INTRODUCTION

Statement of Problem

Water quality degradation due to excess nutrients from fertilizers, confined feeding operations, sediment erosion from streambanks and soil and nutrient surface runoff from crop and pasture acreage are major concerns in large portions of rural Iowa (Kalkhoff et al. 2003). Some non-farm interest groups perceive agricultural producers as the primary source of this non-point water degradation (Buttel 2003). These groups are expressing their concerns at the community, county and state levels to legislate changes to agriculture production through land use ordinance and tax initiatives at the subwatershed level and on a regional or ecosystem wide basis (Sweeny 2003).

Many agricultural producers in Iowa have come to recognize the emerging threat to their operations and way of life by continuing with the same methods of operation, some of which may be unsustainable. A few producers realize there is an urgency to modify existing operations before state and local authorities, pushed by special interest groups, formulate county land use ordinance or taxing structures based on projected amounts of nutrient runoff from crop and pasture fields (Petty 2003).

These producers see the benefit of working with academic experts to proactively implement a holistic approach, utilizing natural methods to control excess nutrient movement in surface runoff and the groundwater system. This group also advocates taking a stronger hands-on, adaptive management, approach to farming systems management. Major system changes recommended in land use include shifting from continuous to rotational grazing, improving the existing forage, reducing sediment loss from streambank erosion and surface runoff, and protecting the streams from excess nutrients and sediments.

Purpose of Paper

The purpose of the paper is to develop a management plan for the Black Hawk Beef Farm (BHBF) located in north central Iowa (Figure 1). This plan will be limited to addressing three distinct and separate spatial areas that significantly impact water quality. These areas are associated with runoff from row crop production, which is the primary function of this farming unit. A second purpose of equal importance is to establish BHBF as a model of the practices addressed for other small family farms to emulate in the region.

Permanent pastures managed in a rotational sequence have demonstrated they will produce a greater amount of biomass than previously produced under a continuous grazing system. A comparison of the 26-acre plot identified in Appendix A in the Iowa Forage and Livestock Balance Worksheet (Ranum 2004) demonstrates a 67 percent increase of tall warm season grass over continuous grazing with single dominant Kentucky bluegrass forage. This biomass will increase infiltration and reduce soil erosion from both streambanks and the land surface.

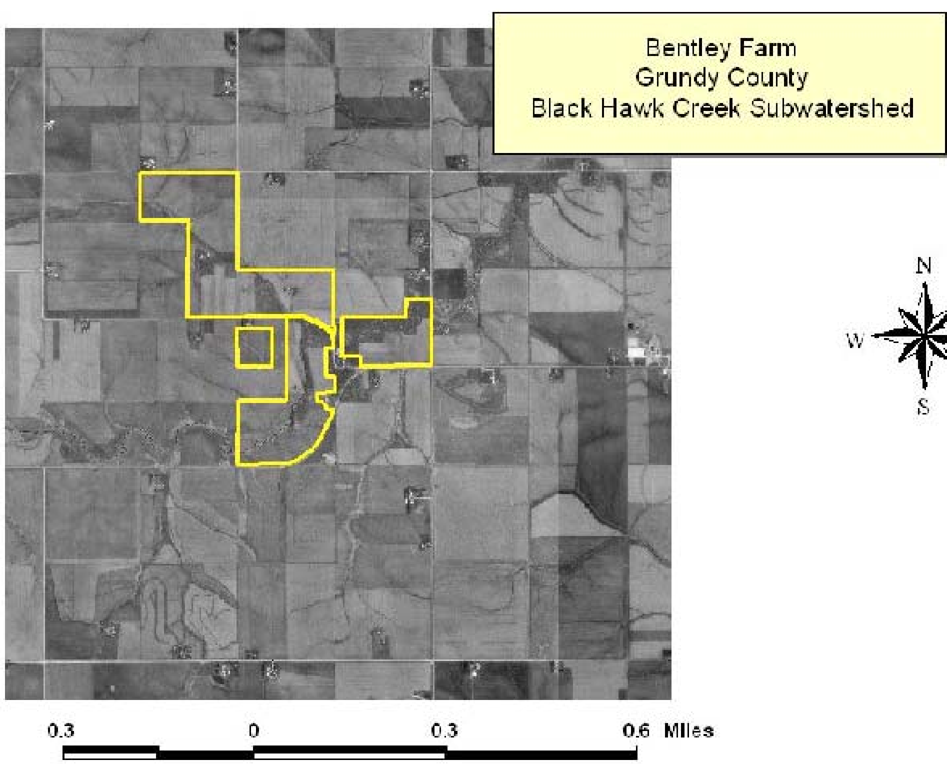


Figure 1 Black Hawk Beef Farm (BHBF) Footprint

The second area to be addressed is improved water quality derived from establishing riparian buffer zones between the freshwater stream and row-cropped fields. This vegetative barrier increases infiltration contributing to nutrient pollutant sequestration in the soil column. Increased infiltration provides a greater period of time to filter out these nutrients. Johnston (1998) estimated that residence time of groundwater in 82 foot wide buffers at the Risdal Farm on Bear Creek in Story County, Iowa is between 105 and 281 days. These buffers have been established for one to seven years, respectively. These measurements provide an indication of the time groundwater could be in residency within the proposed 100 foot wide buffers (22 percent larger versus Risdal Farm buffers) for BHBF.

The third area is limited to the outside edge of the stream channel of Black Hawk Creek where it interacts with the existing incised streambank. These sand and silty clay loam streambanks are susceptible to undercutting from the faster moving water that is eroding the pasture forage area and contributes significant soil mass to the stream flow. Sand from this erosive action quickly settles out of the water column accumulating on the channel bed while the silty clay loam particles are suspended and carried further downstream.

Goals of the Management Plan

The overall goals of the management plan are to place BHBF on a path toward increased short-term profitability and initiate the preliminary steps needed to achieve and maintain long-term ecological sustainability with a health soil base. This will be accomplished by implementing the following practices in the permanent pastures, the riparian areas adjacent to cropped fields and within the stream channel of the incised stream predominately located in the permanent pastures.

Increased profitability for the livestock portion of the farming operation, in the short-term, is derived from a healthy soil producing higher levels of diverse forage for consumption. When managed as planned, the rotational grazed forage is continually consumed at a highly nutritious stage and is available for a longer period during the growing season than the existing continuous grazing system. Availability of a diverse grass mix, including legumes, over a longer period contributes to a better cash management position by reducing expenses for feed supplements and soil additives. These supplements may be feed additives or silage and hay produced with a large input of costly fossil fuel, expensive equipment and scarce time resources on BHBF.

Implementation of the rotational system also contributes to development of a healthy soil. This is accomplished with the construction of permanent and temporary fenced paddocks. Allowing forage within a paddock an opportunity to rest 18-25 days between grazing events will enable it to restore protein energy levels needed for continuous shoot and root development (ISU Extension Service 1998). This resting period is a significant contributor to development of stronger and deeper fine root biomass, which also leads to higher levels of soil aeration deeper into the soil column. Soil respiration is a strong indicator of higher levels of soil biological activity leading to better soil health (Tufekcioglu et al. 1999), which is an important goal of this farming enterprise.

Multi-species riparian buffers are highly effective in reducing nutrient runoff from entering the freshwater network (Schultz et al. 1993, 1995). These systems have also improved fine root biomass below ground (Macher 1999, Tufekcioglu et al. 1999) that functions as a natural filter for dissolved nutrients (Walton 1983). Native grass species (Big bluestem, Indiangrass and Eastern gamagrass) selected for the buffer zones have achieved rooting depths up to seven feet (ARS 1999). These larger riparian buffers also contribute to increased insect and invertebrate populations within the food web (DeVore 2002). An expanded food web will also attract a greater number of wildlife species seeking food, shelter, nesting sites, and areas to raise their young. This ecological benefit must be balanced against the risk of disease transmission to crop production, which is still the goal of this farming unit.

Expansion of riparian buffers beyond currently established areas may reduce streambank degradation. These expanded buffers consist of selected herbaceous and woody species with characteristics of fast growth that structurally holds soil particles in place through increased fine root biomass and reduced moisture content through higher levels of evapotranspiration. Reduction of the moisture levels within the soil column makes the soil particles less susceptible to fracture and movement (Burkart 2004). The buffers will be enclosed with adequate electric fencing to restrict livestock grazing following harvest operations. Eliminating grazing in these areas will allow the natural healing process to begin enabling the existing seedbed to germinate and provide an herbaceous cover to the bank soil. The dominant grass, Kentucky bluegrass, and others within the seedbed (i.e. Smooth bromegrass and Common reed canarygrass) will also become established. Native species of the Iowa savannah and other introduced exotics that may have been waterborne or windblown may also appear. Eradication efforts should be considered if and when exotics appear.

Proven engineering and bioengineering practices will be initiated in the permanent pasture where the stream has become incised to an approximate depth of seven to eight feet exposing a sheer streambank to fast moving water following storm events. These practices shall include enclosing Black Hawk Creek behind an electric woven and smooth wire fence to prevent bank overgrazing. Native grass species addressed above with deep fine root biomass characteristics will be interseeded or frost seeded in the area between the electric fence and the edge of the streambank. Restricting movement on the bank slope down to the waters edge will also allow the existing seedbed to germinate and develop a canopy cover.

Other in-stream practices will consist of anchoring bundles of Eastern red cedar or cut trees at the foot of the streambank with a combination of willow or cottonwood posts (Riparian Management System 2004). Red cedar has a high tolerance to rot in a wet environment and willow or cottonwood has a demonstrated rapid growth with extensive development of root biomass. The combination of cedar or cut trees will protect the bank face from the streams velocity and should increase the accumulation of siltation at the base of the bank.

Implementing protocols previously developed for rotational grazing, buffer development and improvement of soil biological activity can attain achievement of these goals. Future research is still required to determine other important characteristics of the stream such as mean flow velocity, velocity at the bankfull stage and the sediment bedload carrying capacity are but a few of the measures required to determine the forces acting on the streambank and creating significant erosion. Results of this future research will influence the size of the in-stream bioengineering practices being considered. All of the measures addressed above are designed to increase profitability, ecological sustainability, water quality, soil health and plant and insect diversity. It is also a positive demonstration of the effort by BHBF of its ecological commitment to the larger community downstream of this farming operation as well as a model for other small farm operations.

Government Programs

There are several government programs such as the Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP), Wildlife Habitat Incentives Program (WHIP), the Wetlands Reserve Program (WRP) and the Conservation of Private Grazing Land Program (CPGL) that relate to agricultural operations for small farms. This paper will focus on EQIP as it relates to the forage enhancement and establishment of a rotational grazing system in the permanent pastures and the problems associated with Black Hawk Creek and livestock in that location. The other major program addressed is CRP as it relates to the establishment of riparian buffer zones between row cropped fields and Black Hawk Creek. The primary focus of the buffer zones is on its functional capability to mitigate surface and groundwater movement carrying suspended nutrient pollutants as surface flow or base flow into Black Hawk Creek. The beneficial impact of expanded buffers to wildlife habitat is recognized, but that is not the focus of this paper. Both of these programs are authorized under The Farm Security and Rural Investment Act (NRCS 2002), which expire in 2007.

EQIP provides technical and financial assistance to install or implement structural management practices on eligible agricultural land (NRCS 2004) related to a forage management change (i.e. rotational grazing); installation of non-borderline high tensile electric fencing on both sides of Black Hawk Creek in permanent pasture and paddocks; protection of stream crossing pathways; clean water distribution system for livestock; and grass seed for pasture improvement. The resource concerns for Grundy County in 2004 are soil quality, water quality, livestock, and wildlife habitat. Highly erodible land such as the incised banks of the permanent pasture of BHBF would be considered as appropriate projects for cost sharing (NRCS 2004).

The CRP program administered through the Farm Service Agency (FSA) is assisted by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agricultural. CRP provides technical guidance and cost sharing to establish riparian buffer zones between crop production fields adjacent to perennial and intermittent streams (NRCS 2002). The landowner has the option to enter 10 or 15-year contracts for the establishment and maintenance of riparian buffers. Monthly payments will be made to the landowner based on past use of the land (cropland versus pastureland), number of acres withdrawn from production and assigned under this program. Riparian buffers are designed within the guidance provided in Code 392 (NRCS 1997). This guidance may be modified to meet the landowner’s objectives and the soil and water resource concerns, as identified by the local Working Group. The Working Group consists of local organizations that have an interest in conservation practices within the county. They are the NRCS District Conservationist and his staff, FSA representatives, County Executive Director, elected Soil and Water Conservation District Commissioners and the County Conservation Director. The NRCS District Conservationist and the Working Group review this list of conservation practices annually. Riparian buffers are recommended for installation along 1.2 miles on BHBF between crop fields and permanent streams.

Conservation Ethic

Planning and pursuit of conservation goals are part of the stewardship responsibilities assumed by landowners who have made a commitment to improve the land. Their land-use perspective determines how natural resources will be used or in Aldo Leopold's terminology "husbanded" within the existing farming system. Wise use combined with soil improvements aims at achieving profitability in a balanced agroecosystem that can regenerate itself to meet crop and diverse wildlife needs. In this manner, the owners are attempting to combine attainment of a sustainable conservation ethic espoused by Leopold (1949) with a sustainable economic unit.

Broad Recommendations

Recommendations and comments provided here are focused on improvements to be achieved in the health and diversity of forage. Ecological improvements will result by expanding areas and diversity of plants in riparian buffers adjacent to Black Hawk Creek. Recommendations, if undertaken, require land use and management changes from the existing operation. The basic farm will continue to be focused on crop production (corn and soybean) and a forage based cow-calf operation.

STUDY SITE

Location

The BHBF is a family farming operation located in north-central Iowa on the south branch of the Black Hawk Creek subwatershed approximately three-miles below the headwaters. Intermittent streams fed by grassed waterways and tile outlets contribute increasing amounts of nutrient rich surface and groundwater to this perennial stream. BHBF is approximately four miles west of Grundy Center, county seat of Grundy County. Figure 1 displays the location of the operating farm footprint within Iowa. It lies solely within a transitional geologic band of the Yellow Spring Group between the major Kinderhook Series to the west and the Lime Creek Formation to the east (Iowa Geological Survey 1969). The soil is silty clay loam with a high moisture holding capacity with slopes of 0 to 9 %. One small section is moderately eroded silty clay loam on 9 to 14% slope (SCS 1977).

Ownership and Management

The original farm (80 acres) has been continuously farmed since the early part of the 20th century. The Bentley family (current owners) has been operating this farm since the mid 1930's. Beginning in the 1970's additional acres have been added resulting in the current operating footprint of just over 400 acres. The current BHBF owner, Leland Bentley, is retired and relies on a tenant manager for farm operations. This tenant has worked on a 50-50 cost share and now on a leased farm agreement that is reviewed annually. This agreement appears to be working well for both parties, although limited financial information is available due to sensitivities of this subject. All of the existing land, houses, equipment and facilities associated with BHBF are debt free. The tenant, working with members of his family, owns several late model John Deere tractors, combines and other pieces of equipment that are used on BHBF and other farms. At present, there is no cost separation of this equipment. The future owners of BHBF (owner's daughter and son-in-law) wish to continue the relationship with the tenant manager and contribute to managing the natural resources on the farm.

Watershed Characteristics

BHC watershed is in the north central part of the state (Figure 2). There are no centers of population or small towns within the geographical boundaries (~ 35 sq. mi. or 22,400 acres) of the headwaters containing the smaller subwatershed (Figure 3) (USEPA 2004). It is made up of small farms on nearly level to moderately sloping landscape formed from the retreat of the Wisconsin glacial period and the deposition of loess material. The loess that covers much of Grundy County is about 14,000 to 20,000 years old and was deposited about 14,000 years ago (SCS 1977). The Iowan Surface ecoregion is located just to the east of the Des Moines Lobe, which has strongly influenced the directional flow (southeast) of watercourses flowing across the Iowan Surface (Figure 4) (Iowa DNR 2004). In the northern portion of the region, the glacial deposits are thin with loess silty material deposited by wind that covers about 75 percent of Grundy County (SCS 1977).

