Crop Protection and Society, a Course at Wageningen Agricultural University

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"Relevance" was the theme of James Horsfall's speech at the banquet of the APS annual meeting in Spokane in 1969. It was a year of student revolts and of university reconciliation committees. Student participation in university affairs was the price faculty had to pay for peace. In the Netherlands, it was prescribed by a new law, with all the characteristics of emergency legislation. University management reform was followed by curriculum reform. One new item to be included in the curriculum was the relation between science and society. The connotation was that science and technology should serve and not dominate society.

The governing bodies of the Wageningen Agricultural University were specific in their requirements. Each of the 20 specializations, including "Crop Protection," had to offer at least one two-credit course on the theme "X-ology and Society." Participation of students was to be obligatory. In 1982, I became the teacher for the course on "Crop Protection and Society" (in Dutch: *Plantenziektenkunde en Maatschappij*).

Though I agreed with the general feeling that such a course was needed, my personal motivation to offer this course was slightly different. Among the students of that time, the spirit to "do good" was strong but undirected. A touch of realism might help to orient their energies to practical purposes. The immediate motivation was my observation that students at Wageningen lacked a historical perspective and had no notion of methodology in science. As a result, the wildest and most impossible ideas circulated to solve problems related to crop protection. In addition, I thought that some philosophical reflection inspired by the immediate objective of crop protection might be useful.

The design of the course was constrained in several ways. Teaching time—including preparation, updating, actual contact with students, and examination—was strictly standardized, and I had to remain within the time limits imposed. Dutch high school education at the time emphasized discussion rather than reporting. Thus, Dutch students had great difficulty writing papers. They liked discussion, preferably without guidance, and they easily went astray in such a discussion. These constraints led to the following choices: 1) a lecture format, 2) a rather detailed course book, 3) no term papers, and 4) a knowledge-oriented rather than insight-requiring examination.

The course was placed in the second trimester of the third year of the curriculum, at the end of the period of more or less passive acquisition of knowledge and just before the period of active participation in ongoing research. The students, about 21 years old then, had sufficient factual knowledge so that elementary explanations (e.g., on damage done by insects) could be avoided. They would be applying their views on methodology in the near future.

Course content

The course outline, as represented by the chapters of the course book, is: "Prescientific Crop Protection," "Science Coming into Being," "Private Initiative," "Public Initiative," "The Industry," "Methodology of Research," "Methodological Tools," "Applied Methodology," "Before and After Statistics," "Design of Research," "Crop Protection Research and the Demand of Society," and "Crop Protection Research and the Demand of Science."

Six chapters deal mainly with history and six with methodology. A historical introduction has several advantages: 1) The history of crop protection is known, 2) the gradual increase in the complexity of science and society can be demonstrated, and 3) the idea can be demonstrated that science has a historical dimension and thus, *ipse quo*, a future. The second part of the course, dealing with research methodology, emphasizes the art of asking the right question and of finding the answer to just that question. This aspect of methodology is bench-oriented. In a wider scope, the interaction between society at large and the science of crop protection is discussed. Again, finding the right question that society can pose to science is an urgent but very difficult problem. Possible questions of the near future are touched upon. The course usually ends with a philosophical flashback to the interaction of society and science in a period of intense innovation, 1859 and surrounding years.

I find it difficult to explain how large societal issues can be addressed by a discipline-oriented community of scientists. The difficulties are due in part to my own lack of appropriate knowledge and in part to the students' lack of insight into societal affairs. Twelve lecture days with two lecture periods of 45 minutes each are available. The allotted time suffices to discuss each chapter (about 45 minutes per chapter), to elicit general discussions, and to handle some special items. Among these are: 1) a special topic (an in-depth discussion of one recent crop protection problem with strong societal implications), 2) a discussion on the methodological analysis of scientific publications, and 3) a discussion on "actor analysis" of newspaper clippings.

In 1989, students were given the option of presenting a 10-minute talk on an issue in crop protection relevant to society or to themselves. They were requested to render opposing views on the issue objectively and to offer their own opinion only during the last minute. This experiment in increasing the students' participation seems to be appreciated.

