DRAFT

REGIONAL RESOURCE POTENTIAL: AGRICULTURE

The existing national biofuels industry has drawn almost exclusively on agricultural resources, creating new markets for corn grown in the Midwest. It is reasonable to ask whether the Oregon and Washington agricultural industry could similarly provide a significant, sustainable resource and create new economic opportunities for farmers and rural communities. However, many factors specific to the region must be taken into account to adequately examine the true potential for regional agriculture to provide a sufficient, sustainable resource to supply a major new biofuels industry. There are substantial differences between the agricultural system in the Midwest corn belt and the agricultural system in the PNW. Broadly characterized, the Midwest corn belt produces two main crops, corn and soybeans, that are relatively low value per acre, that are fed locally to livestock, grown without irrigation AND ARE GROWN ON A LARGE SCALE IN CONCENTRATED ACREAGE. In contrast, the agricultural system in Oregon and Washington is more diversified, falling into three main categories ON SMALLER, MORE SCATTERED ACREAGE. First, high value fruit and vegetable production grown under intense management including irrigation. Second, nursery, ornamental and grass seed production, again grown under intense management including irrigation. These two systems tend have smaller production units and farm. Third, intermediate value cereal crops grown on large farms in less intensive management systems without irrigation. There are far fewer livestock in Oregon and Washington compared to the Midwest and many of these are dispersed on rangelands.

Dennis, feel free to use the inserted material as you wish. My goal here was to set out the key differences, as I see them, in the agricultural systems in Oregon and Washington and the Midwest.

Focusing the Search for Biomass Resources

Based solely on revenue sources and crop diversity, Oregon and Washington agriculture suggests a myriad of biomass sources. However, factoring in how the land is currently used serves to narrow the focus to the most realistic potential options for obtaining a significant biomass resource. The agricultural land base in Oregon and Washington is approximately 29 million acres, representing 28 percent of the region’s land mass and about 3 percent of total U.S. agricultural acreage. Based upon 2004 statistics, 16.1 million acres were used for range or pasture, 10.2 million acres were cultivated to produce crops, 1.5 million acres were fallow and 1.5 million acres were enrolled in the Conservation Reserve Program (CRP). Because the range and pasture land typically has lower biomass productivity, as do the acres enrolled in the CRP, the search for a significant biomass resource can be focused on the 10.2 million acres that are presently cultivated; these acres offer the highest biomass production potential. Table 3 shows the five crop categories that use 80 percent of the region’s cultivated land, narrowing the focus to these acres and cropping practices in search of biomass for a biofuels industry, either from the primary crop, from residuals of current production, or by substituting an alternative energy crop on these acres.

PRODUCT	ACRES
Cereal grains	3,775,500
Hay & forage crops	2,444,500
Vegetables & berries	745,700
Grass seed	620,500
Orchards & vineyards	606,000

Leading Uses of Cultivated Agricultural Land

Cereal Grains

Together, Oregon and Washington produce more than 200 million bushels of wheat and about 40 million bushels of barley annually, with minor production of oats and feed corn. The simplest way for Northwest agriculture to support biofuels would be to follow the model of the current ethanol industry, using these cereal grain crops as a source of affordable starch for fermentation. However, the export value of wheat, which has averaged about $3 per bushel, and recently exceeded $5 per bushel, (soft white winter wheat is currently more than $6 per bushel at Portland) makes wheat a more expensive source of starch than corn (typically about 25 percent higher than corn). Barley, which at times has a market value closer to that of corn, would also be a comparable source of fermentable sugars, but the limited barley crop in Oregon and Washington would not provide a significant supply for biofuels production. Feed corn (vs. sweet corn for human consumption) can be grown in the region on irrigated land with suitable temperature ranges and could provide a local resource for ethanol production. However, based upon historical feed corn prices, the revenue potential of corn grown for fuel is lower than the revenue potential of other crops that can be produced on the same irrigated acres. In years where corn prices are unusually high, such as the 2007 crop year, a limited number of acres can be expected to be converted to corn production, but again this is unlikely to result in a significant and sustained local grain supply.

While some limited ethanol production could be based upon cereal grains produced within the region, the expectation is that the emerging ethanol industry will almost exclusively rely upon corn from Midwest and that the primary value of Northwest grains will continue to be found in food markets. However, the straw residue associated with the current cereal crops, and possibly production of new energy crops that can be grown in rotation with the traditional cereal grain crops, represent more likely sources of biomass from the 3.8 million acres used for cereal grain production. These potential resource options are addressed in more detail later in this chapter.

