Northern Great Plains Research Laboratory

NORTHERN GREAT PLAINS

INTEGRATOR

For environmentally and economically sound agro ecosystems for the northern Great Plains.

January 2008

New Intermediate Wheatgrass on the Horizon

Intermediate wheatgrass provides many advantages to producers. It is easy to establish and has high yields and quality. However, stands of intermediate wheatgrass are generally not long lived especially when they are grazed. The Northern Great Plains Research Laboratory and the Bismarck Plant Materials Center are currently working on a planned release of a new cultivar of intermediate wheatgrass 'Manifest' which has shown greater ability to withstand grazing while maintaining yield and quality.

Table 1 shows the average yields of Manifest in comparison to other common intermediate wheatgrass cultivars for various locations in the Great Plains and Utah. Average yields for Manifest were very comparable to the other cultivars and Manifest had the highest yield when averaged across all locations. Table 2 shows crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) values for the selected cultivars. IVDMD is a measure of how well livestock can digest the forage. While Manifest had slightly lower CP and IVDMD values than the averages of all the cultivars, it was still high quality forage for livestock.

The big advantage of Manifest is its Improved ability to withstand grazing. This was tested by marking individual tillers or shoots of different cultivars and determining if those shoots remained alive, died or were replaced by new shoots after being grazed. This information was then complied into a shoot replacement ratio. The higher the ratio the better a cultivar does under grazing.

Figure 1 compares the shoot replacement ratio of Manifest with Reliant, Manska, and Oahe. Because of Manifest's high shoot replacement ratio, this cultivar should withstand grazing and have increased stand longevity. Manifest has the traditional high yields and high quality which make intermediate wheatgrass attractive forage for producers in the northern Great Plains. The Increased persistence of Manifest during grazing will result in greater stand longevity for producers. Research at NGPRL has suggested that the best time to graze intermediate wheatgrass to increase its persistence is before the boot stage. This generally occurs in early to mid June at Mandan.

This cooperative release effort between the USDA Northern Great Plains Research Laboratory and the USDA Natural Resources Conservation Service, Plant Materials Center is one of many of the cooperative efforts in assuring that adaptable forage grasses are commercially available to the public. The USDA-NRCS Bismarck Plant Materials Center established a Foundation Seed production field of Manifest in 2006 and the first harvest of seed was in late July of 2007. This seed will be cleaned and allotted for seed increase with hopes of Manifest seed being commercially available in 2010 for pasture, hayland plantings and other conservation uses.

Drs. John Hendrickson, John Berdahl, Mark Liebig, and Wayne Duckwitz
(USDA-NRCS Bismarck Plant Materials Center)

Table 1. Average dry-matter yields of intermediate wheatgrass cultivars in a cooperative regional trial. (2001-2003, also 2000 at Mead, NE)

	Location/ (Number of years)						
Entry	Mandan, ND (3)	Miles City, MT (3)	Mead, NE (4)	Sidney, NE (3)	Blue Creek, UT (3)	Green Canyon, UT (3)	**Mean (19)**
	---Pounds/Acre---						
Manifest	**4614**	**1409**	**9708**	**3215**	**1729**	**3406**	**4611**
Reliant	4867	1295	8738	3162	1192	3365	**4214**
Manska	4206	1396	7774	3076	1361	3783	**3931**
Oahe	4864	990	8466	3355	1506	2706	**4405**
Greenar	3843	1170	8101	2907	1873	3762	**4071**
Beefmaker	4505	1537	9163	3253	1125	2682	**3924**
Haymaker	4422	1369	8996	3091	1116	3152	**4161**
Mean	**4474**	**1310**	**8654**	**3151**	**1415**	**3265**	4150

Figure 1.

