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Forestry's Role in Sustainable Agriculture

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Introduction

Sustainable agriculture is becoming an important land stewardship issue as agriculture heads into the 1990's. Erosion control, non-point source pollution, runoff, habitat diversity, crop rotations and cultivation practices are issues being discussed. The objectives of this paper are to describe the roles that trees and forestry can play in the sustainable agricultural systems being developed for use on the Great Plains.

Trees were important to the early settlers of the plains, and tree planting is a tradition that continues today. Tree sales in the Great Plains during 1989 exceeded 50 million trees, with almost all of these going for conservation purposes (GPAC 1989). Farmstead windbreaks, wildlife habitat, and timber, are the three major uses of trees recognized by most people. Other uses are often overlooked and yet offer considerable benefits to the agricultural community and the individual landowner.

Trees contribute to the stability and overall productivity of agricultural systems in two primary ways: 1) they provide protection for soil, crops, livestock, and people, and 2) they provide additional products for on-farm consumption or sale.

Protection

Trees provide many different types of protection depending on how they are arranged or planted. In the agricultural system, the most common use of trees for protection is in windbreaks to reduce wind speed and moderate the effects of strong winds. They are used to protect soil, crops, livestock, and farmsteads. They can be used to spread snow across a field or to prevent snow drifting on roads. They reduce the annoyance from dust and noise from county roads and provide privacy and aesthetic values.

Field Windbreaks

Field windbreaks provide long term protection for soils subject to wind erosion. Properly located and spaced at intervals of ten times windbreak height

(10H), they essentially eliminate wind erosion. At the same time, they reduce plant damage due to wind and wind-blown soil and prevent crop loss resulting from the blowout of newly planted crops and young seedlings (Brandle and Hintz 1987).

Field windbreaks increase crop yields of many crops for a variety of reasons. In winter wheat, protection during the winter reduces damage due to desiccation and winterkill. In spring sown crops, yield increases may reflect improved water use efficiency, modified canopy structure, improved microclimate, protection from hot, dry winds, or other factors resulting from reduced wind speed. Where snow provides a critical source of soil moisture, the distribution of snow increases the probability of successful crop production. These yield increases will vary from crop to crop and from region to region. The effects of wind protection on crop yields have been summarized recently by Kort (1988), Baldwin (1988), and Norton (1988), and are illustrated for a specific case in Figure 1.

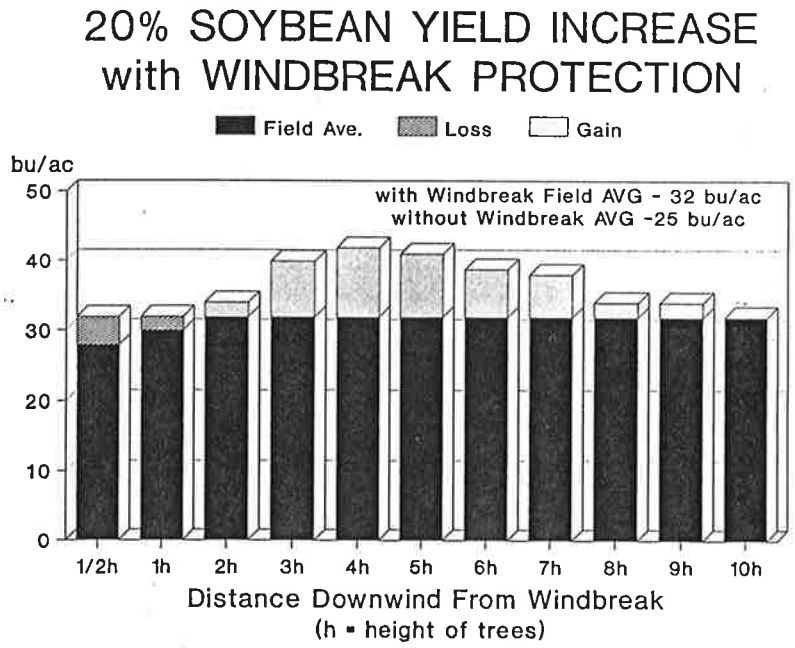

Fig. 1. Average soybean yields for 1980 and 1982 at Ridgetown, Ontario, Canada (Baldwin & Johnson, 1984).

Studies by Brandle et al. (1984, 1988) and Kort (1989) have indicated that with proper design, field windbreaks provide a positive economic return to the producer. The windbreak investment is paid for in 10 to 20 years and more than compensates for any lost production resulting from the land planted to trees.

