin lost soil at rates greater than two times that considered compatible with a *permanent* agriculture! He also stated that in Iowa, an average of two bushels of topsoil was lost for each bushel of corn produced and that some land lost topsoil at three to four times that rate. This is obviously incompatible with a permanent agriculture or with an SYAE; soil erosion is *not* a stable agricultural strategy.

The final thing we must do that is within our expertise and prerogative is to change our relative approach to plant pathology and plant health and to join with other plant science disciplines to deal aggressively, holistically, and competently with plant health.

Eventually, and the sooner the better, we in the United States must establish what I propose calling a National Plant Health System (2).

We can consider this a new, transdisciplinary way of helping plants meet the needs of man in the Age of Plants.

The holistic National Plant Health System will develop and oversee plant populations and cultural systems to meet the needs of increasing populations of people.

Giving this unusual attention to plants is long overdue. In contrast, health care systems for man and his animals developed early. This is understandable. The preciousness of human life gives impetus to the perfection of health care research, teaching, and delivery systems for people. The monetary and/or sentimental value of domesticated animals fostered the development of a parallel system for man's animals. Now, with the increasing pressure on plants to meet the needs of man, it is high time we developed a *plant* health care, research, teaching, and delivery system.

I propose a national system to be overseen by an Assistant Secretary of Agriculture for Plant Health. The U.S. Department of Agriculture and its Agricultural Research Service, Cooperative States Research Service, and Extension Service will be integral parts of the National Plant Health System. However, the *key* system will involve the nation's land-grant agricultural experiment station and university system.

The *focus* of the National Plant Health System must be the healthy, productive green plant, the primary photosynthetic factory. The *goal* will be to develop and maintain SYAEs. IPM and conservation tillage, for example, are very important in their own right, and both are important strategies to apply toward the SYAE goal. But they themselves are far too limited to be the goals of the National Plant Health System, which *must* focus on the healthy, productive green plant and the SYAE goal.

I visualize that the National Plant Health System will operate in four modes: research, teaching, delivery, and reporting.

The research mode will build and maintain SYAEs to recommend to growers as preferred alternatives and will do the basic research necessary to place and keep plant agriculture on a sound scientific footing.

The teaching mode will develop a new degree that we may call the Doctor of Plant Health. Or, since the Doctor of Public Health already uses the DPH acronym, the degree may simply be Plant Doctor. This degree will be a professional degree and parallel very closely the Doctor of Veterinary Medicine degree. Students of plant pathology and other plant health disciplines probably will want and need this degree if they go into

professional practice. In teaching and research, however, they still will want the Ph.D. degree in their academic discipline. The individual disciplines will backstop the professional practitioners, as in human and veterinary medicine.

The third mode, that of delivery or extension, will involve generalists who have earned the professional Plant Doctor degree and who will be prepared to help the grower with any plant problem he is likely to face, whether it involves pathogens, insects, weeds, fertility, irrigation, or other stresses. Again, I define "plant health" in a very positive way as reflecting the freedom from biotic and abiotic stresses that prevent a crop *and its ecosystem* from yielding to the maximum of their genetic potential over time. Thus, *all* disciplines that contribute to plant health would contribute to the education and training of scientists for the Plant Doctor degree, and the general practitioners would practice professionally in the same broad area.

The fourth mode, reporting, would involve a more sophisticated system of reporting crop yield and loss, partitioned by cause, than we enjoy today. Data obtained through the growing season would be used in three ways. It would be used by management for the crop management system, it would be fed to APHIS if something new were discovered, and it would be furnished to the statistical reporting service for estimates of crop yield and departures therefrom partitioned by cause. This would be done through the usual lockup system.

Whither plant pathology? Plant pathology will become recognized as one of several plant health disciplines, the one that deals with interactions between higher plants and disease-causing microorganisms. It will become primarily an academic discipline, for its practice will be taken over by doctors of plant health, whom it will backstop.

For this to happen, it may *appear* that plant pathology, as we know it, will need to die a little, but this is not true. Jesus said that "unless a grain of wheat falls into the earth and dies, it remains alone; but if it dies it bears much fruit" (John 12:14). Any seed scientist knows, of course, that the seed does not and cannot die if the wheat is to grow and "bear much fruit." But it changes *in form*!

So must phytopathology be willing to be changed in form to serve as the "seed" of this new plant health effort and to bear maximum fruit as part of that greater effort.

Whither plant health? Plant health will develop rapidly into a profession parallel with veterinary medicine. Plant pathology, plant entomology, weed science, plant nematology, plant breeding in part, seed science, soil fertility, etc., all will be among existing disciplines that will come to have some or all of their application or delivery overseen by doctors of plant health. This effort will be organized in the United States as the National Plant Health System, which may serve as a model for the rest of the world. Again, the *focus* of the National Plant Health System will be the healthy, productive green plant. The *goal* must be to build and maintain SYAEs; IPM, conservation tillage, etc., will be major strategies. Most important, a hungry world will be the beneficiary.

In the long-range plan for The American Phytopathological Society published in PLANT DISEASE (66:535, 1982), several key issues related to the subject of this presentation. The Long-Range Planning Committee proposed, and Council accepted, recommendations: 1) that APS foster education and training in plant health via the subject matter committees, including teaching and publications; 2) that APS respond to challenges of world population, food, and energy problems by establishing policies and actions of involvement, by public responsibility and subject matter committees, symposia, focus sessions, feature articles, and editorials; and 3) that APS increase its involvement in the promotion of crop health and production by providing a forum for interdisciplinary communication, recognizing and soliciting participation of plant health generalists, increasing liaison or representation by related disciplines, and promoting development of curricula and training for crop health disciplines.

As APS moves toward the celebration of its 75th year and its program concentrating on "Challenging Problems in Plant Health," and in keeping with the desire to begin implementing the APS long-range plan and to thrust APS into leadership in the research and teaching modes of the proposed National Plant Health System, Council has approved appointing two special committees.

The first special committee will consider sustained-yield agroecosystem developmental research and recommend what action, if any, APS should take to foster research by and among the several plant health-related disciplines to build and maintain SYAEs.

The second special committee will consider all aspects of a proposed degree program leading to the professional Plant Doctor degree. This committee is to recommend to Council what action, if any, APS should take to foster an interdisciplinary Plant Doctor degree program. If the report is positive, it should make recommendations relative to curriculum, prerequisites, place and type of any internship, and types of job opportunities anticipated.

I hope that each of these committees can present a final report to Council at the 1984 meeting in Guelph, with a preliminary report to Council at the 1983 meeting in Ames.

Whither plant pathology? Whither plant health? Many disciplines have a rightful claim to a part of plant health using my broad definition, but *the philosophy of the healthy plant belongs to plant pathology*. Thus, much of the answer to these questions depends on the leadership role phytopathology is willing to play.

What should APS do *as a society*, if anything? This is for us to decide. I encourage The American Phytopathological Society to exert its rightful leadership role, plant the seed, and initiate this vast undertaking. This attention to plants and plant health is long overdue. It must wait no longer. This effort will be a major contribution and determinant to the greatest experiment the world has ever known. I urge plant pathologists of the Diamond Jubilee Anniversary era to lead heroically with broad vision and resolve for the good of all humankind, not the least of which will be ourselves and our children.

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