Small family-farms with some scattered larger farming operations compromise the principal land uses. The current corn/soybean cropping systems have replaced the grassland savannah that dominated the midwestern landscape prior to settlement. Many farms have been in a continuous agricultural production over 100 years. Less than 0.1 percent of the original Iowa prairie remains (Anonymous 2004). Forests are almost non-extent, with windbreak shelters surrounding farm buildings or very limited tree stands less than 10 acres in scope.

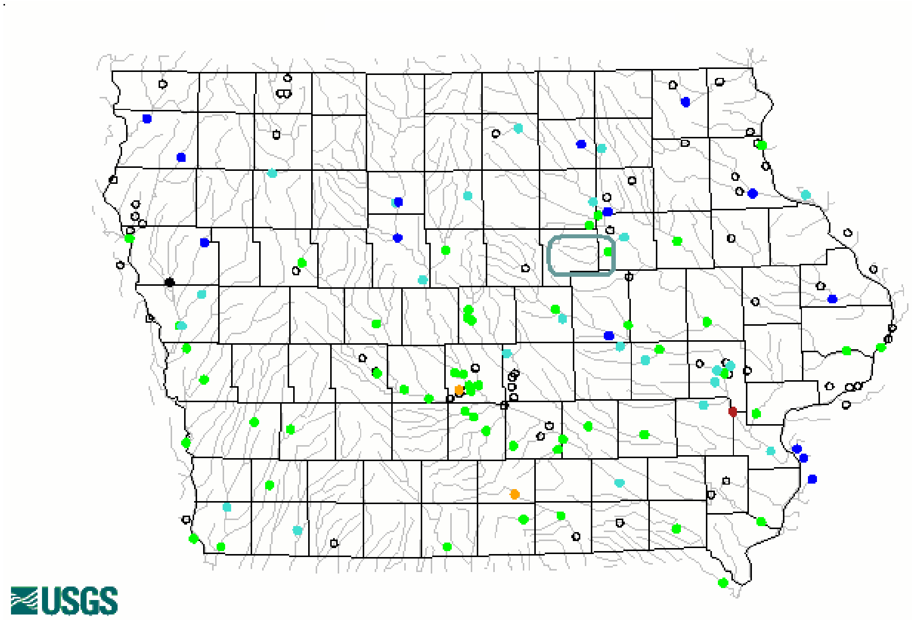


Figure 2 Black Hawk Creek Subwatershed Location (USGS 2004)

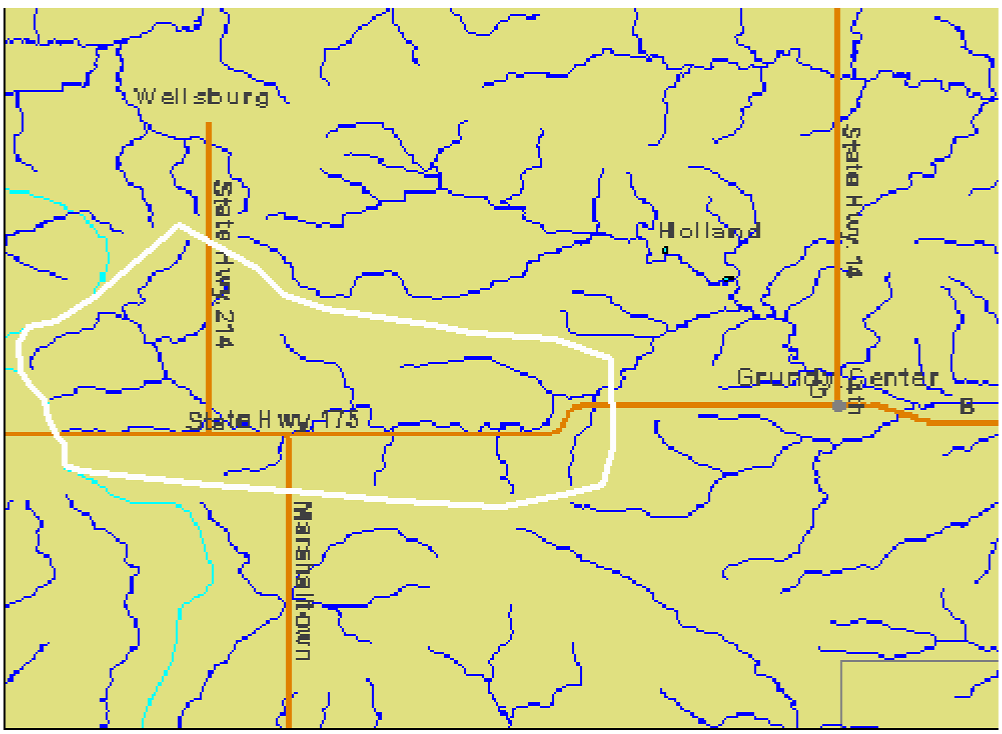


Figure 3 Headwaters to BHBF Subwatershed (USEPA 2004)

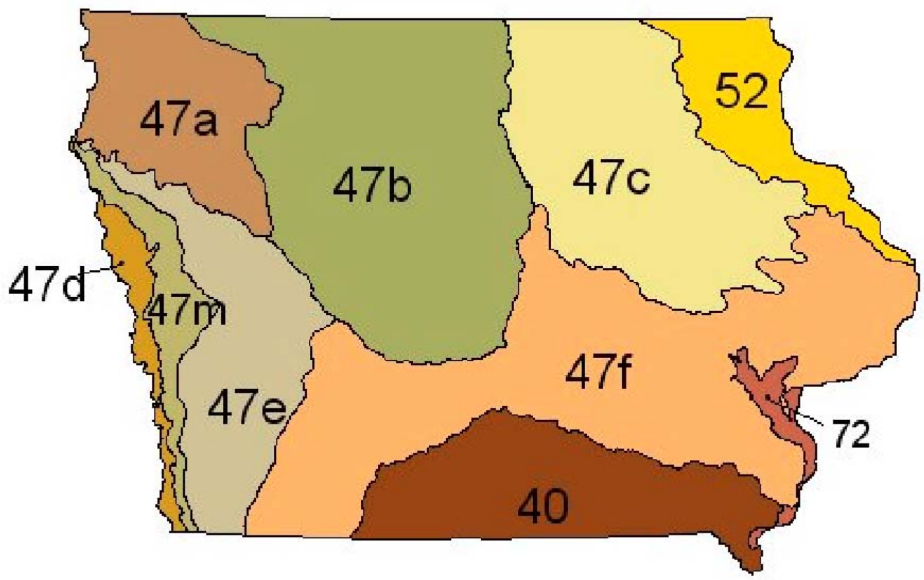


Figure 4 Iowa Ecological Regions (Iowa DNR 2004)

Intensive cropping systems have removed the presettlement prairie ecosystem that formerly slowly released groundwater. The current production systems introduce large amounts of chemicals and some organic fertilizers to achieve high crop yields. In general, the increase of row crops in the 1950's and the use of subsurface tile drainage have each contributed to higher levels of groundwater rapidly entering the stream network following storm events (Jackson and Jackson 2002).

EPA under the authority of the Clean Water Act (CWA) as amended 1977 Section 303(d) requires each state to list those streams or parts of streams that do not meet the water quality standards for which it has been designated. Additionally, the CWA also requires a Watershed Summary Assessment Report be developed to meet the requirements of Section 305(b) (USEPA 1977). Iowa Department of Natural Resources (Iowa DNR) has divided Black Hawk Creek into three segments for the purpose of testing for water quality. Iowa DNR uses both a Benthic Macroinvertebrate-Index of Biotic Integrity (BM-IBI) and a Fish-Index of Biotic Integrity (F-IBI) to classify water quality. Biological monitoring is better able to reflect cumulative impacts of water quality over time and thus is believed to more accurately represent water quality conditions than do monthly monitoring sites of water samples. From the mouth of the creek at

Waterloo upstream to Highway 58 at Hudson, the creek is considered impaired as it is not supportive of Class A status (primary contact recreation) based on high levels of indicator bacteria (fecal coliforms) that violate state water quality standards. Class B status (aquatic life uses) is fully supported based on results of monitoring from the Iowa DNR ambient station southwest of Waterloo from 2000 through 2002 and from three stations monitored in 2001 in support of Total Maximum Daily Load (TMDL) development for this stream reach. Monitoring of water quality criteria for dissolved oxygen, pH, or ammonia-nitrogen showed no violations. In addition, no violations of state criteria for toxic metals and toxic organic compounds occurred in nine samples. Fish consumption uses remain assessed (monitored) as fully supported based on results of EPA/Iowa DNR fish tissue sampling in 1998 near Hudson (Olson 2004).

In the other two segments upstream from Highway 58 at Hudson to the confluence with North Fork Black Hawk Creek and from North Fork Black Hawk Creek to confluence with unnamed tributary in Section 12, T87N, Grundy County showed Class B status (aquatic life uses) were assessed as fully supported. The 2002 F-IBI score was 61 (good) and the BM-IBI score was 63 (good). Stream use assessments showed a moderately diverse fish community from three monitored sites. These sites showed a fish community (8 to 14 species from 2 to 5 families and the presence of a majority of the expected fish taxa (7 of 11, 10 of 11, and 7 of 11) for streams in the Iowan Surface subecoregion 47c. Field sheets indicate generally good aquatic habitats with relatively few significant impacts to the physical characteristics of this stream; although frequent streambank erosion was identified in the last segment (Olson 2004).

The current impact of nutrient and sediment loaded water on the aquatic ecosystem in Black Hawk Creek, at the BHBF location, is unknown at this time. Because of the close proximity to the last segment monitored (less than two miles downstream) BHBF would appear to be comparable. The reported erosion problem is collaborated by observations of the retired owner, indicating storm events contribute to erosion of the streambanks due to high velocity stream surges. The large water volume has incised the previous shallow stream channel from 2 feet to well over 6 or 8 feet in depth and widened the lateral part of the channels from 4 feet to over 30 feet in a 30-year period (Bentley 2003). This morphological change to an F stream type with highly incised banks (Rosgen 1996) is a common characteristic in the upper segments of Black Hawk Creek as it attempts to regain its balance within the highly altered agriculture landscape.

Marginal land near streams is available for livestock forage. Hog operations, which are not conducted on BHBF, have been changed to confined feeder operations within the last 25 years. Two operating facilities are located within 2 miles upstream of BHBF. These confined animal feeding operations (CAFO) are operated under federal limitations utilizing a constructed holding facility for the waste product produced (NPDES 2003).

Planning Context

BHBF is similar to other family farms in the watershed. This farm has implemented several erosion preventative measures (i.e. contour farming, terrace structures, grass waterways, and no-till farming). Small vegetative buffers have developed near all of the intermittent and perennial streams (less than 10 feet), but there are no segments under formal CRP contracts. Based upon these buffer configurations the perennial streams are currently susceptible to continued degradation from nutrient loaded surface runoff. Studies by Lee et al. (2000) indicate 53.5 feet of combined switchgrass-woody buffer removed greater than 98 percent of sand, greater than 93 percent of silt, and greater than 52 percent of clay in rainfall simulations.

Current Grundy County USDA-NRCS recommendations for riparian buffer width have been suggested to be 150 feet (Mier 2004) to fit the recommended national standard widths promulgated by USDA-NRCS Code 391. These recommendations appear to be excess, based upon Iowa regional scientific studies conducted (Schultz et al. 1995 (65.6 feet) and Johnston 1998 (82.0 feet). NRCS Code 391 (1999b) allow these national standards to be modified by each state NRCS office to fit local conditions. A suggested buffer width of 100 feet will be put forward to the USDA-NRCS District Conservation office. This is based on studies that indicate trapping efficiency of sediment particles is increased when the buffer width is increased. Sediment particles are the principal transporting mechanism for much of the total N and all of P (Magette et al. 1989, Chaubey et al. 1994, Barfield et al. 1998). The added width beyond that in studies by Schultz et al. (1995) and Johnston (1998) will provide a greater capacity to compensate for buffer system efficiency loss when the grass buffers are over whelmed by higher than normal surface runoff.

The 65 animal unit cattle herd, consisting of Simmental and Angus crossbreeds, is grazed in a 73 acres continuous grazing system on predominantly Kentucky bluegrass forage during the cool season growing period. Summer forage of 26 acres, with slightly different species composition, is also available. This stocking density may be too high for the dominant grass species, which goes dormant in the warm summer months.

Cattle have free access to the stream for drinking water. This practice has resulted in bank overgrazing and disturbance of the soil contributing to further erosion. Cattle movement in and along the stream contributes fecal and uric waste directly to the freshwater network. Based on the dominant species available and a pasture walk with the NRCS grassland specialist (Ranum 2004), future pasture management requires a focus on pasture improvement by adding three species each of cool season grasses and legumes. Two native warm season grasses and one legume are recommended for the warm season pasture to increase dry matter yield.

Streambank protection from overgrazing and soil disturbance is a second area of focus. Electric fencing on both sides of the stream will provide the required protection. Designated crossing paths will be established to control livestock movement across the stream. Crossing paths will also provide controlled access to meet watering needs during the first year of plan implementation. A permanent freshwater distribution system will be installed in 2006. A side benefit gained from fencing is a natural healing process that can occur over time as streambanks become stabilized.

MATERIALS AND METHODS

Soil Characteristics of Forage Acres

Soil fertility analysis is usually not performed in permanent pastures. Forage acres were considered marginal and used to produce grass, not valued crops. This thinking is no longer valid. Nutritious and diverse forage is now recognized as an important and valuable feed crop by Voisin (1959), Nation (1995), and Gerrish (2004). Properly managed, this crop is relatively inexpensive and can produce substantial added value through livestock production. Therefore, soil fertility for forage production is equally important to good crop fertility, where soil testing is routinely conducted.

The ISU Extension Service (1998) specifically addresses the unique aspects of Grundy County soils as capable of supporting 3.74 animal unit months per acre on a monoculture pasture of Kentucky bluegrass. Their report also indicates that a mixture of cool season grasses can support 6.23 animal unit months per acre on the same soil.

Soil Testing

Soil testing will be conducted on the pastures to determine pH, nitrogen, phosphorus and potassium levels, as well as soil organic matter (SOM) and particulate organic matter (POM), the biologically active organic matter (Cambardella and Elliott 1992a, 1993). The presence of POM is a soil quality indicator due to its rapid response to land use and soil management changes (Janzen et al. 1992, Cambardella and Elliott 1992a, Sikora et al. 1996, Cambardella 1997). Samples should also be taken periodically to monitor below ground biomass development, another indicator of surface dry matter yield.

A soil pH of at least 6.5 is recommended for legumes. Overall soil microorganism activity and plant nutrient availability are optimum at a soil pH level of 6.0 to 6.5. Medium to high soil test levels of phosphorus and potassium are required for rapid establishment (ISU Extension Service 1998). Because the forage acres have been in permanent pasture, organic matter within the O horizon is expected to be high. Jackson et al. (2000) in her study on Swine Manure Management and interviews with grassland specialists (Ranum 2003) indicate the organic content is high (5 to 7 percent) for these north central Iowa soils. This is above the 4 to 5 percent organic matter recommended by Nation (1995). Nation (1995) stresses the importance of increasing soil organic matter as a source of all soil nitrogen. His study concluded that legume cover greater than 40 percent would fix the necessary nitrogen (60 pounds/acre) used by soil microorganisms for organic matter decomposition.

Increasing below ground biomass will enhance SOM and develop a higher moisture holding capacity (Marquez et al. 1999). This characteristic contributes to higher infiltration and reduced surface runoff. A healthy grass canopy retains soil temperature and prevents sudden temperature loss that could reduce the earthworm population. While the grass canopy acts as a blanket, it provides the opportunity for the earthworms to move lower into the soil profile. Over-wintering a larger adult population contributes to greater numbers of young in the spring, yielding higher levels of nitrogen, phosphorous, potassium, magnesium and calcium than soils that do not have this vital composition (Macher 1999). A higher abundance of diverse and nutritious grass is also a contributing factor to success in achieving higher rebreeding rates in the Simmental/Angus crossbreeds pastured on BHBF (Simmental Association 2004).

