Renewable herbaceous biomass using perennial grasses and forbs will become important raw material for conversion to bio-fuels, chemicals, electricity and heat. This article addresses pellets to be burned in pellet stoves and furnaces. Grasses contain constituents known as ash which cannot be converted to energy and which can significantly affect the efficiency of stoves and furnaces. Our study compared how various grasses performed in higher altitude fields with shorter growing seasons as are found upstate in Delaware County, New York.

We researched the whole production chain, including the effects of ash content. The objective was to assess which grasses performed well, from seeding to harvest. Preparation, plant type, planting methods, growing conditions, harvesting time and method, handling systems, pelleting process, efficiency in burning and ash content were considered for each variety. The grasses and forbs studied included tall wheat grass, switchgrass, giant bluestem, Indian grass, miscanthus, canary grass, tall fescue, bamboo, willow, and existing material found in the field consisting of mainly cool season grasses and several forbs such as goldenrod, heleopsis, joe pye weed, milkweed and echinacea.

Ten acres were divided into ten one- acre plots. The seed rate was 10 pounds per acre. The planting preparation began in fall 2009; planting and seeding were done in late spring 2010. Bamboo, willow and miscanthus were plants, cuttings and rhizomes planted by hand and not seed[1]. Since bamboo and miscanthus are warm season grasses, they must be dug when dormant in early spring. The existing hay field was not touched and was left to grow naturally.

There was little or no difference in germination and weed control in fields treated with roundup in fall or spring. Plots turned over using a disc showed a greater variety of weed species. After seeds had germinated and grown to about 4-6 inches there was an initial cutting to control the weeds. Mowing occurred again 4 weeks later and grasses planted by seed were left to grow on until frost. Miscanthus, bamboo and willow all showed excellent survival and growth rates. Estimated costs per acre to plant the various herbaceous biomass grasses and forbs ranged from $145 to $1900, and yields ranged from 3 to 14 tons per acre depending on species and method.

Due to the poor germination rates of tall fescue, Indian grass, giant bluestem and tall wheat grass, it was concluded that these grasses were not good candidates for bio-mass in our region. Warm season grasses need a higher soil temperature to germinate well and this could be the reason for the poorer germination of these grasses. The plots of these grasses were left to grow on in 2011 and the growth and density of the grasses did not improve much. Bamboo was also eliminated as a good bio-mass source for short season climates. Warm season grasses and willow require three years to reach maximum yields. Cool season grasses like canary grass, produce higher yields in the first two years than the warm season grasses. There was little difference between no-till and disc and seed except in time and money. No-till was quicker and less expensive to plant the seeds.

The grass bio-mass was reduced in size using a tub grinder and hammer mill. A California pellet machine was used to make pellets. No additional drying was needed as the grasses were in the appropriate range. No binding agents where added.[2] This allowed for stricter comparison of the quality of the finished pellet. The quality[3] of finished pellets ranged from fair (switchgrass), good (canary grass, mixed forbes) to very good (miscanthus, willow).

Pellets were burned using a multi-fuel stove designed to burn grass, wood, corn, and other bio-mass. Stoves most commonly used by consumers, however, are designed for wood only. Newer stoves made to handle higher ash are designed to handle clinkers and ash better than older stoves designed to burn wood pellets only. This should increase the salability of grass based bio-mass pellets in the future.

One hundred pounds of pellets were burned for each grass. Total ash produced was recorded to determine Btu output of each bio-mass product. Percentage of ash ranged from 1.1% to 6.2% depending on species, The Btu output ranged from 15,008,000 to 15,824,000 Btu's. Grass bio-mass will produce about 16,000,000 Btu's per ton minus the percentage of ash.

Growth was good in all grasses and willow with one exception. Switchgrass remained uneven and did not fill in as the others did. Harvesting was the same for all except the willow which cannot be harvested with conventional haying equipment. Handling moisture content was not difficult if grass was left long enough to leach minerals before harvesting and stored properly. Material pelleted soon after harvesting and not stored over a long time had higher moisture levels and were easier to pellet.

Depending on investment objective, any of the six bio-mass products we tested can produce a good pellet. However, switchgrass might be the most difficult to establish in short season locations. Canary Grass, a cool season grass, performed the best of all the grasses planted by seed. For small bio-mass plantings, we cannot justify the expense of converting entire fields to specialty hybrid grasses. To increase yields on small scale operations, a combination of grasses would work best.

For farmers who choose to start a large bio-mass operation converting hundreds of acres, hiring a bio-mass firm to establish new fields is recommended; there is special equipment required to plant miscanthus on large acreage. The increase in potential dry ton yields in large operations should justify the cost of planting many fields with the specialty bio-mass grasses. The most productive plantings were miscanthus, canary grass and willow. They require a greater initial cost but the yields can quickly turn a profit. For farmers who wish to grow bio-mass with low initial investment, can use existing fields that may have been in corn or another crop, canary grass is recommended. Marketing this bio-mass may be more difficult but if that market can be found or developed, this can be profitable. Bio-mass pelleting

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[1] Bamboo – plants. Miscanthus – plants and rhizomes. Willow – 8 inch cuttings.

[2] Binding Agents are used when material has low lignin. Lignin is a compound found naturally in plants that assists in holding bio-mass together after it has been pressed into pellets.

[3] Quality – Poor was excessive fines and softer pellet. Good had less fines and pellet was denser. Very Good was little fines and the pellet was very dense.

operations emerging all over upstate NY will need bio-mass product. Manufacturers may have specific requirements for the types of grasses they will buy, so before making a large investment, farmers should have an outlet to sell your bio-mass or have a marketing plan in place. Start small, converting several acres at a time and expand as your market grows.

On small scale operations, a combination of grasses produces the best yields. Using existing fields planted with strips of miscanthus rhizomes would spread and crowd out smaller and less productive grasses and increase yield. Miscanthus rhizomes growing beds can be established to avoid purchasing large quantities of miscanthus plugs. Access the full at: **www.sare.org.** More information on specific grasses and at: **www.drerenewables.com.**