Selective harvest of higher value wheat straw components

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Agricultural crop residues are a valuable renewable biomass resource. Producers, including the National Association of Wheat Growers and the Idaho Wheat Commission, have long recognized the potential economic and environmental benefits in producing bioenergy and bioproducts from excess wheat straw residue. More importantly, industry has also recognized the potential value of the estimated 51 million tons of utilizable wheat straw that go to waste in the U.S. each fall. Straw utilization for bioenergy, biomaterials, and for fuels and chemicals has been limited because of the silica, alkali minerals, lignin, and hemicellulose contents of the straw, and because of the waxy cuticle that coats the straw. Thus, not all the parts of the straw residue are equally valuable. For cost-efficient utilization of the straw, the undesirable components must be removed. The current paradigm for straw utilization includes the necessity to transport all the components of the straw to the point of utilization; there is no cost-efficient way to remove the undesirable straw components before transporting it. This is expensive not only because of the low bulk density of straw, but also because it brings the less valuable components to the manufacturer's gate and creates economic and environmental liabilities. We believe that through a distributed low-capital, low-labor system, we can separate out the undesirable parts of the straw residue and leave them in the field where they can do the most good, by building organic matter and maintaining soil nutrient levels.

We will accomplish this separation using a two-step process. The first step is a physical separation to separate the desirable straw stems from the undesirable leaves, sheaths, and nodes, since the fibrous straw stem contains much less silica and waxy cuticle layer than do the leaves and sheaths. The leaves and sheaths contain higher nutrient levels, so they would be better utilized as organic matter for soil conservation. This separation will allow straw stem utilization in existing boilers for bioenergy production. The second step is a limited degradation of the cuticle, lignin, and hemicellulose in the straw by naturally occurring fungi. This step will take place in a low-capital, low-labor composting system that can be easily operated over a wide range of scales, from very small to very large. The fungal degradation will allow utilization of the straw for production of straw-thermoplastic composites. In each step, the separation will take place locally, using existing harvesting, forage, and straw handling equipment.

The distributed straw separation process promotes the use of straw residue to replace conventional feedstocks for energy (coal), and makes the straw a better feedstock for production of new straw-thermoplastic composites that can replace petroleum-based plastics. In addition, the separated straw could also serve as a feedstock in applications not specifically targeted by this proposal—fuels (ethanol), chemicals (lactic acid, glycerol, etc.), linerboard, and straw particleboard production—since the barriers to utilization of straw for these products are much the same as for bioenergy and thermoplastic composites. In short, the distributed straw separation system is a win-win scenario for all involved. It generates a new revenue stream for wheat producers, provides an incentive to reduce air pollution caused by field burning, and accomplishes soil conservation goals. It decreases the need to burn coal for energy, thereby reducing air pollution and net emissions of greenhouse gases. It allows reduced petroleum consumption by providing a superior feedstock for fuels, chemicals, and plastics. It relieves pressure on our dwindling forest resources by providing a feedstock suitable for paper and building materials. Finally, through use as durable goods, it provides a reservoir for carbon dioxide, over time reducing the atmospheric levels of this greenhouse gas.