FOOD, AGRICULTURE, FORESTRY, NATURAL RESOURCES, SCIENCE & TECHNOLOGY[1]

A Round Table Discussion Paper

Agriculture touches all aspects of human activity. Industry, art, and science are all products of a civilization founded on and supported by Agriculture. Agriculture was one of the earliest manifestations of collective human activity and gave birth to the civilization we take for granted today. Somehow, during the evolution of Agriculture from hunting and gathering to settled crop and animal production, to complex modern systems for producing and distributing food, fiber, and forest products throughout the world, Agriculture is no longer recognized by all as central to human life and culture. Agriculture is no longer a primary subject of public interest, political action, and academic study.

Those who tend the land, husband our natural resources, and manage the processes of nature, whether in the fields or the forests or the marble halls of government are the stewards of society and the conservators of civilization.

Land as a source of food, fiber, and shelter is the fundamental capital asset of civilization—the gift of God through the agency of nature by the natural processes which brought that gift from the Almighty to the human race with the admonition to use it wisely for the benefit of all Creation through each succeeding generation until the end of time.

This Round Table has been convened to discuss the level of resource commitment to research related to food, agriculture, forestry and natural resources. Among those who would be the beneficiaries of such economic support, there is broad-based, virtually unanimous agreement that funding of research should increase. In this regard, the Board on Agriculture, National Research Council recently released a report recommending an increase of $500 million for research on food, agricultural, and environmental sciences. Although there is broad-based support for increasing the resources devoted to research, there is a need to develop an improved understanding of the desired mix in the allocation of existing and future funding among competitive grants, formula funding, in-house programs, and

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other allocations.

To convey the essence and importance of modern Agriculture in a Society that takes low-cost food and abundant wood and fiber for granted, a clear conceptual framework is needed which acknowledges the complexity of Agriculture itself and the many strands that bind it to natural systems and human endeavors.

SCIENTIFIC RESEARCH

At the close of World War II there were two models for successful scientific research. The most widely publicized was the Manhattan Project which gave us the fission bomb, artificial radioisotopes in commercial quantities, and large scale radioactive material handling technology. Less widely known but of even greater value to civilization was the OSRD (Office of Scientific Research & Development) which was responsible for literally hundreds of practical inventions ranging from millimeter radar and that branch of mathematics we now call Operations Research (OR), to anti-malarial drugs and blood transfusion technology. The list of OSRD achievements is almost endless, but this kind of research and development effort was never continued because the rapidly growing bureaucracy of higher education and government adopted the single minded Manhattan Project approach as more "efficient." The unstructured methods of OSRD, driven by field-necessity like the *ad hoc* methods of the OSS soon became inconsistent with the burgeoning bureaucracy in both Science and espionage.

The catastrophic failure of American Science to build a broad multi-disciplinary intellectual base spawning innovation and encouraging inductive leaps and the well-touted "intelligence" failures of the CIA are but two sides of the same coin.

The new management books make a great deal about the rediscovery of innovation as the source of industrial progress and the basis for real profit in business and commerce. In 1985 there were whispers about creation of an "All Agricultural University Think Tank" to work on the problems of Agriculture. To date, however, nothing has happened.

Much of the efforts of the educational establishment to develop "generalists" has been nothing more than an excuse to allow people to learn very little of significance about many areas of academic concern and not enough about anything to make a significant contribution to improving the human condition. The free market system has demonstrated that those "management scientists" who taught that managers need only "know how to manage" perpetrated a cruel hoax upon American business and industry. The recent spate of books by management consultants lauding "hands on" management and concern at the top for products and customers is long overdue. Many areas of science are in danger of similarly missing the basic reason for the existence of academic "disciplines" and

“departments.”

Yet when you ask university professors, deans, college presidents, and senior faculty members, “What ever happened to the ‘community of scholars’ that was the ideal of a university?” the answer is, “We don’t know what happened to it or even whether during our lifetimes it ever existed.” The effort to develop a conceptual model of Agriculture as a General System may very well force the reestablishment of a scholarly community if not necessarily a community of scholars. If the effort accomplishes nothing other than to encourage discourse among scholars of different backgrounds there should be a significant improvement in higher education.

We must replicate the successful methods of the OSRD and bring them to bear on the production and distribution of food, clothing and shelter throughout the world. Since it appears that nothing is going to come from the academic community in time to accomplish anything useful, and as our time runs out, I propose that we establish an Agricultural Systems Science Institute or National Academy of Agriculture outside the traditional institutional structures of our Colleges and Universities.

The Institute or Academy should function largely as did the central administration of OSRD during World War II. Its work should be driven entirely from the field and by the demands of those concerned with Agriculture at the working level whether farmers, industrial corporations, agribusiness, and consumers.

