The Potential of Switchgrass as a Biofuel crop in WA

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Switchgrass (*Panicum virgatum*) and other selected perennial warm-season grasses from the Great Plains of the mid-west are adapted to many areas of the irrigated region in the Pacific Northwest (PNW). Switchgrass is a warm-season grass, meaning most of its productive growth occurs during the warm summer months compared to cool-season grasses that are most productive during the cooler spring and fall of the year. Switchgrass is rhizomatous but there are major differences among upland and lowland ecotypes for rhizome aggressiveness. I first saw circles of switchgrass in the Columbia Basin in 2001 when agronomists from Rainier Seed Company toured me around switchgrass grass seed fields they had been growing. It was at that point I knew the grass was adapted to our region but the grass had been grown for seed and not biomass for either forage or biofuel. Our WSU goal became to investigate and establish new agronomic principles for biomass conversion to biofuel from switchgrass. We first established switchgrass and other WSG in research trials at WSU-Prosser in 2002. From the very beginning it was apparent these grasses were different than anything I had previously grown.

Alfalfa and cool-season grass growers in the PNW are experts as growing these forage crops for hay. If you are thinking about converting some of your hayland into bioenergy producing land, switchgrass maybe one crop to seriously consider. There are several advantages to growing switchgrass for biofuel in our region: 1. This is a perennial species and once established and with proper agronomic management, it should be with you for 20 years, 2. The grass is relatively free of insect and disease pressures so annual applications of pesticides should not be required, 3. The grass does not require high inputs of fertility, but it will require annual applications of nitrogen (N) and other nutrients, just lower amounts than you would apply to cool-season grasses, 4. There are several excellent producing and adapted varieties for our region already on the market so you don't have to start from ground zero to get into biofuel production (this doesn't mean newer varieties under development won't be equal or better than what we have evaluated), 5. The grass has a very deep root system with a high amount of carbon fixing capacity; this could pay economic benefits to growers in the future, and 6. There is great interest by the Federal Government and many private individuals and companies to see bioenergy succeed so we are in the initial starting point of the cellulosic biofuel emphasis rather than into a more mature technology, so new innovations are still possible. Several disadvantages to growing switchgrass for bioenergy: 1. There is no open, operating biorefinery in the PNW at this time to convert cellulosic material from switchgrass into bioenergy (but this will be coming in the future), 2. The investment in time is great. I'll discuss this more in this paper, 3. The financial investment in bioenergy is great, and 4. There are many, many questions yet to be answered on growing perennial biofuel crops and research requires time and investment of dollars to develop the answers.

Think of growing switchgrass much like building a house; you start with a solid foundation and build up from there. In the early growth stages switchgrass will try your most important virtue in growing any crop, patience. To achieve the high biomass

potential tonnages that we have measured, 10 dry tons per acre or more from 2 cuttings per growing season, you must establish a good switchgrass stand. I am including two figures that will appear on our WSU website this spring, discussing some of the early growth and development of switchgrass under irrigation in our region. We have ongoing research to confirm and increase our knowledge during this critical time of switchgrass but these figures provide a foundation in which to compare the growth habit of these taller, perennial warm-season grasses to what you are already familiar with the shorter, perennial cool-season grasses.