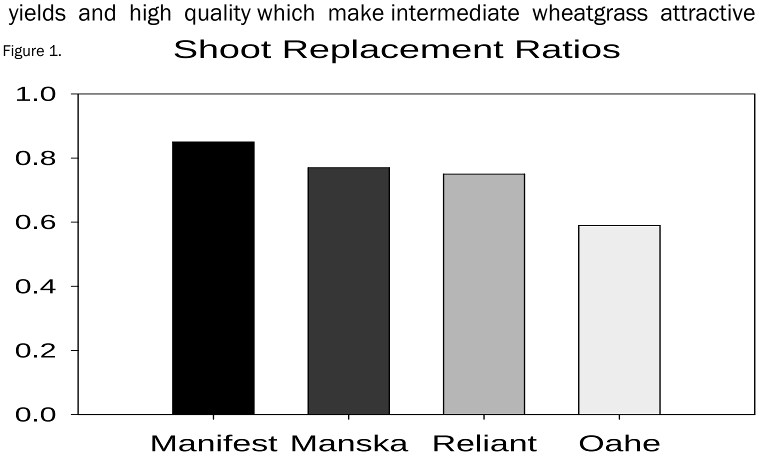

Table 2. Crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) for different intermediate wheatgrass cultivars at Mandan, ND (2 yr) and Mead, NE (4 yr).

	Mandan, ND		Mead, NE	
Entry	IVDMD	CP	IVDMD	CP
	---%---			
Manifest	**62.3**	**6.9**	**65.1**	**9.1**
Reliant	63.2	8.1	66.0	9.5
Manska	63.6	7.5	66.3	9.7
Oahe	61.2	7.5	64.1	8.9
Greenar	62.5	6.9	64.6	9.4
Beefmaker	63.9	8.1	66.5	9.3
Haymaker	63.2	7.5	65.1	9.4
Mean	**62.8**	**7.5**	**65.4**	**9.3**

Increasing Adaptability of Cropping Systems using a Dynamic Crop Sequencing Approach

Many cropping systems throughout the world are managed under extreme climatic conditions resulting in high-risk conditions for agricultural producers. Such a context applies to the Great Plains of North America, as this region is known for periods of instability caused by variability in precipitation and seasonal temperatures. Development of cropping systems resilient to this variability is a major challenge to agriculturists in the region.

Reduction in the use of fallow in Great Plains cropping systems has placed greater emphasis on proper selection and sequencing of crops. Crop selection and sequencing can take many forms. At a very basic level, crops can be sequenced in a consistent, unchanging pattern, thereby reflecting a fixed-sequence cropping system. Fixed-sequence systems, however, can lead to the development of weed, insect, and disease infestations, are generally less responsive to external stresses such as the weather, and may limit opportunities to take advantage of market conditions and/or government programs. To increase responsiveness to external factors, opportunity/flex cropping systems allow producers to adjust cropping system intensity and/or diversity based on externalities, such as soil water status at planting. Additional flexibility in annual crop sequencing can be realized through the application of a *dynamic cropping systems* concept, where crop sequencing decisions are made annually based on externalities as well as management goals. This approach to crop sequencing possesses an inherent flexibility to adapt to high-risk conditions, and therefore may be more economically and environmentally sustainable than other approaches to crop sequencing. Critical to the successful implementation of dynamic cropping systems is a thorough understanding of short-term (1 to 3 yr) crop sequencing effects on relevant agronomic and environmental parameters. Such short-term research efforts can help identify crop sequence 'synergisms' and 'antagonisms', thereby providing the necessary foundation for developing strategies to sequence crops over a longer period of time. To that end, a team-focused, multidisciplinary research effort was undertaken at the USDA-ARS Northern Great Plains Research Laboratory (NGPRL) in Mandan, ND to investigate short-term crop sequence effects of 10 crops on crop production, plant diseases, soil residue coverage, and soil water depletion. Results from the project were published as a series of six papers in the July-August 2007 issue of *Agronomy Journal*, and were originally presented at the 2005 ASA-CSSA-SSSA annual meetings in Salt Lake City, Utah at a symposium entitled 'Dynamic Cropping Systems for Soil and Water Conservation'.

Don Tanaka, project leader for the research effort, used a unique crop by crop-residue matrix design to evaluate 100 crop sequence effects over a period of three years. "The crop by crop-residue matrix approach along with the multidisciplinary research team effort enhanced evaluation of crop interactions that may otherwise be overlooked in crop sequence research," explains Tanaka.