Planting

No-till interseeding is recommended for the permanent pastures due to the availability of equipment. Evans (2004) recommends verifying proper calibration of no-till drilling equipment for the appropriate density of seeds drilled into the soil. The planting shoe must also be checked to guarantee proper seed depth is achieved. Efficient application of a weed suppressing herbicide (i.e. paraquat or glyphosate) and the capability of equipment to achieve the proper seed depth of ¼ to ½ inch, with good seed-soil contact, contributes to a successful stand (Moser and Nelson 2003). Successfully interseeding operations can double or triple production of low-yielding forage stands (ISU Extension Services 1998).

Frost seeding can be utilized in late February and March. This process requires distribution of seed on the surface during these months to take advantage of the normal thawing process to move the seeds into the soil. Germination will take place as seeds achieve the appropriate depth and moisture requirements. Frost seeding can be effectively conducted from the back of a lightweight All Terrain Vehicle (ATV) versus a heavier tractor (Petty 2003).

Rotational Grazing Infrastructure

Shifting from a continuous to a rotational grazing system requires other infrastructure modifications (i.e. fencing, stream crossing paths, water distribution system) to gain the full benefits of managing for high grass productivity (Figures 2 and 3). Voisin (1959), Nation (1995), and Gerrish (2004) demonstrated that introducing ruminants to forage when it is 6 to 10 inches high and grazed to half that level avoids over-grazing. Retaining livestock in confined areas forces them to utilize 80 to 85 percent of the available forage (Macher 1999). This is significantly higher than the 30 to 35 percent utilization from a continuous grazing system (ISU Extension Service 1998). Moving livestock after they have grazed 50 percent of the available forage, to a new confined area, provides the animals with forage in its most nutritious stage (ISU Extension Service 1998). This shift also allows the grazed forage time to rest and regenerate reserves in the root structure needed for regeneration of new leaf material. Voisin (1959) demonstrated that resting and regenerating new growth in the forage is the secret of rotational grazing success.

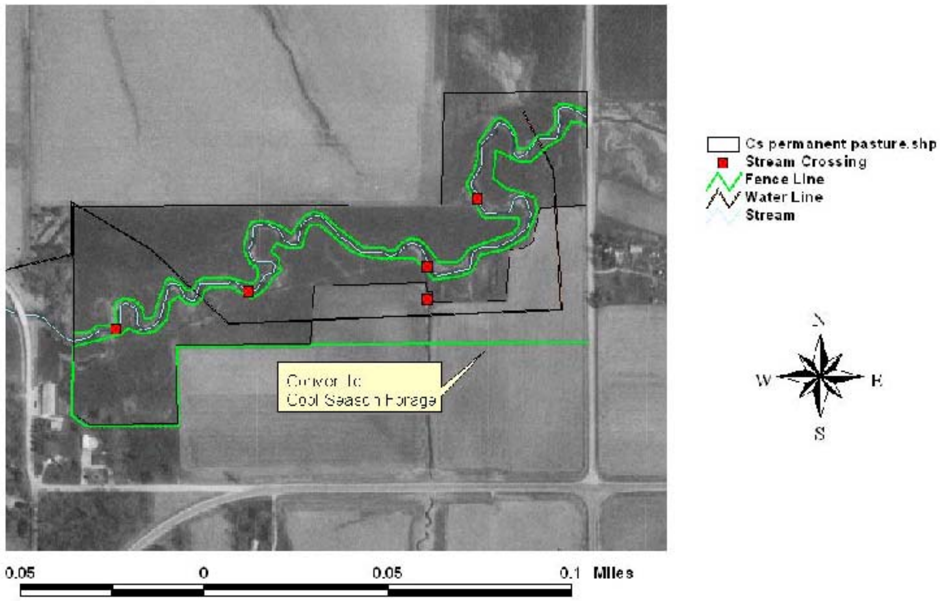


Figure 5 Cool Season Pasture Infrastructure

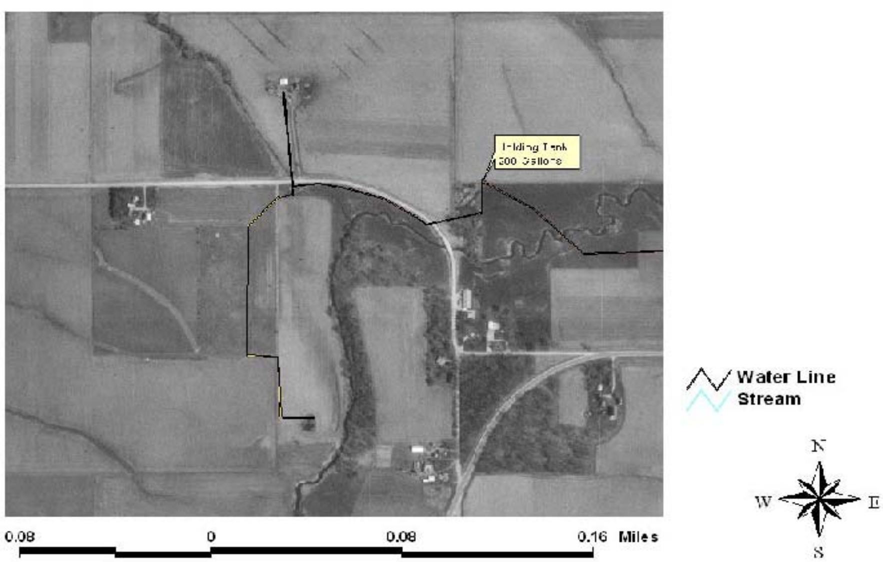


Figure 6 Warm Season Pasture Waterline

Paddock Arrangement

In order to achieve the high levels of grass utilization it is necessary to manage the grazing time of livestock. Dividing the pasture into five paddocks (Figure 7) and rotating the cattle from paddock to paddock on a schedule with the vegetative growth of grass, achieves a higher level of utilization. Development of different types of electric tape, polyrope and smooth wire combined with easily moved metal step-in posts (Premier1 2004) has made establishment of temporary paddocks an effective method of livestock confinement (Gerrish 2004). The breed of cattle enclosed in the confined space is a contributing factor of success. These animals have an even temperament and will most often stay within an area if sufficient forage and water is available (Simmental Association 2004).

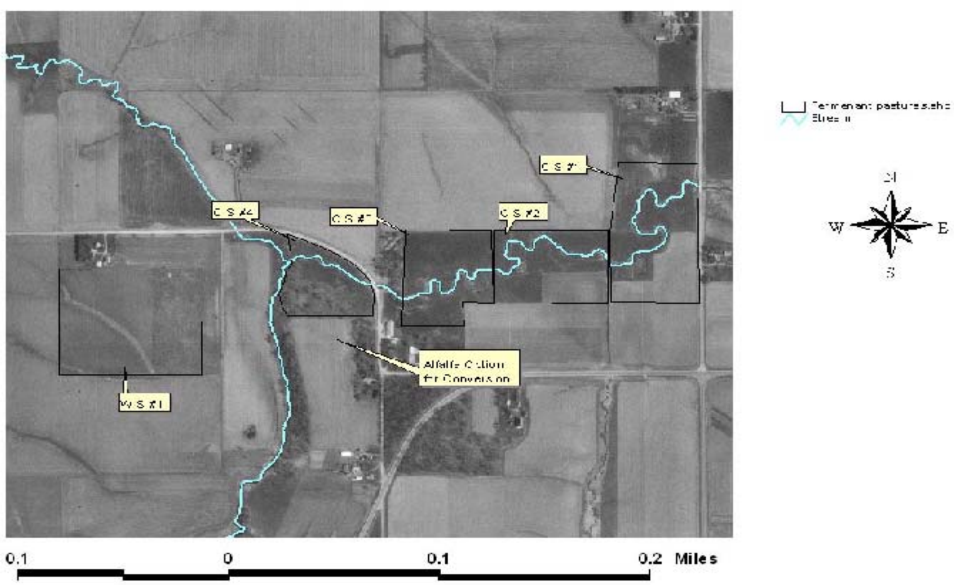


Figure 7 Paddock Arrangement

The existing cool season permanent pasture consists of 73 acres. Six additional acres may be converted from crop to cool season forage. Warm season acreage currently consists of 26 acres. Fourteen cropped acres may be converted to warm season forage, at a future date, and a 4 acre unit of cool season grass may be converted to a warm season stand to meet livestock demand. This arrangement would provide 137 acres (Table 1) for total forage of the current 65 animal unit herd. Conversion of six acres is wise as they are small protrusions of land extending from the primary square fields. Conversion will eliminate inefficient movement of large equipment into these areas and add needed forage acres.

Existing Crop	Cool	Warm	Total
Forage	73	26	99
Corn	6	14	24
Convert		4	4
Alfalfa		14	14
Total	79	58	137

Table 1   Potential acreage available for forage

Based on the Iowa Forage and Livestock Balance Worksheet (Appendix A) these cool and warm season pastures have the potential to produce significantly higher levels than are currently produced on a Kentucky bluegrass dominated system.

Using the 26-acre summer forage as an example, approximately 300,000 lbs. total dry matter versus 178,560 pounds of total dry matter for a bluegrass dominated pasture can be produced with mixed tall grass species during the summer growing season of 92 days (June – August). This projection is based on a 26 lbs. DM/day intake per animal unit with a 50% utilization rate to meet forage requirements for 88 days.
Animal units (AU), Animal Unit Days (AUD), and Animal Unit Months (AUM) are methods of measurement developed by ISU. A standard AU is considered to be 1 mature cow of approximately 1,000 pounds, either dry or with a calf up to 6 months old. This standard AU will consume about 26-lb of dry matter (DM) per day (1 AUD of forage) (ISU Extension Service 1998).

$$\frac{299{,}080 \text{ lbs. DM}}{2} = \frac{149{,}540 \text{ lbs. DM}}{26 \text{ lbs. DM intake}} = \frac{5{,}751 \text{ lbs. DM}}{65 \text{ AU}} = 88 \text{ days}$$

This potential production does not allow for the addition of other AU or provide flexibility during drought conditions that have become more frequent in the region during the past decade. Other sources (Evans 2004) strongly recommend a higher summer intake of 32 lbs. DM per AU for warm season forage with a generalized livestock breed as the animals shift from cool season to warm season forage species. ISU Extension Service (1998) indicates the Simmental breed (Simmental/Angus crossbreed and Angus make up the majority of BHBF livestock) require approximately 36 lbs of daily DM per AU.

$$\frac{299{,}080 \text{ lbs. DM}}{2} = \frac{149{,}540 \text{ lbs. DM}}{36 \text{ lbs. DM intake}} = \frac{4{,}153 \text{ lbs. DM}}{65 \text{ AU}} = 64 \text{ days}$$

These recommendations are based on the ruminant's need for higher intake levels due to increased summer temperatures during the daylight hours. Based on a worst-case scenario, this higher intake level is recommended and should be planned accordingly with either supplemental feed or increased forage acres.

The need for increased warm season forage can be met with conversion of an existing 14 acres (Figure 8) to Eastern gamagrass. Conversion to Eastern gamagrass would significantly increase warm season production in the 2nd year of growth and beyond. Ranum (2004) recommends establishing this species in a field previously devoted to corn production. Eastern gamagrass has a history of high yields (greater than 5 tons of DM/acre). Based on the yield data for this field it is estimated that it has the potential to produce 140,000 pounds of DM that is equal to 29 days of extra forage. This production would meet grass requirements for the existing livestock. This species is adaptable to moist soil conditions and is recommended as a monoculture stand for ease of haying when the cool season grass is abundant.

Corn will be utilized as a cover crop protecting the seedlings of Eastern gamagrass and to compensate for the loss of revenue in the establishment year. Figures 9 provides visual evidence of an establishment process where corn was planted at a density of 20,000 plants per acre and Eastern gamagrass interseeded at a 45 degree angle to the corn rows at a density of 9 lbs pure live seed (PLS) per acre (Ranum 2002). In the year following establishment, two grazing events were conducted in June and August 2003. Figure 6 provides visual evidence of the success of the stand.

Figure 8 Eastern gamagrass with a corn cover crop at end of establishment year (Photo courtesy of J. Everts, 2004, NRCS Field Technician, Grundy County, Iowa).

Figure 9 Eastern gamagrass 2nd-year following establishment with corn stalk residue (Photo courtesy of J. Everts,2004, NRCS Field Technician, Grundy County, Iowa).

Five paddocks are recommended for cool and warm season grasses based on land available for forage production. Mobile electric smooth polyrope fencing will be utilized in 2005 to confine livestock to 4 acre segments within smaller areas of the individual paddocks. Permanent electric fencing for cool-season forage may be installed in 2006 and 2007, based on experiences gained in the initial year of 2005. Permanent perimeter fencing for warm-season grass currently exists.

Water Distribution System

Livestock will be allowed limited access to Black Hawk Creek for water during the implementation year. Limited access space will be determined by the 1½ -inch rule (Gerrish 2004). This rule states the measurement be applied for each animal unit in the existing herd. A maximum of 75 animal units may exist in the herd; therefore this rule will allow approximately 9-10 linear feet along the length of the stream for a limited access drinking area. A single hot wire will prevent animals from crossing over the stream. This water access methodology is based on animal behavior that indicates cattle will drink as individuals when they are within 800 feet of the water source (Nation

1995, Gerrish 2004). The spatial arrangement of temporary confined grazing areas is within these measurements. Limited access drinking will be established at each stream-crossing site (Figure 5) that the animals have used in the past.

A permanent water distribution system will be established in 2006. The source of this system is an existing shallow (200 feet) central water supply. A one horsepower electric pump will provide the lifting power to distribute water via gravity flow through a 1½ -inch diameter buried (5 feet) PVC pipe to a containment tank (200 gallons) located on the edge of the permanent pasture (Spangenburg 2004). This arrangement will provide 10 to 12 gallons per minute (gpm) to refill portable paddock tanks equipped with variable controlled float valves. Incorporating the containment tank provides flexibility to meet higher demands during the summer (Gerrish 2004). The layout of the water supply system (Figures 6) provides water for both cool and warm season pastures.

Location of portable water containers will be random. This placement will help in distributing the grazing pattern to achieve the highest utilization rate, minimize soil disturbance around the watering site and distribute manure droppings throughout the grazing area. Watering troughs will generally be constructed in a 9 foot length by 2 foot width and 2 foot depth configuration equipped with sturdy float valves. This configuration will be set on a wide base to mitigate tipping and set on skids or rubber wheels to facilitate movement with a 3 point tractor hitch. Daily observations will still be required to ensure water is available and operating in a proper manner.

Permanent and Mobile Electric Fencing

Existing permanent perimeter fence consists primarily of three or four strand barbed wire set on wood and step-in metal posts. This fencing has been in place for a long time and may need replacement over a phased period. Permanent perimeter Hi-Tensile (HT) woven and smooth electric wire on wooden posts should be considered as a viable alternative in the near term (second or third year) to the existing perimeter fences.

Figure 5 depicts those areas needing new internal fencing to enclose converted crop to forage acres. EQIP requires livestock be excluded from surface freshwater streams as a method to control overgrazing, damage to streambanks and reduce introduction of animal waste directly into the aquatic habitat. Both sides of Black Hawk Creek in the cool season pasture will require adequate fencing to prevent livestock from grazing within this protected area. Additionally selected areas identified for conversion and buffers adjacent to surface streams will also require new fence. The recommendation for these areas will be HT woven and smooth wire fence constructed mostly with 12.5 or 14 gauge, Class 3 wire with tensile strengths from 170,000 to 200,000 or more pounds per square inch (psi) and breaking strengths up to nearly 1,800 lbs. (NRAES-11 1987).

