UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
SOMERSET, NJ

and

RUTGERS UNIVERSITY-AGRICULTURAL EXPERIMENT STATION
NEW BRUNSWICK, NJ

NOTICE OF RELEASE OF 'CARTHAGE' SWITCHGRASS

The Natural Resources Conservation Service, U.S. Department of Agriculture and Rutgers University-Agricultural Experiment Station announce the naming and release of **'Carthage'** switchgrass (*Panicum virgatum L.*). 'Carthage' switchgrass is a cultivar release and has been assigned the Plant Introduction number 421138 and was tested under the accession number NJ-50. 'Carthage' is being released as a Mid-Atlantic/Northeastern mid to late summer forage variety.

Collection Site Information: The collection site was in Moore County, North Carolina along a highway near the county seat of Carthage. The original stand no longer exists due to highway reconstruction. This area forms the boundary between the Piedmont and Coastal Plain physiographic region of North Carolina more specifically referred to as the Sandhills region. The dominant soils in this region are deep, sandy Quartzipsamments (Lakeland and Kershaw soil series) and Paleudults (Blanton and Troup soil series) on rolling hilly slopes where the upper sandy strata are thick. This area was once an ancient shoreline and the sands were re-deposited by the wind. The elevation is 440 feet above sea level. The biodiversity of the Sandhills region is dependent on a combination of high rainfall, very porous sandy soils, and an active cycle of wildfires that creates a mosaic of longleaf pine community types of which switchgrass is a component. This area is a humid subtropical climate receiving an average of 46-49 inches of annual precipitation distributed evenly throughout the year. Summer high temperatures average from 83-92 degrees F. and winter high temperatures average 52-64 degrees F. This area is in USDA-Plant Hardiness Zone 7b with an average minimum temperature of 5-10 degrees F. Average freeze- free period is 220-240 days.

Plant Description: 'Carthage' switchgrass is a native, perennial warm-season grass. It grows to a height of 4 to 6 feet and spreads by short rhizomes. Switchgrass is a native, erect, coarse, warm-season perennial grass. Foliage height of mature plants is mostly between 3 and 5 feet (0.9-1.5m), the inflorescence, a 6- to 18-inch-long (15-46 cm) open panicle, often extends to a height of 5 to 7 feet (1.5-2.1 m). Switchgrass has both sod and bunch-forming ecotypes. Bunch-forming ecotypes like 'Carthage' are generally encountered on uplands. In the Southeast, bunch-forming ecotypes have only short, vertically oriented rhizomes averaging 0.5 inch (1.4 cm) in length, while sod-forming ecotypes have both short, vertically-oriented rhizomes and long horizontally-oriented rhizomes (2 to 4 times longer than vertical rhizomes) Switchgrass roots may reach depths of 10 feet (3 m) or more.

'Carthage' has a leafy growth habit, exhibits strong seedling vigor, better than average rhizome spread and early spring recovery.

Method of Breeding and Selection: Single clone collected vegetatively by K.E. Graetz, Plant Materials Specialist in 1956 near Carthage, North Carolina. It was later tested under the name 'NJ-50.The clone was multiplied vegetatively and pollinated in isolation. Open-pollinated seed from this isolation constituted initial material for multiplication. Early in the selection process, the 'Carthage' accession was chosen from four other accessions in a multi-center switchgrass strain evaluation. 'Carthage' was tested under numbers BN-8624, SC56-32, AM-77, and NJ 50.

'Carthage' has very good forage quality and has generally out-yielded some midwestern forage varieties including, 'Cave-in-Rock' and 'Blackwell' in the Northeastern and Mid-Atlantic states. It is a wind pollinated out-crossing species exhibiting later maturity than 'Blackwell' and 'Cave-in-Rock'. This characteristic allows Carthage to combines better with cool season grasses for mid to late summer use. Seed production is fair to good depending on the level of management. It has been tested at the Cape May Plant Materials Center and other locations in the northeast for over 35 years.

