converted to ethanol. Unfortunately, switchgrass does not grow well in most of Washington without irrigation. Tall wheatgrass on the other hand has been grown in dryland sites of Washington for over 50 years. It also occurs throughout the Great Plains, western states and Canadian Prairie provinces. This widely adapted grass produces as much as 7 tons of biomass per acre. It is far from an ideal pasture/hay grass, but its biofuel potential is intriguing.

Tall wheatgrass stems make up a large percentage of the total biomass. Stems are mainly composed of cellulose and lignin, and the leaves have less of these structural carbohydrates. Structural carbohydrates are not optimal for ethanol production so ethanol production from tall wheatgrass might not be economical. However, gasification and direct combustion of tall wheatgrass are definite possibilities.

Gasification of tall wheatgrass feedstock involves heating the biomass in order to convert the material into combustible syngas. The syngas can be cleanly burned to produce heat or generate electricity. This process is in operation in Scandinavia. Direct combustion involves burning bales, pellets, or finely chopped feedstock. Direct combustion might be an option for rural people looking to reduce their reliance on natural gas and/or electricity to heat farm buildings and homes.

The Pullman Plant Materials Center in cooperation with WSU established a study at the Prosser Irrigation Agriculture Research and Extension Center to compare 4 tall wheatgrass varieties. One of the varieties, Szarvasi I, is a Hungarian line specifically developed for the European biofuel market. The Prosser data indicate that Szarvasi I is no better then the pasture/hay varieties currently being grown in North America. Plant Materials Centers in several western states are installing similar studies to determine if there are regional differences in yield, energy output, and plant adaptation.

Biofuel Feedstock Research in Irrigated Central Washington

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The biofuel feedstock trials and the search for better crops in our cropping system have been in our program since 2004 under irrigation of central Washington. Most of the temperate and sub tropical crops have been included in our trials from oil producing crops camelina, canola/rapeseed, crambe, mustard, safflower, soybean and sunflower to biomass crops as switchgrass for cellulosic ethanol. Camelina, a short growing season oilseed, belongs to the same family with canola and mustard which can be produced on marginal land with low energy input and is a short growing season crops. Camelina oil is a source of high quality oil with over 30% Omega-3 fatty acid and second to flax oil. Canola both spring and winter species can be produced well in Washington. Winter canola requires 10 months to mature and its yield doubled spring grown canola. Mustard is another *Brassica* species which tolerates more hash weather and low soil nutrient. Safflower produces well in Washington and uses less water than soybean and can produce high yield and high oil concentration. Safflower and winter canola can produce 1700 to 2500 lbs oil per acre. Soybean with maturity groups 000, 00, 0 can be grown in Washington and produced from 2950 to 3900 lbs per acre on sandy soil if enough irrigation is applied. Switchgrass is a perennial warm-season grass produces high biomass yield after the establishment year. Under irrigation we produce two harvestable biomass harvests per growing season. The first biomass harvest is taken in early July and the final in early October. Switchgrass is photoperiod sensitive with early maturing cultivars transitioning into winter dormancy earlier than later maturing cultivars. If allowed to transition into dormancy in the fall, we have not experienced winterkill problems in our environment and under our agronomic management practices.

Camelina Production in Irrigated Central Washington

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Camelina (*Camelina sativa* L.) is an ancient crop and is a native of northern Europe from Finland to Romania and east to Ural Mountains. Camelina is grown for its oil used as lamp oil, medicinal treatment and as an edible oil. It belongs to a large mustard family (Brassicaceae) like canola, rapeseed and vegetable mustard green and mustard seed. It is grown in marginal agriculture lands with low fertilizer and low soil moisture. Camelina is a short

growing season oilseed that matures in 80 days. It produces about 35% oil containing high Omega 3 fatty acids (34 to 36%). Camelina seed is light to bright yellow and very small (about 345,000/lb). Camelina has good agronomic characteristics. It is easy to grow and is low in input requirements (water, nutrients and pesticides). It can be broadcasted. Its oil is more stable than most of the Omega 3 fatty acids producing crops as flax, hemp and perilla.

Camelina at full pod set (~70 days after planting).

Thirty eight commercial and experimental lines of camelina were planted in Othello. Trifluralin (Treflan) was incorporated on the top 4 inches at the rate of 1 qt/a during seed bed preparation. Fertilizers were added to the experimental plot to 100 lbs N and 50 lbs P2O5 per acre. Yields ranged from 1790 lbs/a (BS 74) to 2745 lbs/a (cv. Robbie). Camelina can germinate on saline soil (780 ppm Na or 1.2 mmho/cm) set blooms but most of the flowers were aborted. Camelina was not tolerated Stinger (clopyralid) using to control nightshade as for canola/rapeseed. Stinger aborted camelina flowers, pods were deformed and seeds were not developed.

There are few winter camelina lines that can tolerate cold weather like winter canola. There is no information available about winter camelina in Washington. Research needs to be done to obtain information about its adaptation to Washington.

Arundo donax for Biomass Ethanol, Fiber, Carbon Sequestration

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Arundo donax is one of the highest cellulosic biomass producing plant species known, clearly capable of producing more shoot biomass per acre under irrigation than forage grasses, switchgrass, cereal straws and hybrid poplar (Fig. 1). *Arundo* has a perennial growth habit, does not produce seed under temperate growing conditions, but reproduces vegetatively from apical internodes and root corms. *Arundo* is an invasive weed in many areas of the U.S. such as California and the Southern U.S., particularly where it was introduced to control erosion along stream banks. Nevertheless, it has been successfully cultivated and controlled on arable upland plantations for woodwind reed production. Available herbicides such as glyphosate can effectively control *Arundo*. *Arundo* is a unique C3 plant that is capable of maintaining higher photosynthetic rates than some C4plants. Arundo forms an equally impressive below ground root biomass that can potentially increase soil C sequestration. Initial baseline data on cellulose, lignin, hemicelluloses and ash composition, and biomass yields in south Columbia Basin have been collected. Based on these results and initial papermaking pilots conducted at UW, *Arundo* is a very appealing pulp fiber source for the PNW paper industry.

Two stands of *Arundo donax* have been established at Prosser WA. The first stand of 63 ft x 81 ft was established in March 2003 with stems and rhizomes collected from California. It was observed that a much higher percentage of rhizomes sprouted compared to the stems. A second larger stand (160 ft x 160 ft) was established in May 2006 using all rhizomes from California. Incomplete stand establishment was due to the presence of non-viable rhizomes and the late planting date. Transplants were made into these areas in an attempt to fill in the stand. This second stand was set up to establish plots for examining planting density, water and nutrient variables, as well as herbicide control treatments. The 2006 planting was established with two in row spacings (18 and 36 inches). In 2007, two irrigation regimes were imposed with half of the plots receiving replacement irrigation at 100% and half receiving 66% of replacement. First year yields have ranged from 2 to 11 tons/acre, second year