After cattle have become accustomed to the effects of electric fence a single aluminum energized wire or electric polyrope or polytape may be sufficient to contain animals within smaller grazing areas or at stream crossing points. The 0.25" polyrope is considerably more visible than polywire but less visible than 0.5" polytape. Three options of polyrope are recommended. They are 0.25", 9 stainless steel (ss) wires, and 0.25", 6 ss 0.3 mm wires, with a breaking strength of 850 pounds, or 0.25", 6 tinned 0.4 mm copper wires with a breaking strength of 995 pounds (The Deer-Shock Depot 2004). The 6 tinned 0.4 mm copper wire polyrope is recommended for the separation of small grazing areas within a single paddock. The 0.25", 9 ss wire polyrope is recommended for the bank portions of stream crossing paths while polywire, with a low breaking point, is recommended for that part of the fence that is stretched across the stream. This part of the electric fence is most likely to be broken during a high water storm event and should be considered as a sacrificial section that needs to be restrung or replaced.

While most of the animals may be familiar with the effects of electric fencing replacement cows and new born calves may be unfamiliar. It may be wise to consider establishing a holding pen of three-strand smooth HT electric fencing to familiarize new animals to the effects of this type of fence. The animals would be retained in this space for a limited period in the spring before being allowed into the electrified paddock areas.

Grazing consultants such as Steger (2003) recommend conditioning animals, if practical, to the type of fencing and water sources they will have access to in the enclosed paddocks. The goal of this training is to get the animals familiar with electric fencing to the point that a single energized (12 gauge) aluminum wire will be sufficient to retain the animals within their confined grazing area.

Controlled Stream Crossing Points

Approximately five reinforced crossing points are recommended for efficient movement of livestock from one general grazing area to another to maximize forage utilization as recommended by Ranum (2004) and Gerrish (2004). Crossing points have been selected based on the existing natural crossing paths utilized by the livestock (Figure 5). Each crossing point will require selected stream bank sloping with heavy equipment such as a front-end loader or backhoe. On average, each crossing may have a 60-foot by 16-foot entry and exit slope, entering and leaving the stream channel. The stream averages 30 feet in width with a sandy bottom and a water depth of 1-foot. The reinforced areas on the bank slope and in the stream channel will be 16-feet wide with polywire constricting the actual channel crossing space to 14-feet. This constriction is recommended to control cattle foot traffic from damaging the edge of the reinforced area. The 14-foot crossing space is in the range of space recommended by Gerrish (2004) for limited access to water and would allow the older leaders easy movement through this choke point.

Reinforced Crossing Point Material

The recommended reinforced system is a product developed by Presto Products Company. This system consists of interlocking perforated plastic, honeycomb-like structure designed to hold aggregate in place (Figure 10). This product is sold under the trade name of GEOWEB a cellular confinement system. It has been used successfully in stream crossings on farms and other areas subject to erosion.

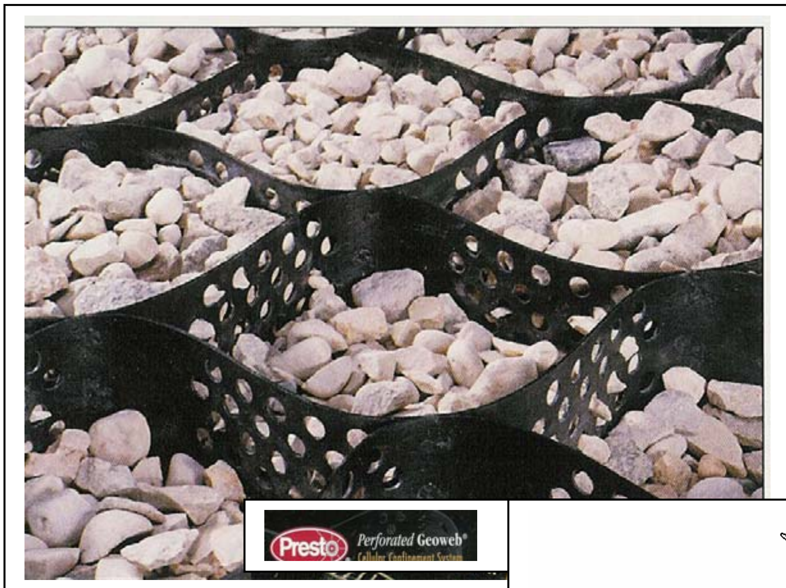
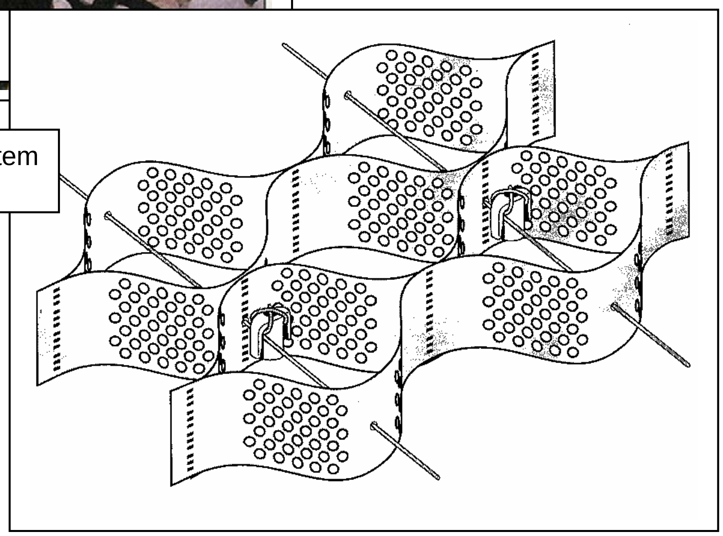


Figure 10 Presto Products Geoweb System



The product comes in a variety of cellular depth sizes ranging from 3” to 8” with each section measuring 8 by 20 feet for a total area of 160 square feet. This system has a high degree of manufacturing design with quantifiable holding strength measurements, a simple anchoring mechanism of cable and rebar to hold the unit in place, proven application in similar situations, is shipped in lightweight bundles and can be installed by individuals at the farm (Presto Products 2003).

Based on the design options available and requirements for each crossing, some modifications in the amount of material may be required. In general, each bank slope will have a 60 by 16 foot reinforced GEOWEB ® ramp. This portion of the system will be made up of company recommended 4” depth cellular confinement cells. Sections making up the actual channel bed will be 6” deep cellular confinement cells. The deeper confinement cells are recommended for the channel bed in order to retain a greater amount of aggregate and sand. High strength polymeric tendons are incorporated to run through the perforated cells. These tendons have tensile strengths of 700 to 3000 foot-pounds and are used as part of the ½ “ rebar anchoring mechanism (Presto Products Company 2003).

Riparian Buffers

Multi-species riparian buffers can be installed between row crop fields and freshwater streams within a 1 year period. The full benefits for water quality improvement and habitat restoration will become evident over time. Properly maintained buffers of grasses, shrubs and fast growing trees will have a cumulative affect over a 10 to15 year period by significantly reducing non-point pollutants from entering Black Hawk Creek. Vegetative and woody growth will also stabilize streambanks over this period. Complete benefits of an expanded tree community will only be realized over the longer life cycle of 25 to 50 years for the trees planted.

Initial establishment of the buffer areas will be conducted on a schedule determined by the NRCS for the Grundy County area. General buffer areas will be negotiated with the NRCS District Conservationist during the winter of 2004-2005. Initial plantings may be started in the spring of 2005. Monitoring of the initial planting will be conducted to determine success levels with follow-up actions conducted in the fall of 2005 to ensure a good establishment before the first freeze. Continual maintenance actions will be conducted throughout the life of the 10 or 15 year contract established with NRCS. Six buffers are planned utilizing four different designs (Appendix B). The locations of each buffer and the design type are identified (Figure 11) with detailed descriptions (Appendix C). All buffers will utilize HT woven and smooth electric fencing enclosing Black Hawk Creek. This superior fencing is required to restrict livestock movement into the buffers, following harvest of row crop fields, when livestock are allowed to graze crop refuse and litter.

Streambank Slumping

Undercutting at the foot of the bank by the fast moving stream flow generates high levels of bank slumping and sedimentation introduced into the stream flow. This action has resulted in high levels of sand deposition throughout the channel bed smothering the benthic aquatic habitat and reducing scarce forage producing soils. Several mitigating actions have been considered for implementation in this unique situation. The two courses of action deemed appropriate for this situation is a natural healing process that encourages regeneration of the existing seedbed on the bank slopes combined with a bioengineering approach utilizing natural materials to protect the exposed bank slopes.

If protected from over grazing the seedbed on the bank slopes will naturally regenerate the dominant pasture species of Kentucky bluegrass, Smooth bromegrass, and possibly Reed canarygrass deposited from upstream sites. These species will be augmented with native species of Big bluestem, Indiangrass, and Eastern gamagrass at or near the top of the bank slope. Natural selection may enable some of these native species to migrate down the slope toward the waters edge. Native shrub species that become established shall be allowed to remain. Natural available materials of coniferous trees such as Eastern red cedar will be anchored on the outside edge of the stream. Placed in this position they will form a naturally flexible barrier from fast moving waters impacting directly upon the exposed bank slope. Where sufficient coniferous materials are not available tree cut bundles 8 inches in diameter will be lashed together and anchored in the same location. Flexibility of both materials will absorb the energy generated by the stream velocity and also filter out suspended soil particles depositing them behind the barrier causing a siltation buildup at the foot of the bank slope.

Healing of these sites will be monitored over time using GIS technology provided by the local NRCS office, photographic evidence, physical examinations, and protocols developed by the ISU Department of Natural Resource Ecology and Management that measures bank morphology.

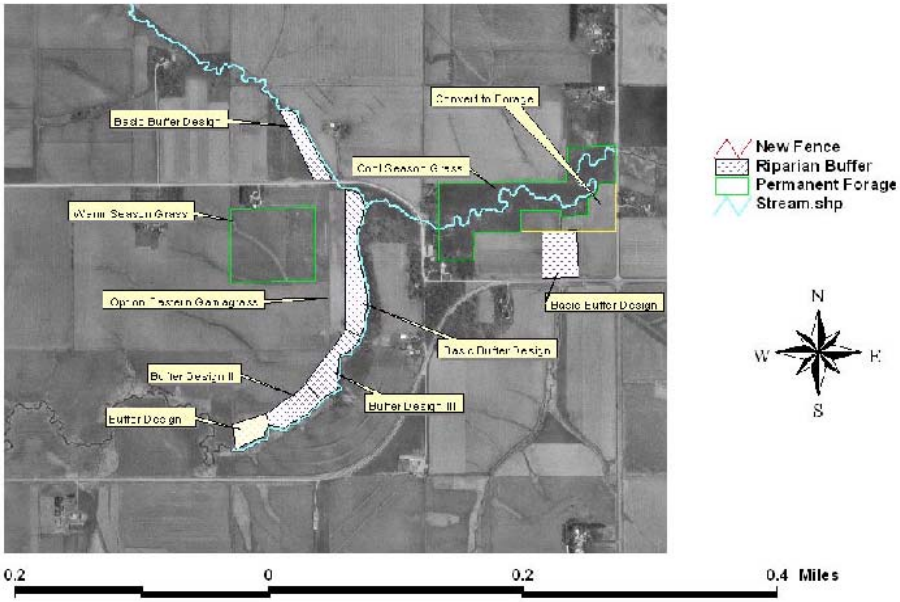


Figure 11 Buffer Locations 1-6

Models

The pasture forage model for rotational grazing is based on studies conducted by Voisin (1959), Nation (1995), the ISU Extension Service (1998), and Gerrish (2004). The model integrated from these multiple sources depends on a diversity of grass and legume species active at different intervals and intensities throughout the growing season. The goal of the model is to keep forage in a high energy/protein (vegetative) state when it is most nutritious for the livestock. Controlled harvesting by the livestock combined with adequate rest and regeneration keeps grass growing in the most nutritious state for the overall benefit of the animal throughout the growing season.

For best utilization cool and warm season pastures are located in separate areas. A legume (Birdsfoot trefoil) should be separated from the other cool season species to assure success in establishment. Due to its low profile, with small leaflets, trefoil is best if grown with low-growing grasses like Kentucky bluegrass or bunchgrasses like Orchardgrass (McGraw and Nelson 2003). Failure to separate this species from other high profile grasses will result in a lower leaf area index (leaf surface to the surrounding land it covers). Reduced leaf surface exposed to the sun will result in lower levels of solar energy reaching the leaf surface leading to stunted growth and fewer individual stems becoming established. Best results are obtained when the leaf canopy intercepts about 95% of sunlight (MacAdam and Nelson 2003).

Multi-species riparian buffers are based on combining the riparian forest buffer practice standard, Code 391 and the filter strip Code 393. This combination is documented under Code 392 (NRCS 1997) and implemented by Iowa State University, under the sponsorship of the Leopold Center for Sustainable Agriculture at the Bear Creek Farm in Story County, Iowa. Based on the negotiations with the Grundy County District Conservationist office filter strip buffer practice standard, Code 393 may be implemented in one location consisting solely of cool season grasses (bromegrass, timothy and fescue). These designs are important as they were developed for a Midwest prairie ecosystem (Schultz et al.1995). In those locations that are not appropriate for the basic multi-species riparian model (Figure 12), modifications will be incorporated to mitigate topographic features that contribute to high volumes and velocities of surface runoff. The basic model is designed to reduce the volumes and velocity of surface runoff over a broad area allowing greater time for water pooling on the sides of fields and infiltration into the groundwater system by way of plant root channels.

Figure 12 is a profile of the basic model that consists of three distinct vegetative zones beginning at the top of the stream bank and moving back toward the row crop field. Fast growing trees are established in zone 1, slow growing trees and open canopy shrubs are established in zone 2, mixed grasses and legumes are established in zone 3 adjacent to the crop field.

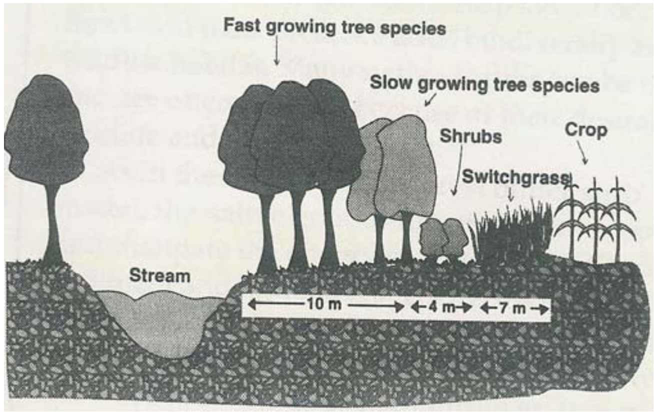


Figure 12 Multi-Species Riparian Buffer Strip (MSRBS) Model (Schultz et al. 1995).

Successful establishment of the above model will help in restoring a simulation of a functioning presettlement Iowa savannah, within the riparian buffers. Fire must also be incorporated as a control agent as part of that establishment process to create a savannah environment. While early spring burning stimulates shoot production (Apfelbaum 1993), prescribed burns are recommended for late summer over different segments at alternative times, in the riparian buffers. This timing is counter to most authorities, but it is considered best to be the least disruptive for nesting songbirds. A late summer burn would also simulate naturally occurring fire events that would have occurred in the presettlement era. Burning frequency is recommended every third or fourth year to remove dead residue and expose soil for regeneration of the seed bank that has built up in the soil. Burning of cool season pastures is not recommended on a routine basis (ISU Extension Service 1998).

Enhancement of the vegetative buffers is expected to expand sources of food, shelter, breeding, nesting and sites for rearing of young. This habitat is anticipated to attract resident, rare and threatened native and naturalized wildlife. Increased nesting and numbers of native and transiting birds is one indication of a diverse food web and a healthy soil, a healthy soil means better yields. The presence of worms and other biological activity in the soil is another indicator that can reflect on the probability of profitability and environmental sustainability of the operation (Jackson and Jackson 2002).

Financial Investment

Financial incentives are available under the Farm Security and Rural Investment Act 2002. NRCS will provide technical guidance for an EQIP contract, which is administered under the Farm Service Agency (FSA). NRCS who will work closely with the landowner to develop a sustainability plan that meets both the needs of the owner and the county goals for water quality improvement and erosion reduction.