The historical part

Crop protection was already applied in the prescientific era. Part of it was rational, viewed in retrospect, but another part was magical. What is the relation between a magical and a scientific approach to a practical problem? Do we still practice magic today?

The notion of infectious agents existing in discrete entities grew slowly through history, but epidemics were described in antiquity. The relation between medical and botanical pathology through time is mentioned. The origins of scientific research in crop protection, originally performed by people of "independent means," later replaced by government officials, and still later also by employees of industry, are discussed. When large groups of producers or consumers are affected, or great economic interests are at stake, legislation comes into being.

The present complexity of society with food producers, processors, and consumers; with farm suppliers, extension

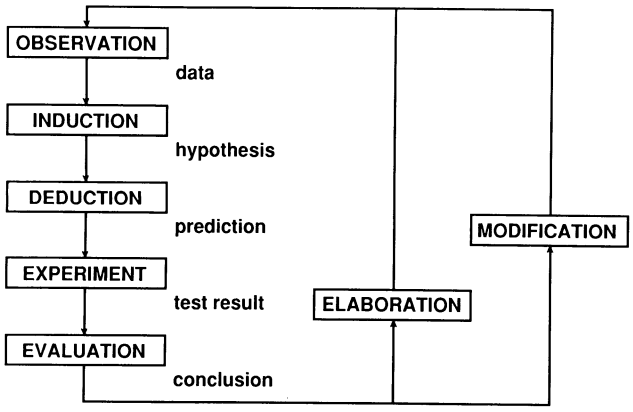

Fig. 1. The empirical cycle. Uppercase terms represent action, lowercase terms represent results of actions.

services, private consultants, and pesticide salesmen; and with research at different levels, from fundamental to applied, is discussed. Attention is given to the organization of research and to the flow of information in crop protection.

The methodological part

The empirical cycle (Fig. 1), used to create new knowledge, introduces the methodological part. It can be applied at the students' own level in research for their M.Sc. theses. Methodological tools ensure sound analysis and good communication. The seven questions of rhetoric—who? what? where? when? how? why? whereto?—are mentioned. The tension between reductionistic science and holistic aspiration, between analysis and synthesis, is discussed. Attention is given to different types of explanation (causal-analytical, functional, and historical). An exercise, the methodological analysis of two publications, is assigned.

The necessity of statistics has to be demonstrated to the students. Mathematical statistics per se are not discussed, but the problems before and after statistics are emphasized. How can we translate a biological, ecological, or agricultural problem into hypotheses that can be tested statistically? What types of experiments are available? After having "gone through the movements" with more or less statistical insight, the statistical answer has to be translated into a biological conclusion, and the biological conclusion into action. How?

A small excursion is made into the problem of "context." Context determines our perception of reality, our way of phrasing research issues, our attitude in envisaging action. What is the consequence of the fact that each of us works in a limited context? Can we find universal truths when constrained by a particular context?

During discussions of the interaction between science and society (whose society?), questions are raised such as about the effects (desirable and undesirable) of technological advance, how to find out what society (which one?) wants from crop protection workers, how to phrase society's needs (and by whom?), how to split complex problems into manageable pieces, and how to finance research. To what degree is scientific research out of phase with societal needs? Such heavy problems can be touched upon only lightly.

The science of crop protection has had its paradigm fights. The most important change of paradigm was due to the victory of the pathogenetists over the physiogenetists. The fight lasted for up to two centuries. Are there other examples of paradigm change in crop protection? The erosion of what was nearly unlimited confidence in chemical control might well be seen as another fundamental change. The impact of molecular biology may cause a new change of paradigm.

The course ends with a general issue, the initiation of new ideas from very different arenas of spiritual life. The enormous changes in science, culture, ethics, literature, and so on in and around the year 1859 are discussed. They are exemplified by the publication of two books that changed the world's thinking: Karl Marx's *Das Kapital* and Charles Darwin's *Origin of Species*. Is the coincidence accidental or not? I try to emphasize that the present is the future's history.

Student participation

Though students must get a "pass" mark for the examination, lecture attendance is not obligatory. Usually, a rather stable group of about 70% of the subscribers emerges every year. These are attentive and critical listeners. It is difficult, however, to engage Dutch students in discussion. If pressed to answer questions, their answers are often well meditated and correctly formulated.