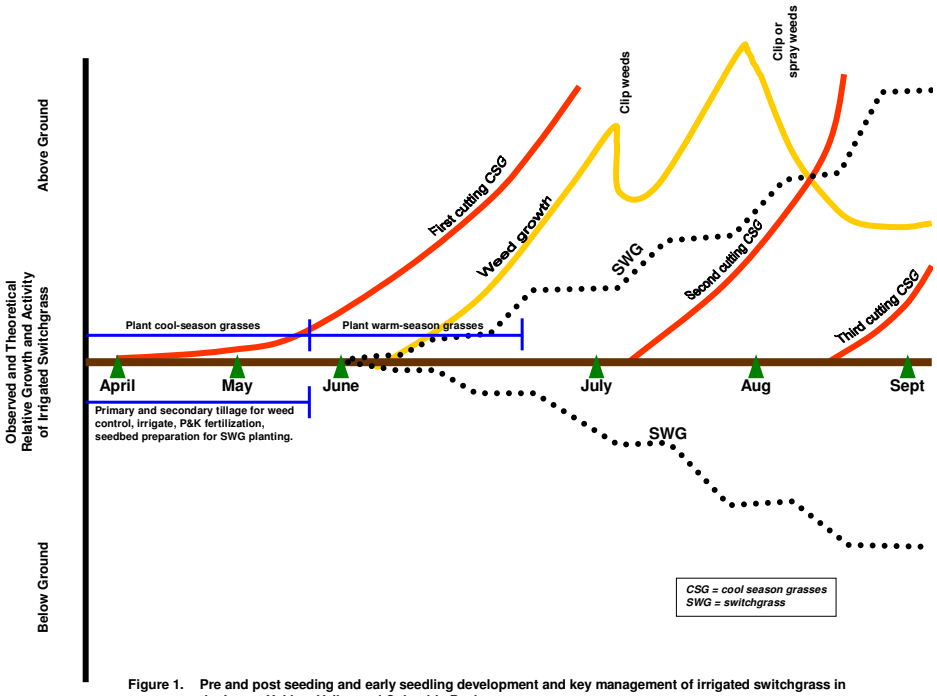

Figure 1. **Pre and post seeding and early seedling development and key management of irrigated switchgrass in the Lower Yakima Valley and Columbia Basin.**

Figure 1 compares the growth habit of a spring seeded cool-season grass hay field to an early summer seeded switchgrass field in the Lower Yakima Valley or in the Columbia Basin. For many cool-season hay spring grass plantings (depending on the species), you'll often harvest 2 or 3 cuttings of hay during the first year, the year of establishment, as shown by the red lines. Switchgrass requires higher soil temperatures for germination than cool-season grasses so plant it from late spring to early summer. This provides a wider window for controlling spring weeds and preparing the land for a switchgrass planting. Weeds will be a major problem to control in most new switchgrass plantings as few herbicides can be used and damage to the grass during this time can be substantial. Shortly after planting the switchgrass will start a very slow and arduous process of becoming established. The three most important virtues for the next 4 months is Patience, Patience, and tons more Patience!! Switchgrass will start growing roots followed by small leaves above the soil. Then the above growth will nearly stop while the root system increases, followed by above growth again. This process occurs over and over during the year of establishment, figure 1. If you compare this growth to cool-season grasses, where above and below ground growth occur at about the same time during the establishment year, you already see differences separating these perennial grass types.

Switchgrass is photoperiod sensitive and will start transitioning into fall dormancy in early September, figure 2. Depending on the weed control, clipping and any post emergence weed control herbicide measures, there maybe a single small harvest of biomass that can be cut in late September until mid-October. Pre-harvested biomass will turn the different autumn colors this is expected and normal. If these leaf symptoms were to occur with cool-season grasses one might tend to apply more fertilizer, not so with switchgrass. Allow switchgrass to take advantage of the shortening daylength and the cooling temperatures and transition into fall then winter dormancy.

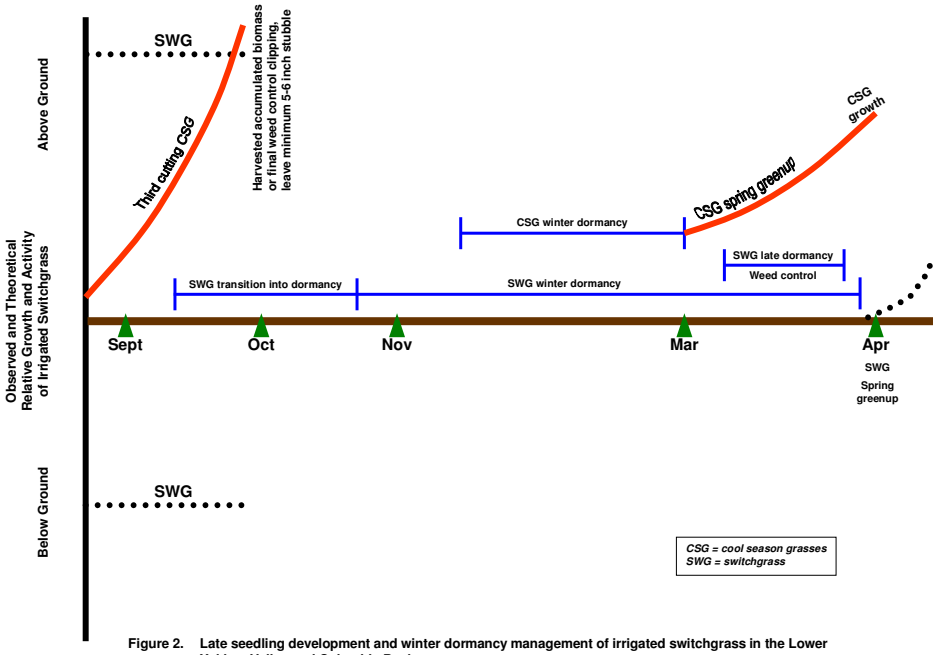

Figure 2. Late seedling development and winter dormancy management of irrigated switchgrass in the Lower Yakima Valley and Columbia Basin.