Incentives include cost sharing of 50 to 75 percent of the financial investment. Limited resource producers and beginning farmers and ranchers may be eligible for cost-shares up to 90 percent. Items covered under the program include non-perimeter fencing, mobile electric fencing and supporting materials, establishment of a water distribution system and seed for the enhancement of permanent pastures (NRCS 2002). A drawback of the program is the need to identify all costs associated with the proposed change, since only those investments identified prior to entry into the program contract will be honored. Capital investments made after consummation of the contract must be borne by the owner.

Information Sources

Recommendations provided have been developed from interviews with other successful farm manager/owners (Petty 2003) and (Sweeny 2003) who have implemented the concepts on operating farms of similar size in the same ecosystem of north-central Iowa. Interviews have been conducted with recognized authorities with the local Iowa United States Department of Agricultural-Natural Resources Conservation Service office (USDA-NRCS) District Conservationist, Mier (2003, 2004) and Ranum, Grassland Specialist (2003, 2004). Other interviews were conducted with Iowa State University buffer authorities (Schultz 2004) and professional staff in the Leopold Center for Sustainable Agriculture (Kirschman 2004). Their operational models were developed for compatibility with corn and soybean monocultures common to the Midwest and Great Plains (Schultz et al. 1993, 1995). Commercial forage management experts, Nation (2004) and Gerrish (2004) were also consulted. These recommendations are viable alternatives that can be adapted in the management of the 400-acre family farm making sustainability a realistic goal.

PLANNING GOALS

Ownership Goals

The goal is to maintain the working relationship established with the tenant farm manager over the past 14 years. With this relationship in mind, the leasing arrangement does not attempt to maximize returns for the owners that may be available in the current market. Instead negotiations for a rental agreement is focused to be within an acceptable range of other agricultural rental property in the area.

During the period of the tenant manager's employment, the production focus has been on achieving high yields with traditional methods for both crop and animal production. While these methods appear to be working, there is limited data to substantiate this success other than what appears to be an adequate cash flow for the tenant manager and the owner. Future production expenses and revenue will be tracked in a structured manner to determine the level of net revenue generated from crop and livestock to determine the long-range outlook for economic sustainability.

Management Goals

Changing from continuous to a rotational grazing management system is the plan goal toward increasing available forage on the same acres achieving higher levels of utilization from the enhanced forage, and increasing daily weight gain by the livestock. This goal requires a focused approach to enhance the existing Kentucky bluegrass dominated pastures and achieve a changeover to a diversity of cool-season grasses and legumes. Infrastructural changes (fencing and watering) within the pastures are also required to assure livestock control and management success. Voisin (1959), Nation (1995), ISU Extension Service (1998), and Gerrish (2004) are four authorities that have identified the applicable principles and techniques to be followed for establishment of a successful rotational grazing management system and achieve this management goal

Installation of multi-species riparian buffers between the cropped fields and the stream is a second land-use management change recommended.   These natural buffers provide a final nutrient filter complementing other systems in place, (i.e. terraced slopes, grassed waterways, contour planting and no-till farming). In addition to the filtering benefits the buffers will increase natural areas or travel corridors attracting resident and migratory species seeking unique habitat for their life cycles. The goal of this land-use change is to decrease nutrient input, from surface runoff to the stream, by amounts greater than 95 percent. A second goal derived from the expanded buffers is to dramatically increase the food web to attract and support a diverse wildlife community native to an Iowa savannah ecosystem.

Stabilization of the streambanks in the permanent pastures is a third important goal for BHBF. Severe erosion of the banks caused by high volumes of water continues to reduce soil and forage resources in the pastures. Controlling or reducing this erosive impact will protect forage resources and reduce the amount of soil particles entering and disrupting the aquatic habitat and ecosystem of the streambed. Modifying the streambanks with engineering methodologies would be costly and is not a guarantee to solve the problem of erosion in this highly dynamic situation. Barnhart (2004) reported that Iowa pastures have experienced a natural healing by controlling foot traffic and over grazing with the installation of adequate fencing. The healing process has been over a 2-3 year time frame where Kentucky bluegrass and Smooth bromegrass have dominated the existing forage. Evans (2004) and Agena (2004) have also counseled a natural healing process will begin in the first year when cattle are restricted from grazing the streambanks. Switchgrass will be added to the bank slopes as an added species to the existing forage. Big bluestem, Indiangrass, and Eastern gamagrass, while difficult to establish, will be seeded on the top of the streambanks. These native species have a deep root growth that will help stabilize the soil structure. The goal related to this problem is to establish a natural grass barrier on the moist bank slopes and stream shallows. It is expected that over time establishment of these herbaceous materials will modify the severity of incised banks by reducing flow velocity. Tall native grasses will also create siltation to accumulate along the stream edge, which is the first step in modifying the severity of the bank slope.

Phased Plan

The implementation plan will be reviewed and negotiated with the tenant farm manager in winter of 2004. His recommendations and management concerns will be adapted to the plan where those changes will enhance economic and ecological sustainability probabilities. Prior to implementation, BHBF must be registered in the CRP and EQIP federal programs through the Grundy County NRCS District Conservationist office.

A five-year phased implementation plan is proposed that would be initiated with frost seeding of legumes in the cool and warm season pastures in late February 2005, followed by interseeding cool and warm season grass species in the spring. Interseeding must be conducted over a timeframe that allows newly interseeded sites sufficient time to develop strong root structures. Evans (2004) recommends each area be allowed 18 months to develop a mature root system that will not be pulled out when grazing begins. Following this establishment protocol dictates this be conducted throughout a long-term phased process.

Monitoring of dry matter yield for the grazed sites will be conducted throughout the growing process. Multiple measurement techniques will be utilized, i.e. clipping/drying and density meter (ISU Extension Service 1998). Measurements will continue following livestock grazing to determine the impacts; observations will be noted of success rates among new grass following the establishment process.

Planning for cool and warm season pasture infrastructure (Figure 5 and 6) respectively, will be conducted in the winter of 2004-05. This will include estimates of high tensile (HT) woven and smooth wire electric fence to enclose Black Hawk Creek. This same type of fence will be required to separate new areas that will be converted to forage from row crop acres. All riparian buffers will require this woven and smooth wire fence to restrict the livestock from grazing these acres. An inventory of currently available fence supplies will be conducted to reduce the cash outlay for this project. Crossing points in the cool season pasture will be confirmed and the materials required will be ordered with installation scheduled for late fall of the implementation year 2005.

The second year of implementation will focus on completing installation at the stream crossing sites and establishing a freshwater distribution system throughout all pastures (Figure 6). Livestock monitoring will continue to determine behavior of the stock to the new water distribution system. Interseeding of new grasses will continue where previous efforts were not successful. Dry matter field measurements of established pastures will be conducted. A survey of successfully established grass species will be conducted in the second year and remedial actions taken where necessary. Monitoring of the trees, shrubs and grasses in riparian buffers will be conducted to ensure a healthy establishment process continues. Interseeding and monitoring will continue in years three through five.

ROTATIONAL GRAZING PLAN

Management System Change

The following section on forage improvement is a major management change in the basic cow/calf operation. Successful completion of this change will provide the livestock with a healthy natural grass diet, while decreasing reliance on expenditures for manufactured food supplements, chemicals, fuel, and machinery used in the production of feed stock corn. Included in this conversion is establishment of a clean water distribution system that eliminates the need to drink directly from the stream. This control also reduces overgrazing of the streambank, damage to the streambank from livestock hoof traffic and disturbance of the soil, which contributes to erosion and sediment deposition in the stream channel.

Current Grazing System

Continuous grazing is a major contributor to the evolution of Kentucky bluegrass as the dominant grass species and contributes to degradation of water quality from soil particle runoff. This system, employed on limited acreage, gives cattle free access to search out and overgraze young succulent grasses with a high level of nutritional value and palatability. Based on Nation (1995) and ISU Extension Service (1998) projections continuous grazing utilizes approximately 30% to 35% of the total forage available to the cattle herd.

Cows are very selective in the parts of grass they will first graze. Given the opportunity they will select the leafy portion of plants in the early to later vegetative stages where the nutritional value (energy and protein) are very high (ISU Extension Service1998). If plants are continuously selected and re-grazed both shoot and root development decline due to reduced solar intake. Lower levels of solar energy result in reduced subsurface growth, access to soil nutrients and moisture within the soil structure (Moser and Nelson 2003). A graphic representation of shoot and root (biomass) development (Figure 13) demonstrates what occurs with sufficient rest versus continuous defoliation (Walton 1983). Plants not allowed to replenish the energy resources stored in leaves and their root system become weak and may eventually die. This impact is the same for both cool and warm season grasses (Dawson et al. 2000).

During a pasture walk (Ranum 2004), smooth bromegrass and timothy were observed. These species have been overgrazed and need replenishment. Implementing a rotational grazing system should enable these species to become re-established with a sustainable reproducible population within the confines of the enclosed paddock structure.

Figure 13 Graphic representation of shoot and root (biomass) development (A) no defoliation, (B) moderate defoliation and (C) close, continuous defoliation (Walton 1983).

Legume species are especially susceptible to overgrazing and usually the first vegetation to disappear in a continuously grazed forage pasture. Loss of legumes reduces nitrogen input levels that are used by other grass species resulting in fewer species survivability. As plant diversity declines overall productivity of individual pastures is reduced to the point that undesirable vegetation (i.e. musk thistle weeds and brush) will invade the stand (ISU Extension Service 1998). During 2003 and 2004 musk thistle and an invasive mustard species became established requiring spot spraying with the herbicide “Graze-on”. Continual grazing from overstocking may also weaken the remaining species and make them susceptible to changing environmental conditions such as lower than normal precipitation in winter and summer seasons, extended days of high temperatures during the growing season or severe drought, which facilitates disease.

Rotational Grazing Sequence

The principal premise of this management system is based on restricting livestock to a limited area of standing biomass for grazing, moving the livestock when 50 percent of forage has been removed, and allowing sufficient time for regeneration to be accomplished before animals are introduced back into that confined area. Ideally Midwest cool-season grasses require 2-3 weeks to recover during the cool spring and autumn growing season, whereas warm-season grasses require 4-6 weeks in the warm summer months (ISU Extension Service 1998). Grazing forage during the mid to late vegetative stage insures harvesting is conducted when the vegetation is at the highest nutritive value of energy and protein.

Depending upon the stocking density employed, animals can be moved daily or stay within one area up to 7-days in order to achieve the harvest goal of 50 percent. Although leaving livestock within one area increases the amount of forage wasted due to trampling, deposition of fecal matter or matting from the animals lying down on the grass. Removing 50 percent of the available vegetation will leave sufficient green leaf area for photosynthesis to continue and the plant replenish carbohydrate reserves while top and root growth is progressing (ISU Extension Service 1998).

Based upon these factors the forage needs of the existing livestock will require approximately 4-acres to hold 65 AU for 3-days of grazing. Four proposed cool season grass paddocks provides 52 acres that can be separated into 13 cells of 4-acres each. Utilizing mobile electric fencing provides the greatest flexibility to meet the livestock grazing needs. Movement of the fencing can be conducted on the desired schedule within 30 minutes (Gerrish 2004). Based upon a 3-day grazing period per cell, this area would provide a 36-day resting period for the first cell grazed. This resting period extends over 12 cells from the beginning of grazing on the second cell to the last day of grazing on cell number twelve. This 36-day average rest period is well within the 18 to 21-day resting period recommended by Voisin (1959) and ISU Extension Service (1998) for the period of May-June and a stocking density of 65 AU. The extra 15-day average of forage availability may provide a forage buffer when precipitation is below normal levels or if its determined the existing breed (Simmental) require a higher level of daily dry matter input.

Thirty acres of warm season grasses (Figure 6) have permanent fencing established. Polyrope will be utilized to separate this area into 10 cells of 3-acres per cell. Based upon a 2.5 day per cell grazing period a resting period of 22-days can be established for this warm season area for each cell. Twenty-two days rest for the first cell may not be sufficient based on the ISU Extension Service (1998) recommendation of four to six weeks rest for warm-season grasses. Therefore, maximizing the cool-season forage for 10-days in July may be required to offset the potential shortfall of warm-season grass.

Legume Options

Nitrogen-fixing legumes (i.e. Birdsfoot trefoil, Red and White clover) contribute to the diversity of the herbaceous mix and extend the growing season with high quality forage during the summer slump (Bates 2004). This need for BHBF was reinforced during a tour of the Iowa River Ranch located in the same region. Petty (2003) indicates that high temperatures are not as responsible for low forage production as low soil moisture content. Petty has developed a thick legume canopy (greater than 25 percent of total forage) of bird's-foot trefoil and multiple clovers that significantly help in the retention of soil moisture. This enhancement makes his late July pastures look like spring-time (Looker 2003). Self-Davies et al. (2003) indicate a mix of grasses and legumes provide a forage canopy that is effective in reducing soil particle movement due to rain drop impact, reducing and distributing runoff over a broad area and increasing infiltration. These two mitigating factors improve soil moisture content and reducing edge of field loss in forage systems while also increasing the probability of a neutral impact on existing stream water quality.

A general growth pattern of grasses and legumes (Figures 14 and 15) highlight the stages of vegetative growth over time and the production over the growing season (ISU Extension Service 1998). Figure 15 also demonstrates the need for establishment of a productive warm season grass to complement legume growth in the summer and fall growing seasons. Separate warm season grass pastures are available in 26 acre and 4 acre units that have been utilized during the last few growing seasons. These pastures are adjacent to the existing operation and are part of the forage production base for the 65 cow/calf units.

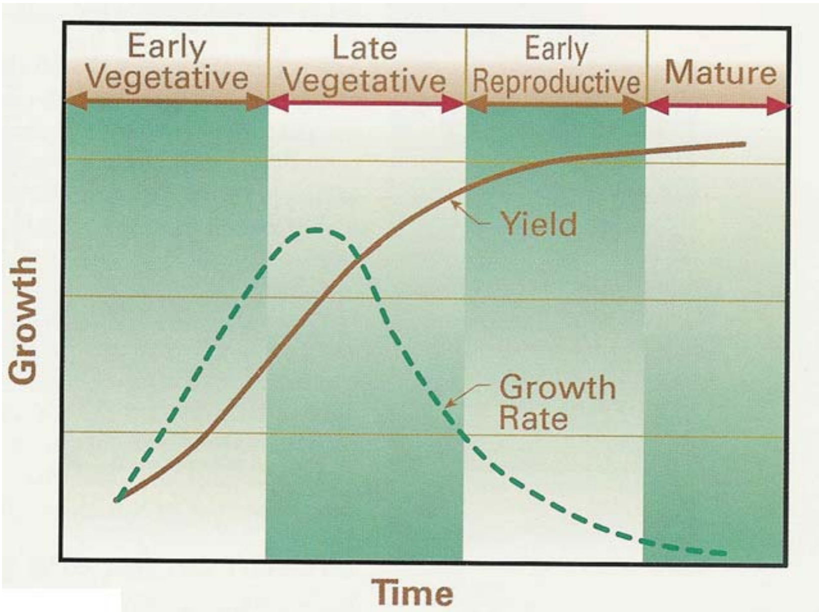


Figure 14 Vegetative growth of grasses and legumes over time (ISU Extension Service 1998)

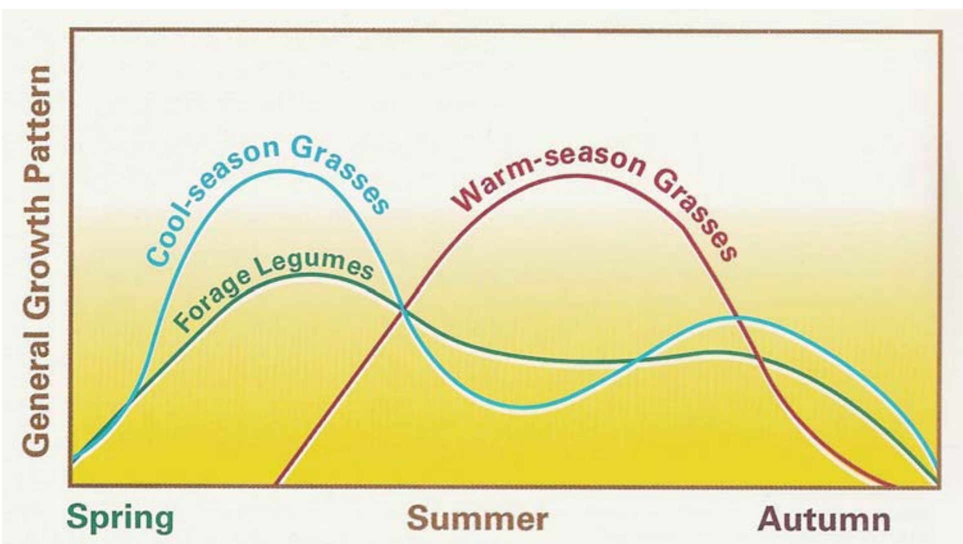


Figure 15 Growth pattern of grasses and legumes over the growing season (ISU Extension Service 1998)

PERMANENT PASTURE

Cool Season Grass

The permanent cool-season pasture has been continually grazed to the point that the Kentucky bluegrass, gives a visual appearance of a low growing, sod bound pasture. The grass appears sparse with bare soil exposed between plant stems in major areas. Table 2 lists cool and warm season grasses and legumes needed to revitalize this single species dominated pasture.