This selection shows better than average spread, a higher forage nutrient value, and earlier spring recovery than current Midwestern cultivars of switchgrass being used in the Northeast. In tests at the Cape May Plant Center, 'Carthage' showed an average protein content of 8-10 percent and a digestibility averaging 50 percent. USDA-Agricultural Research Service (ARS) studies from University Park, PA show 'Carthage' as having very good yields of high quality forage with excellent stand persistence. The good seedling vigor and outstanding leafiness are the most desirable traits of this release. At maturity, it typically reaches a height of four to five feet. Because it matures late compared to other varieties of switchgrass, it complements cool-season forages for mid to late summer use. Seed production is fair-good, but can be improved by good management. Reluctance to release this material in the mid 1980's was based on low seed yield. This was perceived to be a genetic problem, however with changes in cultural and management techniques, seed yield improved. The changes included planting in rows versus solid stands, burning each year in the early spring, and harvesting earlier in September than previously done.

Adaptation studies comparing cool and warm season grasses were conducted by the USDA-SCS, USDA-ARS and various agricultural experiment stations in the northeast in the late 1970's to the mid-1980's. However, most of the research data was collected from USDA-ARS studies coordinated by the Pasture Lab in University Park, PA. Data collected included dry matter yield, stand ratings, % total forage, IVDMD and crude protein, % ground cover and Nitrogen use. A literature review summarizing research results is presented in Appendix A.

Ecological Considerations and Evaluation: The Environmental Evaluation Worksheet developed by the Plant Materials Program was completed in 2000. (See attachment). This assessment indicated that this release has a low chance of negatively impacting the environment and was suitable for release to the commercial market.

Conservation Use: Primary use is for grazing/hay production. Secondary uses include: critical area planting, conservation buffers and vegetative barriers.

Area of Adaptation: 'Carthage' is well adapted to North Carolina, Tennessee, northern Arkansas, and the Mid-Atlantic states from Virginia northward to north-central Pennsylvania and northern New Jersey, (USDA-Plant Hardiness Zones 5b to 8a) but its northern limit is undetermined. Optimum soil type is a loamy to sandy, well drained soil however it will also grow on somewhat droughty to somewhat poorly-drained soils.

Availability of Plant Materials: Foundation seed will be maintained by the USDA-NRCS Cape May, NJ Plant Materials Center. Interested growers may request foundation seed by contacting the Plant Materials Center at 1536 Route 9 North, Cape May Court House, NJ 08210. Telephone:(609) 465-5901, Fax: (609) 465-9284

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APPENDIX A.

Forage Quantity and Quality

Native warm season grasses have a role to play as a mid-summer forage in the Northeast and Mid-Atlantic states. They perform exceptionally well on marginal, nonproductive soils where cool-season forage grasses are not competitive.

Adaptation studies comparing cool and warm season grasses were conducted by the USDA-SCS, USDA-ARS and various agricultural experiment stations in the northeast in the late 1970's to mid 1980's. In one study, Sharp (1./) reported that in most cases the warm season grasses out yielded the cool-season grasses whether fertilized or not. The highest yielding cool season grasses, which received 67 pounds of N per acre (Reed canary grass), produced less forage than the poorest yielding warm season grass without nitrogen fertilizer. NJ-50 switchgrass was the highest yielding warm-season grass with and without fertilizer. See Table 1.

Table 1. Yield of cool and warm season grasses

Grass-Warm Season	**w/o fertilizer**	**w/67 lb./ac N**
	----------lbs./ac.----------	
Niagara big bluestem	3,961	6,040
Blackwell switchgrass	3,713	7,048
NJ-50 switchgrasss	**9,569**	**9,987**
NY-591 indiangrass	4,680	5,525
Grass- Cool Season	**---------- lbs./ac----------**	
Ky-31 tall fescue	712	3,380
Pennlate orchardgrass	1,137	2,722
Reed canarygrass	1,413	3,458

*data from PA, NY, and RI for 2 years (1978-1979) during the fourth and fifth years after planting.