Hay and Forage Crops

The hay and forage segment of the agriculture industry is of interest largely because of the significant number of acres already dedicated to production of biomass; collectively Oregon and Washington produce more than 4.5 million tons of biomass annually as forage on more than 2.4 million acres. However, the livestock feed value of this biomass as a livestock feed averages about $100 per ton, making it too expensive to be practical for production of biofuels. (Alfalfa hay is selling for ~$150 per ton in the Capital Press. Grass hay prices vary depending on the species.) However, it is conceivable that alternative biomass crops could be developed and could be substituted for livestock forage on these acres in a way that could provide a supply to support a biomass industry, while providing comparable revenues for farmers -- a concept explored in the final section of this chapter.

Grass seed

Production of grass and alfalfa seed is an important regional industry, particularly in Oregon where more than 500,000 acres were planted to grass seed in 2004. Several major companies contract with Oregon farmers to grow proprietary seed lines, a central business for Willamette Valley agriculture. With the closure of several food processing facilities in this area, considerable acreage has also been transferred from production of fruits and vegetables to grass seed, a trend that is expected to continue. The seed is separated from the straw in the field and until about 1990 the residual straw was burned to clear the field, prevent disease, rid pests, and remove thatch. Air quality restrictions now limit burning to about 40,000 acres each summer and there is continued pressure to reduce burned acreage further. While much of this straw has found use as livestock feed, this straw is often identified as a resource for biofuels, a prospect explored in this chapter.

Vegetables and Berries/Orchards and Vineyards

Vegetable and fruit crops represent relatively high gross revenue potential (ranging from $1,000 to $6,000 per acre) and established orchards and vineyards represent a long-term investment, so it is unlikely that a substantial proportion of these acres would be converted to produce energy crops – there is simply not the same revenue potential. While vegetable and fruit crops generate small quantities of secondary biomass per acre, these residuals represent a relatively small, and very dispersed, potential resource, even in cases where collection of the residual biomass could be compatible with standard production practices. It is unlikely that this segment of the agricultural industry will constitute a significant biomass resource.

Potential Resource – Straw from Cereal Grain Production

Several studies have estimated the amount of straw that is produced as part of the annual wheat, barley and oat grain crop in Oregon and Washington. The most extensive studies estimate total straw production at between 10 million tons per year (USDA - Banowetz) and 12 million tons per year (Kerstetter), depending upon the methodology used. Most farmers currently leave all of this straw in the field, except in limited parts of the region that enjoy higher rainfall (more than 18 inches per year), and therefore much higher wheat yields (more than 100 bushels per acre). In those areas, there is often a need to remove straw because it does not fully decompose within a year and it interferes with field preparation and seeding, and because these farmers do not need to leave their fields fallow for a year to accumulate soil moisture. This high-yielding, annually cropped area represents only about 20 percent of the total wheat acreage in the region. Within this limited area, some straw is baled and removed, but HISTORICALLY this HAS BEEN done on a very limited basis because there have been limited markets for the straw (e.g., bedding for dairy cattle, mulch for mushroom growers). HIGH HAY PRICES IN 2006-07 HAVE LED TO MORE ROBUST, HIGH-VALUE MARKETS FOR STRAW IN THE EASTERN AREAS OF BOTH STATES. There APPEARS TO BE SOME potential to remove some of the residual straw produced in the region for use in production of biofuels.

Straw from Cereal Grain – Supply Limitations

There are major incentives for farmers to leave straw in the field, including reducing soil erosion, retaining soil moisture, maintaining soil organic matter and desirable soil biological, chemical and physical properties. Such sustainable practices are reinforced by payments from the United States Department of Agriculture for most grain growers and by legislation for land that is designated as highly erodible.