A detailed list of the soil types identified by the map symbol in the Grundy County Soil Survey and associated acreage (SCS 1977) is provided in the Iowa Forage and Livestock Balance Worksheet, Appendix A, (Ranum 2004). The Forage and Livestock Balance Worksheets provide an estimate of dry matter yield from this forage mix and soil combination. Both cool and warm season grasses are included in the worksheets. Appendix D provides additional information on the pure live seed (PLS) pounds and percentages of grasses and legumes needed per acre to complete forage enhancement. Seed procured will meet the recognized standards required for PLS

Forage Crop	Hay	R. Grazing	Palatability	Lb/acre
Legumes				
Birdsfoot trefoil	*G*	*G*	*G*	*4*
Medium red clover	*G*	*E*	*E*	*2*
Alice white clover	*G-E*	*F-G*	*F*	*2*
Cool-season Grasses				
Kentucky bluegrass	*P-F*	*E*	*E*	*Established*
Orchardgrass	*E*	*E*	*F-E*	*2*
Reed canarygrass	*G*	*G*	*P-G*	*2*
Smooth bromegrass	*E*	*E*	*E*	*4*
Timothy	*E*	*G*	*G-E*	*2*
Warm-season Grasses				
Big bluestem	*F*	*G*	*G*	*8-10*
Indiangrass	*F*	*G*	*F-G*	*8-10*
***Eastern gamagrass**	*G*	*G-E*	*G-E*	*3*
Medium Red Clover	*G*	*E*	*E*	*2*

Table 2 Proposed Grasses Selected for Revitalization
E=excellent, G=good, F=fair, P=poor (Barnhart 1995, Ehlke 1997)

The grasses addressed above all demonstrate an erect growth in the range of 2 to 4 feet. The timothy variety has been selected for its quick regrowth due to the very high ratio of leaves to stem. Tekapo Grazing orchardgrass has been selected as a variety specifically developed for grazing. This variety is late maturing and tolerant to heat and drought, which is a concern in north central Iowa. It has a high palatability from its soft leaves as well as being rust resistant. Palaton reed canarygrass will be concentrated in the area closest to the stream for its tolerance in moist areas. This is a new variety with increased palatability and better leaf disease resistance. If surface runoff moves portions of seed onto the streambank, it has the ability to adapt well as erosion control agent (Welter Seed & Honey Company 2004, Ranum 2004).

Legumes, greater than 40 percent of the total forage are recommended for BHBF. This ratio of lbs. per acre is consistent with those recommended by Nation (1995), ISU Extension Service (1998), and Ranum (2004) to achieve a nitrogen equivalent of 60 lbs.

per acre. The legumes of Norcen Birdsfoot trefoil, Medium Red clover and Alice White clover will be included in the lbs. per acre (Appendix D). The Norcen trefoil is a new variety with a rapid regrowth after cutting and it produces a higher yield than other trefoils. Upon the recommendation of the seed company representative, Birdsfoot trefoil may be best established in a separate stand to insure growth above other taller grass competition. The Medium red clover is a new high yielding variety with a unique ability to be cut 3 or 4 times each season. Alice white clover has been selected for its large leaf area and persistence under intense grazing management (Welter Seed & Honey Company 2004 and Ranum 2004).

ROTATIONAL GRAZING INFRASTRUCTURE

Voisin (1959), Nation (1995), ISU Extension Service (1998) and Gerrish (2004) all indicate rotational grazing offers higher utilization rates of 45% - 55% versus 30% - 35% from continuous grazing. While the potential gains for rotational grazing are impressive, they do come at a cost of a higher level of hands-on planning, management, and maintenance of the improved forage and the new grazing infrastructure. Paddock arrangement, high tensile (HT) woven-smooth wire electric fencing, water distribution, and controlled stream crossings are separate, but critical issues that must be addressed as part of a major change in forage management.

Paddock Arrangements

A five-paddock arrangement is proposed for the cool and warm season permanent pastures (Figure 7). The intent is to have permanent paddocks greater than 10 acres. Paddock #4 may be limited to its current 5-acres or expanded at a later date to meet the forage needs by enhancing and expanding into the existing adjacent (14-acre) alfalfa hay field. The 14 acres may be interseeded with warm season grasses to compensate for the lower number acres devoted to warm season species.

Paddock Descriptions

Three of the paddocks have borders abutting other property lines. These established perimeter fence lines will be retained in place. EQIP contracts allow internal fencing under a 50% cost share agreement. In those circumstances where internal paddock fencing is required between crops and pasture, an electric fence will be utilized. The paddocks will be further reduced in size with portable electric polytape attached to stirrup step-in posts. Initially, limited access to water will be provided at the natural crossing points with a temporary fencing arrangement. A permanent freshwater distribution system will be established in 2006, eliminating the need to drink directly from Black Hawk Creek.

Permanent and Mobile Electric Fence

Existing permanent perimeter fence consists of woven wire with 2 strands of barbed wire set on wood and step-in metal posts. In many cases this fencing has been in place for a long time and may need replacement over a phased time period. Permanent perimeter fence of HT woven wire with 2 strands of smooth electric wire attached to wooden posts should be considered as a viable alternative in the near term (second and third year) to the existing perimeter fences. Perimeter fencing must be the strongest to restrain the animals within the general confines of the pasture and away from highways and other crop fields. Polyrope, polytape and stirrup step-in metal posts will be used to create 4-acre grazing areas with the larger paddock arrangements.

Watering Alternatives

Initial watering needs of the herd may be provided by allowing controlled access points to the stream at the selected crossing areas (Figure 5). These areas can be controlled with a floating PVC pipe arrangement in the form of a large U that allows a limited number of animals into the space to drink. The PVC pipe would have 1 to 2 inch diameter wooden doles, 12 inches high at each end and at the bended joint areas. Polytape or polywire would connect each of the posts to the main electric fence line. This barrier would float with the rise and fall of the water volume moving through the channel, be anchored with a line to the streambank and easily removed to allow cattle crossing to other paddock areas (Gerrish 2004).

Damage Control of the Streambank

Black Hawk Creek has significant erosion and loss of the original streambank from bank slumping, surface seepage from a broken tile, and other problems. Figure 5 depicts how the stream has become extremely sinuous in an effort to achieve equilibrium while handling increased water volumes. The sinuosity of the stream often turns at angles greater than 90 degrees. This action and increased volume from surface runoff upstream creates high water velocity on the outside of the stream curve, undercutting streambanks and contributing to bank slumping. This loss of soil resources also creates deeply incised banks (Figure 16).

Overtime the stream will deposit soil particles on the inside of the stream curve where the flow is slower, thereby creating a new area for forage growth. Unfortunately, the farm must operate in the present to remain sustainable. Erosion of the streambank is a major loss of soil and grass resources critical to the sustainability of BHBF. The highest priority for the stream is to reduce the water velocity as a mitigating action to lower the streambank erosion process. Efforts must focus on methods to deflect water velocity directly impacting the face of the streambank.

Stabilization by mechanical methods would be a costly undertaking and may exacerbate the situation. Therefore, a natural healing method is recommended for stabilization that may be achieved within one or two growing seasons. These recommendations would also meet the spirit of the guidelines within EQIP (NRCS 2002). Evans (2004) and Wiksell (2004) recommend restricting cattle grazing opportunities on the streambank will enable natural healing. Barnhart (2004) agrees with this principle adding that Iowa dominated pastures of Kentucky bluegrass and Smooth bromegrass have shown healing within a 2-year window. He recommends including the native Switchgrass to the current species mix, and if Big bluestem, Indiangrass and Eastern gamagrass are attempted it may take several years for those species to become established in areas prone to flooding.

Reed canarygrass, a rhizomatous species often recommended by state offices for these situations, currently exists in other locations on BHBF where it is a problem in obstructing tile drain outlets. Because of its presence upstream of the erosion sites it is believed this species will become evident when cattle are removed from grazing the streambanks. Therefore, introduction of this common species is not recommended at this time.

Figure 16 Examples of bank erosion, potential site for introduction of tall grasses on a point bar for bank stabilization and a natural crossing point (Photo courtesy of J. Everts, 2004, NRCS Field Technician, Grundy County, Iowa).

Figure 17 and 18 depict an erosion problem created by a broken subsurface field tile from an adjacent property. The immediate solution is to replace and repair the disrupted tile segment. Other natural and bioengineered methods may be taken to reduce surface runoff along the fence line and in the damaged area between the fence line and the eroding stream. These measures may include planting willow cuttings along the fence line, erecting a fence on either side of this choke point to eliminate foot traffic by livestock, and seeding Big bluestem and Eastern gamagrass in this location to retard the erosive action of the stream flow. If these measures are implemented a section of PVC may be required in the segment that passes under the property line where willows and deep-rooted grasses are planted. This will prevent tile damage from root intrusion. In that segment between the property line and the stream edge a solution may be installation of sections of GEOWEB. Drawbacks to that solution would be destruction of grass humpbacks that have become established on the stream edge, which is a good nesting habitat for some species.

Figure 17 Erosion caused by broken subsurface field tile (Photo courtesy of J. Everts, 2004, NRCS Field Technician, Grundy County, Iowa).

Figure 18 Temporary measure to retard erosion (Photo courtesy of J. Everts, 2004, NRCS Field Technician, Grundy County, Iowa).

Summary of Rotational Grazing

The utilization rate of forage during grazing is linked to grass productivity in both a continuous and rotational management system. ISU Extension Service (1998) has projected the continuous grazing management system utilizes about 30 to 35 percent of the pasture forage in a field over a full season because livestock continue to re-graze their favorite grass species.

Implementation of a rotational grazing management system with five paddocks restrains cows from selecting the best over a broad area forcing them to graze on the available forage within a confined area. Grazing of other forage does not mean the animal is getting poor quality forage, it just means it is not getting the absolute highest quality. As the cows reduce the available forage by 50 percent in a temporary confined area, they are moved to the next paddock. This process of confinement provides an opportunity to increase utilization of the existing forage to 45 to 55 percent over the full growing season and 50 to 55 percent during the rapid re-growth period in the spring. This system also allows browsed forage an opportunity to rest, regenerate new leaf matter, extend the root system deeper into the soil for necessary nutrients and moisture resulting in a healthier forage stand (Nation 1995, ISU Extension Service 1998, Gerrish 2004).

Higher utilization rates of the basic forage means the grazing herd requires less food resources produced from expensive fossil fuels and other chemicals (corn, silage and protein supplement) to achieve the desired weight goal for sale. Increasing the utilization rate by 15 to 20 percent over those achieved with continuous grazing are projected to result in cash savings from supplemental feed not required.

Cash improvements may not be realized immediately, as there are financial outlays required to change the pasture infrastructure to accommodate a rotational grazing management system. But, changing to this more efficient system enables the operator to achieve a higher level of sustainability on a small operation.

This system will also require fencing animals away from direct access to the streams, thereby significantly reducing streambank damage. Restricting animal movement in the stream also reduces the amount of fecal and uric waste directly deposited into the stream. Establishing a thicker and healthier forage stand will increase infiltration leading to phosphorus and nitrogen sequestration and reducing soil loss carried in surface runoff.

A higher forage utilization rate improvement from rotational grazing leads to development of a dense canopy of diverse grasses and legumes. This thick canopy will also reduce soil particle movement caused by surface runoff. The root structure of this canopy also contributes to higher levels of moisture being retained within the critical 4 inches of the soil surface.

Full establishment of the grazing system modifies land-use by restricting livestock movement on the streambank. This action reduces overgrazing, soil disturbance from continuous foot traffic that contributes to a sediment overload in the stream and water quality degradation. Benefits to the at-large community can be achieved with higher water quality in the immediate area and a reduction in the excess phosphorous and nitrogen load delivered to the Mississippi Watershed and the associated impacts in the Gulf of Mexico.

RIPARIAN BUFFER PLANS

Buffer Design

Buffers may consist of a multiple vegetation zones of variable widths, depending upon: 1) the landowner's objectives; 2) the upland land-use patterns, and; 3) the characteristics desired in the buffer area (Schultz et al. 1995). The riparian buffers established at the Bear Creek Farm in Story County, Iowa have three zones of 32.8, 13.0 and 23.0 feet width (Figure 12) (Schultz et al.1995).

Three distinct areas of vegetation define the Leopold Center for Sustainable Agriculture model. Beginning at the streambank edge and moving away from the stream, zone one includes a strip of 4-5 rows of fast growing native trees, the second zone has a strip of 1-2 rows of native shrubs and slow growing trees and the third zone consists of a strip of warm season grasses ending at the crop zone interface (Schultz et al 1995). The width of proposed buffers for BHBF are based on 100 feet from the one side to the other versus a 69-foot width used in the Leopold Center model.

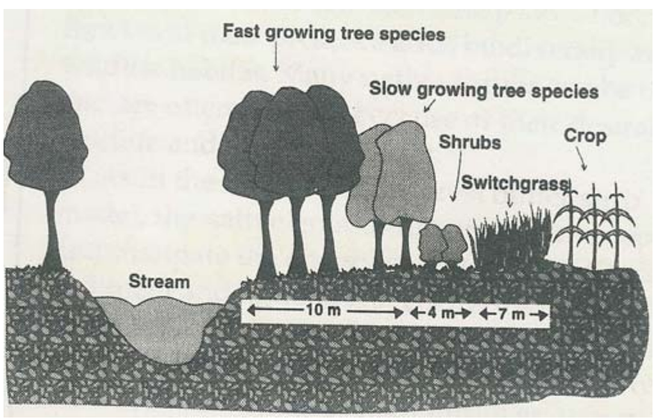


Figure 12 Multi-Species Riparian Buffer Strip (MSRBS) Model (Schultz et al. 1995).

The Leopold Center for Sustainable Agriculture and Iowa State University, Department of Natural Resource Ecology and Management has conducted multiple long-term studies of multi-species riparian buffers established at the Bear Creek Farm during the past decade. Schultz (2004) indicated that continuing research is needed in areas with a natural mixture of grasses rather than distinct separate zones. New studies should also seek to determine what grass species or mixed species buffer offers the highest level of effectiveness. Kirschman (2004) is also interested in leading The Leopold Center to explore major system changes to increase small farm sustainability. These new areas may be expanding wildlife habitat with larger riparian buffer areas, connecting travel corridors in a fragmented ecosystem or shifting from continuous to rotational grazing.

The buffers recommended for BHBF will be configured to accommodate the topographical features of the land surface adjacent to perennial and intermittent streams. These buffers may also be designed to satisfy the research requirements of future studies.