A central Pennsylvania study by Morris, et.al. (2/.) from 1978-1980 compared the production of several warm-season grasses and two commonly used cool-season grasses under high and low phosphorous conditions. All warm-season grasses out-yielded the cool-season grasses under low P conditions. See data in Table 2.

Table 2. Yield of Warm and Cool Season Grasses Grown under Low and High P.

Grasses	Low P	High P
	---------grams dry matter/row----------	
Caucasian bluestem	1,102	1,316
Niagara big bluestem	593	631
Blackwell switchgrass	820	810
NJ-50 switchgrass	**658**	**1,086**
KY-31 tall fescue	341	468
Pennlate orchardgrass	240	437

The USDA-ARS Pasture Lab at University Park, PA has done numerous studies with various cultivars of warm-season grasses alone and in comparison with cool-season forage grasses. The researchers found that the warm-season grasses vary greatly in their adaptation to environmental conditions in the East, depending upon species and cultivar. NY 1145 ('Niagara') big bluestem, KY 1625 and NJ-50 switchgrass were among the accessions well adapted to eastern conditions. Stands of 'Blackwell' switchgrass with origins from the Great Plains, used as a check against NJ-50 switchgrass, established faster but was less persistent than NJ-50. (3/.) Tables 3, 4, and 5, summarize the research done by USDA-ARS Pasture Lab from 1973 to 1986. Dr. Gerry Jung, research agronomist with USDA-ARS, states that these studies clearly show that while NJ-50 and KY 1625 switchgrass and 'Niagara' big bluestem stands took longer to establish, they became more productive and were more persistent than the check cultivars from the Great Plains. He further states the performance data suggests that it would be appropriate to release NJ-50, NY 1145 and KY 1625 to the commercial market for farmer use.(3/.)

Table 3. Stand ratings (percent canopy cover) of switchgrass planted in late June 1973 in Southwestern PA. (3/.)

	Mean Grass Stand Ratings					
Seeded grasses	1973	1974	1975-76	1977	1978*	1982
			----------% cover----------			
Switchgrass						
Blackwell	excellent	good	96a	86a	92a	71ab
NJ-50	**good**	**good**	**74bc**	**82a**	**92a**	**86a**
KY 1625	poor	poor	82ab	78ab	94a	84a
NY 4006	fair	poor	63cd	52c	78ab	52b

* stand fertilized with 56 N/ha

Mean grass stand ratings followed by the same letter (abcde) each year are not significantly different according to the Waller-Duncan t-test.

From 1978 to 1982 stands of 'Blackwell' and 'NY 4006' switchgrass had deteriorated substantially, whereas those of NJ 50 and 'KY1625' did not. Late summer regrowth yields of 'Blackwell', 'NJ-50',and 'KY 1625' switchgrass pastures were high when sampled in 1975, 1977, and 1978 but were low in 1979 averaging only 0.46 Mg/ha. NJ-50 switchgrass had higher yields than the other switchgrass varieties though not statistically significant. However, the October yield of NJ-50 pastures was significantly higher than that of other bluestem species (Big, little bluestem, and old world) in 1977 and 1978. (3/.) Table 4 summarizes these results.

Table 4. Mean Dry matter yields of mixed cool and warm season grass swards, averaged over fertilizer treatments in October in southwestern PA. **(3/.)**

Switchgrass Variety	**1975**	**1977**	**1978**
	----------Yield Mg/ha----------		
Blackwell	2.5a	2.3ab	2.7bc
NJ-50	**2.6a**	**2.6a**	**3.3a**
KY 1625	2.4a	2.5abc	3.0ab
NY 4006	2.1abc	1.8abcd	2.3cd
Bluestem Variety			
Kaw (big)	1.3d	1.2d	1.9de
Niagara (big)	1.5cd	1.4cd	1.7e
Aldous (little)	1.3d	1.2d	1.8de
Caucasian (old world)	2.2ab	1.5bcd	1.9de

