Impressions of South China's Efforts to Achieve Sustainable Agriculture

Walter E. Parham*
(Virginia 22182, USA)

Abstract: Evidence of the damaging effects of South China's long agricultural history is written on the land. The goal of achieving sustainable agriculture in China is part of a change in world thinking of making agriculture and the environment fit hand in hand. To achieve this goal requires that ecological principles be blended smoothly and effectively with agricultural practices into a new applied science called agroecology. However, efforts in sustainable agriculture need careful attention to assure that they do not produce unintended consequences.

Decision makers at whatever level, are faced daily with finding solutions to complex problems related to social, economic, political, and environmental concerns. Because it is likely that such decision makers were not trained specifically as scientists, applied researchers, like those in sustainable agriculture, need to consider the written delivery of their research findings in a form that will be easily understood by the non-technical reader. By simplifying the scientific writing and delivering it to the decision maker(s) as a short, interdisciplinary narrative, the researcher may see his or her work implemented more quickly. By doing so, the researcher may find that in the future support for additional important research will be more forthcoming.

Key words: sustainable agriculture; decision makers; South China

Evidence of the damaging effects of South China's long agricultural history is written on the land. Although progress in land improvement is evident at many localities, one can easily see the adverse effects of forest destruction, extensive and severe soil erosion, siltation of waterways, water-logging of agricultural fields, and loss of wildlife and wildlife habitats to mention a few. China's researchers today are working to bring these damaged lands back into productivity, a productivity that can be sustained. Many field examples exist illustrating techniques that suggest that sustaining long-term land productivity may be possible[1].

The goal of achieving sustainable agriculture is sought today by an increasingly large segment of the world's agricultural researchers and farmers. To achieve this goal requires that ecological principles be blended smoothly and effectively with agricultural practices into a new applied science called agroecology. The acceptance and application of agroecology is developing at different speeds from country to country. It seems to have a firm hold in South China. Perhaps in part, this is because China's agroecologists have been able to draw on China's thousands of years of recorded history of agricultural practices and experiences. From these records, the researchers can gather evidence of past applications of agroecological principles that might be adapted and reapplied today. Similarly, Chinese researchers have studied the agricultural practices of their many minority populations and found, here too, evidence that some groups even without formal training, know how to blend ecological knowledge with farming practices in productive ways.

Large-and small-scale examples of various forms of sustainable agriculture exist on South China's flat lands and steep hillsides. They are too numerous to describe here in detail but some major ones include various forms of stereo-agriculture, combined engineering and biological approaches to halt massive soil erosion and landslides, stabilization of shifting sand dunes, dike-pond systems to reclaim water-logged fields, cropping systems that mimic the structural and ecological characteristics of a tropical forest cover that once existed here, vegetation arrangements to minimize typhoon damage, and biogas generation. Economic data supports that the local population benefits directly from application of such techniques[1].

My impressions of South China's efforts to achieve sustainable agriculture are derived from two different experiences. First, over the past ten years, I have cooperated

* Walter E. Parham, Ph.D., Honorary Professor of South China Agricultural University.

and worked periodically with Chinese researchers who are addressing difficult problems of degraded lands in tropical and subtropical China and who seek innovative ways to improve the land and to sustain those improvements. They have provided me with exposure to a wide range of their field research activities directed toward achieving sustainable agriculture. Second, I directed the Food and Renewable Resources Program for the U.S. Congressional Office of Technology Assessment for sixteen years where we conducted studies on agriculture and renewable resources for committees of the Congress. We were asked to assess the science and technology related to agriculture and renewable resources for the United States as well as many parts of the tropical/subtropical developing world.

1 Unanticipated effects

Each of you probably recognizes some areas of sustainable agriculture research where improvement is needed because of the undesired ecological consequences that have arisen or might arise from well-intended actions. Let me just illustrate with two examples.

The introduction of exotic tree species into the United States is causing and has caused serious damage to the country' native vegetation and wildlife (Tab.1). I have only selected trees brought from the Asia and the Pacific region[2] to include in this example. The introduction of exotic plants and animals generally has cost billions of dollars in damage[3]. These various tree species were introduced into the United States without sufficient consideration of how they would affect native vegetation and wildlife. The trees have become invasive, crowding out native species, destroying wildlife habitat, and thus reducing biological diversity. Looking back, many of the costly problems that resulted could have been avoided if the potential long-term adverse effects of the introductions on the ecosystem had been assessed carefully.