The central Institute or Academy management team would consider each problem presented and identify the areas of academic, scientific and industrial concern and interest the experts in these areas who might be able to contribute to solution of the problem. The principle function of the Institute or Academy would be to enlist the support of these experts in solving the problem and to define the nature of the solution required to meet the goals of the entity which brought the problem to the Institute or Academy.

Had OSRD continued its efforts after World War II and become the principal problem solver for industry in America, the revenues derived could easily have promoted research at the graduate and undergraduate level at every University throughout the United States without the need for taxpayer subsidiaries through government handouts under the control of the associated bureaucracy. OSRD was the leanest nationwide institution in the history of science and it produced some of the most extraordinary results in the history of human endeavor. There is no reason why this glory cannot be recaptured.

Entire industries were born during and after World War II as a result of the OSRD efforts and older, established industries became more efficient and

profitable as a result of OSRD contributions. Nevertheless, nothing as fundamental to world peace and international stability as food, clothing and shelter has received the benefits of such concentrated attention by the academic, scientific, engineering, and intellectual community in America.

If the Japanese can mobilize all of their computer scientists in the race towards Fifth Generation hardware and artificial intelligence, why can't the leaders of industry, academia, government, and public interest groups in America make a relatively limited effort to kick off a more modest endeavor with even greater potential return not just for the institutions and constituencies they each represent, but for the world at large?

Regrettably, there is no individual we can immediately recognize as the charismatic successor to Charles Valentine Riley,[2] nevertheless, some effort must be made to launch this program quickly. I toss this challenge to all of you and the groups you each represent because there may be no other group with the necessary vision and resources to accomplish the task.

There are only a few narrow windows in history through which great projects can be launched and civilization advance. It appears we may be doomed to the fate of other civilizations whose bread baskets turned to deserts and whose greatness turned to ashes.

At the risk of misquoting the Bard, I must remind you that "the fault is not in our stars, but in ourselves;" and "there is a tide in the affairs of men which taken at its flood leads on." The dire consequences for all if we miss this tide should be

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2 Charles Valentine Riley was born on September 18, 1843, and died on September 14, 1895. He left those concerned with providing food, clothing, and shelter for humanity a rich legacy of information, invention, and ingenuity. But above all, Charles Valentine Riley provided us with the example of his life, a model of the free spirit of scientific inquiry. His insights were drawn from the keen observation of nature as it really exists in the world around us, not as it may be distantly perceived from the ivory tower of academe or studied in the sterile environment of a laboratory. Charles Valentine Riley met Nature in the fields and the orchards where the farmers labored, and the meadows and the pastures where the animals grazed.

Charles Valentine Riley established the intellectual framework for modern agriculture. He believed that Agriculture must be well understood by those who vote and those who are chosen to lead and he devoted his life to that cause.

His youngest daughter, Dr. Cathryn Vedalia Riley sought to restore American Agriculture to its proper place in the heart and mind of the American people and re-establish the respect that American agricultural science and technology once held throughout the world. As a physician she recognized the ultimate needs of people for food, clothing and shelter and that the wise use of land and landscape and conservation of our finite natural resources are the fundamental obligations of civilization. She also recognized that technology, no matter how advanced, and scientific studies no matter how detailed, were of little value to Society without enough food, clothing and shelter. She hoped for an Economy which encourages and promotes technological innovation to support a civilization that would promote the evolutionary advance of the human spirit.

obvious to those who witness the plight of not just the Third World, but the malnourished, poorly clothed, ill-housed poor people in American today and the struggle of the peoples of Eastern Europe and the Soviet Union to emerge from the feudalism of twentieth century totalitarianism. Let us at least make an effort to do it right one more time. **A MODEST PROPOSAL**

One of the reasons agricultural policy is in such a muddle is that there is no way of considering, or even identifying the associations among elements of agriculture as a system that may be affected by a particular policy or the lack of any policy.

No research should be funded unless and until the results of that research—whether positive or negative or even inconclusive— can be shown to have some significant relevance to elucidating an association between elements of the complex dynamic General System that is **A**griculture, or modifying such an association in a manner that is consistent with sustaining the entire system.

A substantial communication barrier obscures the relationships among all of the disparate elements of Agriculture as a complex dynamic General System. Communication among the disparate elements of the Societal system that is Agriculture must be improved and networks among experts from among all those concerned with providing sufficient food, clothing and shelter for the peoples of the world must be established forthwith.

There is an obvious need for a conceptual model which enables us to look at Agriculture as the complex dynamic General System it really is but from the inside out. We need to explore the structure of Agriculture as a System from within the system (where we and all the other human beings on earth actually are) rather than attempt to impose a structure on a system we do not yet comprehend from without. Certainly the "inside-out" model is less threatening in the social and political sense than some structure imposed from outside.

