FOOD AND AGRICULTURAL SCIENCE AND TECHNOLOGY: NATURAL RESOURCES AND FOOD AND AGRICULTURE

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1. Setting the Context

In its broadest description, agriculture can be defined as the cultivation and/or production of crop plants or livestock products to be used as food resources for humankind. Food can be defined as any material that can be taken into the human body to maintain life and growth. Since every human is dependent on food in order to survive, agriculture may well be the most important endeavor in place on our planet, and its continued existence in a sustainable fashion is essential to the future of human life as we know it.

Generally synonymous with "farming"—the field or field-dependent production of food, fodder, and industrial organic materials, agriculture is practiced in all parts of the world in a diverse array of environments. As with most other primary industries, the natural resource base for agriculture is the physical environment.

Agriculture is one of the most widespread means by which humans have learned to manage and adapt the natural environment to sustain human activity. The practice of agriculture involves manipulating natural resources such as soil, water, and biological resources to produce enhanced varieties of plant and animal species in greater quantities than would normally occur in wild or natural systems. Agriculture has thus had a significant effect on local- to global-scale ecosystems, and can also be profoundly affected by local and global climatic resources. The way in which the available natural resources are exploited is very much dependent on the political system, the economic condition, the level of scientific knowledge available, and the state of technological development in an area. Agriculture, in terms of land-use, employment, and food production, thus remains the most important of all human activities, and will continue to be so.

Natural resources can generally be defined as products of nature or of natural processes that have value to human societies. Natural resources can have direct, economic value, or more indirect, or implied value. In either case, the adequacy of these products of nature tends to drive or limit the ability of humans to develop agricultural products. Therefore, the distribution and relative abundance of natural resources over our planet is clearly linked to the sustenance of agricultural production.

The purpose of this chapter is to examine the importance of natural resources to agricultural production. The natural resources–agriculture relationships that are explored in this section are linked to ecosystem classifications and their distribution, climatic resources, land resources and soils, water resources, energy resources, and biological diversity. Each of these relationships is considered as separate components as well as through an examination of the various inter-relationships. The concluding commentary provides a perspective of possible future implications that should be considered in terms of sustainable agriculture opportunities, as well as an examination of forward-thinking initiatives that could further enhance agricultural benefits to our human societies.

2. Agrosystems as Ecosystems

The agro-ecosystem differs from “wild” or natural, unmanaged, climax ecosystems, in similar physical environments, in being simpler, in having less diversity of plant and animal species, and in possessing a less complex structure. This also translates into less complexity in terms of biological diversity, whether it is considered at the genetic, species, ecosystem, or landscape level. Since agriculture involves the basic process of photosynthesis, the crop plant is the fundamental ‘production unit’ in agriculture. Because of the loss of complexity in the entire agrosystem, production units channel a higher proportion of the available energy through the system to humans in a more rapid fashion than in a natural ecosystem.

The global land base has been classified in a number of different ways over time by different agencies and individuals, with each classification generally based on plant species and cover types, soil types, or climate, but culminated in the mid-1980s with the production of an ecosystem-based classification system. For example in Canada, terrestrial ecozones were established, that provided a focus on distinctive areas where organisms (including humans) and the physical environment (i.e. soils, water, and climate) cohere as a system. Classification has been done at various scales in a hierarchical approach. Each scale offers different options in terms of data availability, detail, and completeness.

Up-to-date information is generally available for agricultural landscapes (and can be used to describe agro-ecosystems) in many countries of the world that conduct periodic censuses of agriculture. These provide an indication of how agricultural land use and land cover is changing across the country, and can be compared over time. Long-term trend indices can be developed from these data. Five major land cover/use types are generally differentiated from aerial or satellite sources as follows:

1. cropland, divided into crop types;
2. seeded pasture;
3. natural land used for pasture;
4. summerfallow;
5. all other land, including shelterbelts, farm houses and outbuildings, wetlands, and woodlands.

This type of classification system has the added advantage of depicting agricultural production areas of a country in relation to other production zones or "natural" areas, and can be a benefit to sustainability studies.

Another approach to agrosystem classification is to differentiate specific, usually physical, geographic features of a landscape, and ascertain their status. For agricultural areas of Canada, an example is Ducks Unlimited's approach to wildlife habitat classification and management. This technique has substantial spin-off benefits to agriculture sustainability and offers optimal planning and management opportunities for a wide array of different conservation purposes. Much of their work has focused on the Canadian prairie pothole region, where millions of small shallow wetlands dot the landscape. These wetlands and associated upland complexes represent critical breeding habitat for many waterfowl species. Ducks Unlimited personnel select areas for program delivery by ranking townships based on the numbers and permanence of wetlands. Those townships ranking highest are further categorized into key program areas, and ultimately specific target areas for on-ground implementation. Other data are used at this stage to better portray the status of pretreatment habitat. Development of specific land management plans that are designed to change the landscape from being generally unproductive and "duck hostile" to one that will improve recruitment is then carried out. Data for this analysis is provided from satellite imagery analysis, which incorporates census and other administrative datasets for a particular area. This technique has been especially important in allowing Ducks Unlimited to address requirements of the North American Waterfowl Management Plan.

