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Editorial

Biofuels from crop residues

In an editorial in Science "The Billion-Ton Biofuels Vision", Sommerville (2006) makes a strong case for biofuels. Produced from appropriate feedstocks, biofuels can be a viable source of carbon neutral energy. However, the suggestion that "the United States could obtain 100 gallons of ethanol from a ton of cellulosic biomass such as corn stover and stalks remaining after corn has been harvested" is a misconception with drastic adverse ecological and agronomic consequences. While the goal of producing 130 billion gallons of fuel ethanol per year from biomass is desirable, using crop residues as a source of cellulosic feedstock is essentially "robbing Peter to pay Paul". Rather than providing substantial economic and strategic advantages, wholesale removal of crop residues would exacerbate risks of soil erosion by water and wind, deplete soil organic matter, degrade soil quality, increase non-point source pollution, decrease agronomic productivity, reduce crop yields per unit input of fertilizers and water, and render U.S. agriculture unsustainable. This strategy is short-sightedness, poor planning, and cutting corners for quick economic returns.

Crop residue is a precious commodity with numerous ecosystem services essential to maintenance of soil quality, and sequestration of carbon into humus while reducing the rate of abundance of atmospheric CO_2. Residue retention at the rate of 6–8 t/ha along with no-till farming can sequester C in soil at the rate of 500–1000 Kg C/ha/year (Lal et al., 1999). The potential of C sequestration upon conversion of plow tillage to no-till farming with the use of crop residue mulch and other recommended practices is 288 million t/year (Mt/yr) for soils of the U.S. (Lal et al., 2003) and 0.6–1.2 gigat/year (Gt/yr) for those of the world (Lal, 2004). In addition, residue retention also conserves soil and water, moderates temperature, provides food and habitat for soil fauna (earthworms), recycles plant nutrients, and enhances biodiversity (Lal, 2004). The rate of soil erosion decreases exponentially with increase in rate of residue retention (Lal, 1976). Rates of erosion from U.S. cropland soils from which residues are removed may be excessive, and often as much as 10 times the tolerable limit (Wilson et al., 2004; NAS, 2003; Pimentel, 2006; Pimentel, in press). Experiments conducted in Africa showed that the erosion rate on highly erodible soils on 15% slope decreased from >100 t/ha without residue mulch to less than 1 t/ha with application of 6 t/ha of residue mulch (Lal, 1976). Therefore, crucial considerations while planning to harvest the crop residues for biofuels include: increase in risks of soil erosion and non-point source pollution, hypoxia of coastal ecosystems, depletion of soil organic matter pool, excessive use of fertilizers and herbicides to obtain the same crop yields, plowing rather than no-till farming, and global food insecurity. The urgency of breaking the agrarian stagnation and overcoming the perpetual food deficit in Africa require soil application of crop residues and other biosolids to improve quality of African soils. Improving soil organic carbon content by 1 t/ha/year, through residue retention and use of other biosolids, can increase global production by 23–40 Mt/yr of food grains and 7–11 Mt/yr of roots and tubers (Lal, 2006), more than enough to meet the current and projected deficit in Africa and elsewhere. Improving soil quality is essential to meet the challenge of over population in developing countries (2006).

Yet, producing biofuel is an important strategy of reducing the net emissions of CO_2 into the atmosphere and reducing dependence on imported oil. However, projected 130 billion gallons of bioethanol would not

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come from harvesting corn stover sand stalks but from bioenergy plantations established on specifically identified lands. There are numerous plant species with high productivity of 10–20 t dry biomass/ha. These include warm season grasses such as switch grass (*Panicum virgatum* L.), big blue stem (*Andropogan gerardi* vitman), Indian grass (*Sorghastrum nutans* (L) NAS). Some grasses suitable for biomass production in the tropics include guinea grass (*Panicum maximum*), elephant grass (*Pennisetum purpureum* Schm), and kallar or Karnal grass (*Leptochloa fusca*), which can be grown on salt affected soils. There are also short rotation woody perennials such as poplar (*Populus* spp.), willow (*Salix* spp.) and black locust (*Robinia pseudoacacia* L.). Some important halophytes, which can be grown by irrigation with brackish water (>30,000 ppm of salt concentration), include pickle weed (*Salicornia bigelovii*), salt grass (*Distichlis palmeri*), salt brushes (*Artiplex* spp.) and some algae (*Spirulina geitleri*). Non-edible oil contained in seeds of several perennials can be used to produce biodiesel. These plants include jatropha (*Jatropoha curcas*), pongamia (*Pongamia pinnata*), madhuca (*Madhuca latifolia*) etc.

A national biofuel strategy would ultimately depend not only on ‘‘massive support for basic curiosity-driven research’’ but also identification of land, choice of appropriate species, and development of recommended management practices for sustainable management of biofuel plantations. Rather than competing with cropland, biofuel plantations must be established on agriculturally marginal/surplus lands, and degraded or drastically disturbed soils. Restoring degraded soils through establishing biofuel plantations would be a truly win-win-win strategy. It would save crop residues for sustaining agricultural productivity by improving soil quality, restoring degraded soils, and providing biofuel feedstock for producing carbon neutral energy.

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