Proposed Multi-species Riparian Buffer

Four riparian buffer designs are proposed for BHBF. These designs are modifications of the basic design above, which shall also be implemented. The 100-foot width recommended for the proposed buffers are subject to negotiations between the landowners and the local NRCS District Conservationist. The length of each buffer varies based on the location and change in topographical features affecting surface runoff directed toward the stream.

Buffer Locations

Buffers I through VI (Figure 11) has the number design (Appendix C) associated to that location. These buffers are overlaid on a rural orthophotography of Grundy County 1997 (ProMap WebGIS 2004). This overview indicates surface features such as grass waterways (SCS 1991), field terraces (NRCS 2001) and the historical location of the streambed channel. The aerial photograph also depicts the natural surface runoff patterns established from the presence of grass waterways and indicate potential concentrated flows directed toward the buffer area. Design waivers may be necessary for Buffer Number III, but the NRCS District Conservationist has indicated close cooperation with Iowa State University riparian specialists to achieve the landowner and academic goals.

Appendix B includes detailed characteristics related to the location, area, soil type, topographic aspect, proposed design perimeters and vegetative species selected for each buffer area. The buffers will be located on soil that has a 0 to 2 percent or 4 percent slope and is primarily silty clay loam, with a high moisture holding capacity. The vegetative species selected will reflect growth characteristics that have a preference or moisture tolerance for each site.

This proposed mix of riparian buffers provides an opportunity for a joint effort between agriculture scientists and farm owners to study a variety of buffers on an operating farm. The owners and the farm manager will actively participate in the establishment, maintenance, and continuous monitoring of the individual sites. The owners will also participate in the development of preliminary documentation and data analysis that may be included in future journal publications.

Characteristics

Grasses with bunch and sod forming characteristics will significantly contribute to a high degree of infiltration within the proposed borders of the riparian buffers. This process contributes to the retention of soil on the land and filtering of pollutants as they pass through the soil column. The height of the plant material is a strong indicator of the root biomass structure that has evolved overtime below the surface. Long evolution has enabled the species to adapt to seasonal moisture fluctuations. Most midwestern native grasses have evolved a root biomass subsurface depth that is 3 times the height of the surface plant (ISU Extension Service 1998). This mass contains the reservoir of reserves called upon for regeneration following grazing, fire or severe seasonal change such as drought.

Mixing native and naturalized species will provide an opportunity to determine if deep root channels created by the native species in one growing season encourages naturalized species to achieve greater depth in the soil column in following growing seasons than would normally occur. Field tests conducted (Comis 1997) showed soybean had followed old channels of Eastern gamagrass to a depth greater than their normal shallow depth. The test dig indicated the gamagrass had grown through a clay layer and extended beyond a 7-foot depth.

Rhizomatous Switchgrass appears bunchlike but with concentrated short rhizomes above the silty clay layer (Barnhart 1995). Mixing Switchgrass with deep-rooted warm season grasses presents an opportunity to study the possible leader-follower affect between the different grasses. Penetration of the silty clay layer by deep-rooted grasses may enable the rhizomatous species to develop at a higher percentage lower in the soil profile than would normally occur (Evans 2004). This objective is in line with future below ground biomass studies being considered by the ISU Natural Resource Ecology and Management Department (Schultz 2004). Most Midwest grasses will provide significant amounts of POM at the end of the growing season. This litter will contribute to surface stabilization, runoff infiltration and wildlife habitat during the winter and the following pre-emergent spring season.

Orchardgrass, a naturalized cool season grass, emerges in early spring (April) and has the ability to achieve a surface height of 2 to 4 feet. This cool season grass will bear the brunt of surface runoff from the crop fields. Other factors contribute to reducing surface runoff velocity are crop residue remaining on the field from no-till practices and the warm season grasses residue from the previous year. Orchardgrass was selected for its adaptability to north central Iowa and its ability to generate a significant biomass in the soil profile. This species demonstrates a good to excellent palatability and an excellent winter survival rate maintaining the functionality of the buffer overtime. Due to the demonstrated factors it is also a good wildlife habitat. The ability of all selected grass species to generate a significant fibrous root system provides organic carbon and decaying biomass to subsurface soil organisms. The abundance of SOM contributes to stimulating the biological process of denitrification (Groffman et al. 1992).

Multi-species Riparian Buffer Summary

The proposed buffer designs provide the opportunity for multiple ecological sites to evolve and be sustained over time. The design of the multi-species riparian buffers identifies areas for different species vegetation. Implementation and appropriate maintenance practices over time will encourage a transition to an intact habitat that mimics characteristics of a presettlement Iowa savannah ecosystem. Within a limited time, effectiveness comparisons can be conducted against the Leopold Center's model. Data will also be available to compare both systems at comparable yearly stages of development.

These multiple designs will contribute to achieving the primary goal of establishing a natural bio-infiltration system (multi-species riparian buffer) between row crop fields and the stream network. This biophysical barrier helps reduce surface and subsurface movement of excess nutrients through the soil structure. The barrier also facilitates infiltration of surface runoff, thereby enhancing microbial activity on excess nutrients and agrochemical pollutants transported below the surface.

The second goal is to expand the intact range of native and naturalized vegetation within the borders of the buffers providing additional range of diversity in shelter, food, breeding, nesting, and rearing sites for resident and migratory wildlife. These buffers provide additional sites for development of a presettlement environment mimicking a grassland savannah within the corn and soybean monocultures. Non-native species introduction in the past means these species may out-compete native species for selected niches within the area. The landowner cannot control this fight for space. But, the owner can manage natural resources to expand the area integrating patch fragmentations. This long-term process for all buffers is one aspect of the landowner's management approach implementing their conservation ethic.

These two goals will complement future activities pursued by the Leopold Center for Sustainable Agriculture in their efforts to reduce contributions to sediment loading in the Mississippi Valley watershed. Future possible collaborations between Virginia Tech's College of Natural Resources and the ISU Department of Natural Resource Ecology and Management may be considered.

IMPLEMENTATION COSTS

Labor/Equipment/Materials

Estimated cost data for seeds, fencing and a water distribution system are provided (Appendices D through F). These estimates are based on a preliminary survey of resources to meet these needs in the permanent cool and warm season pastures and fence off all riparian areas.

Seeds

Appendix D provides the specific cool season and legume brands with the pounds per acre recommended (Welter Seed & Honey Company 2004). Based on the acreage devoted and proposed for conversion, forage acreage will be 102 acres. Total cost of seed is $5,948 with cool season grasses and legumes at $2,344, while warm season grasses are $3,604, respectively. This equates to approximately $59/acre to improve the existing forage for 102 acres. Purchase of seed to improve existing forage is covered as a cost-share item at 50 percent under the current EQIP regulations and is authorized under Farm Bill 2002. Existing no-till drilling equipment will be used to plant the seed. If frost seeding is conducted, an existing all terrain vehicle with attached grass spreader will be utilized.

Fencing

The fencing estimates proposed (Appendix E) are based on measurements to enclose Black Hawk Creek in the permanent cool season pasture under a proposed EQIP contract. Non-perimeter electric woven and HT smooth wire, as well as temporary portable electric fences will be required to strip graze the individual paddocks. The proposed riparian buffer areas, under a CRP contract adjacent to freshwater streams, must also be enclosed to restrict movement of cattle into these areas following harvest operations.

Water Distribution System

Appendix F provides an estimated cost for a distributed system to both cool and warm season pastures and an option for a future Eastern gamagrass expansion pasture. At present, the closest clean water source is a shallow (200-foot) well located within a confined area on the North Farm. It is recommended this location be tapped as the primary source for a water distribution system. Two primary branches will distribute clean water (Figure 6). The cool-season pasture will be supplied with a 1 ½ -inch buried (5-feet) PVC 160 psi pipe with approximately five surface hydrants supplying water to portable containers moved on sleds. This system will be installed during 2006. Because there is a need to cross under (boring) Black Hawk Creek at three locations the Iowa Department of Natural Resources, Flood Plain Management Program was contacted. Chyi (2004) reported permits are not required if the streambank configuration is not disturbed. With the relatively flat terrain, a low-pressure one horsepower electric pump will be employed to maintain continuous water supply. Cut-off valves for each major pasture will be installed. At a price of $2.50 per foot a local Grundy County contractor can trench, lay pipe and bore under the stream. Additional costs for Iowa water hydrants and a pump are included. BHBF currently has material and equipment to construct water containers, sleds and other miscellaneous connectors.

DISCUSSION

Management

Improvement of the existing forage must begin with an understanding of the soil makeup, which is the source of nutrient for forage growth. North central Iowa soils are known for their fertility and ability to produce a mixture of tall cool season grass pastures capable of maintaining 6.23 animal unit months per acre (ISU Extension Service 1998). While this is the highest rate throughout the state, individual pasture soil tests must be conducted to determine the specific needs for the soils of BHBF.

Selection of the cool-season grasses and legumes planted for improvement of the permanent pastures is a critical decision. Factors influencing this decision are the soil types, topographical aspect, hydrology and similar growth characteristics of the species selected. Other influencing factors are recommendations of successful operators who have implemented rotational grazing systems in the local region and guidance of the NRCS Grassland Specialist.

<u>Cool-season Grass</u>

Smooth bromegrass still exists within the Kentucky bluegrass dominated pastures. To insure an increased density of Smooth bromegrass is established (40 percent) of this species is recommended on a per acre basis versus other cool season grasses (Appendix D). The specific variety selected is Rebound. This variety recovers quickly after grazing, has a higher digestibility and will continue to grow after other grass species have gone dormant during mid-summer. In addition to the seedbed of bluegrass and bromegrass, the seed varieties of Tekapo Grazing orchardgrass, Palaton Reed canarygrass and Tuukka timothy have been selected in the pounds per acre shown in (Appendix D). Common reed canarygrass will not be considered as it has a history of being less palatable than most other grass species seeded for hay and pasture. New varieties such as Palaton are low in indole alkaloid concentration, which leads to an improved animal performance, palatability and produces dry matter yields of 3.7 to 7.2 tons per acre in grazing trails conducted by Minnesota Agricultural Experiment Station between 1990 and 1996 (Ehlke 1997). Follow-up management practices are needed to achieve complete success for both cool and warm-season grasses after all interseeding operations.

Warm-season Grass

Heavy grazing early in the growing season for the established 26-acre warm-season forage is recommended to reduce competition of the existing stand. Mechanical mowing may be necessary to control grass and weed competition. Big bluestem and Indiangrass will be interseeded to achieve improvement of the existing warm season pasture. One legume (Medium Red clover) will be used for the improvement process of this production unit. Because the legume will emerge before the warm season grass, it is believed this feature will allow it to become established and fix the nitrogen levels required for the following native grasses.

If Eastern gamagrass is established in the optional site, mowing in the second year is recommended when the stand reaches a height of twelve inches. This height should be reduced to six-eight inches. When the grass is reduced to this height the remaining grass stem will form a strong stubble barrier that cows will not graze below (Ranum 2002). The grass at the six-eight-inch height retains sufficient leaf surface for regrowth to higher vegetative levels (Ranum 2004) to meet the anticipated forage needs of the existing 65 AU. Based upon experience following the two-year establishment phase stocking density levels may be adjusted upward.

Riparian Buffers

The riparian buffers proposed will require selective management actions to encourage development of a presettlement plains savannah. These management actions will require flash grazing by livestock to simulate the passing of buffalo. Prescribed burns, late in the summer, are also suggested to simulate the low-temperature fast moving prairie fires that helped in seed propagation of selected species and retarding the movement of deciduous trees onto the grassland. Both of these actions will be conducted after the nesting and rearing of young is conducted by migratory and resident avian species. Timing of the limited burns to late summer simulates historical fire events and facilitates ecosystem function.

Opportunities

Enhancing the existing pastures with naturalized cool and native warm season grasses and using these species in the riparian buffers provides an opportunity to create forage diversity contributing to higher average daily gains. This increased forage will contribute to higher levels of free food.   Adapting new management techniques may reduce the need for the costly production of hay as a winter food source.

Establishment of this diverse vegetative cover in larger areas is a critical step in creating a simulation of what had been the presettlement Iowa savannah. While it is not possible to regain the original ecosystem, it is a goal to recreate functioning aspects of that earlier system. The most important function is to increase the level of infiltration following storm events versus what is infiltrated within a monoculture corn crop landscape.

Higher levels of infiltration within the buffers insure higher moisture content deeper in the subsurface soil column. Increased moisture supports vegetative growth for an expanding food web. It is this critical expansion of the insect population that will aerate the soils of a monoculture environment in their effort to establish their territory. But an expanded food web also brings the risk of disturbance to crop production levels from insect borne disease. It is at this point that a balance must be maintained. In a healthy ecosystem higher predators on the food web will keep the insect population in check. Increasing the food web is a critical component in establishing a hospitable environment that can support and attract resident wildlife of low populations into this area.

Increased habitat will also fill in a missing gap in the fragmented landscape caused by the monoculture production of commodity products. New habitat will eliminate gaps in the travel corridors that many species need to maintain a reproducible population and sustainable communities.   Intact travel corridors provide both benefits and drawbacks for this farming operation as the corridor may also be used by larger predator wildlife that could take down or hurt valuable livestock.

State authorities in 2002 estimated that as many as a dozen Cougar may be living in Iowa. These big cats ranging in size from 120 to 200 pounds have been sighted on several occasions in the Iowa River Valley basin. Cougar may travel up to sixty-miles in a single night. The Iowa River basin is less than 12-miles from the farm site (Thompson 2002). Other large predators such as wolves and bears are also following the food source of the exploding Iowa whitetail deer herd that is in excess of 200,000 and left unchecked can double in 3 years (Iowa DNR 2000).

Options

Reduction of the Midwest tallgrass prairie has severely reduced the available seed stock of native vegetative species that are critical for the re-establishment of prairie grasslands desired by many communities. Nurturing the native species introduced presents a possible funding opportunity to help replenish this depleted natural resource through prairie grass seed companies and seed exchange organizations. While riparian buffers and warm-season pastures will be the principal location to introduce native species, roadside areas within the farm is also a viable space for limited production. This area has traditionally been part of the land taxed by local government, but was not considered a part of the revenue generating landscape. Selected private landowners in Iowa have established a market for native grass seed (Kurtz 2001) and need additional product to meet the growing demand. Expanding the native and naturalized forages also presents another funding option to rent space adjacent to riparian buffers and the enhanced pastures for established beekeepers.

Research

Multiple research opportunities exist for observations of introduced forage species as well as the effectiveness of riparian buffer zones. Using established protocols to collect data will help in monitoring pasture and buffer improvements. This process may be conducted by the interested landowner or can be offered as an opportunity for operational research through an educational institution. If consistent observations and structured data gathering are conducted, adverse changes in the natural resources may be identified early in the cyclical process.

Comparative studies can be conducted of buffers established for BHBF to those using the Leopold Center for Sustainable Agriculture model (Schultz et al. 1995, Tufekcioglu et al. 1999). Unexpected observations over time may require adopting new management techniques for future operations.

Adaptive Management

Informational feedback based on observed or formal data gathering procedures may indicate the need to modify existing operational techniques. Daily pasture walks are a method highly recommended to gain an understanding of the forage development process and to identify problems in the early stages of development, which may be mitigated with early intervention of corrective practices. This process will also contribute to a better understanding of the cyclical changes that occur with natural resources. These walks will also provide the cumulative experience that a forage manager needs to correctly estimate the growth of grass to meet the livestock needs.

Measures of Success

Success for forage enhancement will be measured by quantitative data of the percent of introduced grass and legume species established within a consistently measured area conducted randomly throughout the pasture and the growing season. Factors addressed beginning in the soil, supported by normal rainfall amounts, should contribute to achievement of an average daily gain of 4 to 5 pounds per day for Simmental and Simmental/Angus crossbreeds that make up the majority of the livestock (Simmental Association 2004). These benchmarks are measurable and are familiar to small farm operations. Creating healthy abundant forage is the first step followed by harvesting of that forage by the livestock. Abundant and nutritious forage with a content of high energy levels expressed in the form of total digestible nutrients (TDN) will lead to healthy animals capable of producing high valued calves weighing 552 pounds at weaning (Allen et al. 1992b) with a rebreeding rate greater than 95 percent (Fontenot et al. 1995).