The USDA Natural Resource Conservation Service guidelines for good conservation practices indicate that no straw should be removed from land yielding less than 60 bushels per acre and that at least 3,000 pounds of straw per acre should be left in place, with 4,000 pounds per acre being more desirable, and some indication that 5,000 pounds per acre would be ideal. If farmers follow these guidelines, the amount of available straw is dramatically reduced. The Kerstetter analysis calculated that leaving 3,000 pounds per acre would reduce the estimated 12 million tons of total straw to an available amount of 5.9 million tons per year (4.3 million tons in Washington, 1.6 million tons in Oregon). In the USDA analysis, leaving 4,000 pounds of straw per acre reduces the estimated 10 million tons per year total straw production to an available amount of 3.8 million tons per year (3 million tons in Washington, 0.8 million tons in Oregon). While other studies have estimated the available straw as slightly lower for Washington (1.6 million tons, Chen) and slightly higher for Oregon (2.1 million tons, Graf), the USDA estimate is a reasonable characterization of the cereal straw theoretically available for other uses after sustainable agricultural guidelines are satisfied.

It is important to note the uncertainty of this prospective resource. Clearly a drought would reduce the available biomass for at least a year, while early fall rains could result in wet material that is difficult to collect and store, or affecting the straw quality. Also, changing agricultural practices might have significant impacts, as illustrated by a separate study in which Kerstetter indicated that adoption of the recommendation to retain 5,000 pounds per acre in Washington would reduce the available straw in that state to less than 700,000 tons per year, limited only to the highest rainfall band of eastern Washington.

Finally, development of new markets, or periodic increases in the livestock feed value of the straw, could create competing uses with shorter transportation distances and reduce the amount of straw available for fuels production.

Straw from Cereal Grain – Logistical Limitations

The concerns related to the size of the potential resource are matched by issues related to logistics. The first hurdles will be associated with obtaining a resource that currently isn't collected and that may require development of new technology and new grain production practices. For example, if combines leave tall standing stubble, can the straw be windrowed, or will operators need to change practices? Will it be necessary to develop new equipment and field practices to enable collection of the straw while ensuring that the desired 4,000 pounds are left in place (or 3,000 or 5,000, depending upon the selected guideline)? Such questions must be addressed by public and private research and development before growers and businesses can decide to make significant investments.

There also are potentially daunting business considerations that require study. For example, if farmers collect the straw, will they require a purchase contract from the biofuels facility prior to making the capital investment in new equipment? Based upon a review of farm size and straw distribution in the high-yield area of eastern Washington (the area with the greatest straw density), Kerstetter estimated that a small facility (200,000 ton per year) would need to sign contracts with at least 150 different farms in order to ensure sufficient straw supply. Expansion of the secondary industry that provides on-farm straw collection and subsequent storage and transportation would simplify the interface for the biorefinery, but raises other questions as well. Would such companies be willing to share any of the straw revenues with the farmers? Because the motivation of such firms would be to maximize straw delivery to the biorefinery, can the farmer be sure that straw removal is done in sustainable manner (e.g., doesn't deplete the soil to a degree that requires addition of nutrient at a cost to the farmer) or lead to elimination of conservation payments?

Straw from Cereal Grain – Cost Limitations

Finally, there is the question feedstock cost. Graf estimated that on-farm collection would cost $25-$35 per ton and personnel at the Oregon State University and Washington State University experiment stations confirm that $35 per ton would be a typical cost to bale and collect straw on the farm. Kerstetter estimated that storage costs between $7 and $25 per ton (uncovered stacks vs. a covered pole barn), and transportation of 50 miles adds another $10 per ton. It is not clear what the payment would need to be made to the farmer, as some growers in the high-yield areas may benefit from removal of 'excess straw' while other growers may look for a price at least comparable to the nutrient value of the straw, which has been quoted as low as $7 per ton and as high as $40 per ton. Collectively, these factors indicate a minimum delivered feedstock cost of $40-$45 per ton, with significant risk that costs could be much higher. This is reflected in the supply curves produced by Kerstetter et al, which show that the higher resource availability estimates were only reached at delivery costs of $70-$80 per ton. The distributed nature of the straw, the cost of collection and delivery, the overall supply uncertainty, and the logistical difficulty of obtaining this resource will prove to be significant limitations to development of major biofuels capacity based upon use of cereal grain straw. HOWEVER, TAX INCENTIVES RECENTLY ENACTED IN BOTH OREGON AND WASHINGTON WILL MAKE INVESTMENT IN STRAW HANDLING EUIPMENT AND FACILITIES AND STRAW ACCUMULATION MORE LUCRATIVE.