In a pluralistic society, particularly in the area of international relations, the existence of models which may acquire the political and social attributes and characteristics of the modeler yet still be amenable to comparison and evaluation in other cultures and by other peoples might be of great value in offering alternatives to otherwise polarized international confrontations.

Without a conceptual model from which to extract information about the relationships among the various research proposals and their place in the overall program to increase the production of food, clothing and shelter for the peoples of the world, our Congress and the other legislative and deliberative representative bodies throughout the world will make decisions that irrevocably commit the limited natural resources of the earth—soil, water, air, land, landscape, habitat, and the gene pool to short-sighted responses to the whims of the moment. This may seem to be a terribly pessimistic view of our present circumstances, however, it is

consistent with the rather sad experience of the last hundred years.

I suggest that the effort begin with the creation of a conceptual model of Agriculture as a dynamic General System. This is an eminently "doable" project. All it needs is a host, a home, and some seed money. The hosts and the homes are many. All that remains is the will to succeed, a tight timetable, and adequate financial support.

MODELING AGRICULTURE

Any agricultural modeling effort must be treated as an exercise in information management. We must recognize that we are looking at a mass of information in which each item of data is related in some way to one or more other data items and that the conceptual model of the System is nothing more than a relational data base which should permit any concerned citizen to start anywhere and create a thread through the maze of information available about the disparate elements of Agriculture as a General System.

A conceptual Agricultural modeling effort can present the relationships between and among the individual and disparate elements of Agriculture as a dynamic General System and provide the public with a way to manage information about some of the most important resources in the world. This information management technique can then become a "tool" available to the people who are responsible for formulating national and international policy for the management of those natural, social and societal resources that are the basis for maintaining and sustaining World Agriculture as the ultimate source of food, clothing and shelter.

The conceptual modeling effort I propose for Agriculture as a General System starts with the assumption that a model of relationships can be developed if the word "relationship" is loosely defined as any association between system elements (any of which might also be a system in its own right) where a change in one element is associated with (although not necessarily the result of, much less causally related to) a change in the other element. Such a definition of "relationship" permits the construction of an n-dimensional web of associations which can be considered at any time as a less complicated web of n minus m dimensions for the purpose of considering some subsystem of the original system.

A subsystem may be defined as some set of elements from the entire system with some set of associations among them which have been constrained or bounded in time or space or by some precise functional definition.

In order to establish a manageable "representation," a word which may be used instead of "model," of agriculture as the complex system it truly is all we need do is identify the elements of the system, characterize those elements in terms of the information they contain rather then the data which can be gathered

concerning them, and then identify the associations that exist between each element and other elements. Each pair of elements between which an association can be established becomes a relation and the general system we call agriculture is nothing more than the set of all such relations.

Identifying the effects of a particular decision concerning one or more elements of the system or one or more associations between elements or one or more relations within the system first requires the decision maker to accept as a basic policy consideration and, to a certain extent, a constraint upon the freedom to adopt or implement policy decisions, the need to as the question, "Effects upon whom? Effects upon what?" These are not questions which require quantitative answers. In the first instance the issue is not how much of an effect, but where will the effect be perceived. Perception of an effect is more important in many cases than the actual effect, especially when matters of policy are the issue and all of the discussion is essentially speculative.

If the elements of agriculture are identified, and the associations between elements are identified and the associations between relations (defined as a pair of elements and an association between them) then the set of all such identified or perceived relations*(EM the agriculture data base which is the general system we call agriculture can be searched through rather straight forward methods of relational data base management so that the policy makers can immediately perceive the relations which will be affected by any proposed policy should it be put into effect. This will immediately identify constituencies which must be considered and should participate in the decision making process. It will also identify the constituent elements of such constituencies and in many cases identify alliances (associations between disparate groups concerned with various aspects of agriculture as a general system.)

When we succeed in describing agriculture as a general system in terms of its elements, the associations between elements and the associations among elemental relations, all of the existing static models can be accommodated as special cases or subsets or threads, and many of those models can be tested in the qualitative sense for their accuracy as representations of real systems within agriculture as a general System.

The immediate value of a conceptual model of Agriculture is to provide an immediate visualization of where the research for which economic support is sought contributes to the complex system that is Agriculture.[3]

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3 One of the most obvious ways of creating this kind of model of relationships is by simply identifying a item such as a plant or animal and then identifying all of the attributes of that plant or animal no matter how numerous, and all

The first national agricultural forum was, like the forum in ancient Rome, a place where all the people could meet together to hear new and exciting ideas, learn new facts, acquire new information, and test new theories in the crucible of civilized communication, through the dialectic of rational discourse in order to eventually reach some consensus, then move on to hear new ideas and so repeat the cycle. In this way, civilization advanced one short intellectual step at a time.

