AGROFORESTRY: A PROFITABLE LAND USE

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INNOVATIVE AGROFORESTRY DESIGNS: ECOBUFFERS

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Abstract: The predominance of large scale agriculture on the Canadian prairies and the introduction of precision farming technology has led to a noticeable reduction in habitat of marginal lands adjacent to agricultural fields. Removal of existing shelterbelts and a reduction in the number of new shelterbelt plantings is also partially a product of increased field and farm implement size. While improved land management techniques such as zero tillage can help mitigate the negative impact of the loss of shelterbelts, the positive functionality of agroforestry systems cannot be adequately replaced by monocultural farming practices. It is therefore important to target research and development on new agroforestry designs that will fit into modern farming practices. The AAFC Agroforestry Development Centre is conducting research and development on new multifunctional tree planting designs, particularly along field boundaries and riparian zones. The function of the new designs is for multiple purposes including enhancing biodiversity and water quality, conserving soil, biomass production, sequestering carbon and providing economic returns. Three alternative planting designs are being evaluated and demonstrated for their ability to be successfully integrated into current farming systems; ecological buffers (ECOBUFFERS), forest belts and willow buffers. Ecobuffers are a narrow, densely mixed shelterbelt that use native species to mimic natural hedgerows in design and function. Forest Belts are multi species in design, based on traditional plant spacings and willow buffers consist of multiple linear rows of willow cuttings planted in a dense arrangement along riparian areas acting as effective interceptors of nutrients and a source of renewable on farm bio-energy. Only ecobuffers will be addressed in this paper.

Keywords: ecological buffer, new shelterbelt designs, multi-functional, native species, natural hedgerows, habitat, biodiversity, agroforestry design

BACKGROUND

The predominance of large scale agriculture and the introduction of precision farming technology has led to increased field size and a noticeable reduction in marginal habitats within and adjacent to agricultural fields. This has occurred mainly at the expense naturally occurring hedgerows, woodlots and wetlands. In some regions where conservation tillage has reduced the threat of wind erosion there has been removal of planted shelterbelts with the objective of increasing field size to facilitate the use of large equipment. An impact of the implementation of these production system changes is that the role of shelterbelts and hedgerows in agricultural may need to be re-defined

with a conversion to a multi-purpose function that considers carbon sequestration, land and water protection and biodiversity enhancement.

It is well documented in the literature that woody hedgerows, wetlands and small wooded areas present important refuge for native flora and fauna. In Canada three types of woody field boundaries can be found 1) planted shelterbelts, normally consisting of a single row of one species, that were primarily planted for wind erosion control 2) natural woody hedgerows such as those remaining from larger cleared woodlands and left to grow naturally between fields and 3) herbaceous fencerows with few trees and scattered shrubs. The third type is the most commonly found field edge feature found in agricultural landscapes. In the Canadian prairies over 160,000 hectares of shelterbelts, predominately the species caragana and green ash, have been planted since the early 1900's (Schroeder et al. 2008).

The AAFC Agroforestry Development Centre has been conducting research to develop alternative tree planting designs particularly for field boundary planting with the purpose of enhancing biodiversity, conserving soil, protecting water quality and sequestering carbon. Multi-species/row shelterbelts have been used in the United States (Baer 1986) and Europe (Schroeder and Kort 1989) with success. The goal of these plantings was to establish a narrow, dense shelterbelt that captured the site quickly reducing the need for long term weed control. Considering the advantages presented by mixed species shelterbelt designs used in other regions, our goal was to develop a design that resembles natural hedgerows and establishes quickly and will develop into a biologically diverse buffer. The field boundary design being researched by the Centre has been given the descriptive name of Ecological Buffer (Ecobuffer). Ecobuffers are multiple rows of a variety of trees and shrubs in a mixed planting arrangement of trees and shrubs. Ecobuffers could be located anywhere a traditional shelterbelt would be planted or a natural hedgerow may have existed. They can also be used to supplement or rehabilitate existing natural hedgerows or to connect natural habitats such as a wetlands, riparian zones or wooded area. In addition to their ecological function, Ecobuffers could provide a source of wood and non- timber forest products (i.e. fruit, mushrooms).

The fundamental design considerations of Ecobuffers are:

- Consists of a variety of species with different characteristics i.e. thorns, suckering, fast and slow growth, fruiting production, varying flowering periods;
- Trees and shrubs have variable tree and shrub heights to create a layered structure;
- Includes both fast and slow growing trees;
- Includes a minimum of 4-5 shrub species.
- Every 6th plant is a long-lived tree

A variety of tree and shrub species can be used in Ecobuffers, species choice depends on the region and what grows naturally in the area.

