Nitrogen: The key to biofuel energy balance

Peter Scharf, Harlan Palm, Newell Kitchen, and Ken Sudduth
Division of Plant Sciences, University of Missouri and USDA-ARS Cropping Systems & Water Quality unit

Vigorous debate continues regarding the net energy that can be gained in producing liquid fuels from crop materials. However, it is clear that the net energy gain from the process is small relative to the energy demands of producing the fuel. Thus, a small reduction in the energy required to produce biofuels would result in a much larger increase (proportionally) of net energy produced. Nitrogen nutrition of crops is one of the most promising places to gain a small reduction in energy invested in fuels. Most estimates of energy required to produce corn, for example, suggest that nitrogen fertilizer represents nearly half of the energy budget. Grass-based fuels would also require large energy inputs in the form of nitrogen fertilizer.

Our research has shown that the amount of nitrogen fertilizer needed by corn varies widely from field to field and from place to place within a single field. However, corn producers generally apply the same nitrogen fertilizer rate over whole fields and often whole farms. This results in many areas being over-fertilized and represents a large energy input that produces no energy return. Convenient, accurate, and spatially intensive diagnostic tools are needed to match fertilizer use to crop need. Crop sensors are the most promising technology to achieve this goal. They can be mounted on fertilizer applicators, diagnose fertilizer need, and control fertilizer rate within seconds. In 41 on-farm demonstrations of this technology from 2004-2007, we were able to improve system nitrogen efficiency (nitrogen removed in grain/nitrogen fertilizer applied) from 81% (current producer practice) to 96%. This was accomplished by producing the same grain yield with 16% less nitrogen fertilizer, thus decreasing the energy input for corn ethanol and increasing the net energy return.

Current funding for this project is $723,000 for two grants. Total funding over the duration of this work is about $1.7 million.