Taking a road trip through an agricultural landscape, the average person may feel the landscape is monotonous, offering views of acre after acre of corn and soybeans or fields of wheat. However, we know the reality is that farmers are working on a heterogeneous landscape. Some areas are less productive due to drought, some more likely to flood, and sometimes historical use or soil type can affect today’s yield. Modern farming techniques can identify these less productive acres, and farmers may put more resources into these areas (e.g., fertilizer or irrigation) to try to maximize production.

There are numerous reasons why a piece of land may not be ideal for growing crops (see Fig. 1). The soils may be compacted, saline, or prone to erosion. Low-lying areas are often prone to flooding while ridges may be prone to drying faster than the surrounding landscape. Advances in precision agriculture make it easy to determine not only what fields are low yielding, but also areas within fields that require more inputs than they produce.

Producing food and feed is important, and many would prefer to keep something growing on the land rather than establishing commercial or residential buildings. However, if pockets of less productive land are a sink of resources, there may be potential to utilize them in other ways. Being able to identify where these marginal agricultural lands occur may be easy, but determining if there are alternative uses is complex.

Green Energy

Some farmers have already started converting farmland for green energy production. This includes wind turbines, solar arrays, and growing crops for use as biofuel feedstocks. However, as interest in incorporating “green energy” into agricultural landscapes increases, there is a need for careful consideration and planning.

Kirby Calvert, an Assistant Professor of Geography at the University of Guelph, points out the importance of this planning. “Many of us have seen maps of where the wind blows most consistently and where the sun shines strongest.” These map layers are overlaid with those of the energy infrastructure to identify where wind
• With advances in precision agriculture, it is easy to identify agricultural acres that have low yields.

• There is potential to use these acres to produce green energy or to take out of production to maximize ecosystem services.

• Determining what alternative use, if any, is appropriate is a mix of economic, ecological, and social factors.

turbines or solar panels can easily be connected to the existing grid. “But those technical and economic factors are just one small part of the story. We should be thoughtful about where we locate these systems,” Calvert cautions.

In an article published in Applied Geography (https://bit.ly/2IW9Tti), Calvert and his co-author used GIS layers to explore land use and potential conflicts associated with the development of renewable energy sources in Ontario. Calvert describes his research as developing “regional-level information about renewable energy potential that communities and planners and governments can use to guide industry and landowner decisions about where to harvest renewable energy resources in ways that avoid unnecessarily harming local ecosystems or local land-based economies.” These additional impacts range from neighbors who find wind turbines on the horizon unsightly, to consideration for bird migration routes. Similarly, solar panels may sit low on the landscape, but if inappropriately located and poorly designed, solar farms can remove microhabitats (e.g., pollinator grounds) and might also cover land that could be highly productive for food production.
For landowners who prefer the idea of growing crops over wind turbines, growing biomass crops for cellulose energy is an option. These crops can be grown on less productive land while still providing a source of income. Humberto Blanco, Associate Professor of Soil Science at the University of Nebraska–Lincoln, and member of the ASA and SSSA, published a review paper in the *Soil Science Society of America Journal* ([https://bit.ly/2H22cBy](https://bit.ly/2H22cBy)) that synthesized information about growing bioenergy crops on marginal lands. The review identified a number of ecosystem services associated with using marginal land to grow dedicated energy crops.

“The most rapid benefit is water erosion reduction, which can directly reduce non-point source pollution of water resources, improving water quality,” Blanco says. On highly erodible acres, growing a bioenergy crop that can still be harvested would likely have a better long-term outcome than trying to maintain a row crop. “Now the challenge is to convince producers or others that such spots in croplands should be converted to perennials to improve problem soils and produce biofuel,” he says. “It all comes down to economics.” The market for biomass is still developing in some regions. Biofuel production plants need a consistent crop to function, and farmers need a place to sell biofuel crops to make it worthwhile to grow them—one cannot exist without the other.

### Ecosystem Services

For landowners considering wind, solar, or biofuel production, they can estimate expected revenue. However, when marginal lands are converted to provide ecosystem services, it is difficult to quantify what is gained. “Placing a dollar value on the many services provided by perennial grass and woody crops as bioenergy should be further explored,” Blanco says. Some research attempts to put a dollar amount on services like carbon sequestration, the potential for reduced fertilizer runoff, providing habitat for pollinators and other beneficial insects, or reducing the impacts of flood and drought conditions.

Andrea Basche recently completed a research project estimating the impact on flood losses of converting marginal land to perennial crops. Basche was a Kendall Science Fellow at the Union of Concerned Scientists, and the report she authored ([www.ucusa.org/SoilsIntoSponges](http://www.ucusa.org/SoilsIntoSponges)) describes the soil as a sponge—one that can absorb water in times of excess and dries out slowly during droughts.

Many cropping systems in the United States today feature only annual crops and tend to leave the soil bare for many months of the year, making them susceptible to water losses through runoff and evaporation. Incorporating cover crops, trees, and perennial crops for grazing animals is likely to improve properties associated with water storage and can minimize water losses. Source: Union of Concerned Scientists.
“Our hydrologic modeling for the state of Iowa found that a spongier soil with more continuous living cover, targeting less profitable and more erodible regions of the state, could reduce flood frequency by up to 20%,” says Basche, who is currently an Assistant Professor at the University of Nebraska–Lincoln and member of ASA, CSSA, and SSSA. Reducing flood frequency and damage benefits both rural and urban communities in many watersheds.

The monetary damage associated with flooding and droughts is measurable. Floods lead to losses and insurance payouts for crops, homes, and businesses, and droughts lead to the loss of crops. “Floods and droughts are growing more frequent and causing more damage,” Basche says. “We know that soil improvements, through marginal land planted to perennials, can offset those impacts.”

Individual and Community Needs

Determining what alternative use, if any, is appropriate for marginal agricultural land needs to be balanced with individual and community needs. Potential approaches to planning and implementation range from top-down government policy, to community-level decision making. For example, Basche suggests that planting a portion of the landscape into perennials could leverage crop insurance. “Insurance industries charge higher premiums to drivers or homeowners that present greater risks for payouts. Similarly, we could focus on assessing the risks associated with marginal land use more appropriately.”

In addition to the potential to make changes to crop insurance, Basche also sees the opportunity for approaches such as “strengthening markets for perennially-based agriculture, including more cover crops and perennial grain crops, and continuing to invest in the research that makes continuous living cover economically feasible and agronomically sound for producers.”

The scale at which changes are implemented is important too, according to Blanco. “The idea is not to replace existing prime agricultural lands needed for food crops but to insert patches of perennial warm-season grasses or woody crops in a degraded or marginally productive portion of the field,” he says. The thoughtful placement of perennial crops can keep productive acres in row crops while acres converted into perennials provide ecosystem services to the landscape.

Similarly, Calvert sees placing green energy infrastructure on marginal land as both an opportunity and challenge. It could be an opportunity for revenue, but there are other considerations as well. “We need to be sure that our land and water are also able to provide us with all the other things we want, like food and fiber of course, but also health ecosystems, recreation areas, conservation areas, and other things,” he says. “As we look to harvest more renewable energy in the future, we need to come together as communities and stewards of a common land to ensure we maximize the opportunities but minimize the land-use impacts of this transition.”

Dig Deeper