The research team at NGPRL is actively working to translate their research findings for use by agriculturists through an update of the *Crop Sequence Calculator*, an interactive computer program designed to help agricultural producers assess crop sequencing options for optimizing economic, agronomic, and environmental goals within dryland cropping systems.

Originally published in CSA News (V52 N08), August 2007.

Proso Millet for High Quality Forage and Good Cattle Gains in Late-Summer and Early-Fall

If you are interested in running yearling cattle on grass and also raise annual crops, then consider growing warm season annual forages like Proso millet for grazing in August and September until a killing frost.

In August, the nutritional quality of forage on typical grassland is often not good enough to support average daily gains of two or more pounds per day. In contrast to these lower gains, our steers have gained about two and a half pounds per day through August and early September for several summers while grazing Proso millet. For example, this past summer our yearling steers gained from 2.1 to 2.7 pounds per day while grazing Proso millet between July 31st and September 25th. They readily graze its leaves and upper stems when it is immature and then as it matures they graze the seed heads and upper leaves. We are not sure how much nutritional value they get once the seeds are hard, but they continue to graze them and gain weight.

We have found that yearlings will use Proso millet more efficiently if we move an electric cross fence in front of them and only give them access to enough millet for a day of grazing. In the past when we gave them access to a large area of millet we felt that too much of it was stomped down and layed on and not enough was eaten. Even when we give them access to only enough for one day they still knock some of it down and don't graze most of this millet, but the upside of this is that the vegetation that gets knocked down can increase the organic matter levels in the soil and increase its fertility and productivity. Also, we don't worry about preventing their access to the small amount of regrowth that occurs on the millet that they have already grazed. There generally isn't enough regrowth in August to worry about.

Proso millet has high water use efficiency and requires only a small amount of water to produce a nice stand.

We seed Proso millet at 20 pounds of pure live seed per acre in early June and it is usually about two feet tall with seed heads in the boot when we start grazing it in early August. We like the variety Sunrise. We seed it into a firm weed-free seedbed with a no-till drill at a depth of about one inch, and put down thirty pounds per acre of 11 - 52 with the seed and 100 pounds per acre of urea banded.

Avoid high levels of soil nitrogen or you may end up with lodged millet. See the NDSU Extension Circular SF-726 for information on fertilizing millet for your soil. Proso millet can be seeded later in June if the summer starts out dryer than normal and even reseeded if the first seedlings succumb to unusually hot dry conditions.

Although we have not yet tried this, it is possible, at least in better rainfall years, to grow a cool-season crop such as fall triticale, winter wheat or peas for hay or grazing in early summer then after this crop is removed seed Proso millet in late June or early July for late summer grazing. Grazing millet in late summer or early fall is easier than putting it up as hay because getting the millet stems to dry can be challenging especially in early fall.

Dr. Scott Kronberg

Area 4 SCD Cooperative Research Farm

Research Results

& Technology Conference

February 19th

8:30 AM - 3:30 PM CST

SEVEN SEAS CONFERENCE CENTER

MANDAN, NORTH DAKOTA

Hear the Researchers from Mandan's

NORTHERN GREAT PLAINS RESEARCH LABORATORY

Morning Seminars…

No-Till: One Piece of the Puzzle

Crop Sequence Economics

CRP Carbon Uptake

Carbon Sequestration and Switchgrass

Microbial Engineering to Improve Profitability

Afternoon Seminars...