The type of agrosystem in a given area of the world is determined partly by the natural resource base and its potential, and partly by the prevailing social, economic, and political conditions that influence the demand for and profitability of the crops and livestock that can be produced. In most cases, the optimum location for a particular form of agriculture will be that environment in which maximum return for inputs can be achieved. While the environment may govern its potential, its limits tend to be set by socioeconomic conditions. So that finally, much research has shown that farmers and ranchers tend to be conservative and often have deeply entrenched "reasons for doing what they do," so their individual decisions have a great bearing on the resulting agricultural landscape.

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Bibliography

Baydack R. K., Campa H. III, and Haufler J. B. (1999). *Practical Approaches to the Conservation of Biological Diversity*, 313 pp. Washington, DC: Island Press. [An informative textbook on an important future global issue.]

Bocking S. (2000). *Biodiversity in Canada: Ecology, Ideas, and Action*, 426 pp. Peterborough, Ontario: Broadview Press. [A book that provides numerous perspectives to complex environmental issues.]

Briggs D. and Courtney F. (1991). *Agriculture and Environment*, 442 pp. Harlow: Longman Scientific and Technical. [A textbook analyzing the relationships between modern agriculture and the environment.]

Brewer R. (1988). *The Science of Ecology*, 921 pp. Toronto: Saunders College Publishing. [A textbook describing nature as a whole with all of its interconnections.]

Government of Canada (1991). *The State of Canada's Environment*. Ottawa: Ministry of Environment. [A compendium of information relating to natural resources and the environment.]

Mungall C. and McLaren D. J. (1990). *Planet Under Stress: The Challenge of Global Change*, 344 pp. Toronto: Oxford University Press. [An attempt to come to terms with changes occurring on the Earth's surface.]

Owen O. S. (1985). *Natural Resource Conservation: An Ecological Approach*, 657 pp. New York: Macmillan. [A textbook describing the importance of natural resources and their management to society.]

Samson F. B. and Knopf F. J. (1996). *Prairie Conservation: Preserving North America's Most Endangered Ecosystem*, 339 pp. Washington, DC: Island Press. [A textbook describing the challenges and opportunities for promoting sustainable agriculture.]

Scott G. A. J. (1995). *Canada's Vegetation: A World Perspective*, 361 pp. Montreal: McGill-Queen's University Press. [A descriptive presentation of plant species in relation to physical geography.]

Southwick C. H. (1985). *Global Ecology*, 323 pp. Sunderland, MA: Sinauer and Associates. [A collection of essays describing the state of the global environment.]

Tivy J. (1990). *Agricultural Ecology*, 288 pp. Harlow: Longman Scientific and Technical. [A textbook that analyzes relationships crops, livestock, and the environment.]

Biographical Sketch

Dr Richard Kenith Baydack has 24 years of research, teaching, and consulting experience in natural resources management. He has been on faculty with the University of Manitoba since 1979. He holds a B.Sc. (Honors) degree from the University of Manitoba, a Master of Natural Resources Management degree from the University of Manitoba, and a Ph. D. in Fishery and Wildlife Biology from Colorado State University. Dr Baydack has taught the following courses: Ecological Principles in Natural Resources Management, Thesis Research Seminar, Biological Resources Management, Biodiversity, Principles of Wildlife Management, and Waterfowl Ecology and Management, for the Natural Resources Program and the Department of Zoology. Dr Baydack supervises about 10 graduate students per year working toward their Master or Ph.D. degrees in Natural Resources and Environmental Management, and advises other Master's and PhD students in the Departments of Zoology, Botany, Geography, and Recreation Studies. Dr Baydack has served as Associate Director of the Natural Resources Institute, where he assisted in the daily administration of the graduate programs. In addition, he was involved with the development of the PhD program in Natural Resources and Environmental Management, the University's proposal for a new Center for Environmental Studies, and served as an Alternate to the University Deans and Directors Council. Dr Baydack is also Chair of the University Senate Awards Committee, and is a member of the Natural Resources Institute Executive Council, the Native Studies Graduate Program Committee, and the Northern Studies Network. Professionally, he is active as Chair of the Biological Diversity Working Group of the Wildlife Society, Vice-President of the Central Mountains & Plains Section of The Wildlife Society, and is a member of the Manitoba Endangered Species Advisory Committee and the Steering Committee for Ecosystem-Based Management in Manitoba. He has been awarded the University of Manitoba President's Outreach Award, and has been recognized by The Wildlife Society as a Certified Wildlife Biologist.