Field windbreaks also improve the distribution and utilization of irrigation water. By reducing wind speed, less water is lost to evaporation during application, less water needs to be applied resulting in energy savings, and more water is available to the crop.

Field windbreaks are flexible and can be used in conjunction with other conservation practices such as reduced tillage and residue management. By utilizing all available techniques, a producer can utilize the advantages of each, optimize inputs and reduce risks.

On the negative side, field windbreaks remove land from production, reduce yields in the area immediately adjacent to the windbreak, and may increase wildlife damage to some crops. There is some concern that windbreaks harbor various insect pests and act as an over wintering site for some diseases, however, except in the case of cotton, few confirmed cases of such impacts exist. In contrast, windbreaks provide habitat for birds and beneficial insects that will be required in successful sustainable agricultural systems. This is an area that desperately needs additional research to determine the impact of field windbreaks on potential pest management problems. In summary, while the negative impacts of windbreaks must be considered, it appears that the positive benefits far exceed these negative concerns.

Farmstead Windbreaks

Protection of the farmyard and farmstead by a properly designed and located windbreak will result in significant energy savings and enhance the overall profitability of the farm operation. These savings result primarily from the reduction of air infiltration rates into homes and buildings, and the consequent reduction in energy use. Savings will vary throughout the region and may exceed 40 percent in the northern plains area (DeWalle and Heisler 1988).

The protected farmstead provides an improved working environment during winter months. Protection from the wind reduces windchill effects and allows for more efficient and effective time use. The farm garden is more productive and the quality of produce is enhanced. The incorporation of fruit and nut trees into the windbreak design adds additional products for utilization. Tree rows between the road and the home reduce noise and dust pollution. When properly located, windbreaks associated with the farmyard can reduce snow removal costs. Farmstead windbreaks can effectively screen undesirable views and odors, provide aesthetic values, and enhance wildlife habitat.

Living Snow Fence

Windbreaks can be designed to effectively spread snow, as in the case with field windbreaks, or they can be designed to trap and store snow within a specific area (Brandle and Hintz 1987). Snow management can reduce the time and fuel

needed to maintain access to farmyards, livestock feeding areas, and other buildings. Living snow fences enhance wildlife habitat and provide aesthetic values. When located to protect roadways, they reduce the costs associated with winter access. These costs may be privately realized on private roads, or may result in tax savings when used on county or state roads.

Livestock Windbreaks

Windbreaks can be designed to protect livestock either in the feedlot or on the open range. Outdoor barns are windbreak systems designed to provide protection for cattle on open rangeland against blizzards and cold winds. They can be especially beneficial during the calving season when newborn calves may die as a result of exposure to cold, windy conditions (Dronen 1988).

Properly designed feedlot windbreaks can reduce feeding costs significantly. The effect of cold temperatures on livestock is primarily one of an increased need for energy. As temperatures decrease below certain critical temperatures, an animal requires additional energy to maintain body temperature. This energy comes from existing body fat or increased feed intake (Webster 1970). In the northern areas of the Great Plains, feed energy requirements may increase as much as 50 percent. Increases in the central plains range from 10 to 30 percent depending on the condition of the animal. In general, the degree of savings depends on air temperature, wind speed and the resulting windchill factor, the condition of the animal, and the condition of the animal's coat, such as thickness and whether it is wet or dry (Hintz 1983).

Direct injury of livestock due to freezing of exposed flesh will occur at windchills of -25 degrees Fahrenheit. As cold stress increases, latent diseases may begin to appear. Additional benefits have also been reported for dairy cattle, increased milk production in sheltered animals; swine, decreased feed requirements for sheltered animals; and sheep, decreased mortality of lambs when protected (Hintz 1983).

Wildlife Plantings

Multiple row windbreaks provide extremely valuable wildlife habitat in areas dominated by agriculture. They are often the only woody vegetation in these areas, and during winter months may offer the only cover available.

Water Quality

The area adjacent to streams and rivers is generally recognized as critical habitat for many wildlife species. Trees located along the water provide shade for the stream and help maintain cooler water temperatures and improved aquatic habitat. Perhaps more important is the role these areas play in maintaining water quality. They act as filter strips between agricultural lands and the waterway, and

absorb the physical impact of runoff and flood waters. They filter out pollutants such as excess fertilizer and pesticides, and reduce sediment load reaching the waterway. Studies done by the USDA Agricultural Research Service on the Georgia coastal plain found that sediment and nutrient (eg. N, P, K, Ca, Mg) runoff from cropland were kept from entering the stream channel when woody riparian vegetation was left intact (Lawrence et al., 1984).