Beef Production with Less Grain

Flaxseed in Beef Cattle Diets

New Forage Releases and Management

The Need for Agricultural Research

Lunch Provided by These Sponsors and Exhibitors:

Supplementing forage diets with flaxseed

Recent interest in the use of fats has spurred a good deal of research in this area. Fats are an attractive source of energy because they are known to reduce dustiness, greatly increase the energy density of the diet and supply the animal with unique fatty acids that are not only required for physiological functions but have been proven to be healthful to consumers of ruminant derived foods. Unfortunately, there are limitations as to the level at which fats can be fed. It is generally recommended that ruminant diets not contain more than 5% added fat as to avoid a reduction in ruminal digestion. Forages themselves can contain as much as 3% fat, therefore, one could theoretically feed upwards of 8% total dietary fat without seeing a reduction in diet digestibility. One of the other major concerns with feeding fats is related to a reduction in dietary intake. This has been observed in dairy, feedlot, and forage-fed cattle. Many have theorized the cause of this reduction in intake is related to the reduction in ruminal fiber digestibility. However, work from North Dakota State University and Kansas State University has shown that flaxseed, which is around 35% fat, was fed at or around 5% of a high concentrate diet and either did not affect or increased dietary intake.

We know that the rumen environment of cattle consuming forage-based diets is completely different than that of an animal consuming a high-concentrate diet. Therefore, Dr. Eric Scholljegerdes and others at NGPRL set out to determine at what level flaxseed should be fed to forage fed cattle and would this improve growth performance of grazing beef steers?

The first experiment used beef heifers that were both ruminally and intestinally cannulated and given free choice hay and flaxseed for a period of 21 days. This allowed the animals to decide at what level they preferred to consume flaxseed. It was determined that 4 lbs of whole flaxseed was the maximum amount that they would freely consume. A trial was conducted to evaluate the site and extent of digestion when these cattle were fed 0, 2 or 4 pounds of whole flaxseed. It was observed that ruminal organic matter, protein, and fiber digestibility was not affected by these levels of flaxseed. In addition, increasing the level of flaxseed fed also increased the amount of unsaturated fatty acids, which included omega-3 fatty acids, reaching the small intestine where absorption of fat occurs. Nevertheless, a reduction in forage intake was observed with a forage substitution rate of 0.647 pound of forage for every pound of flaxseed (Figure 1).

A decrease in forage intake is not necessarily a bad thing provided the energy density of the diet is such that the energy lost from reduced forage intake is made up with supplemental energy. A second trial was conducted using 18 beef steers with an average initial body weight of 812 pounds. These steers were rotationally grazed on historically native pastures from June, 2006 to September, 2006 and allotted to one of three treatments that were no supplement or were individually fed cracked corn-soybean meal or fed ground flaxseed at either 0.35 or 0.20% of body weight, respectively. The reason the supplements were fed at different levels of body weight was so that we could give equal quantities of total digestible nutrients (TDN). This would allow us to compare the differences between a carbohydrate and fat energy source and fats are 2.25 times more energy dense than carbohydrates. On average, the steers received about 3.0 pounds of the corn supplement or 1.7 pounds of the flaxseed supplement on an as-fed basis throughout the summer.

Unlike the previous experiment, forage intake did not differ between unsupplemented controls and the average intake of the supplemented treatments. However, forage intake was lower for flax-fed cattle compared to corn-fed cattle. As we expected, supplemental energy increased animal weight gain from 1.46 pounds per day for unsupplemented controls to 2.14 and 2.05 pounds for cattle fed corn or flax, respectively (Figure 2). Feed efficiency (pounds of gain per pound of feed) was also increased from 0.09 to 0.12 for supplemented cattle (Figure 3).

From this work we can conclude that feeding flaxseed can increase feed efficiency of grazing cattle compared to unsupplemented controls but not compared to ones fed corn-based supplements. However, more work needs to be done to examine the effects of higher levels of flaxseed in grazing diets, in order to see if an improvement in feed efficiency can be realized over that provided by corn. Furthermore, the increase in intestinal supply of omega-3 fatty acids has implications for those wishing to increase tissue supply of these healthful fatty acids. In addition, omega-3s have been shown to be beneficial to reproductive success in beef heifers.

