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ECOSYSTEM SERVICES FROM UPLAND AGRICULTURE: A RESEARCH AGENDA

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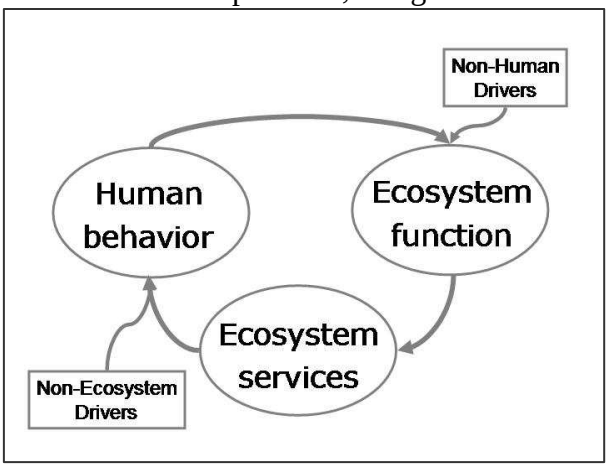
Agriculture as a managed ecosystem

Among ecosystems that are directly managed to meet human objectives, agriculture is the largest – especially if interpreted broadly to include planted forests and aquaculture. Its impressive productivity has simultaneously put the lie to Malthusian fears and raised new ones about environmental contamination and resource depletion (Robertson and Swinton, 2005). Both boon and bane aspects arise from the remarkable responsiveness of agricultural producers and scientists to meeting the demand for marketed food, fiber, and (increasingly) fuel products. The gains in food output that have outstripped world population growth have also generated a host of undesired side-effects. Some of those side-effects are consequences of missing markets, including wildlife habitat loss, greenhouse gas emissions, and waterway sedimentation. Other side-effects appear to be the consequences of information gaps or inadequate incentives, such as loss of beneficial insect habitat and soil fertility.

By thinking of agriculture as a managed ecosystem with many inputs and outputs, rather than as a way to produce marketed plant and livestock products, an agenda for ecosystem management research unfolds. That agenda is inspired by the belief that agriculture has the potential both to produce new, more diverse ecosystem services (ES) and to mitigate production of many current disservices (Swinton et al, 2006). The agenda calls for research to fill important gaps in 1) ecosystem functions that produce ES, 2) field-tested incentive mechanisms, and 3) cost-effective ES monitoring.



State of the biological science

A century and a half of scientific research on agriculture has generated tremendous knowledge of genetics and production input-output relationships. That knowledge base has allowed farmers to respond to changing incentives and constraints in thoughtful and productive ways. By contrast, shockingly little is known about input-output relationships for ES other than food, fiber and fuel products (Figure 1, link from ecosystem function to ES). What is the production function for biological pest control services? Carbon sequestration? Viable populations of desired bird and mammal species?

The implication of this knowledge gap is simple: Without knowledge of how to produce more diverse ES, farmers will produce them only by accident. Greater scientific understanding of *how ES are generated* is a necessary condition for change. In short, if farmers knew more about ES production, they might behave differently.

State of the economic science and the policy environment

Whether farmers really would behave differently depends upon the constraints and incentives that they face. Greater knowledge of ES production functions is a necessary condition for farmers to produce more ES, but knowledge alone is insufficient. Incentives shape managers' priorities at any scale of enterprise (see Figure 1, drivers of human behavior). The nature of property rights over managed resources plays a major role in all economies. Where managers have relatively strong property rights, they can expect to benefit from improved external incentives. Despite the dramatic research advances in nonmarket valuation and incentive design over the past three decades, there have been relatively few successful, creative attempts to translate the incentive lessons into policy. The lion's share of the incentive schemes applied to farmers involve government-financed cost sharing of input-oriented practices or schemes to retire land from agricultural production. Few incentive mechanisms that have been implemented focus on ES outputs, with the important exception of experiments in market-based payments for environmental services are underway, largely for water allocation in Latin American watersheds, and possibly the emerging carbon market. Incentive mechanisms to encourage greater ES production by land managers deserve greater research by economists.

A viable system for inducing greater ES provision by land managers requires not only knowledge of how to produce ES and incentives for why to do it, but also an information feedback loop that can measure the level of ES produced. The diverse and spatially diffuse nature of many ES makes cost-effective measurement a major challenge, yet as the saying goes, "you get what you measure." A third major research gap is for cost-effective measurement of ES, likely relying upon indicators that are well-correlated in time and space with the true ES of interest.

Conclusion

Filling these knowledge gaps on how ecosystems can be managed, as well as the incentives and cost-effective measurement of ES provision will require multidisciplinary research and practical experimentation. The work will need to take place at different scales, both socioeconomic, in order to link collective societal benefits to incentives for individual behavior, and biophysical, in order to capture the size threshold effects that underpin the functioning of many ecosystems. Such research could identify fresh ways to encourage ES provision as well as to improve understanding of how land managers would respond.

Key references

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