Production

Crop diversification is an important component of sustainable agriculture. Trees should be considered as another crop which can help diversify the farm income while keeping the soil in a permanent ground cover. There are traditional and nontraditional approaches in utilizing trees for production. The traditional approach obtains products from contiguous forestlands or by planting contiguous acres of trees for a specific purpose. The nontraditional approach, or agroforestry, integrates the growing of trees into agricultural areas.

In both cases, the products that are produced may be traditional forest products such as timber, fuelwood and woodchips, or they may be more imaginative such as small animal bedding materials, wood shoes and gun stocks. Both concepts have a place in sustainable agriculture on the Great Plains.

Traditional Forestry

The eastern edge of the Great Plains lies at the western extreme of the central hardwood forest type, and as a result, has many productive hardwood stands capable of producing quality timber. Bottomland forests have developed along many of the rivers and waterways throughout the region. Western forest types extend into the region from the Rocky Mountains. All of these forests would benefit from traditional forest management, increasing the quality and quantity of forestland, and resulting in additional products and income for the landowner.

In most cases, these forest stands occupy sites that are steep, routinely flooded, or otherwise unacceptable for farming. Landowners often classify these lands as unproductive, but in fact they are very productive; the products they produce are just different. With proper information and management, these lands will contribute significantly to the profitability of the agricultural system.

Traditional forestry also offers opportunities on other lands. Many farms have odd corners or areas where traditional agriculture is difficult. The areas are relatively small, access may be difficult, they may be subject to periodic flooding, or the land may be separated from the main field by a creek or drainage. These types of areas are prime targets for small woodlot operations. Small plantings of high quality species may provide greater return on the investment over the long term than traditional agriculture.

More intensive forestry also offers opportunities for those willing to make the necessary investments. Nut plantations of walnut or pecan can help to diversify farm income in eastern parts of the Great Plains. Improved varieties are available to provide the desired quality and levels of production. Christmas tree and nursery stock plantings have high labor inputs but provide additional diversity to the integrated system.

It is important to remember that good trees require good sites. Trees cannot be planted on the poor, dry sites and be expected to produce quality timber. If the choice is made to include production of various forest products within the agricultural operation, it should be remembered that their production will require the same careful management that more traditional crops require.

In some areas fuelwood plantations may offer sizable returns. Plantings of silver maple, honey locust, black locust, green ash, hackberry and other hardwood species can be an asset both to the farm and as an off-farm product. Wood burning furnaces and grain dryers are available at competitive prices. For on-farm uses, the major costs may be off season labor. If the product is to be sold commercially, transportation and marketing costs must be considered.

Several commercial wood-fired boilers are operating or nearing completion within the Great Plains region. At Chadron State College in Chadron, Nebraska, conversion of a natural gas-fired facility to wood will reduce costs by over 40 percent from $1000 per day to just $600 per day. The main source of fuel will be lumber mill wastes (sawdust and scrap) from mills located in the Black Hills of South Dakota. Approximately 12,000 tons of fuel per year will be needed (Alvine, 1990).

At Northwest Missouri State, 65 percent of their steam needs (heat and hot water) are being supplied by woodchips from local lumber mills (Auffert, 1990). They are currently using 12,000 tons of chips per year. A new facility at Peru State College in Peru, Nebraska will require 5,000 tons of hardwood chips per year. While most of these will be coming from local mill wastes, some could also come from fuelwood plantations established for the purpose of supplying chips to the new facility.

Management of forested areas will produce additional benefits. Forested watersheds are one of the major purifiers of runoff water. These ecosystems absorb many of the pollutants that are released into the environment and produce massive amounts of oxygen.

Forested lands provide valuable wildlife habitat. For some landowners, these lands and the associated wildlife may provide an additional source of income. Fee hunting is a growing phenomenon in many parts of the Great Plains. While not universally accepted, as land development continues, it will become increasingly difficult to secure access to quality hunting areas. Those landowners with quality

habitat will have a product for which a market will have developed.