Forage Nutritive Quality

Mean forage IVDMD values of switchgrass and big bluestem sampled July 20-25 ranged from 471, 507, 571 g/kg (Table 5). IVDMD (In vitro dry matter digestibility) is a measure of the dry matter lost following incubation in test tubes with rumen microflora. The range of mean IVDMD values across years (503 to 560) was nearly twice as great as the range (515 to 546) across cultivars. 'NJ-50 compares favorably with other accessions although analysis of check samples showed that the IVDMD technique underestimated dry matter digestibility of switchgrass as determined in metabolism trials with beef cows.

Table 5. Forage IVDMD and Crude protein concentration of switchgrass and big bluestem sampled in July in southwestern PA. 1976-1979 (3/.)

Nuritive value/ Grass variety	1976	1977	1978	1979
	----------g/kg----------			
IVDMD				
Switchgrass				
Blackwell	537a	498b	515b	558ab
NJ-50	**528a**	**471c**	**507b**	**553b**
KY 1625	546a	504b	514b	571a
NY 4006	540a	503b	555a	559ab
Big Bluestem				
Kaw	528a	541a	546a	569a
Niagara	528a	503b	550a	552b
Crude Protein*				
Switchgrass				
Blackwell	73b	74d	83c	104cd
NJ-50	**103a**	**80cd**	**90bc**	**105cd**
KY 1625	83b	94b	90bc	107bc
NY 4006	77b	87bc	92bc	109b
Big Bluestem				
Kaw	75b	103a	106a	118a
Niagara	73b	87bc	97ab	102d

* mean of all fertilizer treatments

Forage Production

In another study conducted by USDA-ARS, (4/.) Six genera of warm-season grasses were grown near State College Pennsylvania for 9 years from 1978-1986 on a fine-loamy, mixed mesic, Aquic Fragiudult, to determine their potential as forage grasses on droughty sites. Effects of applied N on yield, plant morphology, and N composition of forages were studied during years 4 through 7 (1981-1984), when N was applied to half of each plot area. Big bluestem, *(Andropogon gerardii)* and switchgrass, (*Panicum virgatum*), showed much cultivar variation in stand development, whereas asiatic bluestem (*Bothriochloa spp.*), and indiangrass, (*Sorghastrum*

nutans), developed productive stands in one season. **Mean dry matter yield of NJ 50 switchgrass from 1981-1984 was 10.1 Mg/ha which was significantly higher than that of all other grasses**. (Table 6. summarizes the switchgrass data.) As a comparison, mean yields for the other switchgrasses ranged from 8.0 to 8.5 Mg/ha. The yield of 'Niagara' big bluestem was higher than that of other big bluestems, (7.6 Mg/ha) and yield of 'KY 591' indiangrass (7.9 Mg/ha) was higher than that of other indiangrasses At the end of the ninth year, NJ-50 switchgrass stand ratings were nearly 100% in both the fertilized and unfertilized treatments. **The authors stated that the performance of the Soil Conservation Service selected eastern strains of the native grasses, particularly NJ-50 was outstanding.**

Table 6. Mean Dry Matter Yields with and without applied N in Milesburg, PA, 1981-1984*

	--------Dry matter yield 1981-1894---------- Mg/ha/yr		
Switchgrass variety	0 N Applied	75 kg/ha N applied	Mean Yields
Blackwell	6.9a-c	9.2 bc	8.05
Caddo	7.7a	9.3bc	8.50
Kentucky 1625	7.1ab	9.6b	8.35
NJ-50	**7.8a**	**12.3a**	**10.1**
Pathfinder	7.8a	9.1b-d	8.45

* Adapted from Table 4., Agronomy Journal Jan./Feb. 1990 v.82, p24