Potential Resource – Grass Seed Straws

The total straw produced in association with the Willamette Valley grass seed harvest is between 0.8 million and 1 million tons annually. A secondary industry has developed to collect, bale and remove the straw from the farms, temporarily store the bales, then transport the bales to the port of Portland where they are loaded into containers for shipment to Japan, Korea and Taiwan as animal feed. Prices paid FOB Portland range from $75 per ton to more than $100 per ton, depending upon the grass species. Approximately $50 per ton is distributed among the various collection/storage, transportation, and brokerage companies, with growers receiving nominal payments ($10 per ton or less) at best. Approximately 50 percent of the grass straw produced in the Willamette Valley (639,000 tons in the 2004 growing season) currently is delivered to the Portland export market. The remaining portion (more than 200,000 tons in 2004) is either annual rye grass straw, which is not a suitable livestock feed, or is too distant from Portland to be transported economically. Some of this remaining resource is burned, some goes to local markets, and the rest is chopped and left in the fields.

Grass Seed Straws – Competitive Market Limitations

In the near term, the export market appears more attractive than a biofuels market unless biofuels companies can afford to pay $50 per delivered ton or more at locations very near farm production, and will continue to consume the bulk of the grass straw resource. Consequently, the current resource available to a biofuels industry would be limited to the 200,000 tons of straw that is not exported -- enough to support one very small (20 million gallons per year or less) fuel production facility. It is possible that the value of straw for export could decline significantly if Australia and China enter the market, which some economists believe is quite probable. Further, rising costs of shipping containers (caused by increased exports from Portland to Asia) could price Oregon grass straw out of the export market. In either case, much more of this very concentrated resource would become available to the biofuels market, possibly at prices at or near the cost of collection and transportation, which could be as low as $35 per ton for short hauls (Graf). However, even if all of the straw produced in the Willamette Valley were diverted from the export and local feed markets, it would still comprise a very small fraction of the needed resource and the fuel value of the straw would represent a "disposal" option for farmers, not a major new market opportunity.

Potential Resource -- Oil Seed Grains in Rotation with Cereal Grain or Grass Seed Crops

There is a longstanding interest around the region in growing oil seed crops for either food markets or for industrial markets such as biodiesel production. The latter potential market has resulted in renewed regional interest in *Brassica spp.* such as canola, rapeseed or mustard. These crops could be grown in rotation with wheat, grass seed and some irrigated crops, both as an alternative in years when market prices are low for the primary crops and as part of sustainable agricultural practices. There have been a number of research trials involving these crops and a few farmers are now experimenting with the crop. However, while there is a great deal of interest, there are a number of uncertainties and limitations that must be addressed to enable production at sufficient scale.

The *Brassica* crops have been studied most extensively because they are better suited to the region than sunflower or safflower, which would require irrigation, or soybeans, which are not viable in the region except in extremely limited acreage. Canola has been of great interest because when used in rotation canola may offer a number of benefits, including reducing the incidence of certain pests, permitting use of a different spectrum of herbicides for weed control and breaking up compacted soil. Under ideal conditions, winter canola can be fall planted in the dryland wheat region, or in the non-irrigated land west of the Cascades, while either winter or spring canola could be grown on irrigated land. Yields of winter canola usually are significantly greater than spring canola. Test plantings of winter canola in the eastern regions of Oregon and Washington indicate that yields between 1,500 and 1,800 pounds per acre could be expected. Trials without irrigation in the Willamette Valley averaged 2,300 pounds per acre and irrigated trials throughout the region have averaged 3,400 pounds per acre, with the promise of yields approaching 4,000 pounds per acre.

Oil Seed Grains – Production Limitations

In spite of the promise, there also are risks and limitations. First, production of canola is not currently permitted in the Willamette Valley or parts of western Washington because of the risk of cross-pollination with, or contamination of, the high-value vegetable seed crops grown in these areas. More study is required to determine appropriate separation distances and other control measures before these restrictions will be lifted. Second, these crops are not ideally suited for areas receiving less than 12 inches of annual precipitation and planting must follow a fallow cycle for soils receiving between 12 and 18 inches of annual rainfall. Third, winter canola productivity has proven to be highly variable in dry land production, with crop establishment greatly impacted by fall weather or fall rains that are too late. Severe cold in late winter, or severe heat in early summer, can also dramatically reduce yields. All of these factors serve to reduce the number of acres available for dry land production until varieties more suited to the regional weather patterns and temperatures become available. Dennis, just for background, I checked with several sources, including canola advocates, and, to the best of anyone’s knowledge, there is no dryland canola in eastern Oregon. There are some irrigated fields of canola.