Agroforestry

In general, agroforestry practices have not been as aggressively pursued in the plains region of the United States as they have in other semi-arid areas of the world. The reasons are many, including tradition, but perhaps foremost is our perception of an abundant land resource that does not require optimization of its productivity. Our systems have been designed to maximize the economic return under a variety of government programs and not necessarily optimize the productivity of a particular site. Under sustainable agriculture, this will change. Total productivity and its sustainability will be important, and in this context, agroforestry practices can contribute significantly to overall productivity.

In fact, agroforestry practices are used in Nebraska; they just aren't recognized as such. In northwest Nebraska there are extensive areas of ponderosa pine where timber and grazing are important. Management of the area includes thinning pine stands for improvement of the forage component, but little consideration has been given to the management of the pine timber that remains, and the proper balance of trees and grass has not reached. Unfortunately, the timber is not considered valuable. Only the forage component is considered to have value. If both products were given consideration, the total return to the landowner would be greater than either product alone.

The new wood-fired heating facility at Chadron State could offer opportunities for landowners in the area to improve both their timber stands and forage production. For example, many of the native stands of ponderosa pine in the vicinity of Chadron are over-crowded and in need of thinning. Trees removed in these thinnings could be chipped and used to supply the college requirements. The landowner, the resource, and the local economy would all benefit. The thinned pine stands would be released and growth enhanced. The associated grasslands would respond to the increased light, and forage production would increase. Total productivity of the resource would be increased. The landowner would benefit from the increases in production of both the timber and forage. The local economy would benefit by the additional jobs and income of the individuals involved in the thinning operation and the sale of chips. The college would benefit by a local source of chips.

There are numerous examples of trees being integrated into the agricultural system. Bagley (1988) reviewed some of these and suggested that a set of three parallel, 2-row windbreaks planted at 10 to 15H and harvested on a 6-year rotation would provide both protection and fuelwood. The same concept could be used with Christmas trees or nursery stock. In southwest Missouri, rows of black walnut have been planted on spacings which encourage nut production and which allow soybeans to be planted between the tree rows. The walnut is planted 10 feet by 40 feet. Soybeans and winter wheat are double cropped in the 40 foot strips. Crop yields

decline as the walnut matures, however, nut and timber harvests offset income lost from crop yield reductions (Ritchie, 1987). Some varieties of honey locust have pods with a high sugar content (Williams 1980). Selection of thornless varieties with high sugar content could be located in pasture situations providing feed for livestock. Selected varieties of mesquite also have high sugar content and are suitable for livestock feed (Felker et al. 1980). Again, agroforestry practices require management levels similar to traditional agricultural systems.

Societal Benefits

Historically, agriculture has tended to be self-centered. The consequences of agricultural practices to other parts of the ecological system have not always received the attention they deserved. Times are changing. The move to more sustainable systems reflects the awareness on the part of agricultural scientists that the impacts of agricultural practices on the ecosystem must be considered. The integration of trees into sustainable systems provides significant gains not only to the individual producer, but to society as well. These benefits should also be included as we add up the positive impacts of the role of trees in sustainable agriculture.

Global warming is just one of the environmental problems facing society which could benefit from the integration of trees into sustainable agricultural systems. Brandle et al. (1990) have recently described the potential direct and indirect impacts of shelterbelt planting on global warming. Direct impacts were those associated with the carbon stored in the wood of the trees. Indirect impacts were those associated with the reduction in use of fossil fuels and the reduced carbon dioxide emissions. They estimated that a minimum national shelterbelt planting program would require 4.9 million acres of shelterbelts and would store in excess of 87 million metric tons of carbon dioxide. More importantly, they estimated the indirect savings to be a reduction in carbon dioxide emissions in excess of 526 million metric tons. This is approximately equivalent to the amount of carbon dioxide sequestered in 7.3 million acres of commercial forest land producing 20-50 cubic feet of wood per acre per year.

Summary

Sustainable agricultural practices are being integrated into agricultural systems in the plains region. Trees and forestry have important roles to play in this process.

Windbreaks provide protection for soils, crops, livestock, and people, and enhance their productivity. Woodlands offer valuable products and significant economic returns to landowners. Tree crops such as nuts, nursery crops, fuelwood, and Christmas trees provide valuable product diversification and can be integrated into the production system.

The role of Great Plains foresters is to provide information to assure that trees are recognized as valuable components of sustainable agriculture, and to offer the management skills to facilitate the utilization of trees within the context of sustainable agriculture.

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