Tab. 1 Troublesome exotic tree species in the United States that originated in the Asia or the Pacific region[1)]

species	common name	associated problems
Acacia auriculiformis	earleaf acacia	invasive[2)]; prone to wind damage
Acer ginnala	amur maple	invasive
Ailanthus altissima	tree-of-heaven	invasive
Bischofia javanica	bishop weed	invasive
Broussonetia papyrifera	paper mulberry	invasive
Casurina equisetifolia	Australian pine	invasive in habitats of sea turtles and crocodiles
Cupaniopsis anacardioides	carrot wood	invasive
Eucalyptus globulus	blue-gum eucalyptus	invasive; fire hazard
Ficus altissima; *F. benghalensis*; *F. microcarpa*	fig	kills native vegetation; causes structural damage to roads, etc.
Melaleuca quinquenervia	melaleuca	invasive; fire hazard
Melia azedarach	China-berry tree	invasive
Paulonia tomentosa	princess tree	invasive
Sapium sebiferum	Chinese tallow tree	invasive
Schefflera actinophylla	queensland umbrella tree	invasive
Tamarix ramosissima; *T. chinensis*; *T. parviflora*	tamarisk	invasive; clogs drainage; fire hazard; increases soil salinity
Ulmus pumila	siberian elm	invasive

1) Exotic tree species in the United States from Asia and the Pacific region. These trees have caused severe impacts on the U. S. biological diversity by crowding out native plant species and by invading animal habitats and, thus, displacing them; 2) crowds out native species; reduces biodiversity.

It seems evident that because China too relies heavily and extensively on exotic tree species in their work to improve degraded lands that China may be headed for some costly, long-term problems as well. Maybe some of the exotic trees species that have been introduced to China will fit into their new ecosystem without causing problems. However, sometimes it takes years before such problems become evident and even longer to rectify the damage.

A second illustration relates to the use of sewage sludge as a soil amendment for degraded agricultural lands. At first glance, this may seem to be a good solution to two problems, (1) disposing of sewage sludge and, (2) increasing the organic matter content of degraded agricultural soils. In some cases, this may work but a wealth of evidence exists warning of potential adverse effects.

The roots of most plants are infected with a mycorrhizal fungus; the combination of root and fungus is called a mycorrhiza. Mycorrhizae provide a host of beneficial services to plants such as the transfer of a wide range of nutrients to the plant, enhancement of water transport to the plant in times of drought, provision of tightly-bound soil phospohorus and, in some cases, an increased rate of photosynthesis. In addition, mycorrhizae help bind soil particles together thus helping to reduce soil erosion. Mycorrhizae, however, commonly are absent or severely reduced in number and kinds in highly degraded sites and sites with heavily eroded soils[4].

Recent and extensive literature surveys suggest that metal-contaminated sewage sludge applied to damaged soils can adversely affect the development of mycorrhizae and the range of species of mycorrhizae that can survive on such sites[5,6]. In addition, heavy metals become mobile in acid soils and can contaminate food crops. Thus, before sewage sludge is added to degraded soils or damaged lands as a soil amendment to support sustainable agriculture, careful analysis is required to determine whether or not heavy metals are present in the sludge, and if so, how much and what kind of heavy metals are present, Damage to the soil's mycorrhiza from metal-contaminated sewage sludge could aggravate soil degradation, slow land recovery, and yield food crops hazardous to people. A sharp eye must be kept on sustainability when using this technology.

2 Expanded responsibilities for researchers

Today, however, I see a new challenge for the degraded lands and sustainable agriculture researchers in South China, one that is more complex than just the introduction of exotic tree species. The challenge is how to make your applied research so compelling to your government decision makers that they will quickly recognize the importance of your work and will eagerly wish to apply it to solving key environment, renewable resource, and sustainable agriculture problems. Not only do you hope that decision maker(s) apply your work quickly for the benefit of China's people but, in turn, you probably hope that such actions will result in increased research support for you to address other important pressing problems in sustainable agriculture.

High-level government decision makers in the United States commonly are not trained in science. While I worked for the U.S. Congressional Office of Technology Assessment, I surveyed the educational background and training for each Member of Congress(Tab.2). I do not know what this kind of survey would show for your government but I suspect that it might be similar. How can you communicate your research effectively to intelligent people but people not trained in science? We will examine this issue.

Tab.2 Average composition of the U.S. congress[1)]

educational background	number
lawyers, business men, etc.	523
scientists, engineers, & doctors	12
total	535

1) The average composition of the U.S. congress in recent years listed by profession and college training.