Dr. Eric Scholljegerdes

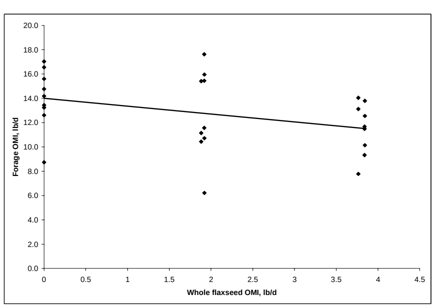

Figure 1. Relationship between forage OMI (lb/d) and whole flaxseed intake (lb/d). Slope of the line equals forage substitution (kg of forage OMI/ kg of flaxseed OMI). y = -0.647x + 6.35, R^2 = 0.13, P = 0.07, SEM = 0.38).

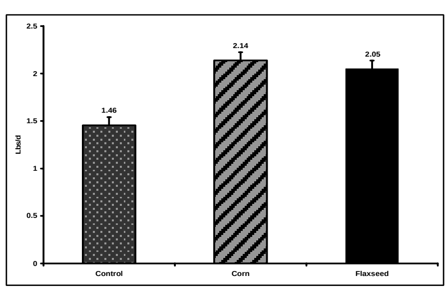

Figure 2. Effects of supplemental flaxseed on average daily gain (lbs/d) in beef steers grazing summer pasture in the northern Great Plains. (Unsupplemented versus supplemented P < 0.001; Corn versus Flaxseed P = 0.47; SE = 0.09)

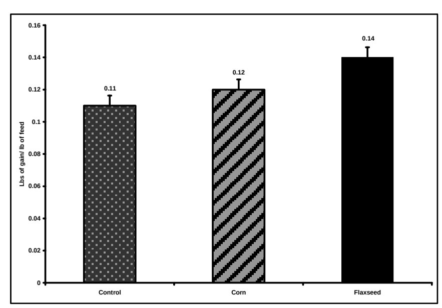

Figure 3. Effects of supplemental flaxseed on feed efficiency (lbs of gain / lb of feed) in beef steers grazing summer pasture in the northern Great Plains. (Unsupplemented treatment versus supplemented treatments P = 0.005;

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Land cover influences soil organic carbon and net flux of carbon

Agricultural landscapes are comprised of multiple types of plant communities which we refer to as land cover (Figure 1). We hypothesized that different types of land cover would influence soil organic carbon and net flux of carbon as greenhouse gases. We tested this hypothesis on agricultural landscapes located in the Missouri Coteau ecoregion. This was performed by first stratifying the landscape into cropland, pasture, deep marsh, shallow marsh, wet meadow, and low prairie categories. Random points were identified for each category within the landscape. At these points, soil carbon and greenhouse gas fluxes were measured in July and August. We found greatest soil organic carbon in the pasture, compared to the other land-cover categories (Figure 2). We also found the fluxes of methane were greatest for deep marsh communities, while fluxes of nitrous oxide were greatest for croplands (Figure 3). When the global warming potential for all three gases was calculated by land-cover, we found the greatest source strength in the deep marsh communities (Table 1).

