Session 3: Sustainable Use of Biodiversity and Land through Scientifically Integrative approach

The Use of Biodiversity

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The most unique feature of earth is the existence of life, and the most unique feature of this life is its amazing biodiversity. Six field experiments that we have performed at the Cedar Creek Ecosystem Science Reserve in Minnesota, USA, show that biodiversity has a surprisingly large effect on ecosystem functioning when compared to other environmental variables. In particular, a comparison of the effects of biodiversity, nitrogen loading, water, carbon dioxide enrichment, warming and herbivory on the productivity of prairie grasslands shows that the effects of biodiversity are as large or larger than of any of these other variables.

The restoration and conservation of biodiversity, which is a major determinant of ecosystem functioning, can provide society with valuable ecosystem services. During the past 15 years, numerous studies have shown that higher biodiversity of plant species is associated with greater primary productivity, greater year-to-year stability of this productivity, greater sequestration and storage of carbon in soil, increased soil fertility, and production of higher-quality ground water. Moreover, plant diversity also influenced foodweb structure, with greater plant diversity leading to foodwebs that had lower abundances of herbivorous insects and higher abundances of predatory and parasitoid insects.

These effects of biodiversity on ecosystem functioning suggest that the restoration and conservation of biodiverse ecosystems may be an efficient way to prevent or amelioriate some of the detrimental affects of agricultural production of food and biomass for biofuels. In particular for biofuels, diverse mixtures of perennial herbaceous plants have been found to produce 200% more biomass energy per hectare than monocultures of the same species. These high-diversity mixtures also removed and sequestered as soil organic carbon about 2000 kg/ha of carbon dioxide, and also increased soil nitrogen content and fertility. Diverse mixtures of plants can be used as buffers on the edges of agricultural fields to intercept nutrient runoff and thus increase water quality. Another benefit of such buffers is that their high abundances of predatory and parasitoid insects can serve as control agents for some agricultural crop pests.

These studies suggest that biodiversity has the potential to be a powerful tool for addressing some of the environmental harm caused by current methods of societal land use. For some societal needs, such as energy crops, diverse mixtures may provide the desired product more efficiently and at a lower cost than food crops. In other cases, appropriate placement of high-diversity buffers may provide agricultural pest control and reduce the impacts of agriculture on water quality.

The effects of biodiversity directly result from the deep evolutionary forces that shaped life on earth and caused the world to contain more than 3 million species. Speciation and coexistence both require that species differ one from the other. In particular, species

must have tradeoffs that make a given species better than other species at doing some things but worse that the other species at doing other tasks. It is these interspecific tradeoffs that explain why greater diversity leads to greater productivity, etc., and why diversity has such strong affects on ecosystems. It is thus imperative that society cease with actions and policies that threaten the earth's biodiversity and replace them with policies that preserve biodiversity and that take advantage of the benefits that biodiversity provides.

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Academic Degrees

1976　Ph.D., University of Michigan, USA
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Field of Study
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