Decision makers at whatever level, are faced daily with finding solutions to complex problems related to social, economic, political, and environmental concerns of the people and the government(Fig.1). Fig.1 is a generalized tetrahedron diagram showing the multiple areas from which decision makers (policy) derive information for decision making. The complexities of questions that relate to sustainable agriculture, renewable resources, and the environment can be daunting. So, how can you help the decision makers and how might your efforts ultimately help you. Your problems as a researcher are difficult enough but I am going to suggest making them more so.

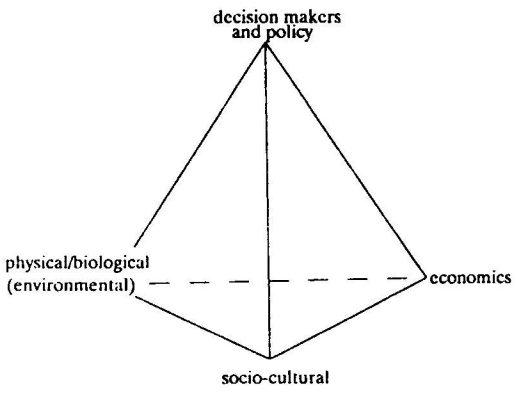

Fig. 1 The problem faced by decision makers

Let's break your new task into two parts. First, the next time that you begin research on some particular applied problem in sustainable agriculture, establish an interdisciplinary advisory panel of your colleagues. Include some individuals from the social sciences, economics, the physical and biological sciences, and someone who has governmental experience in decision making. Present the problem you are addressing and your research plan to your advisory panel. Ask for their assessment of what you need to consider during your work to assure that the study is well rounded. Meet with the advisory panel periodically to discuss your findings. Throughout the entire process, keep the needs of the decision maker(s) in mind. Your final written product should be comprehensive, clear, and objective thus designed to help the decision maker make an informed decision.

Let your advisory panel participate in brain-storming activities designed to help you identify any significant unintended impacts that might arise as a result of implementing your study findings. An interdisciplinary panel can be quite helpful with this task. Do not let potential short-term economic benefits overshadow important environmental concerns that underpin sustainability. Remember, the advisory panel members only provide you with advice. You must weigh their advice objectively but the final decision on the presentation of your work is yours.

Second, your report should tell what you did, what you found, and how it can be used by the decision maker(s), in other words "who cares?". Prepare a one-page summary of your completed research that contains these three points. Keep in mind that the decision maker(s) probably will not be a technical expert on the subject. Therefore, your writing must be clear, compelling, and readable and understandable to a non-technical person. If you provide possible options for the decision maker's consideration, including an assessment of the positive and negative impacts that might occur, should he or she implement your option. Keep your summary to one-page length. If the decision maker(s) shows interest in your summary and wishes to learn more about the subject and your analysis, you have your full report and you can brief the individual yourself. De-mystify science for your decision maker(s) and you generally will receive a positive response from him or her. By doing so, you may find that in the future support for your research will be more forthcoming.

What I have just described to you is a condensed version of how we conducted our technical work for and with the U.S. Congress. It may require additional learning on your part in fields in which you may have little background. The more often that you repeat the process, the more effective will be your scientific communications with your decision makers. Our experience has shown this to be true. Your work in sustainable agriculture is important to China, so don't let your research gather dust on the shelf. Your efforts will be worthwhile.

References cited:

[1] Parham W E, Durana P J, and Hess A L, Degraded tropical lands of China: problems and opportunities; Improving degraded lands: promising experiences from South China. Bishop Museum Press, Honolulu, HI, 1993. 3 ~ 14.

[2] Marinelli J, Brookland Botanic Garden, *Invasive plants*. 1996. 111.

[3] OTA. Harmful non-indigenous species in the United States; Office of Technology Assessment, U. S. Congess, OTA-F-565, 1993, 391.

[4] Allen M F, *The ecology of mycorrhizae*. Cambridge University Press, Cambridge, 1993, 184.

[5] Coral del Val, Barea J M, and Azcon-Aguilar, Assessing the tolerance to heavy metals of arbuscular mycorrhizal fungi isolated from sewage sludge-contaminated soils. Applied Soil Ecology, 1999, 11: 26 ~ 269.

[6] Giller K E, Witter E, and McGrath S P, Toxicity of heavy metals to microorganisms and microbial processes in agricultural soils: a review. Soil Biology and Biochemistry, 1998, 30: 1389 ~ 1414.

【责任编辑 周志红】

Invited Paper

Higher Agricultural Education & Modern Agricultural Science and Technology in the 21st Century

The Academic Workshop for the 90th Anniversary of South China Agricultural University, Guangzhou, China, 2000, p. 26-29.