Oil Seed Grains – Production Cost Limitations

Finally, there is the question of production cost. The generally accepted break-even price for canola with current yields and production practices is between 13 and 16 cents per pound (Hinman, Karow), even when factoring in “credits” for avoided costs and possible rotation benefits. This break-even price is about 40 percent higher than the target price desired by biodiesel producers, indicating that higher yields are needed for canola and other *Brassica* crops to be competitive in a large fuel market. (And the potential return from canola is much less than from wheat, especially when wheat is >$6 per bushel at Portland). In the near term, it is conceivable that a limited number of acres could go into production, serving regional biofuels producers who have access to markets that are not price sensitive while providing a rotational crop to a limited number of growers. However, given the production restrictions in western Oregon and Washington, the variability and risks of dryland production, and the yield improvements required to lower the break-even price even for irrigated canola, considerable research will be required before large scale production occurs in the Northwest.

Reflecting upon the research effort required to create new seed lines that can address all of the issues discussed above, as well as the gap between the break-even production price and the fuel value of the crop, it seems that a more valuable research investment might be development of oil seed crops with desirable human nutrition traits (e.g., oils rich in omega fatty acids). Although this approach does not support advancement of a regional biofuels industry, the higher-priced food market appears to deliver much more promising, long-term value for farmers. Dennis, this is an excellent point and one that needs to be emphasized

Potential Resource - Producing New Energy Crops on Dryland Grain and Irrigated Forage Acres

In addition to oil seed crops, there may be other opportunities to produce crops explicitly for an energy market using either a portion of the acres currently used to produce grains or forage crops. It is conceivable that herbaceous crops could be grown in rotation with current crops on either dryland or irrigated acreage, given the right economics. In some circumstances it might even be possible that short rotation woody crops could be produced on irrigated land rather than forage crops. While no specific crop alternatives have yet been shown to be economical, the following section will evaluate what is required in order to introduce dedicated energy crops to Northwest agriculture.

In order to substitute for wheat in the farmer’s production plan, it is logical that an energy crop would need to provide revenues that are comparable to those that could be realized from growing wheat on the same acres. For the high-yield areas of the region, especially those that produce wheat annually (without a fallow year) and where the net annual revenue potential is high ($350 to $550 per acre using a price of $4.50 per bushel and 80 to 120 bushels per acre), it is very difficult to envision how this could be accomplished. In the drier areas where a fallow year is required and the annual revenue potential is closer to $150 or $160 per acre (based on $4.50 per bushel and a yield range from 35 to 70 bushels per acre, divided by two to reflect the fallow year), it is conceivable that the right energy crop strategy might be competitive. In these areas, the approach would involve growing a plant, or mix of plants, specifically selected to make the best use of the available soil moisture for maximum biomass production per acre (by comparison, wheat has been selectively bred, and production practices optimized, to make the best use of water to produce maximum grain per acre, not total plant biomass). A perennial that requires few (if any) inputs to reach optimal tonnage per acre and that reliably produces for a three or four year span might be an example of how an entrepreneurial farmer could contract to produce an energy crop on part of the farm.

New Energy Crops -- Dryland

However, the hurdle is very high for dryland production of energy crops. Even if such crops were available and new practices could be developed to enable collection and delivery of the biomass at $25 per ton (leaving room for a $10 per ton payment to the farmer while still meeting the delivery price of $35 per ton to the biorefinery), the dryland energy crop would have to produce at least 15 tons per acre annually. As a benchmark to illustrate how high this hurdle is, the regional lands removed from wheat production and enrolled in the CRP typically produce 0.5 tons per acre of native grasses, and wheat yielding 100 bushels per acre only yields 8 tons per acre of biomass. In addition, producing a high yielding biomass crop on these lands will require significant applications of fertilizer to achieve these high yields.

New Energy Crops – Irrigated Land

Producing energy crops on irrigated acres that currently are used to raise forage crops is another option to consider. In this case, the threshold likely would be the value of alfalfa (about $100 per ton [see earlier note]) with productivity of eight tons per acre with three cuttings per year. Assuming that the same equipment can be used to produce and harvest the new energy crop, yields would have to be at least three to five times higher for each cutting in order to generate the same gross revenue per acre, reflecting the lower value of the fuel market.