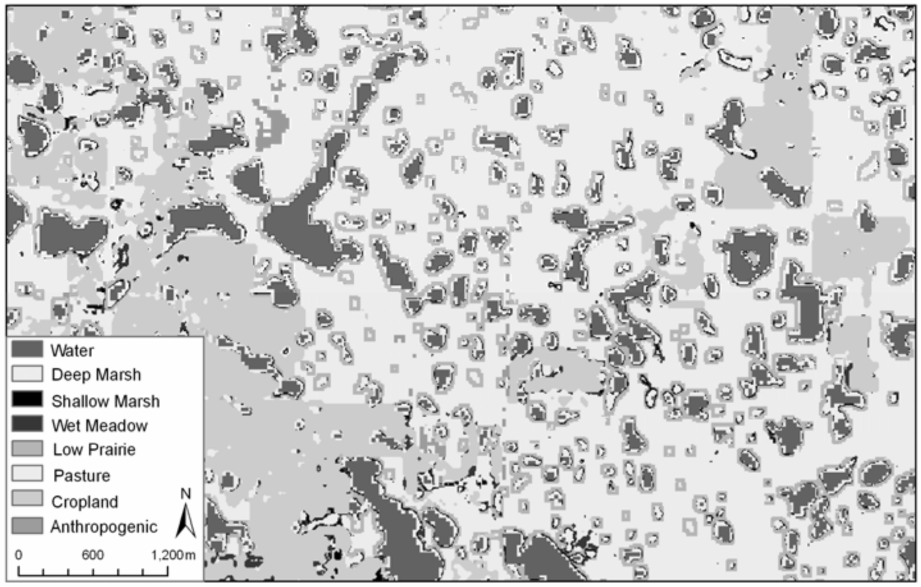


Figure 1 This map illustrates how soils and plant data could be merged with the proposed system for enhanced rangeland assessment. For each shape, the soil type and average spring crude protein content is shown. Remote sensing-based classification for a 205.6 km^2 landscape of interest located in Ward County, North Dakota. Near the edges of water bodies are wetland plants, comprised of deep marsh, shallow marsh and wet meadow communities. The wetland communities are surrounded by low prairie, pasture and/or cropland. Data were classified using methods described in Wetlands (Phillips et al. 2005).

We applied a previously developed remote sensing-based tool for mapping these land cover categories to determine net fluxes of carbon as greenhouse gases for a 205.6 km^2 landscape (Figure 1). "Net greenhouse gas emissions per unit land area were calculated separately for each land-cover category (Table 1). While the emissions per unit land area were greatest from deep marsh communities (1778.4 kg km^{-2} d^{-1}), the area of deep marsh land cover was relatively small. The greatest total greenhouse gas contribution was from croplands for this 205.6 km^2 landscape (45,700 kg d^{-1})."

If total source strength were not weighted by land-cover category, as in Table 1, the net flux of carbon as greenhouse gases for this andscape would have been overestimated by 50%. This study demonstrates the importance of considering land-cover when calculating net fluxes of carbon as greenhouse gases and illustrates how these land-cover categories affect carbon accounting for agricultural landscapes.

Drs. Rebecca Phillips and Ofer Beeri (UND)

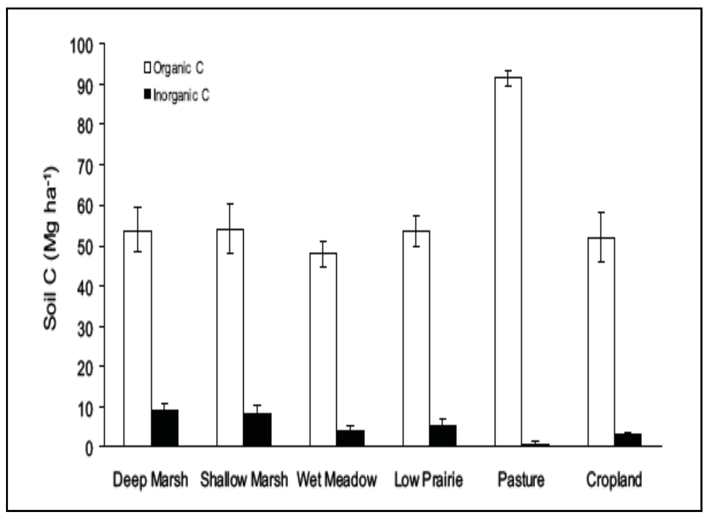


Figure 2 Average (+/- standard deviation) soil organic carbon measured for each land-cover category (n=15) for the 0-15 cm soil depth increment. Significantly greater organic carbon was found for pasture soils.

Class	Area (km^2)	Vegetated Landscape Prop. (%)	Flux GHG-C equiv. (kg km^{-2} d^{-1})	Total GHG-C equiv. (kg d^{-1})
Deep Marsh	10.1	4.9	1778.4	17,900
Shallow Marsh	3.6	1.8	571.9	2,076
Wet Meadow	5.6	2.7	------	------
Low Prairie	14.0	6.8	389.2	5,432
Water	14.3	7.0	------	------
Pasture	60.1	29.2	398.9	23,966
Crop	98.0	47.7	466.1	45,700
Total		100		
Vegetated Landscape Total	205.6			95,075[a]

Table 1 Average net flux of carbon as greenhouse gases, expressed as carbon equivalents, for the entire 205.6 km^2 landscape depicted above weighted by land-cover category. This landscape emits over 95,000 kg of carbon as greenhouse gases per day in summer, or 462 kg km^2 d^{-1}.