Trees

- Mature height greater than 10-20 meters
- A mixture of long an moderate lived species
- Comprises 30 percent of plants in the buffer
- Possible species include: ash, spruce, maple, oak, hackberry, basswood, pin cherry, poplar, aspen, willow, alder, mountain ash

Shrubs

- Mature height of 1 to 5 meters
- Form future understory of the Ecobuffer
- Comprises 70 percent of plants in buffer
- Possible species include: choke cherry, buffaloberry, dogwood, hawthorn, highbush cranberry, native plum, American plum, red elder, willow, nannyberry, hazelnut, snowberry, rose, wolf willow, potentilla, spiraea
- Shorter flowering species are planted on outer rows

PROJECT OBJECTIVES

1. Compare environmental impact of multi-species Ecobuffer design to traditional multi-row shelterbelt design
2. Determine growth and development of tree and shrub species planted in Ecobuffers
3. Provide guidelines for species composition and arrangement in an Ecobuffer design.

METHODS

In the spring of 2004, an Ecobuffer was established using a variety of species arranged in five rows spaced 2.5 meters apart and with 1 meter spacing within the row. Every sixth tree in each row was a tall, long-lived tree. The two outer rows included small shrubs and tall trees, whereas the three inner rows were comprised of tall trees, pioneer trees and tall shrubs. Species were selected for the Ecobuffer based on trees and shrubs found naturally in parkland, boreal or grassland ecoregions. For comparison, a conventional design with three species (caragana, green ash and white spruce) was included. The planting was arranged in a randomized complete block design with four 36 meter long plots per replication.

Prior to planting, a pre-plant herbicide (trifluralin/metribuzin) was applied to the site. Trees and shrubs were machine planted. Weeds were controlled in year one using glyphosate applied with a

shrouded sprayer. At the end of the first growing season linuron was applied as an overall application. No weed control was applied from year two onward.

After five growing seasons, six meter wide transects were set up across each buffer design treatment. Height of all trees and shrubs in the plot were measured and the number of suckering plants with a root collar diameter greater than 7mm were counted.

RESULTS

Species characteristics, after five years is shown in Table 1. Three species rose, choke cherry and especially pin cherry showed strong root suckering tendencies. This characteristic has resulted in dense under story plant communities that have completely captured the buffer floor. Tree and shrub height varied according to species, however height differences of species between designs was not significant. The main difference between the traditional design and ecobuffer designs was species diversity woody plants density (Table 2). This is due to extensive suckering by shrubs in the ecobuffer designs. The ecobuffer designs averaged between 5,059 and 5584 plants per 100 meters of buffer compared to 350 plants per 100 meters for the traditional design. The high density of plants in the ecobuffer did not affect growth or survival of the individual species.

Table 1. Growth characteristics of trees and shrubs

		Design							
		Parkland		Boreal		Grassland		Traditional	
Species	Category	Height[1]	Suckers[2]		Suckers		Suckers		Suckers
Rose	shrub	136	74	139	46	143	78	NP	
Dogwood	Shrub	151	0	152	0	NP[3]		NP	
Buffaloberry	shrub	NP		NP		222	4	NP	
Hawthorn	shrub	144	2	170	1	152	2	NP	
Caragana	shrub	NP		NP		NP		181	0
Choke Cherry	shrub	218	42	214	50	212	38	NP	
Pincherry	tree	250	153	257	181	230	186	NP	
Aspen	tree	230	4	248	1	215	2	NP	
Green Ash	tree	205	0	NP		201	0	187	0
Manitoba Maple	tree	244	0	NP		NP		NP	
White Spruce	tree	NP		49	0	NP		42	0

[1] Height - centimetres
[2] Suckers – number
[3] NP – not planted

Table 2. Plant density in buffer designs

Ecobuffer Design	Trees/Shrubs planted per 100m (0.12 ha)	Trees/Shrubs present per 100m (0.12 ha)
Parkland	500	5059
Boreal	500	5084
Grassland	500	5584
Traditional	350	350

KEY FINDINGS

- Ecobuffers are structurally more complex than traditional multi-row shelterbelt designs. These buffers provide superior habitat for birds, mammals and pollinating insects (Figure 1).
- Tree and shrub growth and survival were not affected by the narrow spacings within the buffer design.
- The traditional shelterbelt design had a higher density of weeds than ecobuffers.
- Ecobuffers resulted in quick site capture eliminating the need for long term weed control

Figure 1. Five year old Ecobuffer

LITERATURE CITED

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