The special topic is a favorite. One lecture day is devoted to it. The first lecture period is used to explain the problem at length, and the second is available for discussion. In recent years it was the problem of fire blight (*Erwinia amylovora*) on pears and hawthorns. Pear growers and nature conservationists are strongly antagonistic groups—the former wanting to destroy all hawthorns (which may serve as an accessory host to the pathogen), the latter wanting to protect the hawthorn (even with their bodies) as an element of beauty in the landscape. Once, the secretary of agriculture had to intervene in person. What regulatory action is possible, which has been taken, and what is its effect?

For the methodological analysis of publications, a set of six to eight papers showing various aspects of one problem (epidemiology of *Septoria tritici* on wheat) is offered. Each student has to comment on two papers, following a long checklist. The goal is to see whether the author has clearly formulated the problem to be addressed, whether he/she has applied adequate methodological reasoning, and whether he/she really answers the research question raised in the introduction of the paper. Great is the astonishment of the students that they can perform such an analysis without factual knowledge of the subject. Even greater is the amazement that in several papers published in journals of good renown, one or more obvious methodological rules are violated.

The students are required to collect newspaper clippings related to the course topics. The "actor analysis" applies a few simple tricks to analyze the objectivity of newspaper articles on crop protection issues. It refers to the formulation of the question, the action taken to answer the question, and whether the response given really answers the question. Moreover, it checks for overt and concealed interests of various parties, including the journalist and his/her informant(s). Even without inside knowledge of the issue, which the students usually do not have, the results of a superficial analysis may be quite revealing. Apparently, objectivity in reporting is difficult, to say the least.

Evaluation

The effect of the course is not easy to assess. For reasons unknown, students tend to underestimate its difficulty and spend too little time on it—on average, some 60 work hours instead of the expected 80. They experience a relatively high failure rate at examination. Possibly, the "talk show" aspect of the course induces them to underestimate the amount of knowledge offered. Several students appreciate the difference relative to other courses and keep coming. A few react with violent feelings and refuse to attend the lectures. Students reacting so emotionally might belong to the critical group considering present society to be "rotten" anyhow. They want to expose their own opinions instead of being exposed to the opinions of a teacher whom they cannot trust because he embodies that despised society.

The student assignments are generally appreciated, according to evaluation forms and personal information. One student confessed that she had learned how to read a newspaper. Most students say they have no time to read newspapers, but they do not contradict my statement that they

take the time to see television. Several students politely informed me that they considered the examination rubbish. Most "questions" have the form of a statement to be identified by either true or false. Indeed, the problem of efficiently examining students in this type cf course is not yet solved satisfactorily.

It seems that the course might eliminate some naiveness that could hamper a student's further development. For example, the first question to the audience in the first lecture hour may be: "Why are we here as crop protectionists?" The answer that we need to safeguard our food supply is never given. These students have never had food shortage problems. Food is always plentiful in the supermarket.

Ethics was an important issue in students' discussions during the early 1970s, subsiding later, and emerging again quite recently, possibly in reaction to the environmental problems and/or the no-nonsense attitude of the late 1980s. Ethics in teaching is another problem. I try to avoid impregnation of the students with my personal opinions and prejudices, as far as possible. Rarely, students demand that I express my own feelings or reasoned opinions.

A possible effect of this course may be a gradual but evident increase in the quality of student research reports, as I have noticed with students taking epidemiology as their research subject. But progress is normal and may have nothing to do with the present course. The incidental student who, older than the lot, has some experience in society and/or in research may repeatedly show nonverbal consent by actively nodding his/her head. I am tempted to conclude that inoculation of students, who have little knowledge of either society or research, with a philosophical injection leads to philosophical fruition only after a long latency period, in their student life or in a following phase of their career.

Acknowledgments

I acknowledge with gratitude the contributions of two small groups of students. Around 1968, a few philosophically trained students helped me to design the predecessor of the present course during a number of sessions of very intensive discussion. Some of these persons now have positions of prominence. Late in 1988, some keen students interested in philosophy criticized the course severely but in a constructive spirit. Changes, such as the 10-minute talks, were introduced accordingly.

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