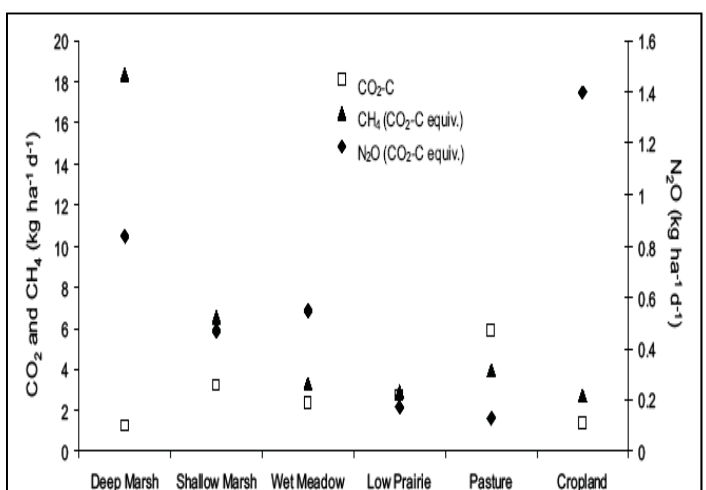
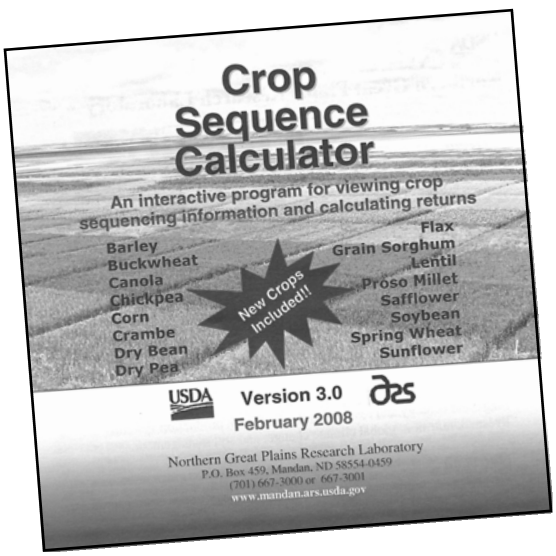


Figure 3 Average net flux of carbon dioxide, methane, and nitrous oxide for each land-cover category, expressed as carbon equivalents, according to the Intergovernmental Panel on Climate Change (2007).

Crop Sequence Calculator 3.0 software to be released



The long-awaited Crop Sequence Calculator 3.0 will be made available to participants of the Research Results & Technology Conference (see page 3) on February 19th.

The calculator provides information on production (grain and forage), economics, disease risk, soil water use, and soil quality for many crop sequences utilized in the northern Great Plains. Producers will be able to review the results of crop sequencing decisions utilizing barley, buckwheat, canola, chickpea, corn, crambe, dry bean, dry pea, flax, grain sorghum, proso millet, safflower, soybean, spring wheat, and sunflower at the Northern Great Plains Research Laboratory from 1999 to 2005. Many PowerPoint® tutorials are also included. To calculate potential economic returns from the various crop sequences, producers can use the Mandan experimental data, or modify it for soil, weather, and other local conditions that may differ from the research location.

The Northern Great Plains Research Laboratory has provided over 12,000 copies of the Crop Sequence Calculator at no cost to producers and educators worldwide. This new CD-ROM contains both version 2.2.5 and 3.0 to assist producers predict results under various anticipated moisture conditions. Phase II research (CSC 2.2.5) was completed under abundant moisture conditions while Phase III research (CSC 3.0) was completed under below-normal moisture conditions.

The new CD-ROM will be available at no cost on the Northern Great Plains Research Laboratory website after March 1, 2008.

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