# THE TRAGEDY OF THE COMMONS AND THE SCIENCE COMMUNITY

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Paper Presented in 1970 at the March Meeting of the APS
Bull. of Amer. Phys. Soc. 15 287 (1970)

In a recent paper in Science called, “The Tragedy of the Commons”[1] Garrett Hardin analyses a group of serious problems for which he concludes there are no technical solutions and thus hopes for a fundamental extension in morality. As an example, he considers the population growth in which individual actions (having as many children as one wishes) conflicts with the overall world health (a stabilized world population). He compares this to the problem 19th century English farmers faced when sharing a common grazing pasture. Should a farmer add an additional cow to graze on the pasture? On a pure self interest basis he might conclude he should since he increases his milk output (at the expense of all the other farmers). If each of the farmers reaches the same conclusion of adding an additional cow, the commons soon can't support the higher total and all the cows die due to famine followed by disease. Thus, the tragedy of the commons. What does all this talk of farmers, cows and pastures have to do with the science community? In a close analogy we can analyze the current crisis facing the science community, the scientists (especially the young), and the health of American science with the tragedy of the commons.

The crises facing all of science comes from many fronts. Recent changes in the attitude of the Government towards science have resulted in tight and in some cases reduced federal research and development budgets. The cuts are having a harmful effect on the present health and future growth of American science. In addition, the cutbacks in funding are having a direct effect on the careers professional development and attitudes of scientific personnel, especially the recent graduate and those students still in the university. While Government's science and fiscal policy can shift in time periods as short as one year, the minimum response time of educational institutions and manpower is much longer on the order of three to six years or more.

In almost all discussions of the crisis of science, most of the attention focuses on the fact that the demands for science, usually determined by the federal budget, have been growing insufficiently and must be increased. Less well debated or discussed is the supply for which we are responsible. In any situation where one considers an imbalance in the supply-demand one must ask: Is it the demand that is out of line with supply, or is the supply out of line with demand, or both? In this short note I would like to analyze each of these questions separately. One can easily conclude that certainly the demand is not growing at a healthy rate, however, even more seriously one can show that the supply seems to be increasing at such a rate that it can eventually overwhelm any demand and is directly related to the reward system which we have helped develop in science.

DEMAND: Demand for advanced science is essentially determined by research and development funds from the federal government. Even industrial demand can be traced back to some direct or indirect federal support. The most important pressures affecting the demand include: 1 . . . . . A leveling or even slightly declining federal support for science . . . . . 2 . . . . . Inflation, 3 . . . . . A general slowdown of the economy leading to a tightness in industrial research funds, 4 . . . . . A natural increase in the cost of doing science due to increasing sophistication and complexity of experiments and instrumentation, 5 . . . . . A probable shift of national goals from areas in the physical sciences to areas like transportation, housing, environment and welfare . . . . . Other societal pressures on the federal budget leave the scientists with only indirect influence on total science support.

SUPPLY: Now let us consider supply. As a yardstick we consider the production of Ph.D. scientists. The most important pressures affecting the supply include: 1- . . . . . In many major areas of science and engineering, the (number of Ph.D. scientists have been growing . . . . . 2 - The reward structure developed in science favors the production of students and the establishment of graduate programs. It is in the interest of each individual professor to produce graduate students since promotion, tenure and the ability to attract more support correlates with research and student production. In addition, it is in the interest of each science department to develop a graduate program since the award of large amounts of federal support favored research-oriented rather than teaching departments. Herein lies the tragedy; WHILE IT IS IN THE INDIVIDUAL RESEARCHER'S INTEREST TO PRODUCE RESEARCH AND STUDENTS, AND IN THE INTEREST OF SCIENCE DEPARTMENTS TO ESTABLISH GRADUATE DEPARTMENTS, THIS GROWTH PROCESS IS UNSTABLE AND NOT NECESSARILY IN THE OVERALL INTEREST OF SCIENCE OR THE SCIENTIST.

At the present time the rate of increase of scientists is leading to an even greater imbalance than the decreasing demand and is especially hurting the younger and untenured scientists. Our profession which prides itself on understanding numbers and extrapolation seems to have had very little foresight in heeding some of the obvious warnings associated with a very rapid growth of supply. The manpower experts have constantly been asking, “Is everyone employed?” and until recently the answer has been, “yes”. However, they should have also been asking, “How many new scientists are graduating and how rapidly is the job market growing?”. The educators of scientists have not reacted and have watched the supply curve crash through the demand curve. We should have reacted much sooner. It seems that the rewards structure plus very poor supply-demand information prevented most individuals, or institutions from taking unilateral action. The primary responsibility to gather, interpret, and publicize manpower data should lie with the professional societies and the national scientific manpower commissions. In a laissez-faire American economy it does not seem proper to deny anyone the right from choosing any career, however, it is most important that the student and the educators be made aware of both the future projected demands, as well as supply in order to let the student make a knowledgeable choice. Many educators argue that that is exactly what they are presently doing. For the currently graduating scientists, it is too little information too late. I would further argue that even today very little easily accessible information is available, and what is available is often contradictory . . . . . .

This sharp rise and fall of growth (of Ph.D.s) however, is a most inefficient situation and is very disruptive to scientific careers and institutions. It would be much wiser to argue for the development of stable growth rates for science output commensurate with pressing national needs and the ability of scientists to use new funds profitably.

PROPOSALS FOR IMMEDIATE ACTION: 1 - An immediate appraisal of the present supply and demand for scientists should be conducted and made public especially to counselors in high schools and colleges. This information alone would probably be enough to keep future supply in line with demand. At the present time, the Bureau of Labor Statistics is still saying that science and engineering offer good job opportunities for young people. 2 - Temporary post doctoral type positions should be created in order to give scientists the opportunity to rearrange their lives in accordance with the true nature of the opportunities in science. 3 - We must appeal to the universities, to reflect in their admissions and student recruitment policy, the true nature of the demand for scientists. 4 The present reward structure of education and research in science must be examined for any inherent instabilities and inequities. 5 - The scientist must fight for a stable growth relationship with the federal government and develop action-oriented institutions to build a constituency to defend and increase support from the federal government.

CAN THERE BE A SHORTAGE OF SCIENTISTS? With all these gloomy prospects for scientists, the scientific establishment keeps issuing warnings that we should be careful not to overreact for in 1980 there may be a “crisis” because of a shortage of scientists and engineers [2]. With the present large base of scientific manpower . . . .the concept of a shortage of scientists is a myth. There are very few signs that any of our national goals in the 1970's or beyond cannot be met with the wise deployment of even the present supply. In fact, science thrives in periods of so called “shortages” because of the varied opportunities available. If one examines the society, the real shortage of manpower is not in science and engineering but in doctors and skilled craftsman.

Many scientists hope that the upgrading and creation of new educational institutions will absorb the supply of graduate scientists. This is simply not true. [3] With a fair degree of certainty this total demand for the education sector is known, and knowledgeable educators indicate that we are presently producing enough Ph.D.'s to more than meet this projected demand in education. In addition, there are very few indications that the specialized advanced degrees are required for many of the new opportunities being discussed for scientists. Often these new jobs, simply require an intelligent person who understands the scientific method and has developed mathematical as well as judgement skills. I doubt very much whether the advanced degree scientists will be truly unemployed, they will however be underemployed, misemployed and underpaid.


1. Science 162, 1243 (1968).
2. Science 168, 555 (1970), Editorial, Physics Today 23, 96 (1970).
3. J.P. Martino, Science 165, 789 (1969) and A.M. Carter, Proc. Social Stat. Sec. Am. Stat Assoc., 70, (1965).