A final hay cutting of cool-season grasses will be taken in the fall. Depending on a number of growth factors from the previous 4 months, there maybe a reasonable biomass harvest to be taken from the establishing switchgrass planting, figure 2. As with all harvests of switchgrass, do not cut below a 5-inch stubble zone (more on this discussion later). Figure 2 shows overall plant transitional changes for both cool and warm-season perennial grasses grown under irrigation in the PNW region. The cool-season grasses progress into winter dormancy much later and what appear to be with less intensity than the warm-season grasses, i.e. cool season grasses often remain green during the fall and into winter dormancy but warm-season species will to completely brown. The winter dormancy period is much shorter for the cool-season grasses than the warm-season species. Spring greenup starts earlier, often a month or more, for the cool vs. warm-season perennials in our region. The period from mid to late March is an excellent time to apply herbicides that could control both winter germinated annual weeds and early emerging cool-season perennial weeds in dormant switchgrass. Care must be exercised not to apply herbicides after the warm-season grasses have broken dormancy and green growth is initiated. Depending on the location in the Lower Yakima Valley or the Columbia Basin, spring growth for switchgrass can range from early to mid-April. Growth is slow until temperatures increase and daylength extends later that month or into

May. I like to apply fertilizer after about 2 weeks of spring growth because I know the root systems are actively growing and taking up those pricey but important nutrients.

Weed control during the first production year of biomass will be from the interplant competition of the switchgrass. Stands can still be rowed in the spring but depending on the rhizome activity during the growing season, many rows will not be obvious in the fall.

When preparing to harvest first cutting switchgrass biomass in the first production year, consider not only the cutting at that time but also prepare for a second cutting in the fall. Thus, if you have chosen a later maturing switchgrass variety, for example, Shawnee, Blackwell or Kanlow, the first cutting crop may not be fully headed by July 4th. So, to ensure a good second cutting I would recommend, at this time, to take that first cutting in early to mid-July allowing for adequate time for a second cutting to regrow. If you delay the first cutting until August, the photoperiod sensitivity of the crop will become engaged and regrowth will be limited even though temperatures are high and you continue to irrigate. Earlier maturing switchgrass varieties, for example, Dacotah or Nebraska 28 will head in late June to early July and most cool-season grass hay growers will respond by wanting to cut them at that time. This is a good reaction and one to follow. More difficult decisions must be made when managing later maturing varieties. You should be able to use the normal haymaking equipment to harvest the switchgrass biomass. The most important aspect of harvesting either biomass cutting is DO NOT CUT LOWER THAN 5 OR 6 INCHES, i.e. leave a stubble height of 5 to 6 inches. Many have heard me talk about leaving a 3-inch stubble height for the cool-season perennial grasses, well, double that height for the warm-season perennial grasses!! It is very important not to cheat and cut below as I would predict regrowth will be very slow (if at all for the rest of the season) and stand losses will greatly increase due to plant death. We have not lost a single stand due to cheating on harvest management. Switchgrass is winterhardy in the irrigated PNW region and we have only lost 1 stand due to winterkill. This occurred from an early August planting and the grass never transitioned into fall dormancy before hard killing temperatures. We hope to investigate additional windows for planting in the future. So I do expect switchgrass stands to last 20 years in the PNW region.

To date, switchgrass has received the media's attention. I do think it has great potential for our region. I do think there are other perennial warm-season grasses with equal or higher biomass/biofuel potential at different locations in the region. We will continue to investigate other grasses to understand the growth habits and ethanol/energy potential that is now only beginning to be tapped. We live in a very exciting time and the potential to provide some of our own bioenergy with these grasses I think helps our national energy balance, helps diversity our farm land acreages and breaks up long standing weed, disease and insect cycles, and contributes positively to the soil organic matter bank account where future generations will with draw their food and fuel credits.