The success of the First National Agricultural Forum was in bringing together individual and institutional representatives of the disparate elements of the Agricultural community so they could meet together and discuss matters both informally and formally, without the need to take a formal position at the conclusion of the Forum or even take a formal position during the course of an individual presentation during the Forum.

It is just such freedom from the need to take a formal position on any matter that characterizes a conceptual systems modeling effort. The purpose of the conceptual systems modeling effort is simply to identify relationships. It is not necessarily to quantify the relationships or even define them precisely, merely

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of the other identifiable items which might be associated with the plant or animal in accordance with some definite relationship no matter how transitory or temporary.

For example, the attributes of a plant such as corn might be its genetic characteristics, its growing season, and its nutrient requirements including the energy necessary to grow it, harvest it, process it and distribute it. Among the elements of the General Agricultural Model with which that particular plant, corn, might be associated at any given moment are water, insolation, soil nutrients, atmospheric nutrients, atmospheric contaminants, herbicides, insecticides, other pesticides, the machinery of harvest, the business entities which market. After as many elements of Agriculture as a system have been identified, their attributes listed and their associations and relationships identified, these elements can be related to well-established systems such as the world climatological system, local weather systems, soil associations, the nitrogen cycle, the carbon cycle, the phosphorus cycle, the hydrologic cycle, and then various elements and subsystems of established models such as water balance models, econometric models and the like.

One of the initial tasks in building a conceptual model of Agriculture as a dynamic General System will be to create a composite of all the conceptual aspects of all the extant models which might illuminate the relationships among the elements of the general system that is World Agriculture.

identify the existence of some relation between particular system elements or groups of system elements.

The conceptual modeling effort itself is an exercise in consensus building among disparate elements of the overall Agricultural System, and among those individuals who are particularly concerned with specific and therefore, of necessity, limited, aspects of Agriculture as a System.

Just by assembling a group of individuals from diverse backgrounds for the purpose of discussing the relationships among the elements they each recognize as components of the General Agricultural System and with which they are personally and professionally familiar eventually forces each individual to consider their relationships with the other individuals at the same meeting and the relationship of their discipline with the disciplines and outlooks represented by each of the individuals at the meeting.

The more individuals who assemble in groups for the purpose of building this relational conceptual model of Agriculture as a General System and the more complex the existing relational model which serves as a starting point for each discussion at any particular meeting, the richer the modeling experience.

Since the bounds of the model are undefined and the extent of the relationships unknown *a priori*, the conceptual systems model building effort is always a process in being, a continuous effort to identify relationships among the determinable elements of what may very well be an extraordinarily complex, dynamic and indeed chaotic, system.

The conceptual systems modeling effort is a general case of the Delphi method and initially the freedom to talk about relationships among the elements of the system as impersonal objects provides the participants in the conceptual modeling effort with a period of interaction at the highest professional level without the need to be concerned with personality or, as the psychologists might say, "role-playing." Eventually, as the participants in a particular effort become more comfortable with each other as individuals and realize that they are essentially noncompetitive in the context of the conceptual systems modeling effort, personal relationships may evolve. Inevitably the conceptual systems modeling exercise promotes increased understanding and awareness among experts who might only rarely join together in any common professional exercise.

The conceptual system modeling effort is a continuing process the purpose of which is to uncover more and more relationships even though they may not be quantified or even if they are non-quantifiable. The conceptual modeling effort may even identify a limiting parameter in particular subsystems and thereby point the way for more precise quantitative modeling and drive and focus scientific investigation in the laboratory or in the field.

Conceptual systems modeling is nothing more than identification of relationships among elements which are part of a system by *a priori* definition or inclusion *a posteriori* as the result of an association or relationship with an *a priori* or previously defined system element. There is really no detailed agenda other than to set forth the methodology of the exercise. The conceptual systems modeling effort is very much like a Delphi exercise.[4]

Since the relations which exist between and among elements of the Agricultural System are not necessarily well-behaved functions (in the mathematical sense that a function is a relation in which every element in the domain of the function is related to one and only one element in the range of the function), there is little value in pursuing the precise quantification of either system elements or the parameters by which they are usually characterized. Qualitative expressions (large, small...) and order (greater than, equal to, less than) are really all that is necessary for quantifying relations within a general system at the conceptual level.

Eliminating the need for numerical precision improves the flow of the exercise by encouraging scientists to report their information in qualitative terms without the need to associate their status and reputation with the accuracy and precision of their numerical estimates.

Agriculture must be considered as a General Dynamic System and a Science in both the metaphysical and epistemological sense of those words. There is still no conceptual model of Agriculture as a System nor any definition of Agriculture as a Science which will unify consideration of and promote rational discourse about the problems of food, clothing and shelter for the human species.

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4 See Memorandum annexed on the use of Delphi methods in the ultimate resolution of the Agent Orange Settlement distribution controversy.