Researchers at USDA and regional universities are exploring potential herbaceous plants that could be developed to that level of productivity in the Northwest, including native perennial grasses as well as non-native species. Candidates include high-yield prospects such as *Arundo donax* (25 tons per acre) or *Miscanthus spp*. (~10 tons per acre), illustrating the potential promise of such plants. If energy crops yielding 15 tons per acre could be produced on one-third of the acres currently used to produce hay/forage, this would translate to a biomass supply of 12 million tons per year -- a significant fraction of the resource required. However, much research will be required to understand these plants, assess the potential invasive risks of non-native candidates, select and breed plant lines suitable for the region and develop the accompanying production practices for the varied soils and climatic conditions of the Northwest. In short, use of these plant lines will require an intensive, concerted, long-term effort consistent with past efforts to develop the cereal grain and turf grass varieties currently grown throughout the region.

Resource Summary

This analysis suggests that Northwest agriculture has a limited ability to provide the resource needed to supply a major portion of the region’s fuel requirement in an economically and environmentally sustainable manner. This is a reflection of the relatively limited productivity of the majority of agricultural acres in the eastern two-thirds of the region, as well as the export value of the food and feed crops that have been adapted for production in the region. The most significant existing resource -- residual straw from cereal grain and grass seed production -- is limited by competing uses (sustainable agricultural practices, feed markets), and by the cost of collection, storage, and transportation (Figure 5).

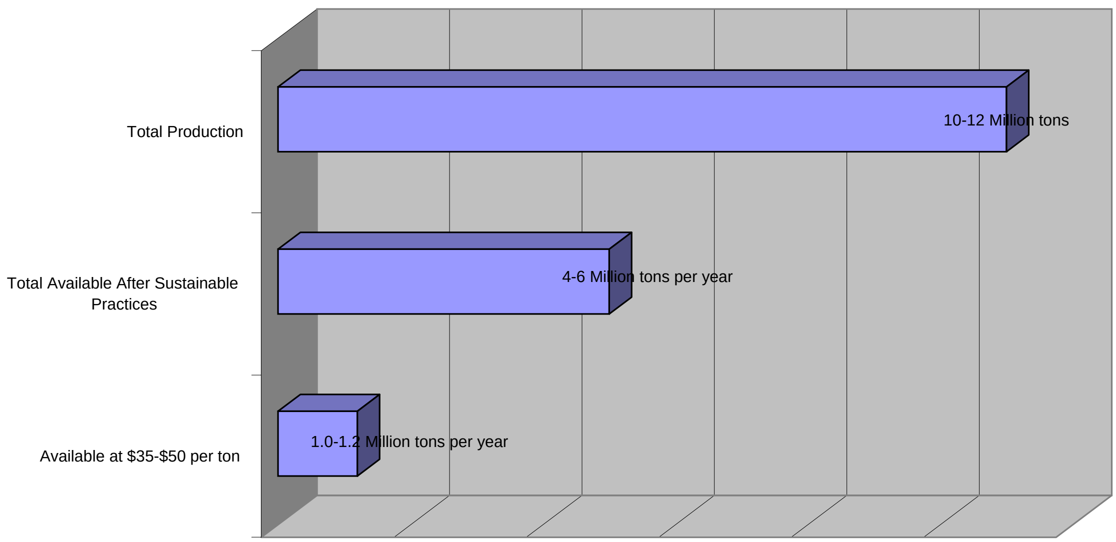

Figure 5. Straw: Total Production vs. Availability

Based upon the analysis of Kerstetter et al, the lower-cost ($35-$50 per ton) cereal straw resource is distributed in such a way that this resource would be divided between five facilities located throughout the region, each drawing about 150,000 to 300,000 tons of dry straw each year. When combined with the available grass straw in the Willamette Valley, this indicates that at best the straw resource potentially could supply six, 20 million gallon per year capacity facilities that collectively could produce approximately 100 to 120 million gallons of biofuel annually. Such an array of very small facilities falls far short of the goal of creating an industry meeting a significant fraction of the region's fuel demand and would do little to create new jobs in the region or to provide economic opportunity for growers.

It is conceivable that a fraction of the region's cultivated acres could be used to produce energy crops, either in rotation with cereal grains or hay/forage, potentially providing a much more significant resource. However, development of the new plant lines and production practices appears to be very difficult, particularly in the case of new herbaceous crops, and success is uncertain even for the promising oil seed crops. While these options should be explored, they appear to represent a long-term research endeavor and a prospective resource that is far in the future, not one that can provide the basis for a sizeable industry in the near-term (i.e., the next decade).