Riparian buffer zones, while not unknown are less familiar to small farmers. The landowner is familiar with several USDA introduced land-use changes designed to control surface runoff and the movement of highly valued soil. Multi-species riparian buffer zones will require sophisticated monitoring and measurements. Some aspects of this process are not beyond the capabilities of the landowner, but not as familiar as the measuring components associated with forage enhancement. Collecting water samples that flow across and beneath the buffer zones may be collected. This may require a modification of the state sponsored volunteer program initiated through the Iowa DNR Water Monitoring Section. The landowner may conduct in-stream monitoring with some training through the state sponsored workshops. Iowa Water, a statewide volunteer water quality-monitoring program, is available to train volunteers in biological assessments, chemical assessments, physical assessments and stream habitat assessments (Neely 2004). All samples should be taken throughout the year and on a fixed schedule.

Other measurements on the effectiveness of the buffer zones would be similar to those carried out by faculty and staff of Iowa State University at the Bear Creek Farm project. Those measurements are beyond the capabilities of the landowner and require specialized equipment and trained staff to implement. A formal agreement between the state university or other educational institution would be necessary to establish the appropriate protocols to determine effectiveness. If a formal agreement of study is established it would be conducted over an extended period of time to coincide with the maturity of the vegetation within the buffer zones.

Sustainability

The Goals of the Management Plan stipulates that sustaining a sufficient level of profitability is the primary operational goal for BHBF in the short-term. This level must be adequate for the tenet manager to meet his rental agreement obligations and the cost of operation that includes maintenance and payment of equipment, replacement of resources expended and adequate compensation for his own labor. Achieving these economic obligations will enable the tenet manager and the owner to begin implementing other management decisions and land-use changes that will contribute to long-term sustainability of BHBF.

Sustainability cannot be based solely on economic return. Decisions must be made now that influences the long-term future. These decisions must be followed up by actions that enhance forage diversity, mitigate soil erosion in sensitive pastures, and establishes natural resources that will regenerate a continuous seedbed capable of supporting a diverse wildlife community.

A small farm such as BHBF requires a continuous review of current systems and methods of operation to determine if modifications will result in a higher level of production and financial return on investment (ROI). Shifting to a different management grazing system is an example of this modification. Rotational grazing holds out great promises for increased forage and higher levels of stocking density on the same acreage. Increasing diversity of the existing forage may add a highly nutritious food source that leads to an added value in the livestock produced and marketed.

Management decisions concerning the existing calving and rebreeding cycle are also actions that need to be considered to bring animal production in sync with maximum forage availability of cool-season grasses in this temperate climate. Decisions affecting forage diversity and its production will have rippling impacts on livestock and how it is managed in relation to the abundance or scarcity of forage. All of these decisions and actions are aimed at maintaining the natural resources in a healthy state to consistently regenerate high levels for economic returns over an extended period.

BHBF produces commodity products, but availability of new markets should not be ignored. Currently, all of the cow-calf operation is sold at the sales barn in Tama County that feeds into the larger commodity market. A new meat processing operation, Iowa Quality Beef Cooperative, located in Tama County has been established that contracts with members for delivery of a given number of higher quality animals on specific dates (Agricultural Outlook Forum 2003). This avenue should be explored to determine if the projected increase in diverse forage availability would be sufficient to increase stocking density of the current herd with a genetically superior breed of cattle that could meet the demanding requirements of this new market. If that is feasible it may be possible to develop livestock to meet the demands of both markets. Black Hawk Beef branding may be a future marketing option.

Maximizing or multi-tasking every available acre within BHBF with little or no input of additional costs will contribute revenue toward the bottom line operation. Working through government programs to increase species populations threatened by habitat loss, such as the Bobwhite, renting out space for honeybee keepers adjacent to the enhanced pastures or buffers, producing native grass seed stock from buffers and ditches next to the road, and maintaining an existing stand of Black Walnut trees are examples of land-uses that produce revenue from assets that have been established on the farm to meet other needs. These actions also insure the sustainability of scarce natural resources.

Continuing education on software programs, such as the Iowa Forage and Livestock Balanced Worksheet, provides a unique management tool that helps the landowner maximize his resources. Applying this and other software tools will keep the operator knowledgeable and the farming unit profitable over the short term and sustainable over a longer period of time.

SUMMARY

Sustaining family farms in the Midwest can be achieved, but a continuous review is required of management and production methods. Additionally, operators must demonstrate a willingness to set aside former practices and preconceived cultural opinions when different ideas demonstrate a more efficient process. Rotational grazing is such an idea. This working concept is based on practical information that has evolved over the last half of the 20th century in multiple climates and ecosystems throughout the globe. Moving or rotating herbivore harvesters of grass from one area to another and allowing the harvested area rest, to gather reserves and regenerate new leaf, creates abundant vegetation for re-grazing.

Rotational grazing increases forage utilization by 15 to 20 percent over the Midwest growing season. This increase adds value by producing large forage quantities from the same acres of productive soil with a small amount of increased inputs. Coordinating the livestock calving cycle to be in sync with this increased productivity assures a quality diet prior to calving and high milk production from the lactating cow following calf delivery. High quality milk generated from improved forage during the first 3-4 months leads to a heavier calf at weaning and a rebreeding success rate in some species greater than 95 percent. These physical changes lead to improved economic returns, holds promise for continuing success in the future with an increasing diversity of needed resources.

Projected market conditions predict a continuing tight harvest supply of animals. This condition indicates that continued added value may be acquired from higher sales of lean meat products, aimed at meeting healthy lifestyle demands, in growing segments of the retail market catering to upscale restaurants. Entry to these markets is through enterprises such as the Iowa Quality Beef Supply Cooperative or high-end international commodity markets. Recent federal court decisions related to obesity in the two-legged population may provide additional retail opportunities for the meat producer community.

Riparian buffer zones proposed adjacent to perennial streams presents an opportunity to maximize utilization of the acres involved. The Conservation Reserve Program authorizing buffers allows multiple uses of the vegetation. These uses include functioning as a nutrient biomass filter that benefits the larger social community, flash grazing for calves and finally as an expansion of travel corridors and habitat for resident and migratory wildlife and the associated food web that will evolve. The vegetative characteristics of this corridor will be managed by the landowner to evolve over time into a simulation of a functioning presettlement Iowa savannah. Management techniques such as flash grazing and low temperature fires will be utilized to simulate historic events that were instrumental in the grassland evolution.

As the buffers mature, spillover benefits will accrue to the land. These benefits are increased carbon sequestration, higher levels of surface water infiltration, expanded food web for a growing wildlife and native bird population as espoused in the *Iowa Breeding Bird Survey* (Jackson et al. 1996) and *Birds in Iowa* (Kent and Dinsmore 1996), increased natural habitat within the diverse vertical space of the buffer structure. The increase of the food web also has positive impacts on the surrounding acres as increased insect and invertebrate populations expand their range in search of breeding partners and new territory to colonize. Insect activities in the subsurface aerate the soil and increases soil health as they die, are recycled and contribute to the growth of new vegetation.

Alternative economic activities are also generated in the maturing buffer process with the opportunity to rent space for migrating beekeepers. These new buffers increase the amount of pollen available to bees and other insects, while maintaining the pollination process for the plants on this property. In the future mature deciduous trees may be harvested as part of another owner’s sustainability program.

CONCLUSION

The information presented indicates small farm sustainability is possible, but will require changes in current forage management practices and adaptation of different land-use philosophies in riparian areas. Improving forage diversity is the highest priority with the introduction of three cool-season and three legume species added to an existing Kentucky bluegrass dominated pasture. Either interseeding or frost seeding during various seasons can accomplish improvements.

A change to the present forage management system requires implementation of infrastructural modifications within the layout of the permanent pasture. This includes change to the existing internal fence lines, establishing electric fences controlling livestock access to Black Hawk Creek, creating controlled stream crossing points for the ease of livestock movement, reinforcing the crossing points with a polymer manufactured slope and channel protection system and establishing a clean water distribution system throughout the pasture. These structural changes can be accomplished in a phased sequence following forage improvements or in conjunction with those improvements.

Increasing forage diversity and implementing a rotational grazing management system promises to increase forage utilization rates by 15 to 20 percent over the existing continuous grazing system. Increased utilization rates will contribute to increasing stocking densities by 10 to 12 percent of the current 65 animal units.

Implementation of the complete package of recommended changes will reduce the level of nutrient pollutants and soil erosion entering Black Hawk Creek from the permanent pasture. These levels are unknown, but offer opportunities for future research in natural methods of erosion control and nutrient movement over the landscape surface.

Implementing multi-species riparian buffers between the row crop fields and Black Hawk Creek promises to dramatically reduce levels of agrochemical and biological nutrients entering the stream. Establishing these buffers will increase surface runoff infiltration rates and present opportunities of study on the rate of growth and effectiveness of biomass filters in a working farm environment.   Buffer design will be directed toward recreating a simulation of a presettlement ecosystem that dramatically expands the food web over the current corn and soybean monocultures. Increased food webs hold multiple promises for improvements to surrounding crop field soil health and attracting wildlife-seeking sites for food, shelter, nesting and rearing of young. Implementing the proposed recommendations will contribute to operational sustainability and establish the farm as a potential site for future long-range natural resource research, collaborating with institutions such as Virginia Tech and Iowa State University.

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APPENDIX A IOWA FORAGE AND LIVESTOCK BALANCE WORKSHEET

Producer:	Pasture **Bob Slusser update**	**Prepared By:**	**R. Mier** County: Grundy
Address:		**Location:**	**Grundy** **Phone:**

Only enter info. in areas of this color or a choice box. **Date:** **11/1/2004**

Page 1

Soil	**Acres**	**Field**	**Kind of Forage**	**Potential #DM/Yr**	**Current #DM/Yr**	
84a	1.8	1		16380	0	
377C2	3.6			50400	0	
120C2	0.6		**Forage Use**	8400	0	
133	5.6			50960	0	
				0	0	
			Utilization Rate %	0	0	**Fill in above livestock information**
			50.00	0	0	**for whole farm. This will transfer to table.**
			Recommended Rates	0	0	
			30% Continuous grazing	0	0	**Select one below using a X to transfer to table.**
			45-55% 7 day rotation	0	0	**Use Potential #DM/Yr** X
			75% <=1-2 day rotation	0	0	**Use Current #DM/Ac/Yr**
			Management Level %	0	0	**Use "Management Level" to adjust the Potential Yield (higher or lower). An example is a pasture with excessive tree growth. You may want to reduce the yield by 25%, 60% or more. Insert the percent in the box and move the"X" to current.**
				0	0	
			This figures current	0	0	
			yield.	0	0	
Totals	**11.6**			**126140**	**0**	

TG/Leg 4-8 pad.

Livestock	**No. of Animals**	**Animal Weight**
Cow	75	1100
Calves > 3 mo	70	375
Bull	5	1800
None		
None		

Soil	Acres	Field	Kind of Forage	Potential #DM/Yr	Current #DM/Yr
			TG/leg 4-8 padd.		
7	2.4	2		34080	0
177c2	0.3			2670	0
120b	0.6		Forage Use	9060	0
			Pasture		
120	0.9			14220	0
133	4.8			43680	0
			Utilization Rate %	0	0
			50.00	0	0
			Recommended Rates	0	0
			30%Continuous Grazing	0	0
			45-55% 7 day rotation	0	0
			75% <=1-2 day rotation	0	0
			Management Level %	0	0
				0	0
			This figures current	0	0
			yield.	0	0
Totals	**9**			**103710**	**0**
			TG/Leg 4-8 pad.		

Select one below using a X to transfer to table.

Use Potential #DM/Yr	**X**
Use Current #DM/Yr	

Page 2

Soil	Acres	Field	Kind of Forage	Potential #DM/Yr	Current #DM/Yr		
133	10.2	3		92820	0		
119B	0.4			5960	0		
120c	0.3		**Forage Use**	4470	0		
177C2	1.6			14240	0		
				0	0		
			Utilization Rate %	0	0		
			50.00	0	0		
			Recommended Rates	0	0		
			30%Continuous Grazing	0	0		
			45-55% 7 day rotation	0	0		
			75% <=1-2 day rotation	0	0		
			Management Level %	0	0		
				0	0		
			This figures current	0	0		
			yield.	0	0	**Select one below using a X to transfer to table.**	
Totals	**12.5**			**117490**	**0**	**Use Potential #DM/Yr**	**X**
			TG/Leg 8to15pad.			**Use Current #DM/Yr**	

TG/leg 8-15 padd.

Pasture

Soil	Acres	Field	Kind of Forage	Potential #DM/Yr	Current #DM/Yr
133	7.9	4	1 Hay then Graze	71890	0
133	0.4			3640	0
119B	1.8		**Forage Use**	26820	0
120	0.3		Pasture	4740	0
177	0.3			2940	0
177C	0.7		**Utilization Rate %**	6510	0
			50.00	0	0
			Recommended Rates	0	0
			30%Continuous Grazing	0	0
			45-55% 7 day rotation	0	0
			75% <=1-2 day rotation	0	0
			Management Level %	0	0
				0	0
			This figures current	0	0
			yield.	0	0
Totals	**11.4**			**116540**	**0**

Select one below using a X to transfer to table.

Use Potential #DM/Yr	**X**
Use Current #DM/Yr	

Page 3

Soil	Acres	Field	Kind of Forage	Potential #DM/Yr	Current #DM/Yr		
84a	3.2	5		29120	0		
177C2	1.5			13350	0		
177	3.2		**Forage Use**	31360	0		
177C	3			27900	0		
120B	13.8			208380	0		
933B	1.8		**Utilization Rate %**	16020	0		
120C	2.2		50.00	32780	0		
			Recommended Rates	0	0		
			30%Continuous Grazing	0	0		
			45-55% 7 day rotation	0	0		
			75% <=1-2 day rotation	0	0		
			Management Level %	0	0		
				0	0		
			This figures current	0	0		
			yield.	0	0	**Select one below using a X to transfer to table.**	
Totals	**28.7**			**358910**	**0**	**Use Potential #DM/Yr**	**X**
			TG/Leg 4-8 pad.			**Use Current #DM/Yr**	

TG/leg 4-8 padd.

Pasture

Soil	Acres	Field	Tall WS Grass	Potential #DM/Yr	Current #DM/Yr
120B	12.6	6		166320	0
177C2	3.5			26950	0
933B	6.5		Pasture	70850	0
120C2	1.6			19520	0
54	1.6			12960	0
88	0.2		**Utilization Rate %**	2480	0
			50.00	0	0
			Recommended Rates	0	0
			30%Continuous Grazing	0	0
			45-55% 7 day rotation	0	0
			75% <=1-2 day rotation	0	0
			Management Level %	0	0
				0	0
			This figures current	0	0
			yield.	0	0
Totals	**26**		**Tall WS Grass**	**299080**	**0**

Select one below using a X to transfer to table.	
Use Potential #DM/Yr	**X**
Use Current #DM/Yr	

				Potential	Current
Soil	**Acres**	**Field**	**Kind of Forage**	**#DM/Yr**	**#DM/Yr**
			Bluegrass		
120B	12.6	2		99540	0
177C2	3.5			15750	0
933B	6.5		**Forage Use**	42250	0
			Pasture		
120C2	1.6			11680	0
54	1.6			7840	0
88	0.2		**Utilization Rate %**	1500	0
			60.00	0	0
			Recommended Rates	0	0
			30%Continuous Grazing	0	0
			45-55% 7 day rotation	0	0
			75% <=1-2 day rotation	0	0
			Management Level %	0	0
				0	0
			This figures current	0	0
			yield.	0	0
Totals	**26**		**Bluegrass**	**178560**	**0**

Select one below using a X to transfer to table.	
Use Potential #DM/Yr	**X**
Use Current #DM/Yr	

APPENDIX B CLASSIFICATION KEY FOR NATURAL RIVERS

(Rosgen 1996)